

Koninklijk Meteorologisch Instituut België

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Preliminary Validation of 18 Years of Broadband Radiation Data from the Geostationary Earth Radiation Budget (GERB) Instruments

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In collaboration with Rutherford Appleton Laboratory (RAL), UK

04 July 2022

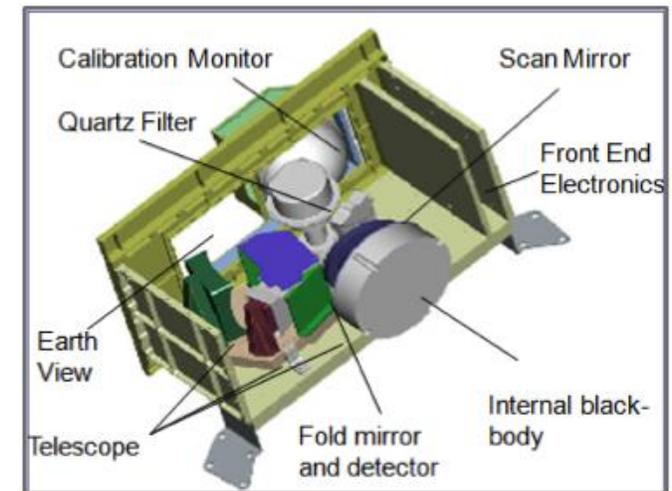
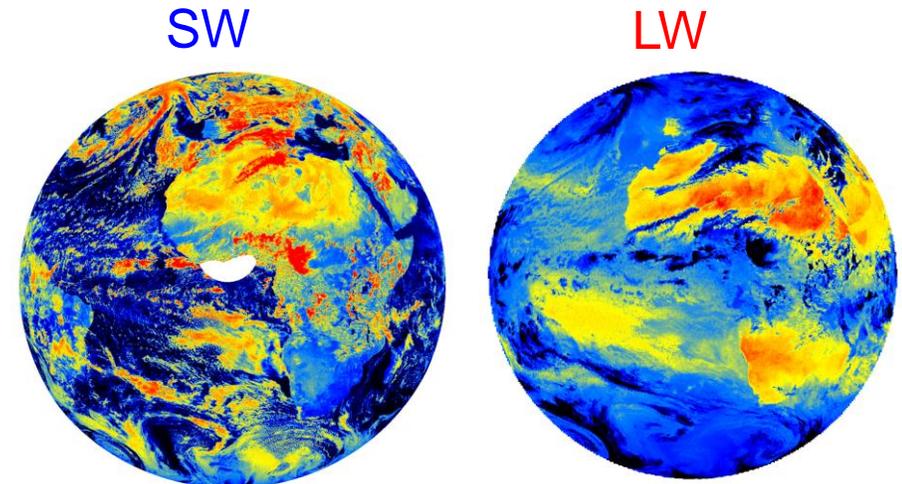
International Radiation Symposium (IRS) 2022, Thessaloniki, Greece

- **Geostationary Earth Radiation Budget (GERB)** instruments on Meteosat Second Generation (MSG) satellites 1 – 4
- Only geostationary broadband radiometer providing TOA SW and LW fluxes:

	Shortwave (SW)	Longwave (LW)*
Spectral range	0.32 μm – 4 μm	4 μm – 100 μm
Absolute accuracy	< 2.25 %	< 1.00 %

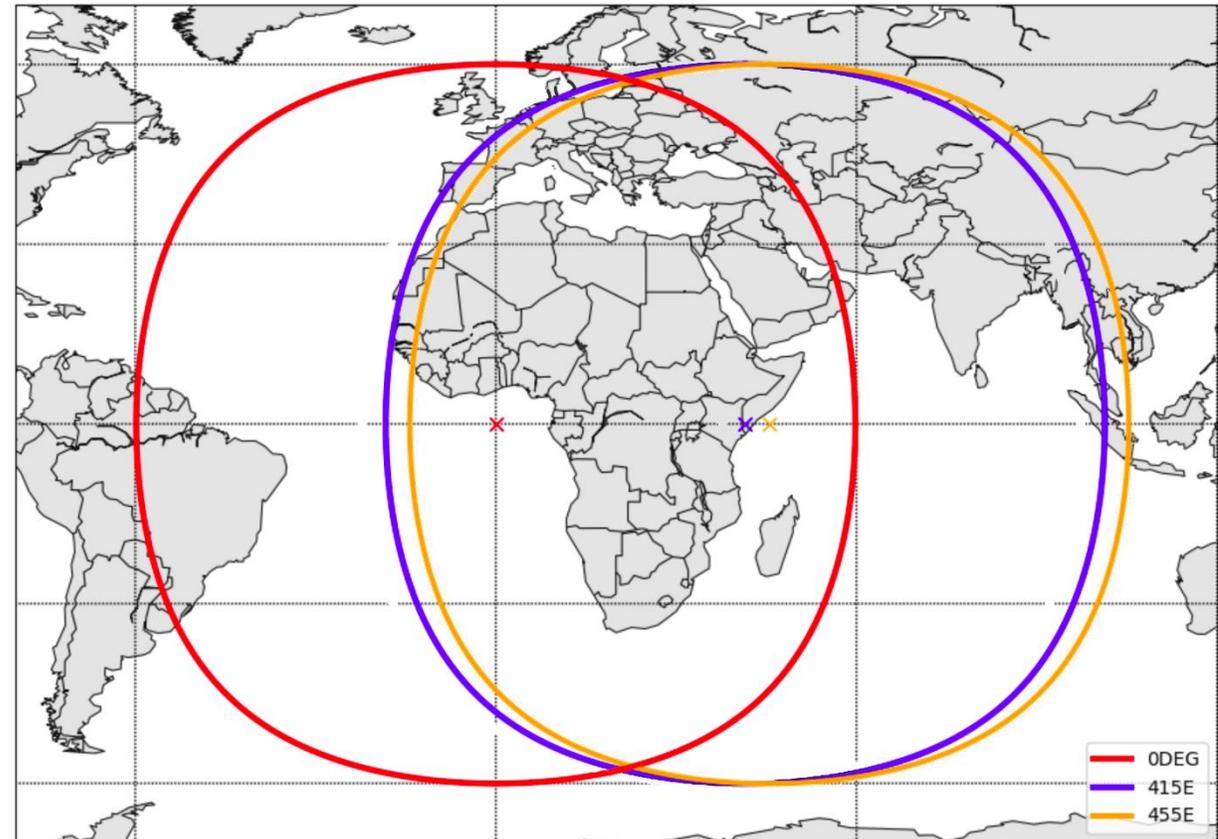
* Generated by subtracting the shortwave from the measured totalwave.

