The climate monitoring SAF TOA radiation products

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Content:

• Brief introduction to Climate Monitoring Satellite Application Facility (CM SAF) – illustrations of available products/datasets
• CM SAF GERB/SEVIRI TOA radiation dataset (edition 1)
• Developments toward an edition-2
• Summary
What is CM SAF?

- Climate products from (weather) satellites
- Part of EUM ground segment
- Products target the energy and water cycles
- 3 types of products:
  - EDR = Environmental Data Record
  - ICDR = Interim Climate Data Record
  - TCDR = Thematic Climate Data Record
- Global/regional products
- Polar and geo satellites
- User’s oriented programme: help desk, web user interface, data ordering system, users training events, ...
- Operational: annual quality ass. Review, operation reviews, ...
- Guidance from a steering group, visiting scientist programme, ...

http://www.cmsaf.eu

also

CM SAF will have a “booth” at the Climate Symposium next week.
CM SAF datasets delivery schedule

temporal coverage of CDR

- TCDS SSM/I Ed. 2
- HOAPS
  - 2017
- TCDR SSM/I + SSMIS Ed. 2
- Cloud, Radiation, LST, FTH
- TCDR TOVS/ATOVS Ed. 1
- Clouds
  - 2016
- TCDR MW_WV_T Ed. 1
- Water vapour, temp
- TCDR SEVIRI Ed. 2
  - 2015
- TCDR AVHRR GAC Ed. 2
- Cloud, Radiation & Surface Albedo
- TCDR MVIRI/SEVIRI/GERB Ed. 1
  - 2014
- TCDR MVIRI/SEVIRI Ed. 1
- ToA fluxes
- TCDR SEVIRI 1S' cloud ed. 1
  - 2013
- TCDR AVHRR GAC Ed. 1
- Cloud & Radiation
- TCDR MVIRI/SEVIRI Ed. 1
  - 2012
- TCDR MVIRI/SEVIRI Ed. 1
- OTH
- TCDR SSM/I Ed. 1
  - 2011
- TCDR MVIRI Ed. 1
- Cloud & Radiation
- TCDR SSM/I Ed. 1
  - 2010
- TCDR ATOVS Ed. 1
- Water Vapour
- TCDR SEVIRI Ed. 1
  - 2009
- TCDR AVHRR LAC Ed. 1
- A&F
- TCDR SEVIRI Ed. 1
  - 2008
- TCDR ATOVS Ed. 1
- Regional
- TCDR SEVIRI Ed. 1
  - 2007
- TCDR AVHRR LAC Ed. 1
- Europe
- TCDR SEVIRI Ed. 1
  - 2006
- TCDR AVHRR LAC Ed. 1
- Europe
- TCDR SEVIRI Ed. 1
  - 2005
- TCDR AVHRR LAC Ed. 1
- Europe
- TCDR SEVIRI Ed. 1
  - 2004
Surface albedo in the Arctic

Monthly mean, 15x15 km², 200904
SAL is based on the FMI retrieval algorithm, here applied to AVHRR.
Surface albedo in the Arctic

Monthly mean 200906
Enables the monitoring of the Arctic melting season.
Clouds diurnal cycle
Meteosat Second Generation

Cloud phase
- water
- ice
- cloud-free

Cloud optical thickness

0  7  14  21  28  35  42  49  56  63  70
Utilises AAPP and IAPP to derive water vapour and temperature profiles from ATOVS observations from NOAA-15, -16, -18 and -19 and MetOp satellites.

Swath-based output of IAPP is quality controlled, vertically integrated and averaged into 5 atm. layers.

A Kriging routine (Lindau+Schulz, 2004) is applied to provide:
- global products on equal area (90 km)$^2$ grid (left), standard deviations (right),
- daily and monthly averages.

