EUMETSAT Satellite Application Facility on
Climate Monitoring

Proposal for the Fifth Continuous Development and Operations Phase (CDOP-5)
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Submitted by:

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1 Executive Summary

1.1 Current Status of the CM SAF

The European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) Satellite Application Facility on Climate Monitoring (CM SAF) successfully established a leading role for sustained climate data record (CDR) and Interim CDR (ICDR) generation and provision within Europe and globally over the past more than 25 years. This includes the capacity to rerun CDRs in order to incorporate the latest scientific developments or corrections and latest user requirements, the traceability of algorithms and CDRs through quality assured documentation and software maintenance, and with this, CM SAF further increased the maturity of its CDRs. For its data records, CM SAF applies successfully the concept of maturity and demonstrates with that the full compliance with the Global Climate Observing System (GCOS) monitoring principles. Furthermore, CM SAF moved towards an operational climate monitoring environment, using the CDR as basis for the ICDRs which are available in short time latency. Already at an early stage, CM SAF has started to move parts of its activities onto EUMETSAT's European Weather Cloud (EWC).

The CM SAF data records are composed of several individual essential climate variables (ECVs), fully documented, carefully validated, doi-referenced (doi: digital object identifier), externally reviewed, and associated methods and results from validation are published in peer-reviewed literature. New versions of the majority of CM SAF heritage data records have been released in the course of CDOP-4 (Continuous Development and Operations Phase 4). New major achievements are the release of the global precipitation data record GIRAFE (Global Interpolated RAinFall Estimation) and regional latent and sensible heat flux data, each an essential component of the energy and water cycle.

An overview of CM SAF products released during CDOP-4 together with an expected status of remaining CDOP-4 product commitments is given in Table 1-1.

Table 1-1: Prospected products status at end of CDOP-4. Product family names are defined at the bottom of the table. TOA: top-of-atmosphere; SEVIRI: Spinning Enhanced Visible and Infrared Imager.

Product families	Prospected Products Status at end of CDOP-4				
	In development	Operational	Released	Discont'd	Backlog
CDOP-4 Activities					
ICDR Regional Clouds and TOA Radiation (CLAAS-4)		x			
ICDR Regional Surface Radiation (SARAH-3)		x			
ICDR Global Clouds and Radiation (CLARA-A3.5)		x			
ICDR Global Precipitation (GIRAFE)		x			
ICDR GEO-Ring Surface Radiation (SARAH-4)	x				x
CDR Regional Clouds and TOA Radiation (CLAAS-4)			x		
CDR GEO-Ring Surface Radiation (SARAH-4)	x				x
CDR GEO-Ring LandFluxes	x				
CDR+ICDR High Resolution Land Surface Temperature, radiation and fluxes (HANNA)	x				
CDR Global Precipitation (GIRAFE R2)	x				

Product families	Prospected Products Status at end of CDOP-4				
	In development	Operational	Released	Discont'd	Backlog
CDR Global Clouds and Radiation (CLARA-A3.5)			x		
CDR Water Vapour, Fluxes, Wind, Clouds over ocean (HOAPS) version 5 Extension			x		
CDR Global Upper Tropospheric Humidity (UTH) R3	x				x
FCDR Microwave Imager R4			x		
No CDOP-3 backlog left					

CM SAF Product Family names	
CLAAS	CLoud property dAtAset using SEVIRI
SARAH	SurfAce Solar RAdiation data set - Heliosat
CLARA	CM SAF Clouds, Albedo and Radiation dataset from AVHRR data
HANNA	High-resolution europeAN surface radiatioN dAta record
GIRAFE R2	Global Interpolated RAinFall Estimation data record, Release 2
GEO-Ring	Large variety of streamlined products based on data from the ring of geostationary satellites
LandFluxes	Meteosat-based product family over land
HOAPS	Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data
UTH R3	Upper Tropospheric Humidity data record, Release 3
FCDR Microwave Imager R4	Fundamental Climate Data Record of Microwave Imager Radiances from SMMR, SSM/I, and SSMIS, Release 4

CM SAF has established and continues excellent contact to various international organisations and research communities. During CDOP-4 CM SAF took over the following responsibilities in international activities:

- Co-chairing of the Global Energy and Water Exchanges (GEWEX) Water Vapor Assessment (G-VAP),
- Co-chairing of the Coordination Group for Meteorological Satellites (CGMS) International Cloud Working Group (ICWG),
- Co-chair of the International Satellite Cloud Climatology Project Next Generation (ISCCP-NG) cloud assessment,
- Support to the IPWG/GEWEX precipitation assessment and the ITWG (International Precipitation and TOVS Working Groups).

In addition, CM SAF frequently supports the drafting of GCOS Implementation Plans and WMO (World Meteorological Organization)/C3S (Copernicus Climate Change Service) state of climate reports. Through the engagement of CM SAF partners in research projects, decent contacts with various scientific communities have been established, and in particular also with C3S and European Space Agency (ESA) Climate Change Initiative (CCI) / Climate Space.

A key CM SAF service element is the user help desk to ensure prompt response to user requests related to the usage of CM SAF data. Dedicated training events and user workshops are further important means to support usage of the data and the exchange with users.

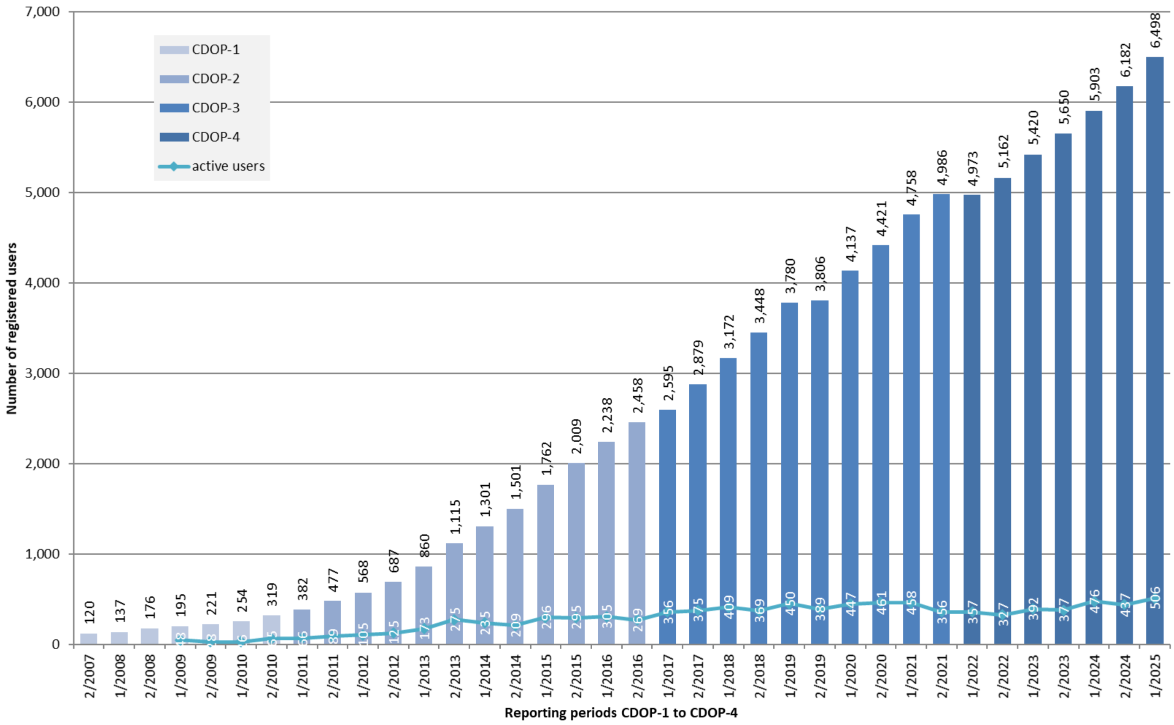


Figure 1-1: Number of registered users since second half of 2007, i.e., start of CDOP-1. A second data line shows the number of active users during the respective reporting period.

Figure 1-1 shows the temporal evolution of the number of CM SAF users and a clear increase in usage (with a rather stable number of active users per reporting period). CM SAF has close to 6,500 unique user registrations from more than 140 countries world-wide (149 different countries at the end of June 2025). It can be noted that the active users remain stable in time since 2017/2018.The majority of users (~48.5%) are from research while ~29% of the users are from National Meteorological and Hydrological Services (NMHSs). The total number of orders is approximately 5,000 / year, with typically slightly more CDR/FCDR orders than ICDR orders (from Operations Report, June 2025). The majority of unique users are downloading CDRs. In the first half of 2025 users from 28 EUMETSAT Member States ordered CM SAF data. Over the same period users from 12 different EUMETSAT Member State countries had active standing orders, i.e., ordered regular updates. Additionally, users from all Member States have registered for retrieval of CM SAF products via the EUMETCast service.
Example operational applications include the utilisation of CM SAF data in WMO RA (Regional Association) VI context, in the WMO/C3S European State of the Climate, in PVGIS (Photovoltaic Geographical Information System) at the EC's JRC (European Commission's Joint Research Centre), and in national climate monitoring activities (e.g., at Deutscher Wetterdienst - DWD, at MeteoSwiss and in preparation at the Met Office). The strong increase in number of users of CM SAF products demonstrates the overall success of CM SAF. It is anticipated that the number of users will continue to increase.
Over the course of CDOP-4 (2022-2024) CM SAF data has been used in more than 200 peer-reviewed publications, including publications by CM SAF and from third parties. Specific

highlights include the use of CM SAF data in IPCC AR6 (Intergovernmental Panel on Climate Change 6th Assessment Report) chapter 2, in the BAMS (Bulletin of the American Meteorological Society) State of Climate in 2021.

Almost 20 publications with CM SAF co-authorship were cited in IPCC AR6 chapters and an additional approximately 25 publications cited CM SAF data.

CM SAF is in close contact with its users. Various feedback mechanisms are in place: help desk with committed response times, dedicated CM SAF User Workshops and training activities, also in cooperation with EUMETSAT as well as topical workshops, surveys, and the invitation of users to CM SAF reviews. A very important aspect is the direct personal contact to various users. CM SAF demonstrated at various occasions that user feedback is taken seriously and led to changes of plans/improvements of the products in order to optimally address the user request.

A few examples of CM SAF product usage and results are mentioned here to give an impression of the fairly wide range of product usage:

- The CM SAF HOAPS 4 total column water vapour CDR features in Figure 2.14 of Chapter 2 of the IPCC AR6 WG1 report (Gulev et al., 2021). The related conclusion is: “positive trends in global total column water vapour are very likely since 1979 when globally representative direct observations began, although uncertainties associated with changes in the observing system imply medium confidence in estimation of the trend magnitudes”.
- Sveriges Meteorologiska och Hydrologiska Institut (SMHI) uses surface incoming solar radiation from CM SAF CLARA to support climate monitoring in Sweden (Normal-Maps — SMHI).
- Koninklijk Nederlands Meteorologisch Instituut (KNMI) is using CM SAF data (SARAH, cloud fraction from CLARA) for climate monitoring, also on global scale (Climate Explorer: Starting point).
- The CM SAF microwave imager FCDR will be assimilated into the upcoming ECMWF (European Centre for Medium-Range Weather Forecasts)/C3S ERA6 (ECMWF reanalysis v6, as its previous version was input for ERA-5).
- The CM SAF land surface temperature data from LandFlux v2 is combined with other data to carry out drought monitoring over Switzerland (https://www.trockenheit.admin.ch/de).
- Various CM SAF products are used by the WMO Regional Climate Centre on Climate Monitoring for the region VI, in particular surface albedo from CLARA (RCCCM - Deutscher Wetterdienst - Monthly, seasonal and annual products).
- CM SAF data is regularly used in the C3S European State of the Climate (ESotC): since 2018/2019 sunshine duration from SARAH and cloud fraction from CLARA are used annually. Results based on CM SAF data and published in the most recent ESotC, i.e., for 2024, are shown in Figure 1-2. A high degree of consistency between sunshine duration and cloud fraction is observed. Also, a distinct east-west separation between positive and negative anomalies is present in 2024, with spring having largest anomalies in sunshine duration.

- CM SAF published a series of new and updated climate data records and associated peer-reviewed publications, among them, Karlsson et al. (2023), Riihelä et al. (2024) on CLARA-A3, Benas et al. (2023) on CLAAS-3, Pfeifroth et al. (2024) on SARAH-3 and Konrad et al. (2025) on GIRAFE v1.

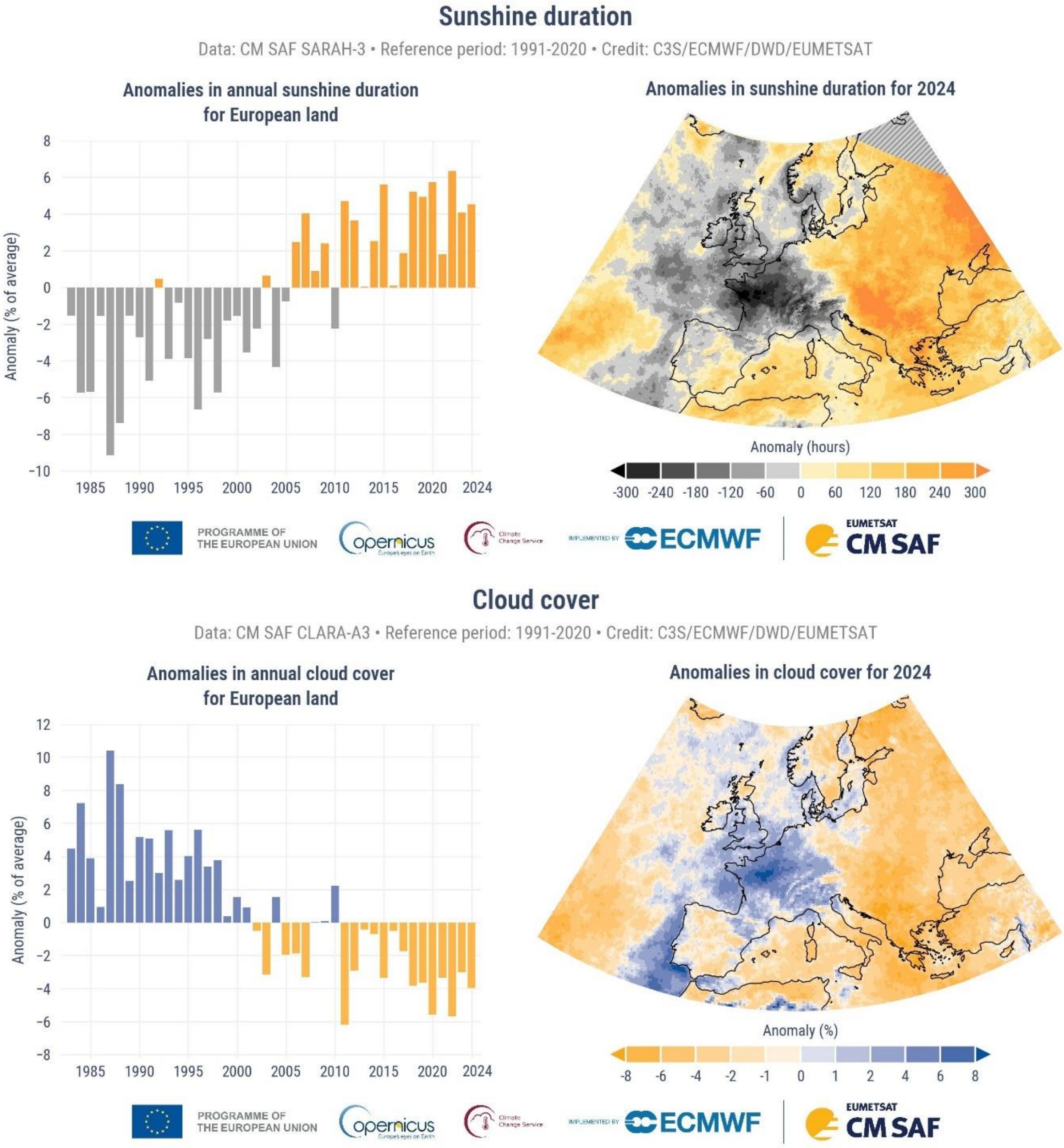


Figure 1-2: Top panels – Relative annual sunshine duration anomalies for Europe, showing positive (orange) and negative (grey) anomalies. The anomalies are for land areas only and expressed as a percentage of the average (left). Sunshine duration anomalies over Europe for 2024, showing positive (shades of orange) and negative (shades of grey) anomalies. Grey hatching in the top right corner of the map indicates missing data. All anomalies are relative to the average for the 1991–2020 reference period and based on the CM SAF SARAH-3 CDR and ICDR. Bottom panels: Similar to the top panels but for cloud cover, based on the CM SAF CLARA-A3 CDR and ICDR. Credit: C3S/ECMWF/DWD/EUMETSAT. Source: 13. Clouds and sunshine | Copernicus.

Over the course of CDOP-4, the following main adaptations of CM SAF commitments were implemented:

- CM SAF considers the CDR and ICDR as a unique element, i.e., CDR and ICDR data are combined into a single Data Object Identifier (doi).
- New Commitment to release a demonstrational data record based on GEO-Ring observations in ISCCP-NG context. A release is expected in late 2025.
- New Commitment to release demonstrational climate normal and anomaly product for SARAH surface solar radiation and sunshine duration. The data is provided to CM SAF beta-users via the EUMETSAT-wide Climate Anomaly and Normal (CAN) service since March 2025 and an official release by CM SAF will occur in early 2026. With this, a new era of CM SAF in support to operational climate services started.

1.2 Concept for CDOP-5

Updated SAF strategy

The updated SAF strategy has been drafted by the EUMETSAT Secretariat based on input from various workshops and Delegate Body meetings. It has been approved by the EUMETSAT Council in summer 2025.

The overarching strategic statement of the updated SAF strategy is:

> ***The success of the SAF Network is defined by the value of SAF products for use in services provided by Member States and in direct use by end users in decision-making.***

All subsequent priorities of the SAF strategy intend to ensure the achievement of this principle.

This updated SAF strategy forms the basis of CM SAF's sustained provision of climate data records and CM SAF's portfolio evolution in CDOP-5 and beyond. The priorities of the SAF strategy and the associated CM SAF products and activities as well as where to find more details are given in Table 1-2.

Table 1-2: Priorities of the updated SAF strategy, the associated CM SAF products and activities and where to find more details.

Pillars of the updated SAF strategy	Section	Workpackage	Products / activities	Comments
Value of CM SAF products for services provided by Member States and for decision making	Sections 2.2.1, 2.2.2, 2.2.4, 2.2.5, 2.2.7, 2.2.8, 2.2.9	WP 5100, WP 5200, WP 5500, WP 5800, WP 5730, WP 5930, 6100 and sub-WP, WP 3110, WP 3120	CLARA-A3.5, CLARA-A4, CLAAS-4, SARAH-4, SARAH-5, GIRAFE v1.1, GIRAFE v2, microwave imager FCDR	sustained service for use in Member States, evolution of CM SAF products – see portfolio management

Pillars of the updated SAF strategy	Section	Workpackage	Products / activities	Comments
	Sections 2.5.5, 2.5.7, 2.4.3, 2.2.3	WP 2400, WP 2500, WP 4300, WP 4500	Use case studies, scientific analysis, climate indicators, COSP simulator	Support to decision making
	Section 2.5.5	WP 1200, WP 2100	Science coordination, user services	User services, science coordination
	Appendix VI			Letters of support
Product usage monitoring	Sections 2.5.1-2.5.7	WPs 2100-2500	All CM SAF products	Product usage monitoring and user engagement
Portfolio management	Section 2.3		Free tropospheric humidity (CM-23722), upper tropospheric humidity (CM-14713)	Discontinued products
	Sections 2.6, 2.2.1, 2.2.2, 2.2.6, 2.2.8, 2.4.1, 2.4.2, 2.5.7	WP 3130, WP 7010-7050, WP 5300, WP 5400, WP 4100, WP 4200, WP 2500	CAN products, HANNA, GeoRing, merging of data from geostationary and polar orbiting platforms, high resolution precipitation, climate indices	New products, preparation for new products in response to needs by services in Member States
Innovation Layer	Sections 2.4.6, 2.4.2, 2.6.3, 5	WP 4600, WP 4200, WP 3200	Uncertainty estimation, high resolution precipitation, cloud ready software at EWC, overview of ideas for the Innovation Layer	
CDOP mid-term reviews	Sections 1.3, 2.5.4, 2.5.6, Annex III	WP 2100, WP 2300, WP 5110, WP 5210, WP 5310, WP 5410, WP 5510	Product usage monitoring, (expert) workshops inform MTR, all requirements reviews prior to MTR	See also figure 1-6
Data processing at cloud infrastructures	Sections 2.6.3, 5	WP 3200	Cloud ready software at EWC	
EU funded SAF activities		WP 1100, WP 1200	Support to the EUMETSAT Sec. on identification of SAF products with potential for contributing to EU programmes and on the integration of SAF expertise in EUMETSAT - EU contribution agreements when requested	CM SAF has a strong interest to support the EU with dedicated products.
SAF funding strategy	Section 4			key CM SAF objective: sustained service (see also *Value of CM SAF products*); of similar relevance: use emerging opportunities and prepare tailored

Pillars of the updated SAF strategy	Section	Workpackage	Products / activities	Comments
				products according to new or evolving user needs (see also *Innovation Layer*)
Software licensing flexibility				Not relevant for CM SAF as no software packages as deliverables

CM SAF mission

> ***The EUMETSAT Satellite Application Facility on Climate Monitoring develops, generates, analyses, archives, distributes, and promotes high-quality satellite-derived products of the energy budget & water cycle in support to monitor, understand and adapt to climate variability and climate change and its impact at global and regional scale.***

CM SAF vision

In recent decades, climate variability and change have caused impacts on natural and human systems on all continents. High quality observations are needed to understand and document these interactions of the climate system. These are increasingly based on remote sensing from satellites, which offer global-scale and continuous coverage.

Only long-term and consistent observations of the Earth system allow us to quantify impacts of climate variability and change on the natural and human dimension. Also, a global view is required to better understand the impact of climate change and variability at local scale. From this understanding one can estimate and eventually predict future states of the Earth system and quantify its vulnerability and resilience to continuing anthropogenic forcing at various scales.

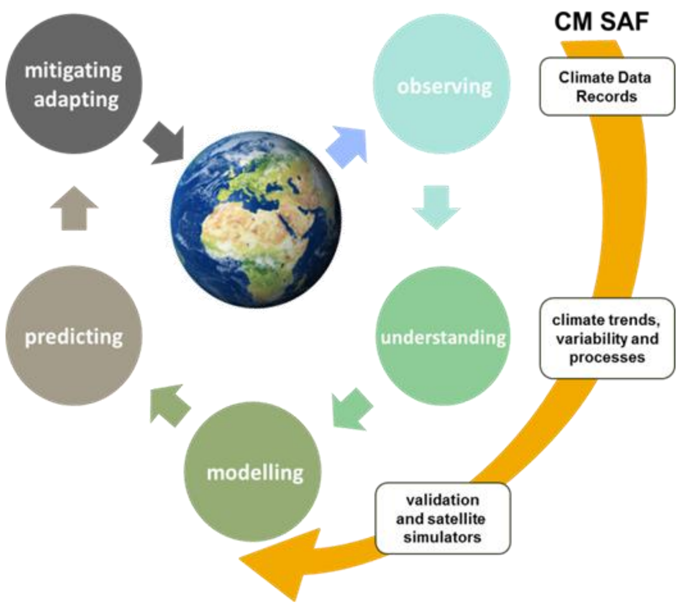


Figure 1-3: CM SAF role in climate monitoring and research.

With accurate climate predictions one can help to decide on adaptation and mitigation strategies, to protect our living planet and to secure socio-economic welfare.
The CM SAF contributes in particular to

- the observational part by contributing relevant data records,
- the understanding by supporting process studies, climate trend and variability analysis,
- the (climate) modelling part by providing data records for initialisation, assimilation and evaluation, as well as by the provision of satellite simulators.

In order to ease subsequent reading the following product types are briefly introduced:

- CDR (climate data record): consistently reprocessed data record with high quality for climate applications.
- ICDR (Interim CDR): consistent temporal extension of a CDR to present time, ideally using the same processing set-up as for the CDR.
- Climate normal: monthly means over the 30-year WMO reference period, based on a CDR.
- Climate anomalies: difference between ICDR and climate normal.

Subsequently, the term climate is dropped in normal and anomaly context, as all CM SAF products in this context are based on CDRs and ICDRs.

CM SAF objectives

CM SAF continues to develop capabilities for a sustained generation and provision of CDRs derived from operational meteorological satellites. The ultimate aim is to make the resulting data sets suitable for the analysis of climate variability and the detection of climate trends. To achieve this goal, CM SAF works in close collaboration with the EUMETSAT Secretariat and other SAFs and liaises with other satellite operators to advance the availability, quality, and usability of FCDRs. CM SAF will utilize these FCDRs to produce records of ECVs as defined by GCOS. Thematically, the focus will be on ECVs associated with the global energy and water cycles and budgets and strong modulators thereof.

CM SAF is supporting climate services at NMHSs, at European level (e.g., C3S) and globally (e.g., WMO) with long-term data records at high spatial resolution for local applications, but also with data sets produced with low latency that can be used to prepare monthly/annual updates of the state of the climate. Both types of products together allow for a consistent description of mean values, climate normals and anomalies, extremes, variability and potential trends for the chosen ECVs. CM SAF ECV data sets further serve the improvement of climate models, both at global and regional scale, as well as training data sets for AI applications. Relative to climate services at national and European level, CM SAF provides near global, satellite-based climate products and with this, complements reanalysis-based climate services at, e.g., European level and allows a spatially homogeneous climate service also beyond national border. I.e., CM SAF provides an alternative data source for national and European services. With an increasing decline of station-based observations CM SAF also started to fill this gap by developing prototype solutions through the combination of satellite-based CM SAF products and ground-based observations.

To ensure continuous services, CM SAF is preparing for the next generation of satellite systems, e.g., MTG (Meteosat Third Generation), EPS-SG (EUMETSAT Polar System – Second Generation), EPS Sterna and other innovative opportunities such as output from consistent reprocessing of GEO-Ring data and first efforts towards combined archives of GEO-Ring and polar orbiting data.

As an essential partner in the related international frameworks the CM SAF - together with the EUMETSAT Secretariat, assumes the role as implementer of EUMETSAT's commitments in support to global climate monitoring. This is achieved through:

- Application of the highest standards and guidelines as outlined by GCOS for satellite data processing,
- (Re-)Processing of satellite data within a true international collaboration benefiting from developments at international level, pollinating the partnership with own ideas and standards,
- Improvement and intensive validation of the CM SAF CDRs, also taking into account the evolution of user requirements,
- Optimized/tailored products and services for consideration in operational services at NMHSs of EUMETSAT Member States, WMO and C3S and at regular scientific assessments such as by IPCC, World Climate Research Programme (WCRP) and similar,
- Further optimized dissemination, e.g., by more direct and standardised access, by APIs, and by seamless and streamlined products in cooperation with other SAFs, supporting the Earth system approach of WMO and WCRP.
- Taking a major role in data set assessments performed by research organisations such as WCRP,
- Maintaining and providing an operational and sustained infrastructure, via the EWC, that can serve the community with the transition of mature CDR/ICDR products from the research community into operational environments.

By being connected to both the operational and research communities that provide climate services to the public and perform climate science, CM SAF continues to play and further strengthen its leading role for sustained CDR+ICDR production and provision within Europe. In particular, CM SAF is prepared for a leading role for all SAFs on how to develop and provide CDRs.

The following outline guides CM SAF's considerations for the evolution of its products, services, and major tasks. Conclusions from this outline, in bullet form, are given in Section 1.3.

Although the CM SAF user community is diverse, CM SAF distinguishes between three main user application areas:

- Global and regional climate analysis, including IPCC and WCRP lighthouse activities as well as energy and water cycle studies. This group has a dedicated need of highest-quality long-term climate data records from several ECVs.

- Regional and global climate modelling and reanalyses efforts. As above but this user group also has a dedicated need for more recent data, with high quality and resolution.
- Support to (operational) climate monitoring and climate services in NMHSs worldwide and in international organisations/programmes, in particular activities under WMO auspices and the C3S. Here a strong need for consistent and stable data records and associated anomalies as well as a need for more recent data are expressed.

It is clear that this classification is not always unique nor exclusive, but it provides an overview of the different core requirements from the user perspective. Additional application areas relevant for CM SAF are briefly and non-exhaustively listed below:

- Climate extremes and attribution,
- Climate adaptation,
- Climate reports,
- Input to CM SAF external (climate) data records,
- Training data for AI/ML (Artificial Intelligence / Machine Learning),
- Energy meteorology,
- Process studies.

It is planned to continue targeting the three main user groups in CDOP-5 and to be active in approaching additional application areas. In the majority of cases CM SAF data record products are generated to support users from all these application areas. Key application areas per CM SAF product are mentioned in the first subsections dedicated for each CM SAF product family (i.e., in subsections 2.2.1 to 2.2.9).
Finally, a key objective of CM SAF is to provide CM SAF products to C3S. Besides their potential value and actual use for C3S tasks around the European State of the Climate, climate indicators, climate intelligence, and more, the inclusion of the CM SAF products into the C3S Climate Data Store is an excellent opportunity to reach the wide user community of C3S.

CM SAF is embedded in a sustained funding scheme, with a planning horizon well into the 2030s, largely utilizes operational satellites and bases its service in an operational (processing) environment. This ensures a long-term planning horizon on the user side as well, and makes reliability, continuity and sustainability key assets of CM SAF. Thus, a strong focus of CM SAF is to continue generating the majority of heritage CM SAF CDRs and ICDRs, with global and regional coverage.

Following the updated SAF strategy dedicated developments are planned that target the support of climate services at NMHSs, in particular of EUMETSAT Member States.

This is guided by the following considerations:

- *Satellite-, ground-based and reanalysis data*

Advantages of ground-based observations are among others high quality and long-term temporal coverage. The advantage of satellite observations is spatial coverage beyond borders, with consistent quality, in the same format. Advantages of reanalyses are, among others, the availability of a large variety of ECVs from a single source, in the same format, on the same grid and without gaps. CM SAF will approach climate service units at EUMETSAT Member States to promote the availability of existing data records from CM SAF and to better understand the requirements which would allow a usage of CM SAF data (if not done so far) and identify means to address them. This will be supported by results from use case studies showing the value of CM SAF data in user relevant application areas and preparing pre-operational software solutions. The latter was pioneered by blending satellite-based CM SAF with ground-based sunshine duration data by the MetOffice within a CM SAF use case study.

- *Climate reports and assessments*

Contributions to regular reporting with relevance for decision making and supporting high level climate monitoring, services as well as science is an important user category for CM SAF. This includes climate monitoring (e.g., C3S, WMO RA VI), contributions to BAMS State of Climate, WMO and C3S (European) State of the Climate, bulletins and reports on climate at NMHSs, IPCC ARs, consideration in WCRP activities and more. With continued, scientific analysis of CM SAF products and other data and the objective to publish results in relevant journals, the value of CM SAF data will be promoted, also with the objective to further increase the uptake of its products in this context. A specific focus will be on the validation and analysis of extremes and dedicated regional analysis at climate change hot spot regions such as the Arctic. Also, CM SAF will further improve the uptake of its data and results in these assessments and reporting through direct contact to people involved in the associated drafting.

- *Global coverage with local focus*

Extreme events usually have a local impact on humans and prosperity. Due to climate change these events occur more frequently and more intensively at least in some regions of the Earth. Thus, it is important to monitor and understand the interplay of climate change, large scale climate variability and specific local conditions. To support this global (and/or regional) data records with high temporal and spatial resolution are required. Such data records and associated scientific analysis aims at supporting IPCC, BAMS, WMO, C3S and other cross-regional institutions. It is anticipated that also at national level cross-regional and even global data are relevant. In addition, global data records with high resolutions can be used to support national interests abroad and long-term planning of companies such as insurance companies.

- *Climate normal and anomalies*

Since the early 2020s CM SAF CDRs cover the WMO reference period for the computation of climate normal and thus, also allows for the computation of climate anomalies. Consequently, CM SAF started the generation and provision of demonstrational climate normal and anomalies products. On 8-9 June 2022 EUMETSAT hosted a user workshop on “Shaping the future – EUMETSAT support to Climate Services”. EUMETSAT users, in particular also from EUMETSAT Member States, stated the need for satellite-based climate normal and anomalies from EUMETSAT. The workshop report, dated 30 January 2023, includes the recommendation to consider a “pathfinder project” on developing a “Climate Anomaly Service” and “Climate Normals”. In response to this recommendation the EUMETSAT Task Team on Climate Anomalies and Normal (TT-CAN) was initiated. All SAFs involved in climate monitoring, including CM SAF, the EUMETSAT Secretariat and C3S are members of the TT-CAN. In addition, EUMETSAT implemented a CAN tool to allow user-driven visualisation of and access to normal and anomaly data. The beta-version was recently released to NMHSs in EUMETSAT Member States and received very positive feedback, among others, that the service is in-line with needs of national climate services. Various recommendations for further development were made, among others, it was stated to include a fairly large variety of additional parameters, including clouds, land surface temperature and precipitation and additional layers, such as minimum and maximum values. CM SAF is closely cooperating with the other SAFs and the EUMETSAT Sec. (Secretariat) via TT-CAN and provides its products to CM SAF users also via the EUMETSAT-wide CAN service.

This CAN service is entirely based on satellite-based products from the SAFs and the EUMETSAT Sec. with near global or Meteosat-disc coverage. It complements services at national climate services who frequently rely on national, station-based data records and the C3S service that presently largely relies on output from reanalyses. CM SAF CAN data may serve as key input for services at national climate services and at C3S. Representatives of C3S are members of TT-CAN to support ensuring either complementarity or consistency between the EUMETSAT CAN service and C3S's Climate Atlas.

During CM SAF User Workshops, expert meetings and personal communication the following key feedback from users was frequently given:

- Provision of normal and anomalies,
- Products with higher spatial and temporal resolution,
- Provision of AI/ML ready data,
- Provision of data in obs4MIPS (Observations for Model Intercomparisons Project) context to ease use in climate model validation context,
- Stronger focus on scientific analysis and related publications in peer-reviewed journals,
- Improved guidance to better find the appropriate data record in need.

The society and the industry increasingly rely on sustainable energies. A specific field in this context is energy-meteorology and CM SAF continues to support this field with dedicated, high-quality surface radiation data records. These data are expected to be taken up by national (e.g., NMHS) as well as international organisations (e.g., European Union - EU) to provide guidance and advise to commercial and governmental users and the public. The data uptake has already grown substantially over the last years and is expected to continue to grow with the continuous expansion of solar energy installations and the overall energy transformation in Europe. An improved and dedicated data provision by CM SAF for solar energy applications is considered. Further key sectors will be identified. Potential additional sectors are agriculture and forestry. CM SAF can support these sectors with data (Land Surface Temperature - LST, cloud cover, surface radiation, precipitation and more) and via dedicated indices, in close cooperation with LSA SAF (Land Surface Analysis SAF) which has a long-standing history in this application area.

The key objective, stated in the new SAF strategy, is: “The success of the SAF Network is defined by the value of SAF products for use in services provided by Member States and in direct use by end users in decision-making”.

Consequently, CM SAF increases its efforts to monitor product usage in Member States and to monitor publications using CM SAF products with potential or approved relevance for policy making. Until recently an analysis of the number of orders and users was in the focus. In addition, CM SAF started to screen webpages and approached users via email and via personal communication to identify explicit product usage. Associated descriptions, links to application, and evidence for CM SAF product usage are collected in product usage overview tables. This also includes links to publications with potential relevance for policy making - potential, as it is not known in advance if it will be considered in future IPCC, BAMS SoC, and similar assessments with policy making relevance. Besides the fact that CM SAF only made a start it is very likely that now and in the future existing applications will be missed as the number of users is fairly large, occasionally CM SAF products are not properly cited, and the response to emails is hesitant. Consequently, the product usage tables contain examples only. In order to provide a more complete picture CM SAF also presents the number of unique users over the period 2022-2024 (approximately the first half of CDOP-4) per CM SAF product for all users and for users from Member States. These examples and overviews are based on already released CM SAF products. They are provided as an indication for anticipated product usage of the CDOP-5 products. The product usage tables and the figures with number of unique users are shown per product family in subsections of Section 2.2. A key result of the product usage figures is that

- all CM SAF products are used in Member States.

This underlines the CM SAF emphasis on continuity and sustainability in product provision to CM SAF users in Member States.

Note that the number of users from Member States and all customers are only based on orders via the CM SAF WUI. Currently, they do not cover downloads via the Copernicus Climate Data Store, the EUMETSAT Data Store or EUMETCast as statistics from these archives only became available rather recently or in the case of EUMETCast cannot cover the needed information.

Thus, the evolution of CM SAF during CDOP-5 can be summarized as follows:

- Enhance efforts to walk the last mile in support of downstream applications by users,
- Strong commitment related to provision of climate normals and anomalies,
- Strong commitment related to streamlined products from GEO-Ring observations,
- New developments and commitments related to higher-resolution products over Europe,
- Activities related to the preparation of combined/merged products from geostationary and low-Earth orbiting satellites,
- Foster utilisation at national, European, and WMO climate services and closer monitoring of product use cases,
- Foster utilisation with NMHSs and Copernicus C3S
- Intensified cooperation with H SAF, LSA SAF, and NWC SAF on various aspects.

1.3 Overall CDOP-5 logic

CM SAF's objective is to generate and release satellite-derived products related to the energy budget & the water cycle. This is illustrated in Figure 1-4. Apart from incoming solar radiation and consequently energy absorbed in the atmosphere all parameters are available or can be directly derived from CM SAF products:

- Surface solar radiation (SIS)*
- Surface albedo (SAL)
- Surface downwelling longwave rad. (SDL)*
- Surface radiation budget (SRB)
- Surface net shortwave rad. (SNS, identical to solar absorbed surface in Figure 1-4)
- Surface net longwave rad. (SNL)
- Outgoing longwave radiation (OLR)*
- Reflected solar radiation (RSF)*
- Latent and sensible heat flux (LEH)*

All above parameters, except the fluxes, are elements of the CM SAF product CLARA (see Section 2.2.1). Those marked with an asterisk are also available in the near global coverage CM SAF product GEO-Ring (see Section 2.2.3).

An overview of the water cycle storage and fluxes is given in Figures 1 and 2 in Dorigo et al. (2021). The following CM SAF products are of direct relevance to the water cycle storage and fluxes:

- Precipitation over land and ocean (GIRAFE, see Section 2.2.8)
- Evaporation/evapotranspiration over land and ocean (GEO-Ring, HOAPS, see Sections 2.2.3 and 2.2.7)
- Total column water vapour (HOAPS, see Section 2.2.7)

Finally, all additional CM SAF products are strong modulators of the energy and water cycle, are elements of GCOS ECVs and receive strong user interest. Of particular relevance are:

- Cloud products (e.g., in CLARA)
- Land surface temperature (e.g., in GEO-Ring)

Adapted from Wild, M., Bosilovich, M.G. The Global Energy Balance as Represented in Atmospheric Reanalyses. Surv Geophys 45, 1799–1825 (2024). https://doi.org/10.1007/s10712-024-09861-9

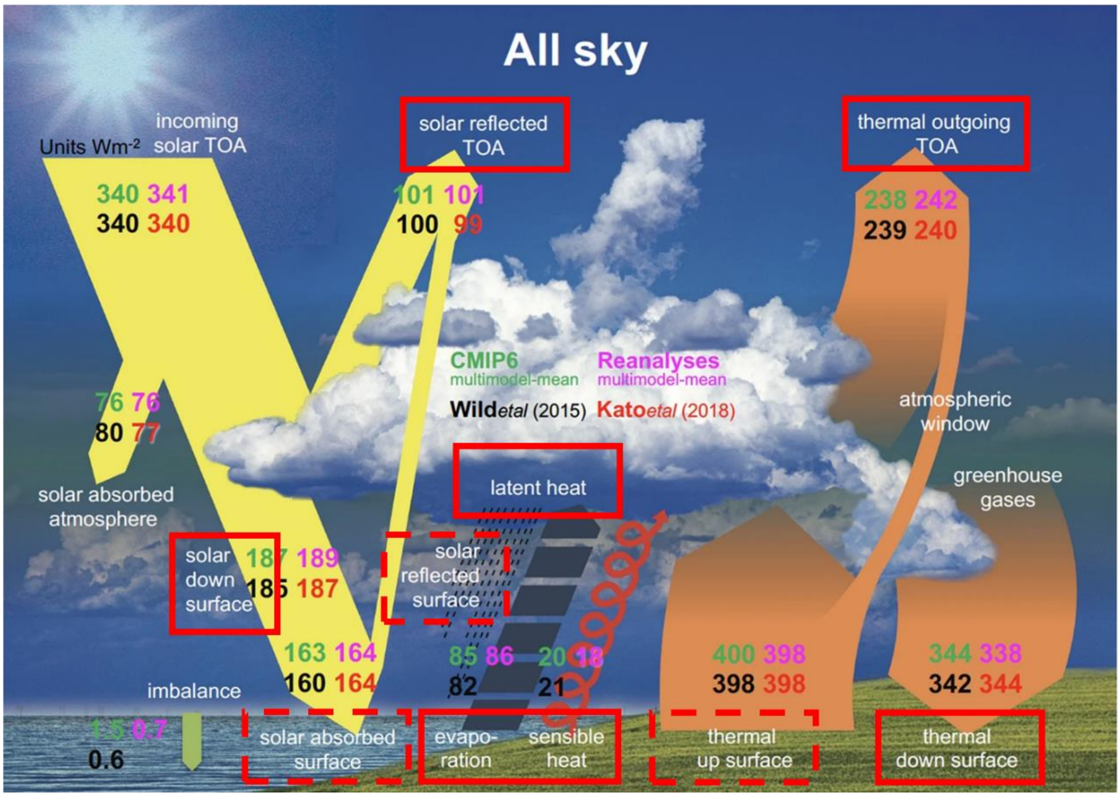


Figure 1-4: Global energy cycle (figure adapted from Wild and Bosilovich, 2024). Parameters marked with red boxes are available from CM SAF. Dashed boxes can directly be derived from available CM SAF products: solar reflected surface and thermal up surface can be computed from SNS and SIS as well as SNL and SDL, respectively while solar absorbed surface is actually identical with SNS. The figure is used for illustration only.

CM SAF responds to the considerations presented in Section 1.2 by fostering the cooperation with other SAFs and the EUMETSAT Sec. to work towards and by focussing on:

- Continue the generation of the majority of CM SAF CDRs and ICDRs, with global and regional coverage and more systematically provide CDRs and associated ICDRs or seamless RT data,
- Continue user engagement activities (workshops, training, etc), user support services (e.g., help desk), and support provision of CM SAF data to C3S,
- Further improve the CM SAF service related to ready to use climate data, e.g., high-level products such as climate indices, enhance the provision of climate normals and anomalies, provide Level 4 climate data, e.g., averages per Member State and ease the use in climate model evaluation via the WCRP ESMO (Earth System Modelling and Observations) obs4MIPs framework, i.e., walk the last the mile,
- Approach streamlined CDR production, i.e., optimise the number of CDRs in common format and on common grid, and seamless CDR, ICDR, and RT products, also via joined products with other SAFs,

- Identify means to avoid or fill gaps in the data records,
- Support the use of CM SAF data in blending ground-based and satellite data,
- Perform use case studies showing the value of CM SAF data in user relevant application areas and preparing pre-operational software solutions and dedicated scientific analysis, with the objective to publish results in peer-reviewed literature, with relevance for IPCC, BAMS SoC, and similar,
- Continue and enhance networking to align with and benefit from European and international developments. Besides SAFs, the EUMETSAT Sec., and C3S this includes regular exchange with ECMWF, groups and projects within WCRP and CGMS, ESA CCI / Climate Space projects such as Clouds, LST as well as Water Vapour, and more,
- Continue to be engaged in regular data record assessments and take leading roles in international efforts,
- Support to WMO State of Climate reports, WMO/C3S European State of Climate report, WMO report on water resources and more,
- Review usage of CM SAF data and its impact annually and establish a user feedback data base,
- Work towards improved spatial and temporal resolutions,
- Further improve uncertainty estimates and work towards harmonisation of how uncertainty estimates are presented,
- Assess consistency and work towards improved consistency with focus on CM SAF data,
- Improve data access: easy and low-threshold access and guidance for users to more easily find the data records in need,
- Strengthen usage of cloud infrastructure (EWC) and usage of EUMETAT Data Store for CM SAF products.

Table 1-3 provides an overview of key CM SAF objectives. The table also shows where associated activities and commitments can be found in the proposal. If not backed with a work package, elements discussed in section 5 (Vision of CM SAF bexond CDOP-5) are not mentioned here. It is noted that all elements in section 5 can be tailored to CM SAF objectives.

Table 1-3: Overview of CM SAF objectives for CDOP-5, the associated CM SAF products and activities and where to find more details. NWC SAF: Support to Nowcasting and Very Short-Range Forecasting SAF; CMIP: Coupled Model Intercomparison Project; COSP: CFMIP Observation Simulator Package; WGORC: Working Group on Observations for Researching Climate.

#	Objective	Product family, CM SAF activity	Information on where to find its implementation		
			WP number	Section	Comments
1	**Continuous, reliable, sustained provision of climate data to CM SAF customers**	CLARA-A3.5, CLARA-A4, CLAAS-4, SARAH-4, SARAH-5, GIRAFE v1.1, GIRAFE v2, microwave imager FCDR	WP 5100, WP 5200, WP 5500, WP 5800, WP 5730, WP 5930, 6100 and sub-WP, WP 3110, WP 3120	Sections 2.2.1, 2.2.2, 2.2.4, 2.2.5, 2.2.7, 2.2.8, 2.2.9	HANNA and GEO-Ring are both based on demonstrator developments and releases in CDOP-4; both rely on developments related to mature processing setups in CM SAF, i.e., CLAAS and LandFlux
2	**Enhanced efforts on ICDR generation**	HOAPS v5, GEO-Ring, HANNA, GiRAFE, ICDR processing	WP 5730, WP 5300, WP 5400, WP 5930, WP 3110, WP 3120	Sections 2.2.3 2.2.6, 2.2.7	New ICDRs, improved latency
3	**Improved portfolio w.r.t. ready to use climate data**	CLARA-A3.5, CLARA-A4, GIRAFE v1.1, GIRAFE v2, GEO-Ring	WP 2500	Sections 2.2.1, 2.2.3, 2.2.8, 2.5	Obs4MIPS for climate model validation, ZARR for AI/ML
		GEO-Ring	WP 5400	Section 2.2.3 GEO-Ring	GEO-Ring
		GIRAFE v1.1, GIRAFE v2, CLARA-A3.5, CLARA-A4, SARAH-4, SARAH-5	WP 2500	Sections 2.2.1, 2.2.3, 2.2.8, 2.5	Provide Level 4 climate data, e.g., averages per Member State; Details TBD, also with TT-CAN
		Microwave imager FCDR	WP 5800	Section 2.2.9	Dedicated, additional gridding for ECMWF/C3S and OSI SAF
		GIRAFE v1.1, GIRAFE v2, CLARA-A3.5, CLARA-A4, SARAH-4, SARAH-5, ICDR anomalies	WP 7010, WP 7020, WP 7030, WP 7040, WP 7050 WP 3130	Sections 2.2.1, 2.2.2, 2.2.8	New normals and anomalies from CM SAF
		Use case studies	WP 2500	Section 2.5.5	Prepare climate indices and pre-operational usage at Member States
		Various, prepare merged products from data of	WP 4100	Section 2.4.1	

#	Objective	Product family, CM SAF activity	Information on where to find its implementation		
			WP number	Section	Comments
4	**Streamlined CDR and ICDR products**	geostationary and polar orbits			
		GEO-Ring, HANNA, SARAH	WP 5400, WP 5500, WP 3110	Sections 2.2.2, 2.2.3	Various GEO-Ring products on a common grid and format
		GEO-Ring	WP 5400	Section 2.2.3	Joined products with LSA SAF
		Prepare a high-resolution precipitation product for Europe	WP 4200	Section 2.4.2	Cooperation with H SAF and NWC SAF
5	**Seamless CDR, ICDR and RT products**	GEO-Ring	WP 5400	Section 2.2.3	Joined products with LSA SAF
		LandFlux v1.1	WP 6100	Section 2.2.5	Cooperation with LSA SAF
		GIRAFE v2	WP 5200	Section 2.2.8	Cooperation with H SAF and NWC SAF
		Prepare a high-resolution precipitation product for Europe	WP 4200	Section 2.4.2	Cooperation with H SAF and NWC SAF
6	**Higher spatial and temporal resolution products**	GEO-Ring HANNA	WP 5300, WP 5400	Sections 2.2.3 2.2.6	
		HOAPS 5	WP 5730	Section 2.2.7	HOAPS 5
		Prepare high resolution precipitation data over Europe	WP 4200	Section 2.4.2	
7	**Improved uncertainty estimation**	SARAH-5, HANNA, GIRAFE v1.1, use case studies	WP 2400 WP 2500	Sections 2.5.52.5.7	Independent analysis of stability
		All/selected CM SAF products	WP 1200 WP 4600		Harmonisation of how uncertainties are presented to users
		CLARA-A4, SARAH-5, HOAPS 5, GIRAFE v2	WP 5100, WP 5200, WP 5500, WP 5730	Sections 2.2.1, 2.2.2, 2.2.7, 2.2.8, 2.5.5	
8	**Improved consistency, consistency analysis**	SARAH-4, SARAH-5, CLARA-A3.5, CLARA-A4, GIRAFE v1.1, GIRAFE v2, HANNA, ICDR anomalies	WP 7010, WP 7020, WP 7030, WP 7040 WP 7050	Sections 2.2.1, 2.2.2, 2.2.6, 2.2.8	Consistency analysis prior to product release
		Use case studies	WP 2400	Section 2.5.5	Assessment of consistency following quality control of anomalies

#	Objective	Product family, CM SAF activity	Information on where to find its implementation		
			WP number	Section	Comments
9	**Blending of ground-based and satellite-data**	HOAPS-5, use case studies	WP 2400	Section 2.5.5	Blended windspeed data (optional)
10	**Global coverage with local focus**	CLARA-A3.5, CLARA-A4, GEO-Ring, SARAH-4, SARAH-5	WP 5100, WP 5400, WP 5500	Sections 2.2.1, 2.2.2, 2.2.3, 2.2.8	Global and near global high-resolution products
11	**Implementation of direct user request (e.g., gap filling)**	GIRAFE v1.1, GIRAFE v2 CLARA-A4 HANNA GEO-Ring Microwave imager FCDR	WP 5100, WP 5200, WP 5300, WP 5400, WP 5800	Sections 2.2.1, 2.2.3, 2.2.6, 2.2.8, 2.2.9, also LoS in the Annex	Including gap filling (GIRAFE, CLARA surface radiation), high resolution (HANNA), dedicated gridding (MI FCDR), COSP simulator (GEO-Ring)
		Prepare a high-resolution precipitation product for Europe	WP 4200	Section 2.4.2	High resolution
12	**Support to decision making and (climate) services at Member States, European Union and WMO via use case studies and scientific analysis**	CLAAS-4, CLARA-A3.5, GIRAFE v1.1, HANNA, HOAPS-5, SARAH-4, use case studies	WP 2400	Section 2.4.2	WP on use case studies and scientific analysis
		GIRAFE v1.1	WP 4300	Section 2.4.3	Analysis of extremes
		HOAPS 5	WP 5730	Section 2.2.7	Efforts towards regional high-resolution wind speed data
		GEO-Ring	WP 5400	Section 2.2.3	COSP simulator to allow usage of GEO-Ring in CMIP context
		User services, science coordination	WP 1200, WP 2100	Section 2.5.5	Personal communication, news and highlight stories, contacts to international projects and experts
13	**Support to climate reporting**	SARAH-3, CLARA-A3, ICDR processing	WP 2400, WP 3100	Section 2.2.2	Existing contributions to the C3S ESotC and their continuation, continuation of ICDRs
		GIRAFE v1.1	WP 2400	Section 2.4.2	contact established to co-authors of the WMO report on State of global water resources, objective to foster use of additional CM SAF data records in this context

#	Objective	Product family, CM SAF activity	Information on where to find its implementation		
			WP number	Section	Comments
14	**Engagement in international activities and networking**	GEO-Ring, HANNA	WP 2400	Section 2.4.2	Links to LST_cci
		WCRP support activities	WP 4300	Section 2.4.3	Member of WCRP ESMO WGORC, Co-chairing of G-VAP, Participation in precipitation assessment
		Science coordination	WP 1200		Focal point for international projects and experts
		GEO-Ring	WP 5400	Section 2.2.3	Key contribution to the GEWEX ISCCP-NG initiative, supervised also by CGMS ICWG
15	**Key elements of the EUMETSAT Climate Anomaly and Normal (CAN) service**	GIRAFE v1.1, GIRAFE v2, CLARA-A3.5, CLARA-A4, SARAH-4, SARAH-5, ICDR anomalies	WP 7010, WP 7020, WP 7030, WP 7040, WP 7050 WP 3130	Sections 2.2.1, 2.2.2, 2.2.8	
16	**Increased visibility (multiplier) through inclusion in the Copernicus Climate Change Data Store (CDS)**	CLARA-A3, GIRAFE v1, Support data provision to CDS	WP 2100	Section 2.5	CM SAF intends to provide various additional products and updated versions to CDS
17	**User engagement and product usage monitoring**	All CM SAF products	WP 2100	Section 2.5.6	
18	**Improved data access**	User Services	WP 2100	Section 2.5.2	
19	**Usage of EWC and EDS**	User Services, all processing related activities	WP 2100, WP 3200	Section 2.5.2, 2.6	
20	**Reduce overall funding needs, improve the SAF product portfolio, cooperation with SAFs**	GIRAFE v2, GEO-Ring, HOAPS-5, microwave imager FCDR, LandFlux v1.1	WP 5200, WP 5400, WP 5800, WP 5730, WP 6100	Sections 2.2.3, 2.2.5, 2.2.7, 2.2.8, 2.2.9	See also points 4 and 5
		High-resolution precipitation product for Europe	WP 4200	Section 2.4.2	

Table 1-4 shows an overview of CM SAF products in the European context. Given the combination of key features and main application areas CM SAF products exhibit unique objectives and characteristics relative to other products, and the table shows again how the SAF network intensifies its cooperation.

Table 1-4: Overview of CM SAF products (marked orange) in context of other satellite-based products from within Europe. Focus is on data available from SAF network (marked in "their" color), ESA cci/climate space, and C3S. Products available on request are not included. Though meant to provide a decent overview the table is not claiming completeness. Products from the "list of the level-2 products developed/operated at the EUMETSAT Central Facility" are only listed here if used in climate data record generation context at the EUMETSAT Sec. AC SAF: Atmospheric Composition monitoring; H SAF: Support to Operational Hydrology and Water Management; NOAA: National Oceanic and Atmospheric Administration; NASA: National Aeronautics and Space Administration; GPCP: Global Precipitation Climatology Project; SM2RAIN: Soil Moisture to Rain; GLEAM: Global Land Evaporation Amsterdam Model; OCA: Optimal Cloud Analysis; MSG: Meteosat Second Generation; AVHRR: Advanced Very High Resolution Radiometer; (A)ATSR: (Advanced) Along-Track Scanning Radiometer; HIRS: High resolution Infrared Radiation Sounder; SLSTR: Sea and Land Surface Temperature Radiometer.

Product family	Key features	main application area
Clouds		
CLAAS	Temporal resolution, instantaneous and aggregated data	Climate model evaluation, process studies
GEO-Ring	Temporal resolution, near-global ECV collection, harmonisation with CLAAS	Climate model evaluation, process studies
CLARA	Global, temporal coverage (>50 years) ECV collection, normals and anomalies	Climate services and analysis
HOAPS	Close to an all-sky product, liquid water path only	Climate services and analysis
Cloud mask – MSG** (EUMETSAT Sec.)	Temporal resolution, instantaneous data	(Anticipated) Input to OCA
OCA from MSG, R2*** (EUMETSAT Sec.)	Temporal resolution, instantaneous data, no aggregated data	Input to atmospheric motion vector product, regional reanalysis
Cloud_cci AVHRR (ESA)	Global, temporal coverage (>35 years), ends in 2017	Climate services and analysis
Cloud_cci (A)ATSR (ESA), SLSTR (C3S)	Global, gap between 2012 and 2017	Climate services and analysis
Surface radiation		
CLARA	Global, temporal coverage (>50 years), ECV collection, normals and anomalies	Climate services and analysis
SARAH	Temporal resolution, temporal coverage (almost 50 years), Contributes to GEO-Ring, dedicated PV parameters, normals and anomalies	Climate services and analysis
HANNA	Temporal resolution, spatial resolution	Climate services
Cloud_cci (A)ATSR (ESA), SLSTR (C3S)	Global, gap between 2012 and 2017	
OSI SAF (GOES-E SSI, MET SSI)	Hourly and daily, NRT (near real-time) only, will be discontinued in CDOP 4 or in early CDOP5	Ocean atmosphere studies
LSA SAF (DSSF)	temporal resolution, data available over Meteosat disc since 2004, presently NRT only Closer cooperation between LSA SAF and CM SAF foreseen	Land surface/drought monitoring
TOA radiation		

Product family	Key features	main application area
CLAAS	Temporal resolution, instantaneous data available	Climate model evaluation, process studies
CLARA	Global, temporal coverage (>50 years) ECV collection, normals and anomalies	Climate services and analysis
GEO-Ring	Temporal resolution, full tropics and subtropics ECV collection, harmonisation with CLAAS	Climate model evaluation, process studies
Cloud_cci (A)ATSR (ESA), SLSTR (C3S)	Global, gap between 2012 and 2017	Climate services and analysis
Cloud_cci (A)ATSR (ESA), SLSTR (C3S)	Global, gap between 2012 and 2017	Climate services and analysis
NOAA/NCEI HIRS OLR	Global, temporal coverage (>50 years), outgoing long wave radiation only	Climate services and analysis
Temperature		
GEO-Ring	Temporal resolution, full tropics and subtropics ECV collection, harmonisation with CLAAS, jointly with LSA SAF	Climate model evaluation, process studies
HANNA	Temporal resolution, spatial resolution, normals and anomalies	Climate services
LSA SAF (based on geostationary data)	temporal resolution, jointly with CM SAF (see Section 2.3.3)	Climate services and analysis, land surface characterization and monitoring
LSA SAF (based on polar orbiters)	Global	Land surface characterization and monitoring
ESA (based on various polar orbiters)	Global, no continuous extension available	Climate services and analysis, no ICDR service
Surface fluxes		
GEO-Ring	Temporal resolution, full tropics and subtropics, land ECV collection, harmonisation with CLAAS, jointly with LSA SAF	Climate model evaluation, process studies
LandFlux	Temporal coverage, land	Climate services and analysis
HANNA	Temporal resolution, spatial resolution, land	Climate services
HOAPS	Temporal coverage, ocean, single source for freshwater flux	Climate services and analysis
LSA SAF (MSG)	Temporal resolution, data record available over Meteosat disc since 2004 and NRT service Close cooperation between LSA SAF and CM SAF (see Section 2.3.4)	Land surface/drought monitoring; water management
GLEAM 4.2b	Global, started end of 2025 as element of an ESA project	Climate services and analysis, likely no ICDR service within the ESA project
Humidity		
HOAPS	Temporal coverage, continuous extension, high sensitivity and stability	Climate services and analysis
AC SAF (based on UV sensors)	Global, multi-sensor product planned for CDOP-5	Provision of high-quality data products for monitoring purposes
Precipitation		

Product family	Key features	main application area
GIRAFE	Global, uncertainty estimates, normals and anomalies	Climate services and analysis
H SAF (SM2RAIN)	Combines soil moisture and microwave-based precipitation estimates	Hydrology
H SAF (various)	Temporal resolution, spatial resolution (mainly L2), no reprocessed data yet, 5 years data records in CDOP5, close cooperation between H SAF and CM SAF (see Section 2.3.7 and 2.5.2)	Operational hydrology
GPCP v3.2 (U. Maryland/NASA) via C3S	Global, temporal coverage (>40 years), continuous extension not available since October 2024	Climate services and analysis
Wind, near surface		
HOAPS	Temporal coverage (start in 1987, ocean)	Climate services and analysis
OSI SAF	Various single sensor data (start in 1992, ocean), cooperation between OSI SAF and CM SAF (see Section 2.2.7)	Climate services and analysis, NRT service

* recently became an element of ESA cci Land Evaporation project
** see email attachment provided to SAF management by the EUMETSAT Sec. on 01 October 2025
*** CSDP, EUM/STG-OPSWG/57/25/DOC/16, 13 February 2025

It is CM SAF's objective to consolidate its products portfolio and streamline CM SAF processing chains. A key goal is to increase cost-effectiveness and reduce costs by fully covering and addressing the full range of user requirements in terms of coverage, resolution, accuracy and other more specific requests. Figure 1-5 shows how CM SAF works towards improved harmonization of processing and how the various CM SAF products potentially evolve into a merged product based on geostationary and polar orbiting satellites. The figure shows the CM SAF approach based on the ECV clouds example. Note that one part of the harmonization process is a common software development and processing pool for various processing chains, here for CLARA, CLAAS and Geo-Ring. It applies similarly to surface+TOA radiation, land surface temperature as well as latent and sensible heat flux.

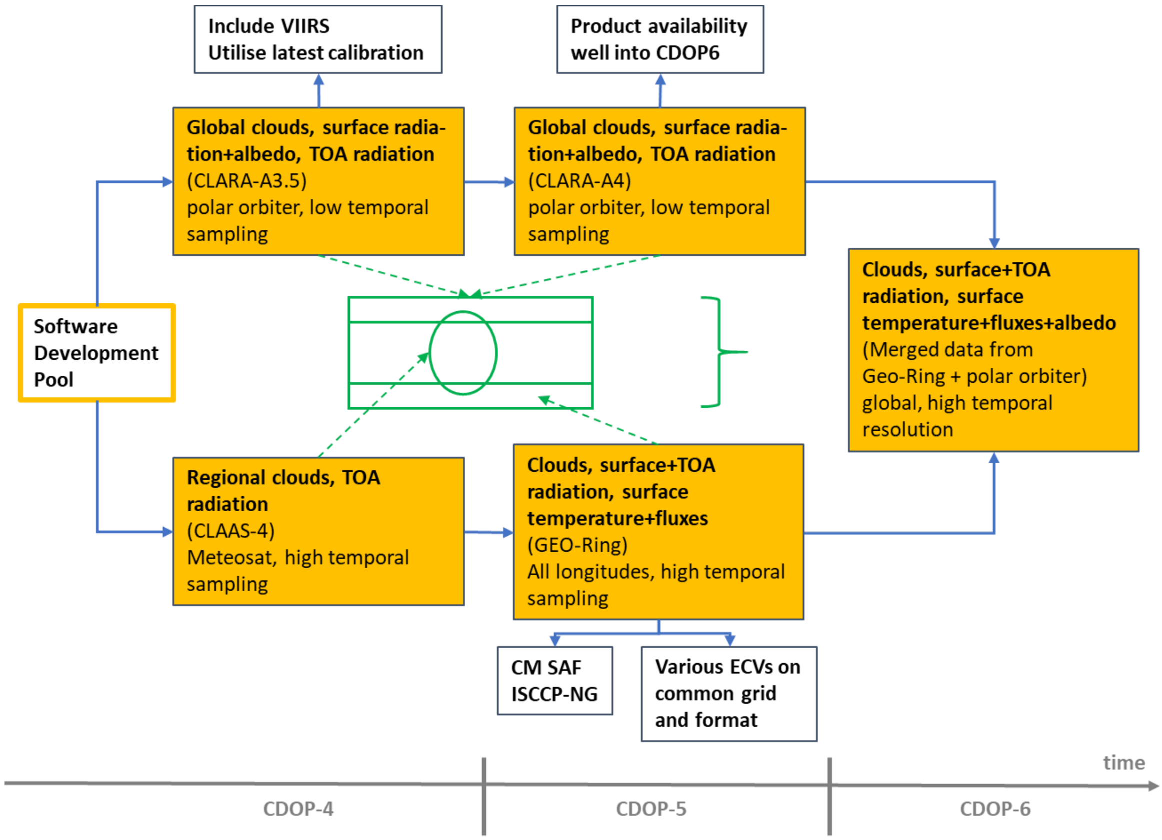


Figure 1-5: Flow chart showing how CM SAF developments and products evolve into a merged product based on geostationary and polar orbiting observations. Orange elements are CM SAF products (filled), with the merged product being an objective for CDOP-6, and a common software pool (blank) and comments are in white boxes. The green element in the centre is a sketch showing the spatial coverage of the individual products. It is noted that the GEO-Ring product family contains more than 10 different products. This example has some focus on the ECV cloud. Boxes filled in orange mark CM SAF committed products and activities. TOA: top-of-atmosphere. VIIRS: Visible Infrared Imaging Radiometer Suite. The box "Software Development Pool" highlights that the retrievals for CLAAS, CLARA and the GEO-Ring have the same origin. It is noted that developments on GEO-Ring products started already in CDOP-4, with a release of demonstrational products in 2026.

Finally, the new SAF strategy introduces a mid-term review as a new SAF element. The overall objective is to "introduce more frequent strategic re-assessments to enable timely integration of innovation opportunities, adaptation to changing needs environments, and more regular engagement with Delegate Bodies on broad strategic SAF objectives and portfolio changes" (from the SAF strategy).

A particular objective is increased transparency of SAF activities to EUMETSAT Member States. Also, it is an additional opportunity to reflect on changes in user requirements from EUMETSAT Member States and adapt CM SAF plans accordingly. In view of the upcoming opportunities and challenges (e.g., Level 1 data from the ring of geostationary satellites, all in one format, on the same grid and in the same resolution, GEO-Ring L1g), merged geostationary and polar orbiting L1 data, various new capacities from modern sensors, the increasing request for higher spatial and temporal resolution products and seamless products) it is planned to carry out requirement reviews related to new CM SAF

products/versions, user workshops and expert workshop <u>prior</u> to the mid-term review. This way the review board of the mid-term review will be optimally informed on the most up-to-date status of request from users and to some extent also on product development status.
CM SAF implemented a flexible and adaptive way to respond to changes in user requests and new opportunities and balancing this with a key asset of CM SAF, that is, reliable and sustained provision of high quality, ready to use climate data. This is graphically illustrated in Figure 1-6. A new element in this approach is the mid-term review. It is noted that some activities are spread over a wider period and exact dates have not yet been defined. Also, product overarching reviews will be carried out. Finally, it is noted that the figure does not list all CM SAF requirements reviews (for increased readability) and focuses on product families that cover all longitudes and complementary parameters (see Figure 1-4 for product family specific key advantages).
A view on Figure 1-5 and Figure 1-6 also showcases that the combination of providing a continuous and reliable service to users, the response to user requirements on higher spatial resolution product (e.g., HANNA), and the advent of new opportunities (e.g., the availability of a GEO-Ring L1g data record in late 2027 and of combined L1 data from geostationary and polar orbits in the early 2030s), leads to an expansion of the CM SAF product portfolio. At the same time both figures illustrate CM SAF's objective to consolidate its product portfolio based on user requests received and clarified during requirements reviews, user workshops, expert meetings and more.

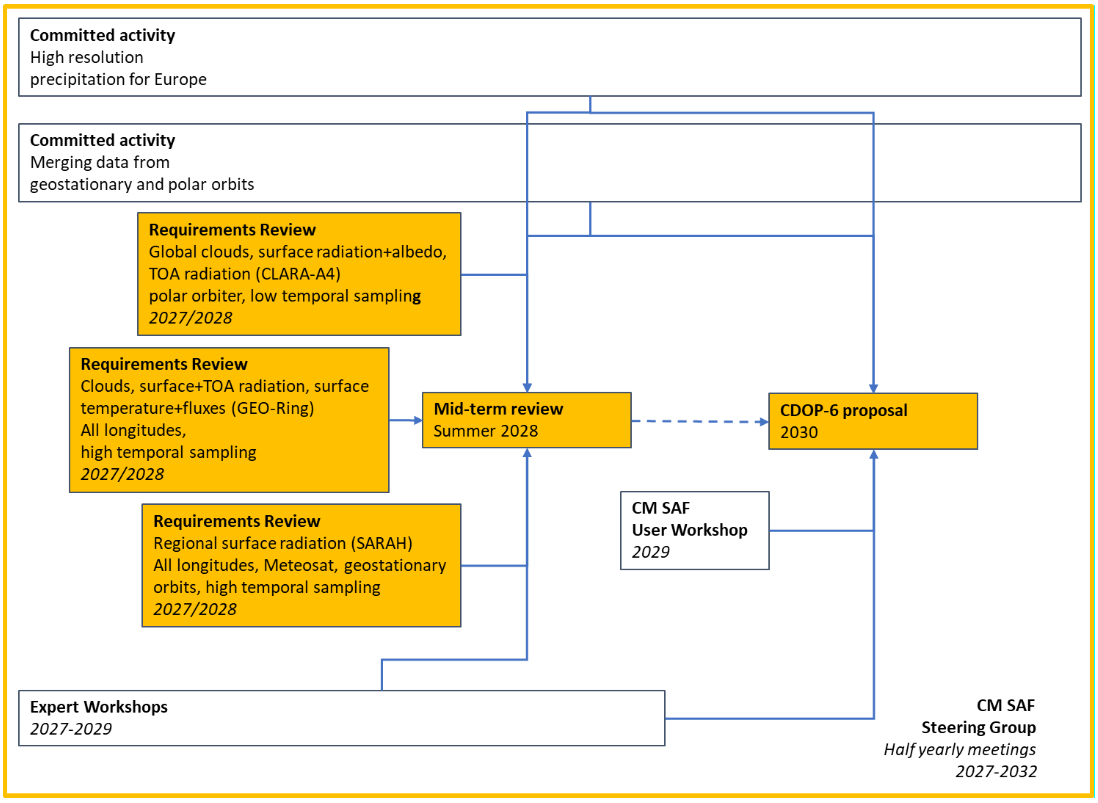


Figure 1-6: Flow chart showing major events in context of replanning of CM SAF activities. Marked in orange are CM SAF Requirements Reviews, the Mid-term Review and CDOP-6 proposal submission. TOA: top-of-atmosphere.

Following the outline above and in section 1.2, CM SAF commits the products and activities listed in Table 1-5 in CDOP-5. Key features of CM SAF products are mentioned as well. The table also clarifies which consistently reprocessed CDRs are seamlessly extended with low latency via ICDRs. Furthermore, for an increasingly large subset of data records, CM SAF offers climate normal, i.e., monthly climatologies covering the WMO reference period (1991-2020) using these CDRs to its users. The anomaly is then the difference between ICDR and normal.

Table 1-5: Summary overview of CM SAF major products, activities and services in CDOP-5. More details on motivations and objectives are given in Table 1-3. HANNA: High-resolution europeAN surface radiatioN dAta record, a new CM SAF product; OSI SAF: Ocean and Sea Ice SAF; SMMR: Scanning Multichannel Microwave Radiometer; SSM/I: Special Sensor Microwave/Imager; SSMIS: Special Sensor Microwave Imager / Sounder, GOES: Geostationary Operational Environmental Satellite.

	ECV		Product types	Key features, main motivation
	Parameter	**Family name**		
Products	Clouds, surface radiation, TOA radiation, surface albedo	CLARA-A3.5, CLARA-A4	CDR, ICDR, normal, anomaly	Global and long-term coverage, wide product spectrum, streamlined products, continuity
	Precipitation	GIRAFE v1.1, GIRAFE v2.0	CDR, ICDR, normal, anomaly	Global coverage, unique (satellite-based, from Europe), continuity, cross-SAF activity
	Clouds, TOA radiation, surface radiation, land surface temperature, latent and sensible heat flux (land)	GEO-Ring	CDR, ICDR	High temporal resolution, near-global coverage, wide product spectrum, streamlined products
	Clouds, TOA radiation	CLAAS-4	CDR, ICDR	High temporal resolution, continuity
	Surface radiation	SARAH-4, SARAH-5	CDR, ICDR, normal, anomaly	High-temporal resolution, long-term coverage, also available on GEO-Ring grid, continuity
	Land surface temperature	LandFlux v2	Normal and anomaly	CAN service for Member States in early CDOP-5, will be replaced by HANNA towards the end of CDOP-5
	Land surface temperature, surface radiation, latent and sensible heat flux (land)	HANNA	CDR, ICDR, normal, anomaly	High temporal and spatial resolution, Europe, requirement from NMHSs in Europe
	Latent and sensible heat flux	LandFlux v1.1	CDR	High temporal resolution, full Meteosat disc
	Water vapour, wind speed, latent and sensible heat (ocean), freshwater flux, liquid water path	HOAPS v5	ICDR	Global ice-free ocean, unqiue (satellite-based, Europe), requirement from altimetry community
	Brightness temperatures from SMMR, SSM/I, SSMIS	Microwave imager FCDR	FCDR	Global coverage, close links to OSI SAF and ECMWF/C3S
Activities	**Type of activity**			
	Prepare merged GEO-Ring and polar orbiter based products			
	Preparing a regional high resolution precipitation product			
	WCRP support activities			
	Microwave Imager Inter-calibration			
	Support to EUMETSAT for FCDR generation			
	Technical Environment EWC			
Se rvi	**Type of services**			
	Data archive & dissemination (Web User Interface, EUMETSAT Data Store)			

	User help desk
	Additional user services and product usage monitoring
	Training and outreach
	Workshops and expert meetings
	Support data provision to C3S
	CM SAF use cases, analysis and support to climate reports

1.4 Consortium structure and responsibilities

Figure 1-7: The CDOP-5 CM SAF consortium.

The CDOP-5 consortium (see Figure 1-7) is composed of the following partners

- Deutscher Wetterdienst (DWD; Leading Entity)
- Finnish Meteorological Institute (FMI)
- Federal Office of Meteorology and Climatology of Switzerland (MeteoSwiss)
- Royal Meteorological Institute of Belgium (RMI)
- Royal Netherlands Meteorological Institute (KNMI)
- Swedish Meteorological and Hydrological Institute (SMHI)
- Met Office, United Kingdom (UKMO)

For CDOP-5 the French partner, Centre National de la Recherche Scientifique (CNRS) which was guiding the successful precipitation activities in the previous CM SAF CDOP phases, withdraw its membership. Following this, all precipitation activities have been taken over by DWD. Independently of a being part of the CM SAF consortium, the CNRS colleagues have agreed to be available for discussions.

The Deutsche Wetterdienst as Leading Entity (LE) of the CM SAF Consortium will sign a cooperation agreement with EUMETSAT and is therefore fully responsible vis-á-vis EUMETSAT. Subsequently, DWD will sign sub-agreements with all consortium partners, which are therefore responsible vis-á-vis DWD for their agreed-upon SAF contribution.

Consortium Partner	Main responsibilities and major activities
DWD	Management, science coordination, user services, processing centre, Development and Validation of FCDRs and CDRs, **New**: Development and Validation of precipitation CDR
FMI	Development and Validation of surface albedo CDR Assessment of CDRs and Use case developments
KNMI	Development and Validation of cloud CDRs
RMI	Development and Validation of top of atmosphere radiation CDRs; Development and validation of surface latent and sensible heat fluxes CDRs

Consortium Partner	Main responsibilities and major activities
SMHI	Development and Validation of cloud CDRs
MeteoSwiss	Development and Validation of land fluxes CDRs, GEO-Ring
UKMO	Use case studies using CM SAF CDRs, including exploration work for the development of new climate indices-based products.

1.5 Summary of Costs and requested funding

The CDOP-5 phase from 1 March 2027 to 29 February 2032 has an overall cost estimate of 17,547,098 EUR based on 2026 economic conditions (e.c.).

Of these overall costs 9,700,000 EUR are expected to be covered by EUMETSAT and 7,847,098 EUR are expected to be covered by the national partners.

Summaries of the planned contributions per partner and the requested funding are shown in Figure 1-8.
All cost categories and the planned expenditures per cost category and per partner are shown in Figure 1-9.

The price given for DWD is subject to VAT. However, EUMETSAT is entitled to use the VAT refund procedure of the Bundeszentralamt für Steuern.

Planned Contributions (EUR, e.c. 2026)			DWD	FMI	KNMI	MeteoSwiss	RMI	SMHI	UKMO		Unallocated
Total Funding		**17.547.098**	**8.892.960**	**1.239.660**	**1.441.773**	**1.154.300**	**1.592.740**	**2.125.686**	**905.980**		**194.000**
EUMETSAT Contribution	55,28	**9.700.000**	4.446.480	619.830	951.570	750.780	796.370	1.487.980	452.990		194.000
1.1) Milestone payments	54,17	9.506.000	4.446.480	619.830	951.570	750.780	796.370	1.487.980	452.990	-	
1.2) Visiting Scientists	0,57	100.000									100.000
1.3) Federated Activities	0,54	94.000									94.000
1.4) User Forum & Promotional		-									
PARTNERS' Contribution	44,72	**7.847.098**	4.446.480	619.830	490.203	403.520	796.370	637.706	452.990		-
2.1) Milestone payments	44,72	7.847.098	4.446.480	619.830	490.203	403.520	796.370	637.706	452.990	-	
2.2) Visiting Scientists	0	-									
2.3) Federated Activities	0	-									
2.4) User Forum & Promotional		-									

890 **Figure 1-8: CM SAF Planned Contributions and requested funding per partner for CDOP-5.**

Planned Expenditures (EUR, e.c. 2026)	Total (mm)	(Eur) %		DWD	FMI	KNMI	MeteoSwiss	RMI	SMHI	UKMO	Unallocated
Total Expenditures	1.084	%	**17.547.098**	**8.892.960**	**1.239.660**	**1.441.773**	**1.154.300**	**1.592.740**	**2.125.686**	**905.980**	**194.000**
MANPOWER (DIRECT, NON-DIRECT LABOR)	1.084	95%	**16.686.499**	8.479.740	1.190.635	1.407.495	1.099.447	1.557.710	2.075.686	875.786	-
1.0) Management	55	5%	857.698	578.848		-	-	-	-	278.850	
2.0) Development	748	69%	11.523.781	5.472.740	701.765	1.136.078	941.107	1.420.265	1.779.906	71.920	
3.0) Operations	93	8%	1.417.882	1.105.073	118.275	58.160	-	78.540	57.834	-	
4.0) User Training	188	17%	2.887.139	1.323.080	370.595	213.257	158.340	58.905	237.946	525.016	
PROCUREMENTS	-	1%	**241.000**	225.000	-	-	10.000	6.000	-		-
1.0) Infrastructure (H/W, COTS,...)		100%	241.000	225.000	-	-	10.000	6.000	-	-	
2.0) Others		0%	-								
OTHER COSTS (e.g. TRAVELS)	-	1%	**169.853**	**58.000**	**25.000**	**15.000**	**20.853**	**14.000**	**24.000**	**13.000**	**-**
VS/FA programmes	-	1%	**194.000**	**-**		**-**					**194.000**
Workshops & Outreach/Publication/Conference	-	1%	**255.746**	**130.220**	**24.025**	**19.277**	**24.000**	**15.030**	**26.000**	**17.194**	**-**

Figure 1-9: CM SAF planned expenditures per partner and category for CDOP-5.

2 Technical Proposal

2.1 Overall CDOP-5 product portfolio

Table 2-1 provides an overview of committed CM SAF products that will be provided to CM SAF users during CDOP-5. New CM SAF products are explicitly marked as well. GIRAFE v1.0, SARAH-4, and CLAAS-4 will become operational already in CDOP-4 / early CDOP-5 and will be continued as ICDRs during CDOP-5 until new versions will replace them. For SARAH-4 and CLAAS-4 CM SAF intends to continuously extend them with the GEO-Ring ICDR. The temporal coverages of all CM SAF ICDRs during CDOP-5 and changes in versions are shown in Figure 2-1.

Table 2-1: Overview of CM SAF products, including the CM SAF product identifiers. The table shows products that will be operational during CDOP-5. New CM SAF products are marked green. No CM SAF backlog products or products already released during CDOP-4 are shown.

Product family	Type	CM ID	Parameter/ECV	Comment
Near global products				
GIRAFE v1.0	ICDR	CM-7610	Precipitation	Operational at start of CDOP-5
GIRAFE v1.1	CDR	CM-25613	Precipitation	New version
	ICDR	CM-7612	Precipitation	New version
	Normal	CM-85613	Precipitation	New product
	Anomaly	CM-8612	Precipitation	New product
GIRAFE v2.0	CDR	CM-25612	Precipitation	New version
	ICDR	CM-7611	Precipitation	New version
	Normal	CM-85612	Precipitation	New version
	Anomaly	CM-8611	Precipitation	New version
MW imager FCDR	FCDR	CM-12006	Brightness temperature (BT)	New version
HOAPS 5	ICDR	CM-6410 CM-6420 CM-6430 CM-6440 CM-6450 CM-6460 CM-6470	Liquid water path (LWP) Total column water vapour (TCWV) Evaporation (E) Latent heat flux (LHF) Freshwater flux (E-F) Near surface specific humidity (q) Near surface wind speed (v)	New product
CLARA-A3.5	ICDR	CM-6012 CM-6022 CM-6032 CM-6042 CM-6052 CM-6062 CM-6212 CM-6226 CM-6227 CM-6228 CM-6262 CM-6272 CM-6282 CM-6292 CM-6322 CM-6332	Cloud fraction (CFC) Joint cloud histograms (JCH) Cloud top parameters (CTO) Cloud phase (CPH) Liquid water path (LWP) Ice water path (IWP) Surface solar radiation (SIS) Surface albedo (SAL, black sky) Surface albedo (WAL, white sky) Surface albedo (BAL, blue sky) Surface downwelling longwave rad. (SDL) Surface radiation budget (SRB) Surface net shortwave rad. SNS) Surface net longwave rad. (SNL) Outgoing longwave radiation (OLR) Reflected solar radiation (RSF)	Operational at start of CDOP-5
	Normal	CM-81013 CM-81203 CM-81226 CM-81313	Cloud fraction (CFC Surface solar radiation (SIS Surface albedo (SAL, black sky) Outgoing longwave radiation (OLR)	New product
	Anomaly	CM-4012 CM-4212	Cloud fraction (CFC Surface solar radiation (SIS	New product

Product family	Type	CM ID	Parameter/ECV	Comment
		CM-4226 CM-4322	Surface albedo (SAL, black sky) Outgoing longwave radiation (OLR)	
CLARA-A4	CDR	CM-11014 CM-11024 CM-11034 CM-11044 CM-11054 CM-11064 CM-11204 CM-11229 CM-11230 CM-11231 CM-11264 CM-11274 CM-11283 CM-11293 CM-11314 CM-11344	Cloud fraction (CFC) Joint cloud histograms (JCH) Cloud top parameters (CTO) Cloud phase (CPH) Liquid water path (LWP) Ice water path (IWP) Surface solar radiation (SIS) Surface albedo (SAL, black sky) Surface albedo (WAL, white sky) Surface albedo (BAL, blue sky) Surface downwelling longwave rad. (SDL) Surface radiation budget (SRB) Surface net shortwave rad. SNS) Surface net longwave rad. (SNL) Outgoing longwave radiation (OLR) Reflected solar radiation (RSF)	New version
	ICDR	CM-6013 CM-6023 CM-6033 CM-6043 CM-6053 CM-6063 CM-6213 CM-6229 CM-6230 CM-6231 CM-6263 CM-6273 CM-6283 CM-6293 CM-6323 CM-6333	Cloud fraction (CFC) Joint cloud histograms (JCH) Cloud top parameters (CTO) Cloud phase (CPH) Liquid water path (LWP) Ice water path (IWP) Surface solar radiation (SIS) Surface albedo (SAL, black sky) Surface albedo (WAL, white sky) Surface albedo (BAL, blue sky) Surface downwelling longwave rad. (SDL) Surface radiation budget (SRB) Surface net shortwave rad. SNS) Surface net longwave rad. (SNL) Outgoing longwave radiation (OLR) Reflected solar radiation (RSF)	New version
	Normal	CM-81014 CM-81204 CM-81229 CM-81314	Cloud fraction (CFC Surface solar radiation (SIS Surface albedo (SAL, black sky) Outgoing longwave radiation (OLR)	New version
	Anomaly	CM-4013 CM-4213 CM-4229 CM-4323	Cloud fraction (CFC Surface solar radiation (SIS Surface albedo (SAL, black sky) Outgoing longwave radiation (OLR)	New version
Regional products				
LandFlux v1.1	CDR	CM-23812	Latent and sensible heat flux (LEH)	New version
CLAAS-4	ICDR	CM-5012 CM-5022 CM-5032 CM-5042 CM-5052 CM-5062 CM-5321 CM-5331	Cloud fraction (CFC) Joint cloud histograms (JCH) Cloud top parameters (CTO) Cloud phase (CPH) Liquid water path (LWP) Ice water path (IWP) Reflected solar radiation (RSF) Outgoing longwave radiation (OLR)	Operational at start of CDOP-5
SARAH-4	ICDR	CM-5082 CM-5212 CM-5292 CM-5282 CM-5272	Cloud albedo (CAL) Surface solar radiation (SIS) Direct solar radiation (SDI) Sunshine duration (SDU) Photosynthetically active radiation (PAR)	Operational in late CDOP-4 / early CDOP-5
	Normal	CM-83204 CM-83294 CM-83284	Surface solar radiation (SIS) Direct solar radiation (SDI) Sunshine duration (SDU)	New product
	Anomaly	CM-8212 CM-8292 CM-8282	Surface solar radiation (SIS) Direct solar radiation (SDI) Sunshine duration (SDU)	New product
GEO-Ring	CDR	CM-25012 CM-25022 CM-25032 CM-25042	Cloud fraction (CFC) Joint cloud histograms (JCH) Cloud top parameters (CTO) Cloud phase (CPH)	New product, based on CDOP-4 demonstrator

Product family	Type	CM ID	Parameter/ECV	Comment
		CM-25052 CM-25062 CM-25302 CM-25332 CM-25201 CM-25261 CM-LSA-21001 CM-25812	Liquid water path (LWP) Ice water path (IWP) Reflected solar radiation (RSF) Outgoing longwave radiation (OLR) Surface solar radiation (SIS) Surface downward longwave radiation (SDL) Land surface temperature (LST) Latent and sensible heat flux (LEH)	
	ICDR	CM-9012 CM-9022 CM-9032 CM-9042 CM-9052 CM-9062 CM-9302 CM-9332 CM-9201 CM-9261 LSA-CM-5001 CM-9812	Cloud fraction (CFC) Joint cloud histograms (JCH) Cloud top parameters (CTO) Cloud phase (CPH) Liquid water path (LWP) Ice water path (IWP) Reflected solar radiation (RSF) Outgoing longwave radiation (OLR) Surface solar radiation (SIS) Surface downward longwave radiation (SDL) Land surface temperature (LST) Latent and sensible heat flux (LEH)	New product
High resolution regional products				
HANNA v1.0	CDR	CM-38201 CM-38291 CM-38221 CM-38281 CM-38271 CM-38811 CM-38921	Surface solar radiation (SIS, SIH) Direct solar radiation (SDI) Surface albedo (SAL) Sunshine duration (SDU) Surface radiation budget (SRB) Latent and sensible heat flux (LEH) Land surface temperature (LST)	New product, based on CDOP-4 demonstrator
	ICDR	CM-7201 CM-7291 CM-7221 CM-7281 CM-7261 CM-7811 CM-7921 CM-7271	Surface solar radiation (SIS, SIH) Direct solar radiation (SDI) Surface albedo (SAL) Sunshine duration (SDU) Surface radiation budget (SRB) Latent and sensible heat flux (LEH) Land surface temperature (LST) SRB (0.05°)	New product
	Normal	CM-88921 CM-88811	Land surface temperature (LST) Latent and sensible heat flux and evapotranspiration (LEH)	New product
	Anomaly	CM-3921 CM-8811	Land surface temperature (LST) Latent and sensible heat flux and evapotranspiration (LEH)	New product
Landflux-2	Normal	CM-83922	Land Surface Temperature for Europe anomaly (LST)	New product
	Anomaly	CM-8921	Land Surface Temperature for Europe anomaly (LST)	New product

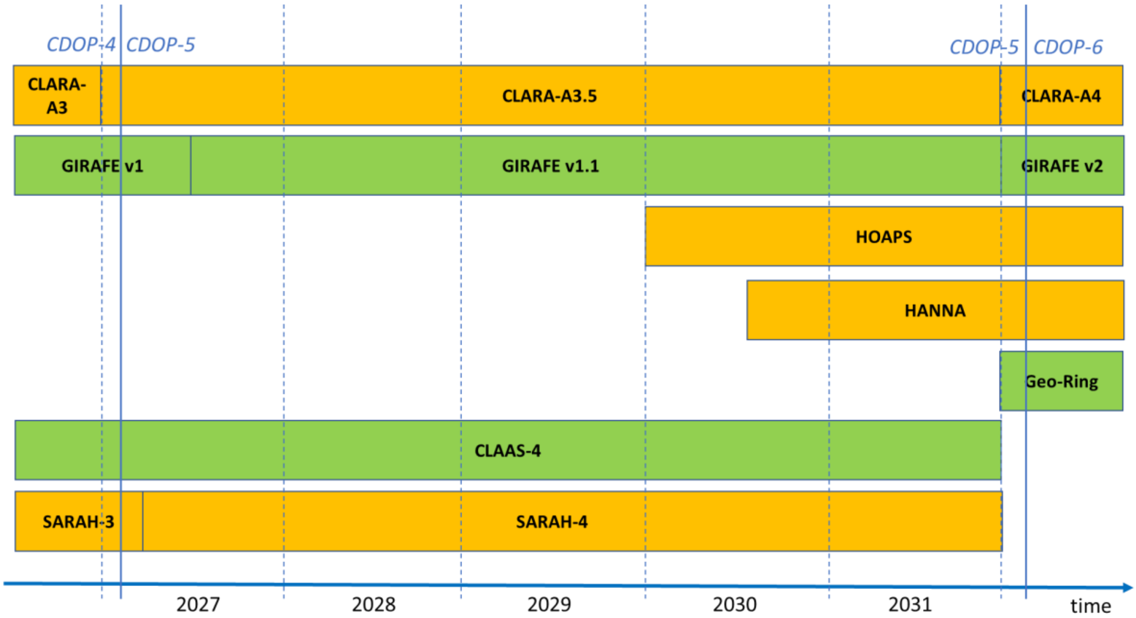


Figure 2-1: Temporal coverage of CM SAF ICDRs during CDOP-5 and changes in versions.