- Nominal spatial resolution at nadir: 50 km
- Full scan time: 6 min
- High-resolution Level-2 product:
 - Spatial resolution: 9 km x 9 km
 - Temporal resolution: 15 min

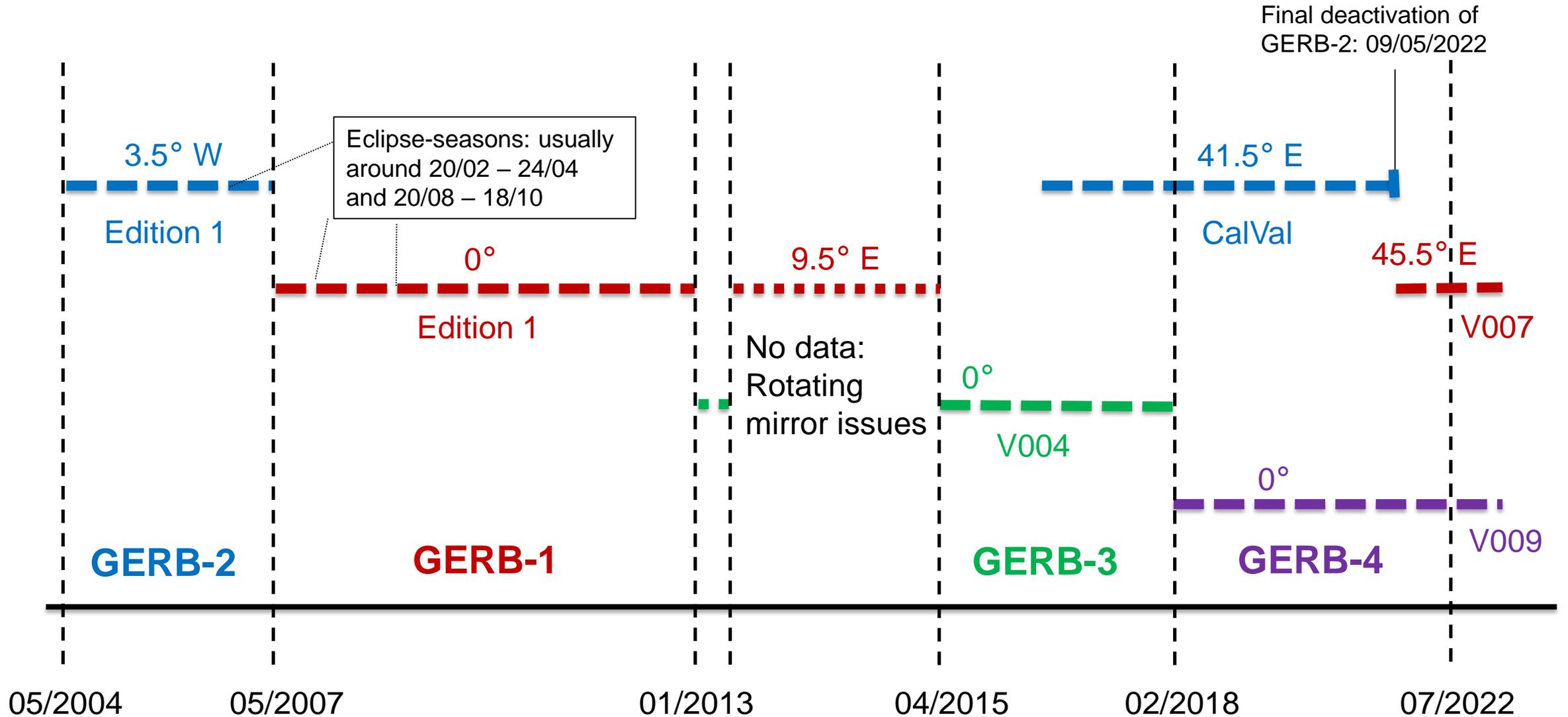


Harries et al., 2005

- Position and field of view ($\pm 60^\circ$ longitude and latitude from sub-satellite point).
- Since 2004, primary instrument at 0° longitude (**red**).
- 2016 - 2022, instrument at 41.5° E (**blue**).
- Since 2022, instrument at 45.5° E (**yellow**).



Introduction GERB: Timeline



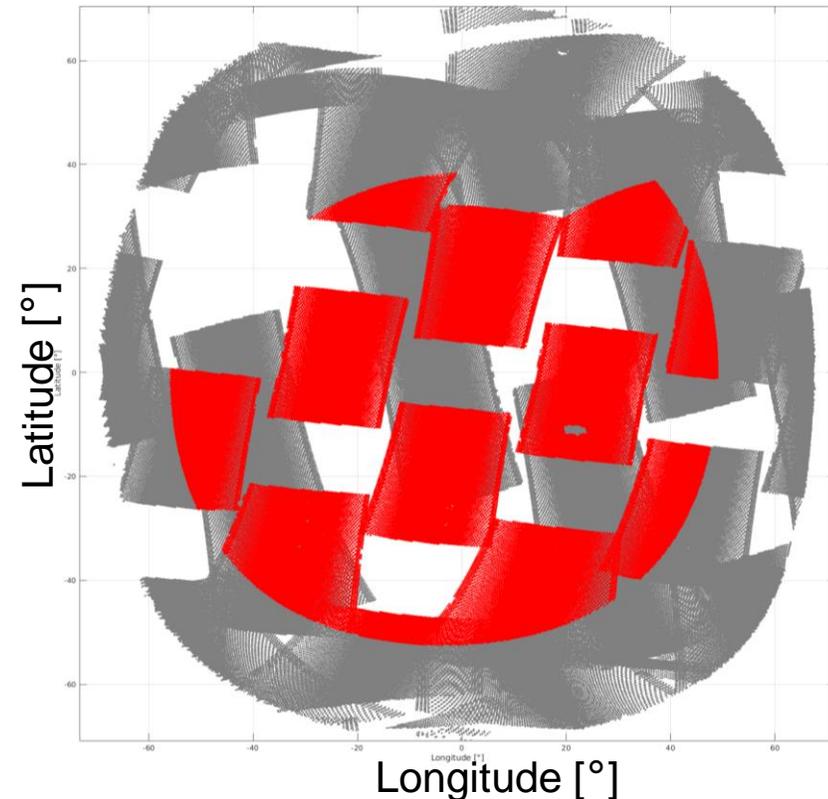
- **Clouds and the Earth's Radiant Energy System (CERES) (Wielicki et al., 1996; Loeb et al., 2016):**
 - FM1 and FM2 on Terra satellite
 - FM3 and FM4 on Aqua satellite
 - FM5 on Suomi-NPP satellite
 - FM6 on JPSS-1 satellite
 - Broadband instrument on polar orbiting satellites
- **GERB-like (internal product)**
 - Narrowband to broadband data based on SEVIRI data
 - Narrowband instrument on MSG satellites