Example for October 2004
TOA radiation EDRs

- TIS : TOA Incoming Solar
- TRS : TOA Reflected Solar
- TET : TOA Emitted Thermal

- Monthly mean
- Daily mean
- Monthly mean diurnal cycle

- Not homogeneous time series
- Produced in NRT since 2004

Example for February 2004
CDR of Surface Radiation products

Solar surface radiation (SIS) (1983-2010)
- e.g. application for Photovoltaic systems
- Accuracy: 10 W/m², high spatial-temporal resolution
Global CDR AVHRR GAC
cloud properties

Cloud Fractional Coverage (CFC)
- First global CM SAF AVHRR GAC cloud data sets
- Temporal coverage 1982 to 2009

Animation of monthly mean cloud fraction for July (2001 - 2009)
Global Surface solar radiation
5-year mean (top)

20 year monthly mean of July in Europe (right)
Hamburg Ocean-Atmosphere Parameters and fluxes from Satellite data (HOAPS) TCDR

- Thematic Climate Data Records from HOAPS released as HOAPS v3.2. Covered time period from 1987 until 2008 using observations from F08, F10, F11, F13, F14 and F15

- Parameters are: near surface wind speed, near surface humidity, precipitation, latent heat flux, evaporation, freshwater flux, ...

- Products available as monthly means and 6-hourly composites on a regular lat-lon grid at 0.5 degree resolution, products also available on native SSM/I resolution on request

Mean precipitation (mm/d, 1987-2008)

Annual cycle of zonal mean prec. (mm/d)
CM SAF GERB/SEVIRI TOA radiation dataset: edition-1

- Released in 2013
- All sky TRS and TET
- SEA grid 45km
- In NetCDF CF conv.
- Monthly Mean (MM), Daily Mean (DM) and Monthly Mean Diurnal Cycle (MMDC = M1hour)

Illustration of Monthly Mean (MM)
Illustration: TOA radiation daily means
Illustration: TOA radiation monthly mean diurnal cycle

CM SAF TOA Fluxes Diurnal Cycle [00:01] UTC, Month 200407
CM SAF GERB/SEVIRI TOA rad. dataset validation

Estimated uncertainty at 1-sigma:

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Monthly mean</td>
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<td>6.2 W/m²</td>
<td>4.6 W/m²</td>
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<td>MM diurnal cycle</td>
<td>14.5 W/m²</td>
<td>4.3 W/m²</td>
</tr>
</tbody>
</table>

(See Validation Report)
Validation: stability of the MM products

+/-0.6 %/ years wrt EBAF
TRS MM validation: intercomparison with CERES

RMS difference with CERES EBAF ~ 3 W/m²
TET MM validation : intercomparison with CERES

RMS difference with CERES EBAF ~ 2 W/m²
Toward CM SAF GERB/SEVIRI dataset ed02
Improvements wrt ed01

Edition-1
(released in 2013)

- GERB with masked sun-glint and terminator
- SEA (45km)² grid
- Allsky TRS and TET
- No aging correction
- Recalibration to GERB-1 level

- Only operational satellite

Edition-2
(to be released mid-2015)

- Improved GERB data at input (filled HR files)
- GERB HR geo grid (9km² sub-sat)
- Allsky and clearsky TRS and TET
- GERB and SEVIRI SW aging corrections
- Recalibration to average of GERB-1 and GERB-2 level (TBC with GERB instrument principal scientist)
- Also use data from the backup MSG satellites in case of decontamination/failure
Edition-2 processing overview

GERB level-2 HR files

GERB-like Level-2 HR files

CM SAF cloud mask

Data preprocessing

Clear sky processing

Daily and monthly averaging

Daily mean

Monthly mean

Monthly mean diurnal cycle

"cmsaf instantaneous clearsky fluxes"

"cmsaf instantaneous clearsky fluxes"
GERB / GERB-like data preprocessing - SW

Aging correction (see after)
GERB / GERB-like data preprocessing - LW

GERB-2 (MSG1) → GERB-like corr., see §5.2.5 → Recalib. See §5.2.6 → Thermal ADM correction see §5.2.7

GERB-like (MSG1) → GERB-like corr., see §5.2.5 → Recalib. See §5.2.6 → Thermal ADM correction see §5.2.7

GERB-1 (MSG2) → GERB-like corr., see §5.2.5 → Recalib. See §5.2.6 → Thermal ADM correction see §5.2.7

GERB-like (MSG2) → Not used

GERB-3 (MSG3) → GERB-like corr., see §5.2.5 → Recalib. See §5.2.6


cmsaf instantaneous 15’ TET fluxes
SW aging correction

- Based on clear desert region or DCC (TBC)
- Linear temp. drift (desert):