Finally, the CM SAF CDR and ICDR are elements of the same product family and are considered as a unit. In particular, the CDR and ICDR are both elements of the same doi. Associated normals and anomalies are fully dependent on the CDR and ICDR, respectively, and thus, consistent. Independent IDs are defined to allow a more precise product usage monitoring and project management. A good example of the close links between CDR, ICDR, normal and anomaly is shown in Figure 2-5.

2.2 *Committed Climate Data Records for CDOP-5*

2.2.1 *Global Clouds, Radiation, Surface Albedo (CLARA-A4)*

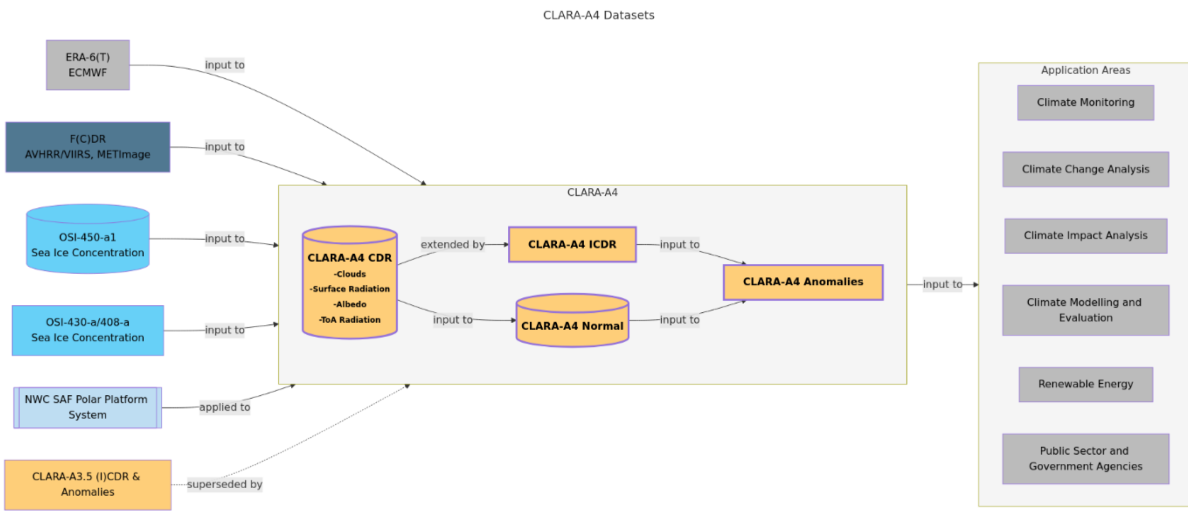
2.2.1.1 Product Family Logic

The CLARA (CM SAF Clouds, Albedo and Radiation dataset from AVHRR data) family consists of a large variety of individual products (see the table in Section 2.2.1.2), several of them containing multiple data layers in addition. In this and the following Sections, the discussion is in most cases structured according to the following product groups:

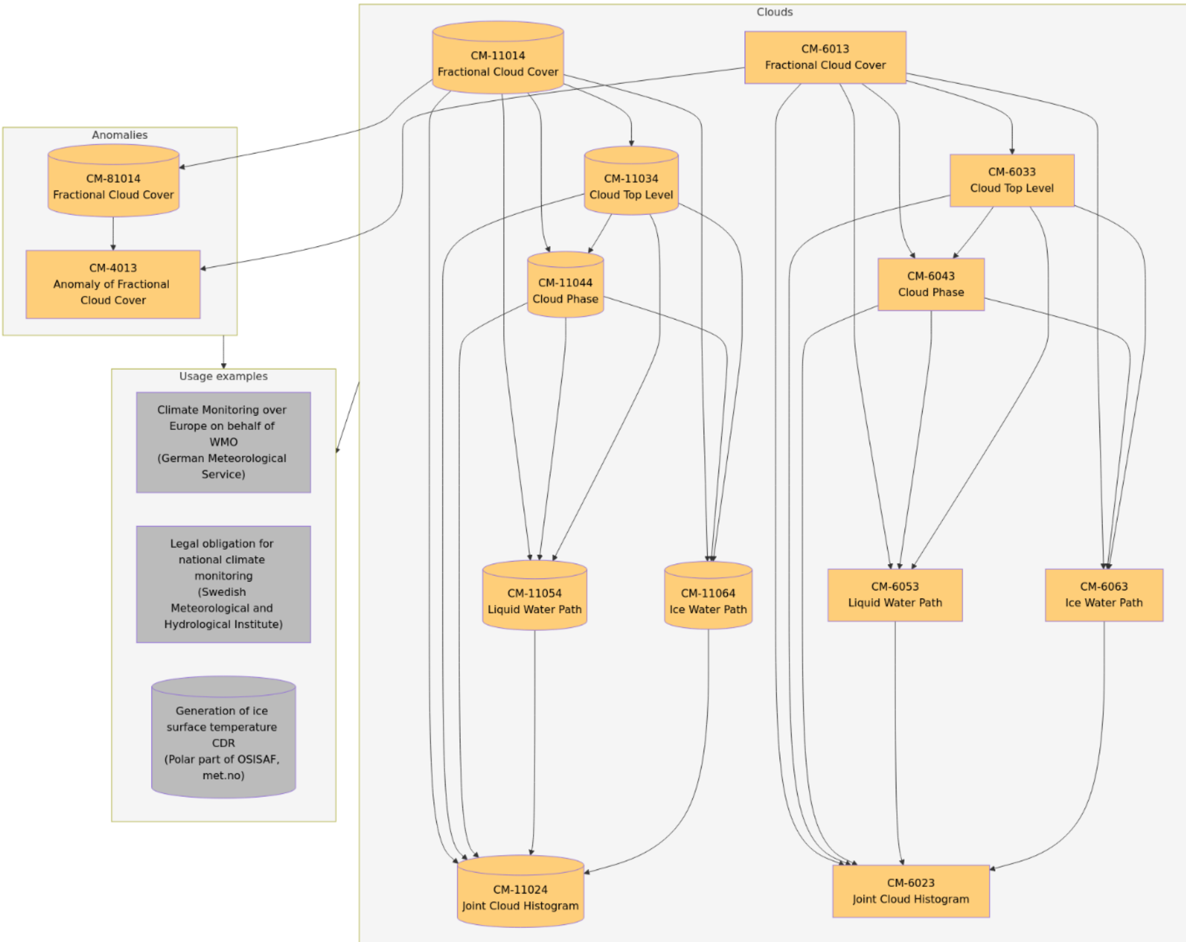
- Clouds
- Surface albedo
- Top-of-atmosphere (TOA) radiation
- Surface radiation

The CLARA-A3.5 CDR and ICDR will be operational by the end of CDOP-4. The CLARA-A3.5 ICDR will be operated until the release of CLARA-A4 by the end of CDOP-5.
The plots show the product logic for the different CLARA editions.
Figure 2-2 gives an overview of the overall product family logic (
Figure 2-2 a)), as well as detailed views of the dependencies for different product groups (
Figure 2-2 b-e). Where products of a different product group are needed, these are shown as “input layer” in the respective detail plot (e.g., cloud fraction needed as input to several other parameters throughout the product family).

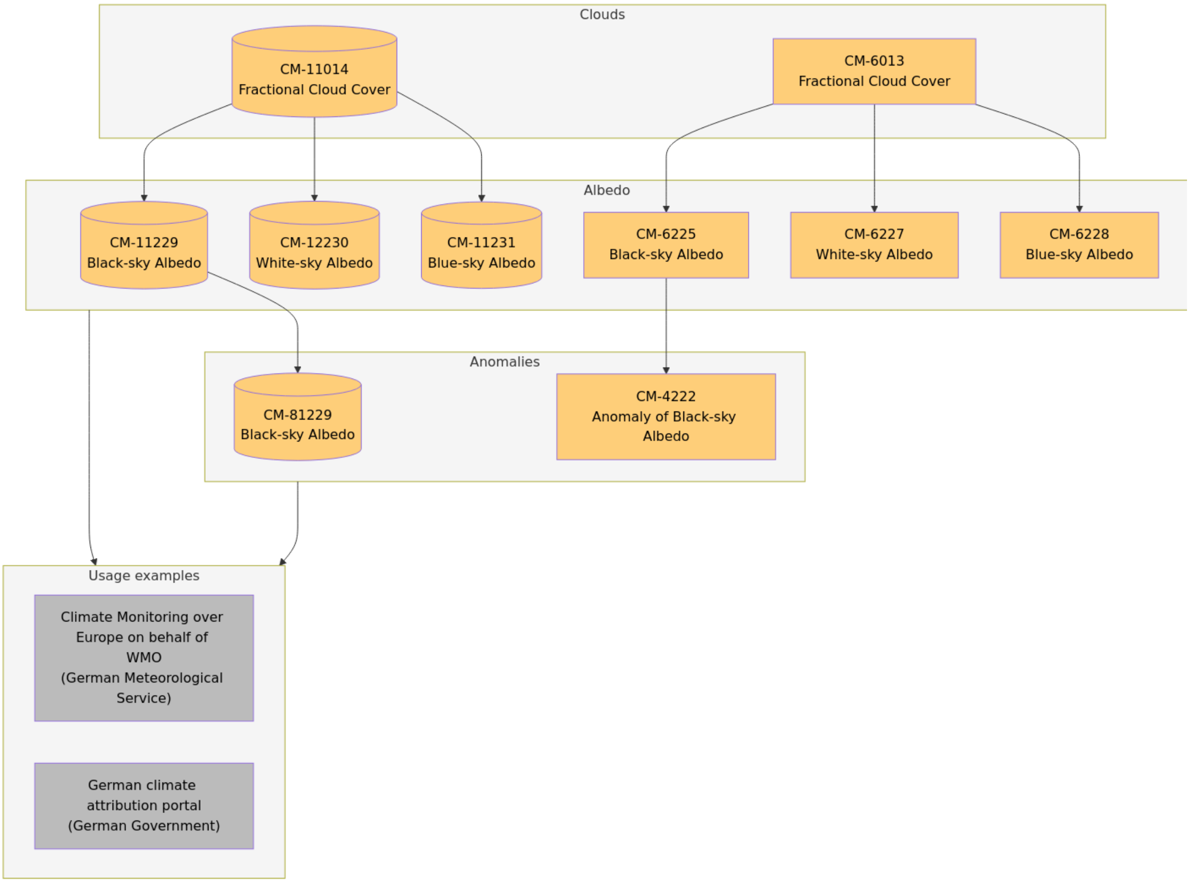
a)



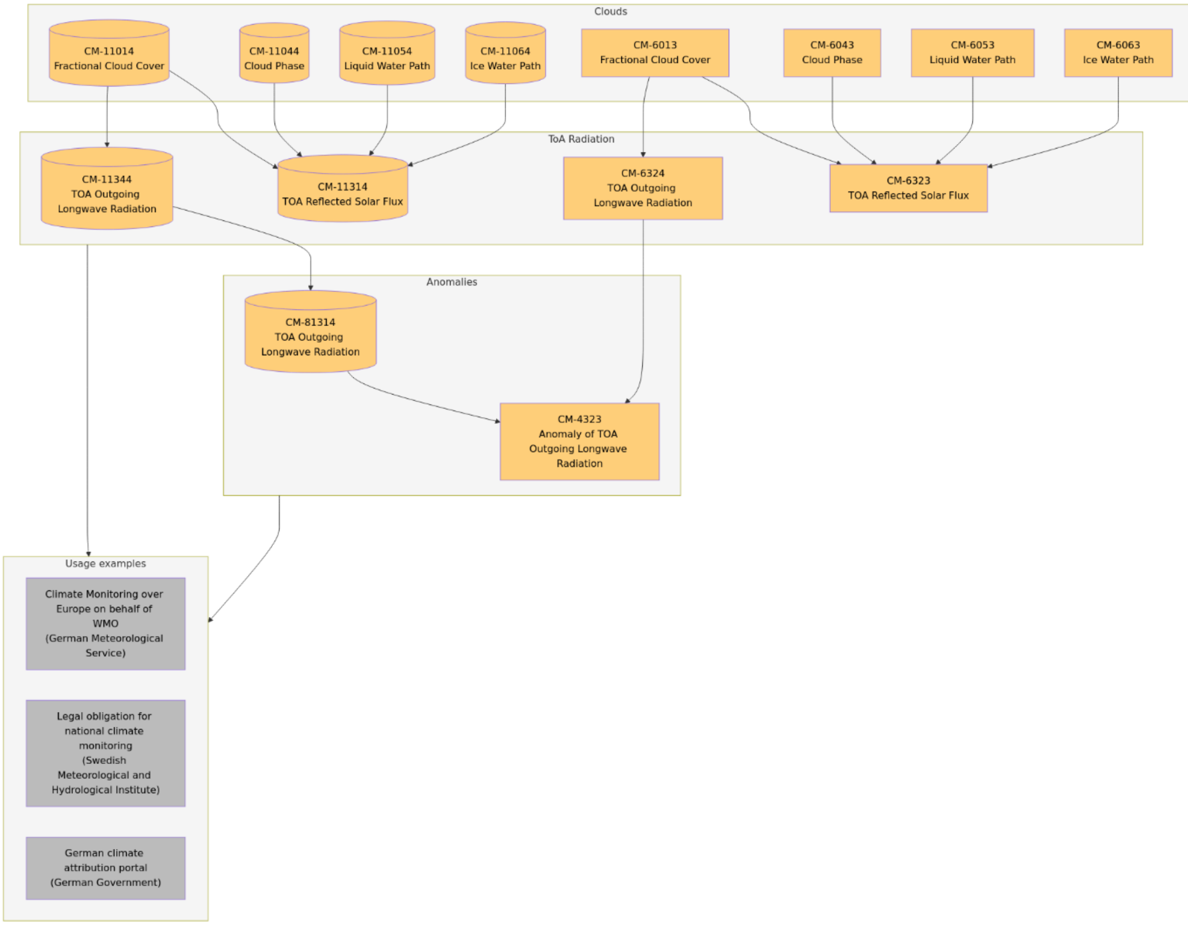
b)


Clouds
CM-11014
Fractional Cloud Cover
CM-6013
Fractional Cloud Cover
Anomalies
CM-81014
Fractional Cloud Cover
CM-4013
Anomaly of Fractional Cloud Cover
CM-11034
Cloud Top Level
CM-6033
Cloud Top Level
CM-11044
Cloud Phase
CM-6043
Cloud Phase
Usage examples
Climate Monitoring over Europe on behalf of WMO
(German Meteorological Service)
Legal obligation for national climate monitoring
(Swedish Meteorological and Hydrological Institute)
Generation of ice surface temperature CDR
(Polar part of OSISAF, met.no)
CM-11054
Liquid Water Path
CM-11064
Ice Water Path
CM-6053
Liquid Water Path
CM-6063
Ice Water Path
CM-11024
Joint Cloud Histogram
CM-6023
Joint Cloud Histogram

c)


Clouds
CM-11014
Fractional Cloud Cover
CM-6013
Fractional Cloud Cover
Albedo
CM-11229
Black-sky Albedo
CM-12230
White-sky Albedo
CM-11231
Blue-sky Albedo
CM-6225
Black-sky Albedo
CM-6227
White-sky Albedo
CM-6228
Blue-sky Albedo
Anomalies
CM-81229
Black-sky Albedo
CM-4222
Anomaly of Black-sky Albedo
Usage examples
Climate Monitoring over Europe on behalf of WMO
(German Meteorological Service)
German climate attribution portal
(German Government)

d)



Clouds
CM-11014 Fractional Cloud Cover
CM-11044 Cloud Phase
CM-11054 Liquid Water Path
CM-11064 Ice Water Path
CM-6013 Fractional Cloud Cover
CM-6043 Cloud Phase
CM-6053 Liquid Water Path
CM-6063 Ice Water Path
ToA Radiation
CM-11344 TOA Outgoing Longwave Radiation
CM-11314 TOA Reflected Solar Flux
CM-6324 TOA Outgoing Longwave Radiation
CM-6323 TOA Reflected Solar Flux
Anomalies
CM-81314 TOA Outgoing Longwave Radiation
CM-4323 Anomaly of TOA Outgoing Longwave Radiation
Usage examples
Climate Monitoring over Europe on behalf of WMO (German Meteorological Service)
Legal obligation for national climate monitoring (Swedish Meteorological and Hydrological Institute)
German climate attribution portal (German Government)

e)

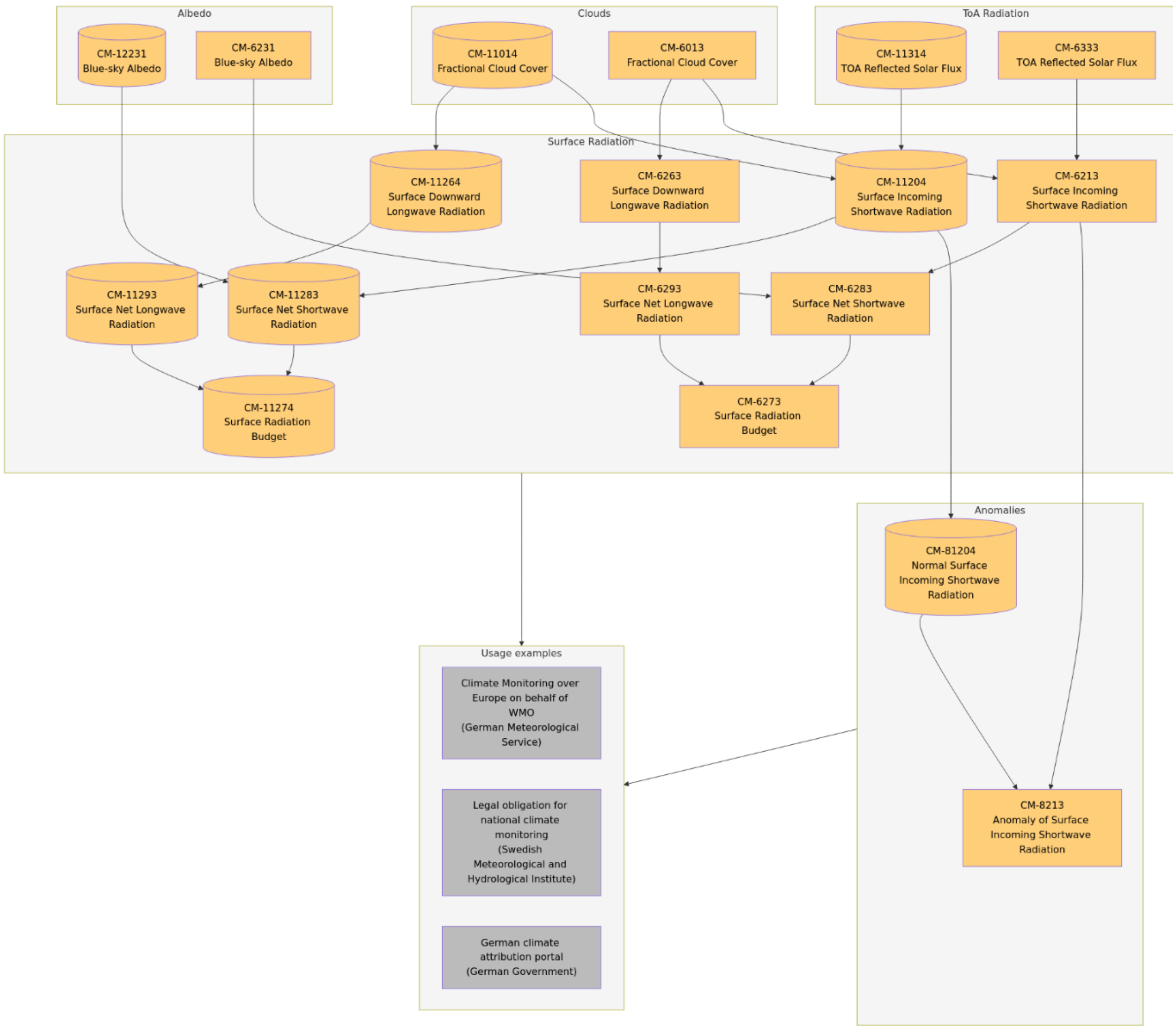


Figure 2-2: Product Logic for CLARA-editions: a) overview, b) cloud parameters, c) surface albedo, d) top-of-atmosphere radiation, e) surface radiation.

The product logic for the ICDR part of CLARA-A3.5 is not given in the detail view for the sake of clarity of the diagrams. The product logic follows the same dependencies as for the respective CLARA-A4 parameters.

940 ## 2.2.1.2 Product Family description

In this Section, product descriptions are provided, starting with a list of products belonging to the product family (see Table 2-2). **New product commitments** are indicated in **bold**.

Table 2-2: Overview of CLARA products.

Product Family:		**Global Clouds, Radiation, Surface Albedo (CLARA-A3.5 ICDR, CLARA-A4 CDR+ICDR)**			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
		CDR			
CM-11014	Fractional Cloud Cover (CFC)	Calculated globally in 0.25^o grid squares	horizontal resolution is the same for all products except JCH	In development, based on CLARA-A3.5	Climate monitoring, analysis and services, climate reports, climate model evaluation, climate data records, process studies
CM-11024	Joint Cloud Histogram (JCH)	Frequency distributions in CTP/COT bins for water and ice clouds in 1^o grids		idem	Climate model evaluation, Weather Regimes
CM-11034	Cloud Top Level (CTO)		Uppermost boundary of clouds	idem	As for JCH
CM-11044	Cloud Phase (CPH)		Water or Ice clouds	idem	As for JCH
CM-11054	Liquid Water Path (LWP)		Integrated cloud water	idem	Climate model evaluation, process studies
CM-11064	Ice Water Path (IWP)		Integrated cloud ice	idem	As for LWP
CM-11204	Surface Incoming Solar Radiation (SIS)			idem	As CFC, energy meteorology, Complementing surface networks
CM-11229	Black-sky albedo (SAL)			idem	As CFC
CM-11230	White-sky albedo (WAL)			idem	Climate model evaluation, process studies
CM-11231	Blue-sky albedo (BAL)			idem	Climate model evaluation, process studies
CM-11264	Surface Downward Longwave Radiation (SDL)			idem	Energy meteorology, Complementing surface networks
CM-11274	Surface Radiation Budget (SRB)			idem	Climate analysis, monitoring, services, climate model evaluation, climate report, complementing surface networks

Product Family:		Global Clouds, Radiation, Surface Albedo (CLARA-A3.5 ICDR, CLARA-A4 CDR+ICDR)			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
CM-11283	Surface Net Shortwave Radiation (SNS)			idem	As SRB
CM-11293	Surface Net Longwave Radiation (SNL)			idem	As SRB
CM-11314	Reflected Solar Flux (RSF)			idem	As SRB, Earth radiation balance studies
CM-11344	Outgoing longwave radiation (OLR)			idem	As SRF
		ICDR			
CM-6013	Fractional Cloud Cover (CFC)			In development, based on CLARA-A3.5	Climate monitoring, analysis, services, Climate reports (all the same below)
CM-6023	Joint Cloud Histogram (JCH)			idem	
CM-6033	Cloud Top Level (CTO)			idem	
CM-6043	Cloud Phase (CPH)			idem	
CM-6053	Liquid Water Path (LWP)			idem	
CM-6063	Ice Water Path (IWP)			idem	
CM-6213	Surface Incoming Solar Radiation (SIS)			idem	As CFC, energy meteorology
CM-6229	Black-sky albedo (SAL)			idem	
CM-6230	White-sky albedo (WAL)			idem	
CM-6231	Blue-sky albedo (BAL)			idem	
CM-6263	Surface Downward Longwave Radiation (SDL)			idem	As SIS
CM-6273	Surface Radiation Budget (SRB)			idem	

Product Family:		**Global Clouds, Radiation, Surface Albedo (CLARA-A3.5 ICDR, CLARA-A4 CDR+ICDR)**			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
CM-6283	Surface Net Shortwave Radiation (SNS)			idem	
CM-6293	Surface Net Longwave Radiation (SNL)			idem	
CM-6323	Reflected Solar Flux (RSF)			idem	
CM-6333	Outgoing longwave radiation (OLR)			idem	
CM-6012	Fractional Cloud Cover (CFC)		ICDR CLARA-A3.5	Operational	
CM-6022	Joint Cloud Histogram (JCH)		ICDR CLARA-A3.5	Operational	
CM-6032	Cloud Top Level (CTO)		ICDR CLARA-A3.5	Operational	
CM-6042	Cloud Phase (CPH)		ICDR CLARA-A3.5	Operational	
CM-6052	Liquid Water Path (LWP)		ICDR CLARA-A3.5	Operational	
CM-6062	Ice Water Path (IWP)		ICDR CLARA-A3.5	Operational	
CM-6212	Surface Incoming Solar Radiation (SIS)		ICDR CLARA-A3.5	Operational	
CM-6226	Black-sky albedo (SAL)		ICDR CLARA-A3.5	Operational	
CM-6227	White-sky albedo (WAL)		ICDR CLARA-A3.5	Operational	
CM-6228	Blue-sky albedo (BAL)		ICDR CLARA-A3.5	Operational	
CM-6262	Surface Downward Longwave Radiation (SDL)		ICDR CLARA-A3.5	Operational	
CM-6272	Surface Radiation Budget (SRB)		ICDR CLARA-A3.5	Operational	
CM-6282	Surface Net Shortwave		ICDR CLARA-A3.5	Operational	

Product Family:		**Global Clouds, Radiation, Surface Albedo (CLARA-A3.5 ICDR, CLARA-A4 CDR+ICDR)**			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
	Radiation (SNS)				
CM-6292	Surface Net Longwave Radiation (SNL)		ICDR CLARA-A3.5	Operational	
CM-6332	Reflected Solar Flux (RSF)		ICDR CLARA-A3.5	Operational	
CM-6322	Outgoing longwave radiation (OLR)		ICDR CLARA-A3.5	Operational	
Normals and anomalies					
CM-81014	Fractional Cloud Cover (CFC)		based on CLARA-A4	In development	Climate services, monitoring, analysis, climate reports (all the same below)
CM-81013	Fractional Cloud Cover (CFC)		based on CLARA-A3.5	In development	
CM-4013	Fractional Cloud Cover (CFC)		based on CLARA-A4	In development	
CM-4012	Fractional Cloud Cover (CFC)		based on CLARA-A3.5	In development	
CM-81204	Surface Incoming Solar Radiation (SIS)		based on CLARA-A4	In development	
CM-81203	Surface Incoming Solar Radiation (SIS)		based on CLARA-A3.5	In development	
CM-4213	Surface Incoming Solar Radiation (SIS)		based on CLARA-A4	In development	
CM-4212	Surface Incoming Solar Radiation (SIS)		based on CLARA-A3.5	In development	
CM-81229	Black-sky albedo (SAL)		based on CLARA-A4	In development	
CM-81226	Black-sky albedo (SAL)		based on CLARA-A3.5	In development	
CM-4222	Black-sky albedo (SAL)		based on CLARA-A4	In development	

Product Family:		**Global Clouds, Radiation, Surface Albedo (CLARA-A3.5 ICDR, CLARA-A4 CDR+ICDR)**			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
CM-4221	Black-sky albedo (SAL)		based on CLARA-A3.5	In development	
CM-81314	Outgoing longwave radiation (OLR)		based on CLARA-A4	In development	
CM-81313	Outgoing longwave radiation (OLR)		based on CLARA-A3.5	In development	
CM-4323	Outgoing longwave radiation (OLR)		based on CLARA-A4	In development	
CM-4322	Outgoing longwave radiation (OLR)		based on CLARA-A3.5	In development	

The CLARA product family has a long heritage within the CM SAF starting in 2012 with the release of the first CLARA version. During the previous phases of the CM SAF the CLARA data records have undergone continuous developments, both in terms of accuracy of the available data, and in terms of providing adapting the product layers (e.g., adding TOA radiation). The latest development within CDOP-4, i.e., the generation of CLARA-A3.5, includes the use of data from VIIRS.

2.2.1.3 Current usage of CM SAF products

CLARA data are among CM SAF's most requested data records. The requests include all provided products, with CFC, SIS, and SAL ranking highest.

2.2.1.3.1 Usage by services in EUMETSAT member states

The number of unique customers from EUMETSAT Member States requesting data from the CLARA-A3 data records over the period 2022-2024 are shown in Figure 2-3. All CLARA-A3 products are used in Member States. Peak usage is observed for cloud fraction, surface albedo and surface incoming solar radiation.

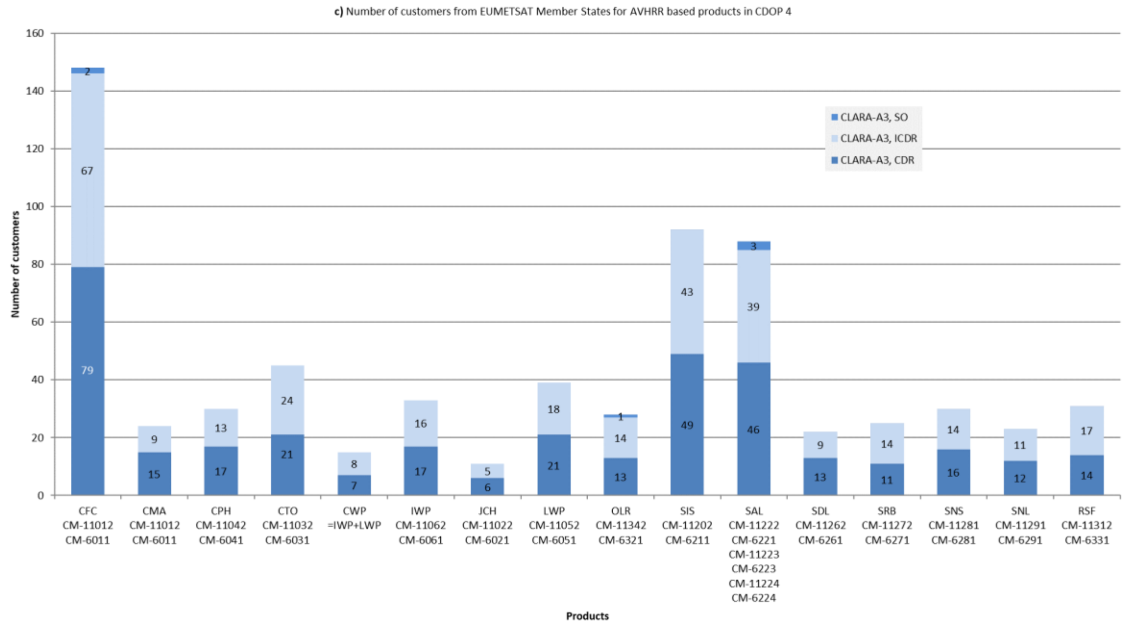


Figure 2-3: Number of unique users of CLARA-A3 products from Member States. The x-axis shows the CM SAF product identifier (5 digits: CDR, 4 digits: ICDR) and an abbreviation of the associated parameter. The abbreviations are defined in the overview table in the Section 2.2.1.2.

960 There are numerous applications of these data in EUMETSAT Member States, some are highlighted in Table 2-2. This includes the user, the application and associated details as well as evidence of the product usage.

Table 2-3: Usage case examples for CLARA-A3.

Product family, parameter	CM-Identifiers	Application area	Detailed description of application	Link to application	Link showing reference to CM SAF data	Institute, country
CLARA-A3, surface albedo	CM-11224, CM-11222	intercomparison of surface albedo retrievals	CLARA-A3 used as a benchmark for evaluating the quality of Univ. Bern surface albedo data record GAC43.	https://www.mdpi.com/2072-4292/17/1/117	https://www.mdpi.com/2072-4292/17/1/117	University of Bern, CH
CLARA-A3, surface albedo, cloud fraction	CM-6221, CM-11222, CM-6011, CM-11012,	surface albedo, cloud fractional cover in Europe	The WMO RA VI Regional Climate Centre (RCC) provides (among various ECVs and indices) monthly maps of global and direct radiation, surface albedo, sunshine duration and cloud fractional cover in Europe based on CM SAF CDRs and ICDRs.	https://www.dwd.de/DE/leistungen/rcccm/int/rcccm_int_sal.html?nn=781516 https://www.dwd.de/DE/leistungen/rcccm/int/rcccm_int_cfc.html?nn=781516	https://www.dwd.de/DE/leistungen/rcccm/int/descriptions/rad/pds_rad_de.pdf?__blob=publicationFile&v=11 https://www.dwd.de/DE/leistungen/rcccm/int/descriptions/cfc/pds_cfc_de.pdf?__blob=publicationFile&v=16	Deutscher Wetterdienst, D

CLARA-A3, cloud fraction	CM-11011, CM-6011	Climate services	European State of the Climate Report 2022, 2023, 2024	https://climate.copernicus.eu/ESOTC	https://climate.copernicus.eu/esotc/2024/about-data	Copernicus Climate Change Service, EU
CLARA-A3, clouds and surface radiation	CM-11012, CM-11022, CM-11032, CM-11042, CM-11052, CM-11062, CM-11202, CM-11262, CM-11272, CM-11281, CM-11291, CM-6011, CM-6021, CM-6031, CM-6041, CM-6051, CM-6061, CM-6211, CM-6261, CM-6271, CM-6281, CM-6291	Climate service	Copernicus Climate Data Store (CDS)	https://cds.climate.copernicus.eu/	https://cds.climate.copernicus.eu/datasets?q=clara	Copernicus Climate Change Service, EU
CLARA-A2, cloud fraction	CM-11011	Climate service	KNMI Climate Explorer: An online tool to analyse and compare a wide range of observational and reanalysis datasets.	https://climexp.knmi.nl/start.cgi	https://climexp.knmi.nl/showmetadata.cgi?field=cfc_cmsaf&id=someone@somewhere	KNMI, NL
CLARA-A3, surface solar radiation	CM-11202	climate monitoring and climate services	Plots of Normal Global radiation for Sweden for normal period 1991-2020, data per month and climate average	https://www.smhi.se/klimat/klimatet-da-och-nu/normalkartor/normal/normal-manadsglobalstralning	https://www.smhi.se/klimat/klimatet-da-och-nu/normalkartor/normal/normal-manadsglobalstralning	SMHI, SE
CLARA-A2 (+ CLARA-A3), clouds	CM-11011 CM-11031 CM-11051 CM-11061	Climate Analysis	GEWEX assessment of satellite-based cloud CDRs		https://link.springer.com/article/10.1007/s10712-024-09824-0	LMD, F
CLARA-A3, TOA radiation	CM-11312, CM-11342, CM-6331, CM-6321	Climate monitoring and climate services	Copernicus Climate Data Store (CDS)	https://cds.climate.copernicus.eu/datasets/satellite-earth-radiation-budget?tab=overview	https://cds.climate.copernicus.eu/datasets/satellite-earth-radiation-budget?tab=overview	Copernicus Climate Change Service, EU

CLARA-A3, TOA radiation	CM-11312, CM-11342	process studies	The trends in CLARA-A3 TOA fluxes (RSF and OLR) are analysed together with a number of other variables (CFCs, surface albedo, ERA5 based sensible and latent heat fluxes, humidity) to investigate the how clouds are changing over the Amazonian basin and if there is any connection to land use change and natural variability induced by ENSO.	Næss F. W., A. Devasthale, A. M. L Ekman, A. Hannachi, A climatological perspective on trends and variability of cloudiness over the Amazonian basin during the last decades, Journal of Climate, under review, 2025.	Næss F. W., A. Devasthale, A. M. L Ekman, A. Hannachi, A climatological perspective on trends and variability of cloudiness over the Amazonian basin during the last decades, Journal of Climate, under review, 2025.	Stockholm University, S
CLARA-A3, surface albedo	CM-11222, CM-11223, CM-11224	Climate monitoring	The Climate Preparedness Services of the federal states and the government find quality approved services offering guidance in taking precautionary measures against the effects of climate change. The data addresses climate monitoring.	KLiVO Portal - KLiVO	https://www.klivoportal.de/SharedDocs/Steckbriefe/DE/dwd_bodenalbedo/bodenalbedo_steckbrief.html	

In a letter of support (see Annex VI) DWD as host of the WMO RA VI expressed the need for a continuous provision of CDRs and ICDRs from CM SAF, here in particular for CFC and SAL from CLARA.

2.2.1.3.2 Other relevant usage

Figure 2-4 shows the number of unique users for CLARA-A3 from all customers. Note that the y-range of the axis is approximately twice as larger as for the corresponding plot for Member States.

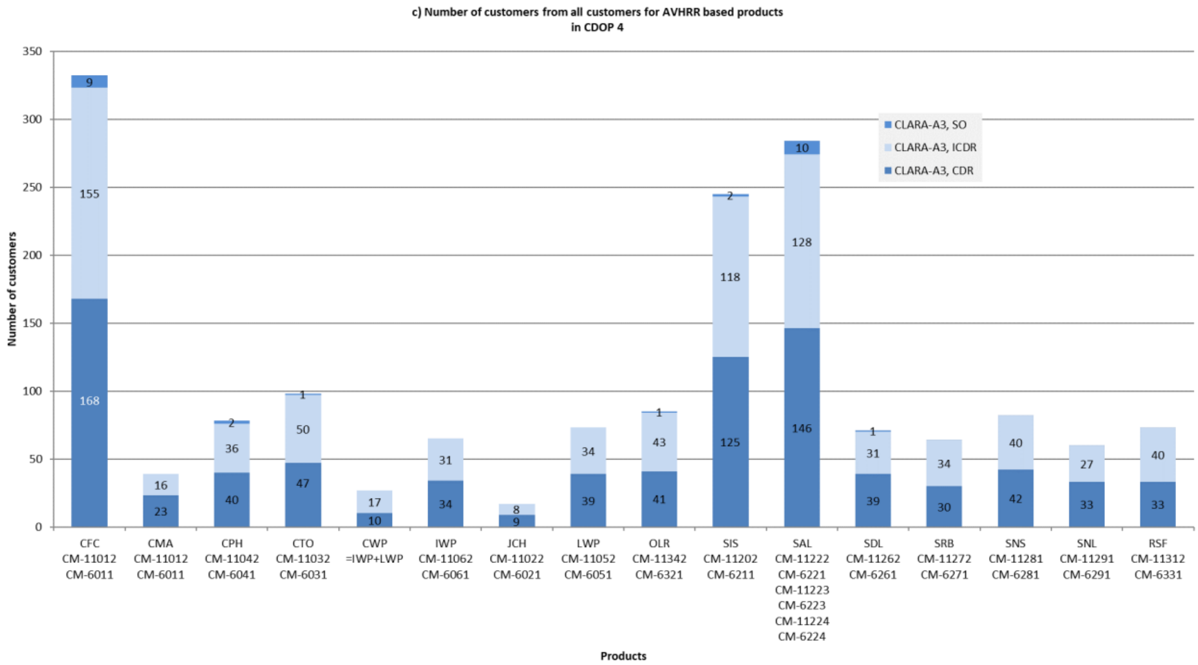


Figure 2-4: Number of unique users of CLARA-A3 from all customers. The x-axis shows the CM SAF product identifier (5 digits: CDR, 4 digits: ICDR) and an abbreviation of the associated parameter. The abbreviations are defined in the overview table in the Section 2.2.1.2.

2.2.1.4 Key improvements

The CLARA CDR is based on observations from AVHRR, first launched in 1978 and still operating on Metop-B and Metop-C. With nearly 50 years of data, AVHRR provides a uniquely long record for climate monitoring and is widely used in applications and publications and applications. However, Metop-C carries the final AVHRR instrument and observations will end once its mission concludes.

Because of its unique long-term coverage, investigations on how to prolong the observation series even further have been undertaken. Karlsson et al. (2025) showed that AVHRR-like data can be simulated from VIIRS, enabling the CLARA-A3.5 update (restoring afternoon orbit coverage after 2012 in the CLARA-A3 CDR). The same approach can be applied to METimage (Meteorological Imager), paving the way for the CLARA-A4 CDR and potentially extending the AVHRR record by decades. A key goal for CLARA-A4 is thus a CDR fully based on AVHRR-heritage data after the loss of original AVHRR data.

Another major task is adopting EUMETSAT’s new AVHRR GAC FCDR (GAC: Global Area Coverage), developed under FIDUCEO standards (see https://www.fiduceo.eu/). Close collaboration with the EUMETSAT Climate Section will define its content, including uncertainty information and integration with VIIRS and METimage heritage data.

Both tasks underpin all CLARA-A4 products. A third focus is testing higher spatial resolution (e.g., from 0.25° to 0.125°).

Until the release of the next edition of the data record, the processing of the CLARA-A3.5 ICDR products, which are expected to be operational at the start of the project phase, will be continued in CDOP-5 in order to extend the CDR and fulfill the user needs described in the use cases above.

Specific method developments for individual products are outlined below.

CDR

- CFC: Finalisation and updated training (i.e., utilization of Earth Clouds, Aerosols and Radiation Explorer - EarthCARE data) of a neural-network based cloud probability product with enhanced uncertainty characterization
- CTO: Updated training with EarthCARE information and use of ERA6 data
- CPH: Introduction of neural network retrieval
- LWP/IWP: Improved Level-2-to-Level-3 aggregation, use of probabilistic cloud information
- SAL: Technical redesign of retrieval code, improved atmospheric correction, and adding per-pixel uncertainty information
- SIS+other surface radiation products: Exploring impact of higher resolution; filling the grid boxes of the surface irradiance data record that are set to missing in CLARA-A3 with data, when possible.
- OLR/RSF: Improving underlying diurnal cycle model, updated narrowband-to-broadband conversion, updated ADM model, adding clear-sky fluxes, and adjusting to new ancillary data.

ICDR

- For all products, adjust to ancillary data available in near-realtime.

2.2.1.5 Description of new products

New data products of the CLARA-A3.5 and CLARA-A4 data records will include the following:

- Normal and anomaly products for CFC, SIS, SAL, and OLR.

The approach will be in-line with existing implementations for the demonstrational SARAH-3 normal and anomaly service. Further enhancements based on analysis within CM SAF, user feedback and following decisions from TT-CAN will be implemented if feasible.

2.2.1.6 User Requirements for new products

A general motivation for normal and anomaly products is given in Section 1.2 (see discussion related to CM SAF normals and anomalies and the EUMETSAT-wide CAN service). During beta user consultation of the EUMETSAT CAN service a strong interest in Cloud normal and anomalies was expressed. The CLARA-based normals and anomalies will be provided to CM SAF users also via the EUMETSAT CAN service.

Specific quality requirements for normals and anomalies will depend on performances of the corresponding CDR and ICDR products. Explicit requirements have to be defined at the upcoming Requirements Reviews. Experiences from the current EUMETSAT CAN service will also play a role for how to define these and other requirements.

2.2.1.7 Product Heritage

The heritage of all products proposed here is the CLARA-A3.5 data record and its associated processing environment. As mentioned earlier, these data records (including previous CLARA editions) have a long-standing history with CM SAF, are well established within the community, and are widely used.

2.2.2 Regional Surface Radiation (SARAH)

2.2.2.1 Product Family Logic

During CDOP-5 the developments of SARAH (Surface Solar Radiation Data Set - Heliosat) will be consolidated; no full release of a new version of the SARAH climate data record is foreseen within CDOP-5. Instead, it is intended to provide specific improvements of the available data records based on user interactions and feedback. In addition, a new ICDR service will be developed and set-up for data from all five available geostationary orbits to support climate monitoring around the globe, complementing the GEO-Ring ICDR products with surface radiation. Also, data of anomalies for SIS and SDU will be released for the Meteosat Disc, also supporting climate monitoring.

The plots show the product logic for the SARAH data records. Figure 2-5 gives an overview of the overall product family logic (Figure 2-5 a)) and the detail view for the geostationary satellite at 0° (Meteosat) (Figure 2-5 b). The GEO-Ring surface radiation logic is shown in Figure 2-8 in Section 2.2.3.

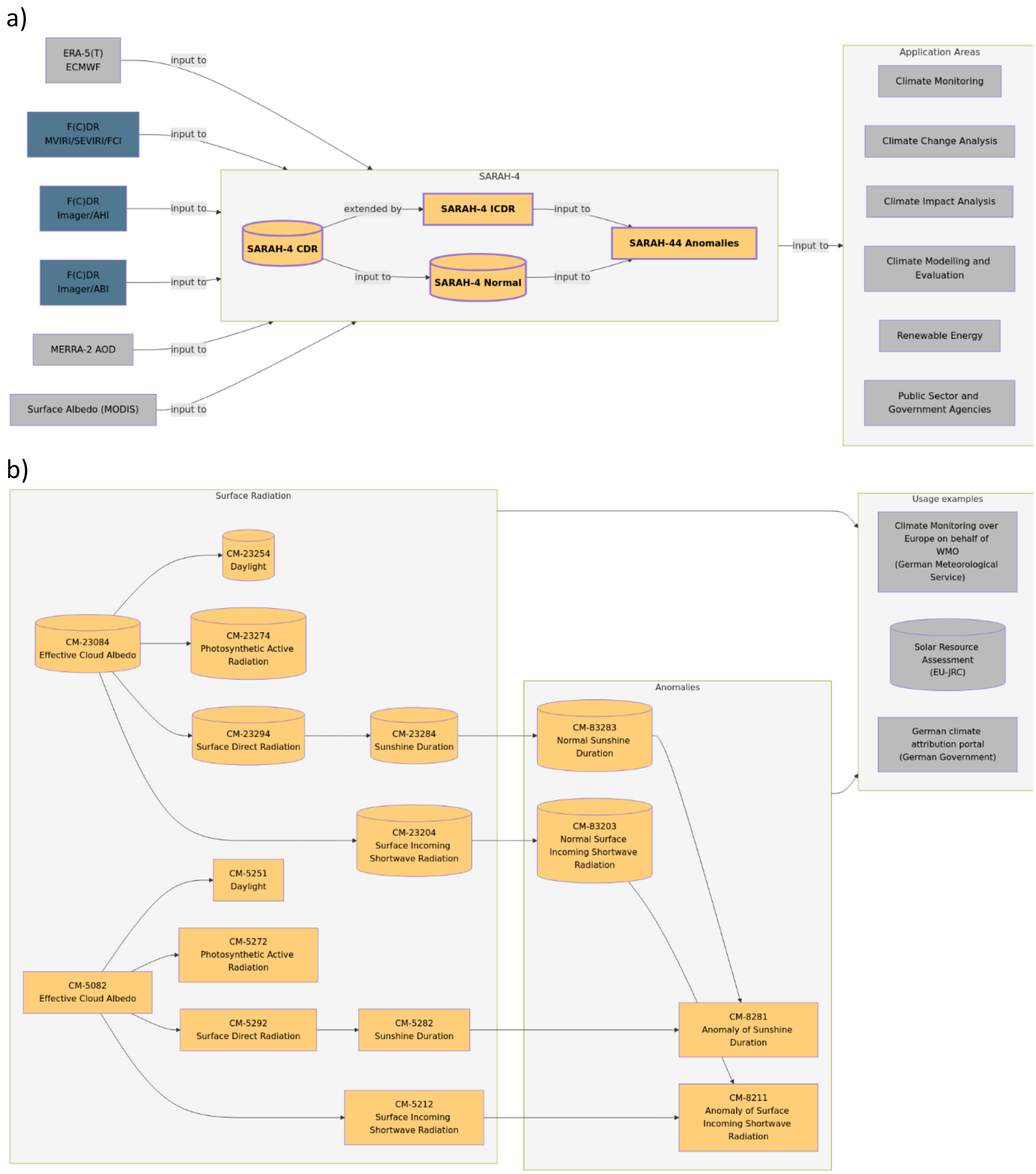


Figure 2-5 Product Logic for SARAH-editions: a) overview and b) geostationary satellite at 0°. The surface radiation GEO-Ring products are included in Figure 2-8.

2.2.2.2 Product Family description

In this Section, product descriptions are provided, starting with a list of products belonging to the product family (see Table 2-4). **New product commitments** are indicated in **bold**.

Table 2-4: Overview of products belonging to SARAH. IODC: Indian Ocean Data Coverage.

Product Family:		**Regional Surface Radiation (SARAH-4, SARAH-5)**			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
			CDR		
CM-23084 / **CM-23085**	Effective Cloud Albedo (CAL)	Effective Cloud Albedo	SARAH-4 / SARAH-5; Meteosat-Prime	SARAH-4 released in late CDOP-4 / early CDOP-5, SARAH-5 in development	Climate model evaluation, process studies
CM-23204 / **CM-23205** / CM-22201 / **CM-22202** / CM-24201 / **CM-24202** / CM-26201 / **CM-26202** / CM-27201 / **CM-27202**	Surface Incoming Shortwave Radiation (SIS)	Surface Incoming Solar Radiation	SARAH-4 / SARAH-5; Meteosat-Prime, Meteosat-IODC, Himawari, GOES-E, GOES-W	idem	Climate analysis, monitoring, services, climate report, climate model evaluation, process studies, climate data records, energy-meteorology
CM-23294 / **CM-23295** / CM-22291 / **CM-22292** / CM-24291 / **CM-24292** / CM-26291 / **CM-26292** / CM-27291 /	Surface Direct Irradiance (SDI)	Surface Direct Radiation	SARAH-4 / SARAH-5; Meteosat-Prime, Meteosat-IODC, Himawari, GOES-E, GOES-W	idem	As SIS

Product Family:		**Regional Surface Radiation (SARAH-4, SARAH-5)**			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
CM-27292					
CM-23274 / **CM-23275**	Photosynthetic Active Radiation (PAR)	Photosynthetic Active Radiation	SARAH-4 / SARAH-5; Meteosat-Prime	idem	As SIS
CM-23254 / **CM-23255**	Daylight (DAL)	Daylight	SARAH-4 / SARAH-5; Meteosat-Prime	idem	As SIS
CM-23284 / **CM-23285** / CM-22281 / **CM-22282** / CM-24281 / **CM-24282** / CM-26281 / **CM-26282** / CM-27281 / **CM-27282**	Sunshine Duration (SDU)	Sunshine Duration	SARAH-4 / SARAH-5; Meteosat-Prime, Meteosat-IODC, Himawari, GOES-E, GOES-W	idem	As SIS
ICDR					
CM-5082	Effective Cloud Albedo (CAL)	Effective Cloud Albedo	Meteosat-Prime	SARAH-4 released in late CDOP-4 / early CDOP-5, SARAH-5 in development	Climate services, monitoring, analysis, climate reports, model evaluation, process studies, climate data records

Product Family:		**Regional Surface Radiation (SARAH-4, SARAH-5)**			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
CM-5212	Surface Incoming Shortwave Radiation (SIS)	Surface Incoming Solar Radiation	Meteosat-Prime	idem	As SIS
CM-5292	Surface Direct Irradiance (SDI)	Surface Direct Radiation	Meteosat-Prime	idem	As SIS
CM-5282	Sunshine Duration (SDU)	Sunshine Duration	Meteosat-Prime	idem	As SIS
CM-5272	Photosynthetic Active Radiation (PAR)	Photosynthetic Active Radiation	Meteosat-Prime	idem	As SIS
CM-5252	Daylight (DAL)	Daylight	Meteosat-Prime	idem	As SIS
Normals and anomalies					
CM-83203 **CM-83204**	Surface Incoming Shortwave Radiation (SIS)	Surface Incoming Solar Radiation	Meteosat-Prime	Demo data available, in development	Climate services, monitoring, analysis, climate reports
CM-83283 **CM-83284**	Sunshine Duration (SDU)	Sunshine Duration	Meteosat-Prime	Demo data available, in development	As SIS
CM-8211 **CM-8212**	Surface Incoming Shortwave Radiation (SIS)	Surface Incoming Solar Radiation	Meteosat-Prime	Demo data available, in development	As SIS
CM-8281 **CM-8282**	Sunshine Duration (SDU)	Sunshine Duration	Meteosat-Prime	Demo data available, in development	As SIS

The SARAH product family has a long heritage within the CM SAF starting in 2011 with the release of the Meteosat Visible Infra-Red Imager (MVIRI)-based CDR of surface radiation products. During the previous phases of the CM SAF the SARAH data records have undergone continuous developments, both in terms of accuracy of the available data, but also in terms of providing additional data sets (e.g., the sunshine duration and the photosynthetically-active radiation). The latest development within CDOP-4, i.e., the generation of SARAH-4, includes the use of data from five geostationary satellite orbits to provide climate data records of temporally- and spatially-high resolved surface radiation data around the globe.

2.2.2.3 Current usage of CM SAF products

The data from the SARAH data record are among the most requested data records from the CM SAF. The requests include all provided products, with SIS, SDI, and SDU ranking highest.

2.2.2.3.1 Usage by services in EUMETSAT member states

The number of unique customers from EUMETSAT Member States requesting data from the SARAH-3 data records over the period 2022-2024 are shown in Figure 2-6.

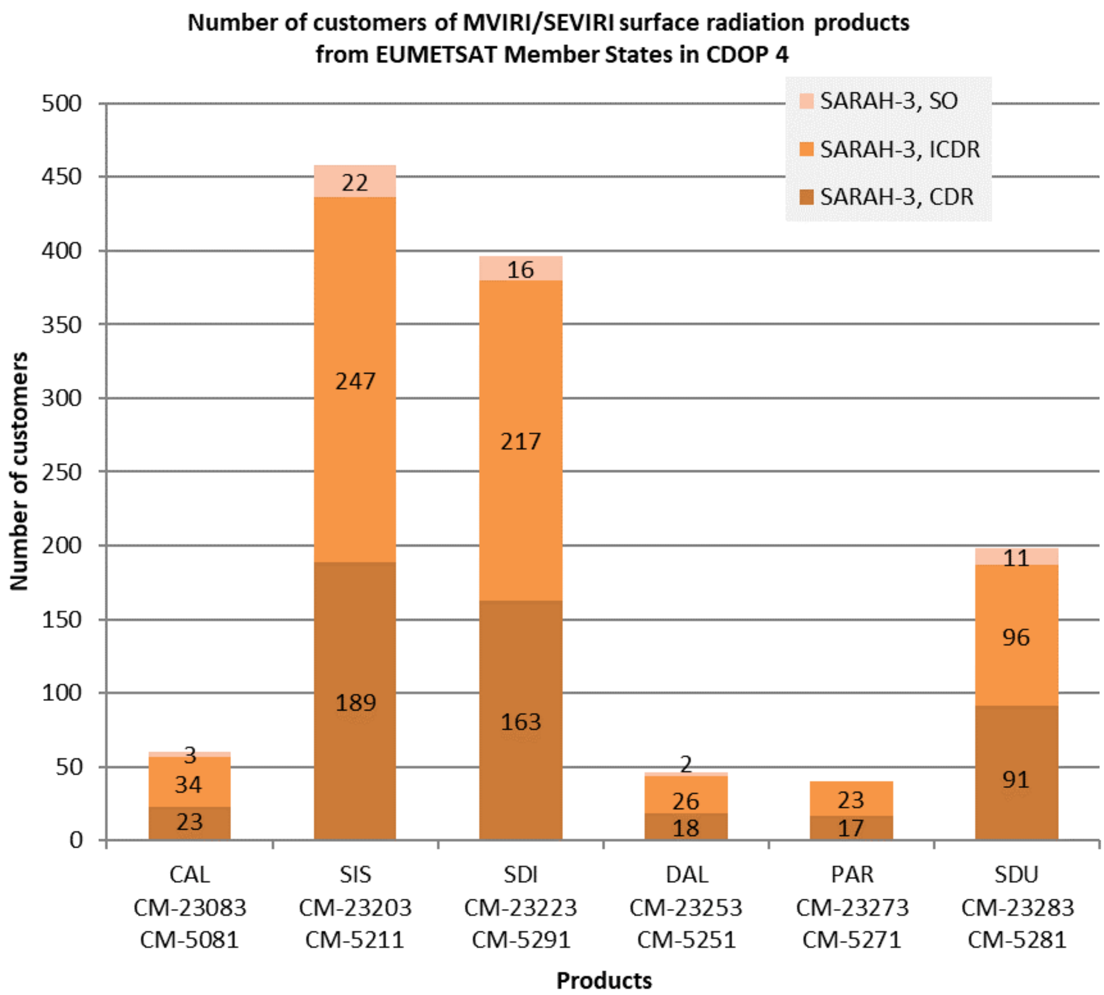


Figure 2-6: Number of unique users of SARAH-3 from Member States. The x-axis shows the CM SAF product identifier (5 digits: CDR, 4 digits: ICDR) and an abbreviation of the associated parameter. The abbreviations are defined in the overview table in the Section 2.2.2.2.

There are numerous applications of these data in EUMETSAT Member States, some are highlighted in the following Table 2-3.

Table 2-5: Usage case examples for SARAH-3.

Product family	CM-Identifiers	Application area	Detailed description of application	Link to application	Link showing reference to CM SAF data	Institute
SARAH-3, sunshine duration	CM-5281	Supporting the QC of surface-based data	The daily sunshine duration data from SARAH-3 are used to support the quality control of the surface data collected at DWD	internal application		Deutscher Wetterdienst, D
SARAH-3, surface radiation	CM-5081, CM-23083, CM-23203, CM-5211, CM-23293, CM-5291	Climate monitoring	The high-resolution grids of hourly variables (HOSTRADA) for Germany is a climatological reference dataset that serves as the basis for the development and update of current test reference years, making it particularly important for technical climatology.	https://www.dwd.de/DE/leistungen/uhi/info_methodic/01_hostrada.html	https://opendata.dwd.de/climate_environment/CDC/grids_germany/hourly/hostrada/BESCHREIBUNG_gridsgermany_hourly_hostrada_de.pdf	Deutscher Wetterdienst, D
SARAH-3, sunshine duration	CM-23283, CM-5281	operational sunshine duration product for the UK based on a combination of station and satellite observations over the UK.	Blended station-satellite sunshine duration for the UK. The Met Office is currently developing an operational sunshine duration product for the UK based on a combination of station and satellite observations over the UK.	Operationalisation: work in progress		MetOffice, UK
SARAH-3, surface radiation	CM-23293, CM-23203, CM-5291, CM-5211, CM-23283, CM-5281	global and direct radiation, sunshine duration in Europe	The WMO RA VI Regional Climate Center (RCC) provides (among various ECVs and indices) monthly maps of global and direct radiation, surface albedo, sunshine duration and cloud fractional cover in Europe based on CM SAF CDRs and ICDRs.	https://www.dwd.de/DE/leistungen/rcccm/int/rcccm_int_rad.html?nn=781516, https://www.dwd.de/DE/leistungen/rcccm/int/rcccm_month_sun.html?nn=781516	https://www.dwd.de/DE/leistungen/rcccm/int/descriptions/rad/pds_rad_de.pdf?__blob=publicationFile&v=11, https://www.dwd.de/DE/leistungen/rcccm/int/descriptions/sun/pds_sun_de.pdf?__blob=publicationFile&v=17	Deutscher Wetterdienst

Product family	CM-Identifiers	Application area	Detailed description of application	Link to application	Link showing reference to CM SAF data	Institute
SARAH-3, sunshine duration	CM-5281, CM-23283	Maps of Sunshine Duration for Hungary	Maps of Sunshine Duration for Hungary, updated regularly with latest data	https://www.met.hu/idojaras/agrometeorologia/napfenytartam/	https://www.met.hu/idojaras/agrometeorologia/napfenytartam/	OMSZ, H
SARAH-3, surface radiation	CM-23283; CM-5281 CM-23203; CM-5211	Climate services	European State of the Climate Report 2022, 2023, 2024	https://climate.copernicus.eu/ESOTC	https://climate.copernicus.eu/esotc/2024/about-data	Copernicus Climate Change Service, EU
SARAH-3, surface radiation	CM-23203; CM-23293	Solar energy	Main data source in PVGIS to calculate average monthly and yearly production of solar power in kWh. Default data base is SARAH-3	https://joint-research-centre.ec.europa.eu/photovoltaic-geographical-information-system-pvgis_en	https://joint-research-centre.ec.europa.eu/photovoltaic-geographical-information-system-pvgis/pvgis-releases/pvgis-53_en	JRC, EU
SARAH-3, surface solar radiation	CM-23203	Climate model validation	KNMI'23 climate scenarios These are produced every ~7 years, and provide a downscaling of IPCC scenarios for the Netherlands and surroundings. SARAH-3 SIS was used to evaluate and bias-correct the regional climate simulations underlying the scenarios.	https://www.knmi.nl/kennis-en-datacentrum/achtergrond/knmi-23-klimaatscenario-s		KNMI, NL
SARAH-3, surface solar radiation	CM-23203	Climate monitoring, climate service	Staat van ons klimaat (Dutch version of State of the Climate). CM SAF data provide anomaly of global radiation in the Netherlands for the past year.	https://cdn.knmi.nl/system/data_center_publications/files/000/072/295/original/KNMI-publicatie_25-01.pdf	https://cdn.knmi.nl/system/data_center_publications/files/000/072/295/original/KNMI-publicatie_25-01.pdf	KNMI, NL
SARAH-3, surface solar radiation	CM-23203	Climate monitoring, climate service	Climatologic surface solar irradiance maps and anomalies based on SARAH from 1984 to 2004	https://www.meteo.be/fr/climat/climat-de-la-belgique/cartes-climatologiques https://www.meteo.be/nl/klimaat/klimaat-van-belgie/klimatologische-kaarten		RMIB, B

Product family	CM-Identifiers	Application area	Detailed description of application	Link to application	Link showing reference to CM SAF data	Institute
SARAH-3, surface solar radiation	CM-23203, CM-5081	Climate monitoring	The Climate Preparedness Services of the federal states and the government find quality approved services offering guidance in taking precautionary measures against the effects of climate change. The data addressess climate monitoring, renewable energies, hydrology, and agrar-meteorology.	KLiVO Portal - KLiVO	https://www.klivoportal.de/SharedDocs/Steckbriefe/DE/dwd_strahlung_boden/strahlung_boden_steckbrief.html	
SARAH-3, surface radiation	CM-83283, CM-83203, CM-8281, CM-8211	Climate monitoring, climate service	The EUMETSAT Climate Anomaly and Normal (CAN) service provides SAF and EUMETSAT Sec. normal and anomaly data, an analysis tool and plotting routines for climate monitoring purposes.	not yet public		EUMETSAT, EU

In a letter of support (see Annex Annex VI) DWD as host of the WMO RA VI expressed the need for a continuous provision of CDRs and ICDRs from CM SAF, here in particular for SIS, SDU, and SDI from SARAH.

2.2.2.3.2 Other relevant usage

Figure 2-7 shows the number of unique users for SARAH-3 from all customers. Note that the y-range of the axis is significantly larger as for the corresponding plot for Member States.

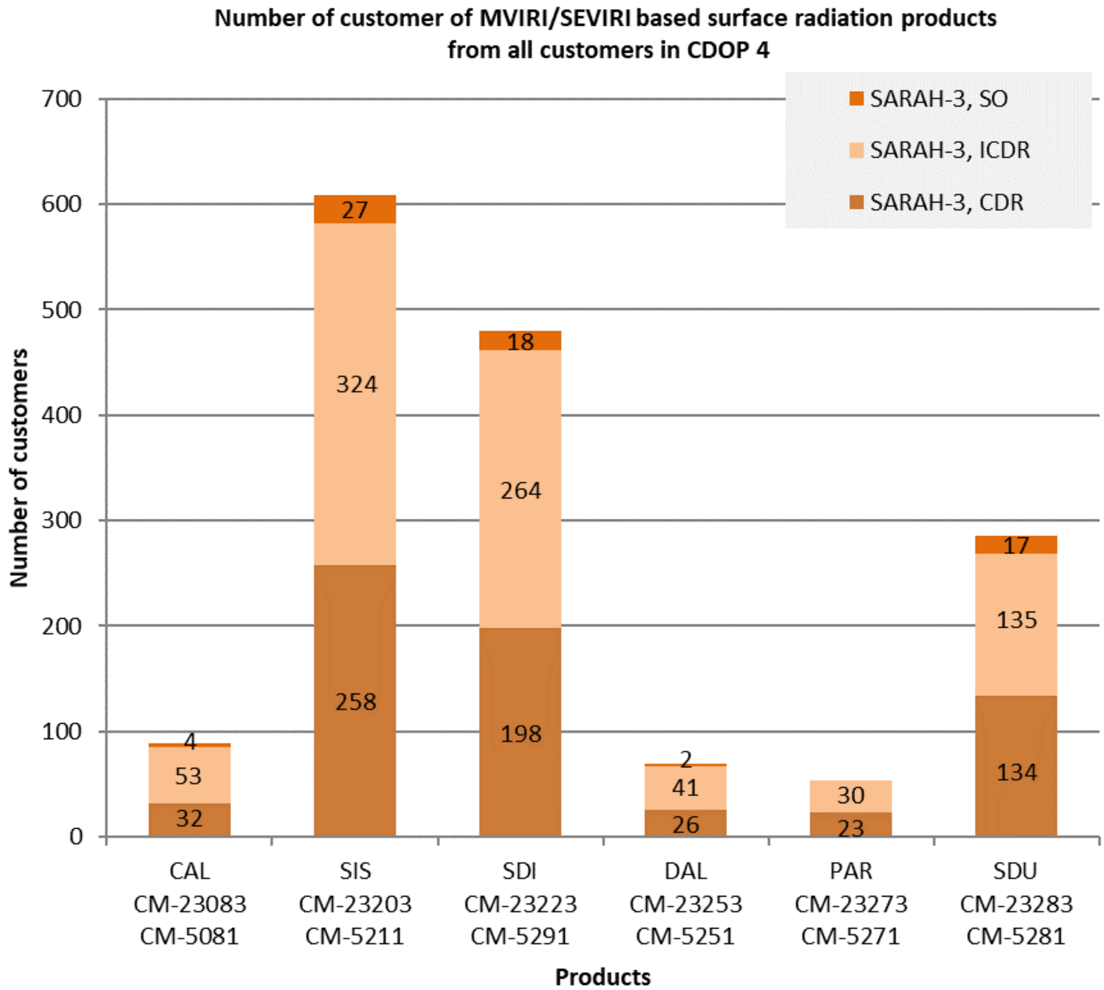


Figure 2-7: Number of unique users of SARAH-3 from all customers. The x-axis shows the CM SAF product identifier (5 digits: CDR, 4 digits: ICDR) and an abbreviation of the associated parameter. The abbreviations are defined in the overview table in the Section 2.2.2.2.

2.2.2.4 Key improvements

CDR, ICDR

During CDOP-5 the newly released SARAH-4 data record will be consolidated and punctually improved based on user feedback. The SARAH-4 data record (available at the beginning of CDOP-5) includes data from all five geostationary satellite orbits, including ICDR data from the Meteosat-Prime orbit (with the latter being continued in CDOP-5).

The release of the new SARAH-4 data records is expected to enhance the number of applications of the SARAH data records and to create feedback. It is intended to respond to these feedbacks within CDOP-5 and provide updated data records for specific and selected applications. Among the requests, which are being addressed within CDOP-5, are

- Provision of uncertainty information
- Provision of UV data
- Provision of specific information for PV applications, e.g., spectral information
- Provision of temporal averages for the local time zone

Depending on user feedback the list of additional / auxiliary data records will be extended. The user feedback (also as part of the requirements review) will result in the preparation of the next full release of the SARAH data record, which is intended to be during CDOP-6; the software developments (until Products Consolidation Review - PCR) (using an agile software development plan) will be conducted within CDOP-5.

Normals and anomalies

The demonstrational normal and anomaly service will be established as an operational service during CDOP-5, providing normals and anomalies for monthly SIS and SDU for the Meteosat Prime data record of SARAH-4 and preparing the next version of normals and anomalies from SARAH-5.

Information and results from all these activities will be integrated in the preparation of the release of the next edition of the SARAH data record, which is intended to be released in CDOP-6; within CDOP-5 two reviews leading towards the new release, namely the RR and the PCR, will be conducted.

2.2.2.5 Description of new products

New data products of the SARAH data will include the following:

CDR/ICDR

- ICDR data based on SARAH-4 for all parameters for Meteosat-Prime is already generated within CDOP-4 and will be continued in CDOP-5
-
-
- On-demand products based on SARAH-4: According to user feedback "on-demand"-data records will be generated and provided based on the SARAH-4 processing, these might include
    - Uncertainty information of SARAH-4 data records
    - ICDR data for additional orbits (in addition to Meteosat Prime)
    - UV (ultra-violet) data
    - Spectral information for PV assessments
    - daily / monthly averages for the local time zone

Normals and anomalies

- Anomalies and normals of the monthly SIS and SDU data records from SARAH-4 will be provided for the Meteosat-Prime SARAH-4 data records. An updated version is planned with SARAH-5. The approach will be in-line with existing implementations for the demonstrational SARAH-3 normal and anomaly service. Further enhancements based on analysis within CM SAF, user feedback and following decisions from TT-CAN will be implemented if feasible.

2.2.2.6 User Requirements for new products

CDR/ICDR

The user requirements for the potential new ICDR data records will be based on the accuracy of the corresponding CDR data records and are expected to be in line with the requirements of the SARAH-4 ICDR for Meteosat-Prime. No alternative data record is currently available.
The generation and provision of ‘on-demand’ products are based on requests for a more faster update cycle of SARAH data to include specific improvements of the data, e.g., adding uncertainty information and/or providing UV data.

Normals and anomalies

A general motivation for normal and anomaly products is given in Section 1.2 (see discussion related to CM SAF normals and anomalies and the EUMETSAT-wide CAN service). The SARAH-3 based normals and anomalies are already and future versions will be distributed to CM SAF users also via the EUMETSAT CAN service.
Specific quality requirements for normals and anomalies will depend on requirements and performances of the corresponding CDR and ICDR products. Specific requirements for the normals and anomalies as generated for the surface irradiance and the sunshine duration are being collected during the provision of the demonstrational product within CDOP-4. Also, experiences from the current demonstrations of anomaly services and from the EUMETSAT CAN service will also play a role for how to define these and other requirements. The requirements will then be defined at Requirements Reviews.

2.2.2.7 Product Heritage

The heritage of all products proposed here is the SARAH-4 data record and its associated processing environment. As mentioned earlier, these data records have a long-standing history with CM SAF and are well established within the community.
The normals and the anomalies are based on the demonstrational product as released during CDOP-4.

2.2.3 Near-Global Clouds, Radiation, Land Surface Temperature and Fluxes (GEO-Ring)

2.2.3.1 Product Family Logic

The GEO-Ring family consists of more than ten individual products (see the table in Section 2.2.2.2), several of them containing multiple data layers in addition, all in the same format, on the same grid and in high spatial and temporal resolution (0.05°, 30 min). The product family utilizes data from the ring of geostationary observational data provided by the EUMETSAT Sec. (“L1g”). In this and the following Sections, the discussion is in most cases structured according to the following product groups:

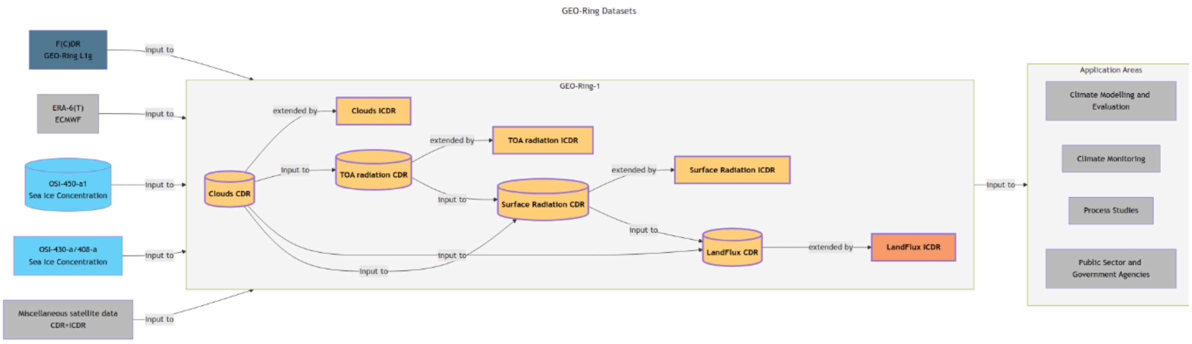
- Clouds
- Top-of-atmosphere (TOA) radiation
- Surface radiation

- Land surface temperature (LST)
- Sensible and latent heat fluxes (LEH).

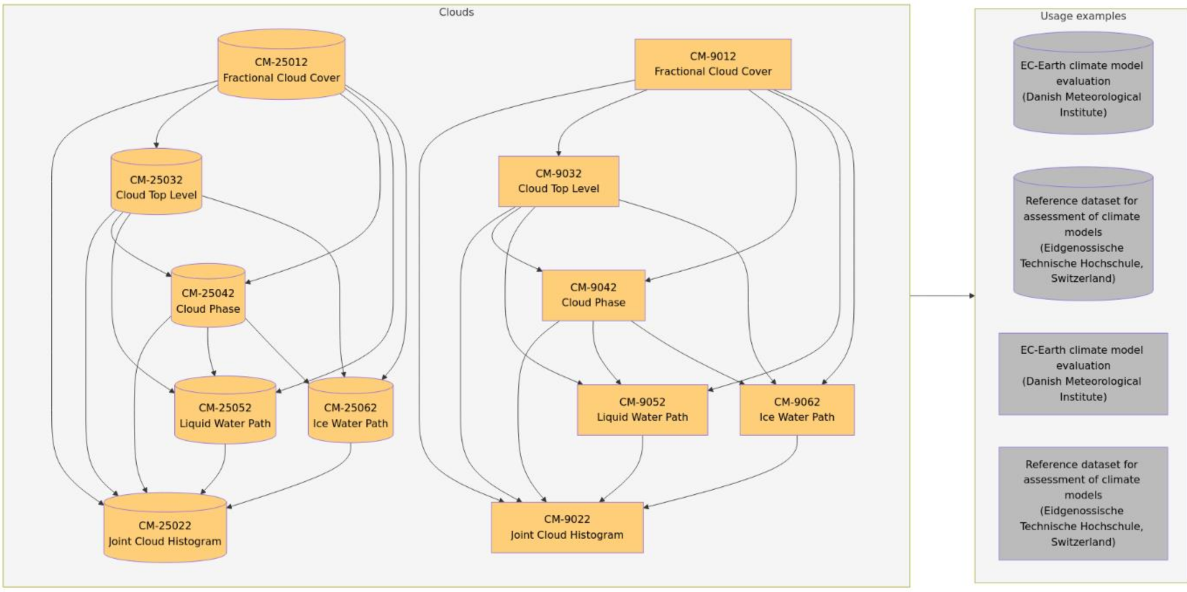
The plots show the product logic for the GEO-ring CDR and ICDR. Figure 2-8 gives an overview of the overall product family logic (Figure 2-8 a) as well as detail views of the dependencies for different product groups (Figure 2-8 b)-e)). Where products of the “cloud” product group are needed, these are shown as “input layer” in the detail plot of the top-of-atmosphere radiation parameters.

The LSA and CM SAFs will jointly develop the GeoRing LST CDR and the corresponding ICDR. To facilitate and align this cooperation, the LSA SAF and CM SAF have, in addition to the standard CM SAF GeoRing WPs, created a separate WP (LSA SAF 1124 and CM SAF 6210) that specifies all tasks the LSA SAF and CM SAF need to conduct to ensure a fully seamless CDR and ICDR. The CM SAF elements of the GEO-Ring LST are fully attached to the CM SAF Geo-Ring product family.

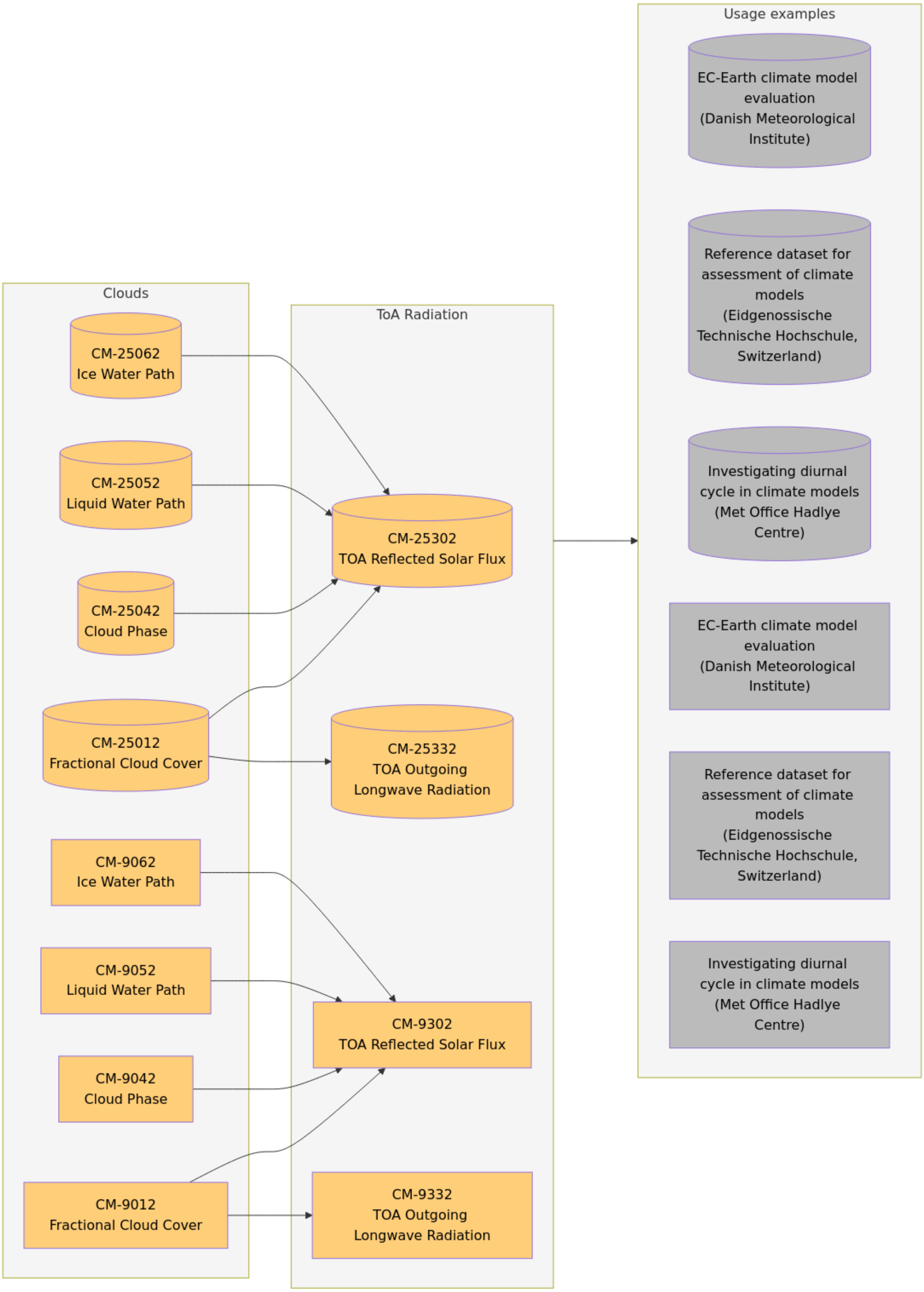
a)


GEO-Ring Datasets
F(C)DR
GEO-Ring L1g
input to
ERA-6(T)
ECMWF
input to
OSI-450-a1
Sea Ice Concentration
input to
OSI-430-a/408-a
Sea Ice Concentration
input to
Miscellaneous satellite data
CDR+ICDR
input to
GEO-Ring-1
Clouds CDR
extended by
Clouds ICDR
input to
TOA radiation CDR
extended by
TOA radiation ICDR
input to
Surface Radiation CDR
extended by
Surface Radiation ICDR
input to
LandFlux CDR
extended by
LandFlux ICDR
input to
input to
input to
Application Areas
Climate Modelling and Evaluation
Climate Monitoring
Process Studies
Public Sector and Government Agencies

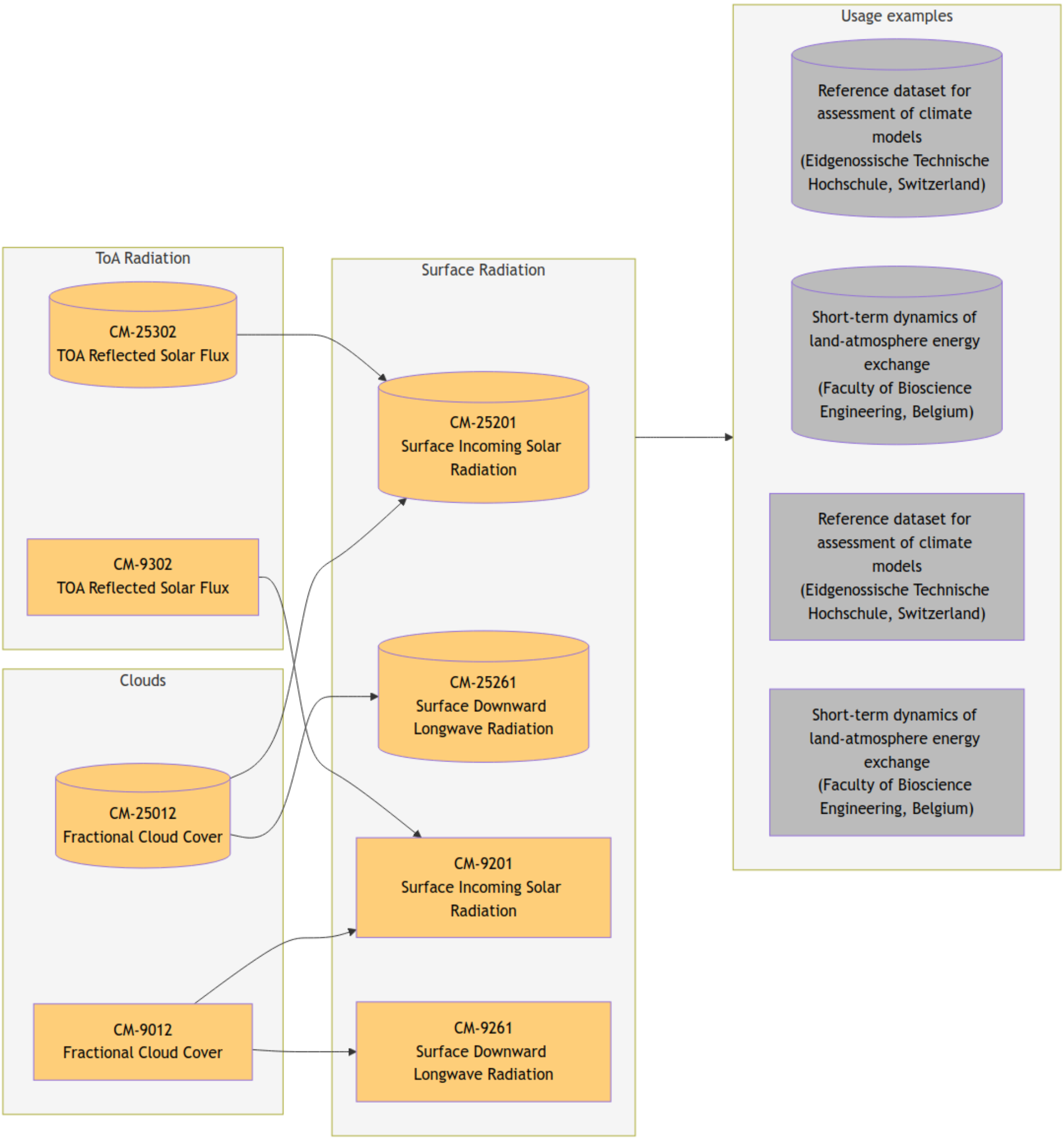
b)


Clouds
CM-25012
Fractional Cloud Cover
CM-25032
Cloud Top Level
CM-25042
Cloud Phase
CM-25052
Liquid Water Path
CM-25062
Ice Water Path
CM-25022
Joint Cloud Histogram
CM-9012
Fractional Cloud Cover
CM-9032
Cloud Top Level
CM-9042
Cloud Phase
CM-9052
Liquid Water Path
CM-9062
Ice Water Path
CM-9022
Joint Cloud Histogram
Usage examples
EC-Earth climate model evaluation (Danish Meteorological Institute)
Reference dataset for assessment of climate models (Eidgenossische Technische Hochschule, Switzerland)
EC-Earth climate model evaluation (Danish Meteorological Institute)
Reference dataset for assessment of climate models (Eidgenossische Technische Hochschule, Switzerland)

c)


Clouds
CM-25062
Ice Water Path
CM-25052
Liquid Water Path
CM-25042
Cloud Phase
CM-25012
Fractional Cloud Cover
CM-9062
Ice Water Path
CM-9052
Liquid Water Path
CM-9042
Cloud Phase
CM-9012
Fractional Cloud Cover
ToA Radiation
CM-25302
TOA Reflected Solar Flux
CM-25332
TOA Outgoing
Longwave Radiation
CM-9302
TOA Reflected Solar Flux
CM-9332
TOA Outgoing
Longwave Radiation
Usage examples
EC-Earth climate model
evaluation
(Danish Meteorological
Institute)
Reference dataset for
assessment of climate
models
(Eidgenossische
Technische Hochschule,
Switzerland)
Investigating diurnal
cycle in climate models
(Met Office Hadlye
Centre)
EC-Earth climate model
evaluation
(Danish Meteorological
Institute)
Reference dataset for
assessment of climate
models
(Eidgenossische
Technische Hochschule,
Switzerland)
Investigating diurnal
cycle in climate models
(Met Office Hadlye
Centre)

d)


Usage examples
Reference dataset for assessment of climate models (Eidgenossische Technische Hochschule, Switzerland)
Short-term dynamics of land-atmosphere energy exchange (Faculty of Bioscience Engineering, Belgium)
Reference dataset for assessment of climate models (Eidgenossische Technische Hochschule, Switzerland)
Short-term dynamics of land-atmosphere energy exchange (Faculty of Bioscience Engineering, Belgium)
ToA Radiation
CM-25302 TOA Reflected Solar Flux
CM-9302 TOA Reflected Solar Flux
Surface Radiation
CM-25201 Surface Incoming Solar Radiation
CM-25261 Surface Downward Longwave Radiation
CM-9201 Surface Incoming Solar Radiation
CM-9261 Surface Downward Longwave Radiation
Clouds
CM-25012 Fractional Cloud Cover
CM-9012 Fractional Cloud Cover

e)

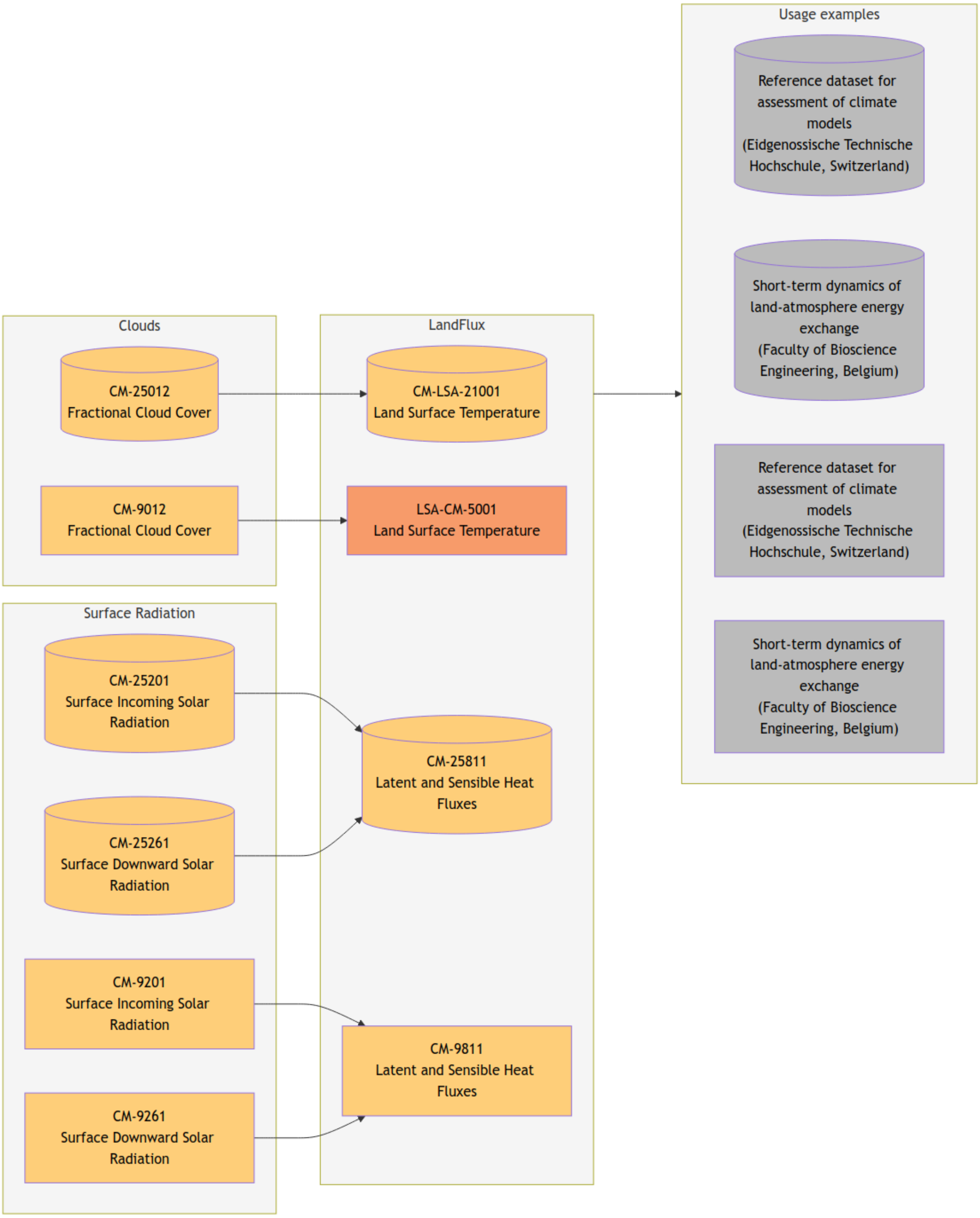


Figure 2-8: Product Logic for GEO-ring CDR and ICDR: a) overview, b) cloud parameters, c) top-of-atmosphere radiation, d) surface radiation, e) LandFlux parameters.