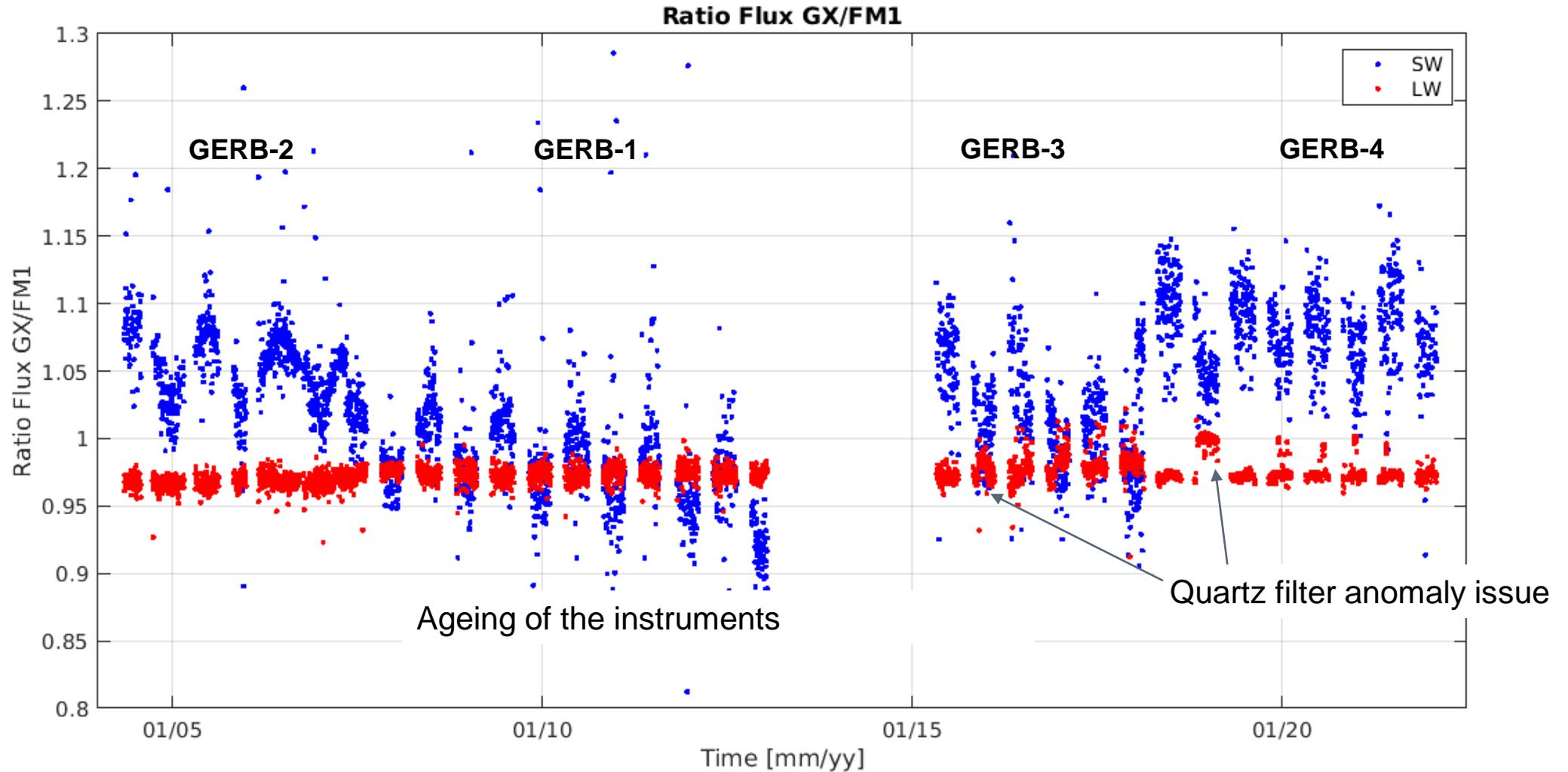
- CERES Single Scanner Footprint (SSF) data FM1 Edition 4A
- Taking into account the Point-Spread-Functions (PSF) of GERB and CERES
- **Conditions for Flux validation:**
 - Maximum time difference: 5 min
 - Maximum tilt-angle: 180°
 - **Maximum solar zenith angle (SZA): 60°**
 - **Maximum viewing zenith angle (VZA): 60°**
- **Calculation daily mean ratio:**