<table>
<thead>
<tr>
<th></th>
<th>GERB</th>
<th>GERB-like</th>
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</thead>
<tbody>
<tr>
<td>MSG1 (GERB2)</td>
<td>-0.696% /year</td>
<td>-0.51% /year</td>
</tr>
<tr>
<td>MSG2 (GERB1)</td>
<td>-0.643% /year</td>
<td>-0.46% /year</td>
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</table>

- Overall level correction:

<table>
<thead>
<tr>
<th></th>
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<th>GERB-like</th>
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</thead>
<tbody>
<tr>
<td>MSG1</td>
<td>0.9776</td>
<td>1.0379</td>
</tr>
<tr>
<td>MSG2</td>
<td>1.0235</td>
<td>1.0309</td>
</tr>
</tbody>
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- Time series GX
- at 12UTC
- VZA<70°

- Time series SAF

B. DESERT
D. DESERT
B. VEGE
D. VEGE
OCLEAN
<table>
<thead>
<tr>
<th></th>
<th>ed01</th>
<th>ed02</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>full</td>
<td>MSG1</td>
</tr>
<tr>
<td>ocean</td>
<td>-0.76%</td>
<td>-0.81%</td>
</tr>
<tr>
<td></td>
<td>/ year</td>
<td>/ year</td>
</tr>
<tr>
<td>dark vege.</td>
<td>-0.81%</td>
<td>-0.82%</td>
</tr>
<tr>
<td></td>
<td>/ year</td>
<td>/ year</td>
</tr>
<tr>
<td>bright vege.</td>
<td>-0.90%</td>
<td>-0.64%</td>
</tr>
<tr>
<td></td>
<td>/ year</td>
<td>/ year</td>
</tr>
<tr>
<td>dark desert</td>
<td>-0.90%</td>
<td>-0.91%</td>
</tr>
<tr>
<td></td>
<td>/ year</td>
<td>/ year</td>
</tr>
<tr>
<td>bright desert</td>
<td>-0.81%</td>
<td>-0.56%</td>
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**Residual drift / anomalies**

**Time series GX**

**Time series SAF**
Clearsky processing

- General method: average the closest in time N (=5) clear sky observations for the same repeat cycle of the day
- Based on CM SAF cloud mask (CM-21012)
- Reject “dust events” (IR flagging) i.e. AOD ~> 0.4
- Fresh snow processing (N=1)
- Post-processing for ocean
Example of comparison with CERES EBAF 2.7r

No aerosol ADM for GERB? Or different aerosol processing in the clearsky products?
Summary

• Several datasets/products available in CM SAF ([http://www.cmsaf.eu](http://www.cmsaf.eu))
• A first edition of the GERB/SEVIRI TOA radiation dataset is available
• The 2nd edition is expected to reduce most of the known problems with the dataset (e.g. aging) and also extend the validations and documentation.
• This 2nd edition will also provide clear sky fluxes e.g. for cloud forcing studies
• Preliminary (pre-released) data can be made available for beta-testing
Thank you!
Validation of the daily mean products: TRS accuracy

Accuracy $\sim 5 \text{ W/m}^2$ ($\sim 5\%$)
Validation of the daily mean products: TET accuracy

Accuracy ~ 4 W/m² (~ 2 %)

Uncertainties of the daily means products

Accuracy ~ 4 W/m² (~ 2 %)
Validation of the monthly mean diurnal cycle
“Diurnal cycle” from CERES
Summary of the validation
(1 σ uncertainty)

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Solar Irradiation at Surface (SIS)

\[ SIS = (n-1) \text{SIS}_{\text{clear}} \]

Clear sky model
gnu-MAGIC

Cloud Index 1.7.2005, 11 h UTC
TOA radiation dataset: edition-2

- GERB/SEVIRI ed01 dataset
  - Released in 2013
  - 2004-2010
  - All sky TRS and TET
  - MM, DM, MMDC
  - SEA grid 45km

- GERB/SEVIRI ed02 dataset
  - In development, release foreseen 2015
  - 2004-2012
  - All sky and clear sky TRS and TET
  - MM, DM, MMDC
  - GEO grid 9km

- MVIRI/GERB/SEVIRI ed02 dataset
  - In development, release foreseen 2015
  - 1982-2014
  - All sky TRS and TET
  - MM, DM, MMDC
  - Lat-lon grid 0.05°

- All datasets in NetCDF CF convention
- Synergy between products
Illustration: TOA radiation monthly means