2.2.3.2 Product Family description

In this Section, product descriptions are provided, starting with a list of products belonging to the product family (see Table 2-6). **New product commitments** are indicated in **bold**.

Table 2-6: Overview of products belonging to GEO-Ring.

Product Family:		**Near Global Clouds, Radiation, Surface Albedo, Temperature, Fluxes (GEO-Ring)**			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
CDR					
CM-25012	Fractional Cloud Cover (CFC)	Quasi-global, 0.05 deg, half-hourly	CDR start in 2004 (Meteosat-8/SEVIRI operational, 2004 or later, depending on longitude). End in 2030	Demonstrational, in development	Climate monitoring, services, (climate) model evaluation, process studies
CM-25022	Joint Cloud Histogram (JCH)	idem		idem	As CFC
CM-25032	Cloud Top Level (CTO)	Idem		idem	As CFC
CM-25042	Cloud Phase (CPH)	Idem		idem	As CFC
CM-25052	Liquid Water Path (LWP)	Idem		idem	As CFC
CM-25062	Ice Water Path (IWP)	Idem		idem	As CFC
CM-25302	Reflected Solar Flux (RSF)	Idem, but hourly		idem	As CFC
CM-25332	Outgoing longwave radiation (OLR)	Idem		idem	As CFC
CM-25201	Surface Incoming Solar Radiation (SIS)	Idem, half-hourly again		based on CLARA-A3.5	As CFC, energy meteorology
CM-25261	Surface Downward Longwave Radiation (SDL)	Quasi-global, 0.05 deg, hourly		demo	As CFC
CM-LSA-21001	Land Surface Temperature (LST)	Idem, half-hourly again	in cooperation with LSA SAF	PCR achieved	As CFC, extremes and attribution

Product Family:		Near Global Clouds, Radiation, Surface Albedo, Temperature, Fluxes (GEO-Ring)			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
CM-25812	Latent and sensible heat flux (LEH)	Idem but hourly		PCR achieved	As CFC
ICDR					
CM-9012	Fractional Cloud Cover (CFC)	Quasi-global, 0.05 deg, half-hourly, 5-10 day latency	Following CDR from 2031 onwards	in development	Climate services, monitoring, (climate) model evaluation, process studies
CM-9022	Joint Cloud Histogram (JCH)	Idem		idem	As CFC
CM-9032	Cloud Top Level (CTO)	Idem		idem	As CFC
CM-9042	Cloud Phase (CPH)	Idem		idem	As CFC
CM-9052	Liquid Water Path (LWP)	Idem		idem	As CFC
CM-9062	Ice Water Path (IWP)	Idem		idem	As CFC
CM-9302	Reflected Solar Flux (RSF)	Idem, but hourly		idem	As CFC
CM-9332	Outgoing Longwave Radiation (OLR)	Idem, but hourly		idem	As CFC
CM-9201	Surface Incoming Solar Radiation (SIS)	Idem		based on CLARA-A3.5	As CFC, energy meteorology
CM-9261	Surface Downward Longwave Radiation (SDL)	Idem		in development	As CFC
LSA-CM-5001	Land Surface Temperature (LST)	Idem, and near real-time	produced by LSA SAF	idem	As CFC, extremes and attribution, climate service for heatwaves and droughts
CM-9811	Latent and sensible heat flux (LEH)	Idem, but hourly		idem	As CFC

All products will be available on a common grid and in a common format. Details for surface incoming solar radiation (SIS) are given in Section 2.2.2.

The GEO-Ring products have strong heritage from – and links to – existing data records based on Meteosat observations. Clouds and TOA radiation are contained in the CLAAS-4 data record, surface radiation will be derived based on the CLARA retrieval algorithm, LST is contained in the SUMET (CM SAF land SUrface temperature dataset from METeosat first and second generation) data record (also an element of LandFlux), and LEH has heritage from the LandFlux CDR.
The GEO-Ring data record will be based on merged Level-1 data from several geostationary satellites, thereby achieving quasi-global coverage (except the Poles) with high spatio-temporal resolution. This merged L1 data is currently under development in the GEO-Ring project, a cross space agency project, with EUMETSAT leading this activity. The data record will start in 2004, when the first SEVIRI instrument, onboard Meteosat-8, became operational. This choice is a compromise between going back as far as possible in time and having a reasonable longitudinal coverage by sensors with at least the spectral channels (visible, shortwave-infrared, water vapour and thermal infrared) required for the retrieval algorithm suite. The data record will at least include the GOES-ABI (Advanced Baseline Imager), MTG-FCI (Flexible Combined Imager), Himawari-AHI (Advanced Himawari Imager) and MSG-SEVIRI instruments, complemented by the GOES second generation and MTSAT imagers. The goal is also to add a L2 cloud mask to GEO-Ring Level-1 data to facilitate further external applications for retrieval of surface parameters and cloud-free atmospheric properties (more details given in Section 2.2.3.5).
ISCCP-NG was initiated by GEWEX by expressing the need to modernize the cutting-edge effort on ISCCP by using a larger set of channels and proving data at higher resolution. CM SAF supported the development of first test data, led by NOAA, and released a demonstrational data record in CDOP-4. ISCCP-NG is now supervised by CGMS ICWG which is currently co-chaired by CM SAF. Also, the assessment of L1g-based cloud products, an ICWG project, is co-chaired by CM SAF. CM SAF continues to pursue a major role in ISCCP-NG.

2.2.3.3 Current usage of CM SAF products

As this is a new data record planned for CDOP-5, there is no current usage to be reported. Instead, future usage prospects described below are based on corresponding usage of Meteosat-based data records, which closely resemble the GEO-Ring products in terms of both spatial and temporal resolution, but do not have (quasi-)global coverage.

2.2.3.3.1 Usage by services in EUMETSAT member states

In the following, results of CM SAF product usage monitoring for Meteosat-based cloud products (CLAAS) are shown. CLAAS products can be seen as precursors of the Geo-Ring products, in a sense that they cover a spatial subset of the GEO-Ring and that Meteosat-based products become an integral part of GEO-Ring products. The table includes information on specific users, describes the application, the link to the application, and evidence for product usage in Member States.

SUMET is an element of the CDOP-4 LandFlux product family and can also be seen as precursor of related GEO-Ring products. Associated statistics are shown in Figure 2-13 in Section 2.2.5.3 and example products usage cases are given in Table 2-7 in Section 2.2.6.3.
Surface radiation product from the SARAH product family can be seen as a precursor of related Geo-Ring products. Associated statistics are shown in Figure 2-6 and example products usage cases are given in Table 2-5 in Section 2.2.2.3.1.

The number of unique customers from EUMETSAT Member States requesting data from the CLAAS data records over the period 2022-2024 are shown in Figure 2-9.

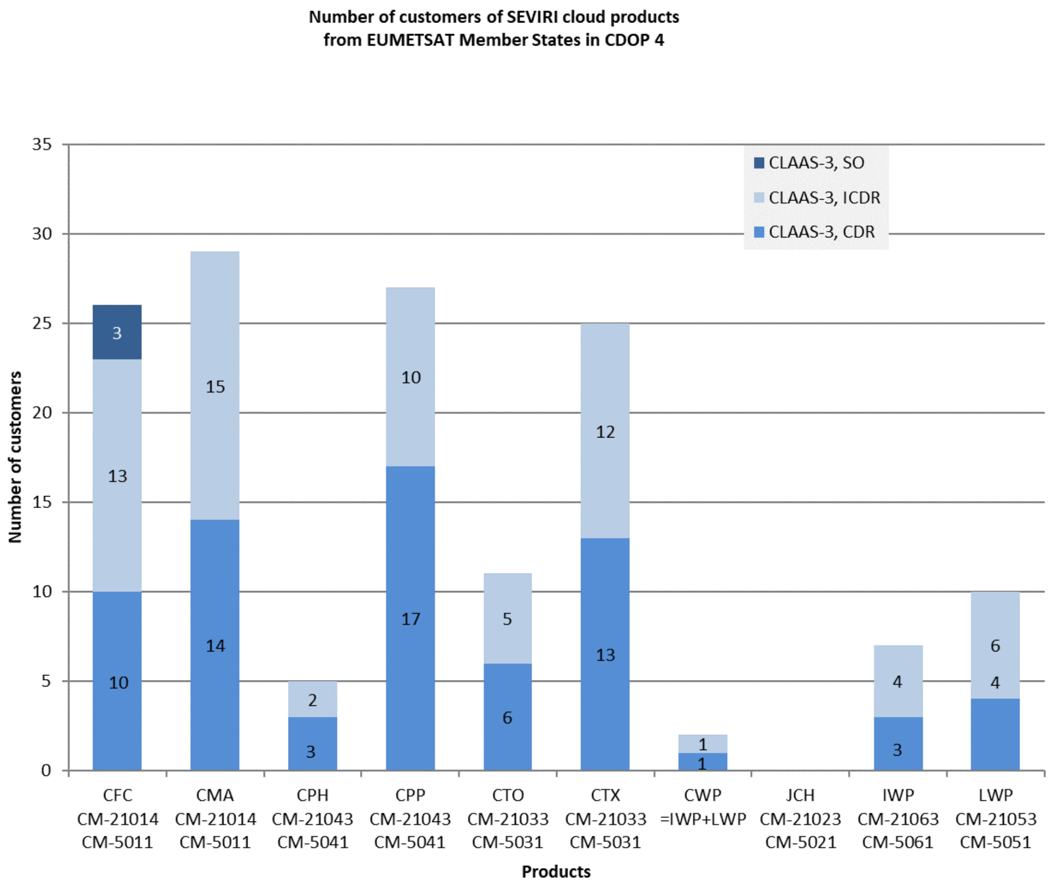


Figure 2-9: Number of unique users of CLAAS-3 from Member States. The x-axis shows the CM SAF product identifier (5 digits: CDR, 4 digits: ICDR) and an abbreviation of the associated parameter. The abbreviations are defined in the overview table in the Section 2.2.3.2. CMA (cloud mask) is the instantaneous cloud mask while CFC is the cloud fraction on regular longitude latitude grid. Similarly, CTX is instantaneous cloud top level, while CTO are aggregated values, and CPP are instantaneous cloud physical properties, while CPH, LWP and IWP are aggregated values.

Figure 2-9 shows that all elements of the CLAAS product family are used in Member States, except joined cloud histograms (JCH). There are numerous applications of these data in EUMETSAT Member States, some are highlighted in Table 2-5. The table also shows example product usage cases for TOA radiation. These products are based on MVIRI/SEVIRI and GERB (Geostationary Earth Radiation Budget) observations and can be seen as a precursor for the TOA product of the GEO-Ring family.

Table 2-7: Usage case examples for CLAAS and GERB/SEVIRI.

Product family	CM-Identifiers	Application area	Detailed description of application	Link to application	Link showing reference to CM SAF data	Institute
CLAAS-3, cloud fraction	CM-5011, CM-21014	Climate monitoring	The high-resolution grids of hourly variables (HOSTRADA) for Germany is a climatological reference dataset that serves as the basis for the development and update of current test reference years, making it particularly important for technical climatology. It provides a wide range of meteorological parameters for the land surface of the Federal Republic of Germany from 1995, with a spatial resolution of one square kilometer and a temporal resolution of one hour.	https://www.dwd.de/DE/leistungen/uhi/info_methodic/01_hostrada.html	https://opendata.dwd.de/climate_environment/CDC/grids_germany/hourly/hostrada/BESCHREIBUNG_gridsgermany_hourly_hostrada_de.pdf	Deutscher Wetterdienst, D
CLAAS-3, liquid water path	CM-21053	Climate Analysis	Comparing the simulated influence of biomass burning plumes on low-level clouds over the southeastern Atlantic under varying smoke conditions	https://acp.copernicus.org/articles/24/4591/2024/	https://acp.copernicus.org/articles/24/4591/2024/	Chalmers Technical University, SE
GERB/SEVIRI ed. 2.0 (precursor of CLAAS-4 TOA products), TOA radiation	CM-21301, CM-21331	Model evaluation	Validation of general circulation models in the Coupled Model Intercomparison Project (CMIP5) with observed seasonal variability in TOA and surface radiation fluxes over West Africa.	https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019EA001017	https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019EA001017	The University of Edinburgh, UK
MVIRI/SEVIRI ed. 1.0 (precursor of CLAAS-4 TOA products), TOA radiation	CM-23311, CM-23341	Model evaluation	Validation of TOA radiative fluxes in climate simulations Over Europe (biases decrease when convection is explicitly resolved instead of parameterized)	https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2018JD030150	https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2018JD030150	ETH Zürich, CH
CLAAS-2, clouds	CM-21051	Process studies	CLAAS data were used to assess stratocumulus adjustments to aerosol perturbations	https://www.nature.com/articles/s41612-023-00452-w	https://www.nature.com/articles/s41612-023-00452-w	Institute for Atmospheric and Climate Science, ETH Zürich, CH

Product family	CM-Identifiers	Application area	Detailed description of application	Link to application	Link showing reference to CM SAF data	Institute
CLAAS-3, cloud fraction	CM-21014, CM-5011	Climate monitoring	The Climate Preparedness Services of the federal states and the government find quality approved services offering guidance in taking precautionary measures against the effects of climate change. The data addresses climate monitoring, renewable energies, hydrology, and agrar-meteorology.	KLiVO Portal - KLiVO	https://www.klivoportal.de/SharedDocs/Steckbriefe/DE/dwd_bewoelkung_freie/bewoelkung_freie_steckbrief.html	German Government, D
GERB/SEVIRI ed. 2.0 (precursor of CLAAS-4 TOA products), TOA radiation	CM-23311, CM-23341	Climate monitoring	The Climate Preparedness Services of the federal states and the government find quality approved services offering guidance in taking precautionary measures against the effects of climate change. The data addresses climate monitoring.	KLiVO Portal - KLiVO	https://www.klivoportal.de/SharedDocs/Steckbriefe/DE/dwd_strahlung_freie/dwd_strahlung_freie_steckbrief.html	German Government, D

2.2.3.3.2 Other relevant usage

Apart from usage cases in services by Member States, the users of CLAAS data records have been mainly scientists performing studies for various applications. Given the extended spatial coverage and the similar spatio-temporal resolution of the GEO-Ring, compared to CLAAS, it is expected that the GEO-Ring usage will be similar, and possibly more extended. Based on detailed monitoring of peer-reviewed studies in which CLAAS data products have been used, the main usage areas for cloud and TOA radiation products can be roughly grouped as follows:

For cloud products:

- Characterization of spatio-temporal distributions of cloud properties
- Cloud life cycle analysis and process studies
- (Regional) climate model evaluation
- Inter-comparison with other satellite data or ground-based observations
- Cloud filtering for the retrieval/evaluation of other product

For TOA radiation products:

- Understanding regional climate mechanisms
- Quantification of atmospheric processes
- Evaluation/Improvement of climate and NWP (Numerical Weather Prediction) models
- Use of TOA reflected radiation as boundary condition to calculate surface radiative fluxes

This categorization indicates a diverse group of scientific users with multiple application areas.

Figure 2-10 shows the number of unique users for CLAAS-3 from all customers. Similar statistics are shown in Figure 2-14 in Section 2.2.5.3 for LandFlux.

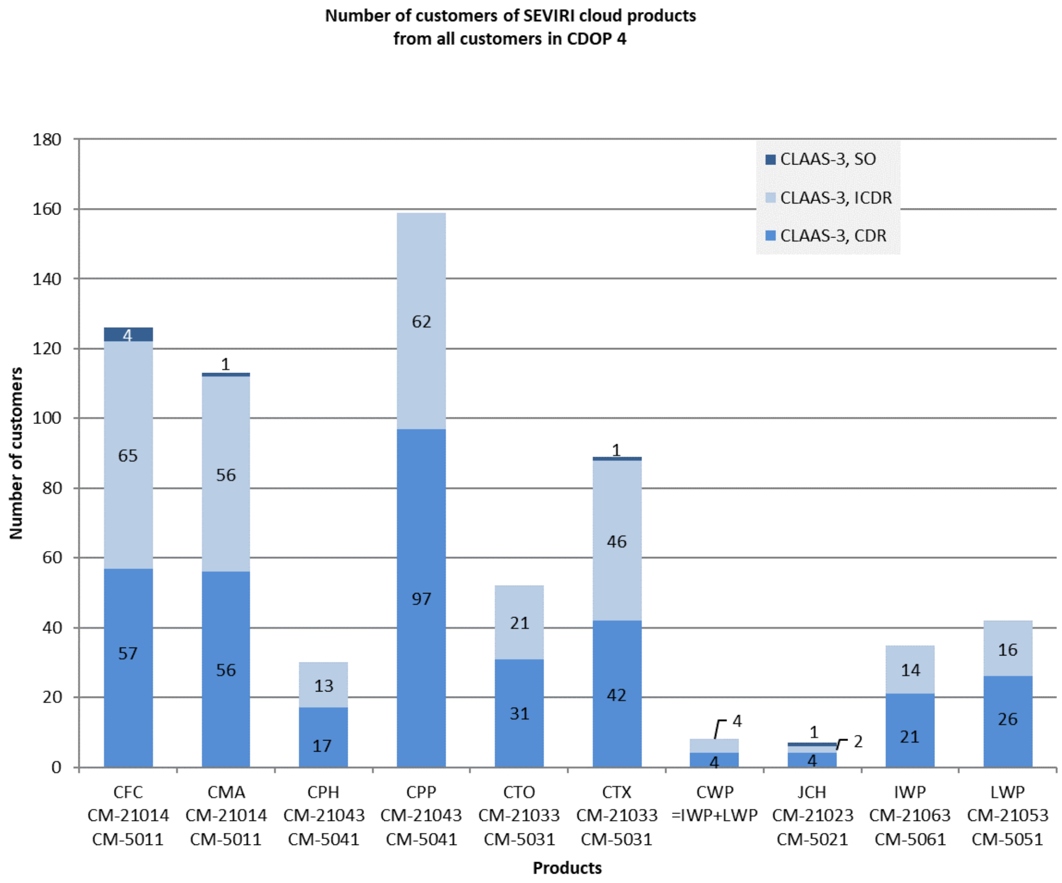


Figure 2-10: Number of unique users of CLAAS-3 from all customers. The x-axis shows the CM SAF product identifier (5 digits: CDR, 4 digits: ICDR) and an abbreviation of the associated parameter. The abbreviations are defined in the overview table in the Section 2.2.3.2. CMA (cloud mask) is the instantaneous cloud mask while CFC is the cloud fraction on regular longitude latitude grid. Similarly, CTX is instantaneous cloud top level, while CTO are aggregated values, and CPP are instantaneous cloud physical properties, while CPH, LWP and IWP are aggregated values.

2.2.3.4 Key improvements

Although a demonstrator will be delivered in CDOP-4, this GEO-Ring dataset is basically a new product. Compared to the demonstrator, several variables will be added and weaknesses will be repaired. The next Section describes the algorithms along with some planned improvements.

2.2.3.5 Description of new products

CDR

Cloud products

The cloud products are generated by the PPS (Polar Platform System) software package. This package is developed by the NWC SAF, with specific contributions by CM SAF. The PPS software was originally established for polar orbiting satellite data and later extended to geostationary imagers. It was applied for the CLAAS-3 dataset and will also be the basis for CLAAS-4. Modifications to apply the algorithms to L1g data are being implemented for the GEO-Ring demonstration product in CDOP-4 and will be further developed and refined in CDOP-5. Besides calibrated satellite radiances (L1g), NWP data from ERA6 will be important inputs, as well as ancillary data including satellite-derived surface albedo.

The main cloud product algorithms are:

- Probabilistic cloud mask: This is based on a naive Bayesian classifier trained with CALIOP (Cloud-Aerosol Lidar with Orthogonal Polarisation) observations (Karlsson et al., 2020). The cloud probability can be transformed to a binary cloud mask by applying a 50% threshold for production of downstream products. The exact definition of the earlier mentioned cloud mask, aimed for future provision together with the GEO-ring L1 product, has still to be decided.
  A new method based on machine learning methods, trained with CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations)-CALIOP and EarthCARE data, and with extended uncertainty characterization, is under development and will replace the naïve Bayesian classifier at a later stage. This product will also provide cloud probabilities as output. Special attention will be given to the handling of data in zones of satellite sensor overlap/boundaries
- Cloud top height: This is retrieved using a multilayer perceptron neural network trained with CALIOP data (Håkansson et al., 2018). The basic retrieved variable is cloud top pressure, which is then converted to cloud top temperature and height.
- Cloud phase: As in CLAAS-4, a neural network approach for distinguishing liquid and ice clouds and providing further cloud types is planned to be used.
- Cloud physical properties (CPP): The basic properties cloud optical thickness and particle effective radius are retrieved following the classic approach introduced by Nakajima and King (1990). Additional cloud properties including liquid/ice water path and cloud droplet number concentration are also provided (Benas et al., 2023).
  A major planned improvement in the cloud product catalogue will be the inclusion of nighttime CPP retrievals along the lines of White et al. (2025). This offers several benefits:

- Complete coverage of the 24-hour cycle with consistent day- and night-time retrievals
- Improved retrievals in twilight conditions (high solar zenith angle retrievals in daytime-only algorithms are characterized by lower retrieval quality)
- Better (fully diurnal) assessment of cloud variability, including cloud changes, long-term trends and regime characterization

These improvements are expected to enhance the quality and utility of the CPP-based GEO-Ring CDRs, offering a useful addition to the daytime-only retrievals.

In addition to planned improvements of individual cloud products, the development of a COSP simulator for the cloud datasets is planned. This will start from the current simulator version for the CLAAS dataset and be expanded to the GEO-Ring. Tentatively, also other products than cloud products can be included in this simulator. The COSP simulators are tools to enable a more efficient inter-comparison between satellite-derived CDRs and datasets from climate models. They are considered essential for the evaluation of climate model results for IPCC assessments (e.g., for the current CMIP-7 experiments and for the successor CMIP-8).

TOA radiation products

The Earth Radiation Budget (ERB) includes the total amount, i.e., integrating all wavelengths, of Reflected Solar Radiation (RSF) and Outgoing Longwave Radiation (OLR), at the top of atmosphere (TOA). The TOA Incoming Solar (TIS) radiation is provided as ancillary data to estimate planetary albedo and TOA net radiation. These radiative fluxes are the main drivers of the atmospheric and oceanic circulations and as such are recognized as ECV by GCOS. TOA fluxes have been added to the CLARA portfolio since CLARA-A3, and to the CLAAS portfolio since CLAAS-4.

The GEO-Ring TOA products are derived from the L1g narrowband channel shortwave reflectances (RSF) and longwave brightness temperatures (OLR) from geostationary satellites, which constitute the main satellite input. The retrieval is done using a series of algorithms, converting in a first place the narrowband observations to a single broadband quantity (using empirical narrowband-to-broadband relations), and subsequently from a directional to a hemispherical quantity (using Angular Dependency Models or ADMs, depending on viewing and illumination geometry). These conversion algorithms are developed for a range of detailed scene types, reflecting their current level of sophistication. Auxiliary data are mostly needed to identify the appropriate scene type; these include cloud products generated with the PPS software package and also released as GEO-Ring end products (cloud cover, phase, thickness,...) but also certain NWP variables from reanalysis remapped on the GEO-Ring grid (e.g. wind speed, integrated water vapor,..) and static data (e.g. land cover type). Besides the all-sky fluxes (based on all available observations), clear-sky fluxes will be produced as well (based on interpolated clear-sky observations), allowing to quantify the cloud radiative effect. Rather than calculating simple temporal averages from each x consecutive images, the Level-3 aggregation is done using accurate pixel-wise temporal integration of instantaneous observations to obtain hourly mean fluxes, and from that also generate daily and monthly mean products.

Surface Irradiance

The surface irradiance is the solar radiation reaching the earth surface; it is the main source of the surface energy budget and has gained substantial attention with increased installation of solar energy / PV installations.
The GEO-Ring surface irradiance products will be based on the CLARA retrieval scheme, which uses as input the data from the probabilistic cloud mask and the reflected solar radiation, ensuring the high consistency among the data records.

Land surface temperature

The LSA and CM SAFs will jointly develop a LST CDR and the corresponding ICDR to be derived from the merged Level 1 GEO-ring data currently being prepared by EUMETSAT (WP 6210). The co-development and production will leverage expertise and production chains maintained and/or under development within each SAF:

- The CDR/ICDR will make use of commonly developed LST algorithms and emissivity data provided by the LSA SAF, to be applied to the merged L1 GEO-ring data; the ICDR and CDR shall also use compatible cloud masks.
- Validate and ensure the consistency of CDR and ICDR – the LSA SAF shall ensure the NRT ICDR is fully consistent with the CDR.
- The LSA SAF will ensure the ICDR is available with low latency (< 1 day).

The Copernicus Monitoring Land Service (CMLS) is operating a geostationary LST, which uses the LSA SAF NRT MSG LST (LSA-004) as input. Future versions of this CMLS LST product may benefit directly from the outcome of this joint LSA-CM SAF activity. As such, we will seek close coordination between LSA SAF, CM SAF and CLMS, as further detailed in WP 6210.

k

Latent and sensible heat fluxes

The data is delivered as hourly, daily, monthly and monthly mean diurnal cycle fields of latent heat flux (LE) and sensible heat flux (H). This product largely builds on LandFlux v1 from CDOP-4 and will be carried out in close cooperation the LSA SAF. The primary satellite inputs are radiative fluxes (shortwave and longwave) from the GEO-Ring constellation of geostationary satellites (SIS from SARAH and SDL from Geosatclim), complemented by auxiliary land surface parameters (e.g., albedo, leaf area index (LAI)) from satellite products and meteorological forcings from reanalysis dataset. The retrieval algorithm is based on an adapted version of the Land Flux v1 CDR algorithm, derived from the LSA SAF v3 methodology. This approach employs a Surface Vegetation–Atmosphere Transfer (SVAT) scheme, originally developed within Tiled ECMWF Scheme for Surface Exchanges over Land (TESSEL)/H-TESSEL (, modified to integrate satellite radiative inputs and external meteorological forcings. The resulting product provides consistent and physically based estimates of LE, H, and ET with sub-daily temporal resolution, enabling the reconstruction of the full diurnal cycle. The dataset is designed to support climate monitoring, hydrological applications, and model evaluation, with rigorous large-scale validation foreseen as part of the operational release process.

ICDR

For the production of the ICDR exactly the same algorithms will be used as for the CDR. Differences occur only for some of the input data (e.g., ERA6-T instead of ERA6) to allow production with a latency of 5-10 days. As noted before, LST will be produced by the LSA SAF, in a fully consistent way, in near real-time.

2.2.3.6 User Requirements for new products

CDR

Cloud products

Satellite-based cloud products are essential for climate and NWP model evaluation. The GEO-Ring data record is particularly useful for this purpose as it has quasi-global coverage, thus enabling global evaluations. Another application is process studies. A major example is cloud-radiation interaction. By resolving the diurnal cycle, the GEO-Ring data record allows evaluating fast cloud processes and their radiative effects. Cloud evolution and organization can be captured by the relatively high temporal resolution.

There are several cloud and radiation data records based on passive VIS-IR imagery. However, most of these rely on stand-alone polar orbiting or geostationary sensors, which yield global data records with limited temporal resolution, or local records with high temporal resolution, respectively. The GEO-Ring data record will combine a quasi-global spatial coverage with a high temporal resolution, which is a unique property. The ISCCP data record, which combines geostationary satellite measurements with polar-orbiting imagers, provides global coverage but lower temporal (3 hours vs. 30 minutes) and spatial (10 km vs. 5 km) resolutions. Another important difference is that ISCCP uses two heritage short- and longwave imager channels (allowing it to go back in time to the first geostationary satellites), whereas the GEO-Ring data record will take advantage of additional shortwave-infrared, water vapour and infrared split-window channels.

TOA radiation

Three main application areas for TOA radiation CDRs have been identified: Understanding regional climate mechanisms, quantification of atmospheric processes, and evaluation/improvement of climate and NWP models. In addition, a TOA radiation CDR can be used as boundary condition to calculate surface radiative fluxes, since the first step in estimating surface radiation often consists in an accurate estimation of TOA reflected radiation (e.g., the algorithm of Pinker and Laszlo, 1992). In these main application areas, the combination of high spatial resolution and temporal resolution (with at least a resolved diurnal cycle), as well as near global coverage, are key properties of the observational data record used to answer the relevant research questions. However, none of the currently existing TOA flux data records combine all these properties. For instance, the well-known global CERES (Clouds and the Earth's Radiant Energy System) products offer high-quality fluxes with hourly temporal resolution, although on a low-resolution grid (1°x1°). The CLAAS-4 TOA flux data record, released within the CM SAF, features a high spatial and temporal resolution, but only for a limited spatial coverage (Meteosat field of view). Now, the Geo-ring TOA flux products will integrate all the above-mentioned requirements and provide a data record on high spatial and temporal resolution, as well featuring a quasi-global coverage. In addition, these empirically derived GEO-Ring TOA products will be valuable to evaluate the future ISCCP-NG heating rate and radiation profiles, calculated from the cloud retrievals.

Surface Irradiance

The applications of surface irradiance are expected to range from climate monitoring, climate analysis to the assessment of solar resources as already documented in the usage of the SARAH and the CLARA data records.

Land surface temperature

Global LST data are used for climate research, monitoring agricultural conditions, urban heat studies, and validating climate models, providing critical information on the energy and water exchanges between land and atmosphere. These data help decision-makers understand and adapt to heatwaves and other extreme events, supporting climate-adaptive policies at national and local levels: Specific applications include:

- **Climate Change Monitoring:**
  LST is one of the fundamental variables that indicates the greenhouse effect and energy fluxes, helping to monitor climate system changes over time.
- **Agriculture and Drought:**
  LST data are used for monitoring crop health, water stress, and agricultural drought, influencing water use and irrigation strategies.
- **Urban Heat Studies:**
  The data are used to monitor and map heat in urban areas, informing policy and planning for heat risk and vulnerability, especially in rapidly urbanizing regions.
- **Climate Model Validation:**
  LST data provide essential, independent information to evaluate and improve land surface models, which are crucial for understanding land surface-atmosphere exchanges.
- **Extreme Event Analysis:**
  LST trends inform planning for and adaptation to extreme events like heatwaves, providing evidence for decision-makers to address heat risk and vulnerability.

LST has a strong diurnal cycle and is a clear sky data set. Hence, hourly data are of utters importance for all described applications. The ESA CCI LST project provides global LST data from the polar orbiting sensors with maximum four overpasses per day. The here proposed half-hourly resolved, quasi global LST CDR is a unique data set, which will foster our understanding of climate change in all described application areas. It can be used in conjunction with the other GEO-Ring cloud and radiation data to monitor land surface interactions in a changing climate.
Please note that this quasi-global LST product will be generated with a similar algorithm, as the local European high-resolution HANNA LST product. This will allow a 1:1 transfer of the HANNA-based climate services MeteoSwiss has developed and the SMHI, UK MetOffice envision to develop to none European countries. With large parts of the world particularly vulnerable for climate change, this activity is very important for the engagement of the Weather Services in developing countries. With e.g., MeteoSwiss being involved in international projects in the framework of the "Climate Risk Early Warning Systems (CREWS)" program in Africa, Asia and Southern America, the integration of those freely available CM SAF data in climate services can be fostered.

Latent and sensible heat fluxes

Regional and near global climate change analysis is a major application area for the proposed LE/H/ET CDR. The main user groups include agricultural planners, re-insurance companies, and national authorities assessing climate vulnerability and risks, as well as a broad scientific community covering agronomy, hydrology, climate, ecology, and policy (Fisher et al., 2017). Latent heat flux (~ET) and sensible heat flux (H) are key variables for climate model evaluation and for studying land–atmosphere interactions (Oki and Kanae, 2006; Randall et al., 2007). They are widely used in research on hydrology, droughts, vegetation feedbacks, water balance, heatwaves, climate monitoring and water management applications. Scientific community require homogeneous long-term time series that capture both long-term trends and short-term variability, particularly in regions where in situ observations are scarce (Miralles et al., 2016; Fisher et al., 2017; Sheffield et al., 2018). The proposed GEO-Ring product uniquely addresses these requirements by combining quasi-global coverage with hourly temporal resolution with a spatial resolution of 0.05°. Current alternatives as e.g., GLEAM or LSA SAF products lack either the required resolution or full coverage, ERA5 is limited by its coarser resolution and model-impacted uncertainties, and C3S has no comparable product despite clear interest. Since LSA SAF has no plans to develop a GEO-Ring product, the proposed dataset would fill a critical and unique role within the SAF portfolio. These requirements have already been confirmed during the successful Requirements Review, and supporting letters of interest and support are attached to this proposal.

ICDR

ICDR products are essential for climate services and in general for all applications requiring recent data rather than a historic data record.

2.2.3.7 Product Heritage

Cloud products

The cloud products build on the GEO-Ring demonstration dataset, which is developed in CDOP-4, and has heritage from the CLAAS algorithms.

TOA radiation

Heritage for the TOA products will come from the GEO-Ring demonstration dataset, developed in CDOP-4. This in turn has heritage from the CLAAS-4 algorithms.

Surface Irradiance

The heritage of the surface irradiance data will come from the global CLARA data record.

Land surface temperature

LST is part of the GEO-Ring LandFlux demonstration dataset, which is developed in CDOP-4. The algorithm (Duguay-Tetzlaff et al. 2015) is the CM SAF SUMET v.1.0 and CM SAF SUMET v.2.0 (Meteosat disk) retrieval algorithm.

Latent and Sensible heat fluxes

The proposed product builds on the GEO-Ring demonstration dataset, currently under development, and on the LandFlux v1.0 CDR for latent heat flux (LE), sensible heat flux (H), and evapotranspiration (ET). It inherits its methodology from the Land Flux v1 CDR algorithm, refined with experience from LSA SAF. This strong heritage ensures continuity, maturity, and proven feasibility for an operational GEO-Ring product.

2.2.4 Regional Clouds and Top-of-Atmosphere Radiation (CLAAS-4)

2.2.4.1 Product Family Logic

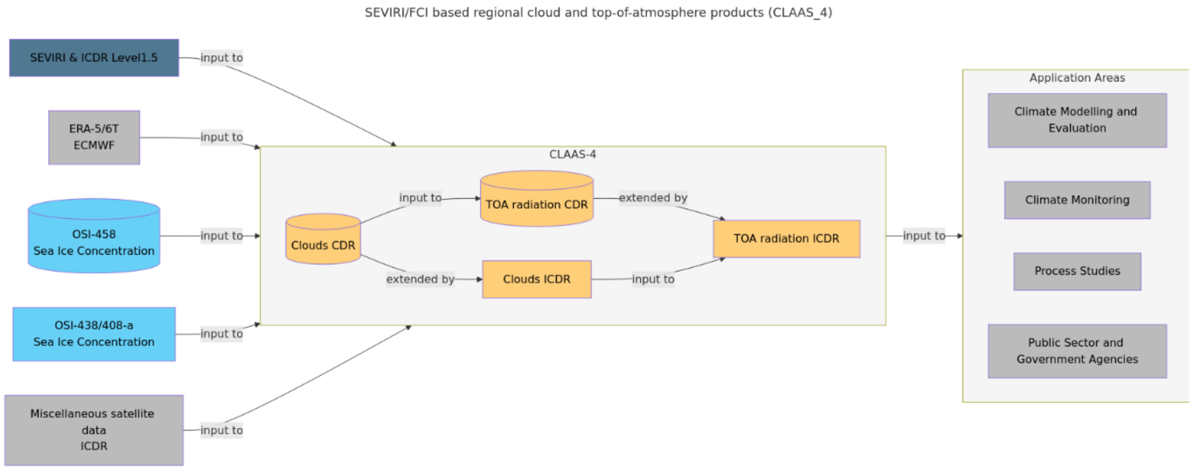
The CLAAS (CLoud property dAtAset using SEVIRI) family consists of the following product groups:

- Clouds
- Top-of-atmosphere (TOA) radiation

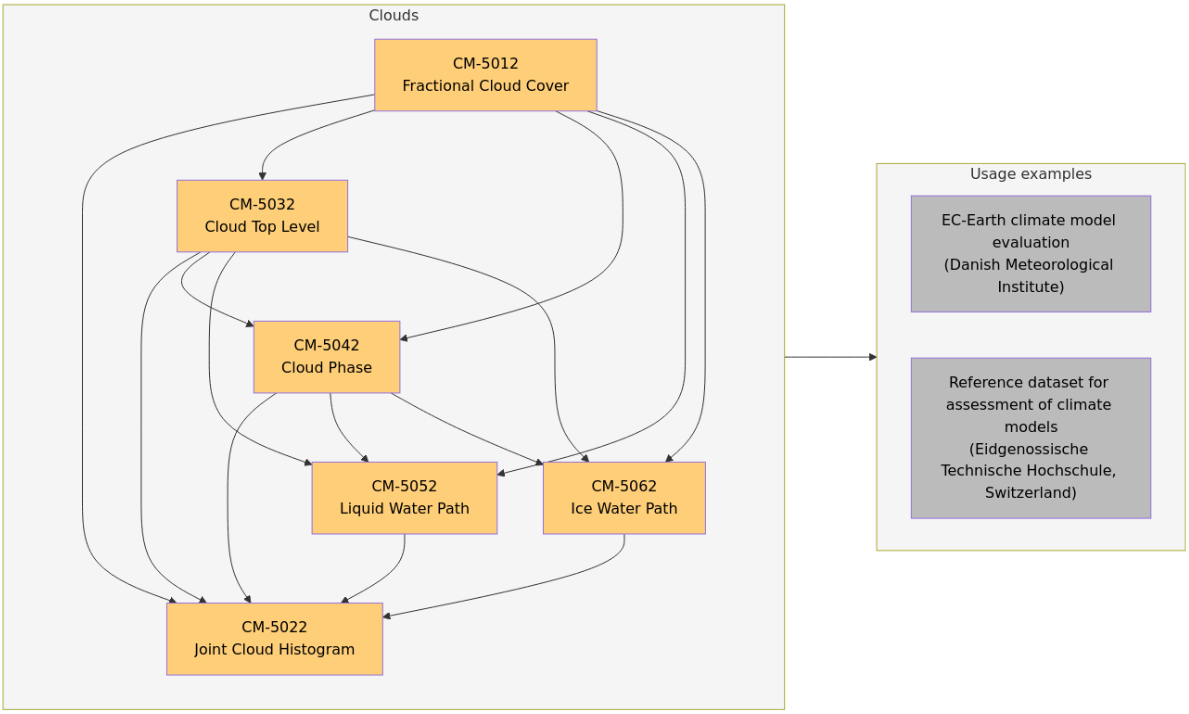
The CLAAS-4 CDR and ICDR will be operational at the end of CDOP-4. The CLAAS-4 ICDR will be operated until the end of CDOP-5.

Figure 2-11 gives the overall product family logic (Figure 2-11 a)) as well as detail views of the dependencies for the cloud parameters (Figure 2-11 b)) and top-of-atmosphere radiation parameters (Figure 2-11 c)) of the CLAAS-4 data records. Products from the “clouds” group are shown as “input layer” in the detail plot of the top-of-atmosphere parameters. The product logic of the respective CDR, which will already be released during CDOP-4, follows the same logic as the respective ICDRs and is not shown here.

a)


SEVIRI/FCI based regional cloud and top-of-atmosphere products (CLAAS_4)
SEVIRI & ICDR Level1.5
ERA-5/6T ECMWF
OSI-458 Sea Ice Concentration
OSI-438/408-a Sea Ice Concentration
Miscellaneous satellite data ICDR
input to
CLAAS-4
Clouds CDR
TOA radiation CDR
Clouds ICDR
TOA radiation ICDR
extended by
Application Areas
Climate Modelling and Evaluation
Climate Monitoring
Process Studies
Public Sector and Government Agencies

b)


Clouds
CM-5012 Fractional Cloud Cover
CM-5032 Cloud Top Level
CM-5042 Cloud Phase
CM-5052 Liquid Water Path
CM-5062 Ice Water Path
CM-5022 Joint Cloud Histogram
Usage examples
EC-Earth climate model evaluation (Danish Meteorological Institute)
Reference dataset for assessment of climate models (Eidgenossische Technische Hochschule, Switzerland)

c)

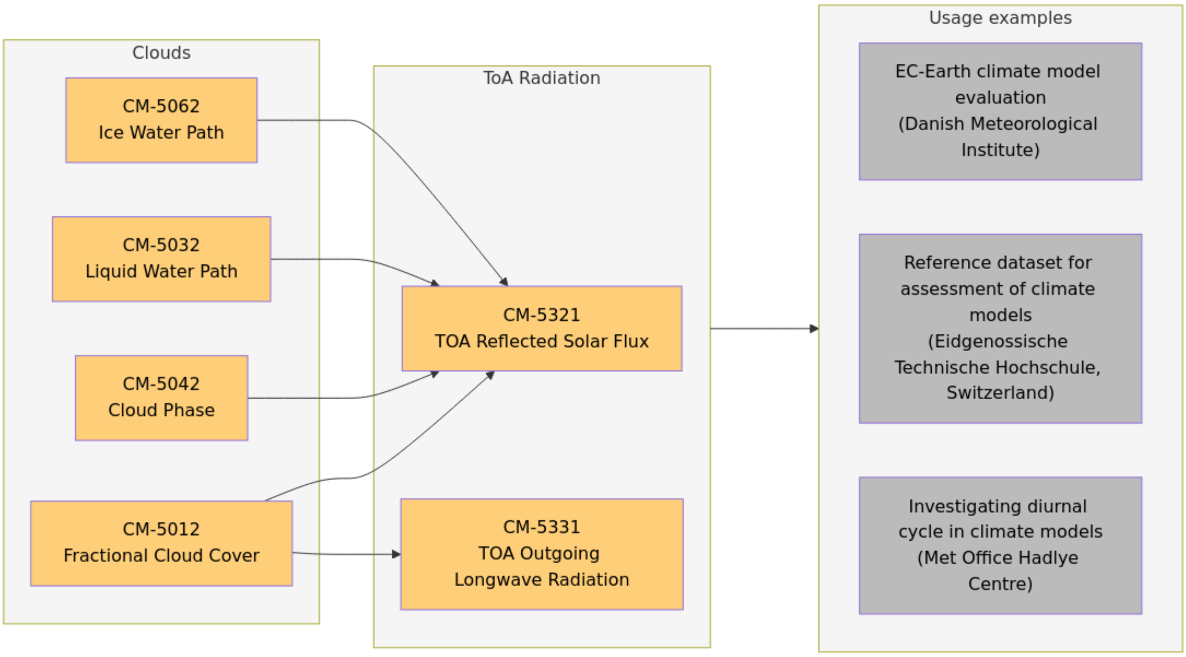


Figure 2-11: Product Logic for CLAAS-4 edition: a) overview, b) cloud parameters, c) TOA radiation.

2.2.4.2 Product Family description

In this Section, product descriptions are provided, starting with a list of products belonging to the product family (see Table 2-8). **New product commitments** are indicated in **bold**.

Table 2-8: Overview of products belonging to CLAAS-4.

Product Family:		**Regional Clouds and Top-of-Atmosphere Radiation (CLAAS-4)**			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
		CDR			
CM-21016	CFC	Mean cloud cover		Released	Climate analysis, monitoring, services, climate reports, climate model evaluation, process studies
CM-21024	JCH	Joint Cloud Histogram		Released	Climate model evaluation, Weather Regimes
CM-21034	CTO	Cloud Top Level		Released	As for JCH

Product Family:		**Regional Clouds and Top-of-Atmosphere Radiation (CLAAS-4)**			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
CM-21044	CPH	Cloud Phase		Released	As for JCH
CM-21054	LWP	Liquid Water Path		Released	Climate model evaluation, process studies
CM-21064	IWP	Ice Water Path		Released	As for LWP
CM-21302	RSF	Reflected Solar Flux		Released	As CFC, Earth radiation balance studies
CM-21332	OLR	Outgoing Longwave Radiation		Released	As CFC, Earth radiation balance studies
			ICDR		
CM-5012	CFC	Mean cloud cover		Operational	Climate analysis, monitoring, services, climate reports, climate model evaluation, process studies
CM-5022	JCH	Joint Cloud Histogram		Operational	Climate model evaluation, Weather Regimes
CM-5032	CTO	Cloud Top Level		Operational	As for JCH
CM-5042	CPH	Cloud Phase		Operational	As for JCH
CM-5052	LWP	Liquid Water Path		Operational	Climate model evaluation, process studies
CM-5062	IWP	Ice Water Path		Operational	As for LWP
CM-5321	RSF	Reflected Solar Flux		Operational	As CFC, Earth radiation balance studies
CM-5331	OLR	Outgoing Longwave Radiation		Operational	As CFC, Earth radiation balance studies

The CLAAS product family has a long heritage within the CM SAF starting in 2013 with the release of the first CLAAS version. During the previous phases of CM SAF the CLAAS data records have undergone continuous developments, both in terms of accuracy of the available data, but also in terms of adapting the data. The latest development within CDOP-4, i.e., the generation of CLAAS-4, encompasses the inclusion of data from FCI.

2.2.4.3 Current usage of CM SAF products

At the time of writing of the proposal the CLAAS-4 CDR and ICDR are still under development, Therefore, no current users can be given for this product family. A detailed view on the usage of the predecessors CLAAS-3 and the GERB/SEVIRI-based top of atmosphere products is given in Section 2.2.3.3.

2.2.4.4 Description of products

The CLAAS-4 CDR and ICDR parameters are a development of the CDOP-4 phase. At the end of CDOP-4 the CDR part of the product family has been released and the processing of the ICDR part is running operationally. The processing of the cloud and TOA parameters will be continued in CDOP-5 to fulfill the user needs described in Section 2.2.3.3.

2.2.5 Regional Latent and Sensible Heat Flux (LandFlux v1.1)

2.2.5.1 Product Family Logic

In CDOP-5 only the latent and sensible heat flux products, as part of the LandFlux product family, are upgraded to a new version. The Meteosat-based products are defined over land only. Figure 2-12 shows the product logic for the LandFlux data record.

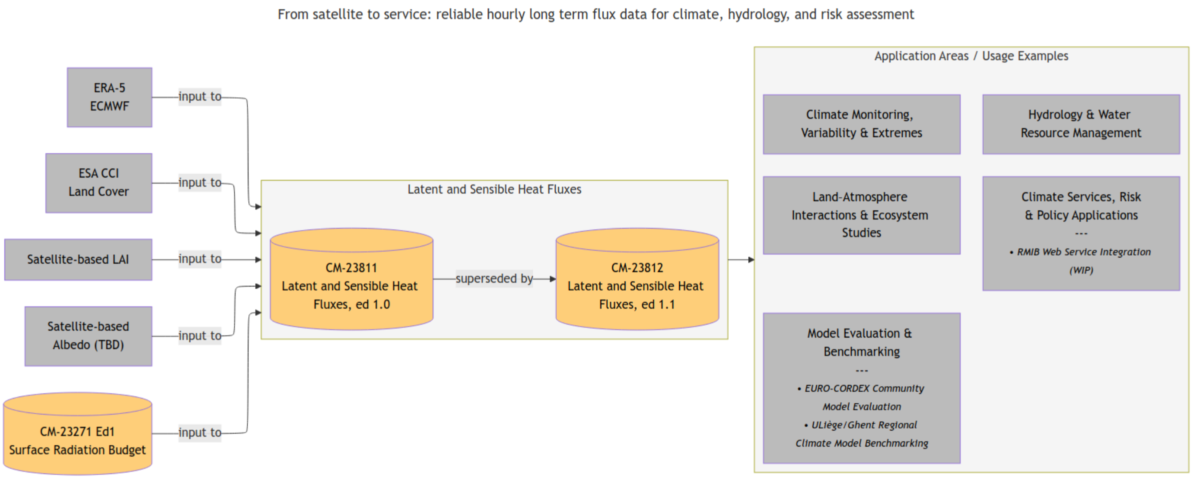


Figure 2-12: Product Logic for LandFlux CDR.

2.2.5.2 Product Family description

In this Section, product descriptions are provided, starting with a list of products belonging to the product family (see Table 2-9). **New product commitments** are indicated in **bold**.

Table 2-9: Overview of products belonging to LandFlux v1.1. DRR: Delivery Readiness Review.

Product Family:		**Regional Latent and Sensible Heat Flux (LandFlux v1.1)**			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
		CDR			
CM-23812	Latent and sensible heat flux (LEH)	Updated version	DRR only (PCR accomplished in CDOP-4)	in development, based LandFlux v1	Climate analysis, (climate) model evaluation, process studies

The LandFlux v1.1 is based on the LandFlux version 1 product that has been released by CM SAF in 2024. It further relies on a cooperation with LSA SAF.

2.2.5.3 Current usage of CM SAF products

As this is a recent product, no structured user feedback is available yet.

2.2.5.3.1 Usage by services in EUMETSAT member states

The CDR has not yet generated systematic feedback from national services, but its close alignment with LSA SAF products creates a strong entry point for operational uptake.
Even though released in 2024 only, quite a few users exist already: Figure 2-13 shows the number of unique users of LandFlux v1.0 from Member States. All LandFlux products are used in Member States.

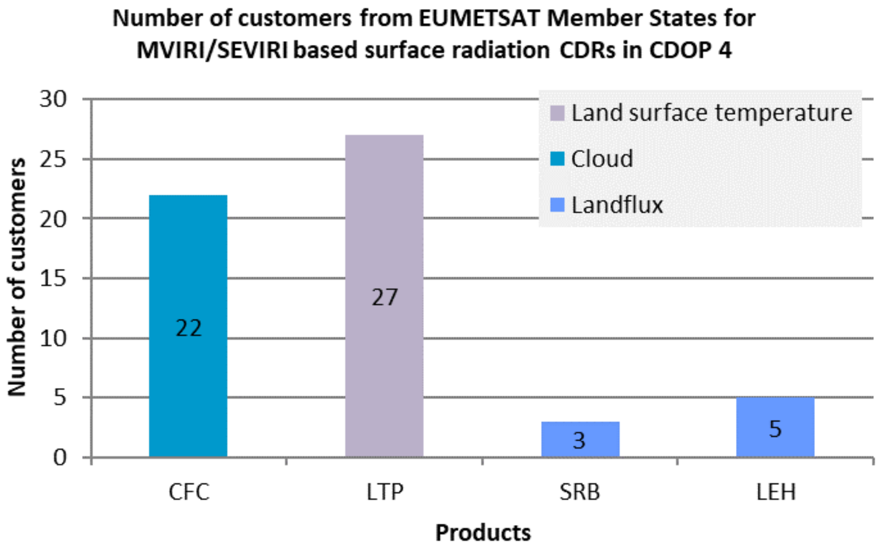


Figure 2-13: Number of unique users of LandFlux V1.0 from Member States. The x-axis shows the CM SAF product identifier (5 digits: CDR, 4 digits: ICDR) and an abbreviation of the associated parameter: CFC - cloud fraction, LTP - land surface temperature, SRB – surface radiation budget, LEH – latent and sensible heat flux.

2.2.5.3.2 Other relevant usage

Outside member states, direct evidence of adoption is also still limited due to the novelty of the product. However, members from CORDEX (COordinated Regional Downscaling Experiment) are already making use of the product (e.g., Dr. Nicolas Ghilain), which illustrates its potential value for the wider community. Beyond potential operational applications, the product is expected to be of high value for the research community in hydrology, land–atmosphere interactions, and climate variability studies. The refinements introduced in Version 1.1 enhance its reliability for long-term analyses, making it a strong candidate for integration into climate services, impact studies, and model evaluation exercises. At the institutional level, CM SAF can also propose its use as a foundation for developing operational climate indicators tailored to user needs.

Figure 2-14 shows the number of unique users for LandFlux v1.0 from all customers.

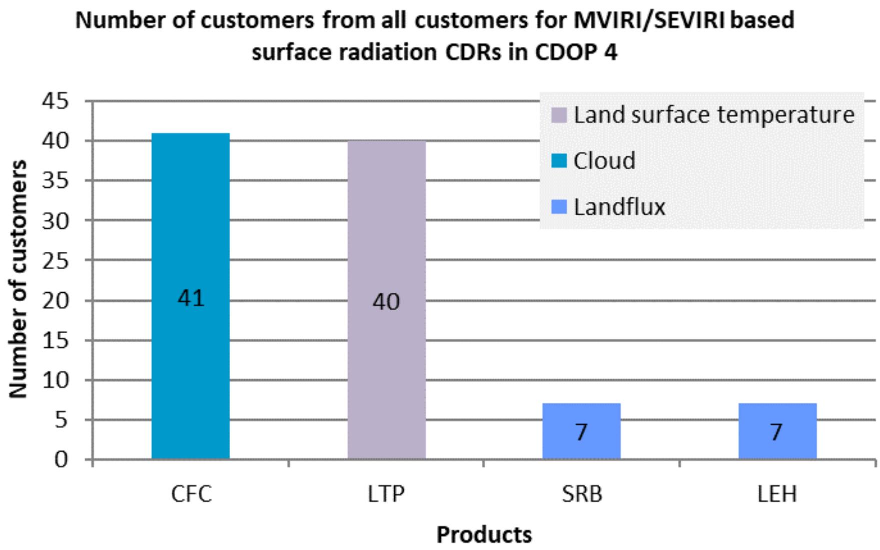


Figure 2-14: Number of unique users of LandFlux v1.0 from all customers. The x-axis shows the CM SAF product identifier (5 digits: CDR, 4 digits: ICDR) and an abbreviation of the associated parameter. CFC - cloud fraction, LTP - land surface temperature, SRB – surface radiation budget, LEH – latent and sensible heat flux.

2.2.5.4 Key improvements

To overcome the limitations of the first release and to strengthen both scientific relevance and usability, the following key improvements will be developed for version 1.1:

- Improved Stability and Homogeneity: Addresses limitations in regions such as North Africa, ensuring reliable trend detection, anomaly quantification, and consistent evaporative fraction monitoring. This includes the replacement of the albedo input, which was identified as the primary source of temporal instabilities in the first version. With this adjustment, the dataset will show improved stability, particularly in arid regions, while maintaining the same spatial and temporal resolution, coverage, and methodological basis.
- Better Alignment with Other Products: Incorporates algorithm refinements to improve consistency across regions and applications, especially in water-limited basins.
- Coordination with LSA SAF: Ensures maximum consistency and complementarity with LSA SAF near-real-time products.
- Reprocessing of the WMO Reference Period (1991–2020): Version 1.1 will include a full reprocessing of the WMO reference period to ensure consistency with climate monitoring standards, facilitating a more robust climate data record.

Version 1.1 should therefore be regarded as a bug-fix and consistency-improvement release, ensuring continuity for users while addressing the most critical limitations of the initial product.

2.2.5.5 Description of new products

Not a new product.

2.2.5.6 User Requirements for new products

The user community has expressed a strong need for stable and reliable estimates of latent and sensible heat fluxes, as well as evapotranspiration, to support applications in climate monitoring, drought assessment, regional water balance studies, and hydrological modeling. Temporal instabilities in Version 1 limited the applicability of the dataset, particularly for trend analysis in arid regions such as North Africa. The refinement in Version 1.1 directly addresses these requirements by improving stability through the updated albedo input, while ensuring continuity with the existing product. This aligns with the SAF mandate to provide long-term, homogeneous Essential Climate Variable (ECV) datasets for climate services. Alternative products such as LSA SAF, GLEAM or reanalysis exist, but none provide the same high temporal and spatial resolution, long-term continuity, and Meteosat-based coverage offered by CM SAF. By improving consistency while retaining methodological continuity, Version 1.1 uniquely meets the demand for a robust, traceable dataset that supports both scientific research and operational applications. The expected future use is high, particularly among hydrological and climate modeling communities, as well as users engaged in climate adaptation and water resource planning.

2.2.5.7 Product Heritage

The proposed Version 1.1 builds on the first CM SAF CDR for latent and sensible heat fluxes and evapotranspiration, ensuring continuity while addressing known issues such as temporal instability and the tendency to underestimate latent heat flux compared to other products.

2.2.6 High-Resolution Land Surface Temperature, Surface Radiation and Fluxes (HANNA)

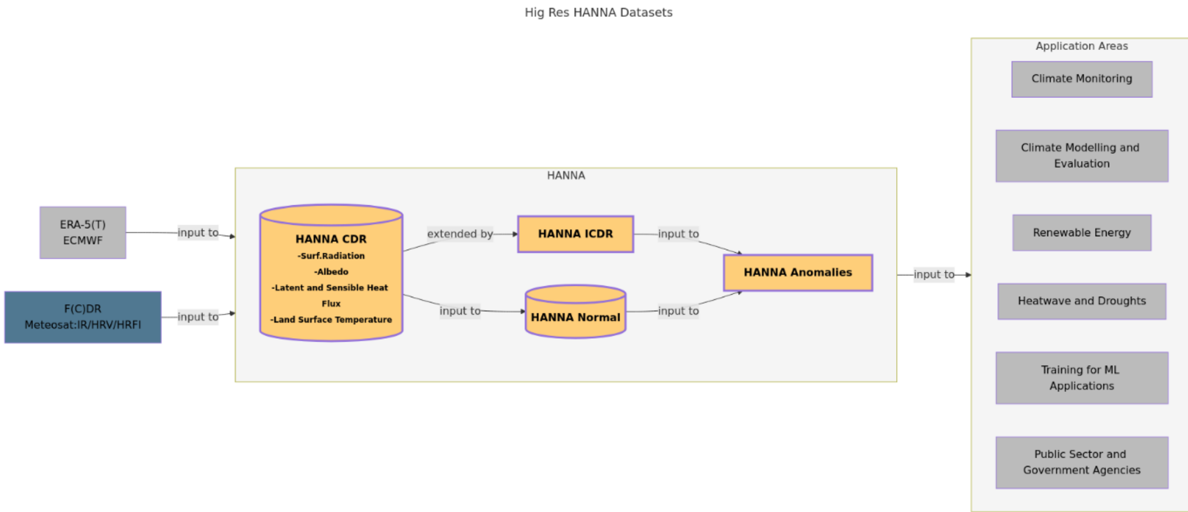
2.2.6.1 Product Family Logic

The HANNA (High-Resolution European Surface Radiation Data Record) family consists of various individual products (see the table in Section 2.2.6), a few of them containing multiple data layers in addition. HANNA contains the following product groups:

- Surface radiation
- Land surface temperature (LST)
- Sensible and latent heat fluxes (LEH).

The plots show the product logic for the HANNA data record. Figure 2-15 gives an overview of the overall product family logic (Figure 2-15 a)) as well as the detailed dependencies for the different parameters (Figure 2-15 b).

a)



b)

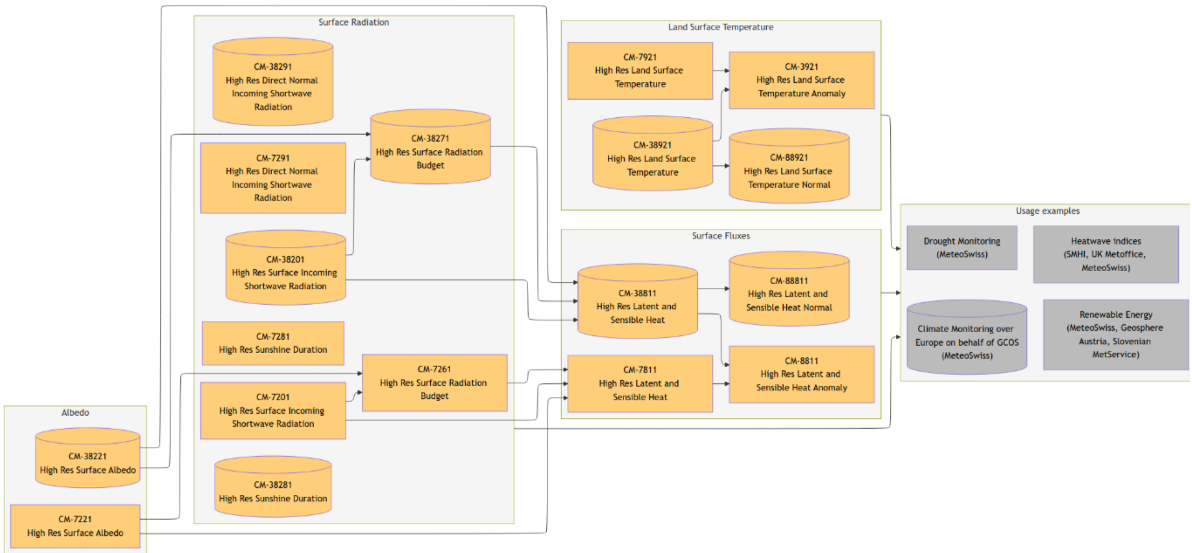


Figure 2-15: Product Logic for HANNA product family: a) overview, b) dependency details for the different parameters.

2.2.6.2 Product Family description

In this Section, product descriptions are provided, starting with a list of products belonging to the product family (see Table 2-10). **New product commitments** are indicated in **bold**.

Table 2-10: Overview of products belonging to HANNA.

Product Family:		High-Resolution Land Surface Temperature, Surface Radiation and Fluxes (HANNA)			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
CDR					
CM-38201	Surface Incoming Solar Radiation (SIS, SIH)	2004 till 2028 0.01° lon/lat grid, Europe	High resolution SIS for Europe	Based on LandFlux v1.0 algorithms (SIH), in development	Climate analysis, monitoring, services, energy meteorology
CM-38291	Surface Direct Irradiance (SDI) (SID, DNI)	idem	High resolution direct solar radiation for Europe with horizon correction	in development	As SIS
CM-38221	Black-sky albedo (SAL)	idem		LandFlux v1.0 algorithm, in development	As SIS
CM-38281	Sunshine duration (SDU)	idem		in development	As SIS
CM-38271	Surface radiation budget (SRB)	Idem		LandFlux v1.0 algorithm, in development	As SIS
CM-38811	Latent and sensible heat flux (LEH)	Idem		idem	As SIS, process studies
CM-38921	Land surface temperature (LST)	idem		idem	As SIS, climate Monitoring for full WMO 1991-2020 period in combination with existing LandFlux, extremes and attribution
ICDR					
CM-7201	Surface Incoming Solar Radiation (SIS, SIH)	2029-now 0.01° lat/lon Grid, Europe	High resolution SIS for Europe	LandFlux v1.0 algorithms (SIH), in development	Climate analysis, monitoring, services, energy meteorology

CM-7291	Surface Direct Irradiance (SDI) (SID, DNI)	Idem		In developmemt	As SIS
CM-7221	Black-sky albedo (SAL)	Idem		LandFlux v1.0 algorithm, in development	As SIS
CM-7281	Sunshine duration (SDU)	Idem		in development	As SIS
CM-7261	Surface radiation budget (SRB)	Idem		LandFlux v1.0 algorithm, in development	As SIS
CM-7811	Latent and sensible heat flux (LEH)	Idem		idem	As SIS
CM-7921	Land surface temperature (LST)	Idem		idem	As SIS, climate Monitoring for full WMO 1991-2020 period in combination with existing LandFlux, extremes and attribution
CM-7271	Surface radiation budget (SRB)	Idem		idem	As SIS, climate Monitoring for full WMO 1991-2020 period in combination with existing LandFlux
Normals and Anomalies					
CM-3921	Land surface temperature (LST) Anomaly	1991-now 0.01° lat/lon Grid, Europe		HANNA LST, in development	Climate analysis, monitoring, services, climate Monitoring for full WMO 1991-2020 period in combination with existing LandFlux, extremes and attribution
CM-88921	Land surface temperature (LST) Normal	1991-2020, 0.01° lat/lon Grid, Europe		HANNA LST, in development	As LST
CM-8921	Land surface temperature (LST) Anomaly	1991-now 0.05° lat/lon Grid, Europe	Precursor for CM-3921	LandFlux Land Surface Temperature CDR v2.0, LSA-	As above

				004.2 near-realtime	
CM-83922	Land surface temperature (LST) Normal	1991-2020, 0.05° lat/lon Grid, Europe	Precursor for CM-88921	LandFlux Land Surface Temperature CDR	As above
CM-8811	Latent and sensible heat flux and evapotranspiration (LEH) Anomaly	2004-now 0.01° lat/lon Grid, Europe		In developmemt	Climate analysis, monitoring, services
CM-88811	Latent and sensible heat flux and evapotranspiration (LEH) Normal	2004-now 0.01° lat/lon Grid, Europe		In developmemt	Climate analysis, monitoring, services

The HANNA LST product is based on the demonstrational CM SAF HANNA product, accessible via [CMSAF - Products - High-Resolution European Surface Radiation Data Record (HANNA)](). All products strongly rely on the LandFlux v1 developments.

2.2.6.3 Current usage of CM SAF products

Please note that this is a new product.

2.2.6.3.1 Usage by services in EUMETSAT member states

HANNA is a new product family and hence, is not in use yet in the Member States. The HANNA demonstrator spawns a period of two years and has no associated ICDR. LandFlux, a precursor on 0.05° resolution, is a standalone CDR without an ICDR. As operational climate monitoring requires ICDRs, HANNA or LandFlux based operational services are not yet established in the Member states.

Nonetheless, HANNA is a product family particularly designed for the use in EUMETSAT Member states. It provides high-quality surface parameters for Europe's climate services. This means:

- High resolution 0.01°: No compromises in terms of spatial resolution for Europe by fully exploiting the Meteosat high-resolution HRV (High Resolution Visible) and HRFI (rectified (Level 1c) Meteosat FCI full disc image data in high spatial) service.
- Surface variables for European Weather Service: Parameter set that is in use and requested by the European Weather Services for the solar energy sector, heatwave and drought monitoring (see support letters from five European Weather Services)
- High accuracy: Physical algorithms which fully exploit the now precisely re-calibrated Meteosat data
- WMO climate reference period: Coverage of the full WMO 1991 to 2020 (in conjunction with LandFlux: Surface radiation and Land Surface Temperature)
- Seamless: Full consistency between CDR and ICDR to depict the climate signal.
- Low latency: ICDR production with lowest possible latency to enable operational climate monitoring.

Currently, MeteoSwiss runs its own ICDR processing based on CM SAF algorithms for Switzerland and combines those data with the CM SAF LandFlux CDRs. Based on those combined CDR and ICDRs MeteoSwiss has established climate services which are specified in the bullet list below. Once HANNA is in place, MeteoSwiss will stop its ICDR production and will use the HANNA ICDR for all applications. Various European Weather Services have expressed strong interest in the planned HANNA CDR and ICDR. Please note that for each of the planned applications, a letter of support is associated with this proposal to highlight the commitment of the Member States to use HANNA for operational climate monitoring:

• MeteoSwiss (in place)	Climate service solar potential (SIS) Climate service & warnings for droughts (LST) SIA climate norms for Switzerland (SIS, SDL, SOL) GCOS Swiss ECV monitoring (LST, Albedo, SIS) Heat Indices (ongoing CM SAF VSA) Sunshine Duration
• UK Hadley Centre (see Section 2.5.5 on use cases)	Development of indices relevant to drought and heatwave monitoring, human and vegetation heat stress and wildfire risk (LST, CM SAF committed activity)
• Royal Meteorological Institute of Belgian RMI (see support letter)	Evaluation of climate models for LE/H
• Swedish Meteorological and Hydrological Institute SMHI (project SCARLET, see support letter)	Development of climate indices for the agriculture sector, renewable energies and the forest sector (project SCARLET)
• Geosphere Austria	Solar radiation monitoring and nowcasting in the Alps
• National Meteorological Service of Slovenia (planned, see support letter)	Solar radiation monitoring and nowcasting in the Alps
• Meteo Romania (see protocol SALGEE User Workshop 2024)	Climate service for drought
• National Institute of Meteorology and Hydrology Bulgaria NIMH (see protocol SALGEE User Workshop 2024)	Climate service for drought

Figure 2-13 (previous Section) shows the number of unique users of LandFlux v1.0 in Member States. Given the demonstrational nature of HANNA such numbers are not available for HANNA.

Table 2-11 shows examples of the results of CM SAF product usage monitoring for the HANNA demonstrator product, SUMET and the LandFlux v1.0 product usage, both being precursors of the new HANNA product family. The table includes information on the specific users, describes the application, the link to the application and evidence for product usage in Member States.

Table 2-11: Product usage overview for HANNA. SUMET and LandFlux v1.0. The table contains examples of product usage.

Product family	CM-Identifiers	Application area	Detailed description of application	Link to application	Link showing reference to CM SAF data	Institute
HANNA, surface solar radiation	n/a	Climate Service	WebService to estimate solar potential of roof in Switzerland	www.sonnendach.ch		MeteoSwiss, CH
HANNA, surface solar radiation	n/a	Climate Service	Solar radiation and sunshine duration monitoring	https://www.meteoswiss.admin.ch/services-and-publications/applications/ext/climate-sunshine-maps-daily.html		MeteoSwiss, CH
HANNA, surface solar radiation	n/a	Climate Monitoring	Solar radiation as input for SIA norms	https://www.sia.ch/de		MeteoSwiss, CH
HANNA, surface solar radiation	n/a	Nowcasting	Training of solar radiation forecasting	https://www.sciencedirect.com/science/article/pii/S0306261924015691	https://www.sciencedirect.com/science/article/pii/S0306261924015691	TU Delft, NL
LANDFLUX v1.0, surface radiation budget	CM-23271	Climate Analysis	Analysis of global brightening in Europe	https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2024JD041101	https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2024JD041101	MeteoSwiss, CH
SUMET v2.0, land surface temperature	CM-23922	Climate Service	National Swiss Cloud Monitoring	https://www.trockenheit.admin.ch/de (Vegetation)	SUMET v2.0, land surface temperature	MeteoSwiss, CH
SUMET v1.0, land surface temperature	CM-23271	Climate Service & Warning	Drought monitoring	www.drought.admin.ch https://www.trockenheit.admin.ch/en/factors/vegetation	https://www.swisstopo.admin.ch/de/satellitenbilder-swisseo-vhi	MeteoSwiss, CH
SUMET v2.0, land surface temperature	CM-23922	Climate Analysis	Proof of concept: Heat Indices based on CM SAF LST data		Submitted to International Journal of Climate	MeteoSwiss, CH

2.2.6.3.2 Other relevant usage

Figure 2-14 (previous Section) shows the number of unique users of LandFlux v1.0 (a precursor version of HANNA) for all customers. Given the demonstrational nature of HANNA such numbers are not available for HANNA.

2.2.6.4 Key improvements

Although a demonstrator was delivered in CDOP-4, this HANNA dataset is basically a new product. Compared to the demonstrator, several variables will be added and weaknesses will be repaired. The next Section describes the algorithms along with some planned improvements.

2.2.6.5 Description of new products

CDR and ICDR

HANNA is a product family particularly designed for the use in EUMETSAT Member states and Europe's climate services. Key aspects are the high resolution 0.01°, the full consistent set of surface variables, the truly physical retrieval algorithms and the low latency of the ICDR.
The HANNA CDR/ICDR provides a major advance by extending the CM SAF portfolio to very high spatial resolution (0.01°) over Europe from 2004 onwards.
HANNA will include: solar radiation, sunshine duration, the entire surface radiation budget, heat fluxes and land surface temperature. The full consistency is achieved by running the software GeoSatClim with similar boundary conditions for all surface radiation parameters simultaneously. Latent and sensible heat fluxes are calculated using the fully consistent GeoSatClim radiation parameters which allows a full closure of the surface budget.
HANNA will be produced with a set of truly physical, precise and modern retrieval algorithms. With the LandFlux CDRs, the CM SAF consortium has demonstrated that, when running consistent radiative transfer-based retrieval algorithm on the now precisely recalibrated Meteosat FCDRs, the climate signal can be fully depicted for the envisioned surface parameter (Schilliger et al. 2023 and Cheda et al. 2025). For HANNA, CM SAF plans to run those fully physical LandFlux algorithms on the Meteosat HRV and HRFI channels. When upscaled, those ICDRs will allow an extension of the existing LandFlux Surface Radiation and SUMET Land Surface Temperature CDRs into the present. This will facilitate observation-based operational climate monitoring in Europe for the entire WMO 1991-2020 climate period.
Fully seamless CDRs and ICDR are the prerequisite for operational climate monitoring. Please note that CM SAF plans to issue the HANNA ICDRs with very low latency of one day (best effort) and 5 days with 95% product availability. Hence, HANNA data can be implemented for time critical climate services such as heat and drought services. With this envisioned low latency, it also allows a quick analysis and response to extreme events (climate attribution).

HANNA will include:
Solar radiation:

- Horizon free solar radiation CDR and ICDR: Land Flux v1.0 HRV Algorithm "Heliomont": HRV and HRFI channel input, sophisticated cloud and snow separation, physical radiance transfer-based algorithm

- Solar radiation with horizon correction (= shadow correction) CDR and ICDR back to 2004: see above but with horizon correction and modelling of the terrain contribution
- Sunshine duration with horizon correction CDR and ICDR back to 2004: GeoSatClim v.4.0
- Direct and direct normal radiation CDR and ICDR: GeoSatClim v.4.0.

Albedo CDR and ICDR: GeoSatClim v.4.0 Albedo, MODIS like Albedo retrieval implemented in GeoSatClim during CDOP-3 in close cooperation with the FMI.

Surface radiation budget:

- Full Surface radiation budget including shortwave and longwave net radiation CDR and ICDR: GeoSatClim 4.0 algorithms: SIS (HRV "Heliomont" algorithm), Albedo (HRV scheme), SDL & SOL (LandFlux HRFI scheme)
- Full Surface radiation budget including shortwave and longwave net radiation at 0.05° grid ICDR back to 2021, extents the LandFlux SRB in the presents SIS (LandFlux VISIR scheme algorithm), Albedo (LandFlux VISIR scheme scheme), SDL & SOL (LandFlux VISIR scheme).

Land surface temperature:

- Clear sky Land Surface temperature: This high resolution is achieved by using the MTG HRFI 1 km thermal channel and by downscaling the MSG LST accordingly. The algorithm is a single channel radiative transfer-based SUMET retrieval (Duguay-Tetzlaff 2015).

Latent and sensible heat fluxes:

- With HANNA the CM SAF will provide a high-resolution CDR and ICDR of latent heat flux (LE), sensible heat flux (H), over Europe. The dataset provides multiple temporal aggregations, including hourly, daily, monthly, and monthly mean diurnal cycles. The retrieval follows a similar approach to the GEO-Ring product, based on the algorithmic heritage of the CM SAF Land Flux v1 CDR, but adapted to higher spatial resolution and optimized for regional applications.

Normals and anomaly

Land Surface Temperature Normal and Anomaly:

- Normal 1991-2020 and Anomaly compared to the 1991-2020 normal at a 0.01° (0.05°) latitude and longitude grid for Europe (in conjunction with LandFlux).

Latent and sensible heat fluxes (and evapotranspiration) Normal and Anomaly:

- Normal 2004-2020 and Anomaly compared to the 2004-2020 normal at a 0.05°latitude and longitude grid for Europe.

The LST anomalies and normals will be issued in a two-step approach. At the beginning of CDOP-5 LST normal and anomalies will be generated and released based on the existing LandFlux v.2.0 LST for the period 1991-2025 and the LSA SAF LST data. The LSA SAF will provide a transfer function from LSA SAF to CM SAF LSTs to ensure near-seamless anomalies. CM SAF will implement the transfer function in the production chain and produce the LST anomalies. It is planned that CM SAF releases normal and anomalies for the period 1991-2025 already in CDOP-4. Once HANNA is implemented (late CDOP-5), the LST anomalies and normal will be calculated from the high-resolution HANNA LST. The approach will be in-line with existing implementations for the demonstrational SARAH-3 normal and anomaly service. Further enhancements based on analysis within CM SAF, user feedback and following decisions from TT-CAN will be implemented if feasible.

2.2.6.6 User Requirements for new products

The high resolution of HANNA enables detailed regional analysis of land–atmosphere interactions and supports applications such as drought monitoring, agricultural planning, and water resource management. In the context of regional attribution studies, HANNA can be used to analyse spatial and temporal patterns of recent extrem events with a unique temporal and spatial resolution. The finer resolution alsomakes the dataset particularly valuable for regional climate services and model evaluation.

High resolution climate data are requested by European Weather Services. The model community has taken up this user requests and now shifts towards high resolution. ICON-D2 analysis is produced on a 0.02° latitude and longitude grid for central Europe. ICON-CH01 is the first analysis data set for the entire Alps produced on a 0.01° grid. Very recently the first 20 years ICON-CH01 reanalysis light was realized. With HANNA, the EUMETSAT HRV and HRFI high resolution (0.5 to 1 km) service will be fully exploited. With the proposed 0.01° grid resolution, CM SAF targets the model community. With 35 % of Europe covered by mountains, where small scale feature matters the most, this unpreceded 0.01° resolution will enable climate monitoring at every corner of Europe.

During the requirements review CM SAF will conduct a user survey among the member states to carefully consider the best possible spatial and temporal sampling as well as the most useful projection for CM SAF users and applications.

CDR and ICDR

Solar radiation:

- Horizon free solar radiation CDR and ICDR: For customers which run their own high-resolution shadow correction (sonnendach.ch)
- Solar radiation with horizon correction (= shadow correction) CDR and ICDR: Ready to use solar radiation particularly for mountain regions (hydrological and glaciological modelling).
- Sunshine duration with horizon correction CDR and ICDR: High resolution sunshine duration with horizon correction: Complementary for HANNA and particularly relevant for rough terrain (e.g., Weather Apps for the public, e.g., MeteoSwiss App)
- Direct and direct normal radiation CDR and ICDR: Norms for the solar energy and construction sector (e.g., MeteoSwiss SIA project)
- Albedo CDR and ICDR back to 2004: Fully consistent with solar radiation, i.e., albedo used in the solar radiation processing. This variable is requested by the PV sector to calculate the backward reflectance of solar radiation beneath the PV modules.

Surface radiation budget:

- Full Surface radiation budget including shortwave and longwave net radiation at 0.01° grid CDR and ICDR: highly relevant for hydrological and climatological modelling, downstream variable for latent and sensible heat flux calculation (e.g., drought.admin.ch in preparation)

- Full Surface radiation budget including shortwave and longwave net radiation at 0.05° grid ICDR: extents the LandFlux SRB in the presents.

Land surface temperature:

- Clear sky Land Surface temperature at a 0.01° grid ICDR and CDR: Daily drought and heatwave monitoring at the highest possible resolution for all points in Europe (drought.admin.ch: vegetation health index, Heat indices in prep. by ongoing CM SAF Visiting Scientist study)

Latent and sensible heat fluxes

- Regional modeling communities require homogeneous, long-term datasets at resolutions matching their models. HANNA responds directly to this need by providing flux data at 0.01°, bridging the gap between coarse global products and the requirements of regional climate and hydrological studies. Expressed user interest, such as the attached letter of support, confirms the strong demand for these datasets in regional climate services and research.

Normal and anomaly

Land surface temperature:

- A general motivation for normal and anomaly products is given in Section 1.2 (see discussion related to CM SAF normals and anomalies and the EUMETSAT-wide CAN service). During beta user consultation of the EUMETSAT CAN service a strong interest in LST normals and anomalies was expressed. The HANNA-based normals and anomalies will be provided to CM SAF users also via the EUMETSAT CAN service.
- Specific quality requirements for normals and anomalies will depend on requirements and performances of the corresponding CDR and ICDR products. Explicit requirements have to be defined at the upcoming Requirements Reviews. Experiences from the current demonstrations of anomaly services and the EUMETSAT CAN service will also play a role for how to define these and other requirements.
- The Land Surface Temperature ECV is a complementary measure to 2m temperature in order to characterize climate change. Cheda et al. (submitted) have clearly outlined that the climate signal can be depicted using CM SAF LSTs. The CM SAF will therefore issue LST normals and anomalies for Europe, which can be directly implemented in the Member States Climate Monitoring. This will enable consistent and fully comparable climate monitoring across Europe.

Latent and sensible heat fluxes (and evapotranspiration):

- A general motivation for normals and anomaly products is to maximize accessibility and support the operational needs of Member States, providing normals and anomalies as ready-to-use products offers significant added value. This approach reduces the computational burden on users and ensures methodological consistency in climate monitoring. RMIB web service and MeteoSwiss have already expressed interest in utilizing these pre-calculated variables for their national climate services.

- The HANNA-based normals and anomalies will be provided to CM SAF users also via the EUMETSAT CAN service.
- Specific quality requirements for normals and anomalies will depend on requirements and performances of the corresponding CDR and ICDR products. Explicit requirements have to be defined at the upcoming Requirements Reviews. Experiences from the current demonstrations of anomaly services and the EUMETSAT CAN service will also play a role for how to define these and other requirements.

2.2.6.7 Product Heritage

HANNA is based on the demonstrational HANNA product available from CM SAF (CMSAF - Products - High-Resolution European Surface Radiation Data Record (HANNA)) and strongly builds on the CM SAF LandFlux v1 developments.

Surface radiation budget ICDR 0.05° grid:
For the surface radiation budget, the GeoSatClim LandFlux retrieval algorithms will be implemented (Bourgeois et al. 2023). This is to ensure full consistency with the LandFlux 1991-2020 CDR. Those algorithms have excellent quality in Europe (Bourgeois et al. 2024) and are fully consistent over the entire WMO reference period to now.

Solar radiation, Albedo, Surface Radiation Budget, Land Surface Temperature 0.01° grid:
The algorithms for the 0.01° grid currently run operational at MeteoSwiss. Solar Radiation and Albedo for the HRV channel was developed by Stöckli (2004) and implemented in the GeoSatClim software by Bourgeois (2023). Please note that those algorithms are fully aligned with the GeoSatClim LandFlux algorithms, but in addition, they exploit the full HRV channel. CM SAF plans to extend those algorithms to MTG HRFI in CDOP-5. The Surface Downward Albedo algorithm is the LSA SAF scheme (Trigo et al. 2012). LST (SOL) uses the single channel LST retrieval (Tetzlaff et al. 2024) and apply those algorithms on SEVIRI and HRFI.

Latent and sensible heat fluxes:
HANNA builds on the GEO-Ring demonstration dataset and on the first CM SAF CDR for latent heat flux (LE), sensible heat flux (H), and evapotranspiration (ET). It inherits its methodology from the Land Flux v1 CDR algorithm, refined with experience from the Land Surface Analysis SAF, and extends these developments to higher spatial resolution. The product leverages long-standing expertise in flux retrievals, ensuring methodological continuity while delivering enhanced detail for regional applications.

2.2.7 Water Vapour, Surface Fluxes and Wind, Clouds over the Ocean (HOAPS)

2.2.7.1 Product Family Logic

The HOAPS (Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data) family consists of a large variety of individual products over the ice-free ocean (see the table in Section 2.2.7.2). HOAPS contains following product groups:

- Total column water vapour
- Near surface specific humidity

- Near surface wind speed
- Latent heat flux and evaporation
- Freshwater flux
- Liquid water path

The HOAPS-5 CDR will be released in CDOP-4.