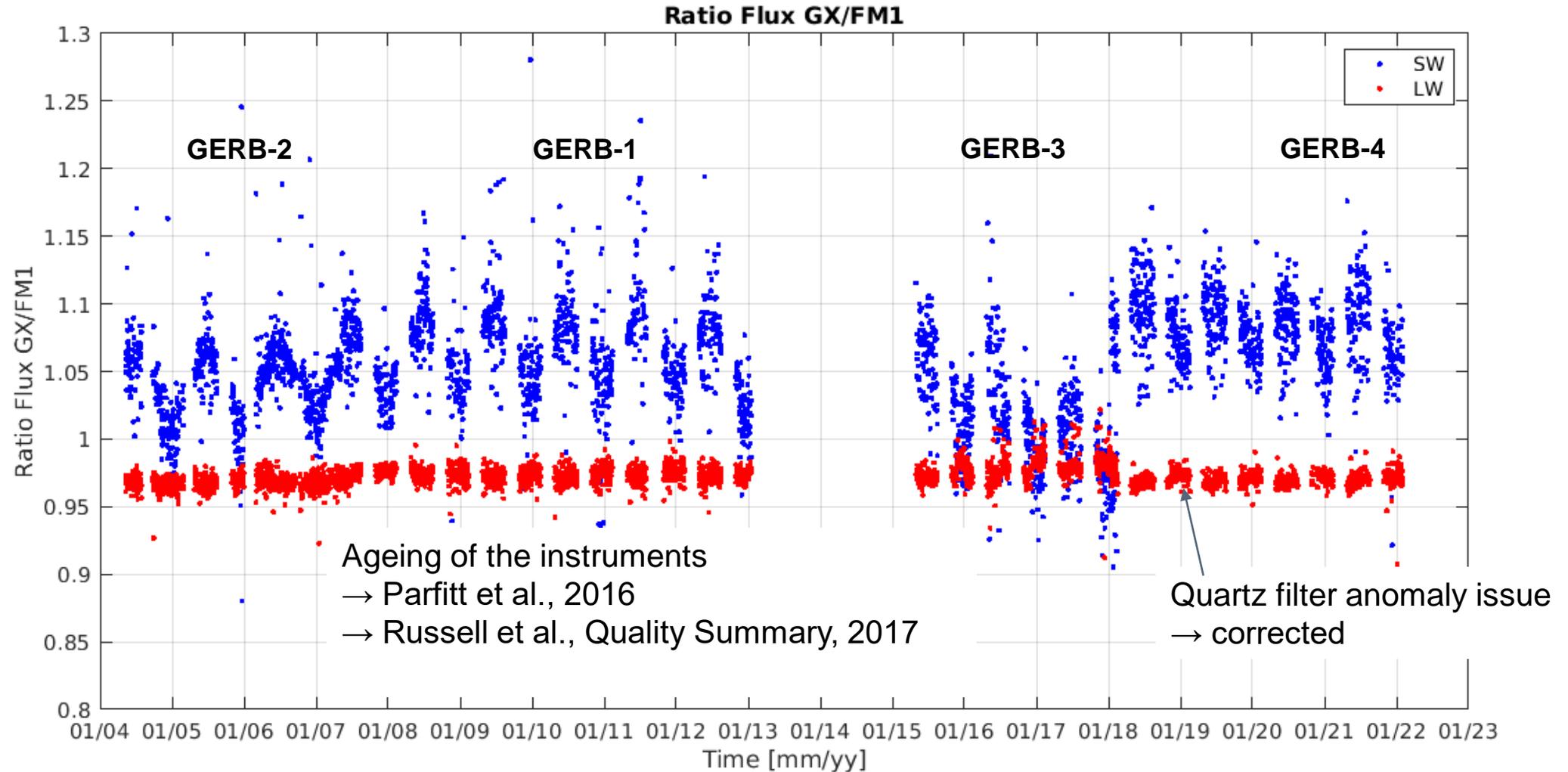
$$\text{Daily mean ratio} = \frac{\sum_{p=1}^N F_p(\text{GERB})}{\sum_{p=1}^N F_p(\text{FM1})}$$

F: Flux

p: Matching point

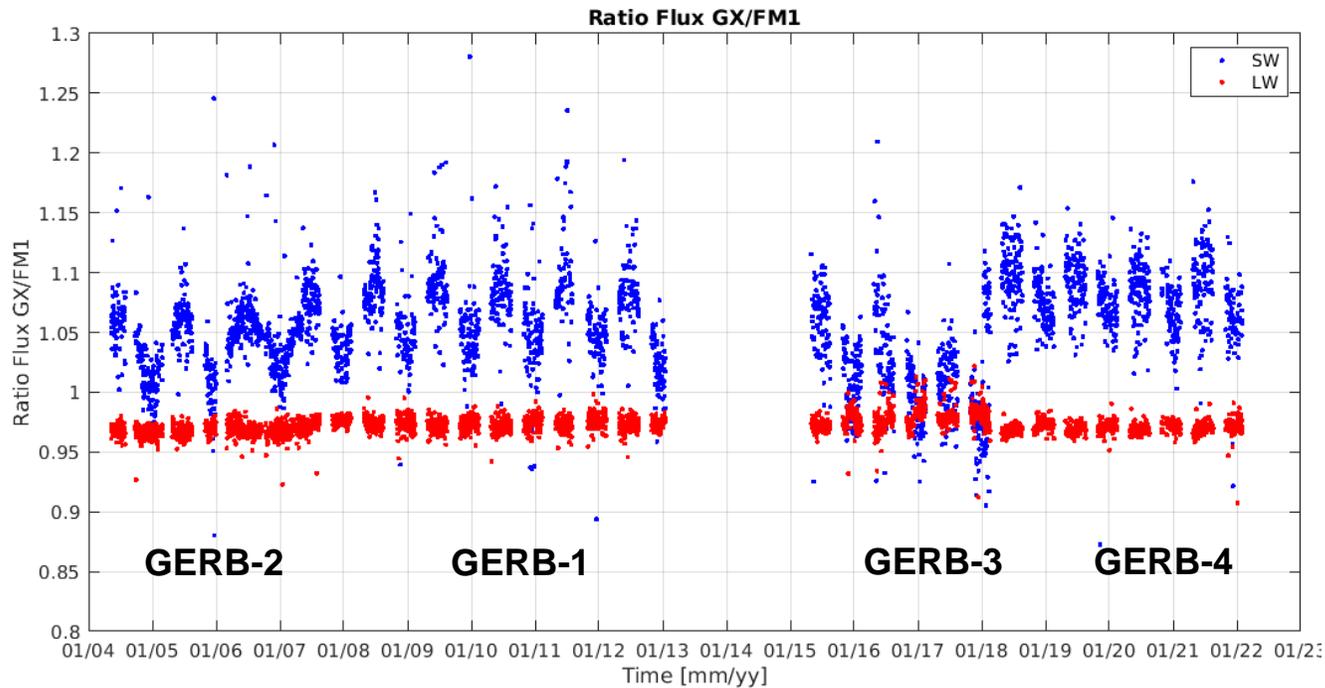








Daily mean ratio GERB/CERES-SSF-FM1



Daily mean ratio

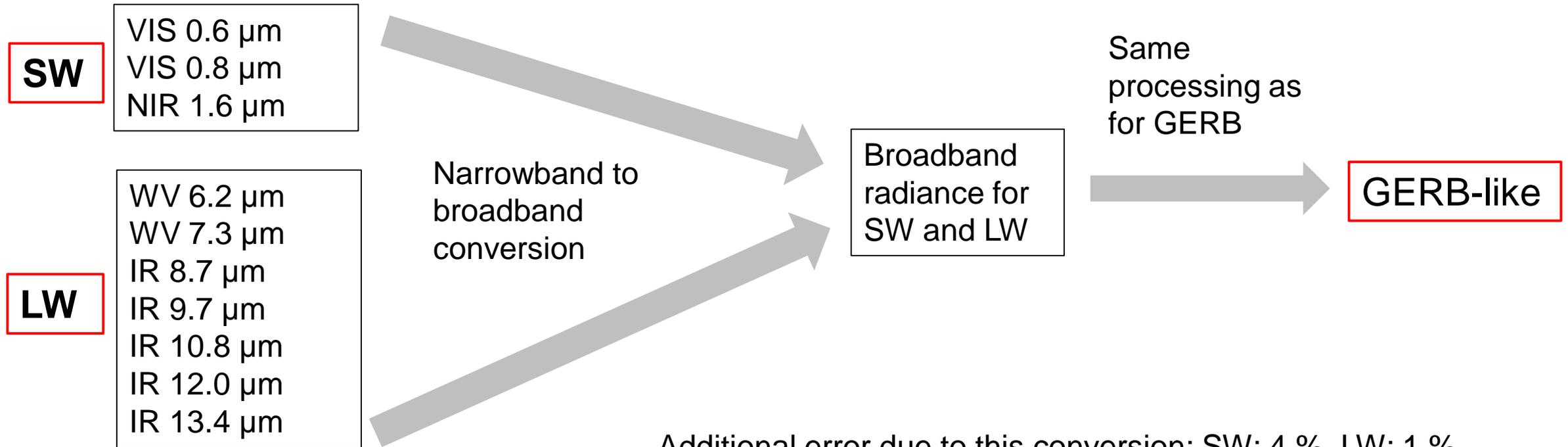
	SW	LW
GERB-2/FM1	1.05	0.97
GERB-1/FM1	1.07	0.97
GERB-3/FM1*	1.01*	0.98*
GERB-4/FM1	1.08	0.97

*GERB-3 has noticeable issues in the data set → be cautious with these values.

- GERB-2 and GERB-1 SW fluxes are 5 – 7 % higher than the ones from CERES FM1.
- GERB-4 SW fluxes are 8 % higher than the ones from CERES FM1.
- GERB LW fluxes are 2 – 3 % lower than the CERES FM1 LW fluxes.
- Similar values when comparing GERB with other CERES FM's (not shown).

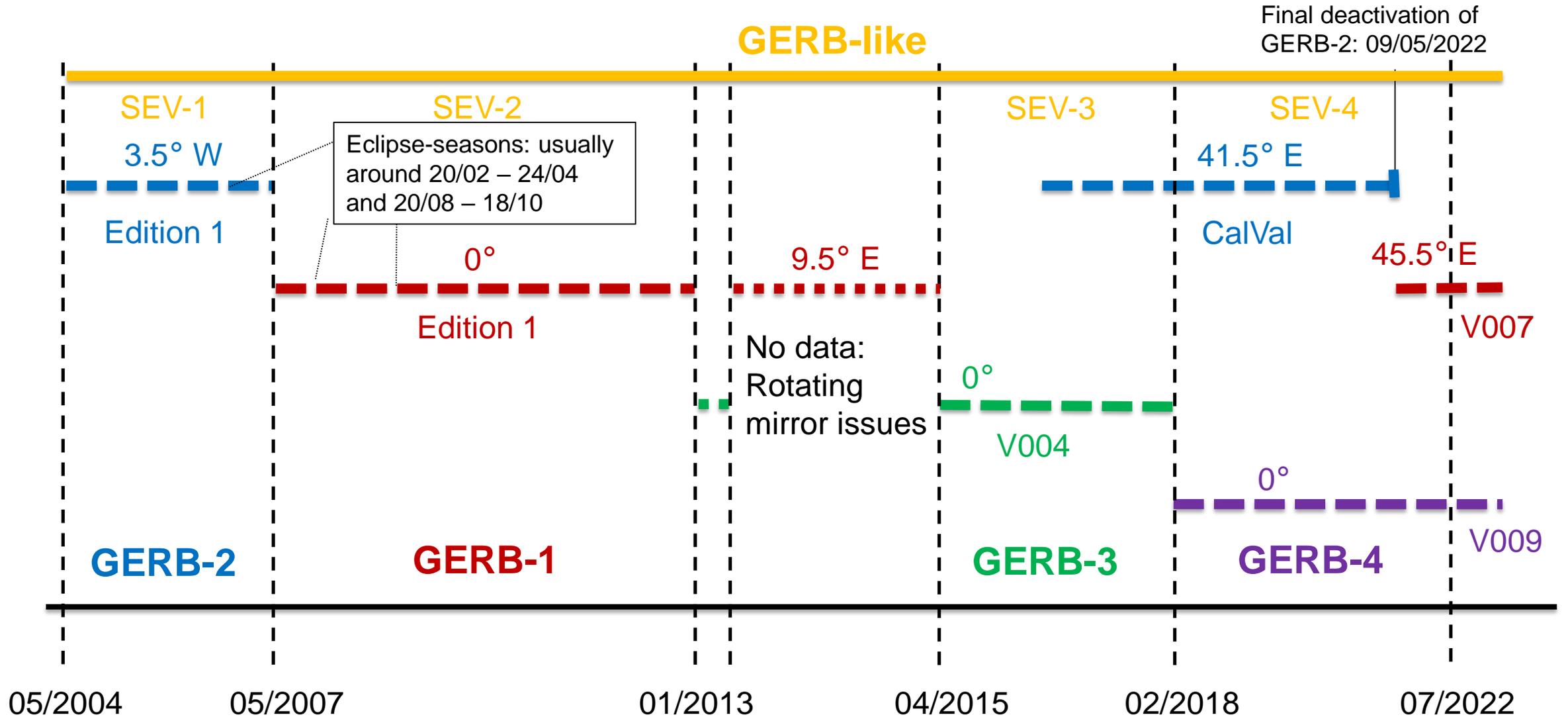
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 - FM6 on JPSS-1 satellite
 - Broadband instrument on polar orbiting satellites
- **GERB-like (internal product)**
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 - Narrowband instrument on MSG satellites