The plots show the product logic for the HOAPS data record. Figure 2-16 gives an overview of the overall product family logic (Figure 2-16 a)) as well as the detailed dependencies for the different parameters (Figure 2-16 b).

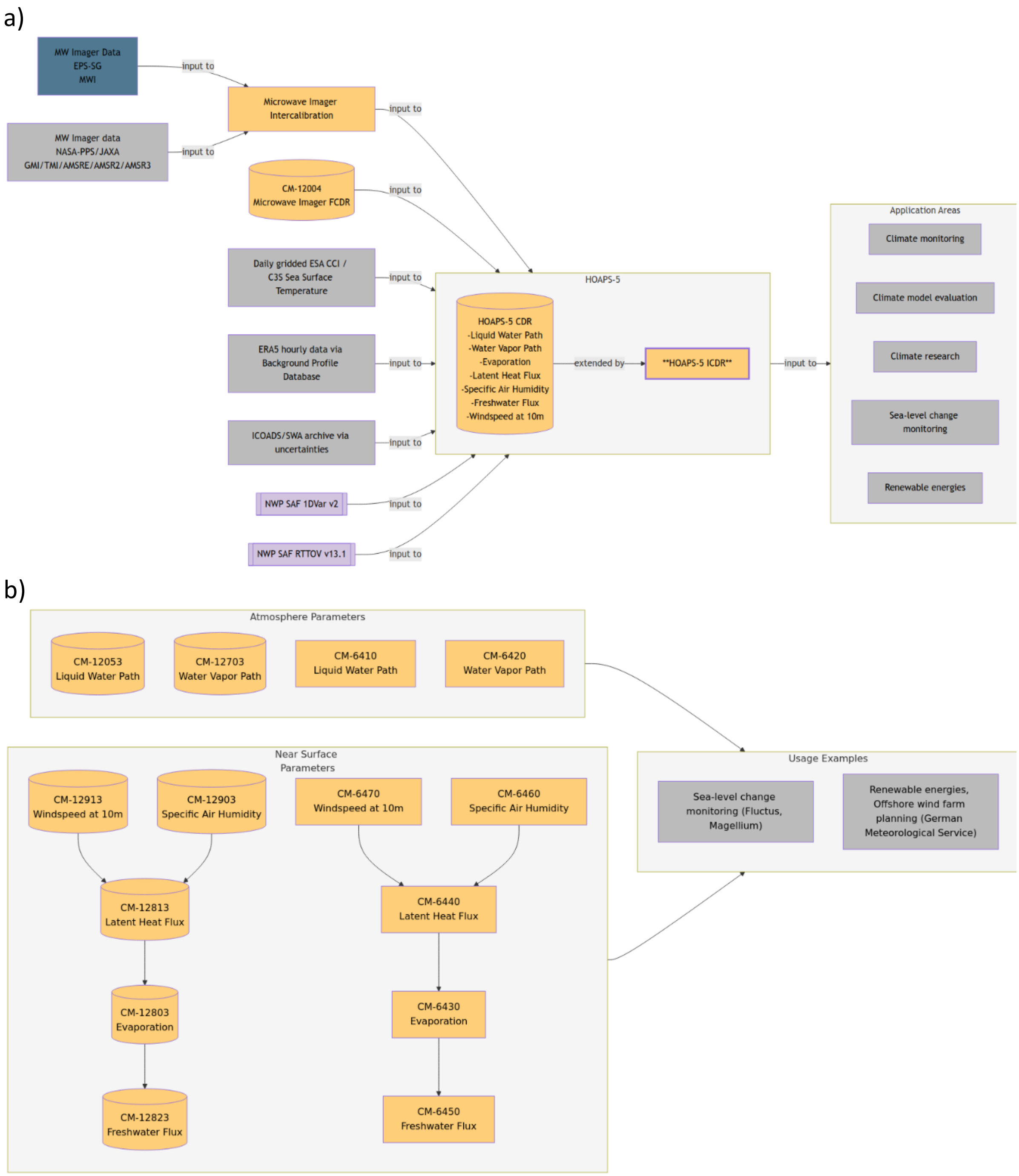


Figure 2-16: Product Logic for HOAPS product family: a) overview, b) dependency details for the different parameters.

2.2.7.2 Product Family description

In this Section, product descriptions are provided, starting with a list of products belonging to the product family (see Table 2-12). **New product commitments** are indicated in **bold**.
The HOAPS-5 CDR is a commitment of CDOP-3 and CDOP-4. The new product in CDOP-5 will be the respective HOAPS 5 ICDR. Here, only the original CDOP-3 product ID (coverage until 2020, CM-12xy3) is listed and the CDOP-4 extension IDs (2021-2024, CM-12xy4) are dropped. The release of the entire period (i.e., covering CM-12xy3 and CM-12xy4 entries) is expected to happen in one single CDR during CDOP-4.

Table 2-12: Overview of products belonging to HOAPS. AMSR-2/-3: Advanced Microwave Scanning Radiometer 2, 3; GMI: Global Precipitation Measurement (GPM) Microwave Imager; MWI: Microwave Imager, RTTOV: Radiative Transfer for TOVS.

Product Family:		**Water Vapour, Surface Fluxes and Wind, Clouds over the Ocean (HOAPS-5)**			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
CDR					
CM-12053	Liquid Water Path (LWP)	Coverage: ice-free ocean; based on RTTOV/1d-Var retrieval on SSM/I, SSMIS and intercalibrated MW imager observations	Version 5	released	Climate analysis, monitoring, services, Climate model evaluation
CM-12703	Vertically Integrated Water Vapour (HTW)	Coverage: ice-free ocean; based on RTTOV/1d-Var retrieval on SSM/I, SSMIS and intercalibrated MW imager observations	Version 5	idem	As LWP, climate data records
CM-12803	Evaporation (EVA)	Coverage: ice-free ocean; based on SSM/I, SSMIS and intercalibrated MW imager observations	Version 5	idem	As LWP
CM-12813	Latent Heat Flux (LHF)	Coverage: ice-free ocean; based on SSM/I, SSMIS and intercalibrated MW imager observations	Version 5	idem	As LWP
CM-12823	Freshwater flux (EMP)	Coverage: ice-free ocean;	Version 5	idem	As LWP

Product Family:		Water Vapour, Surface Fluxes and Wind, Clouds over the Ocean (HOAPS-5)			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
		based on SSM/I, SSMIS and intercalibrated MW imager observations			
CM-12903	Near-surface specific humidity (NSH)	Coverage: ice-free ocean; based on RTTOV/1d-Var retrieval on SSM/I, SSMIS and intercalibrated MW imager observations	Version 5	idem	As LWP
CM-12913	Near-surface wind speed (SWS)	Coverage: ice-free ocean; based on RTTOV/1d-Var retrieval on SSM/I, SSMIS and intercalibrated MW imager observations	Version 5	idem	As LWP
ICDR					
CM-6410	Liquid Water Path (LWP)	Coverage: ice-free ocean; based on AMSR-2, GMI, and AMSR-3 (optional: EPS-SG MWI)	Extending HOAPS v5	Based on HOAPS 5, in development	Climate, monitoring, services, analysis, Climate model evaluation
CM-6420	Vertically Integrated Water Vapour (HTW)	Coverage: ice-free ocean; based on AMSR-2, GMI, and AMSR-3 (optional: EPS-SG MWI)	Extending HOAPS v5	idem	As LWP, climate data records
CM-6430	Evaporation (EVA)	Coverage: ice-free ocean;	Extending HOAPS v5	idem	As LWP

Product Family:		**Water Vapour, Surface Fluxes and Wind, Clouds over the Ocean (HOAPS-5)**			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
		based on AMSR-2, GMI, and AMSR-3 (optional: EPS-SG MWI)			
CM-6440	Latent Heat Flux (LHF)	Coverage: ice-free ocean; based on AMSR-2, GMI, and AMSR-3 (optional: EPS-SG MWI)	Extending HOAPS v5	idem	As LWP
CM-6450	Freshwater flux (EMP)	Coverage: ice-free ocean; based on AMSR-2, GMI, and AMSR-3 (optional: EPS-SG MWI)	Extending HOAPS v5	idem	As LWP
CM-6460	Near-surface specific humidity (NSH)	Coverage: ice-free ocean; based on AMSR-2, GMI, and AMSR-3 (optional: EPS-SG MWI)	Extending HOAPS v5	idem	As LWP
CM-6470	Near-surface wind speed (SWS)	Coverage: ice-free ocean; based on AMSR-2, GMI, and AMSR-3 (optional: EPS-SG MWI)	Extending HOAPS v5	idem	As LWP

The HOAPS product family has a long heritage within the CM SAF starting in 2009 with the release of the first HOAPS version by CM SAF (HOAPS-3.1). Actually, the origin of HOAPS goes back to 1987, when teams at the Max Planck Institute for Meteorology (MPI-M) and the University of Hamburg (UHH) started to develop the first HOAPS version and the first release by CM SAF occurred after a successful transfer to operations that started in 2007. Since then, the HOAPS data records have undergone continuous and substantial developments, both in terms of accuracy of the available data, but also in terms of adapting the product layers.

2.2.7.3 Current usage of CM SAF products

2.2.7.3.1 Usage by services in EUMETSAT member states

The number of unique customers from EUMETSAT Member States requesting data from the HOAPS-4 data records over the period 2022-2024 are shown in Figure 2-17.

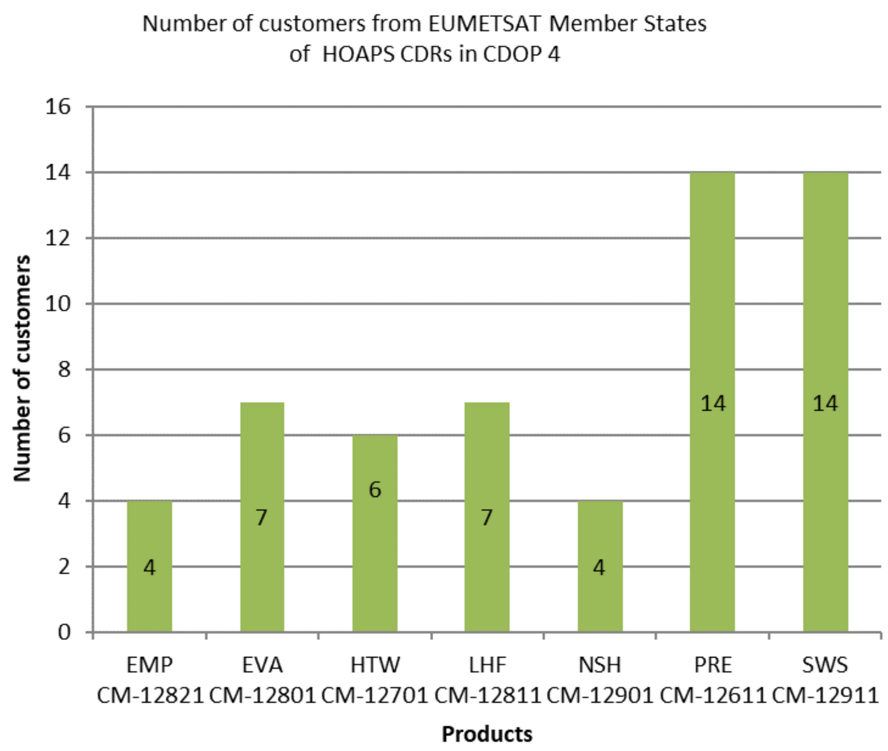


Figure 2-17: Number of unique users of HOAPS-4 from EUMETSAT Member States. The x-axis shows the abbreviation of the associated parameter. The abbreviations are defined in the overview table in the Section 2.2.7.2.

There are numerous applications of these data in EUMETSAT Member States, some are highlighted in the following Table 2-11. Explicitly mentioned here is that IPCC AR6 discusses vertically integrated water vapour based – among others – on the basis of CM-12701 (total column water vapour from CM SAF HOAPS). The liquid water path product will feature for the first time in HOAPS 5 (CM-12053, CM-12054) and hence has no users in a HOAPS 4 variant.

Table 2-13: Usage case examples for HOAPS v5.

Product family	CM-Identifiers	Application area	Detailed description of application	Link to application	Link showing reference to CM SAF data	Institute
HOAPS v4, total column	CM-12701	Policy making	IPCC 6th Assessment Report, The Physical	https://www.ipcc.ch/report/ar6/wg1/chapter/c	https://www.ipcc.ch/report/ar6/wg1/chapter/c	IPCC, UN

Product family	CM-Identifiers	Application area	Detailed description of application	Link to application	Link showing reference to CM SAF data	Institute
water vapour			Science Basis	hapter-2/, Figure 2-14	hapter-2/, Figure 2-14	
HOAPS v4, Latent heat flux, near surface wind speed+specific humidity	CM-12812 CM-12912 CM-12902	Policy making, assessment	IPCC 6th Assessment Report, The Physical Science Basis	https://www.ipcc.ch/report/ar6/wg1/chapter/chapter-2/ https://www.ipcc.ch/report/ar6/wg1/chapter/chapter-8/	https://doi.org/10.1175/JCLI-D-19-0954.1	IPCC, UN
HOAPS v4, total column water vapour	CM-12701	Climate service	Copernicus Climate Data Store (CDS)	https://cds.climate.copernicus.eu/datasets/satellite-total-column-water-vapour-ocean?tab=overview	https://cds.climate.copernicus.eu/datasets?q=hoaps&limit=30	Copernicus Climate Change Service, EU
HOAPS v4, total column water vapour	CM-12701	Input to data records	Preparatory study to include HOAPS TCWV into an operational altimetry service.	https://doi.org/10.1029/2022JC019378	https://doi.org/10.1029/2022JC019378	CNES/LEGOS/ Magellium/ Fluctus, F

2050 At the time of writing, the HOAPS 5 CDR is not yet released, but the PCR 3.4 is imminent. There is a strong interest to use CM-12703/CM-12704 (total column water vapour) for modeling the wet tropospheric correction for radar altimetry-based estimations of global sea level change by a consortium of French public and private companies (LEGOS, Magellium, Fluctus for CNES, see Annex VI). The intention has been backed up with a first scientific publication using HOAPS 4 (CM-12701) (Barnoud et al., 2023).

DWD's national climate monitoring department has used the near-surface wind speed product of HOAPS 4 (CM-12911) for validating its reanalysis with respect to aiding offshore wind energy analysis, see Annex VI.

2.2.7.3.2 Other relevant usage

Figure 2-18 shows the number of unique users for HOAPS-4 from all customers in CDOP-4. Since its release the most used products were latent heat flux and near surface wind speed with each more than 100 unique users.

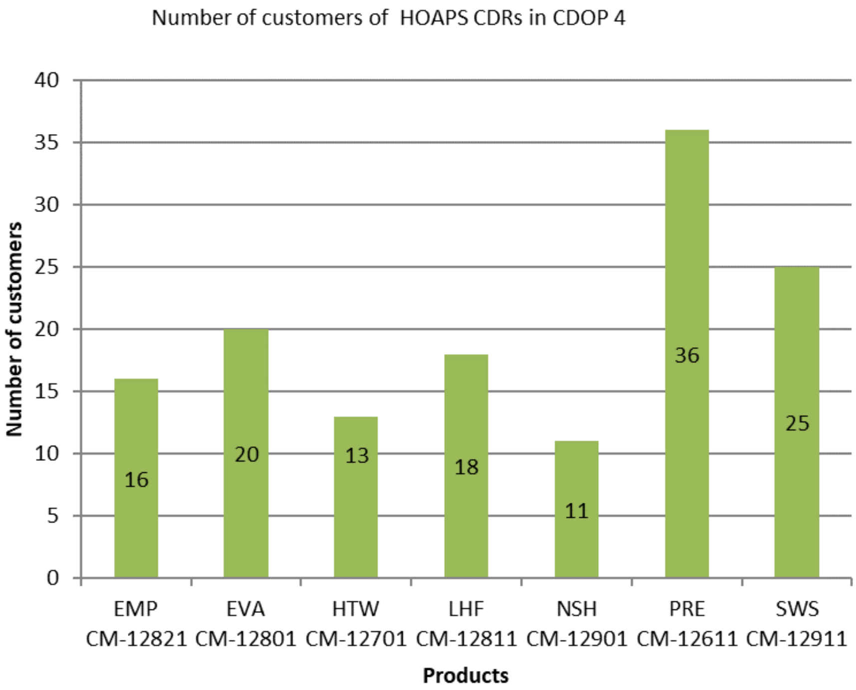


Figure 2-18: Number of unique users of HOAPS-4 from all customers. The x-axis shows abbreviation of the associated parameter. The abbreviations are defined in the overview table in the Section 2.2.7.2.

2.2.7.4 Key improvements

The key improvement planned for CDOP-5 is the installation of an ICDR service that will satisfy the requirement by the above-mentioned consortium led by LEGOS of continuous updates. With SSMIS as the main source of satellite observation for HOAPS in recent years coming to the end of its lifetime and with the remaining instruments/satellites having aged significantly, too (GPM-GMI since 2014, end of lifetime expected in the early 2030s; Global Change Observation Mission for Water (GCOM-W)/AMSR-2 since 2012), updates to the constellation are required. It is planned to adopt previous microwave imager intercalibration activities (WP 4400) for AMSR-3, launched onboard GOSAT-GW (Global Observation SATellite for Greenhouse gases and Water cycle) in June 2025, providing at least one very recent source of information. Additionally, EPS-SG MWI will be added to the constellation utilized in the HOAPS 5 ICDR service. However, MWI’s 31 GHz channels are not well aligned with channels onboard heritage MW imager instruments (36-37 GHz), so significant adaptations are required during intercalibration and/or retrieval adaptation. As EPS-SG B1 (bearing MWI) is not yet launched and due to the above constraints with respect to channel definitions, it is planned to implement the ICDR service initially only based on GMI, AMSR-2, and AMSR-3. If developments for MWI are successful, a delta-ORR can be envisaged at the end of the

CDOP-5. Both AMSR-3 and MWI require a customized bias correction towards RTTOV as developed and applied for the HOAPS 5 CDR.

2.2.7.5 Description of new products

The HOAPS 5 ICDR service will extend the HOAPS 5 CDR from 2025 onwards. SSMIS data services at United States DoD (Department of Defense) and NOAA are currently expected to end in September 2026 and have become volatile during 2025. Hence, the HOAPS 5 ICDR will rely on SSMIS only in the initial months/years, and will then be based on GMI, AMSR-2 and AMSR-3. EPS-SG MWI can be included at a later stage.

The ICDR service is planned for all parameters/products featuring in the HOAPS 5 CDR, i.e., liquid water path (CM-6410), vertically integrated water vapour (CM-6420), evaporation (CM-6430), latent heat flux (CM-6440), freshwater flux (CM-6450), near-surface specific humidity (CM-6460), and near-surface wind speed (CM-6470).

The processing can largely rely on existing software, which, however, needs to be brought together in an operational processing chain in the EWC.

Another item of the HOAPS activities during CDOP-5 will be an intensified interaction with OSI SAF about MW imager-based wind speed retrievals. This interaction will come in the form of i) regular meetings for discussing aspects of 1d-Var-based wind speed retrievals for SSMIS and EPS-SG MWI and ii) a mutual report on the consistency of OSI SAF and CM SAF SSMIS-based wind speed L2 data.

2.2.7.6 User Requirements for new products

The main user requirement is for a regular extension of the HOAPS 5 CDR for the parameter “total column water vapour” (CM-6420) for application in the quantification of global sea level change by the LEGOS-led consortium. Previous interactions have suggested that a relaxed latency of 6-12 months would be sufficient. This specific user request extends to a deeper analysis of the sources of uncertainty. Therefore, efforts will be made towards an improved uncertainty characterization. Possible avenues are data denial experiments, in which sensors are intentionally dropped from the available constellation, or perturbation experiments, in which L1 data are perturbed within plausible bounds. The resulting deviations from the regular HOAPS processing will enable an expert judgement on natures, timings, and strengths of break points or other sources of uncertainty in HOAPS for a more rigorous implementation in the uncertainties of sea-level change.

The national climate monitoring department of DWD has used and expressed interest in the future use of HOAPS wind speed observations for the evaluation of reanalyses for off-shore wind energy applications in the North Sea. The requirement for a higher spatial resolution and extension closer to the coast cannot easily be met in the framework of the HOAPS algorithm, due to the relatively large footprints of SSMI(S) observations which form the backbone of HOAPS. It will be explored whether the reliance on the more recent sensors only, featuring smaller footprints (AMSR-E, AMSR-2, GMI, AMSR-3), will allow meeting this user requirement. It is expected that a respective test dataset covering European seas only will also be useful for the respective use case study outlined in Section 2.5.5. Associated letters of support are in Annex VI.

It is expected that upcoming IPCC activities and generally the climate science community will utilize HOAPS 5. The ICDR service will increase the impact of HOAPS 5 CDR developments in CDOP-3 and CDOP-4 as regular dataset extensions will allow the analysis of events from the recent past.

2.2.7.7 Product Heritage

In 1987, teams at the Max Planck Institute for Meteorology (MPI-M) and the University of Hamburg (UHH) began developing retrieval methods using microwave observations, initially from SSM/I. In 2007, a collaboration between MPI-M, UHH, and CM SAF was initiated, transferring HOAPS into a continuous and operational framework at CM SAF. Since 1998, multiple versions of the HOAPS data set have been released, more recent ones also using SSMIS observations. Version 4 has seen major updates in the retrieval algorithm when the RTTOV and 1d-Var software by NWP SAF were adopted for some of the parameters in the HOAPS suite. The release of the HOAPS 5 CDR is expected for 2026 and will bring further new developments, such as a new parameter (liquid water path, CM-12053/CM-12054), other parameters added to the 1d-Var retrieval block (near-surface specific humidity, CM-12903/12904), new sensors (WP 4400), and a more unified approach to the bias correction of the CM SAF FCDR and intercalibrated data to RTTOV.

2.2.8 Global Precipitation (GIRAFE)

2.2.8.1 Product Family Logic

Figure 2-19 shows the product logic for the different GIRAFE (Global Interpolated RAinFall Estimation data record) editions.

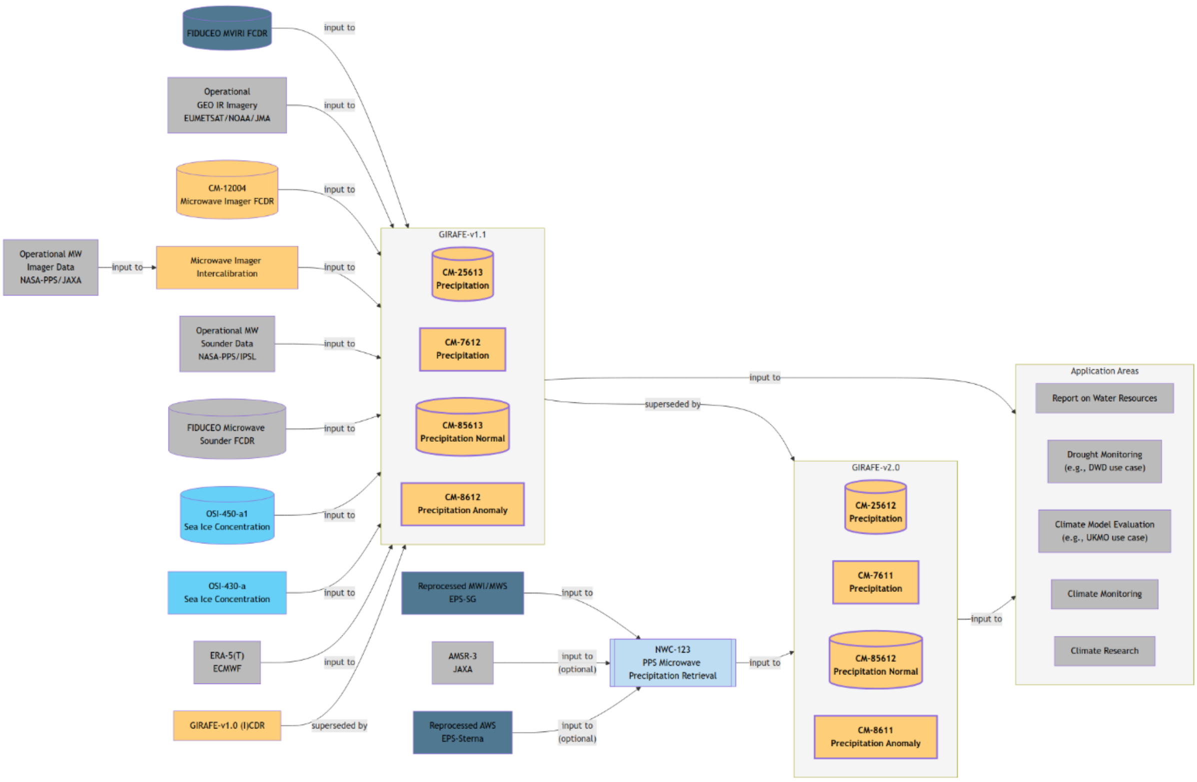


Figure 2-19: Product Logic for GIRAFE data records.

2.2.8.2 Product Family description

In this Section, product descriptions are provided, starting with a list of products belonging to the product family (see Table 2-14). **New product commitments** are indicated in **bold**.

Table 2-14: Overview of products belonging to GIRAFE. LEO: Low Earth Orbit; GEO: Geostationary Earth Orbit.

Product Family:		**Global Precipitation (GIRAFE v1.1, v2)**			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
		CDR			
CM-25613	Global Precipitation Rate CDR R1.1 (GIRAFE v1.1)	Merged LEO MW L2 / GEO IR L1 Sampling uncertainty	2002-2024	based on GIRAFE v1, in development	Climate analysis, monitoring, services, Climate model evaluation, extremes and attribution, climate reporting

Product Family:		Global Precipitation (GIRAFE v1.1, v2)			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
CM-25612	Global Precipitation Rate CDR R2 (GIRAFE v2)	Merged LEO MW L2 / GEO IR L1 Sampling uncertainty	1998-2030	In development, requirements review (RR) achieved	As P
ICDR					
CM-7610	Global Precipitation ICDR (GIRAFE v1 ICDR)	Merged LEO MW L2 / GEO IR L1 Sampling uncertainty		Released	Climate monitoring, services, analysis, Climate model evaluation, extremes and attribution, climate reporting
CM-7612	Global Precipitation ICDR (GIRAFE v1.1 ICDR)	Merged LEO MW L2 / GEO IR L1 Sampling uncertainty		based on GIRAFE v1, in development	As P
CM-7611	Global Precipitation ICDR (GIRAFE v2 ICDR)	Merged LEO MW L2 / GEO IR L1 Sampling uncertainty		In development, RR achieved	As P
Normals and anomalies					
CM-85613	GIRAFE v1.1 climate normal	Derived from GIRAFE v1.1 CDR		in development	Climate services, monitoring, analysis, climate model evaluation, extremes and attribution, climate reporting
CM-8612	GIRAFE v1.1 anomalies	Derived from GIRAFE v1.1 CDR/ICDR		in development	As P
CM-85612	GIRAFE v2 climate normal	Derived from GIRAFE v2 CDR		in development	As P

Product Family:		**Global Precipitation (GIRAFE v1.1, v2)**			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
CM-8611	GIRAFE v2 anomalies	Derived from GIRAFE v2 CDR/ICDR		in development	As P

The GIRAFE versions v1.1 and v2 are based on the GIRAFE v1 CDR and ICDR that will be released by CM SAF in CDOP-4. The GIRAFE products are fully in-line with the SAF strategy on precipitation (see Annex V) and will strongly benefit from an intensified cooperation among the involved SAFs. GIRAFE evolves from the Tropical Amount of Precipitation with an Estimate of Errors (TAPEER) approach (Roca et al., 2018) that has originally been developed in MEGHA-TROPIQUES context and its implementation was strongly supported by former partners from CNRS/Legos and CNRS/IPSL.

2.2.8.3 Current usage of CM SAF products

2.2.8.3.1 Usage by services in EUMETSAT member states

Even though released in 2024 only, quite a few users exist already: Figure 2-20 shows the number of unique users of GIRAFE v1.0 from Member States and all customers. Among the users, is the Copernicus Climate Change Service: GIRAFE v1.0 is part of the C3S' Climate Data Store (Daily and monthly Global Interpolated RainFall Estimation (GIRAFE) data derived from satellite observations).

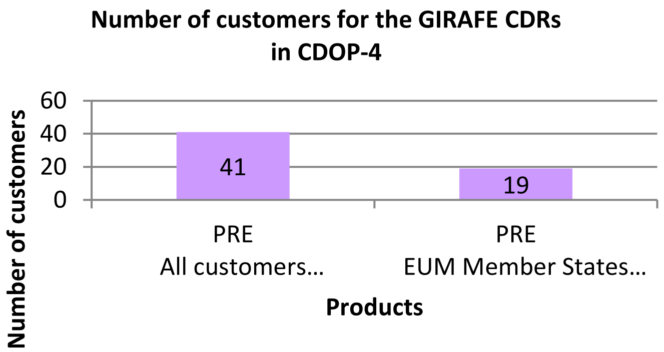


Figure 2-20: Number of unique users of GIRAFE v1.0 from Member States and all customers. PRE – precipitation.

The GIRAFE v1 CDR has been released in April 2024 and is hence still relatively new. It has been used for the verification of the ICON reanalysis at DWD. The UK Met Office has expressed interest in GIRAFE for climate model evaluation but requires fewer gaps in the dataset (see below and Annex VI). However, the Met Office will also explore precipitation-based indices within a use case study in CDOP-5. The global precipitation monitoring Section at DWD has expressed interest in GIRAFE during development of a drought monitoring system for southern Africa and requires a shorter latency than currently envisaged for the GIRAFE v1 ICDR (see also Annex VI).

2.2.8.3.2 Other relevant usage

Figure 2-20 also shows the number of unique users for GIRAFE v1.0 from all customers. On global scale the product usage doubles relative to the use in Member States.
It is also distributed through CNRS's "Frequent Rainfall Observations on GridS" (FROGS) database (https://frogs.ipsl.fr/) which cannot provide user statistics at the moment.

2.2.8.4 Key improvements

2.2.8.4.1 GIRAFE v1.1

CDR and ICDR

The upgrade towards GIRAFE v1.1 is intended to serve user feedback received after the release of the very first version, GIRAFE v1. The UK Met Office has requested monthly precipitation fields with fewer or potentially without gaps. DWD has requested a latency of only about 10 days after completion of a 10-day period. Feedback during the CM SAF user workshop in January 2025 has indicated that GIRAFE v1 may systematically miss precipitation in arid regions. These three items shall be addressed as follows:

- The latency can be improved to meet the requirement by restructuring the GIRAFE module that merges IR and MW observations and derives interim results for the sampling uncertainty and by adjustments to the auxiliary input data streams (currently: regular ERA5 monthly fields; planned: running 30-day mean from hourly ERA5); it is expected that these modifications have no impact on the results.
- The gap filling requirement can be met by applying the GIRAFE "MW-only" mode currently reserved for mid-to-high latitudes if there are no GEO-Ring infrared observations or no MW/IR collocations.
- Detecting precipitation in the GEO-Ring IR in GIRAFE depends on the presence of at least one precipitation event in the MW L2 database in a certain training window around a 1° x 1 day grid cell. The optimal size of the training window is 3° x 1 day. In arid regions, this may not be sufficient for detecting a single precipitation event in many instances; this shortcoming will be addressed by extending the training window in the absence of precipitation in the 3° x 1 day MW database.

Additionally, with SSMIS being close to termination, HOAPS L2 precipitation rate estimate based on AMSR-2 will be included; these are available already through the ongoing HOAPS 5 CDR developments.
User requests, e.g., via letters of support are given in Annex VI.

Normals and anomalies

A first version of normals and anomalies for precipitation based on GIRAFE v1.1 will be implemented.

2.2.8.4.2 GIRAFE v2

The most important improvement for GIRAFE v2 will be the extension of the underlying LEO constellation, providing MW-based L2 precipitation rate estimates.

For a sustainable processing chain, new sensors need to be included as many of the sensors currently feeding into GIRAFE approach their end of lifetime. In line with the cross-SAF strategy on precipitation (see Annex), it is planned to draw on efforts by H SAF and NWC SAF providing ready-to-use software for precipitation retrievals for sensors EPS-SG MWS (Microwave Sounder) and MWI in the PPS MW software. The initial release of this software is planned for 2028. The respective training is based on ATMS (Advanced Technology Microwave Sounder, for MWS) and GMI (for MWI) observations; hence, it is planned to test the inclusions of these additional two sensors (ATMS, GMI) via the H SAF / NWC SAF algorithm for the sake of consistency over the GIRAFE v2 time series. The potential later release of a retrieval algorithm for AWS/EPS-Sterna might be considered for GIRAFE v2, too, but it is likely that such a release would come too late for a GIRAFE v2 DRR in CDOP-5. H SAF work towards an AMSR-3 retrieval may be taken onboard, too. NWC SAF intends to implement this AMSR-3 retrieval in the PPS MW software, too, but again the timeline makes an adoption for GIRAFE v2 in CDOP-5 unlikely. For all these retrieval algorithms, there is a significant risk that the input data streams, and hence the output data, are not climate-compliant as the focus of the respective developments is NRT. It is planned to test replacing the satellite input data with FCDR or at least reprocessed data, and replacing ECWMF/IFS with ERA data, but discrepancies are expected, and it is not clear how these can be mitigated if they prove significant. In principle, a retraining to the new input data streams would then be required. H SAF developers cannot support such a training within their CDOP-5 commitments or elsewhere. Hence, in this case, other options such as the extension of the PRPS algorithm (see below) will be explored. Consequently, a risk for separate developments on precipitation retrievals in the SAF network is present. It is noted that the potential need for a redevelopment is not covered in H SAF or CM SAF WPs presently.

Another addition to the GIRAFE constellation will be the use of SSM/I and SSMIS over land, based on retrievals by the PRPS algorithm. This algorithm has been used already in GIRAFE v1 for sensors ATMS and SAPHIR. The adaptation to SSMIS and SSM/I (CM SAF MW imager FCDR) is carried out via CM SAF Visiting Scientist activities with PRPS author Dr. Christopher Kidd during CDOP-4. It is likely that the retrieval will also replace the HOAPS precipitation retrieval over open ocean.

The above-mentioned inclusion of PRPS SSM(I) will allow a backward extension over the SSM/I era. It is currently planned to extend GIRAFE back to 1991. The GEO-Ring gap over the Indian Ocean up to 1998 (start of MFG IODC) can potentially be bridged by including data over the Indian Ocean geostationary position rescued in the course of an activity at EUMETSAT Secretariat, or by systematically using the MW-only approach pursued during GIRAFE v1.1 for single gaps or scans. In general, the GIRAFE GEO-Ring archive – unless it is replaced by the L1g archive (see below) – will be extended to more recent and older satellites.

It is planned to test replacing the GIRAFE GEO-Ring archive with L1g data; however, with reduced resolutions in both space and time compared to original L1 data, a negative impact on the detection of intermittent precipitation can be expected, which leaves the actual adaptation of L1g in GIRAFE v2 open.

The validation activities for GIRAFE v1 have shown that there is a gap in the hemispheric winter when the underlying MW data hardly see snowfall or precipitation above snow- or ice-covered surfaces. The above-mentioned H SAF retrievals have dedicated snowfall modules in place which would allow addressing this gap, potentially back to the start of the ATMS era (2012). Before that (e.g., MHS), there is currently no retrieval algorithm available. It is planned to exploit the snowfall observations for these sensors. GIRAFE v1 is backed up with an ERA5-based “snow flag”, meant to identify situations which are not well represented in GIRAFE. Analysis has shown that this snow flag is suboptimal in the sense that it sometimes coincides with heavy precipitation events which – in the above logic – should actually be biased towards zero, while in other instances, precipitation is systematically missed even in unflagged situations. Hence, the snow flag will be revised to better represent the situations that it is intended for.

A bias correction scheme will be developed, allowing the calibration of the final GIRAFE v2 data against a reference. It is not clear at the moment whether this reference should be another precipitation dataset, for instance – as is common for satellite-based products – a station-based dataset over land (e.g., GPCC), or whether a budget approach should be taken, e.g., adjusting GIRAFE to close the water cycle given certain realizations of the other contributions. If a bias correction against station-based data is chosen, and if the H SAF PT also decides to implement a bias correction against station data (H SAF WP 2150), the teams at H SAF and CM SAF will strive to identify synergies, but this will not be straightforward due to the different requirements (CM SAF GIRAFE: global, climate-compliant data; H SAF: FCI disk, high-resolution in space and time, potentially NRT timeliness).

There has been regular feedback that the 1° x 1° x 1 day resolution of GIRAFE v1 is too coarse. As one moves to higher resolutions, there must be a trade-off between resolution, accuracy, and information content, especially where the impact of the underlying MW data is involved. Nevertheless, higher output resolutions, both in space and time, will be tested and – if proving accurate – adopted.

GIRAFE v1 is unique in the sense that it provides a sampling uncertainty with the daily dataset, based on sophisticated estimates of the number of independent GEO-Ring IR samples. For a more comprehensive analysis of precipitation, a more complete uncertainty quantification would be very helpful. Options are i) to extend the GIRAFE v1 approach to areas not sampled by the GEO-Ring, i.e., higher latitudes or ii) to propagate uncertainties from L1 to L3. Both options would require significant resources. Feedback from users so far have not indicated a clear preference; the project team will raise this item with users during the CDOP-4 requirements review for GIRAFE v2.

Finally, in the scope of GIRAFE developments, dissemination and exchange with users, the project team will also strive to maintain its contact to the CGMS International Precipitation Working Group (IPWG) and continue the workshop series on global precipitation data in a joined European effort.

2.2.8.5 Description of new products

CDR and ICDR

GIRAFE v1.1 will feature a static CDR (2002-2024), an ICDR data service (2025 onwards). The GIRAFE v1.1 software will see only few updates compared to that used for the released GIRAFE v1 CDR, and only AMSR-2 as additional sensor entering the constellation.

For GIRAFE v2, the portfolio will have the same extent as GIRAFE v1.1, i.e., comprise a static CDR (1998 or earlier – 2030), a dynamic, continuously updated ICDR (2031 onwards). The merging algorithm for GIRAFE v2 will be largely based on that of GIRAFE v1 and v1.1 software, with innovations around the treatment of snowfall and uncertainties and the postprocessing towards bias-corrected data. Upstream of the merging, the processing chain will see major updates (new retrieval algorithms by H SAF / NWC SAF, PRPS SSMI(S), remodeled homogenization procedures). These additions are partly to allow the inclusion of observations by new sensors such as EPS-SG MWS and MWI or AMSR-3.

Normals and anomalies

For GIRAFE v1.1 and v2 normal and anomaly products will be developed and provided as well. The approach will be in-line with existing implementations for the demonstrational SARAH-3 normal and anomaly service. Further enhancements based on analysis within CM SAF, user feedback and following decisions from TT-CAN will be implemented if feasible.

2.2.8.6 User Requirements for new products

CDR and ICDR

Known user requirements are the improved latency, gap-free monthly data, and the improvement of the detection of precipitation in arid regions that will be addressed in GIRAFE v1.1, see Section 2.2.8.4.1. CM SAF is only planning a DRR/ORR as the pyshical baseline will not be changed substantially and because user needs are clearly to updates on latency and gap filling. The CM SAF user survey’s outcome was a clear request for more highly resolved output data and improved uncertainties, although, for the latter, no clear conclusion can be drawn w.r.t. the specific nature of the requirement. Additional requirements collected already during CDOP-4 proposal drafting and the recent workshop on “precipitation monitoring in a joint European effort” emphasized the requirement of a bias correction scheme. These items will be addressed in GIRAFE v2, depending on the outcome of the respective requirements review. The GIRAFE v2 requirements review is currently a milestone during CDOP-4 but will be shifted to CDOP-5. It will be held jointly with H SAF for new developments in the SM2RAIN product line (H-87, H-188) and – if necessary – identify developments towards the discontinuation of one of the two products (SM2RAIN, GIRAFE) or merging of them.

Normals and anomalies

A general motivation for normal and anomaly products is given in Section 1.2 (see discussion related to CM SAF normals and anomalies and the EUMETSAT-wide CAN service). During beta user consultation of the EUMETSAT CAN service a strong interest in Precipitation normals and anomalies was expressed. The GIRAFE-based normals and anomalies will be provided to CM SAF users also via the EUMETSAT CAN service.

Specific quality requirements for normal and anomalies will depend on performances of the corresponding CDR and ICDR products. Explicit requirements have to be defined at the upcoming Requirements Reviews. Experiences from the current EUMETSAT CAN service will also play a role for how to define these and other requirements.

2.2.8.7 Product Heritage

By releasing the GIRAFE v1 CDR in April 2024, CM SAF expanded its portfolio in response to the conclusions of a workshop series titled "Global Precipitation Monitoring in a Joint European Effort," held from 2014 to 2017, after several years of development. Key components of the proof-of-concept product include the homogenization and quality control of all input data streams and a unique daily sampling uncertainty. GIRAFE provides precipitation estimates by merging passive microwave data from low-earth orbiting satellites with infrared observations from geostationary satellites. The technique is based on the Tropical Amount of Precipitation with an Estimate of Errors (TAPEER) algorithm (Chambon et al., 2013). The GIRAFE v1 dataset is documented in the peer-reviewed literature by Konrad et al. (2025).

2.2.9 Brightness Temperatures from Microwave Imagers (MI FCDR)

2.2.9.1 Product Family Logic

Figure 2-21 shows the product logic for the different Microwave Imager FCDRs (Fundamental Climate Data Records).

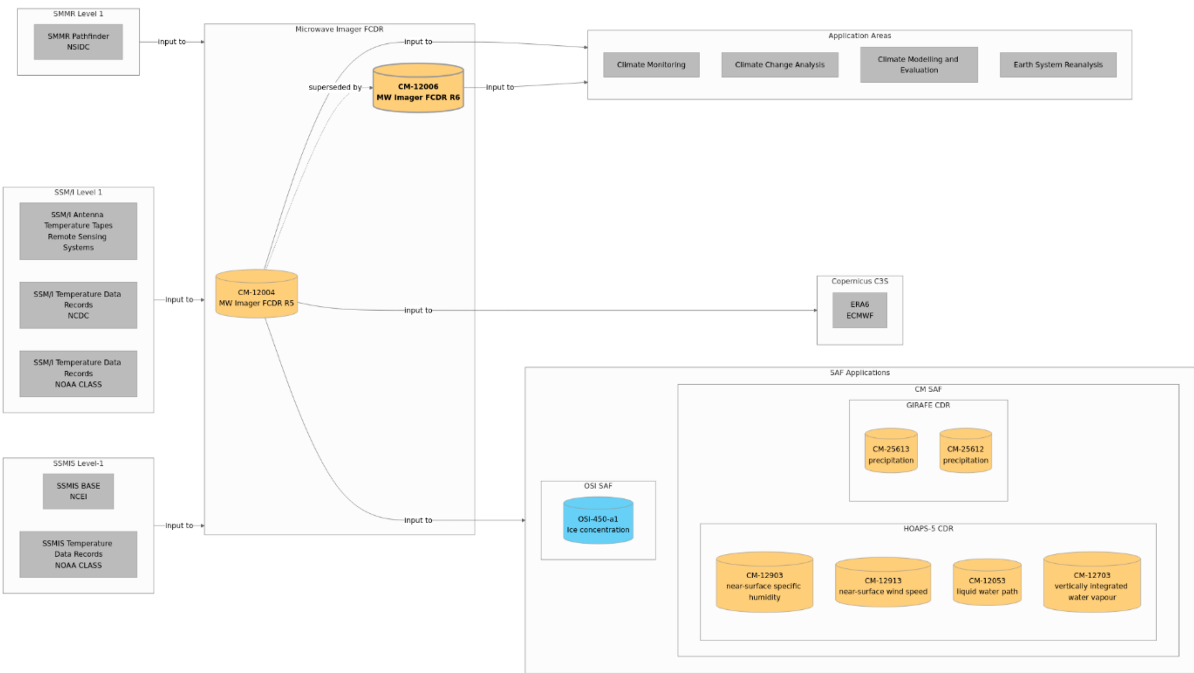


Figure 2-21: Product Logic for Microwave Imager FCDR.

2.2.9.2 Product Family description

In this Section, product descriptions are provided, starting with a list of products belonging to the product family (see Table 2-15). **New product commitments** are indicated in **bold**.

Table 2-15: Overview of products belonging to Microwave imager FCDR.

Product Family:		**Brightness Temperatures from Microwave Imagers (MI FCDR)**			
Product identifier	Product name	Main characteristics	Remarks	Expected status at the beginning of CDOP-5	Usage (key application areas)
FCDR					
CM-12005	Microwave Radiance FCDR R4	Quality-controlled, geolocated, intercalibrated SMMR, SSM/I, SSMIS brightness temperatures	Ends in 2022	Released	Internal and external climate data records
CM-12004	Microwave Radiance FCDR R5	Quality-controlled, geolocated, intercalibrated SMMR, SSM/I, SSMIS brightness temperatures	Ends in 2024, improved quality flagging for SMMR, improved stability for F16	released	idem
CM-12006	Microwave Radiance FCDR R6	Quality-controlled, geolocated, intercalibrated SMMR, SSM/I, SSMIS brightness temperatures	Covering the full SSMIS period	based on R5, in development	idem

The FCDR has a long heritage within the CM SAF starting in 2013 with the release of the first FCDR version by CM SAF). Since then, the FCDR data record has undergone continuous and substantial developments, both in terms of accuracy of the available data, but also in terms of adapting the information layers.

2.2.9.3 Current usage of CM SAF products

2.2.9.3.1 Usage by services in EUMETSAT member states

The number of unique customers from EUMETSAT Member States and from all customers requesting data from the microwave imager FCDR data record over the period 2022-2024 are shown in Figure 2-22.

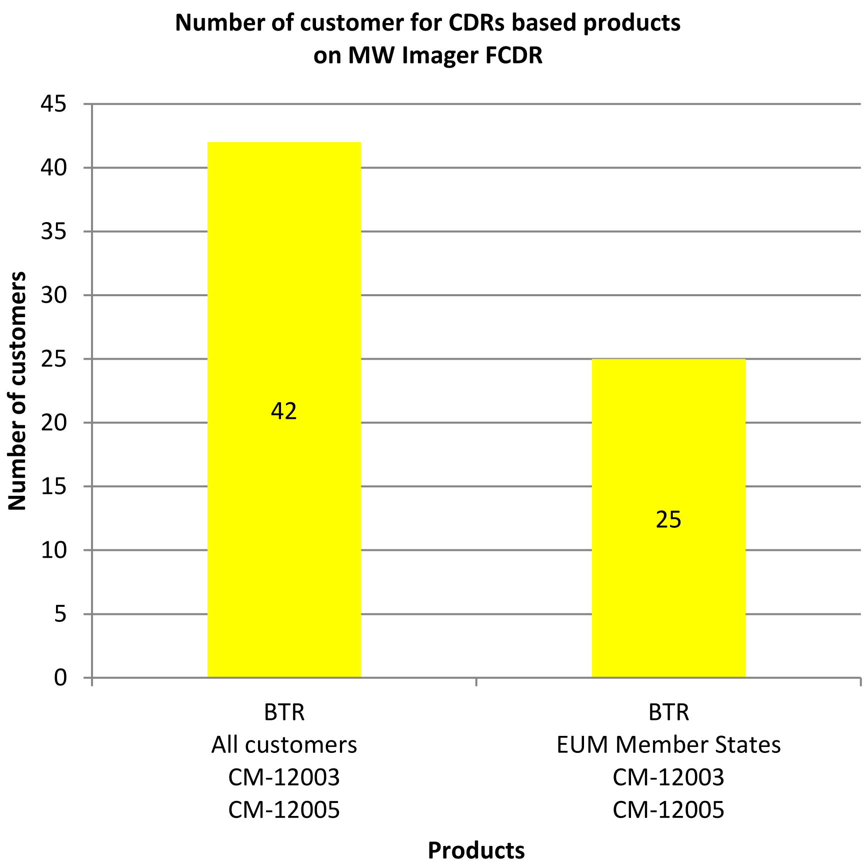


Figure 2-22: Number of unique users of microwave imager FCDR from Member States and all customers. BTR – brightness temperature.

There are numerous applications of these data in EUMETSAT Member States, some are
2400 highlighted in the following Table 2-16.

Table 2-16: Usage case examples for the microwave imager FCDR.

Product family	CM-Identifiers	Application area	Detailed description of application	Link to application	Link showing reference to CM SAF data	Institute
SSMI/S FCDR v4.1, brightness temperature	CM-12003	Input to data records	Assimilation in ERA 5	https://doi.org/10.1002/qj.3803	https://doi.org/10.1002/qj.3803	ECMWF / C3S, EU

Product family	CM-Identifiers	Application area	Detailed description of application	Link to application	Link showing reference to CM SAF data	Institute
SSMI/S FCDR v4.1, brightness temperature	CM-12003	Input to data records	sea-ice CDRs from OSI SAF	http://dx.doi.org/10.15770/EUM_SAF_OSI_0013	http://dx.doi.org/10.15770/EUM_SAF_OSI_0013	Met.no (OSI SAF), N
SSMI/S FCDR v4.1, brightness temperature	CM-12003	Input to data records	Land surface temperature CDRs in ESA LST CCI	https://dx.doi.org/10.5285/a7e811fe11d34df5abac6f18c920bbeb	https://dx.doi.org/10.5285/a7e811fe11d34df5abac6f18c920bbeb	ESTELLUS (ESA CCI LST)

The MW imager FCDR is used for CM SAF products HOAPS and GIRAFE. The OSI SAF uses the FCDR for the generation of sea ice concentration CDRs. The SSM/I part of the FCDR is assimilated at ECMWF in climate reanalysis. At the time of writing, there are plans at ECMWF to assimilate also SMMR brightness temperatures during production of ERA6.

2.2.9.3.2 Other relevant usage

Figure 2-22 (previous Section) also shows the number of unique users for microwave imager FCDR from all customers.

2.2.9.4 Key improvements

The SSMIS data services at DoD and NOAA are currently expected to end in September 2026. This offers the scope for a final version of the FCDR. This release will be an extension of the previous version covering the data series until 2024, closing this longstanding item in the CM SAF portfolio.

2.2.9.5 Description of new products

The new version will again be a L1C data record based on SMMR, SSM/I and SSMIS L1 data; the software will be based on CM SAF heritage software.

2.2.9.6 User Requirements for new products

The CM SAF-internal requirements serving HOAPS and GIRAFE activities are: i) improved zenith angle correction and ii) improved intercalibration (choosing GPM-GMI as reference). This will not be served by the mere extension of the dataset. The project team will strive to identify the required efforts and benefits of such developments during CDOP-5.

OSI SAF and ECMWF experts have expressed their requirements for remapping during PCR 4.1 and iterated afterwards. Likewise, the requirement for bringing EUMETSAT and CM SAF developments together, has been brought up in the context of an easier mutual ingestion in the ECMWF climate reanalysis data assimilation system. Finally, one major requirement by the ECMWF reanalysis is the provision of in-depth support for including the SSMIS part of the FCDR in upcoming version of the ECMWF reanalysis (ERA7) – as intended by ECMWF. These aspects will be served by the User Support and Climate Services (USC) at EUMETSAT Secretariat, supported by the CM SAF project team.
User requests, e.g., via letters of support are given in Annex VI.

2.2.9.7 Product Heritage

The SSM/I and SSMIS FCDR has been taken on as an activity in CM SAF in support of HOAPS (see above) and has developed a large indirect user base via the later adopters (OSI SAF, ECMWF). Recent activities have led to the inclusion of the SMMR observations.

2.3 Product lines to be discontinued

CM SAF regularly carefully assesses its product user statistics, new requirements from CM SAF users, and upcoming opportunities to improve the product portfolio. If a strong need for continuity is not justified anymore, CM SAF will propose to discontinue CM SAF products and with this, free resources for improved products with evidence for user uptake.

In preparation for the proposal writing for CDOP-5 and based on the above considerations, CM SAF decided to discontinue the free tropospheric humidity (FTH, CM-23722) product and to suspend the upper tropospheric humidity product (UTH, CM-14713), i.e., no new version is foreseen to be released by CM SAF in the course of CDOP-5.

2.4 Committed Activities in CDOP-5

2.4.1 Preparing merged GEO-Ring and polar orbiter based products

It is acknowledged that the current ring of geostationary sensors provides a unique suite of spectrally rich measurements that allow the retrieval of a comprehensive set of ECVs at high temporal and spatial resolution (see also Section 2.2.3 Product Family GEO-Ring). However, caveats of using geostationary data alone are for example (i) the significant increase of the footprint size with latitude, (ii) the slant view through the atmosphere with increasing satellite zenith angle and (iii) missing the polar regions more or less completely.
This activity addresses these caveats and attempts to merge polar-orbiting sensor information, as complementary data source primarily for higher latitudes, with GEO-Ring sensor information. As a feasibility study, this activity will make use of achievements made in the ESA CCI+ Cloud project which has just recently started to define and test strategies to ingest polar-orbiting measurements (starting with 0.6 and 11 µm) into existing L1g data (see also Section 2.2.3). Results from the CCI+ Cloud project are expected in 2026, thus well in time for CDOP-5. The expected results will include prototype, merged polar-gap-filled L1g data for selected months, along with prototype cloud mask and cloud phase data. However, the level of maturity of the results remains uncertain for the time being, primarily due to the limited time in that project.

In this activity, the PT will use the then available prototype, merged polar-gap-filled L1g data to apply selected CM SAF algorithms. Here the primary focus is on those algorithms for which a GEO-Ring version, that uses L1g, already exist at the beginning of CDOP-5: cloud properties, TOA fluxes, surface radiation, and LST. In addition, SAL will be included.
Aiming at creating consistent products for Geo and LEO covered regions, this activity will face several difficulties, with two of them being (i) the transition in footprint size and viewing geometry, and (ii) the availability of spectral information in the measurements. If the outcomes of this feasibility study are promising, the PT intends to submit a related Innovation Layer proposal. That proposal will aim at the generation of a comprehensive dataset including further algorithm developments, that will help evaluating whether the combination of Geo and LEO carries the potential for global climate monitoring efforts in CM SAF beyond CDOP-5.

Through this activity, CM SAF commits to the following elements:

- Inspection of Cloud_cci polar-gap filled L1g (and corresponding L2g data) and assessment of their applicability in CM SAF
- Post-processing of L1g data, e.g., application of spectral band adjustments to meeting requirements of downstream CM SAF algorithms
- If available to the project team, inspection of L1g provided by EUMETSAT and provide feedback
- Applying existing algorithms to post-processed L1g for test cases
- Analyse results including comparisons to LEO-only products.
- Support a widespread use/consideration of polar-gap filled L1g data led by the EUMETSAT Secretariat.
- Exchange with other SAFs about (and potentially align on) common goals for usage of L1g and corresponding needs beyond CDOP-5.

- Consolidate results, experiences and opinions from contributing part of the CM SAF consortium in a feasibility report and depending on results draft proposal for submission to the Innovation Layer. This incorporates results of exchange with other SAFs and discussions with the EUMETSAT Secretariat.

2.4.2 Preparing a regional high-resolution precipitation product

Precipitation impacts many aspects of human life, making precipitation data records and related operational products important assets for various application areas. The SAF network receives requests for high-spatial and temporal resolution products through various means, among them, User Workshops, conferences, and personal communication. While high-quality precipitation products exist in various realisations (rain gauges only, ground-based radar, combinations of the two, and satellite-based products), efforts on generating merged, seamless products, i.e., ground-based radar and satellite data, in NRT mode and as CDR are fairly limited. Among others, NWC SAF is providing a satellite-based high-resolution product calibrated to ground-based radar in NRT mode. Based on these NWC SAF developments, and in line with the cross-SAF strategy paper on precipitation (see Annex), it is proposed here to develop a concept for high-resolution, seamless regional precipitation CDR and real-time products for Europe.

The concept will discuss the route to a CDR/ICDR service extending the NRT aspect of existing NWC SAF products to CDR capacities. The core of this concept will be the NWC SAF precipitation retrievals for MSG SEVIRI and MTG FCI brightness temperatures from infrared and visible channels (GEO CRR and CRRPh), trained/calibrated with the European Meteorological Network OPERA radar data. CM SAF will be given access to the related retrieval software. An interface to the SEVIRI FCDR produced by EUMETSAT Secretariat is already available from NWC SAF –Secretariat interactions on atmospheric motion vectors, but needs to be implemented in the CRR/CRRPh software. By generating exemplary L2 data based on both SEVIRI and FCI observations at NRT and FCDR status, the project team will then analyse the potential of applying the retrieval to FCDR or otherwise reprocessed data. Particular attention will be given to expected discontinuities at the SEVIRI/FCI transition, and to the possible requirement of a re-calibration because of mismatches in the NRT/FCDR calibration levels.

The concept will specify spatiotemporal resolutions and coverage of the potential CDR/ICDR product and the efforts necessary to adopt the NRT-aimed software for CDR generation. It will focus on the implementation of the GEO CRR/CRRPh methods for CDR generation. It is not planned here to regularly include observations by LEO satellites in the microwave spectrum, as these occur generally at lower spatial resolution and higher return times. However, with accurate snowfall observations possible by recent and future sensor generations, there is also the potential of improving the representation of this aspect in the envisaged precipitation product. H SAF developments have led to significant improvements in this respect in the retrieval algorithms for sensors ATMS, GMI, MWS, and MWI, with potential extension to AWS (Arctic Weather Satellite)/EPS-Sterna. These developments will become available through the NWC SAF PPS-MW software which will very likely also be used by CM SAF for the GIRAFE v2 CDR and ICDR activities, see also Section 2.2.8.4.2. The concept will hence strive to also discuss an optimal representation of snowfall in the high-resolution regional product based on these developments, guided scientifically by H SAF and technically by the PPS-MW team at NWC SAF. Links to GIRAFE CDR activities at CM SAF, such as imprinting the assumed high stability of GIRAFE onto the potential output dataset or synergies in the production of MW-based L2 data will also be discussed.

On the basis of the concept, the funding for the implementation of the concept will be sought, i.e., the development of the CDR component of the seamless high-resolution precipitation product for Europe, for example via the Innovation Layer. The conceptualizing activity detailed here will then support the implementation with its remaining resources if any.

2.4.3 WCRP support activity

ESMO WGORC

The WCRP Earth System Modelling and Observations (ESMO) Working Group on Observations for Researching Climate (WGORC) has recently been established. The key objective of the WGORC is "to identify and address research gaps in climate observation data and act as a facilitator for collaboration across diverse research and industry sectors" (https://www.wcrp-esmo.org/working-groups/wgorc). CM SAF is a member of this WG, the nomination is initially for four years, i.e., until 2029.

In support to WGORC and to fulfil the role as member, CM SAF will:

- Participate in stakeholder engagement, identify user requirements on observations and foster equitable access to climate data,
- Attend regular ESMO/WGORC meetings,
- Engage and liaise with other relevant activities of ESMO, WCRP and beyond.

GEWEX precipitation and water vapour assessments

A large variety of ECV data records is available to date (see, e.g., ECV Inventory – Climate Monitoring from Space – Joint CEOS/CGMS Working Group). Without proper background information and understanding of the limitations of available data records, these data may be incorrectly utilised or misinterpreted. The overall goal of assessments is to conduct objective and independent evaluations and inter-comparisons of the data records in order to point out strengths, differences and limitations and, if possible, to provide reasons for them. This way the selection process of suitable data records by the GEWEX Data and Analysis Panel (GDAP) for its production of globally consistent water and energy cycle products is supported. Also, related results may guide decisions regarding the fitness for user purpose and trigger data record improvements in the user community, by product responsible persons, and by space agencies, respectively. GEWEX and GDAP expressed a strong interest to turn assessments into sustained GEWEX projects with a strong scientific focus.

The GEWEX water vapour assessment (G-VAP, http://www.gewex-vap.org) has the objective to quantify the state of the art in water vapour products being constructed for climate applications and is already in operation since more than 10 years. CM SAF is co-chairing this activity. Various G-VAP results were cited by the IPCC (Chapter 2 – Gulev et al., 2021, Chapter 8 – Douville et al., 2021): Schröder et al. (2016, 2018, 2019), Shi et al. (2018). Latest results from G-VAP were published in Trent et al. (2024).

For CDOP-5, CM SAF commits the following:

- Re-assess the stability of TCWV data records with focus on Level 1 impact (see also WP 5730),

- Participate in GDAP meetings to present results from recent activities,
- Co-organise and participate in workshops to keep the water vapour community active.

Updated CDRs from CM SAF, that is, TCWV from HOAPS (CM-12703, CM-6420) will be part of the analysis. If adequate, it is foreseen to publish the results in peer-reviewed journals. The GDAP co-chairs support the continuation of G-VAP.

The latest GEWEX / IPWG precipitation assessment had a strong focus on extremes. Results were summarized in a WCRP report (Roca et al., 2021). It was recently decided to continue the assessment of precipitation data records by GEWEX. Details of how the assessment will be implemented are largely TBD at present. CM SAF's intention is to bring in GIRAFE, put it into its international context and to obtain a thorough characterization of its capabilities and specifications in comparison to other existing products. Since the beginning of the project a strong effort has been made in order to acquire as many similar datasets as possible. This large database, that includes ground based, satellite and reanalysis products, is described in Roca et al. (2019). During the previous assessment CM SAF contributed to the WCRP report and co-authored the publication by Masunaga et al. (2019), with a strong focus on extremes. CM SAF intends to play an active role in the continued precipitation assessment by:

- Include GIRAFE v1.1 and GIRAFE v2 into the precipitation data base,
- Assess the stability of precipitation data records with focus on accumulations and extremes and using tools available from G-VAP,
- Participate in GDAP and IPWG meetings to present results from recent activities,
- Potentially participate in assessment workshops.

If adequate, it is foreseen to publish the results in peer-reviewed journals.

2.4.4 Microwave imager intercalibration

Accurately calibrated and homogenized radiance data records are essential for climate analysis, monitoring, and reanalysis. Many National Meteorological Services and reanalysis centers assimilate radiance measurements directly, rather than geophysical parameters. Additionally, producing high-quality Climate Data Records (CDRs) depends on the availability of thoroughly quality-controlled, recalibrated, and inter-calibrated Fundamental Climate Data Records (FCDRs).

A key component of FCDR generation at CM SAF is the inter-calibration process (see Section 2.2.9). Initially developed at MPI Hamburg, the inter-calibration of SSM/I and SSMIS sensors has been further enhanced at CM SAF during previous CDOP phases. With the goal of extending the satellite input database for HOAPS and GIRAFE activities (Sections 2.2.7 and 2.2.8), TMI, AMSR-E, AMSR-2, and GMI data have been intercalibrated with the CM SAF MW imager FCDR. The resulting inter-calibration coefficients have been applied in the HOAPS and GIRAFE products.

The termination of SSMIS data services at DoD and NOAA is currently expected for September 2026 and a general decline in the availability of SSMIS data has been observed during 2025. Hence, new instruments need to be implemented in CM SAF processing chains during CDOP-5. Natural microwave imager candidates are AMSR-3 onboard GOSAT-GW, launched in summer 2025, and EUMETSAT's MWI, to be launched for the first time on EPS-SG B1 in summer 2026. While the adaptation of retrieval algorithms to these sensors for the CM SAF precipitation activities (GIRAFE v2) is generally expected to be based on cooperation with H SAF and NWC SAF (see Annex), HOAPS activities will have to be adapted via similar activities as carried out for TMI, AMSR-E, AMSR-2, and GMI.

CM SAF requirements for EPS-SG MWI services at EUMETSAT Secretariat are:

- An intercalibration towards GPM GMI which can then be easily transferred to the current CM SAF MW imager FCDR intercalibration level (SSM/I – F11),
- A spectral band adjustment (see below), in which case respective plans at CM SAF could be dropped,
- A first multi-year reprocessed dataset ready in late 2029, and
- Regular updates of reprocessed data with a timeliness of 2-5 days (also for EPS-SG MWS for inclusion in GIRAFE v2, see section 2.2.8.4.2).

It is hence planned to set up the inter-calibration of AMSR-3 with the CM SAF MW imager FCDR as early as possible during CDOP-5, so that the planned HOAPS ICDR service can build on at least one recent sensor. The intercalibration of MWI can only start later in CDOP-5, as at least several years of reprocessed observations need to be available. For MWI, another complication is the shift from traditional 36/37 GHz channels to 31 GHz channels which needs to be accounted for either by synthesizing brightness temperatures in the heritage frequency range, 36/37 GHz, (part of this work package), or, if the former approach fails, by adapting the HOAPS retrieval algorithm to this shift (part of the HOAPS ICDR WP 5730).

It is expected that a shift of the reference for intercalibration of the CM SAF MW imager FCDR from F11 SSM/I to GPM-GMI would be beneficial for an optimized intercalibration in terms of uncertainty characterization and stability. This would naturally require a re-processing of the sensors intercalibrated outside the actual FCDR dataset. The actual workload remains relatively small because the underlying match-ups are available and remain valid. It is planned to assess the workload and the impact of such a re-processing during CDOP-5. However, as the CDOP-5 CM SAF FCDR edition will – for now – not feature a respective re-intercalibration, and as no new HOAPS version (main beneficiary of such as shift) is targeted in CDOP-5, the actual adaptation to GMI as the intercalibration reference in the coefficients is currently planned as a CDOP-6 activity.
The Chinese sensor MWRI (Microwave Radiometer Imager) and the SSMIS successor WFS (Weather System Follow-on) MWI remain of interest, but their inclusion depends on resources, which are currently not available.

In detail, the following activities are committed for CDOP-5:

- Gather updated and extended microwave imager data such as AMSR 2, GMI, AMSR-3 and EPS-SG MWI data and convert to CM SAF FCDR format.
- Derive inter-calibration coefficients for microwave imagers AMSR-3 and EPS-SG MWI by applying the CM SAF heritage inter-calibration software, which relies on scene radiances.
- Release the derived inter-calibration coefficients as a report.
- Prepare the shift from F11 SSM/I as the intercalibration reference to GPM-GMI
- Provide feedback of possibly identified issues in the raw data sensor data records to the original data providers.

2.4.5 Support to EUMETSAT for FCDR generation (WP 4500)

The planned new edition of the CLARA CDR (CLARA-A4) will be based on an AVHRR GAC FCDR provided by EUMETSAT, with a planned availability by the end of 2028. Previous CLARA editions have used AVHRR data with only partial FCDR status (i.e., exclusively valid for visible channels) and with limited uncertainty information. The new FCDR will follow FIDUCEO standards and will also tackle known issues with the calibration of the infrared channels. This activity concerns interactions with EUMETSAT on how to define this FCDR, testing improvements of the infrared calibration and finding the best way of using associated uncertainty information.
Important here is that this activity is not only dealing with data from the AVHRR instrument. Since AVHRR is soon finishing its long monitoring mission (i.e., the last AVHRR sensor is carried by the Metop-C satellite), work is needed to prepare for the use of AVHRR-heritage data from modern sensors like VIIRS and METimage in order to extend the CLARA CDR beyond the AVHRR era. This has recently been accomplished in CM SAF based on VIIRS data, which is a cornerstone for the current production of the CLARA-A3.5 edition in CDOP-4. For CLARA-A4, a similar effort is needed to utilize AVHRR-heritage information from the METimage sensor. The method for this has to be developed by CM SAF and be provided to EUMETSAT within this activity. This work is likely to start already at the end of CDOP-4 (depending on the availability of METimage data) but will certainly extend into CDOP-5. Furthermore, the derived information from VIIRS and METimage has to be prepared in a similar way as the original AVHRR GAC information in the AVHRR GAC FCDR.

2.4.6 Towards a consistent approach to estimate uncertainties (WP 4600)

Development of a consistent approach to generate uncertainties across CM SAF products is a *very* significant undertaking, resource-wise and scientifically challenging, and it is very likely that one approach may not be suitable, or even possible, for all datasets. Not all CM SAF products have per-grid cell, per-pixel or per-field of view (FOV) uncertainties and in case uncertainty information is available, diversity in how it has been estimated and how it should be used is present. However, in some sense the CM SAF already has a consistent approach to delivering uncertainty information to users as the metrics used for validation are standardised across most of CM SAF products: the accuracy, precision and stability, is provided for the 'Threshold', 'Target' and 'Optimum' levels (which are aligned with the GCOS terms of 'Threshold', 'Breakthrough' and 'Goal'). In addition, where uncertainties from CM SAF products, and from reference data sets are available, uncertainty validation has been and will be carried out. Examples will be the validation of HOAPS v5 (to be conducted in 2026) and support activities for the sea level and Earth Energy Imbalance community (see Barnoud et al., 2023). Nonetheless, an increasing demand for uncertainty estimates and improved guidance on how to use these could be improved. Thus, this WP will address this topic by developing a plan to provide consistent uncertainty estimates across CM SAF products, with a view to implementing a chosen approach (or approaches) in future CDOPs.
The FIDUCEO approach, which is based on the principles of metrology, is widely considered to be the gold-standard for generating and propagating per-obs uncertainties. This approach provides uncertainty 'components', where each component is designed to capture different sources of uncertainty that have similar correlation properties (Merchant et al., 2019). The

CM SAF Upper Troposphere Humidity (UTH) product is currently the only CM SAF product that uses the FIDUCEO approach. The resources required to generate per-observation (per-obs) UTH uncertainties, implemented in CDOP-3 for UTH v2, were much larger than anticipated: it is estimated that at least 10-12 person months in total were required to design, code, test and evaluate these data for this single, very simple retrieval. Therefore, the task of generating robust per-obs uncertainties for all the target CM SAF products using the FIDUCEO approach would be enormous and beyond the scope of CDOP-5. Notably, to implement the FIDUCEO approach in full also requires provision of uncertainty components with the input Fundamental Climate Data Records (FCDR) data. For the CM SAF UTH product, these data were provided by EUMETSAT. However, the equivalent FCDR data required for all other CM SAF products are not currently available, which would be a significant barrier to applying the FIDUCEO approach in full across the target CM SAF products.

In addition to the complexity and immense resources required, following the FIDUCEO approach for provision of uncertainty information has notable disadvantages. Perhaps the most significant of these is related to usage of component uncertainties by users. E. Good (Met Office, CM SAF PT) also leads the Climate Research Group (CRG) for the ESA Climate Change Initiative for LST (LST_cci). LST_cci has been applying the FIDUCEO approach across all its products. Although LST_cci data are widely used, feedback obtained by the project suggests that virtually no users (e.g. <5) outside of the project have made full use of the component uncertainties (see https://admin.climate.esa.int/media/documents/LST-CCI-D1.1-URD - i3r0 - User Requirement Document.pdf). This is despite several surveys conducted by the LST_cci project indicating that users would like component uncertainties. In general, users tend just to use the total uncertainties (i.e., component uncertainties summed in quadrature) to screen out 'bad' data.

Another significant difficulty associated with the provision of uncertainty components is in providing accurate and usable correlation length scales, which are required for uncertainty propagation, e.g. when regridding data onto a different latitude-longitude grid. Providing and implementing correlation length scales often requires significant assumptions to be made, which may affect the accuracy of the uncertainty information.

Given the resource-heavy experience when applying the FIDUCEO approach to generate uncertainty components for the CM SAF UTH v2 product, and the many years of very low user engagement with uncertainty components experienced in LST_cci project, it is clear that simply implementing the FIDUCEO approach to provide consistent uncertainty information for the target CM SAF products would not be appropriate for CDOP-5.

Of course, there are other approaches that could be adopted, e.g. provision of multiple realisations or ensembles, or machine learning (ML) methods, but these need proper investigation and assessment before they are implemented by the CM SAF. Perhaps the most crucial aspect is to better understand user needs and limitations, for example, handling the large data volumes associated with ensembles. Even the provision of component uncertainties adds multiple, additional layers of data, therefore increasing data volume. Experience within the CM SAF and other projects suggests that most users will require uncertainties, e.g., when estimating trend uncertainties. However, many users do not know how to use uncertainties for this and other applications, so work is also required to understand how to educate and support users in using uncertainties for these and other applications.

Another crucial aspect to consider is what is/is not feasible to implement across the target CM SAF products. For example, CM SAF software, both to generate and validate products may need to be re-written to produce ensembles to represent uncertainty. Similarly, replacing an existing per-obs uncertainty scheme with an ML approach will require significant refactoring of existing software. Both examples would require substantial resources.
Even with the FIDUCEO approach, it is possible to produce inaccurate uncertainties. For example, in the process of developing the CM SAF UTH v2 product, it was evident that the uncertainties for three of the fifteen FCDRs used in the product were erroneous; typical total uncertainties for these FCDRs were ~1 K but were estimated to be at least 2 K in reality (Good et al., 2019). Methods for validating uncertainties do exist but this is a relatively new field and there are still gaps and challenges to overcome (Verhoelst et al., 2026). The provision of inaccurate uncertainties can have serious consequences in drawing scientific conclusions, and it is usually better not to provide uncertainties at all rather than provide erroneous uncertainties. Therefore, the approach used, together with any input data used to calculate the uncertainties must be rigorously assessed.

Thus, the objectives for this work package would be:

1) Generate a list of target CM SAF products
    a. Agree a list of CM SAF products that are useful for energy and water budget studies that should be targeted for this work within the CM SAF board and steering group.
2) Gather user requirements for uncertainties
    a. Address this topic at requirements reviews (covered in related WPs).
    b. Review existing user requirements for provision of uncertainty information, including available information from other SAFs, ESA CCI, and C3S.
    c. Gather user requirements specifically for CM SAF product uncertainties through a user survey, and interviews/discussions with users both in person and online. This activity could include a dedicated session at CM SAF user workshops in CDOP-5, or even a dedicated, focused workshop on the topic of uncertainties.
    d. Detail findings in a dedicated report.
3) Select a consistent approach (or approaches) for provision of uncertainties
    a. Review existing approaches for provision of uncertainties.
    b. Assess the feasibility of implementing these approaches for the target CM SAF products.
    c. Detail findings in a dedicated report.
4) Select a consistent approach (or approaches) for validation of uncertainties
    a. Review state-of-the-art methods for validating uncertainties.
    b. Assess the feasibility of implementing these uncertainty validation methods across the target CM SAF products.
    c. Detail findings in a dedicated report.
5) Develop a plan to implement a consistent approach (or approaches) for the provision and validation of uncertainties for the target CM SAF products. This plan will form the basis for uncertainties work packages in future CDOP proposals.

6) Provide user guidance on available uncertainty estimates and how to use these data.

As part of objective #3 and #4 listed above, a proposal to work with Emma Woolliams from the National Physics Laboratory (NPL, UK) and/or Claire Bulgin (U. Reading, UK) could be submitted as an Innovation Layer proposal. Both Emma Woolliams and Claire Bulgin are international experts on uncertainties associated with Earth Observation data.

During CDOP-4 a dedicated work package on consistency was defined. In CDOP-5 this topic will be continued and dedicated analysis on consistency is included in WP 2400 and WP 2500. In order to keep track of activities associated with consistency and to foster the harmonisation of uncertainty estimation, the CM SAF will have standing agenda items on consistency and uncertainty at project team meetings. Results will be summarised in CM SAF consistency and uncertainty reports.

2.5 User engagement and User services (WP 2100, WP 2200, WP 2300, WP 2400, WP 2500)

The well-established CM SAF user services are offered through the website (https://cm-saf.eumetsat.int)-. CM SAF provides user support and makes information and documentation on CM SAF products and data records available. Access to the CM SAF data is provided via the EUMETSAT Data Store and/or the CM SAF Web User Interface (WUI, https://cm-saf.eumetsat.int). In addition, a subset of parameters is provided via EUMETCast. These data access services will be supported, extended and improved during CDOP-5, taking user needs and user feedback into account.

To ensure that climate data records are accessible, actionable, and impactful, CM SAF is committed to promoting user-friendly access through a range of supportive activities. CM SAF will continue to provide training and workshops to build capacity in understanding and using climate data effectively. CM SAF aims to strengthen user feedback mechanisms to continuously improve the relevance, usability, and delivery of climate information. This will also increase community exchange and knowledge sharing and thereby enabling users to learn from each other, share experiences, and co-develop solutions. Direct contact and exchange with existing and potential future CM SAF users will be continued and strengthened during CDOP-5. This involves proactive engagement and communication with both current and prospective users of CM SAF. Key activities include:

- Maintaining direct, personal contact with climate service teams and relevant stakeholders, particularly within the meteorological and climate services of EUMETSAT Member States.
- Facilitating two-way communication to understand user needs, gather feedback, and provide tailored information or support related to CM SAF products and services.
- Promoting awareness and use of CM SAF products by providing guidance, training opportunities, and technical explanations as needed.
- Supporting the continuous improvement of CM SAF products and services by relaying user requirements and experiences back to the product development and service teams.

This user-focused interaction is a crucial component in ensuring the relevance, usability, and impact of CM SAF data in operational and research-oriented climate services across Europe and beyond.

EUMETSAT Secratariat aims to form a EUMETSAT Working Group on User Engagement to cover the related topics as a mechanism to develop coherent approaches to be applied in the SAF Network and in the EUMETSAT Secretariat. The aim should be to increase visibility across EUMETSAT (including the SAFs), to facilitate product discoverability, and to implement monitoring and evaluation procedures that will help design products which are tailored to actual needs. The working group should also cover product metadata, cataloguing as well as fitness for purpose information and foster discoverability across applications and sectors. CM SAF will participate and contribute to this EUMETSAT Working Group on User Engagement.

2.5.1 CM SAF Webpage (WP 2100)

The CM SAF website https://cm-saf.eumetsat.int provides information and documentation on all CM SAF activities, products and services. This includes information on the organisation of the CM SAF, products, data access, documentation and training and outreach including a Frequently Asked Questions Section. Under the headings “News” and “Highlights” general announcements (new developments, publications, product modifications, next seminars and workshops, Visiting Scientists activities, etc.) are available on the webpage. Furthermore, relevant service messages, DOI classification and other product-related information is available. The CM SAF webpage provides entry points to the data ordering and the User Help Desk. Also links to web-based application of CM SAF data are provided.

The last major redesign has been done in CDOP-3 and while it was still well placed for CDOP-4, a re-design is foreseen in CDOP-5 to properly reflect, e.g., adaptations to the new product portfolio and changes in data access. It will also ensure implementation of improvements in design and functionality as well as making use of state-of-the-art web technology. Technically, the CM SAF web site is maintained with the content management system GSB (Government Site Builder). This Content Management System (CMS) has a modular structure and can be used flexibly. The GSB will also be used during CDOP-5 to continue and improve the provided services. A major version upgrade for the GSB has been announced to become the new standard system. This will require a migration of the current pages to the new CMS. This mandatory technical change will be taken as opportunity for the general redesign of the CM SAF webpage. Web standards will be used and accessibility will be ensured as far as possible (e.g., old documents will not be post-edited, but new documents will be checked for accessibility).

2.5.2 Data Provision (WP 2100)

Until CDOP-4, the CM SAF Web User Interface (WUI, https://wui.cmcmsaf.eu) was the main entry point to access CM SAF data records. During the last CDOP phases this interface was improved continuously by extending its functionalities and enhancing its usability and performance. Several ICDR SEVIRI products are additionally distributed via EUMETCast.

Products ordered in the WUI are provided via a data server with https/sftp access. For product order via the WUI distribution via email is also available for orders with small data volume. Via the WUI data can be ordered and delivered as one-off deliveries or as recurring *standing orders*.

During CDOP-4 CM SAF is changing the main entry point for data access from its WUI to the EUMETSAT Data Store. Using common infrastructure across EUMETSAT, including the SAF Network, will provide a unified interface for the users and enable more combined data analyses in their applications. The EUMETSAT Data Store allows download of data via a web user interface (Web-UI) and/or Application Programming Interface (API).

Information on the data records is already provided to the EUMETSAT Secretariat for inclusion in the EUMETSAT Data Catalogue since several project phases but while in earlier phases users have been redirected to the CM SAF in case of product ordering, CM SAF is now also transferring the data to EUMETSAT for ingestion in the EUMETSAT Data Store. Mechanisms are set up to populate the Data catalogue entries and make the data records available to the EUMETSAT Secretariat for ingestion in the Data Store/Data Lake. This includes one-time transfer of a climate data record as well as updates at regular intervals (e.g., daily, monthly) for the interim climate data records. These processes will be continued and improved during CDOP-5, also depending on further developments at EUMETSAT (e.g., accessibility of data via the EWC, etc.). CDOP-4 is a transition phase between the two data access systems with the majority of CDOP-4 data records already becoming available via the EUMETSAT data store. In CDOP-5 it is foreseen to make all newly released data records available via the EUMETSAT Data Store. The Web User Interface will be maintained (at low level) also during CDOP-5 in order to provide access to all DOI-registered data records, which are not yet retired/superseded and are not available via the EUMETSAT Data Store.

At time of writing of the proposal customising CM SAF data using the EUMETSAT Data Tailor is not yet possible, but is already under discussion with EUMETSAT to further improve the user experience. Also adding CM SAF product to EUMETView will be discussed to provide products as web services following the standards by the Open GIS Consortium (OGC) in order to serve open GIS Web Services (e.g., Web Coverage Service and Web Mapping Service) implemented by users. CM SAF will contribute to the development of services for these EUMETSAT applications as needed to support the uptake of CM SAF products and services.

Product provision procedures need to take into account that climate data records imply large amounts of data, which might be too large for local download for many CM SAF users, in particular in developing countries. Cloud computing provides a powerful tool for these users. CM SAF will evaluate further means of access to the CM SAF products, e.g., in the European Weather Cloud (where most of the processing of CM SAF will be performed). Besides providing new means for data access and data handling, this approach would also create new possibilities for user applications by creating access that is unified with other EUMETSAT products, in particular those from the SAF Network. Sharing data to other SAFs via EWC object storage will enable a smooth collaboration and will avoid data exchange and data duplication.

Until end of 2026, CM SAF parameters are brokered to the C3S Climate Data Store via a dedicated project in the C3S projects. At the time of writing of the CM SAF proposal a concept is developed within this C3S project to facilitate interoperability of the CDS and the EUMETSAT Data Store in order to enable direct provision of satellite data products from the EUMETSAT SAF facilities. During CDOP-5 CM SAF will contribute to the ingestion of selected CM SAF products into the Copernicus Climate Data Store (CDS) as needed. This will include, e.g., providing additional metadata information, detailed product descriptions, and ensuring that all relevant documentation accompanies the data to enhance usability and discoverability for end users via the CDS.

CM SAF will assess emerging needs for data records for new services provided by the Copernicus Services. It is already foreseen to provide several new data records developed during CDOP-4 and CDOP-5 in the CDS. The current plan is reflected in Table 2-17. In addition, further parameters might become candidates for provision via the CDS (e.g., regional data records based on geostationary satellites or from GEO-Ring activities) depending on the developments in C3S.

Table 2-17: List of CDRs and ICDRs foreseen for distribution via CDS.

Product Family	Temporal coverage	Product ID and Product Acronym	Comment
UTH v3	07/1994-12/2024	CM-14713 (UTH)	No ICDR
GIRAFE v1 (ICDR)	01/2021 – ongoing	CM-7819 (PRE)	Until release of V1.1
GIRAFE v1.1 (CDR + ICDR)	2002-2024 (CDR) 2025-ongoing (ICDR)	CM-25613, CM-7612 (PRE)	Until release of V2
GIRAFE v2	1998-2030 (CDR), 2031 – ongoing (ICDR)	CM-25612, CM-7611 (PRE)	
CLARA-A3.5 (CDR + ICDR)	1979 – 2024 (CDR) 2025 – ongoing (ICDR)	CM-11013, CM-6012 (CFC) CM-11023, CM-6022 (JCH) CM-11033, CM-6032 (CTO) CM-11043, CM-6042 (CPH) CM-11053, CM-6052 (LWP) CM-11063, CM-6062 (IWP) CM-11203, CM-6212 (SIS) CM-11263, CM-6262 (SDL) CM-11273, CM-6272 (SRB) CM-11282, CM-6282 (SNS) CM-11292, CM-6292 (SNL) CM-11226, CM-6226 (SAL) CM-11227, CM-6227 (WAL) CM-11228, CM-6228 (BAL) CM-11313, CM-6332 (RSF) CM-11343, CM-6322 (OLR)	Until release of CLARA-A4
CLARA-A4 (CDR + ICDR)	1979 – 2030 (CDR) 2031– ongoing (ICDR)	CM-11014, CM-6013, (CFC) CM-11024, CM-6023, (JCH) CM-11034, CM-6033, (CTO) CM-11044, CM-6043, (CPH) CM-11054, CM-6053, (LWP) CM-11064, CM-6063, (IWP) CM-11204, CM-6213, (SIS) CM-11229, CM-6222, (SAL) CM-11230, CM-6224, (WAL) CM-11231, CM-6225, (BAL) CM-11264, CM-6263, (SDL) CM-11274, CM-6273, (SRB) CM-11283, CM-6283, (SNS) CM-11293, CM-6293, (SNL) CM-11314, CM-6323, (OLR) CM-11344, CM-6333, (RSF)	
HOAPS v5 (CDR + ICDR)	1987–07 – ongoing	CM-12053, CM-12054, CM-6410 (TWP) CM-12703, CM-12704, CM-6420 (HTW) CM-12803, CM-12804, CM 6430 (EVA)	With latency in the order of several months

Product Family	Temporal coverage	Product ID and Product Acronym	Comment
		CM-12813, CM-12814, CM 6440 (LHF) CM-12823, CM-12824, CM-6450 (EMP) CM-12903, CM-12904, CM-6460 (NSH) CM-12913, CM-12914, CM-6470 (SWS)	

CM SAF will assist EUMETSAT Secretariat in the integration and ingestion of the selected CM SAF products into the Copernicus Climate Data Store (CDS, including provision of additional metadata information, detailed product descriptions) and ensure that all relevant documentation accompanies the data to enhance usability and discoverability for end users via the CDS.

2.5.3 User Help Desk and Feedback (WP 2100)

The support to requests from individual users will be continued in CDOP-5. Users are welcomed and encouraged to contact the CM SAF in case of questions or comments on all CM SAF products and services. CM SAF will support the users as far as possible. If detailed knowledge on the respective product is necessary, the request will be forwarded to the respective specialist in the CM SAF team.

The CM SAF User Help Desk (UHD) will act as single point of contact with easy accessibility: Users can reach this service through a dedicated email address or by telephone during office hours. The Help Desk then provides information, will contact experts or redirect the user as needed. Additionally, it supports the gathering of feedback from users needed to improve the CM SAF services. The user receives feedback on any comment or problem that he/she has reported. Questions forwarded from the EUMETSAT Help Desk will also be directly answered by the CM SAF UHD (via already implemented procedures).

This user interaction is seen as an efficient way for the CM SAF to collect feedback and improve the CM SAF data records and the CM SAF climate services. It thus complements the feedback collected at training events and the User Workshop, cf. Section 2.5.4, as well as user engagement in the context of the product usage monitoring (see Section 2.5.6).

The CM SAF Help Desk website will be adapted and improved if necessary. Interactive functionalities have been implemented in CDOP-4 and will activities will be continued in order to intensify the contact to the users. A gallery of user applications with graphics, code examples and interactive discussions is available using padlet (www.padlet.com). It allows an easy and attractive for users to contribute to this gallery. The gallery will further evolve depending on user uptake, for example, it may be split into sub-galleries dedicated to applications, validation/evaluation, graphical representations and different programming/scripting languages.

Furthermore, CM SAF will send Newsletters containing information on new products, services, workshops, training opportunities and achievements, and other relevant information, to a mailing list, which is also maintained by the User Help Desk.