Spinning Enhanced Visible and InfraRed Imager (SEVIRI) on MSG:





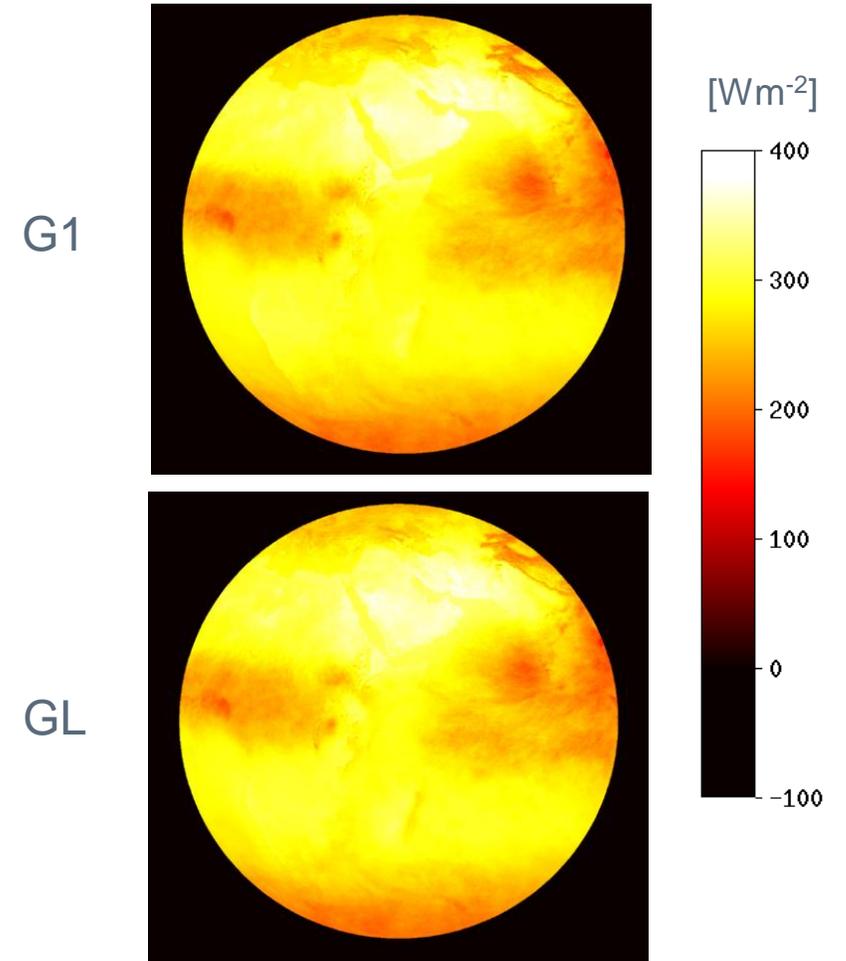
Introduction GERB: Timeline

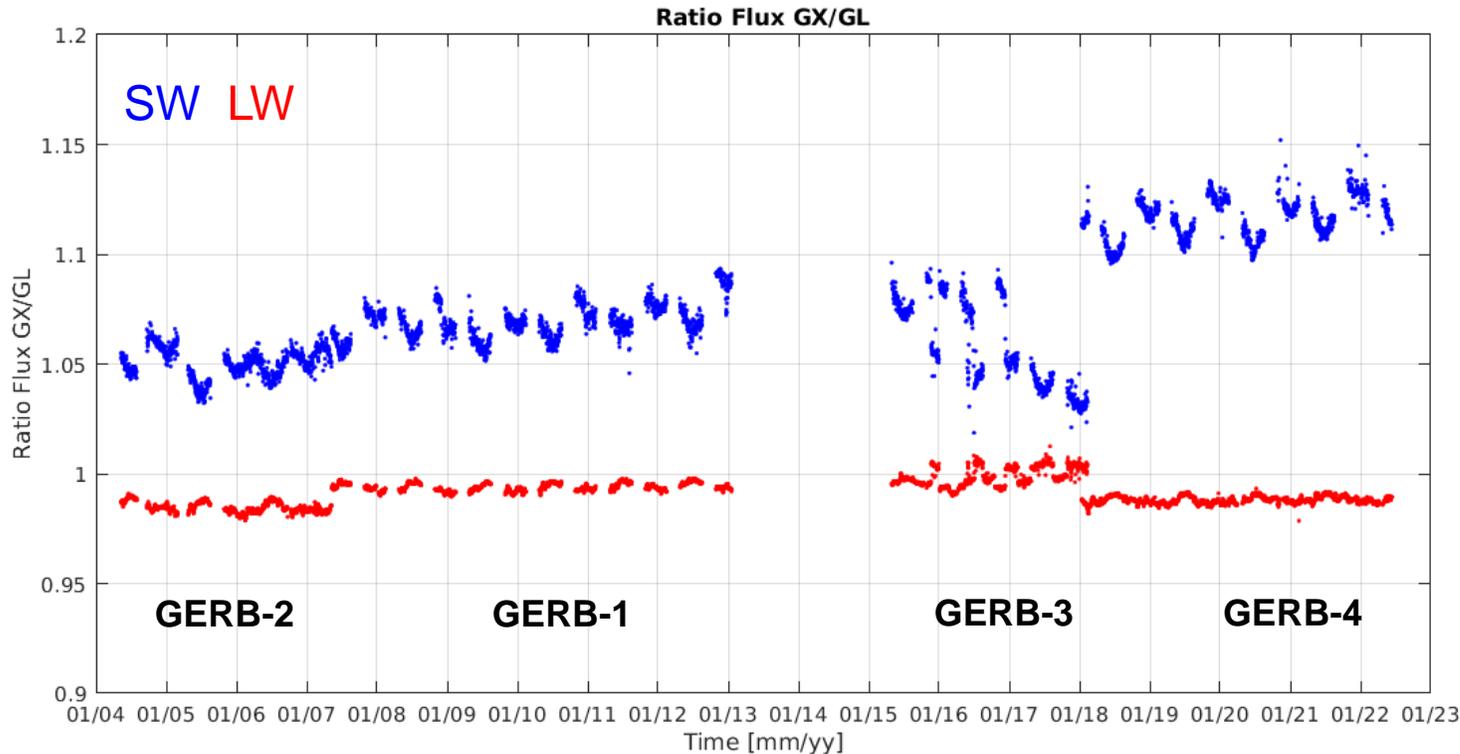


- Both GERB and GERB-like same FOV
- **Conditions for Flux validation:**
 - Maximum solar zenith angle (SZA): 60°
 - Maximum viewing zenith angle (VZA): 60°
- **Calculation daily mean ratio:**

$$\text{Daily mean ratio} = \frac{\sum_{p=1}^N F_p(\text{GERB})}{\sum_{p=1}^N F_p(\text{GL})}$$