DWD is responsible for operating the CM SAF User help desk. All partners support the user help desk if issues of their specific area of responsibility are raised.

CM SAF is also active in Social Media. At the time of writing of the proposal, CM SAF has an active accounts on bluesky (@cm-saf.eumetsat.int) and LinkedIn (The activities on X/formerly Twitter have been discontinued in mid-2025). CM SAF plans to continue activities on social media and follow and engage with key partners and (potential) users. The CM SAF social media channels will be used to inform about, e.g., latest developments, new releases, upcoming workshops, publications, interesting use cases. CM SAF will follow a cross-use approach in order to use the same content on different platforms such as different social media channels, the CM SAF webpage and in training activities. Development of the different social media channels will be monitored and activities adapted as needed, e.g., adding an additional social media channel such as Mastodon.

2.5.4 Training, workshops and expert meetings (WP 2200, WP 2300)

Workshops provide a platform to intensify the communication and discussion with and between the users. CM SAF will organize one User Workshop in 2029. The exact topic of the workshop will be defined during the early phase of CDOP-5 considering feedback from the user community. While covering all user aspects of the CM SAF, a potential focus might be on the users' experience on working with CM SAF data in a cloud environment (such as the EWC). A summary report will be delivered and feedback from the workshops will be used to improve CM SAF services and products.

Additionally, several targeted expert workshops will be organized as required. These workshops will allow to react and adapt to new scientific developments that are relevant either for the production or the usage of CM SAF products. One of these workshops may investigate the opportunities that different approaches in the processing of GEO-Ring data provide and support decision on the way forward for this product group in CM SAF. Further topics will be decided on-demand during CDOP-5, allowing a quick reaction to emerging opportunities or issues.

CM SAF will establish and continuously extend a library of online training material covering its products and services. For training events in CDOP-4 several Jupyter notebooks have been developed. Jupyter Notebooks are a well suited easy to use open-source training tool for beginners and experts to work directly with CM SAF data. The interactive interface allows users to write and run code in small and manageable cells combining explanatory text, code execution, and visualizations, building a highly suited toll for training and exploration of CM SAF products. Following the positive feedback from past training events, CM SAF plans to develop and provide further Jupyter Notebooks showcasing the use of different CM SAF data records, especially for newly released data records. A Jupyter notebook per product family/DOI-entry for each new product release in CDOP-5 is currently foreseen rt courses). In case of larger product families covering several different ECVs (e.g., CLARA-A4), CM SAF Jupyter notebooks for different groups of products within the product family will be provided as needed. There might also be overarching Jupyter notebooks which are valid/useful for more than one product family, which only need to be developed once. Additionally, further Jupyter Notebooks might be developed for user training in CDOP-5 which are not directly related to new releases.

To enhance the learning experience for CM SAF users, short "how-to" clips and cheat sheets will be developed as another key components of the online training program. These resources will provide users with easy-to-follow instructions offering quick access to crucial information and practical skills. The online training material will be complemented by a product gallery, in which users can showcase their applications using CM SAF products (currently done via www.padlet.org). It will also serve the exchange of experience between users, with support from CM SAF staff, if required.

Through continued training events in close cooperation with EUMETSAT Secretariat and further related activities during CDOP-4 it was ensured that NMHSs and other users (especially in EUMETSAT Member States) have been enabled to work competently with complex satellite variables. CM SAF will continue to support and contribute to the EUMETSAT training activities. Training activities are increasingly performed as online training courses, but in-person courses will still be offered when needed. With its own training activities focusing on short online courses (e.g., a modular series on "climate data basics"), CM SAF will be well-positioned to contribute to EUMETSAT activities.

All CM SAF training events, user workshops, expert meetings and of course the roadshow aim to collect feedback and user requirements to enhance future product development.

2.5.5 CM SAF use cases, analysis and support to climate reports (WP 2400)

The value of the data records that CM SAF produces is realized through user application. The data may be used to feed data-driven services which produce added observational value to the user's specific needs. In the climate change context, the CM SAF data in particular can serve as primary input to studies which advance our understanding of the Earth's climate system. Explaining processes and feedback mechanisms, highlighting key trends and evaluating the robustness of climate model projections are among the high-impact science applications which in turn form a key input to climate reports from international bodies such as IPCC or AMAP.

The overall objective of this work package is to foster uptake of CM SAF products by the following means: First, a set of use case studies is proposed which are designed as steps along paths to application of CM SAF data into operational services. The second goal is the completion of a climate analysis with broad arrays of multiple CM SAF data records as input, whose results are expected to have sufficiently high impact to directly support the preparation of prominent climate reports during CDOP-5, e.g., the future evolutions of the IPCC Assessment Reports beyond the current AR7. The third goal is to foster uptake of CM SAF data in high-level climate reports by WMO (state of climate, water resources, …), C3S (European State of the Climate, …), BAMS State of Climate and others by actively approaching lead and contributing authors and provision of timely input where possible.

The specific topics, responsible project partners and proposed completion timelines of the studies are outlined in Table 2-18:

Table 2-18: Planned Use cases, analyses and support to climate report activities.

Use Case (UC) / Climate Analysis (CA)	Topic	Project partner(s)	Completion timeline	Deliverable(s) and their timing
UC1	Showcasing the use of the new CLAAS-4 TOA radiation field for model evaluation	RMIB	2027-2028	Report, due 1.1.2029.
UC2	Analysis of cloud regimes based on CLAAS data	KNMI, DWD	2027-2029	Report, due 1.1.2030 + demonstrator data.
CA1	Satellite-based observed climate change in the Arctic region	SMHI, FMI, DWD	2027-2031	Report, due 1.1.2032 + peer-review publication (submitted).
~~UC6UC3~~	Event attribution study on the exceptionally sunny UK winter/spring of 2024/2025 *OR* Assess the feasibility of producing a blended windspeed dataset	UKMO	2029-2031	Report, due 1.1.2032. *OR* Report, due 1.1.2032.
~~UCS7~~				
UCS4	CM SAF News or highlight stories based on consistency analysis of anomalies	DWD	Various, over CDOP-5 period	Variable

Brief descriptions of the studies are:

<u>UC1 – Showcasing the use of the new CLAAS-4 TOA radiation field for model evaluation:</u>
During CDOP-4, the CM SAF has expanded its CLAAS dataset with the TOA radiation components, covering both shortwave/longwave and all sky/clearsky conditions. With respect to other Earth Radiation Budget records (e.g., from CERES or GERB), the CM SAF product is featured by both a very high spatial resolution (3km sub-sat point) and high temporal resolutions (15’). In the proposed use case, it will be showcased how the new CLAAS-4 TOA fluxes can be used to evaluate the radiation schemes in different classes of atmospheric models. The models will be the ones used for reanalysis e.g., in ERA-5 (or ERA-6 once available), the global climate models of the CMIP/AMIP experiment e.g., HadGEM3-GC31-LL, IPSL-CM6A-LR, GFDL-CM4 (or newer versions once available) and regional climate models, e.g., from the CORDEX.be experiment.

The focus will be put on how well these models are representing the diurnal cycle of radiation, in particular in regions or conditions that exhibit “non-standard” diurnal cycles for either the reflected shortwave radiation or the OLR. These diurnal asymmetries are observed, a.o., in regions that are affected by strong diurnal surface warming, diurnal development of convection, or diurnal “burning” of some kind of clouds.

Preliminary investigations (e.g., from Brindley et al., 2022) have shown that the models often don’t correctly represent the diurnal cycle of radiation in these regions. It is believed that a systematic evaluation of the diurnal cycle with respect to CLAAS will be valuable for the climate modelling community to better understand the current limitations of the atmospheric models. The aim of this showcase is not to understand and explain the models’ limitations but to promote the use of the CLAAS TOA radiation products that can be used, without the need of complex satellite simulator, for model evaluation.
The output from this user case study will be a report/draft paper

UC2 – Analysis of cloud regimes based on CLAAS data:
Cloud Regime (CR) studies contribute to various applications, including climate monitoring, evaluation of climate and weather models, and cloud process studies. Retrievals from a previous CLAAS edition (CLAAS-2.1), have been used to identify and study CRs over Europe during 2004-2017.
The goal of the proposed use case is to produce and analyze an updated and expanded (in both space and time) CR dataset, based on the latest CLAAS edition. The temporal extension will cover at least the 21-year period 2004-2024. The spatial extension will include Africa and parts of the Atlantic Ocean, i.e., large areas of significant cloud regimes and processes. The production will be based on the k-means clustering algorithm, applied to Joint Cloud Histograms (JCHs) of COT and CTP.
The envisaged CR dataset offers many opportunities for analysis. The variability of cloud regimes can be examined in various temporal scales, i.e., diurnal, seasonal and annual. The 21-year period covered by the dataset justifies the analysis of trends in CR frequency of occurrence and CR transitions. Special focus will be given to regions of high climatic importance, such as the Intertropical Convergence Zone (ITCZ), the trade wind regions in the tropical Atlantic and the marine stratocumulus cloud deck in the southeastern Atlantic.
Apart from the analysis planned for this use case, the CR dataset will be publicly available. Both the CR dataset and the report describing the analysis will be delivered end of 2029. Depending on its uptake, its impact could also extend to studies in the fields of climate and weather model evaluation and improvement, the radiative effects of clouds and renewable energy applications.

CA1 – Satellite-based observed climate change in the Arctic region:
The CLARA CDR offers a unique long time series of global observations, in CDOP-5 covering five decades. Although daily time sampling is limited, some observations and some parameters appear mature enough for deeper investigations related to the observed and predicted climate change. This concerns especially products over the poles. The products in the separate grids for North Pole and South Pole are based on more frequent observations (i.e., about 14 observations per day and satellite) than those used in the global product in the lat/lon grid. The latter is sub-sampled to only use four observations per day and satellite globally. In addition, climate predictions have pointed out that global warming will be largest and fastest in the polar regions. Large changes to cryospheric and radiation conditions can be expected and the CLARA CDR has the potential to monitor these effects. Also, cloud

conditions might change but predictions are unclear here and CLARA can therefore give new insights on the interaction between ice cover and surface radiation changes and cloudiness. Studies have to be based on the CLARA-A3.5 CDR since CLARA-A4 is not available until at the end of CDOP-5. Focus should be on Polar Summer conditions since observation quality and the retrieval potential drastically decreases during Polar Winter. However, the study should also investigate what parts of the dataset during the Polar Winter that could still be used with some confidence. Output will be a submitted publication and a report.

UC3 –
Two options are mentioned here. A decision will be made at an early CDOP-5 stage at the lastest.
Either: Event attribution study on the exceptionally sunny UK winter/spring of 2024/2025
This study will conduct an event attribution study building on a previous sunshine attribution study that used only in situ data (Christidis et al., 2016). In this study, the SARAH sunshine duration product will be used in place of the gridded station sunshine product used by Christidis et al (2016), potentially with a parallel attribution experiment that uses the blended and/or station-based sunshine duration for comparison. It has been established that winter and spring sunshine duration in the UK has increased in the recent past, whereas summer sunshine duration has remained quite constant. Sunshine duration is affected by a combination of natural variability and circulation changes. Aerosols will also impact sunshine duration at the surface, so this study will include analysis of aerosol forcing experiments where available. The goal for the output of this study would be a draft paper; however, depending on the study outputs, a report may be more appropriate.

Or: Assess the feasibility of producing a blended windspeed dataset
In this user case study, the feasibility of producing a blended windspeed product that transitions seamlessly between the ocean and the land will be assessed. The output from this study would be useful for the energy sector to calculate energy produced by wind turbines. The study will use CM SAF HOAPS windspeed data over the ocean (Section 2.2.7) and UK station windspeed observations over land. Adjusting/accounting for the height of the windspeed observations will need to be considered so that they are applicable to wind turbines which can reach over 200m offshore, whereas typical windspeed measurements are a few m above the surface. UK Government stakeholders have expressed an interest in a gridded windspeed dataset for Europe, however, more work is needed to establish exactly what is required. The goal for the output of this study would be a draft paper; however, depending on the study outputs, a report may be more appropriate.

UC4 – News or highlight stories
CM SAF strongly intensifies its engagement in the generation of climate normals and anomalies, also in close cooperation with the SAF network and the EUMETSAT Sec. through TT-CAN. An important aspect of a normal and anomaly service is a consistent representation of anomalies across various, partly dependent variables. CM SAF implemented an operational quality control that automatically detects intense anomalies, i.e., anomalies being outside the min/max range of the climate data record. Depending on the intensity and location of the anomalies, CM SAF will carry consistency analyses by looking at various dependent variables at the time of the anomaly. The goal is to publish a small story on the CM SAF webpage (News

or highlight) to advertise the associated products and straightforward analysis. It is also envisaged to approach NMHSs in case intense anomalies are observed over the respective country. These activities will be coordinated with TT-CAN.

2.5.6 Product usage monitoring (WP 2100)

EUMETSAT will establish a process for a systematic product usage monitoring and portfolio management to ensure that SAF products remain operationally relevant and effective (see the SAF Strategy). The operational impact and value of SAF products will be centrally documented and reviewed at the Operations Reviews and mid-term review, collected input discussed at project team and steering group meetings, and input for the central collection of the information at EUMETSAT. Effective product usage monitoring is key to understanding how well a product performs, how it is used, and where improvements may be needed. Collection of information on usage is challenging as it strongly depends on receiving feedback from the users and correct citation of the product usage in applications (e.g., by proper citing of DOI references in web applications, journal articles etc.). Especially in case of operational non-public usage of the products (e.g., regular climate monitoring application using CM SAF products in a NHMS of a member state, which is only available for internal use at the respective NHMS), CM SAF relies on direct feedback from these users. The collection of feedback through different channels is an essential component of this process. CM SAF will use a mix of feedback channels to ensure that products remain aligned with user expectations (with a focus on services in EUMETAT member states):

- Surveys are one of the most common and structured methods of collecting feedback. Surveys may be distributed through online platforms (digital survey via email, cloud-based tools, …) or regular feedback loops (e.g., periodic surveys providing insights over time, ensuring that evolving needs are captured)
- Direct email contact: Another effective way to monitor product usage are personalized emails, especially contacting users who have been actively engaged with a product. This can be done via e.g., targeted follow-ups (e.g., after specific interaction with a product), related to customer service requests (asking for detailed feedback about the user experience) or requesting detailed use cases.
- Web Search Analysis: by monitoring online discussions, reviews, and mentions across various platforms such as social media platforms and making use of different search engines further feedback is collected.

Contact with key personnel in operational services with a focus on EUMETSAT Member States via e.g., periodic meetings or calls with service providers in EUMETSAT member states, engaging with personnel involved in operational climate monitoring to gather immediate feedback, organizing workshop or webinars giving stakeholders a chance to discuss their product usage aid needs directly. Here, especially contacts at different EUMETSAT delegate body meetings are valuable points of contact.

2.5.7 Preparing new Level 4 climate products and associated coordination, including CAN

CM SAF mostly generates climate data records of essential climate variables associated with the energy and water cycles of the Earth. The data is analysis-ready via application of format standards that allow the application of standard tools. This workpackage focuses on aspects of how to further improve the CM SAF services through post-processing of CM SAF products. A focus will be on developing prototype climate indices based on CM SAF CDRs. Climate indices demonstrate the impacts of climate change on nature and society - examples are number of days with heavy precipation and the number of tropical nights. It is anticipated that the user demand for Level 4 products such as climate indices will increase in the future, and CM SAF intends to address this growing user need by preparing a dedicated service.
Also other SAFs, in particular LSA SAF and H SAF, improve their service by developing climate indices. Considering that the products, product applications and related activities being planned by different SAFs provide complementary information, potentially of great value for users, the CM SAF will coordinate the SAF Network group on climate indices by organizing bi-annual meetings with relevant SAFs and the EUMETSAT Secretariat to:

- Ensure full transparency of ongoing developments, promoting the SAF Network to work towards maximising the information to be made available to users.
- Align data formats and when applicable projections, temporal compositing to facilitate user uptake and product display.

Normals and anomalies can be considered as Level 4 products as well and depending on details of results from coordination, might well have overlap with a future EUMETSAT-wide service on climate indices. Thus, the coordination on CAN activities is also covered in this WP.

In order to enhance the usability and accessibility of climate data for various user groups by providing dedicated tailored data services, the following activities will be conducted:

- Data Reformatting Customized to User Needs:

CM SAF foresees to reformat and adapt datasets to meet the specific requirements of different user communities. For example, to facilitate seamless integration and use in climate model evaluation, data might be tailored to align with the WCRP ESMO obs4MIPs framework. This approach ensures that users can efficiently incorporate observational data into their climate modeling workflows, improving both the quality and speed of analyses. Where applicable, it will be evaluated how to provide data in Zarr cloud-ready format, enabling scalable, efficient, and flexible access for users working with cloud-based infrastructures and high-performance computing environments. The sets of parameters will be agreed on with the respective user communities.

- Post-Processing of CM SAF Data to Deliver Level 4 Climate Products:

Provision of advanced post-processing of CM SAF datasets will be considered to generate Level 4 climate products. This might include creating aggregated metrics such as averages per Member State, enabling policymakers and researchers to access summarized climate information relevant to their region.

- Dedicated use case studies on preparing climate indices

The specific topics, responsible project partners and proposed completion timelines of the studies are outlined in Table 2-18:

Table 2-19: Planned studies on climate indicators.

Study on climate indicators	Topic	Project partner(s)	Completion timeline	Deliverable(s) and their timing
CI1	Heat indices	UKMO, MeteoSwiss	UKMO: 2027-2029, MeteoSwiss 2028-2030	UKMO – Report, due 1.1.2031, MeteoSwiss – Report, due 1.1.2031
CI2	Renewable energy	MeteoSwiss	2028-2030	Report, due 1.1.2031.
CI3	UCS on precipitation, vegetation and wildfire indices over the UK and potentially Europe	UKMO	2027-2029	Report, due 1.1.2030

CI1, part a - Towards producing operational heat indices products for the UK (and potentially Europe and beyond)

As part of the CM SAF work towards developing Level 4 products, UKMO will perform a user case study on the development of indices relevant to heatwave monitoring and heat stress. This mostly includes extreme heat indices related to surface temperature, including identification of super extreme land surface temperature hotspots (see Good et al., 2025) and heat stress. This study would primarily use the CM SAF LST dataset, together with some auxiliary datasets, working closely with MeteoSwiss, who already produce some of these indices for Switzerland. The aim would be to test the indices over the UK, where there is existing in-depth knowledge of weather station data. Experience with the CDOP-4 use case study on producing a blended satellite-station sunshine duration ("BleSS-UK") has demonstrated that a comparison of station and satellite observations in developing these indices can be used to identify issues in both types of data sources, leading to improved satellite- and station-only products. A key part of the study would be to conduct an independent stability analysis of the satellite data using known, stable weather station data. This type of analysis in BleSS-UK allowed the identification of a non-climatic discontinuity in the SARAH-3 sunshine duration product that corresponds to the transition from Meteosat First Generation to Meteosat Second Generation. The goal for the output of this study would be a draft paper; however, depending on the study outputs, a report may be more appropriate. The software to produce the blended sunshine data set would be developed in a robust and traceable way, with a high-level of quality assurance, including unit and end-to-end testing, and detailed documentation, so that the software can be made publicly available as a stand-alone Python software package for use by other NMS (noting that the software would be a MetOffice product, rather than a CM SAF).The output from this user case study would be a report/draft paper.

CI1, part b - In CDOP-5 the CM SAF will produce Land Surface Temperature CDRs with unprecedented spatial resolution (HANNA: 0.01° lat/lon grid Europe) and coverage (GEO-Ring

LST: 0.05° lat/lon grid quasi globally). For the first time, the CM SAF and LSA SAF will run a LST ICDR production extending those CDRs into the presence. This will enable operational heatwave monitoring. With this use case it will be demonstrated how the HANNA and GEO-Ring LST CDRs and ICDRs can be integrated for heatwave monitoring. Cheda et al. (2026) has demonstrated that satellite-based heat indices can overcome the lack of observational station data and provide meaningful heatwave indices. Summer Days and Tropical Nights indices defined by the Expert Team on Climate Change Detection and Indices (ETCCDI) based CM SAF SUMET v2.0 Land Surface Temperature (LST) and the Extremely Hot Days index defined particularly for LST are highly correlated with station-based indices in Switzerland. With this use case CM SAF will bring the analysis on a quasi-global scale and also outline the added benefit of the high resolution LST heat indices for Europe. Urban heat effects will be visible on 0.01° lat/lon grid and in this use case, the CM SAF will develop heat indices particularly tailored for urban heat. Please note that the result will be a report which summarizes the methods and provides concrete examples. Depending on the science findings, the CM SAF also envisions a peer reviewed publication and a very close cooperation with the ETH (group Sonia Seneviratne, see support letter).

CI2 – Renewable energy:
With HANNA and SARAH GEO-Ring, solar radiation CDRs and ICDRs particularly tailored for the solar energy market will be issued. Solar energy plays a major role in climate change mitigation. With rising shares of solar power in the grid, solar radiation is becoming increasingly important for grid operators to enable cost-efficient supply and demand balancing. However, renewable energy production is heavily dependent on the prevailing weather conditions, which are changing as a result of climate change. It is therefore necessary to build energy systems that are robust to energy shortages caused by weather-dependent changes to energy demand and renewable energy production. In this use case, the CM SAF will develop climate indices which are tailored for the CM SAF solar radiation data. Those indices will facilitate the comparisons between regions with different climates and installed capacities. The result of this Use Case will be a report which summarizes the methods and provides examples on how to calculate CM SAF-based indices for the solar energy sector. Both MeteoSwiss and the SMHI have concrete plans to integrate CM SAF-based solar energy indices in their operational climate monitoring through additional, CM SAF external founding (e.g., SMHI’s SCARLET project proposal).

CI3 - Towards operational indices related to precipitation, vegetation and wildfire indices over the UK (and potentially Europe and beyond)
This study is aimed at assessing the feasibility of precipitation, vegetation and wildfire indices over the UK and potentially Europe and beyond using CM SAF LST, precipitation and potentially other CM SAF products as appropriate (e.g., sunshine, radiation). This would include a subset of the ‘Climpact’ indices for precipitation and sector-specific indices, such as growing degree days (GDD), and threshold temperatures for stomatal closure, which depends on plant functional type (PFT). Indices that use more than one satellite variable will also be used to assess the consistency between different, but related, satellite variables. A key part of the study would be to conduct an independent stability analysis of the satellite data. As noted in the above UKMO study on heat indices, this type of analysis in BleSS-UK allowed the identification of a non-climatic discontinuity in the SARAH-3 sunshine duration product that

corresponds to the transition from Meteosat First Generation to Meteosat Second Generation. The goal for the output of this study would be a draft paper; however, depending on the study outputs, a report may be more appropriate. Depending on the outcome of this study, it generally envisaged that one or more of the indices can be made into an operational product and extended to European scale during the latter part of CDOP-5 or in CDOP-6 in CM SAF. Options of how to implement these results are a replanning of CM SAF CDOP-5 activities, proposal drafting and submission to the Innovation Layer, or preparation for CDOP-6. As with BleSS-UK, the software to produce the blended sunshine dataset will be developed in a robust and traceable way, with a high-level of quality assurance, including unit and end-to-end testing, and detailed documentation, so that the software can be made publicly available as a stand-alone Python software package for use by other NMS (noting that the software would be a Met Office product, rather than a CM SAF product as discussed at previous meetings).

Depending on the outcome of the studies, it is generally foreseen that one or more of the indices described above can be made into an operational product during the latter part of CDOP-5 or in CDOP-6 within CM SAF. Options of how to implement these results from the use cases above are a replanning of CM SAF CDOP-5 activities, proposal drafting and submission to the Innovation Layer, or preparation for CDOP-6.

The activities in this WP will be closely coordinated with activities in WP 3130, WP 7010, WP WP 7020, WP 7030, WP 7040, WP 7050 (CAN), WP 2400 (use cases) and WP 2100 (User services).
By implementing these additional data services, CM SAF aims to enhance data utility across a wide spectrum of stakeholders, ranging from climate modelers to policymakers, facilitating improved climate assessment, research, and regional planning.

2.6 System Engineering

2.6.1 Overall System Engineering overview

The core task of CM SAF is the generation, archiving and provision of long-term climate data records processed for fixed periods ((F)CDRs) on one side and being continuously updated (ICDRs) on the other side. The Interim Climate Data Records (ICDRs) have the same characteristics and are based on the same algorithms as the corresponding Climate Data Records (CDRs). They are derived from satellite data in an off-line mode with a short-term latency.

The system configuration of the CM SAF will be capable of achieving the objectives of CDOP-5 especially in terms of all processing activities including development and validation. All processing centers provide specific systems in distributed environments.
During CDOP-5, the majority of data records will be produced at the EWC at EUMETSAT. Some processing environments already operational at the start of CDOP-5 will remain on their current systems until the respective CDRs are either superseded or CDRs released (in some cases new editions in CDOP-5 will be based on already available processing systems, see Section 2.6.2). For all new processing environments, it is planned to set new systems up at EWC, re-using modules from the current processing system as feasible. CM SAF will use two production centers, namely a processing center at DWD, which will be using resources at EWC, DWD and ECMWF and a processing center at RMI using resources at ECMWF.

All products which will be released until end of CDOP-4 and during CDOP-5 will be disseminated via the EUMETSAT Data Store. CM SAF will provide all information needed to populate the respective entries in the data catalogue at EUMETSAT and make the data available to the EUMETSAT Secretariat for ingestion in the Data Store. Data records released before the transition to the EUMETSAT Data Store will be available via the CM SAF Web User Interface (WUI) until the data records are superseded or retired. As in CDOP-4 selected products will be disseminated via EUMETCast.

2.6.2 Reuse of existing Infrastructure and cloud deployment roadmap

The existing user services with web page and user help desk will be re-used in CDOP-5 (with update of web page including mandatory migration to new CMS version and re-design planned during CDOP-5). Even after the complete change to archiving and dissemination of the most recent CM SAF data records via the EUMETSAT systems, CM SAF needs to keep older versions (according to e.g., DOI regulations) and needs to be able to make this available to interested users (on demand) in the long term. Therefore, the product archiving and dissemination systems will also remain in use on the existing infrastructure at DWD.
The production infrastructure for the FCDR at DWD used in CDOP-4 will be used again. As only minor changes are needed in the respective processing systems, the new edition will be processed on the local system at DWD (MultiNode Batch system on virtual Linux servers) again. Similarly, the processing environment for the Land Flux edition generated by RMI will be re-used. As only minor changes are needed in the processing system, the new edition will be processed by RMI at ECMWF again (as in CDOP-3).
In early CDOP-5 the ICDR processing of the product families CLARA-A3.5 (@ECMWF), GIRAFE v1 (@DWD), CLAAS-4 and SARAH-4 (both @EWC) will be operational. They will be used “as

is" at the respective computing centres until new versions will be released. The processing environment for GIRAFE v1 will also be re-used for the successor GIRAFE v1.1.

For all other releases planned for CDOP-5 the processing is foreseen to be done on the European Weather Cloud. Some of the new editions can build on existing predecessors in EWC, for others a migration to or new development in the EWC is needed. Whenever possible modules of pre-existing software environments will be re-used. Table 2-20 gives an overview on the different processing systems foreseen for the CM SAF product families during CDOP-5 and beyond. CM SAF will be in close contact with the EUMETSAT Secretariat (e.g., via regular coordination meetings) regarding the development of needed resources and functionalities in the EWC to ensure a smooth and resource-efficient transition of the processing to the EWC for these new developments.

Table 2-20: Overview of processing systems and processing centers of the different product families during CDOP-5.

DWD "local"	DWD @ECMWF	DWD @EWC	RMI @ECMWF	reuse/ update/ new development
FCDR SSM/I+SSMIS ed. 6				reuse (from CDOP-4)
GIRAFE v1 (ICDR)				reuse (from CDOP-4)
GIRAFE v1.1 (CDR + ICDR)				reuse (from CDOP-4, same as GIRAFE v1)
		GIRAFE v2 (CDR + ICDR)		**New** (re-using modules from GIRAFE v1.1 where possible)
	CLARA-A3.5 (ICDR)			reuse (from CDOP-4)
		CLARA-A4 (CDR + ICDR)		**New** (re-using modules from CLARA-A3.5 where feasible)
		HOAPS v5 (ICDR)		**New** (CDR part @DWD during CDOP-4, re-using modules where feasible)
		SARAH-v4 (ICDR)		reuse (from CDOP-4)
		SARAH-v5 (CDR+ICDR)		update (based on SARAH-4 environment)
		CLAAS-v4 (ICDR)		reuse (from CDOP-4)
		GEO-Ring Clouds & TOA (CDR+ICDR)		**New** (benefits from CLAAS-4 and

DWD "local"	DWD @ECMWF	DWD @EWC	RMI @ECMWF	reuse/ update/ new development
				HANNA developments in EWC and demonstrator in CDOP-4)
		HANNA (CDR + ICDR)		**New** (benefits from developments for demonstrator in EWC in CDOP-4 and experience at MeteoSwiss)
			Land Flux (CDR)	update (from CDOP-3, minor updates compared to Land Flux ed. 1)
		ICDR anomalies		**New** (benefits from developments for demonstrator in CDOP-4)

As CM SAF progresses with the migration of several processing environments to the European Weather Cloud infrastructure, it requires additional cloud computing resources compared to the CDOP-4 phase. The transition will also introduce increased computing workloads across the development, testing, and integration environments in addition to the main processing of the different CDRs and ICDRs. To support these activities, CM SAF requires expanded cloud computing resources (virtual CPUs, memory, and storage) are needed. The resource estimates are based on information from processing performance during CDOP-3 and CDOP-4. At time of writing of the proposal, several of the CDOP-4 CDRs are still under development and no consolidated numbers on processing needs for the CDOP-4 releases are available yet).

Figure 2-23 provides information on the temporal distribution of required number of processing cores (as bars in plot) and total memory (line). The temporal distribution of the needed storage resources is shown in Figure 2-24.

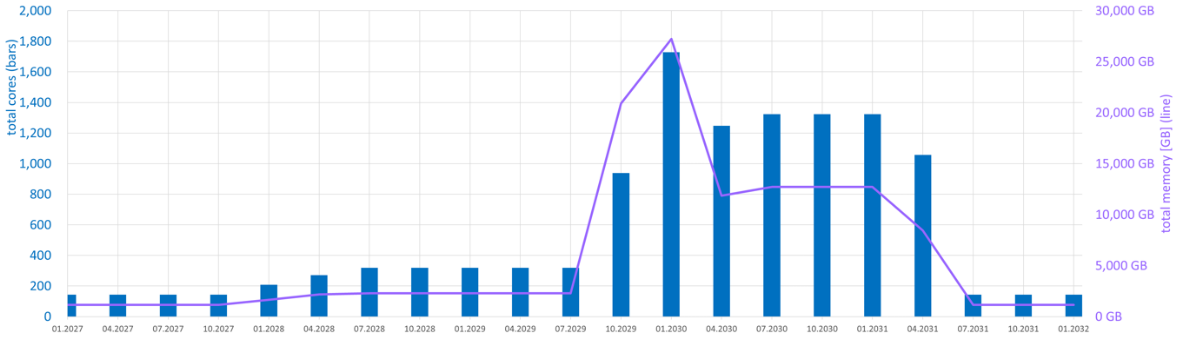


Figure 2-23 Timeline of requested total number of processing cores (bars) and total memory (line) in CDOP-5

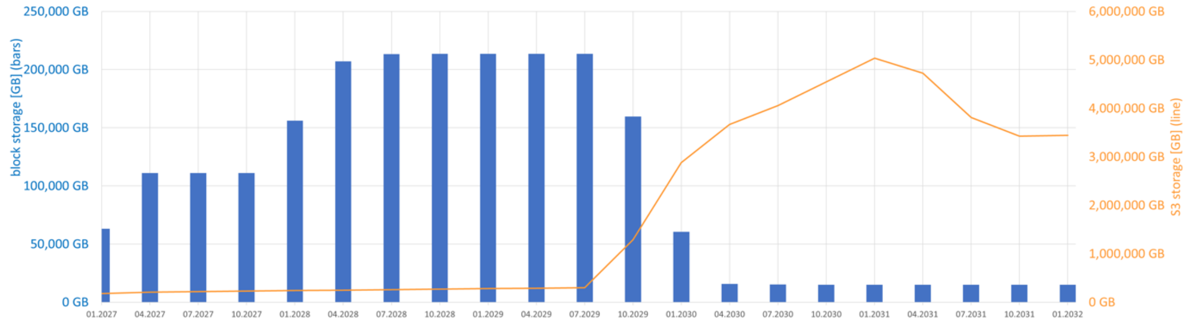


Figure 2-24: Timeline of requested block storage (bars) and storage in S3-buckets (line) during CDOP-5

The planning considers the “one-time” processing of CM SAF CDRs and the continuous processing of the different ICDRs. While CDRs are processed with high resource demand over a shorter time period (typically several months), ICDRs are processed on a regular schedule (often daily). To efficiently use and minimize the needed computing resources (number of processing cores, memory), resources, the processing for the different ICDRs will be distributed over the full day, with the largest individual system defining the requirements.
The presented storage requirements (Figure 2-24) distinguish between block storage and object storage (S3-buckets). It is assumed that the final products are stored in S3-buckets, taking advantage of new data access methods in cloud systems during CDOP-5 to enhance user-friendliness and facilitate cross-SAF activities (see also Section 2.5.2). Intermediate data from the processing will be temporarily stored in S3-buckets to conserve disk space, with automatic deletion after a limited period. The block storage will be primarily utilized during the development phase of the respective CDRs and their processing environments.
All new CDRs are planned to include data up to the end of 2030 to align with the next WMO reference period. This may result in a temporary peak in required resources as shown in Figure 2-23 and Figure 2-24. To manage this effectively, coordination with the SAF network and the EUMETSAT Secretariat is planned. Efforts will be made to distribute the workload by, e.g., initiating processing of large data volumes as soon as development is complete for the majority of the time period, starting early validation activities, and scheduling the final processing phase – including the remaining data up to 2030 – for 2031. Together with the release of the new editions in CDOP-5 also more CM SAF data records will include an accompanying ICDR processing. Which will increase the level of permanently needed resources in EWC.

2.6.3 Operational Configuration for CDOP-5

This Section describes the configuration devoted to support operations of the CM SAF during CDOP-5, including operational interfaces to other SAFs, the Secretariat and other organisations.

The Operations Manager is responsible for the overall management, including configuration and change management, of the operational activities within the CM SAF (processing, data access and provision, CM SAF user services). As shown in Section 2.6.1, CM SAF operates two processing centres, namely at DWD and RMI. DWD as leading entity has the overall responsibility for the configuration and change management of the CM SAF, related to the processing of all CM SAF products, data access and provision as well as all CM SAF user services. The rules and procedures for configuration identification and control are laid down in the Configuration Management Plan. This plan in particular includes document control and code control. The Operations Manager is responsible for the Configuration Management.

DWD is also in charge of the local configuration and change management for the CDR and ICDR products generated at the processing centre DWD (using resources at DWD, ECMWF and EWC). RMI has the responsibility for local configuration and change management for processing performed at the RMI processing centre (using resources at ECMWF). The local configuration manager at RMI reports to the configuration manager at DWD.

The operations management is responsible for the scheduling of the (re-)processing events and the proper and timely planning and allocation of needed IT-resources.
Operations management also includes User Help Desk functionality and anomaly handling. The Operations Report covers all operations activities and developments. As in CDOP-4, this report will be published half-yearly.

During CDOP-5, CM SAF will administrate a tenancy in the EUMETSAT Cloud Infrastructure in order to provide an efficient, modern and collaborative computing environment for its developments as well as the CDR and ICDR production. CM SAF already administrates a tenancy in the EUMETSAT Cloud Infrastructure. It is administrated by CM SAF with technical support from EUMETSAT Secretariat as needed. Tasks will include the user administration for the CM SAF project team, including account setup and access management, as well as management of virtual machines (VMs) and storage infrastructure to support both production and development activities. The team at DWD will be acting as the single point of contact between the EUMETSAT Secretariat and the CM SAF project team, ensuring smooth communication and coordination. The team at DWD will coordinate cross-SAF activities to promote better integration and collaboration between CM SAF and other SAFs, optimizing shared service delivery.

To provide a combined development and production environment within the EWC, the team at DWD will maintain and provide essential software libraries and compilers required for development and processing tasks. The management of a version control system (git-server) to support collaborative development and code management will continue unless a system managed by the EUMETSAT Secretariat becomes available in the EWC. To facilitate standardised data workflows and reduce duplication, processes will be established for the preparation, pre-processing and storage of shared input products. The CM SAF tenancy infrastructure will provide support for containerised solutions and technologies such as HTCondor and Kubernetes, enabling scalable and efficient deployment environments. Assistance in migrating services and processes to a cloud-first architecture, with a focus on modern storage solutions and containerization, to enhance scalability, reliability, and maintainability of services, will be provided. In order to even better support the transition into the European Weather Cloud and support the adaptation of existing (heritage) software as well as to supporting development of cloud-ready software modules, CM SAF foresees a demonstrator as part of the innovation layer, which will feed back in the WP 3200 (Technical Environment European Weather Cloud).

An effective and clearly defined interface with EUMETSAT is essential to ensure alignment in resource planning and the seamless dissemination of CM SAF products. This interface will serve as a strategic and operational link between the CM SAF project team and EUMETSAT Secretariat. Regular coordination meetings will be carried out throughout CDOP-5 to assess and plan among others the infrastructure resource needs in the European Weather Cloud (e.g., compute, storage, access to input satellite data and meteorological data provided by the EUMETSAT Secretariat), based on current usage and future needs, and ensure usage in an efficient way. Integration of the CM SAF products into the EUMETSAT Data Store will be done through aligned workflows for product registration, ingestion, metadata management, and publication. Monitoring and support processes will be coordinated to ensure reliable data access and performance.

3 Management Proposal

CM SAF relies on the existing structures as they have been successfully been practiced in CDOP previous phases.

3.1 Consortium and Management Structure (first level cooperating entities, lower level partners/subcontractors)

The CM SAF is part of the EUMETSAT SAF network comprising eight SAFs. The CM SAF Consortium is led by DWD as Leading Entity (LE) and 6 Cooperating Entities (CE) and is composed of all institutes involved in the work of the CM SAF contributing to the funding of the SAF. This means that each Consortium Entity (CE) and the Leading Entity (LE), respectively, provide at least 25% of the respective funding of the entire CM SAF CDOP-4 costs.

Figure 3-1 shows the matrix of responsibilities per partner and work package.

DWD		FMI	KNMI	MeteosSwiss	RMIB	SMHI	UKMO
CM SAF Management	WCRP support activities	CM SAF use cases, analysis and support to climate reports	Prepare merged Geo-Ring and polar orbiter based products	CDR+ICDR high-resolution Europe (HANNA) RR	CDR+ICDR high-resolution Europe (HANNA) DRR	Support to EUMETSAT for FCDR generation	WP consistency
Science Coordination	Microwave Imager Inter-calibration		CDR+ICDR GeoRing (clouds, TOA, incl pot CLAAS-5 prep, LandFlux)	CDR+ICDR high-resolution Europe (HANNA) PCR	CDR LandFlux (Meteosat, fluxes only)	CDR+ICDR global CLARA-A4	
Operations Management	Preparing a regional high resolution precipitation product			CDR+ICDR GeoRing (LST)		Global clouds and surface radiation Normals and Anomalies	
User engagement, user services and product usage monitoring	CDR+ICDR global Precipitation (GIRAFE v2)						
Training and Outreach	CDR+ICDR GeoRing Surface Radiation (SARAH-5)						
Workshops and expert meetings	ICDR HOAPS-5						
Regional ICDR products (CLAAS-4, SARAH-4, HANNA, GeoRing)	CDR+ICDR GIRAFE v1.1						
Global ICDR products (GIRAFE v1, v1.1, v2, HOAPS 5, CLARA-A3.5, CLARA-A4)	FCDR SSM/I+SSMIS FCDR Edition 6.0 (extension)						
ICDR anomalies	High resolution solar radiation Europe Normals and Anomalies						
Technical Environment EWC	Global precipitation Normals and Anomalies						
Preparing new Level 4 climate products and associated coordination, including CAN	Regional Surface Radiation Normals and Anomalies						
Common WP H SAF, RR							

Figure 3-1: Organisation Breakdown Structure and mapping of responsibilities against Work Breakdown Structure. Updated WP are marked in red.

3.2 Organisational Structure

CM SAF uses the same organizational structure as in previous phases. The consortiums co-operation is formalized by related agreements (see Figure 3-2:):

- As CM SAF Leading Entity, DWD will sign the cooperation agreement with EUMETSAT and is therefore fully responsible vis-à-vis EUMETSAT.
- Subsequently, DWD will sign sub-agreements with all consortium partners, which are therefore responsible vis-à-vis DWD for their agreed-upon CM SAF contribution.

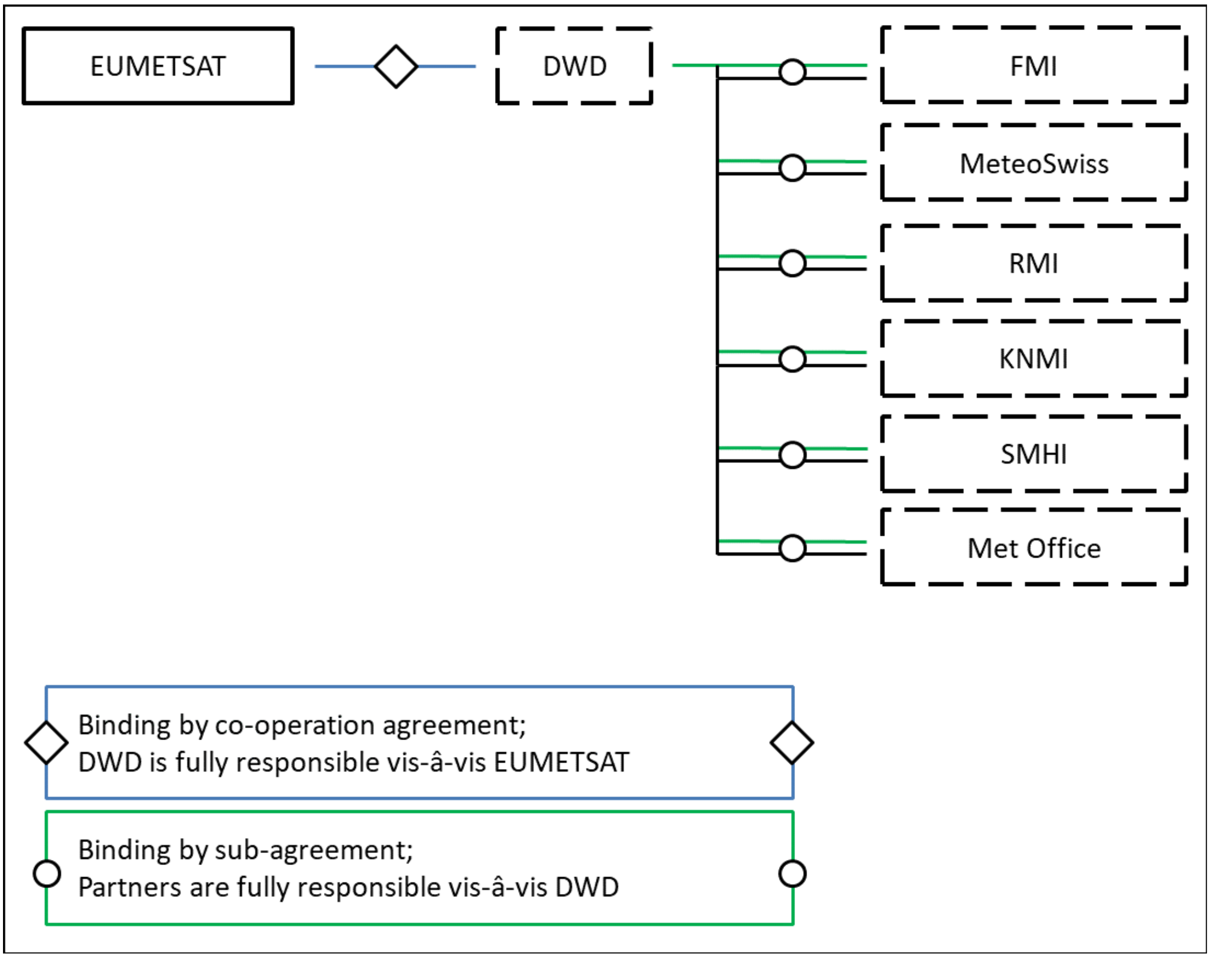


Figure 3-2: Cooperation Agreements of CM SAF.

The CM SAF project is managed by the CM SAF Board Team, led by the Board Manager. The CM SAF Board Team is the technical authority of the SAF and responsible for the day-to-day-execution of all CM SAF CDOP-5 activities, including the responsibility for project execution technically, financially and with respect to scheduling.

The Board Team consists of the focal points nominated by the consortium members (supported by expert(s) from the work packages as necessary), the Scientific Coordinator and the Configuration Manager (see also Figure 3-3:).

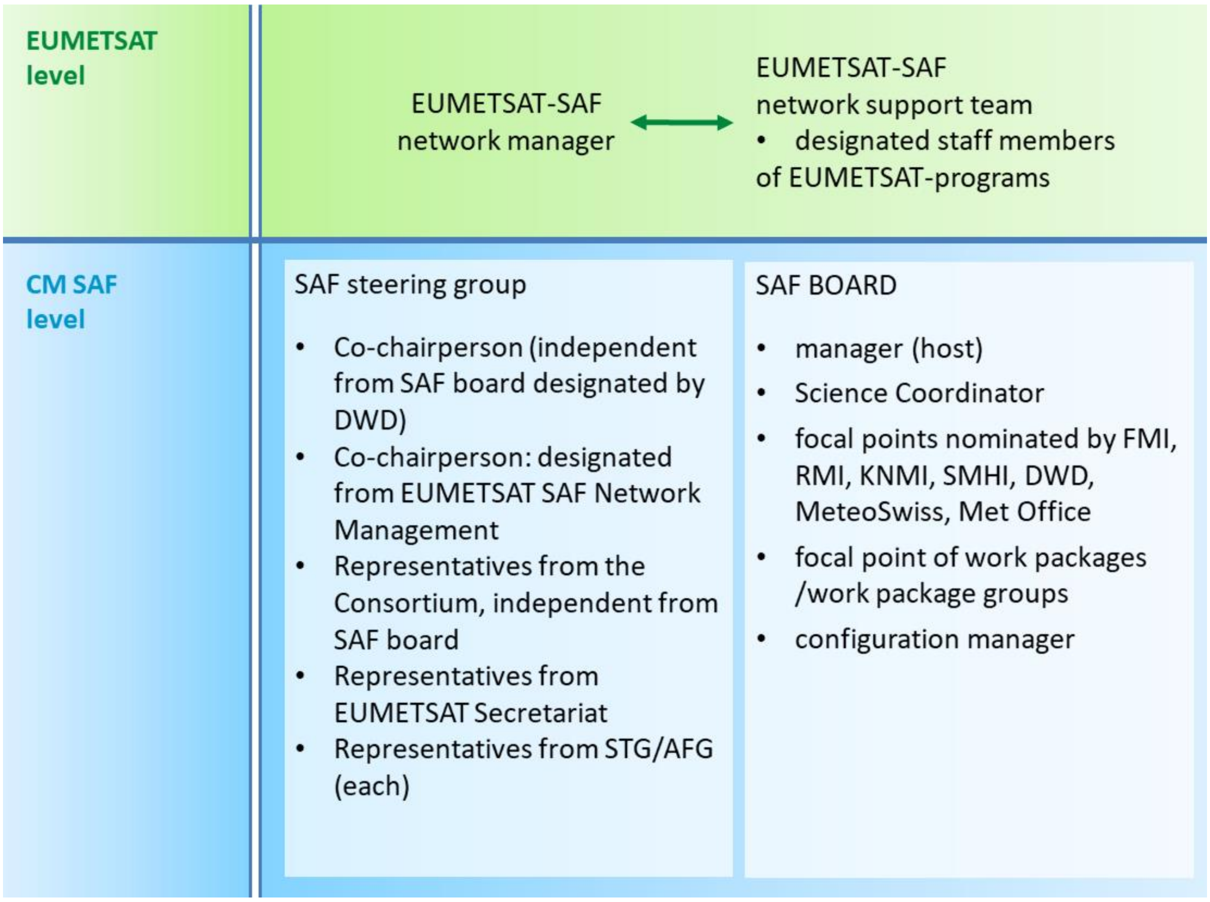


Figure 3-3: Management scheme for CM SAF.

All items presented to Steering Group (SG) for decision will be discussed at CM SAF board level and forwarded to SG in case of consensus. The CM SAF Board Team meets once a year in person and virtually as often as necessary.

3.3 *Project Planning Elements*

3600 The established main planning elements for a CDOP are:

- PRD (provided as stand-alone document)
- Work packages (see Annex II)
- Master Schedule (see Annex III)

The initial versions of these documents are included in the proposal as annexes.

Task	WP No.	Associated Reviews	Start date	End date	dur. [days]	dur. [mo]	DWD	FMI	KNMI	MeSw	RMIB	SMHI	UKMO sci	UKMO Mngt	Sum	
Management																Management
CM SAF Management	WP 1100		01.03.2027	29.02.2032	1826	60	12,5								12,5	
Science Coordination	WP 1200		01.03.2027	29.02.2032	1826	60	12,0							6,0	18,0	
Operations Management	WP 1300		01.03.2027	29.02.2032	1826	60	14,0								14,0	
SUM Management							38,5	0,0	0,0	0,0	0,0	0,0	0,0	6,0	44,5	
User Support																User
User engagement, User services and product usage monitoring	WP 2100		01.03.2027	29.02.2032	1826	60	48,0								48,0	
Training and Outreach	WP 2200		01.03.2027	29.02.2032	1826	60	19,0		0,5		0,5	0,5			20,5	
Workshops and expert meetings	WP 2300		01.03.2027	29.02.2032	1826	60	10,0	1,5	1,0		1,0	2,4	0,5	0,5	16,9	
CM SAF use cases, analysis and support to climate reports	WP 2400		01.03.2027	29.02.2032	1826	60	6,0	22,0	9,5		3,0	11,5	9,0	1,0	62,0	
Preparing new Level 4 climate products and associated coordination, including CAN	WP 2500		01.03.2027	29.02.2032	1826	60	5,0			10,0			27,0	4,0	46,0	
SUM user services							88,0	23,5	11,0	10,0	4,5	14,4	36,5	5,5	193,4	
Processing																
ICDR Processing	WP 3100		01.03.2027	29.02.2032	1826	60										
Regional ICDR products (CLAAS-4, SARAH-4, HANNA, GeoRing)	WP 3110	ORR 5.6, ORR5 5.7, OR2027-2031	01.03.2027	29.02.2032	1826	60	23,0		1,5		3,5	1,0			29,0	
Global ICDR products (GIRAFE v1, v1.1, v2, HOAPS 5, CLARA-A3.5, CLARA-A4)	WP 3120	ORR 5.5, ORR 5.9, ORR 5.1, ORR 5.2, OR2027-2031	01.03.2027	29.02.2032	1826	60	25,0	5,0	1,5		1,5	1,5			34,5	
ICDR anomalies	WP 3130	ORR 5.2, ORR 5.3, ORR 5.5, ORR 5.8, ORR 5.9, OR2027-2031	01.03.2027	29.02.2032	1826	60	15,5	2,5			1,0	1,0			20,0	
Technical Environment EWC	WP 3200		01.03.2027	29.02.2032	1826	60	10,0								10,0	
Committed Activities																
Prepare merged Geo-Ring and polar orbiter based products	WP 4100		01.03.2027	29.02.2032	1826	60	12,0	5,0	2,1	2,0	2,0	2,5			25,6	
Concept for a consistent NRT and CDR high-resolution precipitation product for Europe. Collaboration with NWC SAF	WP 4200		01.03.2027	29.02.2032	1826	60	10,0								10,0	
WCRP support activities	WP 4300		01.03.2027	29.02.2032	1826	60	10,0								10,0	
Microwave Imager Inter-calibration	WP 4400		01.03.2027	29.02.2032	1826	60	8,0								8,0	
Support to EUMETSAT for FCDR generation	WP 4500		01.03.2027	31.12.2028	671	22	1,0	0,5	1,0		0,5	7,0			10,0	
Towards a consistent approach to estimate uncertainties	WP 4600		01.03.2027	31.12.2028	671	22	2,5						5,0	5,0	12,5	
SUM committed activities + techn. support / ICDR							117,0	13,0	6,1	2,0	8,5	13,0	5,0	5,0	169,6	
Committed CDRs and ICDRs																
CDR+ICDR global CLARA-A4	WP 5100		01.03.2027	29.02.2032	1826	60	50,0	32,0	19,0	0,0	27,5	56,2	0,0	0,0	184,7	
CDR+ICDR global CLARA-A4	WP 5110	RR 5.2	01.03.2027	30.06.2028	487	16	5,0	7,5	5,0		5,0	15,0			37,5	
CDR+ICDR global CLARA-A4	WP 5120	PCR 5.2	01.07.2028	31.12.2029	548	18	22,0	12,0	6,5		11,5	22,0			74,0	
CDR+ICDR global CLARA-A4	WP 5130	DRR 5.2/ORR 5.2	01.01.2030	29.02.2032	789	26	23,0	12,5	7,5		11,0	19,2			73,2	
CDR+ICDR global Precipitation (GIRAFE v2)	WP 5200		01.03.2027	31.12.2031	1766	58	79,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	79,0	
CM SAF and H SAF - joint precipitation RR	WP 5210	RR 5.5	01.03.2027	31.12.2028	671	22	2,0								2,0	
CDR+ICDR global Precipitation (GIRAFE v2)	WP 5220	PCR 5.5	01.07.2028	30.06.2030	729	24	56,0								56,0	
CDR+ICDR global Precipitation (GIRAFE v2)	WP 5230	DRR 5.5/ORR5.5	01.07.2030	31.12.2031	548	18	21,0								21,0	
CDR+ICDR high-resolution Europe (HANNA)	WP 5300		01.03.2027	31.08.2030	1279	42	36,0	0,0	0,0	30,0	28,0	0,0	0,0	0,0	94,0	
CDR+ICDR high-resolution Europe (HANNA)	WP 5310	RR 5.6	01.03.2027	29.02.2028	365	12	6,0			6,0	5,0				17,0	
CDR+ICDR high-resolution Europe (HANNA)	WP 5320	PCR 5.6	01.03.2028	31.08.2029	548	18	14,0			12,0	12,0				38,0	
CDR+ICDR high-resolution Europe (HANNA)	WP 5330	DRR 5.6/ORR5.6	01.09.2029	31.03.2031	576	19	16,0			12,0	11,0				39,0	
CDR+ICDR GeoRing (clouds, TOA, surf. rad, LandFlux)	WP 5400		01.03.2027	31.08.2031	1644	54	55,0	2,0	36,5	11,5	40,5	38,0	0,0	0,0	183,5	
CDR+ICDR GeoRing (clouds, TOA, surf. rad, LandFlux)	WP 5410	RR 5.7	01.03.2027	31.12.2028	671	22	9,0		8,0	1,0	5,0	10,0			33,0	
CDR+ICDR GeoRing (clouds, TOA, surf. rad,LandFlux)	WP 5420	PCR 5.7	01.01.2029	31.03.2030	454	15	22,0		14,0	6,0	9,5	14,0			65,5	
CDR+ICDR GeoRing (clouds, TOA, surf. Rad, LandFlux)	WP 5430	DRR 5.7, ORR 5.7	01.04.2030	31.08.2031	517	17	24,0	2,0	14,5	4,5	26,0	14,0			85,0	
CDR+ICDR GeoRing Surface Radiation (SARAH-5)	WP 5500		01.03.2027	29.02.2032	1826	60	27,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	27,0	
CDR+ICDR GeoRing Surface Radiation (SARAH-5)	WP 5510	RR 5.4	01.03.2027	30.06.2028	487	16	7,0								7,0	
CDR+ICDR GeoRing Surface Radiation (SARAH-5)	WP 5520	PCR 5.4	01.07.2028	29.02.2032	1338	44	20,0								20,0	
ICDR HOAPS-5	WP 5730	ORR 5.1	01.03.2027	29.02.2032	1826	60	30,0								30,0	
FCDR SSM/I+SSMIS FCDR Edition 6.0 (extension)	WP 5830	DRR 5.1	01.10.2029	29.02.2032	881	29	9,0								9,0	
CDR+ICDR GIRAFE v1.1	WP 5930	DRR 5.9 / ORR 5.9	01.03.2027	31.12.2027	305	10	12,0								12,0	
CDR LandFlux (Meteosat, fluxes only)	WP 6100	DRR 5.10	01.03.2027	31.12.2028	671	22	0,5			1,5	6,0				8,0	
GEO-ring LST – In Coordination with LSA SAF	WP 6210		01.03.2027	29.02.2032	1826	60				10,0					10,0	
Committed normal and anomalies							22,0	5,0	0,0	4,4	4,0	4,0	0,0	0,0	39,4	
Normal and anomalies	WP 7000		01.03.2027	29.02.2032	1826	60										
Regional Surface Radiation (SARAH-4, SARAH-5)	WP 7010	DRR 5.3 / ORR 5.3 (SARAH-4), RR 5.4 / PCR 5.4 (SARAH-5)	01.03.2027	29.02.2032	1826	60	7,0								7,0	
Global clouds and surface radiation (CLARA-A3.5, CLARA-A4)	WP 7020	DRR 5.8 / ORR 5.8 (CLARA-A3.5), RR 5.2 / PCR 5.2 / DRR 5.2 / ORR 5.2 (CLARA-A4)	01.03.2027	29.02.2032	1826	60	5,0	5,0			4,0	4,0			18,0	
Global precipitation (GIRAFE v1.1, v2)	WP 7030	DRR 5.9 / ORR 5.9 (v1.1), PCR 5.5 / DRR 5.5 / ORR 5.5 (v2)	01.03.2027	29.02.2032	1826	60	8,0								8,0	
High resolution Europe (HANNA)	WP 7040	RR 5.6 / PCR 5.6 / DRR 5.6 / ORR 5.6	01.03.2027	31.03.2031	1491	49	1,0			3,0					4,0	
Normals and Anomalies LANDFLUX LST	WP 7050		01.03.2027	31.08.2030	1279	42	1,0			1,4					2,4	
SUM CDRs							320,5	39,0	55,5	57,4	106,0	98,2	0,0	0,0	676,6	
SUM ALL							564,0	75,5	72,60	69,4	119,0	125,6	41,5	16,5	1084,1	

Figure 3-4: Overview of person-months per work package and per partner.

Figure 3-4 shows an overview of person-months per partner and work package. The detailed task and the distribution of person-months per year and partner is shown for each work packages in Annex II.

4 Financial Proposal

The proposed CDOP-5 project from 1 March 2027 to 29 February 2032 has an overall cost estimate of 17,547,098 EUR based on 2026 economic conditions (e.c.). Of these overall costs 9,700,000 EUR are expected to be covered by EUMETSAT and 7,847,098 EUR are expected to be covered by the national partners.

4.1 Cost Categories

Costs are itemized by following categories:

- Manpower – it includes staff in charge of development and the cost of operational staff for running the activities. Envisaged manpower effort and related costs are fully detailed, along with their association with work packages.
- Infrastructures – the cost of the improvement of the basic infrastructures for, in particular dedicated HW (servers, storage, workstations). For HW facilities, only the fraction of usage possible to assign to CM SAF purposes is included.
- Travel – the basis for computation is the list of milestones/meetings (project meeting, Steering Group and Review meetings for project partners).
- Training/workshops – it mainly includes the cost of organization and management of the workshop and training activities.
- Conferences: the basis of the computation is the list of conferences identified by each project partner, only conferences relevant to CM SAF are listed. The cost covers travel including daily allowance and conference fees.
- Publications: Each partner plans the publication of a certain number of papers during CDOP-5. The expected sum of publication cost for these publications is given.

Table 4-1 shows the monthly man power rate for each partner based on 2026 economic conditions, which is the basis for the calculation of the direct labour costs.

Table 4-1: Man power Monthly Rates (at 2026 e.c.) in EUR.

Consortium Member/ WP Category	Management	Science & Development	Engineering	Operational Services	User Services
DWD	15.035	15.035	15.035	15.035	15.035
FMI	15.770	15.770	15.770	15.770	15.770
KNMI	23.672	19.387	16.052	16.052	19.387
MeteoSwiss	15.834	15.834	15.834	15.834	15.834
RMI	13.090	13.090	13.090	13.090	13.090
SMHI	16.524	16.524	16.524	16.524	16.524
UKMO	16.900	14.384	14.384	14.384	14.384

The sum of the manpower rate and the contribution of the other cost categories (procurement, travel, conferences, workshop, and publications) per month is the so-called full cost rate. This rate is used in the following as a dedicated assignment of the cost factors (e.g., travel) to individual work packages. Is not always possible and allows the handling of the financial budget.

4.2 Cost Breakdown (CBS)

Table 4-2 shows the planned expenditure breakdown per cost category (management, development, operational services, and user training/support) for CM SAF for CDOP-5.

Table 4-2: Planned Expenditure Breakdown per Cost Category for CDOP-5. Expenditure is given in full EUR

Planned Expenditures (EUR, e.c. 2026)				DWD	FMI	KNMI	MeteoSwiss	RMI	SMHI	UKMO	Unallocated
Total Expenditures	Total		**17.547.098**	**8.892.960**	**1.239.660**	**1.441.773**	**1.154.300**	**1.592.740**	**2.125.686**	**905.980**	**194.000**
	(mm) 1.084	(Eur) %									
MANAGEMENT	55	6%	**1.027.551**	636.848	25.000	15.000	20.853	14.000	24.000	291.850	-
1.0) Direct Labour	55	83%	857.698	578.848						278.850	
2.0) Other Costs (e.g. Travel)		17%	169.853	58.000	25.000	15.000	20.853	14.000	24.000	13.000	
DEVELOPMENT	748	66%	**11.664.781**	**5.597.740**	**701.765**	**1.136.078**	**951.107**	**1.426.265**	**1.779.906**	**71.920**	-
1.0) Direct Labour	748	99%	11.523.781	5.472.740	701.765	1.136.078	941.107	1.420.265	1.779.906	71.920	
2.0) Non-Direct Labor (Sub-contracts)		0%	-								
3.0) Procurement/Material		1%	141.000	125.000	-	-	10.000	6.000	-		
4.0) Other Costs (Travel)		0%	-								
OPERATIONAL SERVICES	93	9%	**1.517.882**	**1.205.073**	**118.275**	**58.160**	**-**	**78.540**	**57.834**	**-**	**-**
1.0) Direct Labour	93	93%	1.417.882	1.105.073	118.275	58.160	-	78.540	57.834	-	
2.0) Non-Direct Labor (Sub-contracts)		0%	-								
3.0) Procurement/Material		7%	100.000	100.000	-	-	-	-	-	-	
4.0) Other Costs (Travel)		0%	-								
USER SUPPORT &TRAINING	188	18%	**3.142.885**	**1.453.300**	**394.620**	**232.534**	**182.340**	**73.935**	**263.946**	**542.210**	**-**
1.0) Direct Labour	188	92%	2.887.139	1.323.080	370.595	213.257	158.340	58.905	237.946	525.016	
2.0) Procurement/Material		0%	-								
3.0) Training Workshops		2%	66.455	57.000	2.025	2.000	2.000	1.030	-	2.400	
4.0) Conferences & Publications		6%	189.291	73.220	22.000	17.277	22.000	14.000	26.000	14.794	
VS/FA	-	1%	**194.000**	-	-	-	-	-	-	-	194.000
1.0) Visiting Scientists		50%	97.000								97.000
2.0) Federated Activities		50%	97.000								97.000

Table 4-3 shows the cost breakdown and funding per Country/Consortium member. Table 4-4 shows the planned contributions and requested funding.

Table 4-3: Expenditure Breakdown per Country and Consortium member. Costs are given in full EUR.

Country	Institute	COST ITEMS								FUNDING			
		Manpower		Industrial sub-contracts	Infrastructures/Facilities/HW	(Consumables) Conferences and Publications	Other (e.g. Travel)	Workshops	**TOTAL COST**	EUMETSAT Funding		Partners' Funding	
		mm	EUR	EUR	EUR	EUR	EUR	EUR	EUR	EUR	%	EUR	%
Germany	DWD	564,0	8.479.740		225.000	73.220	58.000	57.000	**8.892.960**	4.446.480	50,00	4.446.480	50,00
Finland	FMI	75,5	1.190.635			22.000	25.000	2.025	**1.239.660**	619.830	50,00	619.830	50,00
Netherlands	KNMI	72,6	1.407.495			17.277	15.000	2.000	**1.441.773**	951.570	66,00	490.203	34,00
Switzerland	MeteoSwiss	69,4	1.099.447		10.000	22.000	20.853	2.000	**1.154.300**	750.780	65,04	403.520	34,96
Belgium	RMI	119,0	1.557.710		6.000	14.000	14.000	1.030	**1.592.740**	796.370	50,00	796.370	50,00
Sweden	SMHI	125,6	2.075.686			26.000	24.000		**2.125.686**	1.487.980	70,00	637.706	30,00
United Kingdom	UKMO	58,0	875.786			14.794	13.000	2.400	**905.980**	452.990	50,00	452.990	50,00

Table 4-4: CM SAF planned contributions and requested funding including unallocated funding for VS/FA.

Planned Contributions (EUR, e.c. 2026)			DWD	FMI	KNMI	MeteoSwiss	RMI	SMHI	UKMO		Unallocated
Total Funding		**17.547.098**	**8.892.960**	**1.239.660**	**1.441.773**	**1.154.300**	**1.592.740**	**2.125.686**	**905.980**		**194.000**
EUMETSAT Contribution	55,28	**9.700.000**	4.446.480	619.830	951.570	750.780	796.370	1.487.980	452.990		194.000
1.1) Milestone payments	54,17	9.506.000	4.446.480	619.830	951.570	750.780	796.370	1.487.980	452.990	-	
1.2) Visiting Scientists	0,57	100.000									100.000
1.3) Federated Activities	0,54	94.000									94.000
1.4) User Forum & Promotional		-									
PARTNERS' Contribution	44,72	**7.847.098**	4.446.480	619.830	490.203	403.520	796.370	637.706	452.990		-
2.1) Milestone payments	44,72	7.847.098	4.446.480	619.830	490.203	403.520	796.370	637.706	452.990	-	
2.2) Visiting Scientists	0	-									
2.3) Federated Activities	0	-									
2.4) User Forum & Promotional		-									

The direct labour done by team members is integrated in traceable work packages (WP) for all partners.
Annex VIII shows the detailed cost breakdown structure of direct labour costs for CDOP-5 for each work package per year and per partner. As mentioned in Section 4.1 the full cost approach includes the labour cost as well as the monthly contribution of all other costs such as travel, procurement, etc. Additionally, each work package description sheet in Annex II includes a detailed breakdown of the labour cost and full cost per partner.

4.3 Cost Justification

Over the whole CDOP-5 period the CM SAF partners follow the EUMETSAT rules for SAF contribution. The overall EUMETSAT share over all categories and all partners is between 50% and 70% with an average EUMETSAT contribution of 57 % (Table 4-3). The detailed breakdown per work package is given in Annex VIII.

In the following a justification for the budget assigned to the different non-labour cost is given:

Other costs (e.g., travel)
This category allows for travel to the different official CM SAF meetings such as Steering Group meetings and the CM SAF Board meetings (hereafter also International Board meeting, IBM) as well as for management meetings with the secretariat or SAF network meetings. Steering group meetings and CM SAF Board meetings typically take place once a year as an in-person meeting at different locations (hosted by one of the partners), where the CM SAF board meeting typically takes 4 days and Steering Group 2 days, respectively. In addition, a 2nd meeting per year of SG and CM SAF board is planned as videoconference. Furthermore, travel to review meetings is eligible in this cost category. Review meetings typically take 1 days as online event, however, based on experience, some of them are in-person meetings. The number of participants for these meetings depends on the involved project partners. Table 4-5 gives the detailed breakdown of cost per partner and type of meeting.
In comparison with CDOP-4 numbers for travel, a cost increase occurred due to the overall considerably higher hotel, transportation and other travel costs. Overall, the planned expenditures for travel are less than 1% of the total budget.

Table 4-5: Breakdown of cost per partner and in-person meetings. The number of attending persons per meeting and per partner are given.

Partner	SG		IBM		Reviews		Budget
	Meetings	Participants	Meetings	Participants	Meetings	Participants	In EUR
DWD	5	4	5	6	10	1-2	58,000
FMI	5	1	5	1	2	1	25,000
KNMI	5	1	5	1.6	2	1	15,000
MeteoSwiss	5	1	5	1	2	1	20,853
RMI	5	1	5	1	2	2	14,000
SMHI	5	1	5	1.5	2	1	24,000
UKMO	5	1	5	1	2	1	13,000

Conferences and working group meetings

This cost category summarizes the planned participation in conferences and workshops (including training and user workshop), where CM SAF is represented by the project partners. The planned budget includes conference fees as well as costs for travel (including daily allowance).

Table 4-6 gives the planned participation in conferences per partners and the assigned budget. The budget is based on an average cost per conference including travel (flight, train, etc.), accommodation, daily allowance and conference fee. These costs are different depending on partner.

Table 4-6: Budget for conferences and working group meetings.

Partner	number of participants	Budget
DWD	24	48,000
FMI	7	16,000
KNMI	10	10,677
MeteoSwiss	5	18,000
SMHI	10	18,000
UKMO	5	6,000

CM SAF partners plan to attend the following conferences and working groups:

- EUMETSAT conference
- European Geosciences Union General Assembly (EGU)
- Conferences of European Meteorological Society (EMS) and European Conference on Applied Climatology (ECAC)
- International Radiation Symposium
- International Precipitation working Group (IPWG)
- International TOVS Working Group (ITWG)
- International Clouds Working Group (ICWG)
- GEWEX Water Vapor Assessment (G-VAP)
- Annual WCRP ESMO meetings
- EUMETSAT African User Fora
- ESA’s Living Planet Symposium

The number of participants per partner depends on the importance of the event. Depending on future developments participation in further conferences is foreseen.

Overall, the planned expenditures for conferences and working group meetings are less than 1% of the total budget.

Procurement

DWD, MeteoSwiss, and RMI plan the acquisition of hardware or usage of high-performance computers.

Concerning DWD, the hardware resources comprise, e.g., storage systems for data (hard disk plus required servers/storage systems) and/or the cost for usage of supercomputing resources. This is, among others, needed, as not all existing CDRs are being generated in the EUMETSAT cloud infrastructure but the related processing environments will remain at the local processing centres. Additionally, local resources are needed in the framework of the development of algorithms and corresponding processing environments for those data records for which the main processing might be done at the EUMETSAT Cloud Infrastructure. Furthermore, resources such as disk space are needed to locally store the respective results for extensive validation of the products (usually consisting not only of the main products but additional intermediate and auxiliary files from the processing as well as the validation data). Overall, this approach will change in the course of CDOP-5, as described in Section 2.6.2 CM SAF is increasingly relying on the central EUMETSAT Infrastructure. During CDOP-4 all new CDRs have already been archived in the EUMETSAT data store. However, due to existing commitments (e.g., a DOI registration requires a commitment for at least 10 years) the maintenance of the existing long-term storage of all CM SAF existing data at DWD is needed as well. These storage resource on, e.g., hard disk is also needed to allow for an efficient distribution of the products to our users including resources for user-requested post-processing of the data (e.g., keeping a cache of requested products on disk instead of a more time-consuming access via the database). Existing storage resources also need to be replaced by new storage systems on regular intervals due to the aging of the systems (maintainability, security updates and system support, etc.). Altogether DWD reserves for this 225,000 EUR.

Concerning RMI, procurement amounts to 10,000 EUR for local storage capacity needed for development and validation that cannot be done on the EUMETSAT Cloud Infrastructure. The amount is estimated as 20 TB * 5 years * 100 EUR/TB/year.

MeteoSwiss uses the 2,500 EUR procurement per year entirely to cover costs for development and product validation at the Swiss National Supercomputing Centre CSCS. Please note that the CM SAF project actually uses 70% of the CSCS memory and CPU of the MeteoSwiss Climate Department for validation and development. The Climate Department of MeteoSwiss pays 85,000 EUR per year to the CSCS. Hence, the 2,500 EUR per year only cover a small fraction of the actual costs and the remaining difference is an in-kind contribution from MeteoSwiss.
Overall, the procurement of CM SAF partners is very marginal with 1.6% of the planned expenditures.

Training and User Workshops

The budget in this category covers the organization of and to some extent travel to the CM SAF Training and User Workshops and necessary expert meetings in the following years described in Section 2.5.4. A total budget of 66,455 EUR is foreseen for these activities. The majority of the budget assigned to DWD is used for the organization of the workshops. During CDOP-4 CM SAF changed the strategy and hold more than one general User Workshop towards hosting several dedicated focused workshops (See Section 2.5.4 and the related work package description in Annex II). The focus of such a workshop can, e.g., address specific user groups such as NMHSs or thematical topics.
For the other partners only travel cost to these events is covered here. The budget is based on experience on typical costs during the previous project phases. There is no overlap/duplication with the EUMETSAT Training Plan.

Publications

The CM SAF partners plan to publish several (peer-reviewed) articles during CDOP-5. Peer-review publications are an essential element to document the data sets, applications and use cases of CM SAF and are a required step for any use in global climate assessments, e.g., the IPCC. This budget covers the publication cost for these journal articles and Table 4-7 gives the overview on the assigned budgets per partner.

Table 4-7: CM SAF budget for publications.

Partner	Planned number of publications	Total budget in EUR
DWD	5-10	20,000
FMI	2-3	6,000
KNMI	3	6,600
MeteoSwiss	3	4,000
RMI	1	2,000
SMHI	5	8,000
UKMO	3	7,846

5 Vision for CM SAF beyond CDOP-5

In this Section, an outlook of CM SAF in the context of EUMETSAT and Europe beyond the specific CDOP-5 commitments, e.g., with respect to possible Innovation Layer ideas and contribution to EU funded activities of EUMETSAT, is provided. The following topics are addressed in subsequent subsections and are foreseen to be activities in the Innovation layer:

- Development of global products based on merged polar and geostationary data
- Hosting of a “European GEWEX Project Office”
- Development of a high-resolution precipitation product for Europe
- Cloud-ready processing systems in EWC – a demonstrator/feasibility study
- Development and generation of climate indices
- Prototyping ice cloud property CDRs from microwave imagers
- Bringing CLARA CDRs to a 1 km scale over Europe

5.1 Development and evaluation of global products based on merged polar and geostationary data

The cross-agency development on a GEO-Ring L1g data record, quality controlled intercalibrated and gridded with resolution close to common sensor capacities, led by EUMETSAT, with initial support from NOAA and CM SAF for prototype development, and efforts towards combining L1 data from geostationary and polar orbits, also carried out at the EUMETSAT Sec., with initial support from DWD via the ESA Cloud_cci, offers enormous opportunities for satellite-based climate monitoring. It has great potential to meet various user requirements on resolution and coverage with a single merged global product. This harmonization may lead to substantial reduction in costs for product generation.

However, various challenges exist. Among them are differences in available channels, channel characteristics, data gaps and even small differences in temporal and spatial sampling can cause inhomogeneities in product space for some parameters.

CM SAF’s objective is work towards merged products from geostationary and polar orbit observations. This will be prepared via the dedicated WP 4100, see also Section 2.4.1. It is foreseen to implement the results of this preparatory efforts via the Innovation Layer, given an accepted proposal on this topic, being submitted based on output from WP 4100.

5.2 Development of a high-resolution precipitation product for Europe

Precipitation impacts many aspects of human life, making data records and operational products covering precipitation important assets for various application areas. The SAF network receives requests for high-spatial and temporal resolution products through various means, among them, User Workshops, conferences, and personal communication. While high-quality precipitation products exist in various realisations (rain gauges only, ground-based radar, combinations of the two, and satellite-based products), efforts on generating merged, seamless products, i.e., ground-based radar and satellite data, in NRT mode and as CDR are fairly limited. Among others, NWC SAF is providing a satellite-based high-resolution product calibrated to ground-based radar in NRT mode. Based on these developments and in line with the cross-SAF strategy on precipitation, CM SAF, NWC SAF, and H SAF will develop a concept for a high-resolution, seamless regional precipitation product for Europe. The overall objectives are: combine the quality of the radar with the full areal coverage data of geostationary IR observations to provide a product at nominal resolution of SEVIRI/FCI and through reprocessing and homogenization with the CM SAF CDR to achieve a stable and seamless CDR product. Details are provided in Section 2.4.2 and WP 4200. In case substantial resources will be needed to fully implement the concept, this concept will form the basis for a proposal on a high-resolution precipitation product for Europe to the Innovation Layer.

5.3 Cloud-ready processing systems for CM SAF CDRs and ICDR in cloud systems such as EWC – a demonstrator

Most current data processing workflows and applications have been developed and optimized for traditional environments such as on-premise high-performance computing (HPC) clusters, virtual machines, or dedicated servers using monolithic software architectures. These setups often lack the flexibility, elasticity, and automation capabilities offered by modern infrastructures (i.e., cloud environments).

The objective of this initiative is to demonstrate the potential benefits of modern infrastructures for legacy data processing software, as well as to illustrate a transition strategy that incorporates the adaptation and re-engineering of existing software components. The feasibility of this transition is illustrated through the following projects:

- **Technology research:** In the recent past, the rapid development of new approaches to data processing, such as cloud technologies, has led to the creation of a large number of new toolsets. The objective of the technology research project is to identify suitable tools, including data formats, workflow management systems, and programming languages, that align with the requirements of CM SAF and can bolster future development and transition processes.
- **Technology demonstrator:** To capitalize on the potential of modern (cloud) computing infrastructures, it is essential to implement new techniques, e.g., for data access and modularization. The technology demonstrator will showcase the foundational operations of data processing software, including data input/output (I/O) and the implementation of parallelism. This is essential for leveraging the distributed processing and scalability capabilities. This demonstrator will make use of the results of the above-mentioned technology research.
- **Efficiency enhancement:** Legacy code is often developed over an extended period, with numerous extensions and add-ons that are not seamlessly integrated into the code base. In addition to leveraging programming language features that were underutilized in the past, refactoring and integrating new programming paradigms can substantially enhance code performance. This project will implement the previously mentioned steps on an existing data processing software to demonstrate the potential transformation to cloud-ready software components, the resulting performance improvements, and how they can be implemented.

The results of the three projects will provide a detailed roadmap for transitioning to cloud-ready data processing pipelines for future CM SAF activities. Results are potentially also useful for other SAFs in their transition to cloud processing systems. CM SAF will get in contact with the other SAFs and the EUMETSAT Secretariat in preparation of a proposal for the Innovation Layer and their feedback will be taken into account.

5.4 Development and generation of climate indices

A key objective of CM SAF is to provide to its customers ready to use climate data and with this walk the last mile. CM SAF is addressing this objective, among others, by developing climate indices based on CM SAF products (see Section 2.5.7). All such efforts are preparatory efforts, on the one hand by addressing scientific challenges and on the other hand by showcasing the value of using satellite data in this context to CM SAF users. Depending on the outcome of these use cases, CM SAF will draft a proposal for submission to the Innovation Layer on further scientific analysis as well as implementation and generation of climate indices.

5.5 Prototyping ice cloud property CDRs from microwave imagers

Ice clouds play an important role in modulating incoming and outgoing radiation from the Earth-atmosphere system, thus having a substantial impact on climate processes. They are also key to understand latent heat release in the atmosphere in connection to convective systems and extra-tropical cyclones. Climate and NWP models have problems to successfully simulate ice clouds and the amount of frozen water (Duncan and Eriksson, 2018). Current satellite observations from visible and infrared imagers have also limitations in correctly identifying all ice clouds and, in particular, to accurately estimate the existing amounts of frozen water. It has been shown (e.g., by May et al., 2024) that sub-millimeter microwave observations have the capability to improve ice cloud property retrievals, especially if used together with other microwave observations at longer wavelengths. With access to measurements from the ice cloud and microwave imagers (ICI + MWI) on the EPS-SG satellites combined with microwave measurements from the AWS satellite (and later from the EPS-Sterna programme), it is anticipated that ice cloud retrievals will be much improved. We hereby suggest to investigate this prospect in a dedicated Innovation Layer project to prepare for a potential future ice cloud property CDR production in the CDOP-6 phase.

5.6 Bringing CLARA CDRs to a 1 km scale over Europe

User requests at the recent CM SAF User Workshop in Bonn asked, in particular, for an improved CLARA CDR horizontal resolution. This will be addressed in the development of the next CLARA edition, CLARA-A4. However, the global AVHRR GAC dataset horizontal resolution is limited to about 5 km.

Recently, a full resolution 1 km AVHRR dataset (FDR4AVHRR) was compiled in an ESA-project based on AVHRR LAC data from direct receiving High Resolution Picture Transmission (HRPT) stations operating since 1980, in particular covering the European region. Also, the EUMETSAT Sec. will release an AVHRR LAC (Local Area Coverage, higher resolution) FCDR in late 2025. Thus, this offers an opportunity to bring the CLARA CDR to 1 km over the European region. Other CDRs based on 1 km resolution AVHRR data will be prototyped in an upcoming 2-year ESA project (no envolvement of CM SAF partners). Results from this ESA project will inevitably be compared with results from the current CLARA CDR. However, to fully exploit and interpret the benefits of these high-resolution CDRs, a high-resolution version of the entire CLARA products portfolio and a continuous extension with ICDRs would be of great value.

We propose that this prospect is considered for a dedicated Innovation Layer project. An additional argument for exploring this is that CM SAF's efforts to simulate AVHRR from the

VIIRS and METimage sensors for use in CLARA-A4 is also a way to further exploit the FDR4AVHRR dataset and the AVHRR LAC FCDR from the EUMETSAT Sec. beyond the CDRs produced in the ESA project. Thus, CM SAF could consider to produce extended 1 km AVHRR CDRs together with operationally produced ICDRs in CDOP-6. The proposed Innovation Layer activity will investigate the feasibility of producing these extended CDRs and the associated ICDRs, and assess the added value over the GAC-based CDRs in the European region.

Annex I CM SAF Product Requirements Tables for CDOP-5

The PRD v5.0, draft is provided as stand-alone document. The PRD v5.0, draft is based on the PRD v4.3 and includes a dedicated Section 7 on CDOP-5 products commitments.