F: Flux
p: Pixel





Daily mean ratios:

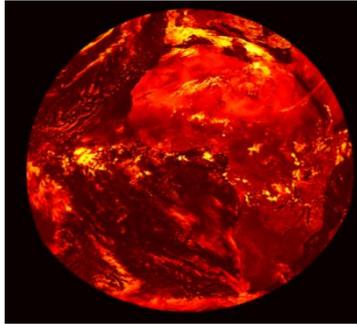
	SW	LW
GERB-2/GL-SEV1	1.05	0.98
GERB-1/GL-SEV2	1.07	0.99
GERB-3/GL-SEV3*	1.06*	1.00*
GERB-4/GL-SEV4	1.12	0.99

*GERB-3 has noticeable issues in the data set → be cautious with these values.

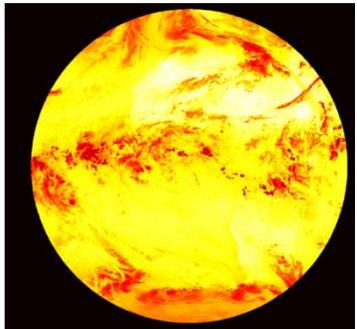
- GERB-2 and GERB-1 SW fluxes are 5 – 7 % higher than the ones from GERB-like.
- GERB-4 SW fluxes are 12 % higher than the ones from GERB-like.
- LW fluxes of the two instruments are in a similar range.