Annex II CM SAF Work packages for CDOP-5

Task	WP No.	Associated Reviews	Start date	End date	dur. [days]	dur. [mo]	DWD	FMI	KNMI	MeSw	RMIB	SMHI	UKMO sci	UKMO Mngt	Sum	
Management																
CM SAF Management	WP 1100		01.03.2027	29.02.2032	1826	60	12,5								12,5	Management
Science Coordination	WP 1200		01.03.2027	29.02.2032	1826	60	12,0							6,0	18,0	
Operations Management	WP 1300		01.03.2027	29.02.2032	1826	60	14,0								14,0	
SUM Management							38,5	0,0	0,0	0,0	0,0	0,0	0,0	6,0	44,5	
User Support																
User engagement, User services and product usage monitoring	WP 2100		01.03.2027	29.02.2032	1826	60	48,0								48,0	User
Training and Outreach	WP 2200		01.03.2027	29.02.2032	1826	60	19,0		0,5		0,5	0,5			20,5	
Workshops and expert meetings	WP 2300		01.03.2027	29.02.2032	1826	60	10,0	1,5	1,0		1,0	2,4	0,5	0,5	16,9	
CM SAF use cases, analysis and support to climate reports	WP 2400		01.03.2027	29.02.2032	1826	60	6,0	22,0	9,5		3,0	11,5	9,0	1,0	62,0	
Preparing new Level 4 climate products and associated coordination, including CAN	WP 2500		01.03.2027	29.02.2032	1826	60	5,0			10,0			27,0	4,0	46,0	
SUM user services							88,0	23,5	11,0	10,0	4,5	14,4	36,5	5,5	193,4	
Processing																
ICDR Processing	WP 3100		01.03.2027	29.02.2032	1826	60										
Regional ICDR products (CLAAS-4, SARAH-4, HANNA, GeoRing)	WP 3110	ORR 5.6, ORR5 5.7, OR2027-2031	01.03.2027	29.02.2032	1826	60	23,0		1,5		3,5	1,0			29,0	
Global ICDR products (GIRAFE v1, v1.1, v2, HOAPS 5, CLARA-A3.5, CLARA-A4)	WP 3120	ORR 5.5, ORR 5.9, ORR 5.1, ORR 5.2, OR2027-2031	01.03.2027	29.02.2032	1826	60	25,0	5,0	1,5		1,5	1,5			34,5	
ICDR anomalies	WP 3130	ORR 5.2, ORR 5.3, ORR 5.5, ORR 5.8, ORR 5.9, OR2027-2031	01.03.2027	29.02.2032	1826	60	15,5	2,5			1,0	1,0			20,0	
Technical Environment EWC	WP 3200		01.03.2027	29.02.2032	1826	60	10,0								10,0	
Committed Activities																
Prepare merged Geo-Ring and polar orbiter based products	WP 4100		01.03.2027	29.02.2032	1826	60	12,0	5,0	2,1	2,0	2,0	2,5			25,6	
Concept for a consistent NRT and CDR high-resolution precipitation product for Europe. Collaboration with NWC SAF	WP 4200		01.03.2027	29.02.2032	1826	60	10,0								10,0	
WCRP support activities	WP 4300		01.03.2027	29.02.2032	1826	60	10,0								10,0	
Microwave Imager Inter-calibration	WP 4400		01.03.2027	29.02.2032	1826	60	8,0								8,0	
Support to EUMETSAT for FCDR generation	WP 4500		01.03.2027	31.12.2028	671	22	1,0	0,5	1,0		0,5	7,0			10,0	
Towards a consistent approach to estimate uncertainties	WP 4600		01.03.2027	31.12.2028	671	22	2,5						5,0	5,0	12,5	
SUM committed activities + techn. support / ICDR							117,0	13,0	6,1	2,0	8,5	13,0	5,0	5,0	169,6	
Committed CDRs and ICDRs																
CDR+ICDR global CLARA-A4	WP 5100		01.03.2027	29.02.2032	1826	60	50,0	32,0	19,0	0,0	27,5	56,2	0,0	0,0	184,7	
CDR+ICDR global CLARA-A4	WP 5110	RR 5.2	01.03.2027	30.06.2028	487	16	5,0	7,5	5,0		5,0	15,0			37,5	
CDR+ICDR global CLARA-A4	WP 5120	PCR 5.2	01.07.2028	31.12.2029	548	18	22,0	12,0	6,5		11,5	22,0			74,0	
CDR+ICDR global CLARA-A4	WP 5130	DRR 5.2/ORR 5.2	01.01.2030	29.02.2032	789	26	23,0	12,5	7,5		11,0	19,2			73,2	
CDR+ICDR global Precipitation (GIRAFE v2)	WP 5200		01.03.2027	31.12.2031	1766	58	79,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	79,0	
CM SAF and H SAF - joint precipitation RR	WP 5210	RR 5.5	01.03.2027	31.12.2028	671	22	2,0								2,0	
CDR+ICDR global Precipitation (GIRAFE v2)	WP 5220	PCR 5.5	01.07.2028	30.06.2030	729	24	56,0								56,0	
CDR+ICDR global Precipitation (GIRAFE v2)	WP 5230	DRR 5.5/ORR5.5	01.07.2030	31.12.2031	548	18	21,0								21,0	
CDR+ICDR high-resolution Europe (HANNA)	WP 5300		01.03.2027	31.08.2030	1279	42	36,0	0,0	0,0	30,0	28,0	0,0	0,0	0,0	94,0	
CDR+ICDR high-resolution Europe (HANNA)	WP 5310	RR 5.6	01.03.2027	29.02.2028	365	12	6,0			6,0	5,0				17,0	
CDR+ICDR high-resolution Europe (HANNA)	WP 5320	PCR 5.6	01.03.2028	31.08.2029	548	18	14,0			12,0	12,0				38,0	
CDR+ICDR high-resolution Europe (HANNA)	WP 5330	DRR 5.6/ORR5.6	01.09.2029	31.03.2031	576	19	16,0			12,0	11,0				39,0	
CDR+ICDR GeoRing (clouds, TOA, surf. rad, LandFlux)	WP 5400		01.03.2027	31.08.2031	1644	54	55,0	2,0	36,5	11,5	40,5	38,0	0,0	0,0	183,5	
CDR+ICDR GeoRing (clouds, TOA, surf. rad, LandFlux)	WP 5410	RR 5.7	01.03.2027	31.12.2028	671	22	9,0		8,0	1,0	5,0	10,0			33,0	
CDR+ICDR GeoRing (clouds, TOA, surf. rad,LandFlux)	WP 5420	PCR 5.7	01.01.2029	31.03.2030	454	15	22,0		14,0	6,0	9,5	14,0			65,5	
CDR+ICDR GeoRing (clouds, TOA, surf. Rad, LandFlux)	WP 5430	DRR 5.7, ORR 5.7	01.04.2030	31.08.2031	517	17	24,0	2,0	14,5	4,5	26,0	14,0			85,0	
CDR+ICDR GeoRing Surface Radiation (SARAH-5)	WP 5500		01.03.2027	29.02.2032	1826	60	27,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	27,0	
CDR+ICDR GeoRing Surface Radiation (SARAH-5)	WP 5510	RR 5.4	01.03.2027	30.06.2028	487	16	7,0								7,0	
CDR+ICDR GeoRing Surface Radiation (SARAH-5)	WP 5520	PCR 5.4	01.07.2028	29.02.2032	1338	44	20,0								20,0	
ICDR HOAPS-5	WP 5730	ORR 5.1	01.03.2027	29.02.2032	1826	60	30,0								30,0	
FCDR SSM/I+SSMIS FCDR Edition 6.0 (extension)	WP 5830	DRR 5.1	01.10.2029	29.02.2032	881	29	9,0								9,0	
CDR+ICDR GIRAFE v1.1	WP 5930	DRR 5.9 / ORR 5.9	01.03.2027	31.12.2027	305	10	12,0								12,0	
CDR LandFlux (Meteosat, fluxes only)	WP 6100	DRR 5.10	01.03.2027	31.12.2028	671	22	0,5			1,5	6,0				8,0	
GEO-ring LST – In Coordination with LSA SAF	WP 6210		01.03.2027	29.02.2032	1826	60				10,0					10,0	
Committed normal and anomalies							22,0	5,0	0,0	4,4	4,0	4,0	0,0	0,0	39,4	
Normal and anomalies	WP 7000		01.03.2027	29.02.2032	1826	60										
Regional Surface Radiation (SARAH-4, SARAH-5)	WP 7010	DRR 5.3 / ORR 5.3 (SARAH-4), RR 5.4 / PCR 5.4 (SARAH-5)	01.03.2027	29.02.2032	1826	60	7,0								7,0	
Global clouds and surface radiation (CLARA-A3.5, CLARA-A4)	WP 7020	DRR 5.8 / ORR 5.8 (CLARA-A3.5), RR 5.2 / PCR 5.2 / DRR 5.2 / ORR 5.2 (CLARA-A4)	01.03.2027	29.02.2032	1826	60	5,0	5,0			4,0	4,0			18,0	
Global precipitation (GIRAFE v1.1, v2)	WP 7030	DRR 5.9 / ORR 5.9 (v1.1), PCR 5.5 / DRR 5.5 / ORR 5.5 (v2)	01.03.2027	29.02.2032	1826	60	8,0								8,0	
High resolution Europe (HANNA)	WP 7040	RR 5.6 / PCR 5.6 / DRR 5.6 / ORR 5.6	01.03.2027	31.03.2031	1491	49	1,0			3,0					4,0	
Normals and Anomalies LANDFLUX LST	WP 7050		01.03.2027	31.08.2030	1279	42	1,0			1,4					2,4	
SUM CDRs							320,5	39,0	55,5	57,4	106,0	98,2	0,0	0,0	676,6	
SUM ALL							564,0	75,5	72,60	69,4	119,0	125,6	41,5	16,5	1084,1	

Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**20.03.2026**

Programme	CM SAF
WP Number	1100
WP-Title	**Project Management**
WP Manager (WPM)	Rainer Hollmann
Start of WP	1.03.2027
End of WP	29.02.2032
Start event	KO
End event	end of CDOP-5

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	12.5	2.5	2	2	2	2	2	187,938		58,000
FMI	0							0		25,000
KNMI	0							0		15,000
Meteo Swiss	0							0		20,853
RMI	0							0		14,000
SMHI	0							0		24,000
UKMO (sci)	0							0		
UKMO (mngt)	0							0		13,000
Sum	12.5	2.5	2	2	2	2	2	187,938	0	169,853
overall total (EUR)										357,791

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	Travelcosts
WP description	Overall Management and Coordination of CM SAF
WP tasks	
	· Host function
	· Overall management, administration and schedule control of the CM SAF (leading entity) and Federate Activities
	· Management of documentation and reports (overall responsibility)
	· CDOP-4 planning and monitoring
	· Change management
	· Supervision of overall SAF operations
	· Reporting to EUMETSAT
	· Support to the EUMETSAT Sec. on identification of SAF products with potential for contributing to EU programmes and on the integration of SAF expertise in EUMETSAT - EU contribution agreements when requested
	· Management of finance, procurements, contracts
	· Organisation, execution and evaluation of CM SAF International Board Meetings
	· Quality Management

	· Reviews (overall responsibility)
	· Secretary to Steering Group
	· Content management / maintenance of CM SAF internet and extranet site
	· Recruitment
WP input	Oral/written reports from Science Coordinator and Operations Manager and team members
WP output/deliverables	Updated PMPs, Master schedule
	Documents and Reports
	Minutes of Meetings
WP Constraints and risks	None
WP Dependencies	
Interactions with other SAFs	Coordination with other SAFs
Federated Activities	
Notes:	

Work Package Description Sheet	CDOP-5	Issue / Revision No.:	2.0	Date:	20.03.2026
Programme	CM SAF				
WP Number	1200				
WP-Title	**Science Coordination**				
WP Manager (WPM)	Marc Schröder				
Start of WP	1.03.2027				
End of WP	29.02.2032				
Start event	KO				
End event	end of CDOP-5				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	12	2	2	2	2	2	2	180,420		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	0							0		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	6	1	1.2	1.2	1.2	1.2	0.2	101,400		
Sum	18	3	3.2	3.2	3.2	3.2	2.2	281,820	0	0
overall total (EUR)										281,820

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)
WP description	Overall Science Coordination of CM SAF
WP tasks	
	DWD:
	- Interaction with scientists internal of CM SAF and steer the science discussion in CM SAF. Examples include the consolidation of CM SAF's product port-folio and the coordination of CAN-related activities within CM SAF.
	- Collaborate with external funded projects where CM SAF can benefit from
	- Contribute to science conferences and CM SAF workshops and expert meetings
	- Organize, guide & evaluate VS and FA activities
	- Organise/support to CM SAF reviews
	- Coordination of science aspects with other SAFs, mainly via online meetings
	- Representation of CM SAF in TT-CAN and contributing to the work being done within the TT-CAN
	- Focal point to international activities, e.g., GCOS, GSICS, GEWEX, GDAP, C3S, ESA Climate Space, WCRP,…

	- Adaptation of the CM SAF product structure and nomenclature to ensure maximum compliance to the new GCOS ECV structure.
	- Continued exchange with (inter-)national experts in fields relevant for CM SAF. E.g., with R. Roca from CNRS/LEGOS on precipitation, assessments, tracking of cloud systems,… and with S. Crewell from U. of Cologne on scientific studies over hot spots of climate change such as the Arctic.
	- Prepare contributions to international activities
	- Represent CM SAF in EUMETSAT Working Group on Data Rrecord Generation
	- Scientific coordination of proposals for the Innovation Layer and EU funded SAF activities
	- Support to the EUMETSAT Sec. on identification of SAF products with potential for contributing to EU programmes and on the integration of SAF expertise in EUMETSAT - EU contribution agreements when requested
	- Document management for science documents
	- SG and IBM attendance
	UKMO:
	- Coordination of CM SAF related activities at the Met Office including interaction with other SAFs
	- Participate in Steering Group Activities
	- Participate in International Board Meetings and Steering Group Meetings and related preparation; attend one online SG & IB meeting online, and one SG & IB meeting in-person per year (T&S costs indicated)
	- Contribute to financial and operations reporting as required
WP input	Oral/written reports from team members and reviews
WP output/deliverables	Scientific documents
	Annual Quality Assessment Reports
	Science Reports for SG
WP Constraints and risks	None
WP Dependencies	nearly all CM SAF WPs, in particular WP 4300
Interactions with other SAFs	Coordination with other SAFs via online meetings
Federated Activities	
Notes:	

Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**20.03.2026**
Programme	CM SAF				
WP Number	1300				
WP-Title	**Operations Management**				
WP Manager (WPM)	Nathalie Selbach				
Start of WP	01.03.2027				
End of WP	29.02.2032				
Start event	Kick-off CDOP-5				
End event	Close-out CDOP-5				
WP pm and cost breakdown					

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	14	2	2.5	2.5	2.5	2.5	2	210,490		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	0							0		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	14	2	2.5	2.5	2.5	2.5	2	210,490	0	0
overall total (EUR)										210,490

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)
WP description	Operations Management
WP tasks	
	DWD:
	- Coordination of all CM SAF engineering and operations activities
	- CM SAF configuration management
	- System change management
	- Coordination of user services
	- Operations Reporting to EUMETSAT
	- Impact evaluation with focus on users
	- Planning and management on interfaces with entities re-distributing CM SAF data
	- Coordination and provision of technical documentation
	- Coordination and performance of reviews (technical part)
	- Reporting to SG concerning technical issues

	- Quality management related to all CM SAF products and services
	- Regular Coordination Meetings with EUMETSAT Secretariat, including w.r.t. European Weather Cloud
	- Participation and contribution to the EUMETSAT Working Group on User Engagement
WP input	
WP output/deliverables	Technical documents
	Operations Report (half-yearly)
WP Constraints and risks	
WP Dependencies	None
Interactions with other SAFs	
Federated Activities	
Notes:	

Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**20.03.2026**
Programme	CM SAF				
WP Number	2100				
WP-Title	**User engagement, user services and product usage monitoring**				
WP Manager (WPM)	Nathalie Selbach				
Start of WP	01.03.2027				
End of WP	29.02.2032				
Start event	Kick-off CDOP-5				
End event	Close-out CDOP-5				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	50	8	10	10	10	10	2	751,750		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	0							0		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	50	8	10	10	10	10	2	751,750	0	0
overall total (EUR)										751,750

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)
WP description	CM SAF User Services
WP tasks	
	DWD:
	- Provide User Support related to the CM SAF data records and products
	- Provide the CM SAF user helpdesk functionality and monitor the service
	- Maintain, improve and update continuously the CM SAF webseite https://cm-saf.eumetsat.int
	- Provide general information and documentation through the CM SAF website
	- Provide data records for archiving and dissemination in the EDS at EUMETSAT and support implementation of functionalities to Data Tailor and Web Services needed for CM SAF data records (e.g., EUMETView)
	- Administrate CM SAF DOI entries under responsibility of CM SAF and support introduction of new CM SAF DOI entries in EUMETSAT systems (i.e., for data records archived at EUMETSAT)

	- Operate and maintain the automated ordering system at DWD (in support of earlier releases of data records)
	- Disseminate earlier CM SAF products via the Web User Interface (WUI) (for CDRs archived at DWD)
	- Operate, maintain and improve the CM SAF data model and data base (data and metadata) taking into account versioning and performance
	- Monitor product usage of CM SAF products (via all data dissemination ways)
	- Direct contact and exchange with existing and potential future CM SAF product users, a.o., via personal communication with climate service teams at Member States services
	- Contribution to the provision of CM SAF data in the Copernicus Data Stores (e.g., the CDS) and the assessment of emerging needs for data records for new services provided by the Copernicus Services
WP input	
WP output/deliverables	CM SAF User Help Desk Service
	CM SAF webpages
	CM SAF Web user Interface
	CM SAF products accessible for archiving at EUMETSAT Secretariat
WP Constraints and risks	
WP Dependencies	WP 3110, WP 3120, WP 3130, WP 5130, WP 5230, WP 5330. WP 5430. WP 5730, WP 5930, WP 6100, WP 6200, WP 5830, WP 7010, WP 7020, WP 7030, WP 7040, WP 7050
Interactions with other SAFs	
Federated Activities	
Notes:	

Work Package Description Sheet	CDOP-5	Issue / Revision No.:	2.0	Date:	20.03.2026
Programme	CM SAF				
WP Number	2200				
WP-Title	**Training and Outreach**				
WP Manager (WPM)	Nathalie Selbach				
Start of WP	01.03.2027				
End of WP	29.02.2032				
Start event	Kick-off CDOP-5				
End event	Close-out CDOP-5				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	19	3	3,5	3,5	4	4	1	285,665		73,220
FMI	0							0		22,000
KNMI	0.5	0.1	0.1	0.1	0.1	0.1		9,604		17,277
Meteo Swiss	0							0		22,000
RMI	0.5					0.5		6,545		14,000
SMHI	0.5	0.1	0.1	0.1	0.1	0.1		8,262		26,000
UKMO (sci)	0							0		14,794
UKMO (mngt)	0							0		
Sum	20.5	3.2	3.7	3.7	4.2	4.7	1	310,076	0	189,291
overall total (EUR)										499,367

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	Costs related to planned publications and conferences
WP description	Training and outreach
WP tasks	
	DWD:
	- Preparation of online CM SAF Training courses
	- Support of EUMETSAT training activities, online and in-person
	- Prepare contributions and monitor the different CM SAF Social Media channels (Bluesky, LinkedIn)
	- Development of Jupyter Notebooks for new data releases in CDOP-5 and overarching notebooks (e.g., data access, etc), as well as further notebooks for training events (e.g., use cases for applications of CM SAF products)
	- Development of on-demand-training material such as "how-to"-clips, cheat sheets, etc.

	- Preparation of Information and promotional material (flyers, leaflets, fact sheets, poster, presentation etc. for users and specific conferences)
	- Maintenance and monitoring of online CM SAF Gallery of user applications
	all
	- Attendance at international conferences and meetings to publicise CM SAF-related work
	- Preparation of CM SAF-related publications
	Contribution to CM SAF Jupyter notebooks.
WP input	
WP output/deliverables	
	Online training courses
	Promotional material
	Jupyter notebooks, "how-to"-clips
	Online user application gallery
WP Constraints and risks	
WP Dependencies	None
Interactions with other SAFs	
Federated Activities	
Notes:	

Work Package Description Sheet	CDOP-5	Issue / Revision No.:	2.0	Date:	20.03.2026
Programme	CM SAF				
WP Number	2300				
WP-Title	**User Workshop and expert meetings**				
WP Manager (WPM)	Nathalie Selbach				
Start of WP	01.03.2027				
End of WP	29.02.2032				
Start event	Kick-off CDOP-5				
End event	Close-out CDOP-5				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	10	1.5	2	2.5	1.5	1.5	1	150,350		57,000
FMI	1.5			1	0.5			23,655		2,025
KNMI	1		0.3	0.4	0.3			19,387		2,000
Meteo Swiss	0							0		2,000
RMI	1.0		0.5	0.5				13,090		1,030
SMHI	2.4	0.4	0.5	0.5	0.5	0.5		39,658		
UKMO (sci)	0.5				0.25	0.25		7,192		1,200
UKMO (mngt)	0.5			0.5				8,450		1,200
Sum	16.9	1.9	3.3	5.4	3.05	2.25	1.0	270,229	0	66,455
overall total (EUR)										336,684

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	workshop related costs (e.g., rental of event location, catering, etc.), Travel (support)
WP description	User workshop and expert meetings
WP tasks	
	DWD:
	- Preparation and execution of CM SAF User Workshop in 2029
	-Evaluation of user workshop feedback
	Aim: support continuous improvement of CM SAF products and services, provision of input to CDOP-6 proposal
	- Preparation and execution of expert meetings in response to scientific and application developments, e.g., on approaches in GEO-Ring-processing or performing bilateral meetings with services in EUMETSAT member states)
	FMI, RMIB, SMHI, KNMI, MeteoSwiss, Met Office:

	- Participation and support of CM SAF User Workshop in 2029
	- Participation in expert meetings (to be defined)
WP input	
WP output/deliverables	
	User Workshop 2029 and reporting on user workshop
	Expert Meetings Q4 2027 - Q1 2029 as necessary and feasible and minutes as appropriate
WP Constraints and risks	
WP Dependencies	None
Interactions with other SAFs	
Federated Activities	
Notes:	

Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**20.03.2026**
Programme	CM SAF				
WP Number	2400				
WP-Title	**CM SAF use cases, analysis and support to climate reports**				
WP Manager (WPM)	Aku Riihelä				
Start of WP	01.03.2027				
End of WP	29.02.2032				
Start event	Kick-off CDOP-5				
End event	End of CDOP-5				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	6	1	2	1	1	1		90,210		
FMI	22	6	4	5	4	3		346,940		
KNMI	9.5	3.5	3	3				184,177		
Meteo Swiss										
RMI	3.0	1	2					39,270		
SMHI	11.5	2	2.5	2,7	2,8	1	0.5	190,026		
UKMO (sci)	9	1	2	2	2	2	0	129,465		
UKMO (mngt)	1	0	0	0.5	0.5	0	0	16,900		
Sum	62.0	14.5	15.5	14.2	10.3	7.0	0.5	996,979		
overall total (EUR)										996,979
*** Description of procurement cost:**										
**** Description of other cost:**	Travel and subsistence costs associated with attending conferences and workshops, and review meetings, to present findings and costs to publish papers.									

WP description	Scientific use cases to enhance product uptake and operational applications, as well as scientific analyses in support of climate reporting.
WP tasks	**FMI (WP lead, Polar assessment)**
	- WP lead, reporting coordination
	- Lead in science assessment on polar climate change as seen by CLARA-A3.5
	SMHI (Polar assessment)
	- Contributing to science assessment on polar climate change as seen by CLARA-A3.5
	KNMI (UCS on CLAAS cloud regimes)
	-Contributing to the UCS "Analysis of cloud regimes based on CLAAS data".
	RMI (UCS on model evaluation)
	- Contributing to the use case on the CLAAS-4 TOA radiation fields for model evaluation
	DWD (UCS on CLAAS, Polar assessment)
	- Contributing to the UCS "Analysis of cloud regimes based on CLAAS data" and to the polar climate change assessment.
	- Foster uptake of CM SAF data in high-level reporting by WMO (state of climate, water resources,…), C3s, BAMS and others, in particular also support to the WMO/C3S reporting on the European State of the Climate.
	- Publish CM SAF News or highlight stories based on consistency analysis of anomalies.
	UKMO (UCS on an event attribution study on the exceptionally sunny UK winter/spring of 2024/2025)
	- Leading UCS on event attribution study using CM SAF satellite sunshine duration product
	OR
	UKMO (UCS to assess the feasibility of producing a blended windspeed dataset)
	- Leading UCS to assess the feasibility of producing a blended land-ocean windspeed dataset for the UK using HOAPs ocean windspeed and land-based observations of wind over the UK.

WP input	CLARA-A3.5 CDR+ICDR, CLAAS-4 CDR, LandFlux CDR, CM SAF anomaly data, HOAPS windspeed, SARAH-3 Sunshine duration
WP output/deliverables	Final reports/draft papers for the use case studies & science assessment
	UC1: Showcasing the use of the new CLAAS-4 TOA radiation field for model evaluation (RMIB)
	UC2: Report on analysis of cloud regimes based on CLAAS data and cloud regime dataset (KNMI, DWD)
	CA1: Satellite-based observed climate change in the Arctic region (SMHI, FMI, DWD)
	~~UCS5: precipitation, vegetation and wildfire indices over the UK and potentially Europe~~
	UC3: Event attribution study on the exceptionally sunny UK winter/spring of 2024/2025 ***OR*** Assess the feasibility of producing a blended windspeed dataset for the UK
	~~UCS7: assess the feasibility of producing a blended windspeed dataset for the UK~~
	UC4: News or highlight stories on the CM SAF webpage
	Summary report of the WP
WP Constraints and risks	
WP Dependencies	
Interactions with other SAFs	
Federated Activities	
Notes:	As noted in Section 2.5.5 we need more time to decide which UC to pursue. Either windspeed OR Sunshine or UKMO UC.

Work Package Description Sheet	CDOP-5	Issue / Revision No.:	2.0	Date:	20.03.2026
Programme	CM SAF				
WP Number	2500				
WP-Title	**Preparing new Level 4 climate products and associated coordination, including CAN**				
WP Manager (WPM)	Marc Schröder				
Start of WP	01.03.2027				
End of WP	29.02.2032				
Start event	Kick-off CDOP-5				
End event	End of CDOP-5				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	5	1.5	1.0	0.5	1.0	1.0		75,175		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	10	1	3	3	1	1	1	158,340		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	27		6	7	7	7		388,368		
UKMO (mngt)	4	0.25	0.75	1	1	0.75	0.25	67,600		
Sum	46.0	2.75	10.75	11.5	10.0	9.75	1.25	689,483	0	0
overall total (EUR)										689,483

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)

WP description	Preparing new Level 4 climate products and associated coordination, including CAN
WP tasks	
	DWD:
	- Organise bi-annual online coordination meetings with SAFs envolved in developing climate indices (e.g., LSA SAF and H SAF) and the EUMETSAT Sec. to discuss status and way forward.
	- Support to EUMETSAT-wide coordination of coherently designing, developing and operating CAN products including participation in TT-CAN meetings.
	- Efforts towards ensuring alignment of climate indices efforts with TT-CAN through joint memberships.
	- Provide additional data services for different user groups (as needed) such as a) reformatting of data, tailored to specific user groups, e.g., easing the use in climate model evaluation via the WCRP ESMO obs4MIPs framework, ZARR-format for ML/AI data assimilation and b) post-processing of CM SAF data to provide Level 4 climate data, e.g., averages per Member State country (to be coordinated via TT-CAN)

	UKMO:
	- CI1: Co-leading & contributing on UC on heat indices over the UK and potentially Europe and beyond in collaboration with MeteoSwiss using the CM SAF LST product (including prototype GEO-Ring if/when available). To include a sub-set of the 'Climpact' indices as well as 'super extreme LST hotspots' and extremely hot days over the UK(/Europe).
	- CI3: Leading on UCS on precipitation, vegetation and wildfire indices over the UK and potentially Europe and beyond using CM SAF LST, precipitation and potentially other CM SAF products as appropriate (e.g., sunshine, radiation). To include a subset of the 'Climpact' indices for precipitation and sector-specific indices, such as growing degree days, and include new indices as appropriate, e.g., threshold temperatures for stomatal closure.
	MeteoSwiss:
	- Leading & contributing on UCs on heat indices (CI1) and renewable energy (CI2)
WP input	(Subset of) CM SAF products for format conversion GIRAFE v1/v1.1, CLARA-A3.5, LandFlux v2, potentially GeoRing
WP output/deliverables	Final reports/draft papers for: CI1 on heat indices, CI2 on renewable energy, CI3 on precipitation, vegetation and wildfire indices over the UK and potentially Europe
	Reformatted CM SAF data
WP Constraints and risks	-
WP Dependencies	-
Interactions with other SAFs	all SAFs with tasks on climate indicators (e.g., LSA SAF, H SAF), various SAFs through TT-CAN
Federated Activities	-
Notes:	-

Work Package Description Sheet		CDOP-5		Issue / Revision No.:		2.0	Date:	20.03.2026	
Programme		CM SAF							
WP Number		3110							
WP-Title		**Regional ICDR products**							
WP Manager (WPM)		Nathalie Selbach							
Start of WP		01.03.2027							
End of WP		29.02.2032							
Start event		Kick-off CDOP-5							
End event		Close-out CDOP-5							
WP pm and cost breakdown									
Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	23	3	3	3	6	6	2	345,805	50,000	
FMI	0							0		
KNMI	1.5	0.2	0.3	0.3	0.3	0.3	0.1	29,081		
Meteo Swiss	0							0		
RMI	3.5		1	0.5		1	1	45,815		
SMHI	1	0.15	0.2	0.2	0.2	0.2	0.05	16,524		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	29	3.35	4.5	4	6.5	7.5	3.15	437,224	50,000	0
overall total (EUR)										487,224
*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)									
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)									
WP description	Global ICDR products									
WP tasks										
	DWD:									
	CLAAS edition:									
	- continued operational ICDR processing of CLAAS-4 at DWD processing centre, using resources at EWC									
	SARAH edition:									
	- continued operational ICDR processing of SARAH-4 at DWD processing centre, using resources at EWC									
	HANNA editions:									
	- set-up and continuous operational ICDR processing of HANNA ICDR at DWD processing centre, using resources in EWC, including gap-filling to respective CDR									

	GEO-Ring edition
	-set-up and continuous operational ICDR processing of GEO-Ring ICDR at DWD processing centre, using resources in EWC, including gap-filling to respective CDR
	- for all ICDRs above: regular processing including product monitoring and maintenance, (contributions to) annual quality assessment report
	KNMI
	- Contributions to Annual Quality Assessment Reports on cloud products for CLAAS and GEO-Ring editions
	SMHI:
	- Contributions to Annual Quality Assessment Reports on cloud products for CLAAS and GEO-Ring editions
	MeteoSwiss
	- Contributions to Annual Quality Assessment Reports on products for HANNA and GEO-Ring editions
	RMI:
	- Contributions to Annual Quality Assessment Reports on products for CLAAS (TOA products), HANNA (landflux products) and GEO-Ring (TOA+Landflux products) editions
WP input	Output of respective ORRs, OPDs for respective product families
WP output/deliverables	- ICDR products from CLAAS-4, SARAH-4, HANNA, Georing product families
	- contributions to half-yearly Operations Reports
	- Annual Quality Assessment Report (yearly)
WP Constraints and risks	Availability of respective input data from the different satellite sensors
WP Dependencies	WP 5330, WP 5430, ORRs for CLAAS-4 and SARAH-4 (CDOP-4 activities)
Interactions with other SAFs	
Federated Activities	
Notes:	

Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**20.03.2026**

Programme	CM SAF
WP Number	3120
WP-Title	**Global ICDR products**
WP Manager (WPM)	Nathalie Selbach
Start of WP	01.03.2027
End of WP	29.02.2032
Start event	Kick-off CDOP-5
End event	Close-out CDOP-5

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	25	3	4.5	4	4	6.5	3	375,875	50,000	
FMI	5	1	1	1	1	1		78,850		
KNMI	1.5	0.2	0.3	0.3	0.3	0.3	0.1	29,081		
Meteo Swiss	0							0		
RMI	1.5		0.5			0.5	0.5	19,635		
SMHI	1.5	0.2	0.3	0.3	0.3	0.3	0.1	24,786		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	34.5	4.4	6.6	5.6	5.6	8.6	3.7	528,227	50,000	0
overall total (EUR)										578,227

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)

WP description	Global ICDR products
WP tasks	
	DWD:
	CLARA editions:
	- continued operational ICDR processing of CLARA-A3.5 at DWD processing centre, using resources at ECMWF (until superseded by CLARA-A4)
	- set-up and continuous operational ICDR processing of CLARA-A4 at DWD processing centre, using resources in EWC, including gap-filling to respective CDR
	GIRAFE editions:
	- continued operational ICDR processing of GIRAFE edition 1 at DWD processing centre, using resources at DWD (until superseded by GIRAFE ed. 1.1)

	- set-up and continuous operational ICDR processing of GIRAFE edition 1.1 at DWD processing centre, using resources in EWC (until superseded by GIRAFE ed. 2), including gap-filling to respective CDR
	- set-up and continuous operational ICDR processing of GIRAFE edition 2 at DWD processing centre, using resources in EWC, including gap-filling to respective CDR
	HOAPS editions:
	- set-up and continuous operational ICDR processing of HOAPS-5 at DWD processing centre, using resources in EWC, including gap-filling to respective CDR
	- for all ICDRs above: regular processing including product monitoring and maintenance, (contributions to) annual quality assessment report
	FMI:
	- Contributions to Annual Quality Assessment Reports on SAL products for CLARA editions
	SMHI:
	- Contributions to Annual Quality Assessment Reports on CFC and CTO products for CLARA editions
	KNMI:
	- Contributions to Annual Quality Assessment Reports on CPP products for CLARA editions
	RMI:
	- Contributions to Annual Quality Assessment Reports on ToA products for CLARA editions
WP input	Output of respective ORRs, OPDs for respective product families
WP output/deliverables	- ICDR products according to PRD for product families CLARA-A3.5, CLARA-A4, GIRAFE v1 and v1,1, GIRAFE v2, HOAPS v5
	- contributions to half-yearly Operations Reports
	- Annual Quality Assessment Report (yearly)
WP Constraints and risks	Availability of respective input data from the different satellite sensors
WP Dependencies	CLARA-A3.5 and GIRAFE v1 ORR (CDOP-4 activties), WP 5130, WP 5230, WP 5730, WP 5930
Interactions with other SAFs	
Federated Activities	
Notes:	

Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**20.03.2026**
Programme	CM SAF				
WP Number	3130				
WP-Title	**Anomalies from ICDR products**				
WP Manager (WPM)	Nathalie Selbach				
Start of WP	01.03.2027				
End of WP	29.02.2032				
Start event	Kick-off CDOP-5				
End event	Close-out CDOP-5				
WP pm and cost breakdown					

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	15.5	3	3	2.5	2.5	2.5	2	233,043		
FMI	2.5	0.5	0.5	0.5	0.5	0.5		39,425		
KNMI	0							0		
Meteo Swiss	0							0		
RMI	1		1					13,090		
SMHI	1	0.3	0.2	0.2	0.1	0.1	0.1	16,524		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	20	3.8	4.7	3.2	3.1	3.1	2.1	302,082	0	0
overall total (EUR)										302,082
*** Description of procurement cost:**		Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)								
**** Description of other cost:**		Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)								

WP description	Anomalies from ICDR products
WP tasks	
	DWD:
	- set-up and continuous operational processing of ICDR anomalies at DWD processing centre for ICDRs SARAH-4, CLARA-A3.5 (until CLARA-A4 becomes available), CLARA-A4, GIRAFE v1 (until GIRAFE v2), GIRAFE v2, HANNA, LandFlux v2, using resources in EWC, including gap-filling to respective CDR as needed
	- for all ICDRs above: regular processing including product monitoring, quality control and maintenance, (contributions to) annual quality assessment report
	FMI:
	- Contributions to Annual Quality Assessment Reports
	SMHI:
	- Contributions to Annual Quality Assessment Reports
	RMI:
	- Contributions to Annual Quality Assessment Reports
WP input	Output of respective ORRs, OPDs for respective product families
WP output/deliverables	- ICDR anomalies products according to PRD for respective paramters of product family CLARA-A3.5, CLARA-A4, SARAH-4, HANNA, LandFlux v2, GIRAFE v1.1 and GIRAFE v2
	- contributions to half-yearly Operations Reports
	- Annual Quality Assessment Report (yearly)
WP Constraints and risks	Availability of respective input data from the different satellite sensors
WP Dependencies	WP 3110, WP 3120
Interactions with other SAFs	
Federated Activities	
Notes:	

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Work Package Description Sheet	CDOP-5	Issue / Revision No.:	2.0	Date:	20.03.2026

Programme	CM SAF
WP Number	3200
WP-Title	**Technical Environment European Weather Cloud**
WP Manager (WPM)	Nathalie Selbach
Start of WP	01.03.2027
End of WP	29.02.2032
Start event	Kick-off CDOP-5
End event	Close-out CDOP-5

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	10	1.5	2	2.5	1.5	1.5	1	150,350		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	0							0		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	10	1.5	2	2.5	1.5	1.5	1	150,350	0	0
overall total (EUR)										150,350

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)
WP description	Technical Environment European Weather Cloud
WP tasks	
	DWD:
	- Administration of CM SAF Tenancy in EWC
	- user administration for CM SAF project team
	- virtual machines (VMs) and storage for production and development
	- single point of contact for EUMETSAT Secretariat and CM SAF project team
	- coordination of cross SAF activities for better integration of services
	- Provision of combined development and production environment on VMs
	- software libraries, compiler
	- version control system
	- Preparation, pre-processing and storage of shared input products
	- provision of infrastructure for container solution (e.g., HTCondor, Kubernetes)

	- Support for migration to cloud first implementations (e.g., storage, containerization)
	Workshop, demonstration, hackathon on cloud first data processing and efficient data processing (demonstrator might be added to innovation layer)
	- interfaces to cloud services
	EUMETSAT data store, data storage in EWC (local, S3,…)
WP input	
WP output/deliverables	- Contributions to CM SAF Operations Report (half-yearly)
WP Constraints and risks	This WP depends on the processing resources in the EWC and technical support by EUMETSAT Secretariat
WP Dependencies	
Interactions with other SAFs	
Federated Activities	
Notes:	

Work Package Description Sheet			**CDOP-5**		**Issue / Revision No.:**		**2.0**	**Date:**	**20.03.2026**	
Programme			CM SAF							
WP Number			4100							
WP-Title			**Prepare merged Geo-Ring and polar orbiter based products**							
WP Manager (WPM)			Martin Stengel							
Start of WP			01.03.2027							
End of WP			29.02.2032							
Start event			Start of CDOP-5							
End event			n/a							
WP pm and cost breakdown										
Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	12	1	2	2	3	3	1	180,420		
FMI	5				2	3		78,850		
KNMI	2.1	1	0.7	0.4				46,529		
Meteo Swiss	2	1	1					31,668		
RMI	2.0	0.5	0.5	0.5			0,5	26,180		
SMHI	2.5	0.5	1	0.5	0	0.3	0.2	41,310		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	25.6	4	5.5	3.4	6	5.3	1.7	399,141	0	0
overall total (EUR)										399,141
* **Description of procurement cost:**		Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)								

**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)	
WP description		Assess feasibility of generating (a subset of) CM SAF Geo-ring products from merged Geo-ring+Leo L1g* data
		All:
		- assess applicability of CM SAF geo-ring algorithms to 'polar-filled geo-ring' L1g* input data
		- contribute to assessment report
		DWD - clouds
		- Coordination of this activity
		- Inspection of Cloud_cci results and assessment of their applicability in CM SAF
		- Preparation of L1g data with polar gaps filled and provision to partners
		- Inspect L1g provided by EUMETSAT and provide feedback on working level communication
		- Support to assessing cloud products
		- Consolidate results, experiences and opinions from contributing partners and channel into a possible recommendation (or not) for an Innovation Layer activity as follow up
		- Lead preparation of feasibility report
		DWD - radiation
		- Apply geo-ring surface radiation algorithms to 'polar-filled geo-ring' L1g* input data for test cases
		- Evaluation of surface radiation products for test cases
		- Contribute to feasibility report
		SMHI
		- Apply geo-ring cloud algorithms to 'polar-filled geo-ring' L1g* input data for test cases
		- Evaluation of cloud products for test cases
		- Contribute to feasibility report
		KNMI
		- Support evaluation of cloud products for test cases

	- Contribute to feasibility report
	RMIB
	- Apply geo-ring TOA algorithms to 'polar-filled geo-ring' L1g* input data for test cases
	- Evaluation of TOA products for test cases
	- Contribute to feasibility report
	FMI
	- Evaluate the best candidate SAL algorithm to apply to 'polar-filled geo-ring' L1g* input data for test cases
	- Carry out test case processing and evaluate SAL products for test cases
	- Contribute to feasibility report
	Meteo Swiss
	- Apply geo-ring LST and SDL algorithms to 'polar-filled geo-ring' L1g* input data for test cases
	- Evaluation of LST and SDL products for test cases
	- Contribute to feasibility report
	- L1g* data (= lat/lon L1g data with polar regions filled with leo data) from Cloud_cci (Planned release date: 01.01.2026).
WP input	- Cloud_cci Technical Report on development undertaken to include polar data in L1g (Planned date of issue: 01.01.2026).
	- Cloud_cci Product Validation and intercomparison Report (Planned date of issue: 01.07.2026)
	- L1g* data from EUMETSAT
WP output/deliverables	Report on feasibility of producing CM SAF product based on merged Geo and Leo measurements incl. possible recommendation (or not) for follow-up activity in Innovation Layer.
WP Constraints and risks	Results from ESA Cloud_cci will be at a feasibility study level only, and thus limited in scope and in applicability
WP Dependencies	
Interactions with other SAFs	
Federated Activities	
Notes:	

<table>
<tr><td>Work Package Description Sheet</td><td colspan="3">CDOP-5</td><td colspan="2">Issue / Revision No.:</td><td>2.0</td><td>Date:</td><td colspan="2">20.03.2026</td></tr>
<tr><td>Programme</td><td colspan="9">CM SAF</td></tr>
<tr><td>WP Number</td><td colspan="9">4200</td></tr>
<tr><td>WP-Title</td><td colspan="9">Concept for a consistent NRT and CDR high-resolution precipitation product for Europe</td></tr>
<tr><td>WP Manager (WPM)</td><td colspan="9">Hannes Konrad</td></tr>
<tr><td>Start of WP</td><td colspan="9">1.03.2027</td></tr>
<tr><td>End of WP</td><td colspan="9">29.02.2032</td></tr>
<tr><td>Start event</td><td colspan="9">Kick Off CDOP-5</td></tr>
<tr><td>End event</td><td colspan="9">Close Out CDOP-5</td></tr>
<tr><td colspan="10">WP pm and cost breakdown</td></tr>
</table>

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	10	4	4.5	0.5	0.5	0.5	0	150,350		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	0							0		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	10	4	4.5	0.5	0.5	0.5	0	150,350	0	0
overall total (EUR)										150,350

<table>
<tr><td>* Description of procurement cost:</td><td></td></tr>
<tr><td>** Description of other cost:</td><td></td></tr>
<tr><td>WP description</td><td>Collaboration with NWC SAF to set a plan towards a Climate regional high resolution precipitation product. The long-term goal is that CM SAF and NWC SAF generate seamless products, i.e., CDR and NRT precipitation data for Europe</td></tr>
<tr><td rowspan="8">WP tasks</td><td></td></tr>
<tr><td>DWD (CM SAF):</td></tr>
<tr><td>- implement interface for NWC SAF 's GEO CRR / CRRPh software to SEVIRI/FCI FCDR</td></tr>
<tr><td>- carry out test runs on SEVIRI and FCI NRT and FCDR data</td></tr>
<tr><td>- analyse results with respect to accuracy and homogeneity, preferably validating against reference dataset, such as EURADCLIM</td></tr>
<tr><td>- draft the final report based on the cross-SAF discussions and the analyses</td></tr>
<tr><td>- deliver support to the implementation of the concept</td></tr>
<tr><td>- research possibilities for including MW-based retrievals of precipitation (PPS MW) (optional)</td></tr>
</table>

	- regularly liaise with the cross-SAF working group consisting of NWC SAF / AEMET (support to GEO CRR and CRRPh) and H SAF / CNR-ISAC and NWC SAF / SMHI (support to PPS MW-related precipitation retrievals)
	AEMET (NWC SAF): - Scientific and technical support of precipitation products within the NWCSAF v2025 software package - Support on the NWCSAF software adaptation to ingest the FCDR (Fundamental Climate Data Records) - Planning collaboration with CM SAF to recalibrate precipitation products if necessary
WP input	SAF Strategy Paper on Precipitation, GEO CRR/CRRPh software by NWC SAF, SEVIRI FCDR, FCI reprocessed data/FCDR
WP output/deliverables	NWC SAF: NWC SAF GEO-I software to generate precipitation products from FCDRs CM SAF: Report, detailing the concept for a consistent NRT and CDR high-resolution precipitation product for Europe
WP Constraints and risks	n/a
WP Dependencies	NWC SAF: WP 3300 (joint WP) CM SAF: WP 5220 (commissioning of PPS-MW retrievals for GIRAFE v2 PCR) H SAF: WP 2130
Interactions with other SAFs	NWC SAF, H SAF
Federated Activities	
Notes:	

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Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**20.03.2026**
Programme	CM SAF				
WP Number	4300				
WP-Title	**WCRP support activities**				
WP Manager (WPM)	Marc Schröder				
Start of WP	1.03.2027				
End of WP	29.02.2032				
Start event	KO				
End event	end of CDOP-5				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	10	2.5	2.5	2	1.5	1.5	0	150,350		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	0							0		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	10	2.5	2.5	2	1.5	1.5	0	150,350	0	0
overall total (EUR)										150,350

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)
WP description	Support to various WCRP panels and projects
WP tasks	
	DWD:
	- Co-chairing of the WCRP GEWEX Water Vapor Assessment (G-VAP): organise workshops, organise summary reports for WCRP GEWEX, and assess impact of improved FCDRs on TCWV stability
	- Support to the WCRP GEWEX precipitation assessment: analyse stability of mature near-global precipitation CDRs
	- Participate in WCRP ESMO WGORC meetings and support implementation of WGORC objectives
	- Participate in WCRP, GEWEX and GDAP conferences and meetings

WP input	ToR for WGORC, existing tools from previous support to G-VAP and P assessment
WP output/deliverables	Depending on results from G-VAP and P assessment analysis, reports to GDAP
WP Constraints and risks	
WP Dependencies	WP 5930, WP 1200
Interactions with other SAFs	ROM SAF
Federated Activities	
Notes:	

Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**20.03.2026**

Programme	CM SAF
WP Number	4400
WP-Title	**Microwave Imager Inter-calibration**
WP Manager (WPM)	Hannes Konrad, DWD
Start of WP	1.03.2027
End of WP	29.02.2032
Start event	Kick Off CDOP-5
End event	Close Out CDOP-5

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	8	1	2	1	2	1	1	120,280		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	0							0		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	8	1	2	1	2	1	1	120,280	0	0
overall total (EUR)										120,280

*** Description of procurement cost:**	
**** Description of other cost:**	
WP description	Microwave Imager Inter-calibration
WP tasks	
	DWD:
	Gather extended and updated microwave imager data such as TMI, AMSR-E, AMSR-2, AMSR-3, GMI and EPS-SG MWI data and convert to CM SAF FCDR format
	Update inter-calibration coefficients for microwave imagers such as TMI, AMSR-E, AMSR-2, AMSR-3, GMI and EPS-SG MWI by applying heritage inter-calibration software, which relies on scene radiances
	For EPS SG MWI, develop a mitigation strategy for the spectral gap between other sensors (36-37 GHz) to MWI (31 GHz)
	Release the derived inter-calibration coefficients in a report

	Provide feedback of possibly identified issues in the raw data sensor data records to the original data providers
WP input	Microwave imager data such as TMI, AMSR-E, AMSR-2, AMSR-3, GMI and EPS-SG MWI raw data from X-CAL/PPS/JAXA, EUMETSAT, PCR 4.1 and 5.1 document: ATBD, intercalibration tool
WP output/deliverables	Report on intercalibration coefficients for microwave imagers such as TMI, AMSR-E, AMSR-2, AMSR-3, GMI, and EPS-SG MWI
WP Constraints and risks	Availability of input for operational (AMSR-2, GMI) or upcoming (AMSR-3, EPS SG MWI) sensors; incompatibility of 31/36 GHz channel gap (EPS SG MWI)
WP Dependencies	WP 5820, WP 5730, WP 5200
Interactions with other SAFs	
Federated Activities	
Notes:	The focus will be on EPS SG MWI and AMSR-3, supporting the HOAPS ICDR (WP 5730) and potentially GIRAFE v2 (WP 5200)

Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**20.03.2026**
Programme	CM SAF				
WP Number	4500				
WP-Title	**Support to EUMETSAT for AVHRR GAC FCDR generation**				
WP Manager (WPM)	SMHI				
Start of WP	1.03.2027				
End of WP	31.12.2028				
Start event	Kick-off CDOP-5				
End event	Release of AVHRR GAC FCDR				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	1	0.5	0.5					15,035		
FMI	0.5	0.5						7,885		
KNMI	1	0.5	0.5					19,387		
Meteo Swiss	0							0		
RMI	0.5	0.5						6,545		
SMHI	7	3	4					115,668		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	10	5	5	0	0	0	0	164,520	0	0
overall total (EUR)										164,520

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)
WP description	Interact with EUMETSAT on the content and accuracy requirements on the AVHRR GAC FCDR
WP tasks	
	All:
	- Exchange FCDR requirements with EUMETSAT and evaluate test datasets
	RMIB (TOA radiation)
	- Participate in meetings with EUMETSAT on FCDR requirements and evaluate test datasets
	SMHI
	- Collect and distribute to EUMETSAT the latest information about the status of the current AVHRR GAC FDR as experienced by the CLARA development team
	- Collect and distribute to EUMETSAT the latest information on the achievements reported from ESA project on European LAC FCDR development regarding AVHRR navigation and calibration

	- Specify required improvements of calibration methods, not present in the current FDR
	- Specify the definition of simulated AVHRR data from AVHRR-heritage channels of VIIRS and METimage sensors and synchronize with datasets from original AVHRR datasets
	- Develop and exchange method for simulating AVHRR data from AVHRR-heritage channels of the METimage sensor
	- Continuously evaluate test datasets from FCDR development
	- Specify levels of associated uncertainty information
	- Participate in regular meetings with EUMETSAT on FCDR development
	* Note: Some of these tasks might have started already at the end of CDOP-4
	KNMI (CPP products)
	- Participate in meetings with EUMETSAT on FCDR requirements and evaluate test datasets
	DWD
	- Participate in regular meetings with EUMETSAT on FCDR requirements
	- Continuously evaluate test datasets from FCDR development
	FMI (Surface albedo)
	- Participate in meetings with EUMETSAT on FCDR requirements and evaluate test datasets
WP input	AVHRR FDR+VIIRS (VGAC) F(C)DR + METimage (MGAC) F(C)DR
WP output/deliverables	- Documentation and components for provision of VIIRS- and METimage-simulated AVHRR data - Test reports and validation results regarding the impact of updated AVHRR calibration - Guidance on the appropriate levels of FCDR uncertainty information
WP Constraints and risks	
WP Dependencies	
Interactions with other SAFs	
Federated Activities	
Notes:	

Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**1.0**	**Date:**	**20.03.2026**
Programme	CM SAF				
WP Number	4600				
WP-Title	**Towards a consistent approach to estimate uncertainties**				
WP Manager (WPM)	Elizabeth Good				
Start of WP	01.03.2027				
End of WP	29.02.2032				
Start event	Kick-off CDOP-5				
End event	End of CDOP-5				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	2.5	1	0.5	0.5	0.25	0.25		37,588		
FMI										
KNMI										
Meteo Swiss										
RMI										
SMHI										
UKMO (sci)	5	1	1	1	1	1		71,920		
UKMO (mngt)	5	1	1	1	1	1		84,500		
Sum	12.5	3	2.5	2.5	2.25	2.25		194,008		
overall total (EUR)										194,008

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)
WP description	Towards a consistent approach to estimate uncertainties
WP tasks	**All:**
	- Address user request related to uncertainty estimates at requirements reviews (covered in related WPs).
	- Support to drafting the user guidance on the use of currently available uncertainties and the development of a plan to implement a consistent approach (or approaches) for the provision and validation of uncertainties (covered by data record WPs)
	UKMO:
	- Generate a list of target CM SAF products: agree a list of CM SAF products that are useful for energy and water budget studies that should be targeted for this work within the CM SAF board and Steering Group.

	- Gather user requirements for uncertainties - Address this topic at requirements reviews. - Review existing user requirements for provision of uncertainty information, including available information from other SAFs, ESA CCI, and C3S. - Gather user requirements specifically for CM SAF product uncertainties through a user survey, and interviews/discussions with users both in person and online. This activity could include a dedicated session at CM SAF user workshops in CDOP-5, or even a dedicated, focused workshop on the topic of uncertainties. - Detail findings in a dedicated report.
	- Select a consistent approach (or approaches) for provision of uncertainties - Review existing approaches for provision of uncertainties. - Assess the feasibility of implementing these approaches for the target CM SAF products. - Detail findings in a dedicated report.
	- Select a consistent approach (or approaches) for validation of uncertainties - Review state-of-the-art methods for validating uncertainties. - Assess the feasibility of implementing these uncertainty validation methods across the target CM SAF products. - Detail findings in a dedicated report.
	- Develop a plan to implement a consistent approach (or approaches) for the provision and validation of uncertainties for the target CM SAF products. This plan will form the basis for uncertainties work packages in future CDOP proposals.
	DWD
	- Provide overview of available uncertainty estimates and user guidance on how to use these; approach harmonization of how uncertainty estimates are presented to users
	- Support to UKMO on coordinating this effort
WP input	- User experiences and requirements - Literature on existing approaches for provision and validation of uncertainties
WP output/deliverables	- Report on user requirements for uncertainties - Report on the selection of a consistent approach for provision of uncertainties - Report on the selection of a consistent approach for validation of uncertainties - Implementation plan for provision and validation of uncertainties for target CM SAF products
WP Constraints and risks	Large diversity in product generation and (lack of) availability of reference observations with uncertainties
WP Dependencies	All CM SAF data record WPs
Interactions with other SAFs	
Federated Activities	
Notes:	May include an Innovation Layer proposal to seek assistance from non-CM SAF experts on uncertainty in EO data, e.g., NPL & U. Reading.

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Work Package Description Sheet	CDOP-5	Issue / Revision No.:	2.0	Date:	20.03.2026
Programme	CM SAF				
WP Number	5110				
WP-Title	**CDR + ICDR global CLARA-A4 - RR**				
WP Manager (WPM)	Salomon Eliasson				
Start of WP	1.03.2027				
End of WP	30.06.2028				
Start event	Kick-off CDOP-5				
End event	RR 5.2				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	5	2	3					75,175		
FMI	7.5	3.5	4					118,275		
KNMI	5	3	2					96,935		
Meteo Swiss	0							0		
RMI	5	5						65,450		
SMHI	15	7	8					247,860		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	37.5	20.5	17	0	0	0	0	603,695	0	0
overall total (EUR)										603,695

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)
WP description	CDR+ICDR CLARA-A4 scientific evaluation, quality/feasibility studies and requirement definitions – RR 5.2
WP tasks	
	All:
	- Start preparations for the use of the AVHRR GAC FCDR and inclusion of METimage data
	- Prepare RR document for CDR and ICDR
	- Organize, prepare and perform RR review
	- Collect input from users on their use of and requirements for uncertainty estimates. Feed this into WP4600 and support the development of a consistent approach for the provision and validation of uncertainties.
	RMIB (TOA radiation)
	- General analysis of user's requirement for CLARA-A4

	- Input for requirement review document
	- Participate to requirement review
	SMHI (Cloud mask and cloud top height)
	- Interact with EUMETSAT Climate group on requirements on AVHRR GAC FCDR
	- Assess emerging user requirements from the targeted applications and collect user experiences of previous CLARA-A3.5 release
	- Regular meetings (at least bi-annual) between CM SAF, NWC SAF PPS and NWC SAF GEO to align evolution of cloud products.
	KNMI (CPP products)
	- Assess emerging user requirements from the targeted applications and collect user experiences of previous CLARA-A3.5 release
	- Prepare CPP algorithm for METimage inclusion
	- Regular meetings with NWC SAF to contribute to PPS and align evolution of cloud products
	DWD (Surface radiation + clouds + operational processing)
	- Prepare input data and tools for new cloud phase algorithm developments
	- Contribution to updating user requirements and product specifications
	FMI (Surface albedo)
	- Contributing to RR and to updating of PRD document
	- Assess existing and emerging user requirements, update specifications accordingly
WP input	AVHRR+VIIRS GAC F(C)DR, MetImage, ERA5/6, auxiliary and ancillary data
WP output/deliverables	RR document
	Updated PRD entries for CM-11014, CM-11024, CM-11034, CM-11044, CM-11054,
	CM-11064, CM-11204, CM-11229, CM-11230, CM-11231, CM-11264, CM-11274, CM-11314,
	CM-11344, CM-6013, CM-6023, CM-6033, CM-6043, CM-6053, CM-6063, CM-6213, CM-6222, CM-6224,
	CM-6225, CM-6263, CM-6273, CM-6283, CM-6293, CM-6323, CM-6333
WP Constraints and risks	
WP Dependencies	
Interactions with other SAFs	NWC SAF, OSI SAF
Federated Activities	
Notes:	

Work Package Description Sheet	**CDOP-5**				**Issue / Revision No.:**		**2.0**	**Date:**	**20.03.2026**	
Programme	CM SAF									
WP Number	5120									
WP-Title	**CDR and ICDR global CLARA-A4 - PCR**									
WP Manager (WPM)	Salomon Eliasson									
Start of WP	01.07.2028									
End of WP	31.12.2029									
Start event	RR 5.2									
End event	PCR 5.2									
WP pm and cost breakdown										
Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	22		10	12				330,770		
FMI	12		5	7				189,240		
KNMI	6.5		3	3,5				126,016		
Meteo Swiss	0							0		
RMI	11.5		5.5	6				150,535		
SMHI	22		9	13				363,528		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	74	0	34.5	43	0	0	0	1,160,089	0	0
overall total (EUR)										1,160,089
*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)									
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)									
WP description	CDR and ICDR CLARA-A4 scientific algorithm developments, design and feedback loop – PCR 5.2									
WP tasks										
	All:									
	- Prepare PCR documents: ATBD, DGCDD									
	- Evaluate feedback loop results									
	- Organize, prepare and perform PCR 5.2 review									
	RMIB (TOA radiation)									
	- Development and implementation of several improvements w.r.t. CLARA-A3: hourly diurnal cycle, updated narrowband-to-broadband conversion, updated angular dependency model (ADM), introduction of clear-sky fluxes, smaller improvements such as new landcover and snow cover maps; Optionally: correct/compensate for single observation per day during first decade. Better spatial resolution (TBD, should be in line with other CLARA products).									
	- Input for ATBD document and DGCDD									

	- Participate to product consolidation review
	SMHI (Cloud mask and cloud top height)
	- Finalise Neural Network-based cloud probability product with enhanced uncertainty measures
	- Adapt algorithms to new or updated ancillary datasets (e.g., ERA6, new emissivity and ice cover information)
	- Update algorithms for the cloud top height retrieval with latest NWC SAF PPS developments
	- Contribute to ATBD on cloud products
	- Regular meetings (at least bi-annual) between CM SAF, NWC SAF PPS and NWC SAF GEO to align evolution of cloud products.
	KNMI (CPP products)
	- Implement CPP improvements based on CLARA-A3.5 evaluations
	- Implement CPP algorithm extension for METimage
	- Regular meetings with NWC SAF to contribute to PPS and align evolution of cloud products
	FMI (Surface albedo)
	- Design and implement algorithm improvements: per-pixel uncertainty, atm. correction
	- Implement a technical redesign of retrieval code for improved flexibility and user experience
	- prepare review documents, contribute to review
	DWD (Surface radiation + operational processing)
	- Contribution to PCR
	DWD (clouds)
	- Develop and test new cloud phase algorithm
	- Contribution to PCR
	DWD (Operations)
	- provide development environment with control flow for processing chain for CDR and ICDR
	- calculate feedback loops (for CDR and ICDR)
WP input	RR 5.2 document + PRD most recent PPS version from NWC SAF, AVHRR+VIIRS GAC F(C)DR, MetImage, ERA, auxiliary and ancillary data; OSI SAF sea-ice mask (CDR+ICDR)
WP output/deliverables	ATBDs for entries (CM identifiers):
	CM-11014, CM-11024, CM-11034, CM-11044, CM-11054, CM-11064, CM-11204, CM-11229, CM-11230, CM-11231, CM-11264, CM-11274, CM-11314, CM-11344, CM-6013, CM-6023, CM-6033, CM-6043, CM-6053, CM-6063, CM-6213, CM-6222, CM-6224, CM-6225, CM-6263, CM-6273, CM-6283, CM-6293, CM-6323, CM-6333
	DGCDD, example files for all parameters
WP Constraints and risks	Timely availability of input data
WP Dependencies	Access to input data from EUMETSAT Sec.
Interactions with other SAFs	NWC SAF, OSI SAF
Federated Activities	
Notes:	

Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**20.03.2026**
Programme	CM SAF				
WP Number	5130				
WP-Title	**CDR and ICDR global CLARA-A4 - DRR**				
WP Manager (WPM)	Salomon Eliasson				
Start of WP	01.01.2030				
End of WP	29.02.2032				
Start event	PCR 5.2				
End event	DRR 5.2 / ORR5.2				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	23				11	12		345,805	25,000	
FMI	12.5				5	5.5	2	197,125		
KNMI	7.5				2.5	4	1	145,403		
Meteo Swiss	0							0		
RMI	11				5.5	5.5		143,990		
SMHI	19.2				8	9.2	2	317,532		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	73.2	0	0	0	32	36.2	5	1,149,855	25,000	0
overall total (EUR)										1,174,855

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)

WP description	CDR and ICDR CLARA-A4 data record generation and validation – DRR 5.2
	All:
	- Prepare DRR documents: PUM, ValRep and update ATBD, consistency report as needed
	- Organize, prepare and perform DRR and ORR review
	- Comparison to complementary parameters from CM SAF
	- Compare CDR and ICDR in absolute and anomaly space as needed
	RMIB (TOA radiation)
	- Support processing team
	- CDR+ICDR evaluation
	- Input for Validation report and PUM document
	- support setup of processing environment for CDR and ICDR
	- Participate to dataset readiness review (DRR/ORR)

	SMHI (Cloud mask and cloud top height)
	- Validate CFC and CTO products using A-Train data, EarthCARE data and other historical data records
	- Evaluate full effect of introduction of FCDR and modern sensors AVHRR-heritage information compared to previous CLARA editions
	- support setup of processing environment for CDR and ICDR
	- Contribute to DRR/ORR review
	- Contribution to CLARA-A4 papers
	- Update COSP CLARA simulator to allow AVHRR-heritage products from VIIRS and METimage data
	- Regular meetings (at least bi-annual) between CM SAF, NWC SAF PPS and NWC SAF GEO to align evolution of cloud products.
	KNMI (CPP products)
	- Evaluate CLARA-A4 CPP products by comparison with comparable datasets from e.g., MODIS/VIIRS and PATMOS-x
	- Validate CLARA-A4 CPP products by comparison with independent observations from microwave imagers and active sensors
	- Regular meetings with NWC SAF to contribute to PPS and align evolution of cloud products
	DWD (Surface radiation + clouds)
	- Evaluation of surface radiation L3 products by validation to surface refererence data
	- Evaluation of cloud record L3 products (CFC, CTO, JCH) by validation to SYNOP and comparisons to existing data records (e.g. ISCCP, Cloud_cci, Patmos-X, MODIS)
	- Contribution to DRR/ORR documents and DRR/ORR
	FMI (Surface albedo)
	- Production support of CLARA-A4 SAL, quality assessment and documentation
	- Evaluation or surface albedo products though validation against in situ observations (e.g. BSRN, PROMICE, ICOS) and through intercomparison with existing albedo data records (e.g. CERES, LSA SAF AL, MODIS)
	- Provision of updated ATBD, PUM and VR documents for review, participation in DRR review.
	DWD (Operations)
	- Setup of CDR and ICDR processing chain
	- Calculate products
	- Prepare OPD and update DGCDD as needed
	- Archive products
WP input	PRD, PCR 5.2 documents: ATBDs, DGCDD AVHRR+VIIRS GAC F(C)DR, MetImage, ERA, auxiliary and ancillary data OSI SAF sea-ice mask (CDR+ICDR)
WP output/deliverables	CDR+ICDR CLARA-A4 data record including (CM identifiers):
	CM-11014, CM-11024, CM-11034, CM-11044, CM-11054, CM-11064, CM-11204, CM-11229, CM-11230, CM-11231, CM-11264, CM-11274, CM-11314, CM-11344, CM-6013, CM-6023, CM-6033, CM-6043, CM-6053, CM-6063, CM-6213, CM-6222, CM-6224, CM-6225, CM-6263, CM-6273, CM-6283, CM-6293, CM-6323, CM-6333

	Documents and Reports (updated ATBD+DGCCD+consistency report as needed; ValRep, PUM, OPD)
	Metadata fact sheet, DOI landing page, information material
	Scientific papers
WP Constraints and Risks	Timely availability of input data
WP Dependencies	Availability of input data
Interactions with other SAFs	NWC SAF, OSI SAF
Federated Activities	
Notes:	

Work Package Description Sheet	CDOP-5	Issue / Revision No.:	2.0	Date:	16.03.2026
Programme	CM SAF				
WP Number	5210				
WP-Title	**CMSAF and H SAF - joint precipitation RR**				
WP Manager (WPM)	Hannes Konrad, DWD				
Start of WP	1.03.2027				
End of WP	31.12.2028				
Start event	Kick Off CDOP-5				
End event	RR 5.5				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	2	1	1					30,070		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	0							0		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	2	1	1					30,070	0	0
overall total (EUR)										30,070
*** Description of procurement cost:**										
**** Description of other cost:**										

WP description	Joint H SAF / CM SAF Precipitation scientific evaluation, quality/feasibility studies and requirement definitions – RR 5.5
WP tasks	**All:** - Prepare RR document for CDR and ICDR - Organize, prepare and perform RR review
	DWD (CM SAF):
	- Consolidate received user feedback from key users and via user help desk, user workshops, etc. for GIRAFE v1(.1) CDR & ICDR - Initial formulation of requirements for precipitation climate data records, including normals and anomalies
	CNR-IRPI (H SAF):

	- Consolidate received user feedback from key users and via user help desk, user workshops, etc. for H87 and H188 - Initial formulation of requirements for hyrological applications and long-term water management studies
WP input	CM SAF: CDOP-3/4 CDR+ICDR global precipitation (GIRAFE v1, CM-25611, CM-6710) and CDOP-5 update (GIRAFE v1.1, CM-25613, CM-6712), DWD and CM SAF heritage tools, ICDR processing chain (from CDOP-4 WP 3130), RR 3.5 document, PRD, Visiting Scientist Reports C. Kidd, ATBDs for external software H SAF: CDOP/4 CDR+ICDR global precipitation (H87-H188), ICDR processing chain, product documentation (RR, PRD, PVR, ATBD, PUM)
WP output/deliverables	RR document
	Updated PRD entries for: CM-25612, CM-7611 (GIRAFE v2 CDR+ICDR) H-189, H190 (CDR and ICDR)
	or - if the RR concludes that a single, possibly joint product can serve user needs - a proposal to H SAF and CM SAF Steering Groups defining the work packages for such a single product
WP Constraints and risks	
WP Dependencies	WP 5220, WP 5230
Interactions with other SAFs	H SAF (joint WP)
Federated Activities	
Notes:	

3990

Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**16.03.2026**

Programme	CM SAF
WP Number	5220
WP-Title	**GIRAFE v2 CDR + ICDR - PCR**
WP Manager (WPM)	Hannes Konrad, DWD
Start of WP	30.06.2028
End of WP	30.06.2030
Start event	RR 5.5
End event	PCR 5.5

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	56		21	22	13			841,960		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	0							0		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	56	0	21	22	13	0	0	841,960	0	0
overall total (EUR)										841,960

*** Description of procurement cost:**	
**** Description of other cost:**	

WP description	CDR and ICDR GIRAFE v2 scientific algorithm developments, design and feedback loop – PCR 5.5
WP tasks	
	DWD:
	- test and include PRPS SSMI(S) algorithm over land, possibly replace HOAPS over ocean
	- test and include H / NWC SAF day-one algorithms for EPS-SG MWS and MWI (PPS MW software)
	- test the extension of the above day-one algorithms for EPS-SG MWS and MWI to ATMS and GMI for consistency
	- test and include H SAF algorithms for AMSR-3 via NWC SAF 's PPS MW (optional)
	- test and include H SAF algorithms for AWS/EPS-Sterna via NWC SAF 's PPS MW (optional)
	- implement a dedicated treatment of snowfall information from H SAF algorithms
	- test the impact of GEO-Ring L1g

	- improve ERA-based snow mask if necessary after previous task (snowfall retrieval)
	- develop a bias correction scheme (gauges over land or allowing budget closure)
	- test and implement output at higher spatial and temporal resolutions
	- Improve uncertainty estimates (propagation from L1 to L3, extend sampling uncertainty to high latitudes)
	- adjust MW L2 homogenisation (quantile mapping) to new constellation
	- Prepare PCR documents: ATBD, DGCDD
	- Evaluate feedback loop results
	- Organize, prepare and perform PCR review
	- liaise with CGMS IPWG, participate in IPWG meetings and workshops
	- liaise with H SAF for the identification of possible synergies in the possible developments of corrections towards rain gauge observations
	DWD (Operations)
	- Initiate transfer of the GIRAFE processing software to EWC
	- Provide development environment with control flow for processing chain for CDR and ICDR
	- Calculate feedback loops (for CDR and ICDR)
WP input	RR 4.5 document + PRD pre-existing software: GIRAFE v1 / v1.1 processing chain NWC SAF PPS MW software Infrared brightness temperatures observed by geostationary satellites (Geo-Ring) Microwave brightness temperature observed by polar-orbiting satellites (SSMI(S), GMI, TMI, AMSR-E/2/3, EPS-SG MWI, AMSU-B, MHS, ATMS, EPS-SG MWS, AWS/EPS-Sterna auxiliary input: sea ice concentration CDR, climate reanalysis
WP output/deliverables	ATBDs for entries:
	CM-25612, CM-7611
	DGCDD, example files for all parameters
WP Constraints and risks	Availability of satellite observations Availability of H / NWC SAF algorithms Climate compliance of H / NWC SAF algorithms for EPS-SG MWS and MWI and their input datastreams; there is a significant risk that re-training would be necessary which cannot be accommodated by any of the involved SAFs Compatibility of ERA5 and ERA6 in auxiliary datastreams Snowfall retrievals only back to 2012 Improvements of uncertainty estimates will need to be prioritized GEO-Ring L1g data will be resolved 0.05° and 30 minutes; this may lead to degraded quality in GIRAFE compared to the higher resolved original per-sensor L1 archives.
WP Dependencies	WP 4400, WP 5830, WP 5730
Interactions with other SAFs	H SAF, NWC SAF
Federated Activities	
Notes:	

Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**20.03.2026**

Programme	CM SAF
WP Number	5230
WP-Title	**GIRAFE v2 CDR and ICDR - DRR**
WP Manager (WPM)	Hannes Konrad, DWD
Start of WP	1.07.2030
End of WP	31.12.2031
Start event	PCR 5.5
End event	DRR 5.5 / ORR5.5
WP pm and cost breakdown	

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	21				7	14		315,735	25,000	
FMI	0							0		
KNMI	0							0		
Meteo Swiss	0							0		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	21	0	0	0	7	14	0	315,735	25,000	0
overall total (EUR)										340,735

*** Description of procurement cost:**	
**** Description of other cost:**	

WP description	CDR and ICDR GIRAFE v2 – DRR 5.5
	All:
	- Prepare DRR documents: PUM, ValRep and update ATBD, consistency report as needed
	- Organize, prepare and perform DRR and ORR review
	- Compare CDR and ICDR in absolute and anomaly space as needed
	- Validate against selected reference datasets: EURADCLIM (radar/gauges over Europe), AMMA-CATCH (gauge network), GPCC (if definition of day allows)
	- Intercompare with other (quasi-)global precipitation datasets such as GPCP, ERA, IMERG
	- liaise with CGMS IPWG, participate in IPWG meetings and workshops
	DWD (Operations)
	- Setup of CDR and ICDR processing chain

	- Calculate products
	- Prepare OPD and update DGCDD as needed
	- Archive products
WP input	PRD, PCR 5.5 documents: ATBDs, DGCDD GIRAFE software as developed during WP 5220, including software by H / NWC SAF Infrared brightness temperatures observed by geostationary satellites (Geo-Ring) Microwave brightness temperature observed by polar-orbiting satellites (SSMI(S), GMI, TMI, AMSR-E/2/3, EPS-SG MWI, AMSU-B, MHS, ATMS, EPS-SG MWS, AWS/EPS-Sterna auxiliary input: sea ice concentration CDR, climate reanalysis
WP output/deliverables	CDR+ICDR GIRAFE v2 data record including:
	CM-25612, CM-7611
	Documents and Reports (updated ATBD+DGCCD+consistency report as needed; ValRep, PUM, OPD)
	Metadata fact sheet, DOI landing page, information material
	Scientific papers
WP Constraints and Risks	Availability of satellite observations Availability of H / NWC SAF algorithms Climate compliance of H / NWC SAF algorithms for EPS-SG MWS and MWI and their input datastreams Compatibility of ERA5 and ERA6 in auxiliary datastreams Snowfall retrievals only back to 2012 Improvements of uncertainty estimates will need to be prioritized
WP Dependencies	WP 5220, WP 4400, WP 5830, WP 5730
Interactions with other SAFs	H SAF, NWC SAF
Federated Activities	
Notes:	

Work Package Description Sheet	**CDOP-5**		**Issue / Revision No.:**		**2.0**		**Date:**		**20.03.2026**	
Programme	CM SAF									
WP Number	5310									
WP-Title	**CDR+ICDR high-resolution Europe (HANNA) - RR**									
WP Manager (WPM)	Anke Tetzlaff									
Start of WP	1.03.2027									
End of WP	29.02.2028									
Start event	Kick-off CDOP-5									
End event	RR 5.6									
WP pm and cost breakdown										
Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	6	4	2					90,210		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	6	4	2					95,004		
RMI	5	5						65,450		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	17	13	4	0	0	0	0	250,664	0	0
overall total (EUR)										250,664
*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)									

** Description of other cost:	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)
WP description	CDR+ICDR high-resolution Europe (HANNA): scientific evaluation, quality/feasibility studies and requirement definitions – RR 5.6
WP tasks	
	All:
	- Prepare RR document for CDR and ICDR
	- Organize, prepare and perform RR review
	MeteoSwiss
	- Coordinate the RR document and the progress
	- Assess user requirements for HANNA SIS and related, Albedo, LST, SRB products
	RMI
	- Assess user requirements for HANNA LEH products
	DWD
	- Contribute to user requirements for HANNA SIS data and product specifications
WP input	PRD
WP output/deliverables	RR document
	Updated PRD entries for (CM identifiers):
	CM-38201, CM-38291, CM-38221, CM-38281, CM-38271, CM-38811, CM-38921 CM-7201, CM-7291, CM-7221, CM-7281, CM-7261, CM-7811, CM-7921, CM-7271
WP Constraints and risks	
WP Dependencies	
Interactions with other SAFs	LSA SAF
Federated Activities	
Notes:	

Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**20.03.2026**
Programme	CM SAF				
WP Number	5320				
WP-Title	**CDR+ICDR high-resolution Europe (HANNA) - PCR**				
WP Manager (WPM)	Anke Tetzlaff				
Start of WP	1.03.2028				
End of WP	31.08.2029				
Start event	RR 5.6				
End event	PCR 5.6				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	14		5	9				210,490		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	12		8	4				190,008		
RMI	12		8	4				157,080		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	38	0	21	17	0	0	0	557,578	0	0
overall total (EUR)										557,578

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)

WP description	CDR+ICDR high-resolution Europe (HANNA): scientific algorithm developments, design and feedback loop – PCR 5.6
WP tasks	**All:**
	- Prepare PCR documents: ATBD, DGCDD
	- Evaluate feedback loop results
	- Organize, prepare and perform PCR review
	MeteoSwiss
	- Prepare GeoSatClim for MTG: SIS and related, Albedo, SRB, LST GeoSatClim algorithm updates for MTG
	- Coordinate PCR
	RMI
	- LEH algorithm updates for Europe
	- Test and evaluate various L2 to L3 compilations
	DWD
	Support the development and the preliminary evaluation of HANNA data sets
	DWD (Operations)
	- Provide development environment with control flow for processing chain for CDR and ICDR
	- Calculate feedback loops (for CDR and ICDR)
WP input	RR 5.6 document + PRD, GeoSatClim Meteosal level 1 data, ERA6, auxillary and ancillary data
WP output/deliverables	ATBDs for entries (CM identifiers):
	CM-38201, CM-38291, CM-38221, CM-38281, CM-38271, CM-38811, CM-38921 CM-7201, CM-7291, CM-7221, CM-7281, CM-7261, CM-7811, CM-7921, CM-7271
	DGCDD, example files for all parameters
WP Constraints and risks	Timely availability of input data
WP Dependencies	Access to input
Interactions with other SAFs	LSA SAF
Federated Activities	
Notes:	

Work Package Description Sheet	CDOP-5	Issue / Revision No.:	2.0	Date:	20.03.2026
Programme	CM SAF				
WP Number	5330				
WP-Title	**CDR+ICDR high-resolution Europe (HANNA) - DRR**				
WP Manager (WPM)	Nicolas Clerbaux				
Start of WP	01.09.2029				
End of WP	31.03.2031				
Start event	PCR 5.6				
End event	DRR 5.6 / ORR5.6				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	16			6	10			240,560		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	12			4	8			190,008		
RMI	11			5.5	5.5			143.990		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	39	0	0	15.5	23.5	0	0	574.558	0	0
overall total (EUR)										574.558
*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)									
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)									

WP description	CDR+ICDR high-resolution Europe (HANNA): data record generation and validation – DRR 5.6
	All:
	- Prepare DRR documents: PUM, ValRep and update ATBD, consistency report as needed
	- Organize, prepare and perform DRR and ORR review
	- Comparison to complementary parameters from CM SAF
	- Compare CDR and ICDR in absolute and anomaly space as needed
	MeteoSwiss
	- Coordinate the progress
	- Validate HANNA SIS and related, Albedo, SRB and LST products by comparision with independent datasets: e.g., SARAH, ERA6, ICON Reanalysis, LSA SAF LST
	- Prepare GeoSatClim for transfer to DWD (Container)
	- Knowledge transfer from MeteoSwiss operations to DWD operations
	RMI
	- Validate HANNA LEH by comparision with independent datasets
	DWD
	- Support validation of HANNA data records
	DWD (Operations)
	- Setup of CDR and ICDR processing chain
	- Calculate products
	- Prepare OPD and update DGCDD as needed
	- Archive products
WP input	PRD, PCR 5.6 documents: ATBDs, DGCDD, Meteosat level 1, ERA6, auxillary and ancillary data
WP output/deliverables	CDR+ICDR HANNA data record including (CM identifiers):
	CM-38201, CM-38291, CM-38221, CM-38281, CM-38271, CM-38811, CM-38921

	CM-7201, CM-7291, CM-7221, CM-7281, CM-7261, CM-7811, CM-7921, CM-7271
	Documents and Reports (updated ATBD+DGCCD+consistency report as needed; ValRep, PUM, OPD)
	Metadata fact sheet, DOI landing page, information material
WP Constraints and Risks	Timely availability of input data
WP Dependencies	Availability of input data
Interactions with other SAFs	LSA SAF
Federated Activities	
Notes:	

Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**20.03.2026**
Programme	CM SAF				
WP Number	5410				
WP-Title	**CDR + ICDR GEO-Ring - RR**				
WP Manager (WPM)	Jan Fokke Meirink				
Start of WP	01.03.2027				
End of WP	31.12.2028				
Start event	Kick-off CDOP-5				
End event	RR 5.7				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	9	4	5					135,315		
FMI	0							0		
KNMI	8	3.5	4.5					155,096		
Meteo Swiss	1		1					15,834	2,500	
RMI	5	4	1					65,450		
SMHI	10	5	5					165,240		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	33	16.5	16.5	0	0	0	0	536,935	2,500	0
overall total (EUR)										539,435

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)

** Description of other cost:	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)

WP description	CDR+ICDR GEO-Ring scientific evaluation, quality/feasibility studies and requirement definitions – RR 5.7
WP tasks	
	All:
	- Prepare RR document for CDR and ICDR
	- Organize, prepare and perform RR review
	- Collect input from users on their use of and requirements for uncertainty estimates. Feed this into WP4600 and support the development of a consistent approach for the provision and validation of uncertainties.
	KNMI
	- Coordinate WP progress
	- Assess user requirements for GEO-Ring CPP products
	- First preparations for nighttime CPP retrieval development based on neural network approach
	- Assess user requirements for cloud products in potential future CLAAS-5 dataset
	SMHI
	- Assess user requirements for GEO-Ring cloud mask and cloud top height products
	- Investigate ways of reducing differences and discontinuities in transition zones between GEO sensors
	- Re-train cloud mask and cloud top retrieval methods, either for individual GEOs or for SBAF-corrected data
	DWD
	- Contribute to user requirements for GEO-Ring dataset and product specifications
	RMIB
	- Assess user requirements for GEO-Ring TOA radiation products
	- Contribute to user requirements for latent/sensible heat (reference to GEO-Ring LEH v1.0 ATBD)

	MeteoSwiss
	- Contribute to user requirements for GEO-Ring dataset and product specifications
	(reference to GEO-Ring LandFlux v1.0 ATBD)
WP input	PRD
WP output/deliverables	RR document
	Updated PRD entries for (CM identifiers):
	CM-25012, CM-25022, CM-25032, CM-25042, CM-25052, CM-25062, CM-25302, CM-25332, CM-25201, CM-25261, CM-LSA-21001, CM-25812 CM-9012, CM-9022, CM-9032, CM-9042, CM-9052, CM-9062, CM-9302, CM-9332, CM-9201, CM-9261, LSA-CM-5001, CM-9812
WP Constraints and risks	
WP Dependencies	Interface with LSA SAF WP 1124 for LST, WP 6210, WP 5420
Interactions with other SAFs	LSA SAF, NWC SAF, CM SAF
Federated Activities	
Notes:	

Work Package Description Sheet		**CDOP-5**		**Issue / Revision No.:**		**2.0**	**Date:**	**20.03.2026**		
Programme		CM SAF								
WP Number		5420								
WP-Title		**CDR and ICDR GEO-Ring - PCR**								
WP Manager (WPM)		Jan Fokke Meirink								
Start of WP		1.01.2029								
End of WP		31.03.2030								
Start event		RR 5.7								
End event		PCR 5.7								
WP pm and cost breakdown										
Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	22			12	10			330,770		
FMI	0							0		
KNMI	14			7	7			271,418		
Meteo Swiss	6			5	1			95,004	5,000	
RMI	9.5			7.	2.5			124,355		
SMHI	14			9	5			231,336		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	65.5	0	0	40	25.5	0	0	1.052,883	5,000	0
overall total (EUR)										1,057,883
*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)									

** Description of other cost:	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)

WP description	CDR and ICDR GEO-Ring scientific algorithm developments, design and feedback loop – PCR 5.7
WP tasks	
	All:
	- Prepare PCR documents: ATBD, DGCDD
	- Evaluate feedback loop results
	- Organize, prepare and perform PCR review
	KNMI
	- Coordinate WP progress
	- Implement CPP algorithm updates following experiences with GEO-Ring demonstration dataset
	- Implement nighttime CPP retrievals based on a neural network approach
	SMHI
	- Extensive training of algorithms based on CALIPSO and EarthCARE data
	- Algorithm updates for cloud mask and cloud top height
	- Developing appropriate uncertainty measures for cloud mask and cloud top height
	- Start prototyping a COSP simulator for GEO-Ring datasets
	DWD
	- Algorithm updates for cloud phase
	Adaptation of the CLARA algorithm for surface irradiance
	- Implement and test the surface irradiance algorithm
	RMIB
	- Algorithm updates for TOA radiation
	- Test and implement existing LEH GEO-Ring v1.0 algorithm on new L1g data
	MeteoSwiss

	- GeoSatClim software updates to updated level 1g format
	- Synchronize CM SAF (Single Window) and LSA SAF (Split Window) LST retrieval
	- Implement LSA SAF Split Window LST retrieval in GeoSatClim
	- Test and evaluate various L2 to L3 compilations for LST and SDL
	- Contribute to PCR document (delta review, reference to LandFlux LST v2.0 algorithm/LSA SAF split window algorithm)
	IMPA (LSA SAF)
	- Provide broadband emissivity for LST and cloud retrieval (?)
	- Provide new LUTs for Split Window LST retrival
	- Provide homogensation functions to transfer CM SAF LST into LSA SAF LST
	- Test and evaluate single and split window LST retrieval on GEO-Ring
	DWD (Operations)
	- Provide development environment with control flow for processing chain for CDR and ICDR
	- Calculate feedback loops (for CDR and ICDR)
WP input	RR 5.7 document + PRD PPS version TBD from NWC SAF, TOA radiation processor, GeoSatClim GEO-Ring L1g data from EUMETSAT, ERA6, auxiliary and ancillary data
WP output/deliverables	ATBDs for entries (CM identifiers):
	CM-25012, CM-25022, CM-25032, CM-25042, CM-25052, CM-25062, CM-25302, CM-25332, CM-25201, , CM-25261, CM-LSA-21001, CM-25812 CM-9012, CM-9022, CM-9032, CM-9042, CM-9052, CM-9062, CM-9302, CM-9332, CM-9201, , CM-9261, LSA-CM-5001, CM-9812
	ATBDs, DGCDD, example files for all parameters
WP Constraints and risks	Timely availability of input data, incl. L1g from EUMETSAT
WP Dependencies	Interface with LSA SAF WP 1124 for LST. Interface with EUMETSAT for L1g data, WP 6210, WP 5430
Interactions with other SAFs	NWC SAF, LSA SAF
Federated Activities	
Notes:	

Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**20.03.2026**

Programme	CM SAF
WP Number	5430
WP-Title	**CDR and ICDR GEO-Ring - DRR/ORR**
WP Manager (WPM)	Jan Fokke Meirink
Start of WP	1.04.2030
End of WP	31.08.2031
Start event	PCR 5.7
End event	DRR 5.7 / ORR5.7

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	24				12	12		360.840	25,000	
FMI	2				1	1		31,540		
KNMI	14.5				4	9.5	1	281,112		
Meteo Swiss	4.5				2	2.5		71,253	2,500	
RMI	26				10.5	15.5		340,340	6,000	
SMHI	14				5	9		231,336		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	85	0	0	0	34.5	49.5	1	1,316,421	33,500	0
overall total (EUR)										1,349,921

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)

** Description of other cost:	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)

WP description	CDR and ICDR GEO-Ring data record generation and validation – DRR 5.7
	All:
	- Prepare DRR documents: PUM, ValRep and update ATBD, consistency report as needed
	- Organize, prepare and perform DRR and ORR review
	- Comparison to complementary parameters from CM SAF
	- Compare CDR and ICDR in absolute and anomaly space as needed
	KNMI
	- Coordinate WP progress
	- Validate GEO-Ring CPP products by comparison with independent satellite datasets: e.g.,
	CLARA-A4, MODIS/VIIRS, ISCCP-H, EarthCARE
	- Validate CPP products using in situ measurements from aircraft/campaigns
	- Assess complementarity between GEO-Ring and CLAAS-4 cloud products in preparation for potential CLAAS-5 data record
	SMHI
	- Validate GEO-Ring cloud mask and cloud top height
	- Finalise prototyping of a COSP simulator for GEO-Ring datasets
	DWD
	- General validation of GEO-Ring cloud and surface solar radiation products
	RMIB
	- Validation of GEO-Ring TOA radiation products radiation products RSF, RSFclearsky, OLR, OLRclearsky
	- Validation of GEO-Ring land flux products (latent heat, sensible heat, evapotranspiration)
	- Adaptation of the LEH code to handle the new GEO-Ring inputs.
	IMPA (LSA SAF)
	- Production of GEO-Ring NRT-ICDR LST
	- Validation of GEO-Ring LST (full review for ICDRs)

	Meteo Swiss
	- Validation of GEO-Ring LST and SDL (full review for CDRs)
	DWD (Operations)
	- Setup of CDR and ICDR processing chain
	- Calculate products
	- Prepare OPD and update DGCDD as needed
	- Archive products
WP input	PRD, PCR 5.7 documents: ATBDs, DGCDD most PPS version from NWC SAF, TOA radiation processor, LST processor, SH/LH flux processor GEO-Ring L1g data from EUMETSAT, ERA6, auxiliary and ancillary data, SARAH
WP output/deliverables	CDR+ICDR GEO-Ring data record including (CM identifiers):
	CM-25012, CM-25022, CM-25032, CM-25042, CM-25052, CM-25062, CM-25302, CM-25332, CM-25201, CM-25261, CM-LSA-21001, CM-25812 CM-9012, CM-9022, CM-9032, CM-9042, CM-9052, CM-9062, CM-9302, CM-9332, CM-9201, CM-9261, LSA-CM-5001, CM-9812
	Documents and Reports (updated ATBD + DGCCD + consistency report as needed; ValRep, PUM, OPD)
	Metadata fact sheet, DOI landing page, information material
	Report with Use case example of COSP simulator for GEO-Ring datasets
	Scientific papers
WP Constraints and Risks	Timely availability of input data, including L1g ICDR from EUMETSAT
WP Dependencies	Interface with LSA SAF WP 1124 for LST. Interface with EUMETSAT for L1g data, WP 6210.
Interactions with other SAFs	LSA SAF, NWC SAF
Federated Activities	
Notes:	

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Work Package Description Sheet	CDOP-5	Issue / Revision No.:	2.0	Date:	20.03.2026
Programme	CM SAF				
WP Number	5510				
WP-Title	**CDR + ICDR - SARAH 5 RR**				
WP Manager (WPM)	Jörg Trentmann				
Start of WP	1.03.2027				
End of WP	30.06.2028				
Start event	Kick-off CDOP-5				
End event	RR 5.4				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	7	4	3					105,245		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	0							0		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	7	4	3	0	0	0	0	105,245	0	0
overall total (EUR)										105,245

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)
WP description	CDR+ICDR SARAH-5 scientific evaluation, quality/feasibility studies and requirement definitions – RR 5.4
WP tasks	
	All:
	- Prepare RR document for CDR and ICDR
	- Organize, prepare and perform RR review
	DWD
	- assess emerging user requirements based on the release of SARAH-4

WP input	PRD
WP output/deliverables	RR document
	Updated PRD entries for (CM identifiers):
	CM-23085, CM-23205, CM-23295, CM-23275, CM-23255, CM-23285, CM-22202, CM-22282, CM-22292, CM-24202, CM-24282, CM-24292, CM-26202, CM-26282, CM-26292, CM-27202, CM-27282, CM-27292
WP Constraints and risks	
WP Dependencies	WP 5520
Interactions with other SAFs	
Federated Activities	
Notes:	

Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**20.03.2026**
Programme	CM SAF				
WP Number	5520				
WP-Title	**CDR and ICDR - SARAH 5 PCR**				
WP Manager (WPM)	Jörg Trentmann				
Start of WP	1.07.2028				
End of WP	29.02.2032				
Start event	RR 5.4				
End event	PCR 5.4				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	20		4	7	7	2		300,700		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	0							0		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	20	0	4	7	7	2	0	300,700	0	0
overall total (EUR)										300,700

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)
WP description	CDR+ICDR SARAH-5 scientific algorithm developments, design and feedback loop – PCR 5.4
WP tasks	
	All:
	- Prepare PCR documents: ATBD, DGCDD
	- Evaluate feedback loop results
	- Organize, prepare and perform PCR review
	DWD (Science)
	- Adapt algorithms to new or updated ancillary datasets (e.g., ERA6, aerosol data sets)
	- Assess the possibility to fulfill emerging user requirements
	- provide improved / extended data records based on user request, e.g. incl., potentially, uncertainty information, additonal ICDR, UV, SMM, "local daily"-averages

	- prepare the generation of the SARAH-5 data records based user feedback
	DWD (Operations)
	- Provide development environment with control flow for processing chain for CDR and ICDR
	- Calculate feedback loops (for CDR and ICDR)
WP input	RR 5.4 document + PRD; SARAH-4 software
WP output/deliverables	ATBDs for entries (CM identifiers):
	CM-23085, CM-23205, CM-23295, CM-23275, CM-23255, CM-23285, CM-22202, CM-22282, CM-22292, CM-24202, CM-24282, CM-24292, CM-26202, CM-26282, CM-26292, CM-27202, CM-27282, CM-27292
	DGCDD, example files for all parameters
WP Constraints and risks	Timely availability of input data; sufficient computing ressoures at EWC
WP Dependencies	Access to input
Interactions with other SAFs	
Federated Activities	
Notes:	

Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**20.03.2026**
Programme	CM SAF				
WP Number	5730				
WP-Title	**HOAPS 5 ICDR**				
WP Manager (WPM)	Hannes Konrad, DWD				
Start of WP	1.03.2027				
End of WP	29.02.2032				
Start event	Kick Off CDOP-5				
End event	ORR 5.1				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	30	5	6.5	6.5	5.5	5.5	1	451,050	25,000	
FMI	0							0		
KNMI	0							0		
Meteo Swiss	0							0		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	30	5	6.5	6.5	5.5	5.5	1	451,050	25,000	0
overall total (EUR)										476,050
*** Description of procurement cost:**										
**** Description of other cost:**										

WP description	HOAPS 5 ICDR
	DWD:
	- adjust HOAPS (RTTOV/1D-VAR) algorithm for AMSR-3
	- develop sensor-specific RTTOV bias correction for AMSR-3
	- Organise ORR 5.1 and draft associated documents
	- Validation of ICDR
	- implement EPS-SG MWI once intercalibration (WP 4400) is complete; a second ORR can be organised aiming at the release of an updated version with MWI adding to the constellation
	- Collocate HOAPS and OSI SAF radiometer wind data with each other and potentially with scatterometer data and NWP stress-equivalent winds
	- Assess Quality Control issues in all-weather radiometer wind retrievals.