10/05/2008 12 UTC

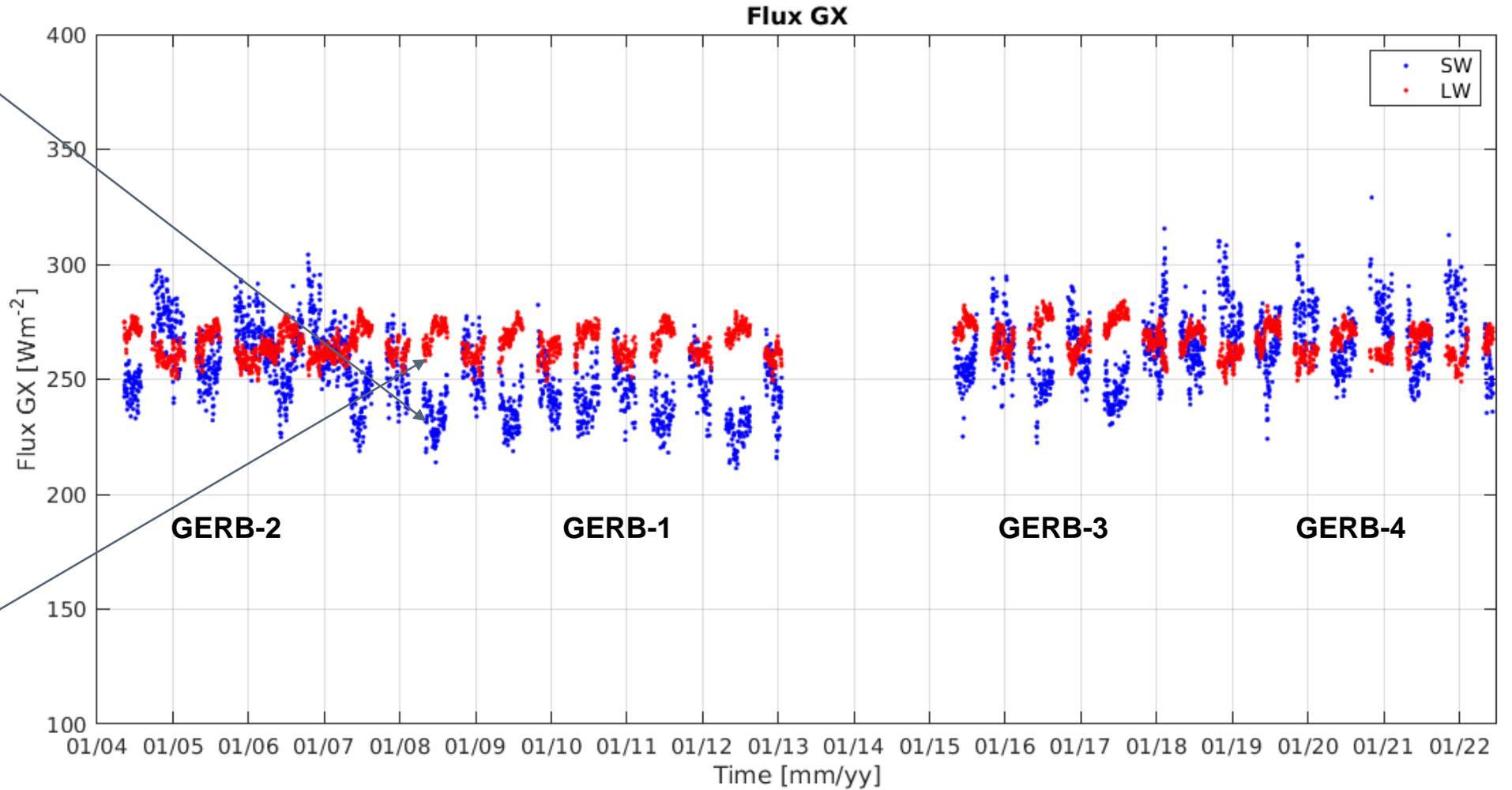
SW: 231 Wm^{-2}

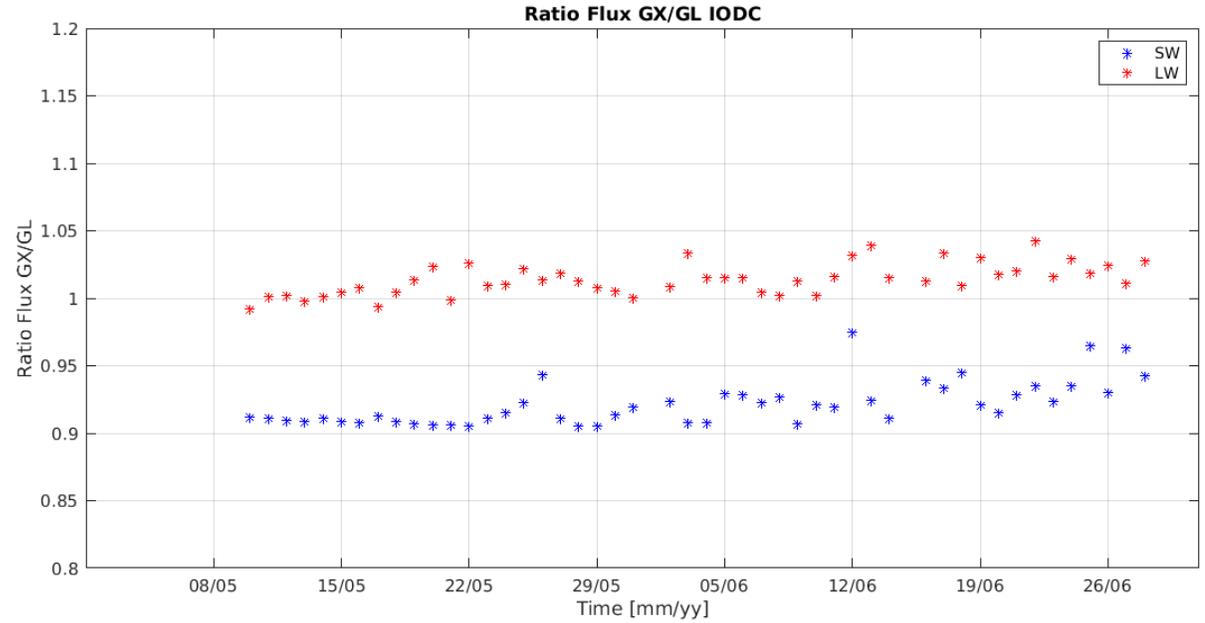
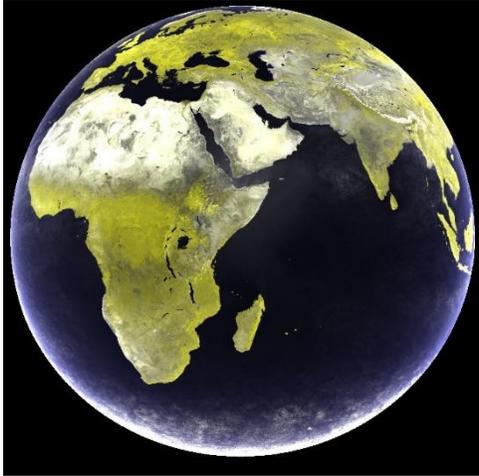


LW: 266 Wm^{-2}

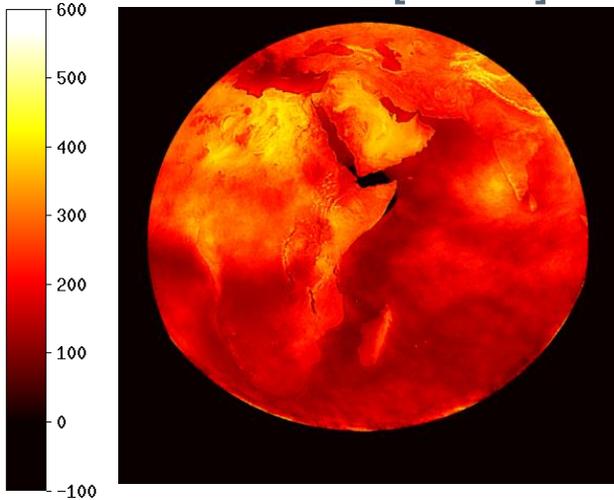


Raw-Level-2-data:

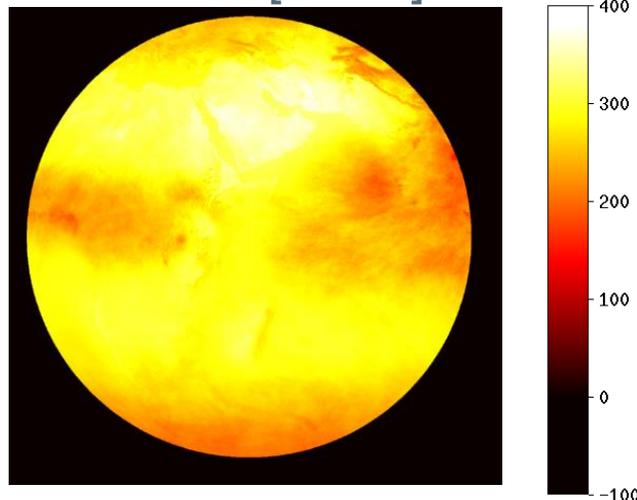




SW Flux [Wm^{-2}]



LW Flux [Wm^{-2}]



- Measuring since 9 May 2022
- Located at 45.5° E

- There are 18 years (2004 – now) of TOA shortwave and longwave flux data from the **Geostationary Earth Radiation Budget (GERB)** instruments.
- **2004 – 2013** (GERB-1 and GERB-2): TOA SW fluxes are within max. 7 % and TOA LW fluxes are within max. 3 % differences to GERB-like or CERES SSF FM1.
 - **Edition 1 available**
- **2018 – now** (GERB-4): TOA SW fluxes are within 12 % and TOA LW fluxes are within 3 % differences to GERB-like or CERES SSF FM1.
 - **Preliminary data set available by the end of 2022**
- **2015 – 2018** (GERB-3): suffers from various issues that need (more) investigation.
 - **Development will start after the release of the GERB-4 data set**

GERB data collection:
<https://catalogue.ceda.ac.uk/?q=gerb> and
<https://gerb.oma.be>

Thank you !