	- Organise half-yearly (online) meetings between key people on OSI SAF and CM SAF side, to exchange ideas, discuss progress and keep each other informed on the latest developments.
	- draft a report on consistency between 1d-var based wind speed in OSI SAF NRT and CM SAF CDR data streams
	- test high-resolution variant for European seas based on AMSRs and potentially GMI
	- user support HTW (CM-12703, CM-6420) for sea-level monitoring: dedicated analyses towards an improved uncertainty characterisation
	DWD (Operations)
	- Setup of CDR and ICDR processing chain
	- Calculate products
	- Prepare OPD and update DGCDD as needed
	- Archive products
WP input	PRD, PCR 3.4 documents: ATBD, DGCDD, DRR 3.4 / 4.10 documents PUM, ValRep JAXA AMSR-2 and AMSR-3 L1, EUMETSAT EPS-SG MWI L1, NASA GPM GMI L1, ESA/C3S sea surface temperature CDR and datasets for validation software for HOAPS 5 CDR generation
WP output/deliverables	HOAPS 5 ICDR data record:
	CM-6410, CM-6420, CM-6430, CM-6440, CM-6450, CM-6460, CM-6470
	Documents and Reports (updated RR document, ATBD, DGCCD); initial version of OPD
	Metadata fact sheet, DOI landing page, information material
	Mutual OSI/CM SAF report on consistency of wind speed retrievals
	Scientific papers
WP Constraints and Risks	Availability of satellite input data and auxiliary data (SST) Incompatibility of EPS-SG MWI 31 GHz channels with heritage 36/37 GHz channels
WP Dependencies	WP 4400, WP 5830, WP 3100, WP 3200, WP 2400 (blended windspeed dataset)
Interactions with other SAFs	OSI SAF
Federated Activities	
Notes:	will not rely on new FCDR version developed during CDOP-5

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Work Package Description Sheet	CDOP-5	Issue / Revision No.:	2.0	Date:	16.03.2026
Programme	CM SAF				
WP Number	5830				
WP-Title	**SSM/I and SSMIS FCDR Edition 6.0 - DRR**				
WP Manager (WPM)	Hannes Konrad, DWD				
Start of WP	01.03.2027				
End of WP	29.02.2032				
Start event	Kick-Off CDOP-5				
End event	Close Out CDOP-5				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DW	9	5	2	0.5	0.5	0.5	0.5	135,315	25,000	
FMI	0							0		
KNMI	0							0		
Meteo Swiss	0							0		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	9	5	2	0.5	0.5	0.5	0.5	135,315	25,000	0
overall total (EUR)										160,315

*** Description of procurement cost:**	
**** Description of other cost:**	
WP description	SSM/I and SSMIS FCDR data record generation and validation – DRR 5.1 / Support to user uptake at ECMWF and OSI SAF
	DWD:
	Develop and implement processing chain applicable to the full period
	Inter-calibration of SSM/I and SSMIS by applying the CM SAF heritage inter-calibration software which relies on scene radiances
	Remapping of footprints
	Process SSM/I and SSMIS FCDR using heritage CM SAF software
	Perform evaluation through inter-sensor comparison and comparisons to reanalysis ERA-5
	integrate EUMETSAT results for SMMR and SSMIS UAS channels (if requested, optional)

	Prepare PUM and Validation Report
	Organize and participate in DRR 5.1
	Provide support to EUMETSAT Secretariat in their design of optimal remapping for ECMWF and OSI SAF applications
	DWD (Operations)
	Archive FCDR data files
WP input	PRD, PCR 4.1 and DRR 4.1 documents: ATBDs DGCDD, PUM, Validation Report SSMIS raw data from NOAA-CLASS/CSU, documents from precursor version, software from precursor version, climate reanalysis for comparison
WP output/deliverables	SSM/I and SSMIS FCDR (CM-12006)
	Documents and Reports (updated ATBD + DGCCD as needed; ValRep, PUM)
	Metadata fact sheet, DOI landing page, information material
WP Constraints and Risks	Timely availability of input data
WP Dependencies	WP 5730, WP 5220
Interactions with other SAFs	OSI SAF
Federated Activities	
Notes:	

Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**20.03.2026**

Programme	CM SAF
WP Number	5930
WP-Title	**GIRAFE v1.1 - DRR**
WP Manager (WPM)	Hannes Konrad, DWD
Start of WP	1.03.2027
End of WP	31.12.2027
Start event	Kick Off CDOP-5
End event	DRR 5.9 / ORR5.9

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	12	12						180,420		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	0							0		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	12	12	0	0	0	0	0	180,420	0	0
overall total (EUR)										180,420

*** Description of procurement cost:**	
**** Description of other cost:**	

WP description	GIRAFE v1.1 data record generation and validation – DRR 5.9
	DWD:
	- implement gap filling in MW L2-only mode
	- integrate HOAPS AMSR-2 L2 data in processing chain
	- adjust training of Geo IR for precipitation fraction to larger environments in the case of zero precipitation
	- adjust modules of the processing chain for an improved latency
	- Prepare DRR documents: PUM, ValRep and update ATBD with the above innovations
	- Organize, prepare and perform DRR and ORR review
	- Compare CDR and ICDR in absolute and anomaly space as needed

	- Validate CDR by comparing to GIRAFE v1 CDR and showcasing the improvements
	DWD (Operations)
	- Update of GIRAFE v1 CDR and ICDR processing chain
	- Calculate products (CDR part, ICDR part in WP 3120)
	- Update OPD and DGCDD as needed
	- Archive products (CDR part, ICDR part in WP 3120)
WP input	PRD; PCR 3.5 documents: ATBD, DGCDD; DRR 3.5 documents: PUM, ValRep; ORR 4.4 document: OPD MW satellite radiances from JAXA and NASA PPS (GMI, AMSR-2, MHS, ATMS); Geo-Ring IR radiances from EUMETSAT, NOAA, JAXA; climate reanalysis from ECMWF; sea surface temperature (I)CDR from C3S; sea ice concentration from CMEMS
WP output/deliverables	GIRAFE v1.1 CDR and ICDR data record including:
	CM-25613, CM-7612
	Documents and Reports (updated ATBD+DGCCD as needed; ValRep, PUM, OPD)
	Metadata fact sheet, DOI landing page, information material
WP Constraints and Risks	Timely availability of input data; GPM-GMI, GCOM-W1-AMSR2, and MetOp-B MHS approaching the end of their lifetimes; SSMIS will probably be discontinued at the time; remaining observing system (MetOp-C MHS and ATMS platforms) has reduced sampling capabilities
WP Dependencies	WP 4400, WP 5200, WP 5730
Interactions with other SAFs	H SAF, NWC SAF
Federated Activities	
Notes:	Interactions with other SAFs expected more for GIRAFE v2 (WP 5200)

Work Package Description Sheet	CDOP-5	Issue / Revision No.:	2.0	Date:	20.03.2026
Programme	CM SAF				
WP Number	6100				
WP-Title	**CDR Land Flux update v1.1 (LE/H)- DRR**				
WP Manager (WPM)	William Moutier				
Start of WP	1.03.2027				
End of WP	31.12.2028				
Start event					
End event	DRR 5.10				
WP pm and cost breakdown					

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	0.5		0.5					7,518		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	1.5		1.5					23,751		
RMI	6	3	3					78,540		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	8	3	5	0	0	0	0	109,809	0	0
overall total (EUR)										109,809

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)

WP description	CDR Land Flux data record generation and validation (LE/H) – DRR 5.10
	All:
	- Prepare DRR documents: ValRep (update ATBD and PUM if needed).
	- Organize, prepare and perform DRR review
	RMIB
	- Validation of updated LE/H (ET) products
	- Production and validation of latent and sensible heat flux products
	- Assess the consistency with LSA SAF LE/H outputs
	Meteo Swiss
	- Albedo product expert and advisor role.
	DWD (Operations)
	- Ensure metadata and file format compliance.
	- Archive products
WP input	PRD, PCR 3.9 documents: ATBDs, DGCDD. L2 data from CM-23271.
WP output/deliverables	CDR Land Flux data record including (CM identifiers):
	CM-**23811**
	Documents and Reports (updated ATBD, updated ValRep, PUM)
	Metadata fact sheet, DOI landing page, information material
WP Constraints and Risks	Ensure consistency with LSA SAF.
WP Dependencies	
Interactions with other SAFs	LSA SAF
Federated Activities	
Notes:	

Work Package Description Sheet		**CDOP-5**		**Issue / Revision No.:**		**2.0**	**Date:**	**20.03.2026**		
Programme		CM SAF								
WP Number		6210								
WP-Title		**Geo-ring LST - In coordination with LSA SAF**								
WP Manager (WPM)		Anke Tezlaff								
Start of WP		1.03.2027								
End of WP		29.02.2032								
Start event		Kick Off CDOP-5								
End event		End of CDOP-5								
WP pm and cost breakdown										
Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	0	0						0		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	10	2	2	2	2	2		158,340		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	10	2	2	2	2	2		158,340		0
overall total (EUR)										158,340
*** Description of procurement cost:**										
**** Description of other cost:**										
WP description		Development and Validation of GEO-ring LST CDR/ICDR in coordination with the LSA SAF (CM-LSA-21001, LSA-CM-5001)								
		LSA SAF: - Provide broadband emissivity for LST for GEO-ring instruments (SEVIRI, FCI, ABI, AHI) - Adjust split-window algorithm coefficients (following experience in CGLS) - Harmonise CM SAF and LSA SAF products for GEO-ring observations, taking into account the CDR/ICDR overlapping period to ensure fully consistency of the two (with CM SAF support) A first protype of the harmonized CM – LSA SAF LST products will be provided for Europe (i.e., MSG only). - Test and evaluate single and split window LST retrieval on GEO-ring level 1g (with support from CM SAF) - Validation of GEO-Ring LST (hourly, 0.05º) ICDR - Provide code for NRT processing in the LSA SAF NRT chain, including the preparation of needed input data to ensure ICDR latency < 1day - Contribute to documentation (ATBD, VR, PUM)								

	CM SAF – see corresponding CM SAF WPs: - Synchronize CM SAF (Single Window) and LSA SAF (Split Window) LST retrieval - Implement LSA SAF Split Window LST retrieval in GeoSatClim - Production and validation of GEO-Ring LST CDR (hourly, 0.05º) - Contribute to documentation (ATBD, VR, PUM) Link to other programmes (CMLS) Copernicus Land Monitoring Land Service (CLMS) is operating a geostationary (georing) LST product, which uses the LSA SAF NRT MSG LST (LSA-004) as input. Considering CLMS may benefit directly from the outcome of this WP, we will seek close coordination with this service by: - Involving CLMS manager/project officer (e.g., HYGEOS, JRC) in RR and ORR/DRR, ensuring at least 1 review board member represents/covers CLMS needs. - Liaise with CLMS while implementing the tasks described above. This will be mostly done by IPMA, given its role as service provider of the CLMS geostationary LST.
WP input	CM-LSA-21001, LSA-CM-5001
WP output/deliverables	Contribute to code package (LST & Emissivity & LST harmonization coefficients) CM-LSA-21001 & LSA-CM-5001 documentation (ATBD, VR, PUM)
WP Constraints and Risks	Timely availability of input data, including L1g ICDR from EUMETSAT
WP Dependencies	Interface with LSA SAF WP 1124 for LST. Interface with EUMETSAT for L1g data.
Interactions with other SAFs	LSA SAF
Federated Activities	
Notes:	

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Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**20.03.2026**

Programme	CM SAF
WP Number	7010
WP-Title	**Normals and anomalies - Regional Surface Radiation (SARAH-4)**
WP Manager (WPM)	Jörg Trentmann
Start of WP	1.03.2027
End of WP	29.02.2032
Start event	Kick-Off (SARAH-4), RR 5.4 / PCR 5.4 (SARAH-5)
End event	DRR 5.3, ORR 5.3

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	7	2.5	4.5					105,245		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	0							0		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	7	2.5	4.5	0	0	0	0	105,245	0	0
overall total (EUR)										105,245

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)

WP description	Normals and anomalies - Regional Surface Radiation (SARAH-4): requirement analysis, development, generation and validation
	All:
	- Carry out validation of normals and anomalies
	- Assess consistency with (other) CM SAF data and a subset of CAN data from other SAFs if physical dependence is given

	- Implement minor updates of normals and anomalies following recommendations from Task Team on Climate Anomalies and Normal (TT-CAN)
	- Prepare DRR documents: update ATBD and consistency report if needed and update PUM, ValRep
	- Organize, prepare and perform DRR and ORR review
	DWD (Operations)
	- Adaptation/extension of normal and anomaly processing chain
	- Adaptation/extension of operational quality control software
	- Calculate products (Normal and anomaly for CDR part, anomalies ICDR task in WP 3130)
	- Carry out (operational) quality control
	- Update OPD and DGCDD
	- Archive products
WP input	SARAH-4 CDR and ICDR, reference data and data records for comparison Documents related to CM SAF input data (DGCDD, OPD), normal and anomaly documents (RR, ATBD, PUM, ValRep), consistency report, PRD Existing software to generate normals and anomalies and to carry out quality control Output from TT-CAN, user statistics from EUMETSAT CAN service
WP output/deliverables	
	CM-83204, CM-83284, CM-8212, CM-8282
	Documents and Reports (updated DGCDD, OPD, RR, ATBD, PUM, ValRep, consistency report)
WP Constraints and Risks	Timely availability of input data, stability of observing system
WP Dependencies	Availability of input data
Interactions with other SAFs	various SAFs through the TT-CAN
Federated Activities	
Notes:	

Work Package Description Sheet	**CDOP-5**	**Issue / Revision No.:**	**2.0**	**Date:**	**20.03.2026**
Programme	CM SAF				
WP Number	7020				
WP-Title	**Normals and anomalies - Global clouds and radiation**				
WP Manager (WPM)	Salomon Eliasson				
Start of WP	01.03.2027				
End of WP	29.02.2032				
Start event	Kick-Off (CLARA-A3.5), RR 5.2 (CLARA-A4)				
End event	DRR 5.8 / ORR 5.8 (CLARA-A3.5), DRR 5.2 / ORR 5.2 (CLARA-A4)				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	5		2	1	1	1		75,175		
FMI	5	1	1	1	1	1		78,850		
KNMI	0							0		
Meteo Swiss	0							0		
RMI	4	1	1			1	1	52,360		
SMHI	4	0.8	0.8	0.8	0.8	0.8		66,096		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	18	2.8	4.8	2.8	2.8	3.8	1	272,481	0	0
overall total (EUR)										272,481

*** Description of procurement cost:**	Specification of procurement cost (procurement under art 410 (hardware/software)) per partner (if applicable)
**** Description of other cost:**	Specification of other costs per partner (e.g., travel, publications, conferences, etc., if applicable)
WP description	Normals and anomalies - Global clouds and radiation (CLARA-A3.5, CLARA-A4): requirement analysis, development, generation and validation
	All:
	- Carry out validation of normal (maps of bias) and anomalies (time series of anomaly differences and maps of mean absolute anomaly differences) using either reference data or data records with full coverage of CLARA; compare healpix version with version on regular longitude/latitude version
	- Assess consistency by analysing anomaly time series of dependent variables and provide anomaly correlation (and time series) and maps of anomaly correlation using CM SAF data and a subset of CAN data from other SAFs if physical dependence is given; discuss reasons for observed features

	- Implement minor updates of normals and anomalies following recommendations from Task Team on Climate Anomalies and Normal (TT-CAN)
	All (CLARA-A3.5 DRR/ORR only - Depending on status of CLARA-A3.5 at CDOP-5 start)
	- Prepare DRR documents: update ATBD and consistency report if needed and update PUM, ValRep
	- Organize, prepare and perform DRR and ORR review
	All (CLARA-A4)
	- Prepare RR, PCR, DRR documents: update ATBD and consistency report if needed and update RR, PUM, ValRep
	- Support RR, PCR, DRR and ORR review
	DWD (Operations)
	- Adaptation/extension of normal and anomaly processing chain
	- Adaptation/extension of operational quality control software
	- Calculate products (Normal and anomaly for CDR part, anomalies ICDR task in WP 3130)
	- Carry out (operational) quality control
	- Update OPD and DGCDD
	- Archive products
WP input	CLARA-A3.5 and CLARA-A4 CDR and ICDR, reference data and data records for comparison Documents related to CM SAF input data (DGCDD, OPD), normal and anomaly documents (RR, ATBD, PUM, ValRep), consistency report, PRD Existing software to generate normals and anomalies and to carry out quality control Output from TT-CAN, user statistics from EUMETSAT CAN service
WP output/deliverables	Normals and anomalies from CLARA-A3.5 and CLARA-A4 data records
	CLARA-A3.5: CM-81013, CM-81203, CM-81226, CM-81313, CM-4012, CM-4212, CM-4221, CM-4322
	CLARA-A4: CM-81014, CM-81204, CM-81229, CM-81314, CM-4013, CM-4213, CM-4222, CM-4323
	Metadata fact sheet, DOI landing page, information material
	Scientific papers
WP Constraints and Risks	Timely availability of input data, stability of observing system
WP Dependencies	Availability of input data
Interactions with other SAFs	various SAFs through the TT-CAN
Federated Activities	
Notes:	

Work Package Description Sheet			**CDOP-5**		**Issue / Revision No.:**		**2.0**	**Date:**	**20.03.2026**	
Programme			CM SAF							
WP Number			7030							
WP-Title			**Normals and anomalies - Global precipitation (GIRAFE v1.1, v2)**							
WP Manager (WPM)			Hannes Konrad, DWD							
Start of WP			1.03.2027							
End of WP			29.02.2032							
Start event			DRR 5.9 / ORR 5.9							
End event			DRR 5.5 / ORR 5.5							
WP pm and cost breakdown										
Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	8	4.5				3.5		120,280		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	0							0		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	8	4.5	0	0	0	3.5	0	120,280	0	0
overall total (EUR)										120,280
*** Description of procurement cost:**										
**** Description of other cost:**										
WP description			Normals and anomalies - Global precipitation (GIRAFE v1.1, v2): requirement analysis, development, generation and validation							
			DWD:							
			- Carry out validation of normal (maps of bias) and anomalies (time series of anomaly differences and maps of mean absolute anomaly differences) using either reference data or data records with full coverage of GIRAFE v1.1/v2; compare healpix version with version on regular longitude/latitude version							
			- Assess consistency by analysing anomaly time series of dependent variables and provide anomaly correlation (and time series) and maps of anomaly correlation using CM SAF data and a subset of CAN data from other SAFs if physical dependence is given; discuss reasons for observed features							
			- Implement minor updates of normals and anomalies following recommendations from Task Team on Climate Anomalies and Normal (TT-CAN)							

	- reference datasets for validation can comprise latest versions of GPCC, GPCP or ERA5
	DWD (v1.1):
	- Prepare DRR documents: update ATBD and consistency report if needed and update PUM, ValRep
	- Organize, prepare and perform DRR and ORR review
	DWD (v2):
	- Prepare PCR, DRR documents: update ATBD and consistency report if needed and update RR, PUM, ValRep
	- Support PCR, DRR and ORR review
	DWD (Operations)
	- Adaptation/extension of normal and anomaly processing chain
	- Adaptation/extension of operational quality control software
	- Calculate products (Normal and anomaly for CDR part, anomalies ICDR task in WP 3130)
	- Carry out (operational) quality control
	- Update OPD and DGCDD
	- Archive products
WP input	GIRAFE v1.1/v2 CDR and ICDR, reference data and data records for comparison Documents related to CM SAF input data (DGCDD, OPD), normal and anomaly documents (RR, ATBD, PUM, ValRep), consistency report, PRD Existing software to generate normals and anomalies and to carry out quality control Output from TT-CAN, user statistics from EUMETSAT CAN service
WP output/deliverables	Normals and anomalies from GIRAFE v1.1 and v2 data record including (CM identifiers):
	CM-85613, CM-8612 (v1.1) CM-85612, CM-8611 (v2)
	Documents and Reports (updated DGCDD, OPD, RR, ATBD, PUM, ValRep, consistency report)
	Metadata fact sheet, DOI landing page, information material
	Scientific papers
WP Constraints and Risks	Timely availability of input data, stability of observing system
WP Dependencies	WP 5930, WP 5200
Interactions with other SAFs	various SAFs through the TT-CAN
Federated Activities	
Notes:	

Work Package Description Sheet	CDOP-5	Issue / Revision No.:	2.0	Date:	20.03.2026
Programme	CM SAF				
WP Number	7040				
WP-Title	**Normals and anomalies – High resolution Europe (HANNA)**				
WP Manager (WPM)	Nathalie Selbach				
Start of WP	1.03.2027				
End of WP	31.03.2031				
Start event	RR 5.6				
End event	ORR 5.6				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	1					1		15,035		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	3					3		47,502		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	4	0	0	0	0	4	0	62,537	0	0
overall total (EUR)										62,537

*** Description of procurement cost:**	
**** Description of other cost:**	
WP description	Normals and anomalies High resolution Europe (HANNA): requirement analysis, development, generation and validation
	All:
	- Implement minor updates of normals and anomalies following recommendations from Task Team on Climate Anomalies and Normal (TT-CAN)

	MeteoSwiss and RMIB
	- Prepare DRR documents: update ATBD and consistency report if needed and update PUM, ValRep
	- Carry out validation of normal (maps of bias) and anomalies (time series of anomaly differences and maps of mean absolute anomaly differences) using ground-based temperature anomalies and normal in Europe (UK Hadley Centre data, MeteoSwiss) and/or reference data or data records with full coverage of HANNA ET data (RMIB); compare healpix version with version on regular longitude/latitude version;
	- Assess consistency by analysing anomaly time series of dependent variables and provide anomaly correlation (and time series) and maps of anomaly correlation using CM SAF data and a subset of CAN data from other SAFs if physical dependence is given; discuss reasons for observed feature
	DWD (Science)
	- Organise, prepare and perform DRR and ORR review
	DWD (Operations)
	- Adaptation/extension of normal and anomaly processing chain
	- Adaptation/extension of operational quality control software
	- Calculate products (Normal and anomaly for CDR part, anomalies ICDR task in WP 3130)
	- Carry out (operational) quality control
	- Update OPD and DGCDD
	- Archive products
WP input	HANNA CDR and ICDR, LANDFLUX CDR, reference data and data records for comparison Documents related to CM SAF input data (DGCDD, OPD), normal and anomaly documents (RR, ATBD, PUM, ValRep), consistency report, PRD Existing software to generate normals and anomalies and to carry out quality control Output from TT-CAN, user statistics from EUMETSAT CAN service
WP output/deliverables	Normals and anomalies from HANNA data record including:
	CM-88921, CM-88811 CM-3921, CM-8811
	Documents and Reports (updated DGCDD, OPD, RR, ATBD, PUM, ValRep, consistency report)
	Metadata fact sheet, DOI landing page, information material
	Scientific papers
WP Constraints and Risks	Timely availability of input data, stability of observing system
WP Dependencies	Availability of input data
Interactions with other SAFs	various SAFs through the TT-CAN
Federated Activities	
Notes:	

Work Package Descrition Sheet	CDOP 5	Issue / Revision No.:	2.0	Date:	20.03.2026
Programme	CM SAF				
WP Number	7050				
WP-Title	Normals and anomalies - LANDFLUX Land Surface Temperature				
WP Manager (WPM)	Nathalie Selbach				
Start of WP	01.03.2027				
End of WP	31.08.2030				
Start event	KickOff CDOP-5				
End event	DRR 5.11 / ORR 5.11				

WP pm and cost breakdown

Institute	Total pm	2027	2028	2029	2030	2031	2032	pm cost (EUR)	procurement costs (EUR) *	other cost (EUR) **
DWD	1	0,5	0,5					15,035		
FMI	0							0		
KNMI	0							0		
Meteo Swiss	1.4	1	0.4					22,735		
RMI	0							0		
SMHI	0							0		
UKMO (sci)	0							0		
UKMO (mngt)	0							0		
Sum	2.4	1	0.4	0	0	0	0	37,770	0	0
overall total (EUR)										37,770
*** Description of procurement cost:**										
**** Description of other cost:**										

WP description	Normal and anomalies CM SAF LandFlux & LSA SAF LST Land Surface Temperature requirement analysis, development, generation and validation
	All: - - Implement minor updates of normals and anomalies following recommendations from Task Team on Climate Anomalies and Normal (TT-CAN) - - - Implement minor updates of normal and anomalies following recommendations from Task Team on Climate Anomalies and Normal (TT-CAN) -

	MeteoSwiss: - Prepare DRR documents: update ATBD and consistency report if needed and update PUM, ValRep - - Carry out validation of normal (maps of bias) and anomalies (time series of anomaly differences and maps of mean absolute anomaly differences) using ground-based temperature anomalies and normal in Europe (UK Hadley Centre data, MeteoSwiss); compare healpix version with version on regular longitude/latitude version;- - Assess consistency by analysing anomaly time series of dependent variables and provide anomaly correlation (and time series) and maps of anomaly correlation using CM SAF data and a subset of CAN data from other SAFs if physical dependence is given; discuss reasons for observed feature - Implement transfer function from LSA SAF into CM SAF LST (see also joint CM SAF - LSA SAF WP 6210) **DWD (Science)** - Organise, prepare and perform DRR and ORR review **DWD (Operations)** - Adaptation/extension of normal and anomaly processing chain - Adaptation/extension of operational quality control software - Calculate products (Normal and anomaly for CDR part, anomalies ICDR task in WP 3130) - Carry out (operational) quality control - Update OPD and DGCDD - Archive products
WP input	LSA SAF LST, LANDFLUX CDR, reference data and data records for comparison Documents related to CM SAF input data (DGCDD, OPD), normal and anomaly documents (RR, ATBD, PUM, ValRep), consistency report, PRD Existing software to generate normal and anomalies and to carry out quality control Output from TT-CAN, user statistics from EUMETSAT CAN service
WP output/deliverables	Normal and anomalies from LandFlux data record including CM-8921, CM-83922 Documents and Reports (updated DGCDD, OPD, RR, ATBD, PUM, ValRep, consistency report) Metadata fact sheet, DOI landing page, information material Potentially: Scientific papers
WP Constraints and Risks	Timely availability of input data, stability of observing system
WP Dependencies	Availability of input data
Interactions with other SAFs **Federated Activities**	Various SAFs through the TT-CAN, LSA SAF on near-realtime LST
Notes:	

Annex III CM SAF Master Schedule for CDOP-5

ID	Date	Event / milestone	Description / Deliverable	Dependency in	Dependency out	WP references	PRD references	Comments
CM_CDOP5_MS_01	Q1 2027	Kick-off	CDOP-5 Project Plan and other baseline documents.	Project Plan and other baseline documents.		n/a		Payment milestone
CM_CDOP5_MS_02	Q2 2027	DRR 5.11/ ORR 5.11	Review board report	LSA SAF RT		WP 7050	CM-8921, CM-83922	
CM_CDOP5_MS_03	Q2 2027	OR-2027	review board report	Annual Quality Assessment Report (AQA) Operations Report		WP 1200 WP 1300		
CM_CDOP5_MS_04	Q2 2027	Bilateral coordination meeting with Sec.	report			WP 1100, WP 1200, WP 1300		
CM_CDOP5_MS_05	Q3 2027		First overarching Jupyter notebooks, "how-to"-clips			WP 2200		
CM_CDOP5_MS_06	Q3 2027	Data release	Jupyter Notebook for LST normal/anomaly	DRR 5.11 / ORR5.11		WP 2200	CM-8921, CM-83922	
CM_CDOP5_MS_07	Q3 2027	Submission to EUM Sec.	operations report 2027/1			WP 1300		
CM_CDOP5_MS_08	Q3 2027	1. Expert / thematic Workshop	Workshop report			WP 2300		
CM_CDOP5_MS_09	Q4 2027		Online training course			WP 2200		
CM_CDOP5_MS_10	Q4 2027	DRR 5.9 / ORR5.9	review board report			WP 5930	CM-25613, CM-7612	
2028								

ID	Date	Event / milestone	Description / Deliverable	Dependency in	Dependency out	WP references	PRD references	Comments
CM_CDOP5_MS_11	Q1 2028	Data release	Jupyter Notebook for GIRAFE v1.1	DRR 5.9 / ORR5.9		WP 2200	CM-25613, CM-7612	
CM_CDOP5_MS_12	Q1 2028	Submission to EUM Sec.	operations report 2027/2			WP 1300		
CM_CDOP5_MS_13	Q1 2028		Report on feasibility of producing CM SAF product based on merged Geo and Leo measurements			WP 4100		
CM_CDOP5_MS_14	Q1 2028	2. Expert / thematic Workshop	Workshop report			WP 2300		
CM_CDOP5_MS_15	Q1 2028	DRR 5.8 / ORR 5.8	review board report			WP 7020	CM-81013, CM-81203 CM-81226, CM-81313, CM-4012, CM-4212 CM-4226, CM-4322	
CM_CDOP5_MS_16	Q1 2028	RR 5.5	Review board report	H SAF		WP 5210	CM-85612, CM-8611 CM-25612, CM-7611	Joint WP with H SAF
CM_CDOP5_MS_17	Q2 2028	Data release	Jupyter Notebooks for GIRAFE v1.1 NAC products	DRR 5.8 / ORR 5.8		WP 2200	CM-85613, CM-8612 CM-25612, CM-7611	
CM_CDOP5_MS_18	Q1 2028	RR 5.2	review board report			WP 5110	CM-11014, CM-11024, CM-11034, CM-11044, CM-11054, CM-11064, CM-11204, CM-11229, CM-11230, CM-11231, CM-11264, CM-11274, CM-11314, CM-11344, CM-6013, CM-6023, CM-6033, CM-6043, CM-6053, CM-6063, CM-6213, CM-6222, CM-6224, CM-6225, CM-6263, CM-6273, CM-6283, CM-6293, CM-6323, CM-6333 CM-81014, CM-81204, CM-81229, CM-81314, CM-4013, CM-4213, CM-4229, CM-4323	

ID	Date	Event / milestone	Description / Deliverable	Dependency in	Dependency out	WP references	PRD references	Comments
CM_CDOP5_MS_19	Q2 2028	Bilateral coordination meeting with Sec.	Report			WP 1100, WP 1200, WP 1300		
CM_CDOP5_MS_20	Q2 2028	OR-2028	review board report	AQA Operations Report		WP 1200 WP 1300		
CM_CDOP5_MS_21	Q2 2028	RR 5.4	review board report			WP 5510	CM-23085, CM-23205, CM-23295, CM-23275, CM-23255, CM-23285, CM-22202, CM-22282, CM-22292, CM-24202, CM-24282, CM-24292, CM-26202, CM-26282, CM-26292, CM-27202, CM-27282, CM-27292 CM-5083, CM-5213, CM-5293, CM-5283, CM-5273 CM-83205, CM-83294, CM-83285, CM-8213, CM-8293, CM-8283	
CM_CDOP5_MS_22	Q2 2028	RR 5.6	review board report			WP 5310	CM-38201, CM-38291, CM-38221, CM-38281, CM-38271, CM-38811, CM-38921 CM-7201, CM-7291, CM-7221, CM-7281, CM-7261, CM-7811, CM-7921, CM-7271	
CM_CDOP5_MS_23	Q2 2028		report to GDAP on G-VAP and P assessment			WP 4300		
CM_CDOP5_MS_24	Q3 2028	RR 5.7	review board report			WP 5410	CM-25012, CM-25022, CM-25032, CM-25042, CM-25052, CM-25062, CM-25302, CM-25332, CM-25201 , CM-25261, CM-LSA-21001, CM-25812	

ID	Date	Event / milestone	Description / Deliverable	Dependency in	Dependency out	WP references	PRD references	Comments
							CM-9012, CM-9022, CM-9032, CM-9042, CM-9052, CM-9062, CM-9302, CM-9332, CM-9201, , CM-9261, LSA-CM-5001, CM-9812	
CM_CDOP5_MS_25	Q3 2028		Report, detailing the concept for a consistent NRT and CDR high-resolution precipitation product for Europe					
CM_CDOP5_MS_26	Q3 2028	PMR-2028	review board report			WP 1100		Payment milestone
CM_CDOP5_MS_27	Q3 2028	DRR 5.3 /ORR 5.3	review board report			WP 7010	CM-83204, CM-83284, CM-8212, CM-8282	
CM_CDOP5_MS_28	Q3 2028	Submission to EUM Sec.	operations report 2028/1			WP 1300		
CM_CDOP5_MS_29	Q3 2028	Midterm Review Meeting	review board report			WP 1100, WP 1200, WP 1300		
CM_CDOP5_MS_30	Q4/2028	Data release	Jupyter Notebook for NAC Products from SARAH-4	DRR 5.3 / ORR 5.3		WP 2200	CM-83204, CM-83284, CM-8212, CM-8282	
CM_CDOP5_MS_31	Q4 2028	DRR 5.1	review board report			WP 5830	CM-12006	
CM_CDOP5_MS_32	Q4 2028		Report about FCDR support			WP 4500		
CM_CDOP5_MS_33	Q4 2028	DRR 5.10	review board report			WP 6100	CM-23811	
2029								
CM_CDOP5_MS_34	Q1/2029	Data release	Jupyter Notebook for FCDR	DRR 5.10		WP 2200	CM-23811	
CM_CDOP5_MS_35	Q1 2029	Submission to EUM Sec.	operations report 2028/2			WP 1300		
CM_CDOP5_MS_36	Q1 2029		Report UC1: Showcasing the use of the new CLAAS-4 TOA radiation field for model evaluation.			WP 2400		

ID	Date	Event / milestone	Description / Deliverable	Dependency in	Dependency out	WP references	PRD references	Comments
CM_CDOP5_MS_37	Q1 2029		UC4: News or highlight story on the CM SAF webpage			WP 2400		
CM_CDOP5_MS_38	Q1 2029	DRR 5.8 / ORR 5.8	review board report			WP 7020	CM-81013, CM-81203, CM-81226, CM-81313, CM-4012, CM-4212, CM-4221, CM-4322	
CM_CDOP5_MS_39	Q2/2029	Data release	Jupyter Notebooks for NAC from CLARA-A3.5	DRR 5.8 / ORR 5.8		WP 2200	CM-81013, CM-81203, CM-81226, CM-81313, CM-4012, CM-4212, CM-4221, CM-4322	
CM_CDOP5_MS_40	Q2 2029		Promotional material			WP 2200		
CM_CDOP5_MS_41	Q2 2029	OR-2029	AQA Operations Report RB report			WP 1200 WP 1300		
CM_CDOP5_MS_42	Q2 2029	Bilateral coordination meeting with Sec.	report					
CM_CDOP5_MS_43	Q2 2029		report to GDAP on G-VAP and P assessment			WP 4300		
CM_CDOP5_MS_44	Q2 2029	CM SAF User Workshop	Report					
CM_CDOP5_MS_45	Q3 2029	Submission to EUM Sec.	operations report 2029/1			WP 1300		
CM_CDOP5_MS_46	Q3 2029	PMR-2029	RB report			WP 1100		Payment milestone
CM_CDOP5_MS_47	Q3 2029	PCR 5.2	review board report			WP 5120	CM-11014, CM-11024, CM-11034, CM-11044, CM-11054, CM-11064, CM-11204, CM-11229, CM-11230, CM-11231, CM-11264, CM-11274, CM-11314, CM-11344, CM-6013, CM-6023, CM-6033, CM-6043, CM-6053, CM-6063, CM-6213, CM-6222, CM-6224, CM-6225, CM-6263, CM-6273,	

ID	Date	Event / milestone	Description / Deliverable	Dependency in	Dependency out	WP references	PRD references	Comments
							CM-6283, CM-6293, CM-6323, CM-6333 CM-81014, CM-81204, CM-81229, CM-81314, CM-4013, CM-4213, CM-4229, CM-4323	
CM_CDOP5_MS_48	Q3 2029	PCR 5.6	review board report			WP 5320	CM-38201, CM-38291, CM-38221, CM-38281, CM-38271, CM-38811, CM-38921 CM-7201, CM-7291, CM-7221, CM-7281, CM-7261, CM-7811, CM-7921, CM-7271	
CM_CDOP5_MS_49	Q4 2029	ORR 5.1	review board report			WP 5730	CM-6410, CM-6420, CM-6430, CM-6440, CM-6450, CM-6460, CM-6470	
CM_CDOP5_MS_50	Q4 2029		Report UC2: Report on analysis of cloud regimes based on CLAAS data and cloud regime dataset			WP 2400		
2030								
CM_CDOP5_MS_51	Q1/2030	Data release	Jupyter Notebooks for HOAPS 5 ICDR	ORR 5.1		WP 2200	CM-6410, CM-6420, CM-6430, CM-6440, CM-6450, CM-6460, CM-6470	
CM_CDOP5_MS_52	Q1 2030	Submission to EUM Sec.	operations report 2029/2			WP 1300		
CM_CDOP5_MS_53	Q1 2030	3. Expert / thematic Workshop	Workshop report			WP 2300		
CM_CDOP5_MS_54	Q1 2030		Report CI3: precipitation, vegetation and wildfire indices over the UK and potentially Europe			WP 2400		
CM_CDOP5_MS_55	Q1 2030		UC4: News or highlight story on			WP 2400		

ID	Date	Event / milestone	Description / Deliverable	Dependency in	Dependency out	WP references	PRD references	Comments
			the CM SAF webpage					
CM_CDOP5_MS_56	Q1 2030		Reports on requirements on uncertainy , on uncertainty estimation and validation			WP 4600		
CM_CDOP5_MS_57	Q2 2030	PCR 5.5	review board report			WP 5220	CM-85612, CM-8611 CM-25612, CM-7611	
CM_CDOP5_MS_58	Q2 2030		Report on intercalibration coefficients for microwave imagers			WP 4400		
CM_CDOP5_MS_59	Q2 2030	OR-2030	AQA Operations Report RB report			WP 1200 WP 1300		
CM_CDOP5_MS_60	Q2 2030	Bilateral coordination meeting with Sec.	Report					
CM_CDOP5_MS_61	Q2 2030	PCR 5.7	review board report			WP 5420	CM-25012, CM-25022, CM-25032, CM-25042, CM-25052, CM-25062, CM-25302, CM-25332, CM-25201, , CM-25261, CM-LSA-21001, CM-25812 CM-9012, CM-9022, CM-9032, CM-9042, CM-9052, CM-9062, CM-9302, CM-9332, CM-9201, , CM-9261, LSA-CM-5001, CM-9812	
CM_CDOP5_MS_62	Q2 2030		report to GDAP on G-VAP and P assessment			WP 4300		
CM_CDOP5_MS_63	Q2 2030		Implementation plan for provision and validation of uncertainties			WP 4600		
CM_CDOP5_MS_64	Q3 2030	PMR-2030	review board report			WP 1100		Payment milestone

ID	Date	Event / milestone	Description / Deliverable	Dependency in	Dependency out	WP references	PRD references	Comments
CM_CDOP5_MS_65	Q3 2030	Submission to EUM Sec.	operations report 2030/1			WP 1300		
CM_CDOP5_MS_66	Q3 2030	DRR 5.6 / ORR 5.6	review board report			WP 5330	CM-38201, CM-38291, CM-38221, CM-38281, CM-38271, CM-38811, CM-38921 CM-7201, CM-7291, CM-7221, CM-7281, CM-7261, CM-7811, CM-7921, CM-7271	
CM_CDOP5_MS_67	Q4/2030	Data release	Jupyter Notebooks for HANNA CDR & ICDR	DRR 5.6 / ORR 5.6		WP 2200	CM-38201, CM-38291, CM-38221, CM-38281, CM-38271, CM-38811, CM-38921 CM-7201, CM-7291, CM-7221, CM-7281, CM-7261, CM-7811, CM-7921, CM-7271	
CM_CDOP5_MS_68	Q4 2030	PCR 5.4	review board report			WP 5520	CM-23085, CM-23205, CM-23295, CM-23275, CM-23255, CM-23285, CM-22202, CM-22282, CM-22292, CM-24202, CM-24282, CM-24292, CM-26202, CM-26282, CM-26292, CM-27202, CM-27282, CM-27292 CM-5083, CM-5213, CM-5293, CM-5283, CM-5273 CM-83205, CM-83294, CM-83285, CM-8213, CM-8293, CM-8283	
CM_CDOP5_MS_69	Q4 2030		Mutual OSI/CM SAF report on consistency of MW imager-based wind speed retrievals			WP 5730	CM-6470	
2031								
CM_CDOP5_MS_70	Q1 2031	Submission to EUM Sec.	operations report 2030/2			WP 1300		

ID	Date	Event / milestone	Description / Deliverable	Dependency in	Dependency out	WP references	PRD references	Comments
CM_CDOP5_MS_71	Q1 2031		Report CI1: Heat indices			WP 2400		
CM_CDOP5_MS_72	Q1 2031		Report CI2: Renewable Energy			WP 2400		
CM_CDOP5_MS_73	Q2 2031	Bilateral coordination meeting with Sec.	Report			WP 2400		
CM_CDOP5_MS_74	Q2 2031		report to GDAP on G-VAP and P assessment			WP 4300		
CM_CDOP5_MS_75	Q2 2031	OR-2031	RB report	AQA., Operations Report		WP 1200 WP 1300		
CM_CDOP5_MS_76	Q3 2031	PMR-2031	review board report			WP 1100		Payment milestone
CM_CDOP5_MS_77	Q3 2031	Submission to EUM Sec.	operations report 2031/1			WP 1300		
CM_CDOP5_MS_78	Q3 2031	DRR 5.2 / ORR 5.2	review board report			WP 5130	CM-11014, CM-11024, CM-11034, CM-11044, CM-11054, CM-11064, CM-11204, CM-11229, CM-11230, CM-11231, CM-11264, CM-11274, CM-11314, CM-11344, CM-6013, CM-6023, CM-6033, CM-6043, CM-6053, CM-6063, CM-6213, CM-6222, CM-6224, CM-6225, CM-6263, CM-6273, CM-6283, CM-6293, CM-6323, CM-6333 CM-81014, CM-81204, CM-81229, CM-81314, CM-4013, CM-4213, CM-4229, CM-4323	
CM_CDOP5_MS_79	Q4/2031	Data release	Jupyter Notebooks for CLARA-A4	DRR 5.2 / ORR 5.2		WP 2200	CM-11014, CM-11024, CM-11034, CM-11044, CM-11054, CM-11064, CM-11204, CM-11229, CM-11230, CM-11231, CM-11264, CM-11274,	

ID	Date	Event / milestone	Description / Deliverable	Dependency in	Dependency out	WP references	PRD references	Comments
							CM-11314, CM-11344, CM-6013, CM-6023, CM-6033, CM-6043, CM-6053, CM-6063, CM-6213, CM-6222, CM-6224, CM-6225, CM-6263, CM-6273, CM-6283, CM-6293, CM-6323, CM-6333 CM-81014, CM-81204, CM-81229, CM-81314, CM-4013, CM-4213, CM-4229, CM-4323	
CM_CDOP5_MS_80	Q4 2031	DRR 5.5 / ORR 5.5	review board report			WP 7030 WP 5230	CM-85612, CM-8611 CM-25612, CM-7611	
CM_CDOP5_MS_81	Q4 2031	DRR 5.7 / ORR 5.7	review board report			WP 5430	CM-25012, CM-25022, CM-25032, CM-25042, CM-25052, CM-25062, CM-25302, CM-25332, CM-25201, CM-25261, CM-LSA-21001, CM-25812 CM-9012, CM-9022, CM-9032, CM-9042, CM-9052, CM-9062, CM-9302, CM-9332, CM-9201, , CM-9261, LSA-CM-5001, CM-9812	
2032								
CM_CDOP5_MS_82	Q1/2032	Data release	Jupyter Notebooks for GIRAFE ed. 2	DRR 5.3 / ORR 5.3	DRR 5.5 / ORR 5.5	WP 2200	CM-85612, CM-8611 CM-25612, CM-7611	
CM_CDOP5_MS_83	Q1/2032	Data release	Jupyter Notebooks for Georing CDR & ICDR	DRR 5.3 / ORR 5.3	DRR 5.7 / ORR 5.7	WP 2200	CM-25012, CM-25022, CM-25032, CM-25042, CM-25052, CM-25062, CM-25302, CM-25332, CM-25201, CM-25261, CM-LSA-21001, CM-25812 CM-9012, CM-9022, CM-9032, CM-9042, CM-9052, CM-9062,	

ID	Date	Event / milestone	Description / Deliverable	Dependency in	Dependency out	WP references	PRD references	Comments
							CM-9302, CM-9332, CM-9201, , CM-9261, LSA-CM-5001, CM-9812	
CM_CDOP5_MS_84	Q1 2032	Submission to EUM Sec.	Operations Report 2031/2			WP 1300		
CM_CDOP5_MS_85	Q1 2032		Report CA1: Satellite-based observed climate change in the Arctic region			WP 2400		
CM_CDOP5_MS_86	Q1 2032		Report UC3: assess the feasibility of producing a blended windspeed dataset for the UK OR event attribution study on the exceptionally sunny UK winter/spring of 2024/2025			WP 2400		
CM_CDOP5_MS_87	Q1 2032		Summary report of the WP 2400			WP 2400		
CM_CDOP5_MS_88	Q1 2032	CDOP-5 close out	CDOP-5 Close-out report			WP 1100		Payment milestone

Annex IV Federated Activities

None at time of proposal writing.

Annex V SAF Strategy on Precipitation

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Version control:

Version	Date	Document name	Comment
1.0, draft	06 June 2025	SAF_White_Paper_Precipitation_v1.0_draft.docx	First draft
1.0	25 August 2025	SAF_White_Paper_Precipitation_v1.0.docx	Final version
1.1	11 September 2025	SAF_White_Paper_Precipitation_v1.1.docx	Updates implemented prior to the September meeting
1.2	19 September 2025	SAF_White_Paper_Precipitation_v1.2.docx	Update following discussions at meeting on 12.09.2025
1.3	26 September 2025	SAF_White_Paper_Precipitation_v1.3.docx	Update following discussions at meeting on 26.09.2025
1.4	02 October 2025	SAF_White_Paper_Precipitation_v1.4.docx	Feedback on v1.3 implemented
1.5	09 October 2025	SAF_White_Paper_Precipitation_v1.4.docx	Final version

Annex V.1

Precipitation has direct and indirect effects on many areas of human life. Data records of precipitation estimates as well as operational precipitation products are intensively requested for various applications areas.

Within EUMETSAT's Satellite Application Facility (SAF) network, the SAF on Climate Monitoring (CM SAF), the Hydrology SAF (H SAF), and the Nowcasting SAF (NWC SAF) are developing, generating and releasing precipitation products. These products are dedicated and tailored to different application areas and thus, have different characteristics.

EUMETSAT and the SAFs update their products following feedback from users. It is not always clear for user which product would be best suitable for a given application. Therefore, a joint utilisation of products from different SAFs is of high interest for users.

According to the new SAF strategy, the key measure of success for the SAF network is regular product usage in EUMETSAT Member States. The SAFs serve already various users from Member States and intend to improve the service, increase the consistency and ultimately obtain new users from Member States.

The three SAFs discussed how to improve the coordination among the three SAFs in order to:

- Define a common way forward on providing ready-to-use precipitation products,
- Jointly exploit available and future data and address challenges ahead together,

- Collaborate on product generation while maintaining individual, per-SAF mandates and with this,
- More effectively use available resources.

This strategy summarises the results of the discussions and defines a framework for the three SAFs for the CDOP-5 proposal drafting. It will thus form an annex of the CM SAF, H SAF, and NWC SAF proposals for CDOP-5.

Annex V.2 Application areas and SAF objectives

Satellite-based precipitation products are valuable input for a wide range of application areas. Each of the application areas and actually individual use cases within application areas bring their own, specific requirements on resolution, latency, achieved quality, uncertainty characterisation and more. This summary is not aiming at completeness but has the objective to briefly introduce key application areas at the core of the involved SAFs' main mandates and briefly outlines how the SAFs will cooperate to jointly improve the service to the users.
The following applications areas discussed in the next Section.

Annex V.2.1 Nowcasting, very short-range forecasting, weather forecasting

Precipitation nowcasting is crucial for weather-dependent decision-making in a variety of sectors, including emergency services, energy management, retail, flood early-warning systems, air traffic control, and marine services.
The key objective of the NWC SAF is to provide software packages for the near real time generation of a set of meteorological products, including precipitation, from both geostationary and polar orbiting satellites, to support nowcasting activities:

- NRT products to support National Meteorological Services (NMSs) in their day-to-day prediction work, including very short-term data driven forecasts.
- Input to models to obtain prediction/warning based on knowledge of the present situation.
- Verification of model forecasts.
- Improvement of NWP physics.

Additional to delivering software products, data products for METEOSAT with a latency of 10 minutes or less will be added to the NWC SAF portfolio in CDOP-5.
Timeliness, coverage and warning for extreme events are key aspects of precipitation nowcasting, and the NWC SAF aims to support both geostationary and polar orbiting satellites, providing different views of clouds and precipitation from above.
For geostationary satellites the NWC SAF provides precipitation algorithms for precipitation products focused on short timeliness and support to Nowcasting. For CDOP-5, the NWC SAF for geostationary satellites will collaborate with the CM SAF towards a seamless regional high-resolution precipitation product.
For polar satellites the software can be used to obtain products from data collected by direct readout ground stations while they are in direct line of sight to satellites and visible above the horizon. The user of the NWC SAF software packages with access to such data, typically NMSs, can then obtain the products with a best possible latency (few minutes).

The NWCSAF for Polar satellites aims to integrate state of the art retrieval algorithms, possibly developed by other SAFs to avoid double work and product duplication, and offer users consistent and validated software/level2 products, with a spatial resolution close to the one of the native observations.

Annex V.2.2 Climate Science and Services

The following applications are gathered under this heading:

- Climate monitoring, climate services (including climate normals, climate anomalies, climate indices, related reporting by WMO – e.g., on water resource management –, by C3S – e.g., the European State of the Climate –, etc.)
- Climate model assessments, evaluation of numerical climate / re-analysis models, utilisation in climate modelling or reanalysis (e.g., assimilation, calibration)
- Investigations of climate change and climate variability, their assessment for adaptation and potential mitigation (disaster risk reduction) and use for attribution studies
- Long-term infrastructure planning, insurance companies, etc.
- Climate extremes and long-term adaptation, and more

In general, consistently processed, long-term climate data records (CDRs) and their continuous extension with ideally identical processing systems and input streams, so-called Interim CDRs (ICDRs), are mandatory prerequisites to provide fit-for-purpose data in climate science and climate service context. A pragmatic and frequently applied approach is to start speaking of CDRs if they cover at least 10 years and to consider latencies in the order of a few days up to months.

CM SAF serves these application areas through the generation of a global precipitation CDR and ICDR with uncertainty estimates. The global precipitation data record merges high-quality instantaneous precipitation rates from the majority of passive microwave imager and sounder data with the high spatial and temporal resolution observations from the ring of geostationary observations. Key characteristics of the current product are: 1° daily resolution, accumulated precipitation, global coverage, covering the period 2002-present, ICDR latency 10-30 days.

Annex V.2.3 Hydrology

H SAF delivers satellite-based precipitation products (along with soil moisture and snow parameters), as well as user services supporting operational hydrology, meteorology, risk management, and water resource management. The primary objective is to provide quality-controlled, easily accessible, near-real-time (NRT) quantitative precipitation estimates (QPE) for use in operational hydrology applications such as hydrological modelling, flood forecasting, landslide and avalanche risk assessment.

In addition to NRT products, H SAF also provides higher-quality, offline precipitation datasets and long-term data records with greater latency. These are intended for regional and global applications in hydrology and water management.

The H SAF precipitation products are developed using all available passive microwave (PMW) radiometers equipped with precipitation-sensitive channels, both conically and cross-track scanning—onboard Low Earth Orbit (LEO) satellites, as they become available over time.

Machine learning techniques are used to fully exploit PMW radiometer capabilities, enabling global precipitation rate estimation, including at higher latitudes (>60°N/S), through the implementation of specialized modules for retrieving surface snowfall rates.
To ensure optimal quality precipitation estimation (QPE), the most up-to-date PMW input data are utilized. However, since PMW sensors onboard LEO satellites do not provide continuous coverage over specific locations, different techniques, including advance deep learning models, are employed to combine geostationary (GEO) infrared (IR) observations with PMW precipitation estimates. This fusion results in high-resolution, combined MW/IR products that merge the accuracy of LEO data with the high temporal resolution of GEO observations.
These multi-platform algorithms integrate the high-quality but intermittently sampled LEO data with the continuously sampled GEO/IR data, offering enhanced accumulated precipitation monitoring. Additionally, Level 3 PMW-based products consolidate information from all Level 2 PMW precipitation estimates to produce global precipitation datasets on a regular grid and consistent time intervals.
Over land, soil moisture-based rainfall estimates—using the SM2RAIN approach—are employed to derive accumulated precipitation globally. These are then merged with PMW-based estimates to generate global daily precipitation accumulation products. This process leverages H SAF Level 2 passive MW precipitation rate estimates and soil moisture-derived products.

Annex V.3 Opportunities and challenges

Substantial efforts have been invested to continue improving the precipitation retrievals, the merging techniques, the uncertainty characterisation and validation, and finally, the precipitation products themselves. Nonetheless, existing challenges include:

- (Improved) retrievals of snowfall, retrieval of precipitation rate above snow or ice-covered surfaces.
- (Independent) validation of remotely sensed precipitation over global ocean and of snowfall.
- (Improved) precipitation data over mountain regions and their validation.
- (Improved) detection and quantification of extreme precipitation events, together with adequate validation.
- (Improved) uncertainty characterization, in particular of systematic biases.
- Enhanced latency for provision of NRT and climate-quality data.
- Provision of gap-free data.
- Generation of a high-resolution precipitation product that is seamless for Nowcasting and Climate applications, with evidence for increased information content and quality meeting user requirements.

Various opportunities provide potential to improve satellite-based remote sensing of precipitation:

- Geo-Ring project: EUMETSAT, in cooperation with NOAA and other space agencies, quality controls, recalibrates and intercalibrates the full archive of observations from geostationary satellites.
- Various space agencies launch a variety of microwave imagers and sounders with partly innovative channel definitions, allowing for improved remote sensing of precipitation.

- Recent developments in the community regarding retrieval of snowfall mark a significant step forward.
- Increasing spatio-temporal resolution in combination with lightning observations likely improve nowcasting capacities.

Annex V.4. Common objectives and way forward

Key differences in the characteristic of the CM SAF, H SAF, and NWC SAF precipitation products are:

	Timeliness*	Parameter	Resolution	Coverag e	Quality (key requirements)
NWC SAF	2 minutes	accumulations, precipitation rates, precipitation probability	as defined by GEO IR or LEO MW observing systems	Meteosat, global	timeliness, identification of areas of high precipitation
H SAF	10 minutes or more, depending on product	accumulations, precipitation rates	as defined by GEO IR or LEO MW observing systems	Meteosat, global	accuracy of quantitative precipitation estimation
CM SAF	10 days to 1 month	accumulations	consistent with historical MW	global	stability

*(timeliness: time since reception of satellite data):

In the majority of cases the differences in characteristics are strongly linked to key requirements from the SAF's key application area.

Nonetheless, the long-term objective of CM SAF, H SAF, and NWC SAF is the generation of seamless precipitation data, ranging from CDRs, via data records (e.g., with coverage of 5-10 years), ICDRs, near-real time to real time data. The agreement is to work towards consistent precipitation data such that a joint utilization of data with various latencies can be achieved. Ultimately, this could lead to a single processing environment for global and a second one for a regional, Europe-focused high-resolution precipitation product. It was noted that achieving full consistency is hardly possible given the contrasting constraints on timeliness and quality. Nonetheless, the SAFs will pursue various means to at least improve consistency. The collaboration is also directed towards improved quality as well as improved sampling/coverage and resolution of the precipitation products and a documentation of differences among them. The SAFs are also aiming at easing the development of products via software exchange and eventually joint development. All efforts are intended to improve the usefulness for the application areas listed above and beyond and to attract and convince new users of the high quality of SAF precipitation data.

The following major tasks define the SAF framework on precipitation:

- Cooperate on sharing/developing approaches to take new opportunities onboard and to address the challenges ahead,
- Exchange of software, with a first focus on retrieval software

- Creating (and using) a common software platform for precipitation validation
- Exchange of data and services, with a first focus on L2 data
- Concept development towards the generation of an operational high-resolution precipitation product over Europe
- Implementation of processing chains at EWC to ease software exchange, to allow cross-SAF development, and to optimize processing
- Product release via EDS to ease also cross-SAF product usage and allow an easier overview of available products plus directions for users
- Intercomparison of precipitation products from SAFs as extended quality assurance
- Cooperation on validation and intercomparison using SAF-external data
- Improve documentation, e.g., guidance on product usage and summaries from intercomparison exercises
- Conduct regular meetings and jointly organize workshops with the thematic focus on precipitation
- Cooperation with the EUMETSAT Secretariat groups (e.g., RSP)

Annex V.5. Planned cooperation during CDOP-5

The CDOP-5 of the SAF network will run from 01 March 2027 until 29 February 2032. In this Section details of the cooperation between CM SAF, H SAF, and NWC SAF during CDOP-5 are outlined. A focus is on products (data and software), dependencies, timeline and implementation.

As outlined in Section 4 key objective of this strategy is improving consistency between precipitation products from the SAF network, the Secretariat and to work towards seamless products. In more detail, **Table 5-1** provides an overview of committed products related to precipitation from each SAF, and the dependencies between the SAFs and the timeline are outlined in some more detail in **Table 5-2**.

Table 5-1: Overview of committed products (data and software) related to precipitation in CDOP-5.

Product (acronym and ID)	Resp. SAF	Key characteristics	Required input from other SAFs	Planned release
CM SAF - Global precipitation data records (daily accumulation, LEO+GEO)				
GIRAFE v1.1 (CM-25613, CM-7612, CM-85613, CM-8612)	CM SAF	CDR+ICDR, normals+anomalies, global, a.o., for climate services and analysis	None, continuation of CDOP-4 developments	Late 2027
GIRAFE v2 (CM-25612, CM-7611, CM-85612, CM-8611)	CM SAF	CDR+ICDR, normals+anomalies, global, a.o., for climate services and analysis	Python version of H SAF retrievals via NWC SAF	2031
NWC SAF – Software product for retrieving precipitation rates				
NWC-156c1, NWC-156c2	NWC SA F	Software PPS-MW1 Instruments: ATMS, MWS, MWI	H SAF code and data: H-70 & H-71 Trained with ATMS and GMI data respectively	2028

Product (acronym and ID)	Resp. SAF	Key characteristics	Required input from other SAFs	Planned release
NWC-161	NWC SAF	Software PPS-MW1 Instruments: ATMS, AWS, MWS		2028
NWC-384, NWC-386	NWC SAF	Software PPS-MW2 Instruments: MWS, MWI, ATMS, AWS/Sterna [TBC], AMSR3[TBD]	H SAF code and data: H72, H74 & H-AUX-18G	2031
NWC-388, NWC-390	NWC SAF	Software PPS-MW2. High latitude, MW and MTG input. Instruments: ATMS, MWS, AWS/EPS-Sterna [TBC], MWHS [TBD] & MWTS [TBD]		2031
NWC-224 Prate (former CRRPh)	NWC SAF	Software NWC SAF GEO-I NGI3 Intensity of precipitation and 1 hour accumulations Available full disk for: • Meteosat/SEVIRI and FCI Calibrated/Validated in Europe • GOES-R/ABI (subjective validation) and Himawari 8/9/AHI (objective validation done by BOM-Australia)	-	2029
NWC-221 Pprob (former PCPh)	NWC SAF	Software NWC SAF GEO-I NGI3 Probability of Precipitation Available full disk for: • Meteosat/SEVIRI and FCI Calibrated/Validated in Europe • GOES-R/ABI and Himawari 8/9/AHI (subjective validation) Technically available for Meteosat full disk, GOES-R, Himawari 8/9	-	2029
NWC-228 CRR	NWC SAF	Software NWC SAF GEO-I NGI3 Intensity of precipitation and 1 hour accumulations Available full disk for: • Meteosat/SEVIRI and FCI Calibrated/Validated in Europe • GOES-R/ABI and Himawari 8/9/AHI (subjective validation)	-	2029

Product (acronym and ID)	Resp. SAF	Key characteristics	Required input from other SAFs	Planned release
NWC-324 Prate (former CRRPh)	NWC SAF	Software NWC SAF GEO-I NGI4 Intensity of precipitation and 1 hour accumulations Available full disk for: • Meteosat/SEVIRI and FCI Calibrated/Validated in Europe • GOES-R/ABI (subjective validation) and Himawari 8/9/AHI (objective validation done by BOM-Australia) Plan to extend calibration/validation to Global with GPM/DPr	-	2031
NWC-322 Pprob (former PCPh)	NWC SAF	Software NWC SAF GEO-I NGI4 Probability of Precipitation Available full disk for: • Meteosat/SEVIRI and FCI Calibrated/Validated in Europe • GOES-R/ABI (subjective validation) and Himawari 8/9/AHI (objective validation done by BOM-Australia) Plan to extend calibration/validation to Global with GPM/DPR	-	2031
H SAF - Global Level 2 – Instantaneous Precipitation- MW based products (LEO)				
P-IN-MWS H70	H SAF	Precipitation Rate (rainfall and snowfall) at ground by EPS-SG MWS (day 1 product)	None	2026
P-IN-MWI H71	H SAF	Precipitation Rate (rainfall and snowfall) at ground by EPS-SG MWI (day 1 product)	None	2027
P-IN-MWS H72	H SAF	Precipitation Rate (rainfall and snowfall) at ground by EPS-SG MWS (day 2 product)	None	2028
P-IN-MWI H74	H SAF	Precipitation Rate (rainfall and snowfall) at ground by EPS-SG MWI (day 2 product)	None	2029
P-IN-MWR H150	H SAF	Precipitation Rate (rainfall and snowfall) at ground by AWS/EPS-Sterna	None	2028
P-IN-GMI H-AUX-20	H SAF	Precipitation rate (rainfall and snowfall) at ground by MW conical scanner GMI	None	2025

Product (acronym and ID)	Resp. SAF	Key characteristics	Required input from other SAFs	Planned release
P-IN-ATMS H-AUX-18	H SAF	Precipitation rate at ground (rainfall and snowfall) by MW cross-track scanner ATMS	None	2025
P-IN-MWHS (H-AUX-151)	H SAF	Instantaneous precipitation rate (rainfall and snowfall) - by FY-3 Cross Track humidity sounder	None	2027
P-IN-AMSR3 (H-AUX-152)	H SAF	Instantaneous precipitation rate (rainfall and snowfall) by AMSR3	None	2030
P-IN-MWRI (H-AUX-153)	H SAF	Instantaneous precipitation rate (rainfall and snowfall) by FY-3-MWRI-RM imager	None	2031
H SAF – Level 3 - Instantaneous precipitation – Multi-sensor products using L2 global MW precipitation rates				
P-IN-PMW (H78)	H SAF	Global Level 3 multi-sensor Intercalibrated Instantaneous precipitation rate (rainfall and snowfall); MW-only NRT product exploiting all available L2 MW precipitation rates	None	Q4 2026 (To be superseded by P-IN-GEO-PMW)
P-IN-GEO-PMW (H51)	H SAF	Global precipitation rate at ground by GEO-Ring composite supported by LEO/MW products	None	2031
P-IN-FCI-PMW (H45)	H SAF	Precipitation rate at ground by MTG FCI supported by LEO/MW products based on ML techniques (MTG day 2 product, NRT)	None	2027
P-IN-FCI (H40)	H SAF	Precipitation rate at ground by MTG FCI supported by LEO/MW products based on blending technique (MTG day 1 product, NRT)	CT and CTH from NWC SAF	Operational
P-IN-SEVIRI-PMW (H60B)	H SAF	Precipitation rate at ground by MSG SEVIRI supported by LEO/MW products based on blending technique	CT and CTH from NWC SAF	Operational
P-IN-SEVIRI-E (H63)	H SAF	Precipitation rate at ground by MSG SEVIRI supported by LEO/MW products based on blending technique over IODC area	CT and CTH from NWC SAF	Operational

Product (acronym and ID)	Resp. SAF	Key characteristics	Required input from other SAFs	Planned release
P-IN-FCI-DS (H-DS-40)	H SAF	5-year dataset of P-IN-FCI	CT and CTH from NWC SAF 5 year L2 data of HSAF MW algorithm provided by CMSAF	TBD
P-IN-FCI-PMW-DS (H-DS-45)	H SAF	5-year dataset of P-IN-FCI-PMW	5 year L2 data of HSAF MW algorithm provided by CMSAF	TBD
P-IN-GEO-PMW-DS (H-DS-51)	H SAF	5-year dataset of P-IN-GEO-PMW	5 year L2 data of HSAF MW algorithm provided by CMSAF	TBD

Please, note that for H SAF Table 1 includes only global Level 2 PMW products/auxiliary modules and Level 3 instantaneous precipitation rate products using L2 PMW precipitation rates as input. All other derived H SAF MW/IR (MTG and GEO-Ring), MW-only and SM2RAIN-based accumulated precipitation NRT products, Data Records, and Late Runs are not included.

Table 5-2: Dependencies between the SAFs in CDOP-5 and beyond.

	Product / support	Provider	Estimated availability	Receiver	Usage
EPS-SG	MWI and MWS day 1 retrievals (matlab)	H SAF	2023/2024	NWC SAF	Implementation in PPS-MW software*
	MWI and MWS day 1 retrievals (python)	NWC SAF	2026 (pre-release version) 2028 (version 1)	CM SAF	Implementation in GIRAFE v2 processing chain for MWI/GMI and MWS/ATMS*
	5 year MWI and MWS L2 based on day-1 retrieval (python)	CM SAF	≥2030	H SAF	Postprocessing, release for calibration towards hydrological applications
	MWS day 2 retrievals (matlab)	H SAF	2028	NWC SAF	Implementation in PPS-MW software**
	MWI day 2 retrievals (matlab)	H SAF	2029	NWC SAF	Implementation in PPS-MW software**
AMSR-3	AMSR-3 retrieval (matlab)	H SAF	2030	NWC SAF	Implementation in PPS-MW software
	AMSR-3 retrievals (python) (TBD)	NWC SAF	2031	CM SAF	Implementation in GIRAFE processing chain***
	5 year AMSR-3 L2 (based on python retrieval)	CM SAF	2033	H SAF	Postprocessing, release for calibration towards hydrological applications
	AWS/EPS-Sterna retrieval (matlab)	H SAF	2028	NWC SAF	Implementation in PPS-MW software
AWS/EPS-	AWS/EPS-Sterna retrieval (python)	NWC SAF	2031	CM SAF	Implementation in GIRAFE processing chain***

	5 year AWS/EPS-Sterna L2 (based on python retrieval)	CM SAF	2033	H SAF	Postprocessing, release for calibration towards hydrological applications
GEO-I	Retrieval for high-resolution precipitation from NWC SAF Prate (former CRRPh) in Europe	NWC SAF	2027 and successive NWC SAF GEO-I software versions	CM SAF	Tests to develop a plan for regional High-Resolution Precipitation CDR for Europe

* A dedicated activity for implementing ATMS or GMI retrieval algorithms in the PPS-MW software is not required by CM SAF as it is planned to apply the day-one MWS and MWI algorithms for enhanced inter-sensor consistency.

** Usage of the MWS/MWI day-two algorithms by CM SAF in GIRAFE is currently not planned, as the day-two algorithms will not be extendable to heritage GMI and ATMS observations.

*** Usage by CM SAF in CDOP-5 GIRAFE v2 is unlikely given the current timeline; these algorithms will be addressed during CM SAF CDOP-6 activities.

Regular reporting to the involved Steering Groups on the status of the cooperation and the dependencies will be achieved by updating **Table 5-2** of this strategy paper and presenting the updated table to the respective SG. I.e., a few weeks prior to, e.g., an H SAF SG meeting the H SAF point of contact will approach the point of contacts of all other SAFs and asks for an update of **Table 5-2** and explanations for why the changes are necessary. In the example, H SAF will then present the updated table to the H SAF SG. The final version after the H SAF SG meeting will be shared by the H SAF point of contact with all point of contacts (and similar for all other SAFs). The points of contact are:

- CM SAF: point of contact - Marc Schröder (marc.schroeder@dwd.de)
- H SAF: Davide Melfi (davide.melfi@aeronautica.difesa.it)
- NWC SAF Polar: Nina Hakansson (nina.hakansson@smhi.se)
- NWC SAF Geo: Xavier Calbet (xcalbeta@aemet.es)

Finally, CM SAF, H SAF, and NWC SAF agreed to develop a plan on how to develop and implement seamless regional high-resolution precipitation CDR and RT products over Europe. Details will be covered in SAF individual WP and cross referencing.

Annex V.5.1 Risks

There are two main risks related to the interaction detailed above:

- A delay of one of the above exchanges will result in a delay of downstream exchanges, which will likely require changes to the respective SAFs' project plans.
- The retrieval algorithms provided by H SAF and implemented by NWC SAF are designed for NRT input data both in terms of L1 satellite observations and auxiliary data, typically ECMWF IFS Forecast (Section 4).
  It is likely that the resulting output is incompliant with CM SAF's main requirement for stability (Section 4). Furthermore, it is also likely that the input data cannot be simply

replaced (NRT L1 by reprocessed L1/FCDR; IFS Forecast by reanalysis) while retaining an acceptable level of accuracy. In this case, a retraining of the algorithms with these climate-compliant input data will be necessary. As it is not clear yet if this would be needed, dedicated resources have not yet been allocated for such a retraining. In such case, the retraining will not be carried out in H SAF and would need CM SAF to identify approaches to implement retrievals for affected sensors, with one option being a retraining with H SAF technical and scientific support. Moreover, if a retraining is achieved, it is assumed that the downstream adaptation of the algorithm to the retrained coefficients and input data in the PPS-MW software can be carried out by NWC SAF or CM SAF as part of their regular CDOP-5 commitments.

Annex VI Letters of support

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Deutscher Wetterdienst - Postfach 10 04 65 - 63004 Offenbach

Geschäftsbereich Klima und Umwelt

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KU4/10.01.09
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UST-ID: DE221793973

Offenbach, 30. Oktober 2025

Unterstützungserklärung für die geplante Weiterentwicklung des CM SAF Niederschlagsdatensatzes „Global Interpolated RAinFall Estimation“ (GIRAFE)

Sehr geehrte Damen und Herren,

mit diesem Schreiben bestätige ich das Interesse der Abteilung Hydrometeorologie des Deutschen Wetterdienstes an der Weiterentwicklung des Niederschlagsdatensatzes GIRAFE. Der DWD betreibt das Weltzentrum für Niederschlagsklimatologie (WZN/GPCC) unter der Schirmherrschaft der WMO und stellt Datenprodukte zum Niederschlags- und Dürremonitoring mit freiem Zugang bereit, die unter Nutzung von Stationsdaten erstellt werden. Die Aktivitäten sind eingebettet in die deutschen Beiträge zur Beobachtung des globalen Wasserkreislaufs, die in Form des Betriebs der Datenzentren im Deutschen Wetterdienst und der Bundesanstalt für Gewässerkunde einen thematischen Schwerpunkt auch in der Zusammenarbeit beider Behörden bilden.

Der GIRAFE-Datensatz ermöglicht die Niederschlagsüberwachung auch in Gebieten mit geringer Stationsdichte. Das WZN entwickelt derzeit im BMFTR geförderten Projekt „Co-Design eines hydrometeorologischen Informationssystems für die nachhaltige Bewirtschaftung von Wasserressourcen im südlichen Afrika“ (Co-Hydim-SA) seine Aktivitäten im Bereich des Dürre-Monitoring weiter und begrüßt in für diesen und weitere Anwendungsfälle eine zeitnahe regelmäßige (10-tägige) Aktualisierung des GIRAFE-Produkts.

Dies ermöglicht eine verbesserte Datengrundlage für das globale operationelle Dürremonitoring (u.a. für den GPCC-Drought-Index und dem Co-Hydim-SA Projekt) bereitzustellen, die in weitere Berichte einfließen (beispielsweise die alle 10 Tage herausgegebenen Berichte des Namibischen und Botswanischen Wetterdienstes).

Vor diesen Hintergrund begrüßen wir die geplanten Entwicklungsarbeiten und stehen gerne für die Diskussion der Nutzeranforderungen zur Verfügung. Kontaktperson im DWD ist Elke Rustemeier.

Mit freundlichen Grüßen

im Auftrag
Dr. Frank Kaspar
Leiter Abteilung Hydrometeorologie

Bern University of Applied Sciences

Prof. Dr. Angela Meyer
School of Engineering and
Computer Science
Quellgasse 21, CH-2501 Biel
angela.meyer@bfh.ch
Phone: +41 32 321 64 69

September 11, 2025

Letter of Support

To Whom It May Concern,

With this letter, I would like to express my support of the plans of the Climate Fundamentals team at MeteoSwiss for next CM SAF phase. We have been in exchange with the team with regard to high resolution solar radiation data for Switzerland and Europe for several years.

Examples of how we have been using the datasets of the MeteoSwiss Climate Fundamentals team include the results documented in

- Carpentieri, A., D. Folini, M. Wild, L. Vuilleumier, A. Meyer, Satellite-derived solar radiation for intra-hour and intra-day applications: Biases and uncertainties by season and altitude, Solar Energy, 255, 274-284, doi: 10.1016/j.solener.2023.03.027, 2023.
- Carpentieri, A., S. Pulkkinen, D. Nerini, D. Folini, M. Wild, A. Meyer, Intraday probabilistic forecasts of surface solar radiation with cloud scale-dependent autoregressive advection, Applied Energy, 351, 2023. doi: 10.1016/j.apenergy.2023.121775

We have also been users of the two years demonstrator data set (HANNA) provided by the team on high resolution solar radiation that is particularly adapted to mountaineous regions. Our group supports the plan to put those data into operations in the next phase. This would enable a consistent multi-decadal long-term high resolution climate data record, which would provide a valuable record for atmospheric and climate research.

Should you require any additional information, do not hesitate to contact me.

Best regards,

Prof. Angela Meyer

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

DWD

Deutscher Wetterdienst - Postfach 10 04 65 - 63004 Offenbach

Dr. Rainer Hollmann
Satellite-based Climate Monitoring
Deutscher Wetterdienst
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Offenbach, 17. September 2025

Letter of intent in respect of HOAPS 5 TCDR and ICDR

To whom it may concern

Wind information across the North Sea and Baltic Sea in all four dimensions is needed to support the further built up and expansion of wind farms in these areas as part of the transition to renewable energies. Therefore, the German Meteorological Service (DWD) provides the Federal Maritime and Hydrographic Agency (BSH) with the required information derived from meteorological reanalyses for the German exclusive economic zone (EEZ) of the North Sea and Baltic Sea. This data and related reports are published as part of the tendering process in accordance with the Offshore Wind Energy Act via https://pinta.bsh.de.

We plan to consider the near-surface wind speed over the ice-free oceans of the proposed HOAPS 5 Thematic Climate Data Record (TCDR) and Interim Climate Data Record (ICDR) for evaluation and bias-adjustment of our model-based reanalysis data products. Compared to other data sources such as tower and floating LiDAR measurements, satellite-based data enables a suitable spatial representation of the wind field. In doing so a horizontal resolution of 0.5 degree or preferably higher is needed. It would also be an advantage if the data were available for areas close to the coast. Furthermore, a time resolution of 1 hour is desired. The work would benefit if, in addition to near-surface wind data, wind information up to a height of 300 m were available.

Moreover, information on the near-surface wind speed over the ice-free oceans for the period from 1987 to present would be very helpful to analyse atmospheric circulation pattern occurrences and variabilities in the context of climate monitoring and climate change.

Yours sincerely,

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology MeteoSwiss
Climate Division

CH-8058 Zurich Airport
MeteoSwiss

Zurich Airport, 22 September 2025

Letter of Support by MeteoSwiss for CM SAF CDOP5 HANNA

To whom it may concern,

With this letter by the Federal Office of Meteorology and Climatology MeteoSwiss, we express our full support for the High-Resolution European Surface Radiation Data Record (HANNA) product family in EUMETSAT CM SAF CDOP5. HANNA will provide operational and seamless climate satellite observations issued with low latency at a high spatial resolution 0.01° grid.

The potential benefits and applications of such satellite data-sets are diverse, ranging from the validation of model-based data products to the training of machine learning models and the development of dedicated climate services. In the following, we highlight specific applications of particular relevance for MeteoSwiss.

Reanalysis data sets already represent, and will increasingly constitute, the reference standard for climatological assessments. Several high-resolution reanalyses exist today, such as COSMO-REA2 and other regional products. MeteoSwiss is currently developing a reanalysis-type data set with a spatial resolution of 1 km, covering the period from 2005 onward. This product will provide unprecedented opportunities for detailed climate analyses in complex alpine terrain. The planned HANNA observations will be of crucial importance for the validation of such high-resolution European reanalysis products. High-resolution satellite data such as HANNA also provide an important source for validating climate model data. MeteoSwiss considers HANNA to be a significant opportunity for the improvement of its national climate scenarios, as well as for the validation of, for example, EU DestinE ClimateTwins.

In addition, HANNA will deliver a unique set of surface parameters – including radiation, energy fluxes, and land surface temperature – that can serve as foundational input for training machine learning models, for example in applications such as solar radiation nowcasting and drought monitoring. High-resolution parameters of the type provided by HANNA are already integrated into operational climate services at MeteoSwiss, such as sonnendach.ch and drought.admin.ch. They also form a key component of the GCOS Switzerland 2025 report, support the derivation of reference values for the Swiss energy sector, and are actively used in MeteoSwiss model postprocessing.

Federal Office of Meteorology and Climatology MeteoSwiss
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Several European weather services[1] have expressed strong interest to collaborate with MeteoSwiss on those satellite-based climate applications, including projects on solar radiation, sunshine duration, heat indices, and drought monitoring. In order to successfully implement these collaborations, we consider the Europe-wide release of HANNA as essential.

Yours sincerely,

Croci-Maspoli Mischa 0K4UDN
Digital unterschrieben von Croci-Maspoli Mischa 0K4UDN
Datum: [illegible]

Dr. Mischa Croci-Maspoli
Head Climate Division

Liniger Mark 2TTQUF
Digitally signed by Liniger Mark 2TTQUF
Date: 2025.09.24 15:15:40 +02'00'

Dr. Mark Liniger
Head Services and Development
Member of the Management Board

---

[1] *GeoSphere Austria, National Slovenian Meteorological Servic, UK Hadley Centre, Swedish Meteorological and Hydrological Institute, Meteo Romania, National Institute of Meteorology and Hydrology Bulgaria*

Karlsruhe Institute of Technology

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Date: 4th October 2025

CMSAF products at original sensor resolution

To whom it may concern!

As a research institute active in climate remote sensing we are involved in the design and operation of remote-sensing instruments and in-situ observations, as well as the exploitation of datasets from operational satellites. We greatly value the datasets produced and made available by the EUMETSAT Satellite Application Facility on Climate Monitoring (CMSAF). The Meteosat-based CLAAS datasets in particular are frequently used in our research; teaching in our international "Remote Sensing and Geoinformatics" MSc programme also often draws on these datasets.

What makes CMSAF products so valuable to us is that they retain the original geometry and resolution of the SEVIRI system, and hopefully FCI in future versions. Especially datasets encompassing the entire time series of operations allow us to study climate-relevant processes in great detail. Many of the phenomena and processes we analyze are characterized by fine spatial differences. This includes aerosol and clouds modified by land surface cover, and low-level clouds following terrain features. Any spatial averaging or resampling would not only hamper process studies but also make direct comparisons with our own measurements performed from other platforms and from the ground much more difficult.

With this letter I wish to thank you for your continued dedication to providing products at the original satellite resolution, allowing us to fully profit from the technical advances in sensor technology. I am looking forward to using future versions of CLAAS, and to continued fruitful collaboration.

Yours sincerely,

Prof. Dr. Jan Cermak

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Zurich, September 15, 2025

To whom it may concern,

It is our pleasure to write a letter in support of the Georing dataset to be established by the CM SAF consortium in the framework of CMSAF CDOP5 phase.
This high resolution global climate data record based on a set of geostationary satellites ensures a consistent processing of all flux components of the surface energy balance. It will allow a joint assessment of the magnitudes and trends of the different energy balance components and their interactions in a physically consistent manner, which is crucial for a better understanding of the genesis and evolution of climate. It will also provide a valuable reference dataset for the evaluation of numerical models of weather and climate, and will be timely available for the assessment of the Earth System Models (ESMs) participating in the upcoming Coupled Model Intercomparison Project Phase 7 (CMIP7), which will deliver the climate scenarios for the next (7th) IPCC assessment report. The high temporal (hourly) resolution of the Georing dataset will not only enable the assessment of the climatological aspects of the simulated energy fluxes, but also for example their diurnal cycles, which so far has rarely been undertaken in model evaluation studies. High resolution flux data are also valuable for modelling land-surface processes and for monitoring changes in these variables. For example, the latent heat flux quantified within the Georing dataset will allow a better understanding of the magnitude and changes in the terrestrial water balance, since the latent heat flux and associated evaporation is the water balance component which to date is least constrained by observations. Better quantitative knowledge of the changes in latent heat/evaporation, together with observed precipitation and runoff may help for example to better understand the European summer drying.
In summation, the physically consistent determination of all components of the surface energy balance component, the high resolution in space and time, and the foreseen continuous extension will make the Georing dataset a unique and widely used reference source.

Sincerely,

MWild Lukas Gudmundsson

Martin Wild Lukas Gudmundsson.

Professor Robin Hogan
robin.hogan@ecmwf.int

3 October 2025

Dr Nicolas Clerbaux
Royal Meteorological Institute of Belgium,
Remote Sensing from Space,
Avenue Circulaire 3,
1180 Brussels, Belgium

Letter of support for the generation of Geo Ring top-of-atmosphere radiation products

Dear Dr Clerbaux,

I write to express strong support for your proposal to generate new CM-SAF top-of-atmosphere radiation products from geostationary satellites as part of "Geo Ring". We are regular users of various satellite radiation products for evaluating the ECMWF forecast model, including the CM-SAF Surface Radiation Data Set – Heliosat (SARAH edition 3), and both the CERES Energy Balanced & Filled (EBAF) and FLASHFlux products. While the ECMWF model is primarily used for medium-range weather forecasts, we perform longer simulations for both our seasonal forecasts and our Destination Earth Climate Digital Twin, so it is crucial to monitor and improve the energy balance of the model using observations of top-of-atmosphere shortwave and longwave upwelling fluxes. This is also important for the generation of reanalysis datasets. Your proposal to generate a global dataset of these fluxes at high temporal and spatial resolution with a low latency, exploiting the new spectral channels and using state-of-the-art angular models, is therefore very welcome. We would be keen to use such a dataset both for routine evaluation of our operational forecasts and for testing new research versions of our model.

Yours sincerely

Robin Hogan

Robin Hogan
ECMWF.

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Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Deutscher Wetterdienst - Postfach 10 04 65 - 63004 Offenbach

Herrn
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Geschäftszeichen:
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Offenbach, 27. Oktober 2025

Letter of support to the EUMETSAT Satellite Facility on Climate Monitoring (CM SAF)

The division Regional Climate Monitoring of the Deutscher Wetterdienst is in charge of generating climate-monitoring products for the WMO Regional Association VI Europe. At the same time, it is also leading the climate-monitoring node of the WMO RA VI Regional Climate Centre Network (RCC Node-CM). The RCC Network is a regional infrastructure element of the Climate Services Information System (CSIS) of the WMO-led Global Framework for Climate Services (GFCS). Its task is to support National Meteorological and Hydrological Services (NMHSs) in the Region in fulfilling their national duties related to climate issues.

Climate monitoring products generated by the RCC Node-CM include maps of various climate variables, reports and Climate Watch Advisories. It uses in-situ, model and satellite data as input for its services. Products are provided on daily, decadal, monthly, seasonal and annual timescales.

The data products of the EUMETSAT Satellite Facility on Climate Monitoring (CM SAF) form an essential backbone for the RCC Node-CM products portfolio. Presently the following products based on near-real-time operational CM SAF data are being routinely produced on a monthly basis by the RCC:

- sunshine duration,
- cloud coverage, dull days and fair days,
- global radiation, direct surface radiation, surface albedo.

All products mentioned above need to come with the current WMO reference period 1991-2020. Since we also compute climate anomalies from this reference in near-real time, we use the operational products as well as the climate data records from CM SAF.

We have much appreciated the high quality, the accessibility, and particularly the very reliable and timely data service of CM SAF over many years, which is essential especially for climate ...

Seite: 2

Geschäftszeichen: KU23/02.08.06_RCC/2025.001

Datum: 28. Oktober 2025

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

monitoring. The RCC mandate of DWD is a long-term activity, which is also planned to continue in future. For that reason, we would welcome the continuation of the CM SAF data supply in the next years.

Dr. Laura Lukassen

Head Unit Regional Climate Monitoring,

Coordinator WMO RA VI RCC Network

Danish Meteorological Institute

To whom it may concern

National Centre for
Climate Research (NCKF)

Date
15-09-2025

Letter of support for proposal GEO-Ring

With this letter, on behalf of the EC-Earth consortium, I would like to express my strong support for the CM SAF plans to create a comprehensive GEO-Ring satellite dataset. This dataset will be based on merged geostationary satellite data and include cloud properties, surface and top-of-atmosphere radiation budget, land surface temperature, and surface heat fluxes.

A dataset of this nature, with near-global coverage and high spatiotemporal resolution, would be an invaluable asset for the climate modeling and Earth system science communities. While existing datasets provide subsets of these variables, they do not offer the comprehensive combination proposed here — especially not with the spatial and temporal detail necessary to support rigorous model evaluation.

In particular, the proposed GEO-Ring dataset would significantly enhance our ability to evaluate coupled climate models such as EC-Earth. The availability of physically consistent observations of cloud, radiation, and surface variables would allow for detailed assessments of model performance. This includes evaluating the physical consistency between variables, identifying biases, and improving the representation of key processes.

Furthermore, the high temporal resolution would enable meaningful analysis of variability across timescales, including the diurnal cycle — a critical yet often under-evaluated aspect of climate model behavior. The ability to globally assess both spatial and temporal variability with this dataset would contribute substantially to process-level understanding and model development.

Given the urgent need for improved climate projections and the role that high-quality observations play in model evaluation and development, I believe this proposed data record represents a highly valuable and timely contribution to the field.

I fully support its generation and encourage prioritization of the necessary resources to ensure its successful implementation.

In case you require any additional information, do not hesitate to contact me.

Best regards,

Shuting Yang, PhD
Steering Group Chair, EC-Earth Consortium
Chief Scientific Advisor / chefkonsulent
National Centre for Climate Research (NCKF)
Danish Meteorological Institute
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Side 1/1

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FACULTY OF SCIENCES

DEPARTMENT OF GEOGRAPHY
EARTH AND CLIMATE RESEARCH GROUP

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Krijgslaan 281/N60
B-9000 Ghent
Belgium

To whom it may concern

DATE	OUR REFERENCE
05 September 2025	HANNA support letter

Support Letter HANNA Research Project

Dear,

I am writing to express my strong interest in the HANNA project and its objective to develop new datasets for hourly latent and sensible heat fluxes and evaporation fluxes at an unprecedented spatial resolution of 0.01° within the CMSAF framework. As a research scientist at the Royal Meteorological Institute of Belgium and assistant professor at Ghent University, I believe these datasets would be invaluable for advancing our understanding of land-atmosphere interactions and improving regional climate model performance.

My research focuses on developing, improving, and evaluating high-resolution regional climate models for land-atmosphere interactions across climatically diverse regions including Europe, the Amazon Basin, the Lake Victoria region, and the Maritime Continent. In all these regions, energy flux partitioning at the surface is critical for correct simulation of droughts, heatwaves, and extreme rainfall events, including the longer-term feedbacks in the soil-vegetation-atmosphere continuum. These processes are known to be poorly represented in current climate models, which exhibit significant biases in simulating surface energy fluxes that cascade into errors in predicting extreme weather events.

Current limitations in observational datasets at appropriate spatial and temporal scales restrict our ability to diagnose why these biases develop in our models. Existing land-surface and boundary-layer parameterization schemes inadequately represent the spatial and temporal variability of surface energy partitioning, hampering our understanding of the mechanisms driving land-atmosphere feedbacks during extreme events.

The proposed HANNA datasets would address these critical gaps by providing unprecedented spatial resolution at 0.01° and coverage, enabling evaluation of processes at scales directly relevant to high-resolution regional climate models. The hourly temporal resolution would allow investigation of diurnal cycles and sub-daily processes crucial for extreme event dynamics, while the simultaneous provision of latent heat, sensible heat, and evaporation fluxes would enable comprehensive energy balance evaluations across diverse climate regions.

With access to these datasets, I would use the high-resolution flux data to develop and calibrate improved land-surface schemes that better capture spatial heterogeneity and temporal variability. The data would enable systematic evaluation of regional climate model performance to identify specific processes and conditions where models fail, and allow investigation of how

GHENT UNIVERSITY

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DEPARTMENT OF GEOGRAPHY
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DATE	PAGE	OUR REFERENCE
05 September 2025	2/2	**Error! Reference source not found.**

surface energy flux anomalies contribute to the development and persistence of extreme events. The global coverage would support comparative studies to understand how land-atmosphere coupling varies across different climate zones.

The HANNA project represents a transformative opportunity to advance our understanding of land-atmosphere interactions and improve climate model fidelity. These datasets would provide an unprecedented amount of information upon which we could develop our land-surface and boundary-layer parameterizations and evaluate why biases develop in our models. I strongly support this initiative and would be delighted to serve as an active user and advocate for these important datasets.

I look forward to discussing how my research needs align with the HANNA project objectives and how I might contribute to its success.

Sincerely,

Prof. Dr. Kwinten Van Weverberg

Nicolas GHILAIN

Climate research – Work Leader

Email: nicolas.ghilain@meteo.be

Ph: +32 (0)473 32 78 59

[1]Royal Meteorological Institute of Belgium
Climate modeling & Impact studies Unit

[2]University of Liege
Climatology Laboratory
Climate and biogeochemical cycles modeling unit

1st of September 2025

To whom it may concern

Subject: Intention to use the HANNA ICDR over Europe at 0.01° for regional climate modeling studies

Dear Sir/Madam,

in my activities, we develop and operate regional earth system models to provide climate services in Belgium, especially oriented towards information on future changes. These developments rely extensively on the availability on observational datasets to benchmark our improved modeling skills.

Beside ground networks of observations, we have noticed that spatial information was also crucial to better capture the signature of land-atmosphere interactions and that a dedicated portfolio of multiple consistent variables was a clear asset.

In my groups, we operate regional models over Belgium (http://cordex.meteo.be) and Europe (Euro-Cordex), but not limited to these regions, at resolutions between 1 and 12 km. We have used EUMETSAT datasets for comparison of radiation components, surface temperature and surface turbulent fluxes for improvements in one of our models, and will continue to do so. A better resolution could of course provide new insights into model improvements.
I am eager to start using this new dataset when it would become available.

Best regards

Nicolas Ghilain

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Deutscher Wetterdienst - Postfach 10 04 65 - 63004 Offenbach

EUMETSAT
Eumetsat Allee 1
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Geschäftszeichen:
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Fax:
[Faxnummer]

UST-ID: DE221793973

Offenbach, 14. Oktober 2025

Letter of Support - CM SAF Geo-ring

Deutscher Wetterdienst (DWD) operates a global – to – regional chain of numerical weather prediction models. A key requirement for further development is access to observational datasets. In addition to the classical meteorological measurements from SYNOP or TEMP reports, satellite data has become increasingly important, particularly for process-based model evaluations. Such evaluations do not usually require real-time data availability, so data latency is less important; however quality control and the stability of long-term data records become relevant. The operational extension of such records with a latency of days or weeks would in addition allow for mid- to long-term monitoring of model performance, as well as process-based model evaluation for relatively recent events.

Despite their individual strengths, many existing data records are limited in terms of either temporal resolution (e.g. global datasets based on polar-orbiting satellites), or spatial extent (e.g. geostationary satellite based data). Therefore, the availability of a combined Geo-Ring dataset, provided through CM SAF, with its sustained operational service mandate, can thus be highly valuable for the evaluation of our numerical weather prediction system. This is especially true if it provides quasi-global data with a temporal frequency and spatial resolution comparable to those generated by the current global ICON model run.

It is acknowledged that in the past the Geo-ring was characterized by a variety of different geostationary sensors, with growing limitations in terms of resolution and available spectral information when going back in time. But for the era of advanced sensors, which began with the availability of GOES-17, the Geo-ring sensors provides a comprehensive range of spectral bands allowing for accurate retrieval of geophysical parameters.

In the current CDOP phase, CM SAF has provided samples of a geo-ring demonstrator including TOA fluxes and cloud properties at 30min temporal and 0.05° spatial resolution. The data itself, but also the spatiotemporal resolution and grid, have been inspected and are regarded very suitable for the envisioned verification of a range of processes in the ICON model including (but not limited to) processes related to the radiation and cloud- and microphysics schemes as well as to land surface temperatures. For example, information about the liquid or ice water path, the phase of the water at the cloud top, optical depth or effective radius will be used actively.

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

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Geschäftszeichen:
Datum: 14. Oktober 2025

Furthermore, in the possible generation process of a future reanalysis dataset the geo-ring dataset could play a role; either as a data source for assimilation, or for validation.

We look forward to further collaboration,

Dr. Linda Schlemmer
Head of departmen "Physical Processes"

SMHI

Dr. Anke Tetzlaff,
Federal Office of Meteorology and Climatology MeteoSwiss
Climate Division
CH-8058 Zurich Airport

15 September 2025

Letter of Support for CM SAF CDOP5: HANNA high resolution solar radiation, fluxes and land surface temperature instantaneous climate data record

To whom it may concern,

With this letter by the Meteorological Research Unit and the Community Planning Service Unit of SMHI, we express our support for the development of HANNA high resolution solar radiation, fluxes and land surface temperature instantaneous climate data record.

This novel satellite-based CM SAF climate data will enable climate monitoring in Europe with an unpreceded spatial resolution. With the HANNA demo data and the Land Flux climate data record, the CM SAF has demonstrated that high resolution, long-term climate data records can capture the climate signal back to the 1991s and characterize earth surface parameters with unpreceded quality also in mountainous regions.

Sweden's elongated geography and varying topography with vast mountainous regions in the north and the agricultural areas in the south pose challenges for in-situ measurements of solar radiation. In this context, HANNA will be particularly valuable. At SMHI, we foresee HANNA being used in weather and climate applications, in the evaluations of high-resolution regional reanalysis, as well as for improving forecasts for the solar energy and agriculture sectors. HANNA will facilitate a cost-efficient planning of the PV infrastructure and hence will help the energy transition.

We also foresee high value of HANNA as an important source of training and reference data for the future artificial intelligence and machine learning models and their data-driven research applications in the Nordic regions.

Furthermore, we recognize that integrating HANNA data into European climate monitoring and climate services will contribute to climate impact and attribution studies.

Yours sincerely,

Jorge Amorim
Head of Meteorological Research Unit

Michaela Borg
Head of Weather, Climate and Climate Adaptiation Unit, Community Planning Service

SMHI - Sveriges meteorologiska och hydrologiska institut, 601 76 NORRKÖPING
Besöksadress Folkborgsvägen 17 Tel 011-495 80 00 Fax 011-495 80 01

SMHI
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SMHI
Sven Källfelts Gata 15
426 71 VÄSTRA FRÖLUNDA

Danish Meteorological Institute

To whom it may concern

National Centre for
Climate Research (NCKF)

Date
30-09-2025

Letter of support for COSP satellite simulators for CM SAF datasets

On behalf of the EC-Earth consortium, I would like to express our strong support for the continued development of COSP simulators for CM SAF products.

We value the work already carried out in developing and applying COSP simulators to EC-Earth data for the simulation of CM SAF climate data records. These tools have proven effective in improving our understanding and evaluation of cloud–radiation processes in EC-Earth and other climate models. They also provide an essential means of facilitating inter-comparisons between model output and satellite-based datasets, complementing the standard use of reference observations from the Obs4MIPS database.

We therefore strongly endorse further development of COSP simulators, in particular their extension to simulations of the planned GEO-Ring dataset. In addition, we are exploring their use for radio occultation (RO) data from the ROM SAF, where the experience and expertise gained within CM SAF would be beneficial.

Yours sincerely,

Shuting Yang, PhD
Steering Group Chair, EC-Earth Consortium
Chief Scientific Advisor / chefkonsulent
National Centre for Climate Research (NCKF)
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Side 1/1

Meeting Notes: Discussing future ERA / CM SAF SSMI(S) FCDR requirements/interactions, 27th August 2025 (10:00-11:30)

Participants

Climate Reanalysis Team, Research Department / C3S, ECMWF (William Bell)
Deutscher Wetterdienst (Marc Schröder, Hannes Konrad, Karsten Fennig)

Summary

The main objective of the meeting was to discuss the future needs and requirements of the ECMWF Reanalysis v7 (ERA7) regarding the assimilation of the CM SAF SSMI(S) Fundamental Climate Data Record of Microwave Imager Radiances (FCDR).

Bill Bell described a plausible timeline for ERA7. A possible start of the production could be in the period 2033-to-2034, based on the intervals between recent ECMWF climate reanalyses (ERA-Interim [2008], ERA5 [2016], & ERA6 [2025]). However, in the current environment of rapidly emerging powerful AI tools, various scenarios can be envisaged: traditional physical-variational, hybrid or fully AI/ML reanalyses. There is also the possibility of different types of reanalysis serving different applications, for example long timescale / moderate resolution global reanalyses serving the needs of climate monitoring applications and shorter timescale / high resolution reanalyses serving as training datasets for operational ML-forecast models. The CMSAF SSMIS FCDR would, most likely, serve both applications.

C3S is already using the SSM/I instruments from the CM SAF FCDR and is also highly interested in the integration and usage of the SSM/I–like channels of the SSMIS instruments. However, there are technical issues that need to be resolved before this can be done. Specifically, the optimal strategy for remapping (or not) the data, requires targeted development work on the ECMWF side. In addition, there are parallel and related activities at EUMETSAT on the Upper Atmospheric Sounder (UAS) channel suite that should also be factored into any plans for a final SSMIS FCDR targeting ERA7 and subsequent reanalyses. Due to resource limitations at C3S, it would be advantageous if CM SAF could prepare the FCDR 'ready for ingestion' for the reanalysis processing system, in BUFR format. CM SAF expressed its general willingness to support C3S in this respect. The support would include the following items:

- prepare the data record observations (all channels) on an optimal grid, tailored for the best scientific use of the microwave observations (to be defined in more detail by C3S),
- convert the data format from NetCDF to BUFR,
- if possible, provide all SSMIS channels in one data record, through coordination with the EUMETSAT Team working on the UAS channels.
- in the future FIDUCEO extensions (incorporating comprehensive uncertainty information) might be needed.

It has been agreed that effective feedback loops, focusing on the specific scientific and technical issues encountered in preparing the datasets for assimilation, are a valuable tool to identify outstanding problems and to accelerate progress. Also, it would be most efficient to have personal visits by the responsible CM SAF scientist at C3S/ECMWF(Bonn) to participate in the assimilation and assessment of the delivered datasets with support from C3S. The frequency of these visits would be typically twice a year.

REPUBLIC OF SLOVENIA
MINISTRY OF THE ENVIRONMENT, CLIMATE AND ENERGY

SLOVENIAN ENVIRONMENT AGENCY

Dokument je elektronsko podpisan.

Podpisnik:Miha Skubic
Izdajatelj:Republika Slovenija
Št.certifikata:66 b4 fe 4e 00 00 00 00 56 7e 97
Potek veljavnosti:27.08.2029
Čas podpisa:11:28, 24-09.2025
Ref.št. dokumenta:35902-1/2020-MIG/60

Contact person: Boštjan Muri
12, September 2025

Letter of Support for CM SAF CDOP5: HANNA high resolution solar radiation, fluxes and land surface temperature instantaneous climate data record

To whom it may concern,

With this letter by Slovenian Environment Agency we express our support for the HANNA high resolution solar radiation, fluxes and land surface temperature instantaneous climate data record.

.
Novel satellite-based CM SAF climate data will enable climate monitoring in Europe with un unpreceded spatial resolution. With the HANNA demo data and the Land Flux climate data record the CM SAF has demonstrated that high resolution, long-term climate data records can capture the climate signal back to the 1991s and characterize earth surface parameters with unpreceded quality also in mountain regions.

Due to our long-standing experience as the Slovenian National Meteorological Service in utilising solar radiation, fluxes and temperature (besides other observed meteorological variables), we strongly support all adjustments and enhancements that incorporate full spatial and temporal resolution.

Slovenia's diverse topography, including high mountain regions, presents unique challenges. Therefore, we fully endorse products that take full resolution into account, as they are essential for accurate and reliable applications in our environment.

We find the aforementioned datasets particularly valuable for applications such as comparison studies with our ground-based climatological measurements, as well as for our nowcasting model – where they could also serve as a means of verification.

Moreover, it is of great importance that European Weather Services collaborate on integrating those data into climate monitoring. Satellites provide homogeneous measurements for entire Europe. While collaborating, the weather services can generate fully consistent climate data across Europe. Translated into warnings and climate services, this will enable pan-European climate impact and attribution studies. For the energy sector, climate indices will enable a cost-efficient planning of the PV infrastructure and hence will strongly help the energy transition.

We strongly believe that this is excellent proposal to be granted.
Yours sincerely,

Boštjan Muri	mag. Miha Skubic
Head of Products and Services Division	Secretary

-----Ursprüngliche Nachricht-----
Von: Schröder Marc
Gesendet: Dienstag, 16. September 2025 08:14
An: 'Nick Dunstone'; 'Doug Smith'
Cc: Konrad Hannes
Betreff: AW: global precipitation from CM SAF, GIRAFE

Dear Doug and Nick,

with this email I want to update you briefly on where we stand re the gap-filling.

We made good progress with the continuous extension of the global precipitation data record from CM SAF, GIRAFE ICDR v1.0. A release is expected earlier next year. As mentioned this v1.0 will be based on the existing GIRAFE climate data record, CDR v1.0, such that users can get access to continuous data soon. Starting Q2/Q3 next year we will start to update the ICDR by a) improving the latency and b) fill gaps, with focus on monthly scales. The latter requires a reprocessing such that the ICDR is consistent with the reprocessed CDR. This GIRAFE CDR+ICDR v1.1 will likely be ready in 2027. This version has not been committed yet and requires back up with resources.
Thus, we will include the commitment for the version 1.1 in the CM SAF proposal for the next CM SAF project phase which will start in March 2027.

(…)

Thank you very much for considering this and best regards,
Marc

-----Ursprüngliche Nachricht-----
Von: Schröder Marc
Gesendet: Freitag, 13. Juni 2025 12:51
An: 'Nick Dunstone'; Doug Smith
Cc: Konrad Hannes
Betreff: AW: global precipitation from CM SAF, GIRAFE

Dear Nick,

good point.
We understand the relevance and definitely want to find a solution.

I am not sure anymore about the details of our discussions re this topic. Here some comments:
Given existing commitments, we focus on the implementation of the global precipitation ICDR first (first with monthly latency, then we assess if sub-monthly latency is possible). The monthly ICDR version is likely ready by the end of this year. Then, given the relevance of gap-free data, we can consider to generate an interim version first by addressing this aspect only. The focus on a full new version (with new sensors, updated coverage, updated retrievals, …) will then be shifted to later times. This was actually already discussed earlier and our Steering Group who would need to approve larger changes of our plans is already aware of these thoughts. If we pursue the gap-free version, we can likely work on this starting in ~Q2 2026.
We need to discuss this in more detail internally as well and keep you informed.

Is there a deadline until which gap-free data should become available?

Best regards,

-----Ursprüngliche Nachricht-----
Von: Nick Dunstone
Gesendet: Donnerstag, 12. Juni 2025 17:24
An: Schröder Marc ; Doug Smith
Cc: Konrad Hannes
Betreff: RE: global precipitation from CM SAF, GIRAFE

OFFICIAL

Thanks Marc for the summary and it was nice to meet you too.

I don't think you mentioned in your summary the latest plan (timeline) for trying to make the monthly dataset spatially complete (gap-free) - is there any evolution on plans on this?

Cheers,
Nick

OFFICIAL
-----Original Message-----
From: Schröder Marc <Marc.Schroeder@dwd.de>
Sent: 12 June 2025 16:21
To: Doug Smith <doug.smith@metoffice.gov.uk>; Nick Dunstone <nick.dunstone@metoffice.gov.uk>
Cc: Konrad Hannes <Hannes.Konrad@dwd.de>
Subject: AW: global precipitation from CM SAF, GIRAFE

Hi Doug,

my apologies for using so many abbreviations.
GIRAFE is the name of CM SAF's global precipitation data record.

Thanks for the information.

All the best,
Marc

-----Ursprüngliche Nachricht-----
Von: Doug Smith <doug.smith@metoffice.gov.uk>
Gesendet: Mittwoch, 11. Juni 2025 08:59
An: Schröder Marc <mschroed@exch.dwd.de>; Nick Dunstone <nick.dunstone@metoffice.gov.uk>
Cc: Konrad Hannes <hkonrad@exch.dwd.de>
Betreff: RE: global precipitation from CM SAF, GIRAFE

OFFICIAL

Thanks for the summary Marc.
I'm not sure what GIRAFFE is, but our interest is mainly to assess the skill of our hindcasts.
Hope that helps.
Best,
Doug

OFFICIAL
-----Original Message-----
From: Schröder Marc <Marc.Schroeder@dwd.de>
Sent: 04 June 2025 08:25
To: Doug Smith <doug.smith@metoffice.gov.uk>; Nick Dunstone <nick.dunstone@metoffice.gov.uk>
Cc: Konrad Hannes <Hannes.Konrad@dwd.de>
Subject: global precipitation from CM SAF, GIRAFE

Dear Nick and Doug,

it was a pleasure to meet you and I hope that the discussions were as helpful for you as they were for me. Here is an attempt to summarise our discussions:
top priority is the availability of gap-free monthly data # a continuous update to present time is important (monthly latency is ok, 10 days is optimally but with lower priority) # temporal coverage from 2002 onwards is helpful, from 2000 onwards would be important; ideally, but with lower priority, from 1980 onwards.

I am sorry to say that we talked so much about precipitation data, GIRAFE and requirements that I have only a vague understanding of what you are actually doing with the data. May I kindly ask you to briefly describe how GIRAFE would be used?

The current time line for release of the continuously extended GIRAFE data is by the end of 2025 (monthly latency). Given the deadline for SAF proposals in October 2025 it might be delayed though. In 2026 we will be working on a 10 day latency which will be applied for the same GIRAFE v1.0.
Going backward in time (period 1998-2001) depends on the development of a retrieval for SSM/I over land. The development will start soon. However, these developments are linked to a new version, the GIRAFE v2 and this will take time, i.e., beyond 2027.

I have my colleague Hannes on CC who is actively involved in GIRAFE activities.

My apologies for the late reply - my laptop is dead and I had a series of missions and meetings.

All the best and I hope we keep in touch, Marc

Dr. Marc Schröder

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FACULTEIT BIO-INGENIEURSWETENSCHAPPEN

Department of Environment
H-CEL | Hydro-Climate Extremes Lab

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Professor in Hydrology & Climate

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Faculty of Bioscience Engineering
Ghent University
Coupure links 653
9000 Ghent, Belgium

DATE
07/09/2025

PLACE
Ghent (Belgium)

Letter of Support

I am writing this letter to express my full support for the inclusion of surface latent and sensible heat fluxes as additional variables in the GeoRing product portfolio of the Climate Monitoring SAF (CM SAF). These fluxes, together with land evaporation, are essential elements of the climate system linking the water, energy, and carbon cycles, and they have been recognized as Essential Climate Variables (ECVs) by GCOS/WMO. Their accurate monitoring is therefore crucial for climate, agricultural, hydrological, and meteorological sciences.

For over 15 years, my team has been producing global estimates of latent and sensible heat fluxes for the climate community. This effort led to the eventual consideration of these variables as ECVs by GCOS, where I was responsible for their implementation as a GCOS member over the past 5 years. It also led to a recently funded initiative (ESA CCI Evaporation) to produce long-term global records of these fluxes, which I lead as PI. These activities, however, mainly rely on polar-orbiting satellites and are therefore focused on daily temporal resolutions.

The new GeoRing products, by contrast, will provide latent and sensible heat fluxes at quasi-global coverage with 0.05° spatial resolution (2018 onward) and a 5-day latency. Most importantly, they will resolve fluxes at sub-daily timescales, offering a unique opportunity to capture the short-term dynamics of land–atmosphere energy exchange and terrestrial water fluxes. Sub-daily information is essential to detect vegetation responses to environmental stressors, quantify rapid changes in soil water availability, improve natural hazard prediction, and enhance land data assimilation.

The GeoRing products will thus provide an invaluable complement to other community activities, including ongoing projects in my research team. Their geostationary-based approach enables temporal resolutions that we cannot achieve, while the global daily products produced in my team offer a longer-term perspective for climate studies. Their combination would enable cross-validation, harmonization, and joint exploitation, thereby enhancing the robustness and applicability, serving a wider community of users.

Therefore, I believe that the inclusion of latent and sensible heat fluxes in the GeoRing portfolio represents a transformative step forward and will provide datasets of high value for both research and applications.

Sincerely yours,

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FACULTEIT BIO-INGENIEURSWETENSCHAPPEN

Department of Environment
H-CEL | Hydro-Climate Extremes Lab

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Faculty of Bioscience Engineering
Ghent University
Coupure links 653
9000 Ghent
Belgium

DATE	PLACE
07/09/2025	Ghent (Belgium)

Letter of Support

I am writing this letter to express my full support for the HANNA project and its objective to develop new datasets for latent and sensible heat fluxes. These fluxes are key components of the climate system linking the water, energy and carbon cycles, making their accurate monitoring crucial for climate, agricultural, and hydrological sciences. The objectives in HANNA are complementary to the activities we are conducting in my team, funded by the European Space Agency (ESA) and the Belgian Science Office (BELSPO). However, these activities focus on the use of different methodology and suite of satellite assets, and they have a different target temporal resolution.

For over 15 years, my team has been producing data of sensible and latent heat fluxes for the climate community. This effort led to the eventual consideration of these variables as Essential Climate Variables (ECVs) by GCOS, where I was responsible for their implementation as GCOS member over the past 5 years. This effort also led to the consideration of these variables as ECV by ESA, and to a recently funded initiative (ESA CCI Evaporation) to produce long-term global records of these variables, which I lead as PI. Meanwhile, my team has also been working on their application at high spatial resolution (1 km) for agriculture and water management monitoring. These activities are however so far focused on daily temporal resolutions, given the reliance of our approach on polar orbiting satellites instead of geostationary assets.

Yet, short-term variations of water and heat transfer throughout the soil-plant-atmosphere continuum over the day impose a requirement for sub-daily information for multiple applications. Sub-daily fluxes are essential to capture vegetation responses to environmental controls and stressors, as well as to detect disturbances such as the onset of diseases or insect outbreaks, and to monitor recovery processes. High temporal resolution data also allows the estimation of rapid dynamics in soil water stress, which improves the prediction of natural hazards and enables the quantification of key human impacts on the water balance. In this way, hourly information is necessary to advance both scientific understanding and practical applications in agriculture, hydrology, meteorology, and climate monitoring.

Within HANNA, surface sensible and latent heat fluxes will be estimated at a high spatial resolution of 0.01° within the CM SAF framework for the period 2004 onwards over Europe, with regular updates to maintain continuity, offering unique flexibility for diverse applications. More importantly, they will be made available at hourly temporal resolution, crucial for applications that require the resolution of the diurnal cycle. Its spatial resolution

UNIVERSITEIT GENT

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Department of Environment
H-CEL | Hydro-Climate Extremes Lab

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of 0.01°, combined with the high temporal resolution, will allow investigation of processes across timescales that our current products do not capture.

In addition, the HANNA products will provide opportunities for direct collaboration with our ESA CCI Evaporation activities and our projects aiming for high (spatial) resolution surface sensible and latent heat flux products. This collaboration will enable cross-validation of methodologies, enhance the robustness of existing datasets, and create synergies that will benefit the broader climate, hydrological, and agricultural research communities.

Therefore, I believe that the HANNA project represents a transformative opportunity and will provide datasets of high value for both research and applications.

Sincerely yours,

UNIVERSITEIT GENT

H-CEL | Hydro-Climate Extremes Lab · Ghent University

Met Office
Hadley Centre

Dr. Nicolas CLERBAUX
Royal Meteorological Institute of Belgium
Remote Sensing from Space
Avenue Circulaire 3, 1180 Brussels, Belgium

Dr Alejandro Bodas-Salcedo
Lead Scientist, Climate Model Integration
Met Office Hadley Centre
alejandro.bodas@metoffice.gov.uk

19 September 2025

Dear Dr Clerbaux,

I would like to offer you my support for the development of new GEO-Ring cloud and Earth radiation budget products within the CM SAF project. The Earth radiation budget is one of the most fundamental properties of the climate system, making its monitoring of paramount importance. The pursuit of a better description of the diurnal cycle of the Earth's radiation budget, as well as the clouds governing it, with quasi-global coverage has the potential to significantly improve the assessment of climate models and our understanding of the climate system and its evolution. The new diurnal cycle product will be a valuable complement to the traditional ERB products used for model evaluation, as it provides a more direct connection with the fast cloud processes and can uncover persistent compensating errors through the diurnal cycle.

As a leader of a team that contributes to the development of the Met Office Hadley Centre's global coupled model configuration for climate applications, I envisage the following areas of potential exploitation of the new datasets.

a) Improved evaluation of the monthly mean diurnal cycle in climate models, extending previous analyses (e.g. https://doi.org/10.5194/essd-16-4243-2024) to near-global coverage.
b) Process-based analysis of high-frequency observations that could improve our understanding of differences in cloud feedbacks in models (e.g. http://doi.org/10.1007/s00382-014-2234-1).

Your demonstrated expertise in remote sensing will ensure that the project achieves its goals and delivers high quality outcomes under your leadership.

Yours sincerely,

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Annex VIII Full Cost Breakdown

The following table shows the full cost breakdown structure in EUR per work package. The costs are split per partner and year. Only full Euros are given.

Annex VII, Table 1: Full cost breakdown structure in EUR per work package and per partner.

WORK PACKAGE					Org.	Schedule			Planned Expenditures (Cost Estimate)									FUNDING			
WP ID	WP Type and Title	Partner/Instituti	Country	%Total C	WP Lead	WP Start date	WP End date	Duration	Manpower			other	Infrastructures/Facilities/HW	Consumables	Other (e.g. Travels)	Workshops*	TOTAL COST	EUM Requested Funding		Partners' Contribution	
								months	mm	Cost Rate	EUR	EUR	EUR	EUR	EUR	EUR	EUR	%	EUR	%	EUR
WP-1100	CM SAF Management	DWD	Germany		DWD	01.03.2027	29.02.2032	60	12,5	15035	187.938				58.000		245938	50,0	122969	50,0	122969
WP-1100	CM SAF Management	FMI	Finland		DWD	01.03.2027	29.02.2032	60	0,0	15770	0				25.000		25000	50,0	12500	50,0	12500
WP-1100	CM SAF Management	KNMI	Netherlands		DWD	01.03.2027	29.02.2032	60	0,0	23672	0				15.000		15000	66,0	9900	34,0	5100
WP-1100	CM SAF Management	MeteoSwiss	Switzerland		DWD	01.03.2027	29.02.2032	60	0,0	15834	0				20.853		20853	65,0	13563	35,0	7290
WP-1100	CM SAF Management	RMI	Belgium		DWD	01.03.2027	29.02.2032	60	0,0	13090	0				14.000		14000	50,0	7000	50,0	7000
WP-1100	CM SAF Management	SMHI	Sweden		DWD	01.03.2027	29.02.2032	60	0,0	16524	0				24.000		24000	70,0	16800	30,0	7200
WP-1100	CM SAF Management	UKMO Mngt	United Kingdom		DWD	01.03.2027	29.02.2032	60	0,0	16900	0				13.000		13000	50,0	6500	50,0	6500
WP-1200	Science Coordination	DWD	Germany		DWD	01.03.2027	29.02.2032	60	12,0	15035	180.420						180420	50,0	90210	50,0	90210
WP-1200	Science Coordination	UKMO Mngt	United Kingdom		DWD	01.03.2027	29.02.2032	60	6,0	16900	101.400						101400	50,0	50700	50,0	50700
WP-1300	Operations Management	DWD	Germany		DWD	01.03.2027	29.02.2032	60	14,0	15035	210.490						210490	50,0	105245	50,0	105245
WP-2100	User engagement, User services and product usage monitoring	DWD	Germany		DWD	01.03.2027	29.02.2032	60	48,0	15035	721.680						721680	50,0	360840	50,0	360840
WP-2200	Training and Outreach	DWD	Germany		DWD	01.03.2027	29.02.2032	60	19,0	15035	285.665			73.220			358885	50,0	179443	50,0	179443
WP-2200	Training and Outreach	FMI	Finland		DWD	01.03.2027	29.02.2032	60		15770	0			22.000			22000	50,0	11000	50,0	11000
WP-2200	Training and Outreach	KNMI	Netherlands		DWD	01.03.2027	29.02.2032	60	0,5	19387	9.694			17.277			26971	66,0	17801	34,0	9170
WP-2200	Training and Outreach	MeteoSwiss	Switzerland		DWD	01.03.2027	29.02.2032	60		15834	0			22.000			22000	65,0	14309	35,0	7691
WP-2200	Training and Outreach	RMI	Belgium		DWD	01.03.2027	29.02.2032	60	0,5	13090	6.545			14.000			20545	50,0	10273	50,0	10273
WP-2200	Training and Outreach	SMHI	Sweden		DWD	01.03.2027	29.02.2032	60	0,5	16524	8.262			26.000			34262	70,0	23983	30,0	10279
WP-2200	Training and Outreach	UKMO	United Kingdom		DWD	01.03.2027	29.02.2032	60		14384	0			14.794			14794	50,0	7397	50,0	7397
WP-2300	Workshops and Expert Meetings	DWD	Germany		DWD	01.03.2027	29.02.2032	60	10,0	15035	150.350					57.000	207350	50,0	103675	50,0	103675
WP-2300	Workshops and Expert Meetings	FMI	Finland		DWD	01.03.2027	29.02.2032	60	1,5	15770	23.655					2.025	25680	50,0	12840	50,0	12840
WP-2300	Workshops and Expert Meetings	KNMI	Netherlands		DWD	01.03.2027	29.02.2032	60	1,0	19387	19.387					2.000	21387	66,0	14115	34,0	7272
WP-2300	Workshops and Expert Meetings	MeteoSwiss	Switzerland		DWD	01.03.2027	29.02.2032	60		15834	0					2.000	2000	65,0	1301	35,0	699
WP-2300	Workshops and Expert Meetings	RMI	Belgium		DWD	01.03.2027	29.02.2032	60	1,0	13090	13.090					1030	14120	50,0	7060	50,0	7060
WP-2300	Workshops and Expert Meetings	SMHI	Sweden		DWD	01.03.2027	29.02.2032	60	2,4	16524	39.658						39658	70,0	27760	30,0	11897
WP-2300	Workshops and Expert Meetings	UKMO	United Kingdom		DWD	01.03.2027	29.02.2032	60	0,5	14384	7.192					0,00	7192	50,0	3596	50,0	3596
WP-2300	Workshops and Expert Meetings	UKMO Mngt	United Kingdom		DWD	01.03.2027	29.02.2032	60	0,5	16900	8.450					2.400,00	10850	50,0	5425	50,0	5425
WP-2400	CM SAF CDR use cases, analysis and support to climate reports	DWD	Germany		FMI	01.03.2027	29.02.2032	60	6,0	15035	90.210						90210	50,0	45105	50,0	45105
WP-2400	CM SAF CDR use cases, analysis and support to climate reports	FMI	Finland		FMI	01.03.2027	29.02.2032	60	22,0	15770	346.940						346940	50,0	173470	50,0	173470
WP-2400	CM SAF CDR use cases, analysis and support to climate reports	KNMI	Netherlands		FMI	01.03.2027	29.02.2032	60	9,5	19387	184.177						184177	66,0	121556	34,0	62620
WP-2400	CM SAF CDR use cases, analysis and support to climate reports	MeteoSwiss	Switzerland		FMI	01.03.2027	29.02.2032	60		15834	0						0	65,0	0	35,0	0
WP-2400	CM SAF CDR use cases, analysis and support to climate reports	RMI	Belgium		FMI	01.03.2027	29.02.2032	60	3,0	13090	39.270						39270	50,0	19635	50,0	19635
WP-2400	CM SAF CDR use cases, analysis and support to climate reports	SMHI	Sweden		FMI	01.03.2027	29.02.2032	60	11,5	16524	190.026						190026	70,0	133018	30,0	57008
WP-2400	CM SAF CDR use cases, analysis and support to climate reports	UKMO	United Kingdom		FMI	01.03.2027	29.02.2032	60	9,0	14384	129.456						129456	50,0	64728	50,0	64728
WP-2400	CM SAF CDR use cases, analysis and support to climate reports	UKMO Mngt	United Kingdom		SMHI	01.03.2027	29.02.2032	60	1,0	16900	16.900						16900	50,0	8450	50,0	8450
WP-2500	Preparing new Level 4 climate products and associated coordination, i	DWD	Germany		DWD	01.03.2027	29.02.2032	60	5,0	15035	75.175						75175	50,0	37588	50,0	37588
WP-2500	Preparing new Level 4 climate products and associated coordination, i	MeteoSwiss	Switzerland		DWD	01.03.2027	29.02.2032	60	10,0	15834	158.340						158340	65,0	102988	35,0	55352
WP-2500	Preparing new Level 4 climate products and associated coordination, i	UKMO	United Kingdom		DWD	01.03.2027	29.02.2032	60	27,0	14384	388.368						388368	50,0	194184	50,0	194184
WP-2500	Preparing new Level 4 climate products and associated coordination, i	UKMO Mngt	United Kingdom		DWD	01.03.2027	29.02.2032	60	4,0	16900	67.600						67600	50,0	33800	50,0	33800
WP-3110	Regional ICDR products	DWD	Germany		DWD	01.03.2027	29.02.2032	60	23,0	15035	345.805		50000				395805	50,0	197903	50,0	197903
WP-3110	Regional ICDR products	KNMI	Netherlands		DWD	01.03.2027	29.02.2032	60	1,5	19387	29.080						29080	66,0	19193	34,0	9887
WP-3110	Regional ICDR products	MeteoSwiss	Switzerland		DWD	01.03.2027	29.02.2032	60		15834	0						0	65,0	0	35,0	0
WP-3110	Regional ICDR products	RMI	Belgium		DWD	01.03.2027	29.02.2032	60	3,5	13090	45.815						45815	50,0	22908	50,0	22908
WP-3110	Regional ICDR products	SMHI	Sweden		DWD	01.03.2027	29.02.2032	60	1,0	16524	16.524						16524	70,0	11567	30,0	4957
WP-3120	Global ICDR products	DWD	Germany		DWD	01.03.2027	29.02.2032	60	25,0	15035	375.875		50000				425875	50,0	212938	50,0	212938
WP-3120	Global ICDR products	FMI	Finland		DWD	01.03.2027	29.02.2032	60	5,0	15770	78.850						78850	50,0	39425	50,0	39425
WP-3120	Global ICDR products	KNMI	Netherlands		DWD	01.03.2027	29.02.2032	60	1,5	19387	29.081						29081	66,0	19193	34,0	9887
WP-3120	Global ICDR products	RMI	Belgium		DWD	01.03.2027	29.02.2032	60	1,5	13090	19.635						19635	50,0	9818	50,0	9818
WP-3120	Global ICDR products	SMHI	Sweden		DWD	01.03.2027	29.02.2032	60	1,5	16524	24.786						24786	70,0	17350	30,0	7436

WORK PACKAGE					Org.	Schedule			Planned Expenditures (Cost Estimate)									FUNDING			
WP ID	WP Type and Title	Partner/Instituti	Country	%Total C	WP Lead	WP Start date	WP End date	Duration	Manpower			other	Infrastructures/Facilities/HW	Consumables	Other (e.g. Travels)	Workshops*	TOTAL COST	EUM Requested Funding		Partners' Contribution	
								months	mm	Cost Rate	EUR	EUR	EUR	EUR	EUR	EUR	EUR	%	EUR	%	EUR
WP-3130	ICDR Anomalies	DWD	Germany		DWD	01.03.2027	29.02.2032	60	15,5	15035	233.043						233043	50,0	116521	50,0	116521
WP-3130	ICDR Anomalies	FMI	Finland		DWD	01.03.2027	29.02.2032	60	2,5	15770	39.425						39425	50,0	19713	50,0	19713
WP-3130	ICDR Anomalies	RMI	Belgium		DWD	01.03.2027	29.02.2032	60	1,0	13090	13.090						13090	50,0	6545	50,0	6545
WP-3130	ICDR Anomalies	SMHI	Sweden		DWD	01.03.2027	29.02.2032	60	1,0	16524	16.524						16524	70,0	11567	30,0	4957
WP-3200	Technical Environment EWC	DWD	Germany		DWD	01.03.2027	29.02.2032	60	10,0	15035	150.350						150350	50,0	75175	50,0	75175
WP-4100	Prepare merged GeoRing and polar orbiter based products	DWD	Germany		KNMI	01.03.2027	29.02.2032	60	12,0	15035	180.420						180420	50,0	90210	50,0	90210
WP-4100	Prepare merged GeoRing and polar orbiter based products	FMI	Finland		KNMI	01.03.2027	29.02.2032	60	5,0	15770	78.850						78850	50,0	39425	50,0	39425
WP-4100	Prepare merged GeoRing and polar orbiter based products	KNMI	Netherlands		KNMI	01.03.2027	29.02.2032	60	2,1	19387	40.713						40713	66,0	26870	34,0	13842
WP-4100	Prepare merged GeoRing and polar orbiter based products	MeteoSwiss	Switzerland		KNMI	01.03.2027	29.02.2032	60	2,0	15834	31.668						31668	65,0	20598	35,0	11070
WP-4100	Prepare merged GeoRing and polar orbiter based products	RMI	Belgium		KNMI	01.03.2027	29.02.2032	60	2,0	13090	26.180						26180	50,0	13090	50,0	13090
WP-4100	Prepare merged GeoRing and polar orbiter based products	SMHI	Sweden		KNMI	01.03.2027	29.02.2032	60	2,5	16524	41.310						41310	70,0	28917	30,0	12393
WP-4200	Concept for a consistent NRT and CDR high-resolution precipitation pr	DWD	Germany		DWD	01.03.2027	29.02.2032	60	10,0	15035	150.350						150350	50,0	75175	50,0	75175
WP-4300	WCRP Support activities	DWD	Germany		DWD	01.03.2027	29.02.2032	60	10,0	15035	150.350						150350	50,0	75175	50,0	75175
WP-4400	Microwave Imager Inter-calibration	DWD	Germany		DWD	01.03.2027	29.02.2032	60	8,0	15035	120.280						120280	50,0	60140	50,0	60140
WP-4500	Support to EUMETSAT for FCDR Generation	DWD	Germany		SMHI	01.03.2027	31.12.2028	22	1,0	15035	15.035						15035	50,0	7518	50,0	7518
WP-4500	Support to EUMETSAT for FCDR Generation	FMI	Finland		SMHI	01.03.2027	31.12.2028	22	0,5	15770	7.885						7885	50,0	3943	50,0	3943
WP-4500	Support to EUMETSAT for FCDR Generation	KNMI	Netherlands		SMHI	01.03.2027	31.12.2028	22	1,0	19387	19.387						19387	66,0	12795	34,0	6592
WP-4500	Support to EUMETSAT for FCDR Generation	RMI	Belgium		SMHI	01.03.2027	31.12.2028	22	0,5	13090	6.545						6545	50,0	3273	50,0	3273
WP-4500	Support to EUMETSAT for FCDR Generation	SMHI	Sweden		SMHI	01.03.2027	31.12.2028	22	7,0	16524	115.668						115668	70,0	80968	30,0	34700
WP-4600	Towards a consistent approach to estimate uncertainties	DWD	Germany		UKMO	01.03.2027	29.02.2032	60	2,5	15035	37.588						37588	50,0	18794	50,0	18794
WP-4600	Towards a consistent approach to estimate uncertainties	UKMO	United Kingdom		UKMO	01.03.2027	29.02.2032	60	5,0	14384	71.920						71920	50,0	35960	50,0	35960
WP-4600	Towards a consistent approach to estimate uncertainties	UKMO Mngt	United Kingdom		UKMO	01.03.2027	29.02.2032	60	5,0	16900	84.500						84500	50,0	42250	50,0	42250
WP-5110	CDR + ICDR global CLARA-A4 (RR)	DWD	Germany		SMHI	01.03.2027	30.06.2028	16	5,0	15035	75.175						75175	50,0	37588	50,0	37588
WP-5110	CDR + ICDR global CLARA-A4 (RR)	FMI	Finland		SMHI	01.03.2027	30.06.2028	16	7,5	15770	118.275						118275	50,0	59138	50,0	59138
WP-5110	CDR + ICDR global CLARA-A4 (RR)	KNMI	Netherlands		SMHI	01.03.2027	30.06.2028	16	5,0	19387	96.935						96935	66,0	63977	34,0	32958
WP-5110	CDR + ICDR global CLARA-A4 (RR)	RMI	Belgium		SMHI	01.03.2027	30.06.2028	16	5,0	13090	65.450						65450	50,0	32725	50,0	32725
WP-5110	CDR + ICDR global CLARA-A4 (RR)	SMHI	Sweden		SMHI	01.03.2027	30.06.2028	16	15,0	16524	247.860						247860	70,0	173502	30,0	74358
WP-5120	CDR + ICDR global CLARA-A4 (PCR)	DWD	Germany		SMHI	01.07.2028	31.12.2029	18	22,0	15035	330.770						330770	50,0	165385	50,0	165385
WP-5120	CDR + ICDR global CLARA-A4 (PCR)	FMI	Finland		SMHI	01.07.2028	31.12.2029	18	12,0	15770	189.240						189240	50,0	94620	50,0	94620
WP-5120	CDR + ICDR global CLARA-A4 (PCR)	KNMI	Netherlands		SMHI	01.07.2028	31.12.2029	18	6,5	19387	126.016						126016	66,0	83170	34,0	42845
WP-5120	CDR + ICDR global CLARA-A4 (PCR)	RMI	Belgium		SMHI	01.07.2028	31.12.2029	18	11,5	13090	150.535						150535	50,0	75268	50,0	75268
WP-5120	CDR + ICDR global CLARA-A4 (PCR)	SMHI	Sweden		SMHI	01.07.2028	31.12.2029	18	22,0	16524	363.528						363528	70,0	254470	30,0	109058
WP-5130	CDR + ICDR global CLARA-A4 (DRR)	DWD	Germany		SMHI	01.01.2030	29.02.2032	26	23,0	15035	345.805		25000				370805	50,0	185403	50,0	185403
WP-5130	CDR + ICDR global CLARA-A4 (DRR)	FMI	Finland		SMHI	01.01.2030	29.02.2032	26	12,5	15770	197.125						197125	50,0	98563	50,0	98563
WP-5130	CDR + ICDR global CLARA-A4 (DRR)	KNMI	Netherlands		SMHI	01.01.2030	29.02.2032	26	7,5	19387	145.403						145403	66,0	95966	34,0	49437
WP-5130	CDR + ICDR global CLARA-A4 (DRR)	RMI	Belgium		SMHI	01.01.2030	29.02.2032	26	11,0	13090	143.990						143990	50,0	71995	50,0	71995
WP-5130	CDR + ICDR global CLARA-A4 (DRR)	SMHI	Sweden		SMHI	01.01.2030	29.02.2032	26	19,2	16524	317.532						317532	70,0	222272	30,0	95260
WP-5210	CMSAF and H SAF - joint precipitation RR	DWD	Germany		DWD	01.03.2027	29.02.2032	60	2,0	15035	30.070						30070	50,0	15035	50,0	15035
WP-5220	CDR + ICDR global Precipitation (PCR)	DWD	Germany		DWD	01.07.2028	30.06.2030	24	56,0	15035	841.960						841960	50,0	420980	50,0	420980
WP-5230	CDR + ICDR global Precipitation (DRR)	DWD	Germany		DWD	01.07.2030	29.02.2032	20	21,0	15035	315.735		25000				340735	50,0	170368	50,0	170368
WP-5310	CDR + ICDR High Resolution Radiation Europe (HANNA) (RR)	DWD	Germany		MeteoSwiss	01.03.2027	29.02.2028	12	6,0	15035	90.210						90210	50,0	45105	50,0	45105
WP-5310	CDR + ICDR High Resolution Radiation Europe (HANNA) (RR)	RMI	Belgium		MeteoSwiss	01.03.2027	29.02.2028	12	5,0	13090	65.450						65450	50,0	32725	50,0	32725
WP-5310	CDR + ICDR High Resolution Radiation Europe (HANNA) (RR)	MeteoSwiss	Switzerland		MeteoSwiss	01.03.2027	29.02.2028	12	6,0	15834	95.004						95004	65,0	61793	35,0	33211
WP-5320	CDR + ICDR High Resolution Radiation Europe (HANNA) (PCR)	DWD	Germany		MeteoSwiss	01.03.2028	28.02.2029	12	14,0	15035	210.490						210490	50,0	105245	50,0	105245
WP-5320	CDR + ICDR High Resolution Radiation Europe (HANNA) (PCR)	RMI	Belgium		MeteoSwiss	01.03.2028	28.02.2029	12	12,0	13090	157.080						157080	50,0	78540	50,0	78540
WP-5320	CDR + ICDR High Resolution Radiation Europe (HANNA) (PCR)	MeteoSwiss	Switzerland		MeteoSwiss	01.03.2028	28.02.2029	12	12,0	15834	190.008						190008	65,0	123585	35,0	66423
WP-5330	CDR + ICDR High Resolution Radiation Europe (HANNA) (DRR)	DWD	Germany		RMI	01.03.2029	31.03.2031	25	16,0	15035	240.560						240560	50,0	120280	50,0	120280
WP-5330	CDR + ICDR High Resolution Radiation Europe (HANNA) (DRR)	RMI	Belgium		RMI	01.03.2029	31.03.2031	25	11,0	13090	143.990						143990	50,0	71995	50,0	71995
WP-5330	CDR + ICDR High Resolution Radiation Europe (HANNA) (DRR)	MeteoSwiss	Switzerland		RMI	01.03.2029	31.03.2031	25	12,0	15834	190.008						190008	65,0	123585	35,0	66423

WORK PACKAGE					Org.	Schedule			Planned Expenditures (Cost Estimate)									FUNDING			
WP ID	WP Type and Title	Partner/Institute	Country	%Total C	WP Lead	WP Start date	WP End date	Duration	Manpower			other	Infrastructures/Facilities/HW	Consumables	Other (e.g. Travels)	Workshops*	TOTAL COST	EUM Requested Funding		Partners' Contribution	
								months	mm	Cost Rate	EUR	EUR	EUR	EUR	EUR	EUR	EUR	%	EUR	%	EUR
WP-5410	CDR + ICDR GeoRing (cld, TOA, SRB, landflux) (RR)	DWD	Germany		KNMI	01.03.2027	31.12.2028	22	9,0	15035	135.315						135315	50,0	67658	50,0	67658
WP-5410	CDR + ICDR GeoRing (cld, TOA, SRB, landflux) (RR)	KNMI	Netherlands		KNMI	01.03.2027	31.12.2028	22	8,0	19387	155.096						155096	66,0	102363	34,0	52733
WP-5410	CDR + ICDR GeoRing (cld, TOA, SRB, landflux) (RR)	RMI	Belgium		KNMI	01.03.2027	31.12.2028	22	5,0	13090	65.450						65450	50,0	32725	50,0	32725
WP-5410	CDR + ICDR GeoRing (cld, TOA, SRB, landflux) (RR)	MeteoSwiss	Switzerland		KNMI	01.03.2027	31.12.2028	22	1,0	15834	15.834		2500				18334	65,0	11925	35,0	6409
WP-5410	CDR + ICDR GeoRing (cld, TOA, SRB, landflux) (RR)	SMHI	Sweden		KNMI	01.03.2027	31.12.2028	22	10,0	16524	165.240						165240	70,0	115668	30,0	49572
WP-5420	CDR + ICDR GeoRing (cld, TOA, SRB, landflux) (PCR)	DWD	Germany		KNMI	01.01.2029	31.03.2030	15	22,0	15035	330.770						330770	50,0	165385	50,0	165385
WP-5420	CDR + ICDR GeoRing (cld, TOA, SRB, landflux) (PCR)	KNMI	Netherlands		KNMI	01.01.2029	31.03.2030	15	14,0	19387	271.418						271418	66,0	179136	34,0	92282
WP-5420	CDR + ICDR GeoRing (cld, TOA, SRB, landflux) (PCR)	RMI	Belgium		KNMI	01.01.2029	31.03.2030	15	9,5	13090	124.355						124355	50,0	62178	50,0	62178
WP-5420	CDR + ICDR GeoRing (cld, TOA, SRB, landflux) (PCR)	MeteoSwiss	Switzerland		KNMI	01.01.2029	31.03.2030	15	6,0	15834	95.004		5000				100004	65,0	65045	35,0	34959
WP-5420	CDR + ICDR GeoRing (cld, TOA, SRB, landflux) (PCR)	SMHI	Sweden		KNMI	01.01.2029	31.03.2030	15	14,0	16524	231.336						231336	70,0	161935	30,0	69401
WP-5430	CDR + ICDR GeoRing (cld, TOA, SRB, landflux) (DRR)	DWD	Germany		KNMI	01.04.2030	31.08.2031	17	24,0	15035	360.840		25000				385840	50,0	192920	50,0	192920
WP-5430	CDR + ICDR GeoRing (cld, TOA, SRB, landflux) (DRR)	FMI	Finland		KNMI	01.04.2030	31.08.2031	17	2,0	15770	31.540						31540	50,0	15770	50,0	15770
WP-5430	CDR + ICDR GeoRing (cld, TOA, SRB, landflux) (DRR)	KNMI	Netherlands		KNMI	01.04.2030	31.08.2031	17	14,5	19387	281.112						281112	66,0	185534	34,0	95578
WP-5430	CDR + ICDR GeoRing (cld, TOA, SRB, landflux) (DRR)	RMI	Belgium		KNMI	01.04.2030	31.08.2031	17	26,0	13090	340.340		6000				346340	50,0	173170	50,0	173170
WP-5430	CDR + ICDR GeoRing (cld, TOA, SRB, landflux) (DRR)	MeteoSwiss	Switzerland		KNMI	01.04.2030	31.08.2031	17	4,5	15834	71.253		2500				73753	65,0	47970	35,0	25783
WP-5430	CDR + ICDR GeoRing (cld, TOA, SRB, landflux) (DRR)	SMHI	Sweden		KNMI	01.04.2030	31.08.2031	17	14,0	16524	231.336						231336	70,0	161935	30,0	69401
WP-5510	CDR + ICDR GeoRing Surface Radiation (SARAH-5) (RR)	DWD	Germany		DWD	01.03.2027	30.06.2028	16	7,0	15035	105.245						105245	50,0	52623	50,0	52623
WP-5520	CDR + ICDR GeoRing Surface Radiation (SARAH-5) (PCR)	DWD	Germany		DWD	01.07.2028	29.02.2032	44	20,0	15035	300.700						300700	50,0	150350	50,0	150350
WP-5730	ICDR HOAPS-5	DWD	Germany		DWD	01.03.2027	29.02.2032	60	30,0	15035	451.050		25000				476050	50,0	238025	50,0	238025
WP-5830	FCDR SSM/I+SSMIS FCDR Edition 6.0 ext (DRR)	DWD	Germany		DWD	01.10.2029	29.02.2032	29	9,0	15035	135.315		25000				160315	50,0	80158	50,0	80158
WP-5930	CDR + ICDR Global Precipitation v1.1	DWD	Germany		DWD	01.03.2027	31.12.2027	10	12,0	15035	180.420						180420	50,0	90210	50,0	90210
WP-6100	CDR LandFlux (Meteosat, fluxes only)	DWD	Germany		RMI	01.03.2027	31.12.2028	22	0,5	15035	7.518						7518	50,0	3759	50,0	3759
WP-6100	CDR LandFlux (Meteosat, fluxes only)	RMI	Belgium		RMI	01.03.2027	31.12.2028	22	6,0	13090	78.540						78540	50,0	39270	50,0	39270
WP-6100	CDR LandFlux (Meteosat, fluxes only)	MeteoSwiss	Switzerland		RMI	01.03.2027	31.12.2028	22	1,5	15834	23.751						23751	65,0	15448	35,0	8303
WP-6210	GeoRing LST in Coordination with LSA SAF	MeteoSwiss	Switzerland		MeteoSwiss	01.03.2027	29.02.2032	60	10,0	15834	158.340						158340	65,0	102988	35,0	55352
WP-7010	Normals and Anomalies Regional Surface Radiation	DWD	Germany		DWD	01.03.2027	29.02.2032	60	7,0	15035	105.245						105245	50,0	52623	50,0	52623
WP-7020	Normals and Anomalies Global Clouds and Surface Radiation	DWD	Germany		SMHI	01.03.2027	29.02.2032	60	5,0	15035	75.175						75175	50,0	37588	50,0	37588
WP-7020	Normals and Anomalies Global Clouds and Surface Radiation	FMI	Finland		SMHI	01.03.2027	29.02.2032	60	5,0	15770	78.850						78850	50,0	39425	50,0	39425
WP-7020	Normals and Anomalies Global Clouds and Surface Radiation	RMI	Belgium		SMHI	01.03.2027	29.02.2032	60	4,0	13090	52.360						52360	50,0	26180	50,0	26180
WP-7020	Normals and Anomalies Global Clouds and Surface Radiation	SMHI	Sweden		SMHI	01.03.2027	29.02.2032	60	4,0	16524	66.096						66096	70,0	46267	30,0	19829
WP-7030	Normals and Anomalies Global Precipitation	DWD	Germany		DWD	01.03.2027	29.02.2032	60	8,0	15035	120.280						120280	50,0	60140	50,0	60140
WP-7040	Normals and Anomalies high Resolution Europe	DWD	Germany		DWD	01.03.2027	31.03.2031	49	1,0	15035	15.035						15035	50,0	7518	50,0	7518
WP-7040	Normals and Anomalies high Resolution Europe	MeteoSwiss	Switzerland		DWD	01.03.2027	31.03.2031	49	3,0	15834	47.502						47502	65,0	30896	35,0	16606
WP-7050	Normals and Anomalies LandFlux LST	MeteoSwiss	Switzerland		MeteoSwiss	01.03.2027	31.08.2030	42	1,4	15834	22.735						22735	65,0	14787	35,0	7948
WP-7050	Normals and Anomalies LandFlux LST	DWD	Germany		MeteoSwiss	01.03.2027	31.08.2030	42	1,0	15035	15.035						15035	50,0	7518	50,0	7518

The following table shows the full cost breakdown structure in EUR per work package, work package category, partner and year. The costs are split per partner and year. Only full Euros are given.

Annex VII, Table 2: Full cost breakdown structure in EUR for WP categories. The costs are given per work package category, work package, partner and year. Only full Euros are given.

Detailed Cost Breakdown (WP)

WP Reference/Number	**Consortium Member**														
		2027	**2027**	**2028**	**2028**	**2029**	**2029**	**2030**	**2030**	**2031**	**2031**	**2032**	**2032**	**Σ**	**Σ**
		Man-months	Total Costs	Man-months	Total Costs	Man-months	Total Costs	Man-months	Total Costs	Man-months	Total Costs	Man-months	Total Costs	Man-months	Total Costs
WP Category: Management		Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ				Σ	Σ
		Direct Labor Costs													
WP-1100	DWD	2,50	37587,50	2,00	30070,00	2,00	30070,00	2,00	30070,00	2,00	30070,00	2,00	30070,00	12,50	187937,50
WP-1200	UKMO Mngt	1,00	16900,00	1,20	20280,00	1,20	20280,00	1,20	20280,00	1,20	20280,00	0,20	3380,00	6,00	101400,00
WP-1200	DWD	2,00	30070,00	2,00	30070,00	2,00	30070,00	2,00	30070,00	2,00	30070,00	2,00	30070,00	12,00	180420,00
WP-1300	DWD	2,00	30070,00	2,50	37587,50	2,50	37587,50	2,50	37587,50	2,50	37587,50	2,00	30070,00	14,00	210490,00
WP-2300	UKMO Mngt		0,00		0,00	0,50	8450,00		0,00		0,00		0,00	0,50	8450,00
WP-2400	UKMO Mngt		0,00	0,25	4225,00	0,25	4225,00	0,25	4225,00	0,25	4225,00		0,00	1,00	16900,00
WP-2500	UKMO Mngt	0,25	4225,00	0,75	12675,00	1,00	16900,00	1,00	16900,00	0,75	12675,00	0,25	4225,00	4,00	67600,00
WP-4600	UKMO Mngt	1,00	16900,00	1,00	16900,00	1,00	16900,00	1,00	16900,00	1,00	16900,00		0,00	5,00	84.500
	Sub-total	8,8	135753	9,7	151808	10,5	164483	10,0	156033	9,7	151808	6,5	97815,00	55,0	857.698
		Other (e.g. Travel)													
WP-1100	DWD		9667		11600		11600		11600		11600		1933		58.000
WP-1100	FMI		4167		5000		5000		5000		5000		833		25.000
WP-1100	KNMI		2500		3000		3000		3000		3000		500		15.000
WP-1100	MeteoSwiss		3476		4171		4171		4171		4171		695		20.853
WP-1100	RMI		2333		2800		2800		2800		2800		467		14.000
WP-1100	SMHI		4000		4800		4800		4800		4800		800		24.000
WP-1100	UKMO Mngt		2167		2600		2600		2600		2600		433		13.000
	Sub-total		28309		33971		33971		33971		33971		5662		169.853

Detailed Cost Breakdown (WP)

WP Reference/Number	Consortium Member	2027 Man-months	2027 Total Costs	2028 Man-months	2028 Total Costs	2029 Man-months	2029 Total Costs	2030 Man-months	2030 Total Costs	2031 Man-months	2031 Total Costs	2032 Man-months	2032 Total Costs	Σ Man-months	Σ Total Costs
		Direct Labor Costs													
WP-4100	DWD	1	15035	2	30070	2	30070	3	45105	3	45105	1	15035	12,00	180.420
WP-4100	FMI		0		0		0	2	31540	3	47310		0	5,00	78.850
WP-4100	KNMI	1	19387	0,7	13570,9	0,4	7754,8		0		0		0	2,10	40.713
WP-4100	MeteoSwiss	1	15834	1	15834		0		0		0		0	2,00	31.668
WP-4100	RMI	0,5	6545	0,5	6545	0,5	6545		0		0	0,5	6545	2,00	26.180
WP-4100	SMHI	0,5	8262	1	16524	0,5	8262		0	0,3	4957,2	0,2	3304,8	2,50	41.310
WP-4100	UKMO Science		0		0		0		0		0		0	0,00	0
WP-4200	DWD	4	60140	4,5	67657,5	0,5	7517,5	0,5	7517,5	0,5	7517,5		0	10,00	150.350
WP-4300	DWD	2,5	37587,5	2,5	37587,5	2	30070	1,5	22552,5	1,5	22552,5	0	0	10,00	150.350
WP-4400	DWD	1	15035	2	30070	1	15035	2	30070	1	15035	1	15035	8,00	120.280
WP-4500	DWD	0,5	7517,5	0,5	7517,5		0		0		0		0	1,00	15.035
WP-4500	FMI	0,5	7885		0		0		0		0		0	0,50	7.885
WP-4500	KNMI	0,5	9693,5	0,5	9693,5		0		0		0		0	1,00	19.387
WP-4500	RMI	0,5	6545		0		0		0		0		0	0,50	6.545
WP-4500	SMHI	3	49572	4	66096		0		0		0		0	7,00	115.668
WP-4600	DWD	1	15035	0,5	7517,5	0,5	7517,5	0,25	3758,75	0,25	3758,75		0	2,50	37.588
WP-4600	UKMO Science	1	14384	1	14384	1	14384	1	14384	1	14384		0	5,00	71.920
WP-5110	DWD	2	30070	3	45105		0		0		0		0	5,00	75.175
WP-5110	FMI	3,5	55195	4	63080		0		0		0		0	7,50	118.275
WP-5110	KNMI	3	58161	2	38774		0		0		0		0	5,00	96.935
WP-5110	RMI	5	65450		0		0		0		0		0	5,00	65.450
WP-5110	SMHI	7	115668	8	132192		0		0		0		0	15,00	247.860
WP-5120	DWD		0	10	150350	12	180420		0		0		0	22,00	330.770
WP-5120	FMI		0	5	78850	7	110390		0		0		0	12,00	189.240
WP-5120	KNMI		0	3	58161	3,5	67854,5		0		0		0	6,50	126.016
WP-5120	RMI		0	5,5	71995	6	78540		0		0		0	11,50	150.535
WP-5120	SMHI		0	9	148716	13	214812		0		0		0	22,00	363.528
WP-5130	DWD		0		0		0	11	165385	12	180420		0	23,00	345.805
WP-5130	FMI		0		0		0	5	78850	5,5	86735	2	31540	12,50	197.125
WP-5130	KNMI		0		0		0	2,5	48467,5	4	77548	1	19387	7,50	145.403
WP-5130	RMI		0		0		0	5,5	71995	5,5	71995		0	11,00	143.990
WP-5130	SMHI		0		0		0	8	132192	9,2	152292,1143	2	33048	19,2	317.532
WP-5210	DWD	1	15035	1	15035		0		0		0		0	2,00	30.070
WP-5220	DWD		0	21	315735	22	330770	13	195455		0		0	56,00	841.960
WP-5230	DWD		0		0		0	7	105245	14	210490		0	21,00	315.735
WP-5310	DWD	4	60140	2	30070		0		0		0		0	6,00	90.210
WP-5310	MeteoSwiss	4	63336	2	31668		0		0		0		0	6,00	95.004
WP-5310	RMI	5	65450		0		0		0		0		0	5,00	65.450

Detailed Cost Breakdown (WP)

WP Reference/Number	Consortium Member	2027 Man-months	2027 Total Costs	2028 Man-months	2028 Total Costs	2029 Man-months	2029 Total Costs	2030 Man-months	2030 Total Costs	2031 Man-months	2031 Total Costs	2032 Man-months	2032 Total Costs	Σ Man-months	Σ Total Costs
WP Category: Development		Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ				Σ	Σ
		Direct Labor Costs													
WP-5320	DWD		0	5	75175	9	135315		0		0		0	14,00	210.490
WP-5320	MeteoSwiss		0	8	126672	4	63336		0		0		0	12,00	190.008
WP-5320	RMI		0	8	104720	4	52360		0		0		0	12,00	157.080
WP-5330	DWD		0		0	6	90210	10	150350		0		0	16,00	240.560
WP-5330	MeteoSwiss		0		0	4	63336	8	126672		0		0	12,00	190.008
WP-5330	RMI		0		0	5,5	71995	5,5	71995		0		0	11,00	143.990
WP-5410	DWD	4	60140	5	75175		0		0		0		0	9,00	135.315
WP-5410	KNMI	3,5	67854,5	4,5	87241,5		0		0		0		0	8,00	155.096
WP-5410	MeteoSwiss		0	1	15834		0		0		0		0	1,00	15.834
WP-5410	RMI	4	52360	1	13090		0		0		0		0	5,00	65.450
WP-5410	SMHI	5	82620	5	82620		0		0		0		0	10,00	165.240
WP-5420	DWD		0		0	12	180420	10	150350		0		0	22,00	330.770
WP-5420	KNMI		0		0	7	135709	7	135709		0		0	14,00	271.418
WP-5420	MeteoSwiss		0		0	5	79170	1	15834		0		0	6,00	95.004
WP-5420	RMI		0		0	7	91630	2,5	32725		0		0	9,50	124.355
WP-5420	SMHI		0		0	9	148716	5	82620		0		0	14,00	231.336
WP-5430	DWD		0		0		0	12	180420	12	180420		0	24,00	360.840
WP-5430	FMI		0		0		0	1	15770	1	15770		0	2,00	31.540
WP-5430	KNMI		0		0		0	4	77548	9,5	184176,5	1	19387	14,50	281.112
WP-5430	MeteoSwiss		0		0		0	2	31668	2,5	39585		0	4,50	71.253
WP-5430	RMI		0		0		0	10,5	137445	15,5	202895		0	26,00	340.340
WP-5430	SMHI		0		0		0	5	82620	9	148716		0	14,00	231.336
WP-5510	DWD	4	60140	3	45105		0		0		0		0	7,00	105.245
WP-5520	DWD		0	4	60140	7	105245	7	105245	2	30070		0	20,00	300.700
WP-5730	DWD	5	75175	6,5	97727,5	6,5	97727,5	5,5	82692,5	5,5	82692,5	1	15035	30,00	451.050
WP-5830	DWD		0		0	1,5	22552,5	2,5	37587,5	4	60140	1	15035	9,00	135.315
WP-5930	DWD	12	180420		0		0		0		0		0	12,00	180.420
WP-6100	DWD		0	0,5	7517,5		0		0		0		0	0,50	7.518
WP-6100	MeteoSwiss		0	1,5	23751		0		0		0		0	1,50	23.751
WP-6100	RMI	3	39270	3	39270		0		0		0		0	6,00	78.540

Detailed Cost Breakdown (WP)

WP Reference/Number	Consortium Member	2027 Man-months	2027 Total Costs	2028 Man-months	2028 Total Costs	2029 Man-months	2029 Total Costs	2030 Man-months	2030 Total Costs	2031 Man-months	2031 Total Costs	2032 Man-months	2032 Total Costs	Σ Man-months	Σ Total Costs
WP Category: Development		Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ				Σ	Σ
		Direct Labor Costs													
WP-6210	DWD		0		0		0		0		0		0	0,00	0
WP-6210	MeteoSwiss	2	31668	2	31668	2	31668	2	31668	2	31668		0	10,00	158.340
WP-7010	DWD	2,5	37587,5	4,5	67657,5		0		0		0		0	7,00	105.245
WP-7020	DWD		0	2	30070	1	15035	1	15035	1	15035		0	5,00	75.175
WP-7020	FMI	1	15770	1	15770	1	15770	1	15770	1	15770		0	5,00	78.850
WP-7020	RMI	1	13090	1	13090		0		0	1	13090	1	13090	4,00	52.360
WP-7020	SMHI	0,8	13219,2	0,8	13219,2	0,8	13219,2	0,8	13219,2	0,8	13219,2		0	4,00	66.096
WP-7030	DWD	4,5	67657,5		0		0		0	3,5	52622,5		0	8,00	120.280
WP-7040	DWD		0		0		0		0	1	15035		0	1,00	15.035
WP-7040	MeteoSwiss		0		0		0		0	3	47502		0	3,00	47.502
WP-7050	MeteoSwiss	1	15834	0,435834	6901		0		0		0		0	1,44	22.735
WP-7050	DWD	0,5	7517,5	0,5	7517,5		0		0		0		0	1,00	15.035
	Sub-total	106,8	1.637.285,70	164,4358	2.542.730,10	164,2	2.523.356,50	165,55	2.545.460,45	135,0664	2.088.506,76	11,7	186.441,80	747,7523	11.523.781,31
		Procurement/Material													
WP-5130	DWD						25000								25.000
WP-5130	RMI														0
WP-5230	DWD								25000						25.000
WP-5430	DWD								25000						25.000
WP-5430	RMI						2000		2000		2000				6.000
WP-5430	MeteoSwiss				2500										2.500
WP-5410	MeteoSwiss		2500												2.500
WP-5730	DWD								25000						25.000
WP-5420	MeteoSwiss						2500		2500						5.000
WP-5830	DWD				25000										25.000
	Sub-total		2500		27500		29500		79500						139.000

Detailed Cost Breakdown (WP)

WP Reference/Number	Consortium Member	2027 Man-months	2027 Total Costs	2028 Man-months	2028 Total Costs	2029 Man-months	2029 Total Costs	2030 Man-months	2030 Total Costs	2031 Man-months	2031 Total Costs	2032 Man-months	2032 Total Costs	Σ Man-months	Σ Total Costs
WP Category: Operations		Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ				Σ	Σ
		Direct Labor Costs													
WP-3110	DWD	3	45.105	3	45.105	3	45.105	6	90.210	6	90.210	2	30070	23	345.805
WP-3110	KNMI	0,2	3877	0,3	5816	0,3	5816	0,3	5816	0,3	5816	0,1	1939	1,5	29.080
WP-3110	MeteoSwiss		0		0		0		0		0		0		
WP-3110	RMI		0	1	13090	0,5	6545		0	1	13090	1	13090	3,5	45.815
WP-3110	SMHI	0,15	2478,6	0,2	3304,8	0,2	3304,8	0,2	3304,8	0,2	3304,8	0,05	826,2	1	16.524
WP-3120	DWD	3	45.105	4,5	67.658	4	60140	4	60140	6,5	97727,5	3	45105	25	375.875
WP-3120	FMI	1	15770	1	15770	1	15770	1	15770	1	15770		0	5	78.850
WP-3120	KNMI	0,2	3877	0,3	5816	0,3	5816	0,3	5816	0,3	5816	0,1	1939	1,5	29.081
WP-3120	RMI		0	0,5	6545		0		0	0,5	6545	0,5	6545	1,5	19.635
WP-3120	SMHI	0,2	3304,8	0,3	4957,2	0,3	4957,2	0,3	4957,2	0,3	4957,2	0,1	1652,4	1,5	24.786
WP-3130	DWD	3	45.105	3	45.105	2,5	37.588	2,5	37.588	2,5	37.588	2	30.070	15,5	233.043
WP-3130	FMI	0,5	7885	0,5	7885	0,5	7885	0,5	7885	0,5	7885		0	2,5	39.425
WP-3130	RMI		0	1	13090		0		0		0		0	1	13.090
WP-3130	SMHI	0,3	4957,2	0,2	3304,8	0,2	3304,8	0,1	1652,4	0,1	1652,4	0,1	1652,4	1	16.524
WP-3200	DWD	1,5	22552,5	2	30070	2,5	37587,5	1,5	22552,5	1,5	22552,5	1	15035	10	150.350
	sub-total	13,05	200.017,90	17,79998	267.516,10	15,29998	233.818,60	16,7	255.691,60	20,7	312.914,10	9,95	147.923,40	93,49996	1.417.881,69

		Procurement/Material													
WP-3110	DWD		15000								25000		10000		50.000,00
WP-3110	RMI														0,00
WP-3120	DWD		25000				25000								50.000,00
WP-3120	RMI														0,00
	Sub-total		40000				25000				25000		10000		100.000,00

Detailed Cost Breakdown (WP)

WP Reference/Number	Consortium Member	2027	2027	2028	2028	2029	2029	2030	2030	2031	2031	2032	2032	Σ	Σ
		Man-months	Total Costs	Man-months	Total Costs	Man-months	Total Costs	Man-months	Total Costs	Man-months	Total Costs	Man-months	Total Costs	Man-months	Total Costs
WP Category: User Services		Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ				Σ	Σ
		User support, Training, Workshops													
WP-2100	DWD	8,0	120280	9,0	135315	9,0	135315	10,0	150350	10,0	150350	2,0	30070	48,0	721.680
WP-2200	DWD	3,0	45105	3,5	52623	3,5	52623	4,0	60140	4,0	60140	1,0	15035	19,0	285.665
WP-2200	FMI		0		0		0		0		0		0	0,0	0
WP-2200	KNMI	0,1	1939	0,1	1939	0,1	1939	0,1	1939	0,1	1939		0	0,5	9.694
WP-2200	MeteoSwiss		0		0		0		0		0		0	0,0	0
WP-2200	RMI		0		0		0		0		0	0,5	6545	0,5	6.545
WP-2200	SMHI	0,1	1652	0,1	1652	0,1	1652	0,1	1652		0	0,1	1652	0,5	8.262
WP-2200	UKMO Science		0		0		0		0		0		0	0,0	0
WP-2300	DWD	1,5	22553	2,0	30070	2,5	37588	1,5	22553	1,5	22553	1,0	15035	10,0	150.350
WP-2300	FMI		0		0	1,0	15770	0,5	7885		0		0	1,5	23.655
WP-2300	KNMI		0	0,3	5816	0,4	7755	0,3	5816		0		0	1,0	19.387
WP-2300	MeteoSwiss		0		0		0		0		0		0	0,0	0
WP-2300	RMI		0	0,5	6545	0,5	6545		0		0		0	1,0	13.090
WP-2300	SMHI	0,4	6610	0,5	8262	0,5	8262	0,5	8262	0,5	8262		0	2,4	39.658
WP-2300	UKMO Science		0		0		0	0,3	3596	0,3	3596		0	0,5	7.192
WP-2400	DWD	1,0	15035	2,0	30070	1,0	15035	1,0	15035	1,0	15035		0	6,0	90.210
WP-2400	FMI	6,0	94620	4,0	63080	5,0	78850	4,0	63080	3,0	47310		0	22,0	346.940
WP-2400	KNMI	3,5	67855	3,0	58161	3,0	58161		0		0		0	9,5	184.177
WP-2400	MeteoSwiss		0		0		0		0		0		0	0,0	0
WP-2400	RMI	1,0	13090	2,0	26180		0		0		0		0	3,0	39.270
WP-2400	SMHI	2,0	33048	2,5	41310	2,7	44615	2,8	46267	1,0	16524	0,5	8262	11,5	190.026
WP-2400	UKMO Science	1,0	14384	2,0	28768	2,0	28768	2,0	28768	2,0	28768		0	9,0	129.456
WP-2500	DWD	1,5	22553	1,0	15035	0,5	7518	1,0	15035	1,0	15035		0	5,0	75.175
WP-2500	MeteoSwiss	1,0	15834	3,0	47502	3,0	47502	1,0	15834	1,0	15834	1,0	15834	10,0	158.340
WP-2500	UKMO Science	3,0	43152	6,0	86304	6,0	86304	6,0	86304	5,0	71920	1,0	14384	27,0	388.368
	Sub-total	33,1	517708	41,5	638632	40,8	634200	35,1	532516	30,4	457265	7,1	106817	187,9	2.887.139

Detailed Cost Breakdown (WP)

WP Reference/Number	**Consortium Member**														
		2027	**2027**	**2028**	**2028**	**2029**	**2029**	**2030**	**2030**	**2031**	**2031**	**2032**	**2032**	**Σ**	**Σ**
		Man-months	Total Costs	Man-months	Total Costs	Man-months	Total Costs	Man-months	Total Costs	Man-months	Total Costs	Man-months	Total Costs	Man-months	Total Costs
WP Category: User Services		Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ				Σ	Σ
		Consumables/Workshop													
WP-2300	DWD		9500		11400		11400		11400		11400		1900	0	57.000
WP-2300	FMI						1013		1013					0	2.025
WP-2300	KNMI		200		400		800		400		200			0	2.000
WP-2300	MeteoSwiss		333		400		400		400		400		67	0	2.000
WP-2300	RMI		172		206		206		206		206		34	0	1.030
WP-2300	SMHI		0		0		0		0		0		0	0	0
WP-2300	UKMO Science		400		480		480		480		480		80	0	2.400
	Sub-total		10605		12886		14299		13899		12686		2081	0,0	66.455
...	...														
		Conferences/Publications													
WP-2200	DWD		12203		14644		14644		14644		14644		2441	0	73.220
WP-2200	FMI		3667		4400		4400		4400		4400		733	0	22.000
WP-2200	KNMI		2880		3455		3455		3455		3455		576	0	17.277
WP-2200	MeteoSwiss		3667		4400		4400		4400		4400		733	0	22.000
WP-2200	RMI		2333		2800		2800		2800		2800		467	0	14.000
WP-2200	SMHI		4333		5200		5200		5200		5200		867	0	26.000
WP-2200	UKMO Science		2466		2959		2959		2959		2959		493	0	14.794
	Sub-total		31549		37858		37858		37858		37858		6310	0,0	189.291

Annex IX List of abbreviations

Abbreviations	Meaning
ABI	Advanced Baseline Imager
AC SAF	Atmospheric Composition Satellite Application Facility
AHI	Advanced Himawari Imager
AMSR-E	Advanced Microwave Scanning Radiometer
AMSU-B	Advanced Microwave Sounding Unit-B
ANN	Artificial Neural Network
ATBD	Algorithm Theoretical Basis Document
AQA	Annual Quality Assessment
ATSR	Along Track Scanning Radiometer
AVHRR	Advanced Very High Resolution Receiver
BSRN	Baseline Surface Radiation Network
BTR	Brightness Temperature Record
C3S	Copernicus Climate Change Service
CAL	Cloud Albedo
CALIOP	Cloud-Aerosol Lidar with Orthogonal Polarisation
CALIPSO	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations
CCI	Climate Change Initiative
CDOP	Continuous Development and Operations Phase
CDR	Climate Data Record
CDS	(Copernicus) Climate Data Store
CEOS	Committee on Earth Observation Satellites
CA	Cloud amount
CERES	Clouds and Earth’s Radiant Energy System
CFC	Fractional Cloud Cover
CGMS	Coordination Group for Meteorological Satellite
CLAAS	CM SAF cLoud property dAtAset using SEVIRI
CLARA-A	CM SAF cLoud, Albedo & Radiation data–et – AVHRR-based
Cld	Cloud products
CM	Climate Monitoring
CMA	Cloud Mask
CMEMS	Copernicus Marine Environment Monitoring Service
CMS	Content Management System
CM SAF	Satellite Application Facility on Climate Monitoring
CNES	Centre National d’Etudes Spatiales
CNR	Consiglio Nazionale delle Ricerche
CNRS	Centre National de la Recherche Scientifique
COT	Cloud Optical Thickness
CPH	Cloud (Thermodynamic) Phase
CSCS	Swiss National Supercomputing Centre
CTH	Cloud Top Height
CTO	Cloud Top parameters
CTP	Cloud Top Pressure

CTT	Cloud Top Temperature
CWP	Cloud (Liquid) Water Path
DAL	DayLight
DEM	Digital Elevation Model
DOI	Digital Object Identifier
DRR	Delivery Readiness Review
DWD	Deutscher Wetterdienst (German Meteorological Service)
EarthCARE	Earth Clouds, Aerosol and Radiation Explorer
EASE-grid	Equal-Area Scalable Earth Grid
ECMWF	European Centre for Medium-Range Weather Forecast
ECV	Essential Climate Variable
EMP	Evaporation – Precipitation
EQC	Equilibrium Criterion
EPS	EUMETSAT Polar System
ERA	ECMWF Reanalysis
ERB	Earth Radiation Budget
ESA CCI	European Space Agency Climate Change Initiative.
ETCCDI	Expert Team on Climate Change Detection and Indices
EUM	EUMETSAT
EUMETCast	EUMETSAT's Broadcast System for Environmental Data
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EUMETSAT EO	EUMETSAT Earth Observation
EVA	Evaporation
FA	Federate Activity
FAQ	Frequently Asked Questions
FCDR	Fundamental Climate Data Record
FCI	Flexible Combined Imager
FIDUCEO	Fidelity and Uncertainty in Climate data records from Earth Observations
FMI	Finnish Meteorological Institute
FTH	Free Tropospheric Humidity
ftp	file transfer protocol
GAC	Global Area Coverage
GCOM-W	Global Change Observation Mission for Water
GCOS	Global Climate Observing System
GDAP	GEWEX Data and Assessments Panel
GERB	Geostationary Earth Radiation Budget
GEWEX	Global Energy and Water cycle Exchanges
GMI	Global Microwave Imager
GOES	Geostationary Operational Environmental Satellite
GOSAT-GW	Global Observation SATellite for Greenhouse gases and Water cycle
GPCC	Global Precipitation Climatology Centre
GPCP	Global Precipitation Climatology Project
GPM	Global Precipitation Mission
GVAP	Global Water Vapour Project
HANNA	High-resolution europeAN surface radiatioN dAta record

HIRS	High-resolution Infrared Radiation Sounder
HOAPS	The Hamburg Ocean Atmosphere Fluxes and Parameters from Satellite data
HPC	High Performance Computing
HTTP	HyperText Transfer Protocol
HTW	Vertical integrated water vapour information
IBM	International Board meeting
ICDR	including related documentation; Interim climate data record
ICON	ICOsahedral Nonhydrostatic
IFS	Interchange File Separator
IPCC AR6	Intergovernmental Panel on Climate Change Assessment Report 6
ISAC	Institute of atmospheric sciences and climate
ISCCP	International Satellite Cloud Climatology Project
IWP	Ice Water Path
JCH	Joint Cloud Histogram
JRC	Joint Research Centre
KNMI	Koninklijk Nederlands Meteorologisch Instituut (Royal Meteorological Institute of the Netherlands)
L1g	Level 1 data from the ring of geostationary satellites, all in one format, on the same grid and in the same resolution
LAI	Leaf Area Index
LE	Leading Entity
LEGOS	Laboratoir‘ d‘Etudes en Géophysique et Océanographie Spatiale
LEO	Low earth orbit
LHF	Latent Heat Flux
LIDAR	Light detection and ranging
LMD	Laboratory of Dynamic Meteorology
LSA SAF	Land Surface Analysis Satellite Applications Facility
LST	Land Surface Temperature
LWP	Vertically integrated liquid water
METEOSAT	Meteorological Satellite
MeteoSwiss	Meteorological Service of Switzerland
METimage	Meteorological Imager
MetOp	Meteorological Operational Polar Satellite of EUMETSAT
MHS	Microwave Humidity Sounder
MODIS	Moderate Resolution Imaging Spectroradiometer
MSG	Meteorological Satellite Second Generation
MVIRI	Meteosat Visible and InfraRed Imager
MWR	Microwave Radiometer or Millimeter Wave Radar
MWRI	Microwave Radiometer Imager
NCR	Non Conformance Report
NIR	Near-InfraRed
NMHS	National Meteorological and Hydrological Service
NOAA	National Oceanic & Atmospheric Administration
NRT	Near Real Time

NWP	Numerical Weather Prediction
NSH	Near Surface Humidity
NWC SAF	SAF in Support to Nowcasting and Very Short Range Forecasting
NWP	Numerical Weather Prediction
OLR	Outgoing longwave radiation
OP	Operational
OpsRep	Operations Report
OR	Operation Reviews
OSCAR	Observing Systems Capability Analysis and Review Tool
OSI SAF	Ocean and Sea Ice Satellite Application Facility
PA	Product Availability
PATMOS-x	Pathfinder Atmospheres Extended
PC	Product Completeness
PO	Pre-Operational
PP	Project Plan
PPS	Polar Platform System
PRD	Product Requirement Document
PRE	Precipitation
PUM	Product User Manuals
QA	Quality assessment
Rad	surface Radiation product
RCC	Regional Climate Centre
RD	Reference Documents
RMIB	Royal Meteorological Institute of Belgium
RMS	Root mean square deviation
RO	Radio Occultation
ROM SAF	Satellite Application Facility on Radio Occultation Meteorology
RR	Requirement Review
SAF	Satellite Application Facility
SAL	Surface Albedo
SARAH	SurfAce Solar RAdiation data set – Heliosat
SCR	System Change Reports
SDL	Surface Downward Long-Wave Radiation
SeSp	Service Specification
SEVIRI	Spinning Enhanced Visible and Infrared Imager
Sfc	Surface
SID	Surface Incoming Direct radiation
SLSTR	Sea and Land Surface Temperature Radiometer
SIS	Solar Incoming Surface radiation
SMHI	Swedish Meteorological and Hydrological Institute
SMMR	Scanning Multichannel Microwave Radiometer
SMR	Software Modification Report
SNL	Surface Net Long-wave radiation
SNS	Surface Net Short-wave radiation
SOL	Surface Outgoing Long-wave radiation

SPR	Software Problem Reports
SRB	Surface Radiation Budget
SS	Service Specification
SSMI	Special Sensor Microwave Image
SSMIS	Special Sensor Microwave Imager Sounder
SSM/I	Special Sensor Microwave Imager
SSM/T2	Special Sensor Microwave/Temperature & Humidity Profile
SST	Sea Surface Temperature
SUMET	CM SAF land SUrface temperature dataset from METeosat first and second generation
SW	SoftWare
SWS	near Surface Wind Speed
SYNOP	Surface synoptic observations
tbc	To be continued
tbd	To be done
TCDR	Thematic Climate Data Record
TCWV	Total column water vapour
TESSEL	Tiled ECMWF Scheme for Surface Exchanges over Land
TET	Emitted Thermal radioactive flux at the Top of the atmosphere
TIS	Incoming Solar radioactive flux at the Top of the atmosphere
TOA	Top Of the atmosphere product
TRS	Reflected Solar radioactive flux at the Top of the atmosphere
UHD	User Help Desk
UKMO	National Weather Service of the United Kingdom
UK MetOffice	National Weather Service of the United Kingdom
UTH	Upper Tropospheric Humidity
VAL	VALidation report
VIS	Visible Spectrum
VS	Visiting Scientist
WCRP	World Climate Research Programme
WFS	Weather System Follow-on
WMO	World Meteorological Organisation
WP	Work Package
WUI	Web User Interface
WWW	World Wide Web / World Weather Watch (WMO)

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