Koninklijk Meteorologisch Instituut

Institut Royal Météorologique

Königliche Meteorologische Institut

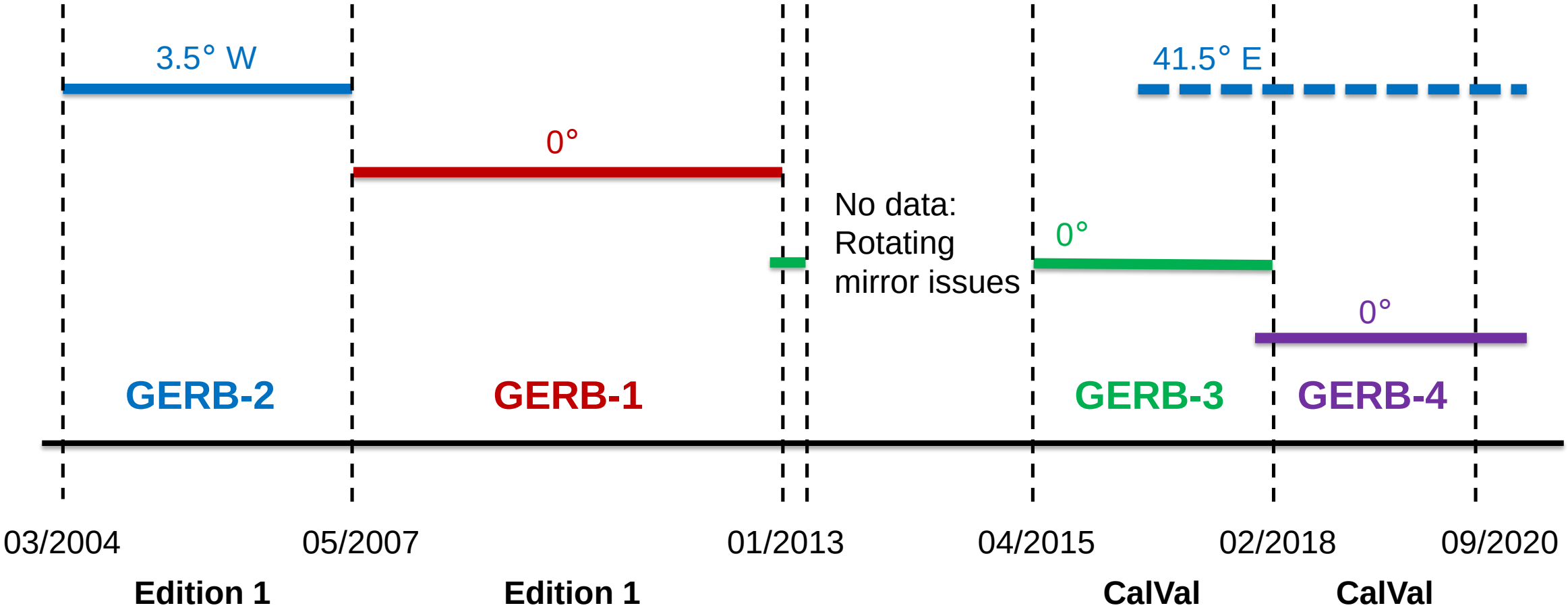
Royal Meteorological Institute

Validation of 16 years of broadband radiation data from the GERB instruments

Christine Aebi, Edward Baudrez, Johan Moreels, Nicolas Clerbaux (all RMI); Richard Bantges, Jon Murray, James Rufus, Jacqueline Russell and Helen Brindley (all Imperial College London); Martin Bantes and Andy Smith (both RAL)

Overview GERB Instruments

- Data availability from the operational GERB instruments at longitude 0°.
- In 2016, GERB-2 was moved to longitude 41.5° E (Indian Ocean).



Overview GERB Validation

GERB:

- GERB-1 – GERB-4
- Products (HR, ARG, BARG, NRT)
- Radiance and flux (SW, LW)
- L1.5 and L2
- Versions and Editions
- Instantaneous, CM SAF daily and monthly mean data

Overview GERB Validation

GERB-like:
- Internal product with same processing as GERB data
- Differences day/night

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CERES
- Different instruments (FM1 – FM5)
- Instantaneous/daily/monthly mean (SSF Ed. 4A, EBAF, SYN1deg, FLASHflux)

Overview GERB Validation

GERB L1.5:
- Different surface types (ocean, desert, DCC)
- Stability of SW retrieval

GERB-like:
- Internal product with same processing as GERB data
- **Differences day/night**

CERES
- Different instruments (**FM1** – FM5)
- Instantaneous/daily/monthly mean (**SSF Ed. 4A**, EBAF, SYN1deg, FLASHflux)

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- GERB-1 – GERB-4
- Products (**HR**, ARG, BARG, NRT)
- Radiance and **flux** (**SW**, **LW**)
- L1.5 and **L2**
- Versions and Editions
- **Instantaneous**, CM SAF daily and monthly mean data

GERB:
- Overlap period
- Overlap region (41.5° vs. 0°)
- Different versions/editions

ERA5:
- Atmospheric reanalysis data set from ECMWF
- Resolution 0.25°

What is GERB-like (GL-SEV)?

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

SW

VIS 0.6 µm
VIS 0.8 µm
NIR 1.6 µm

LW

WV 6.2 µm
WV 7.3 µm
IR 8.7 µm
IR 9.7 µm
IR 10.8 µm
IR 12.0 µm
IR 13.4 µm

Narrowband to broadband conversion

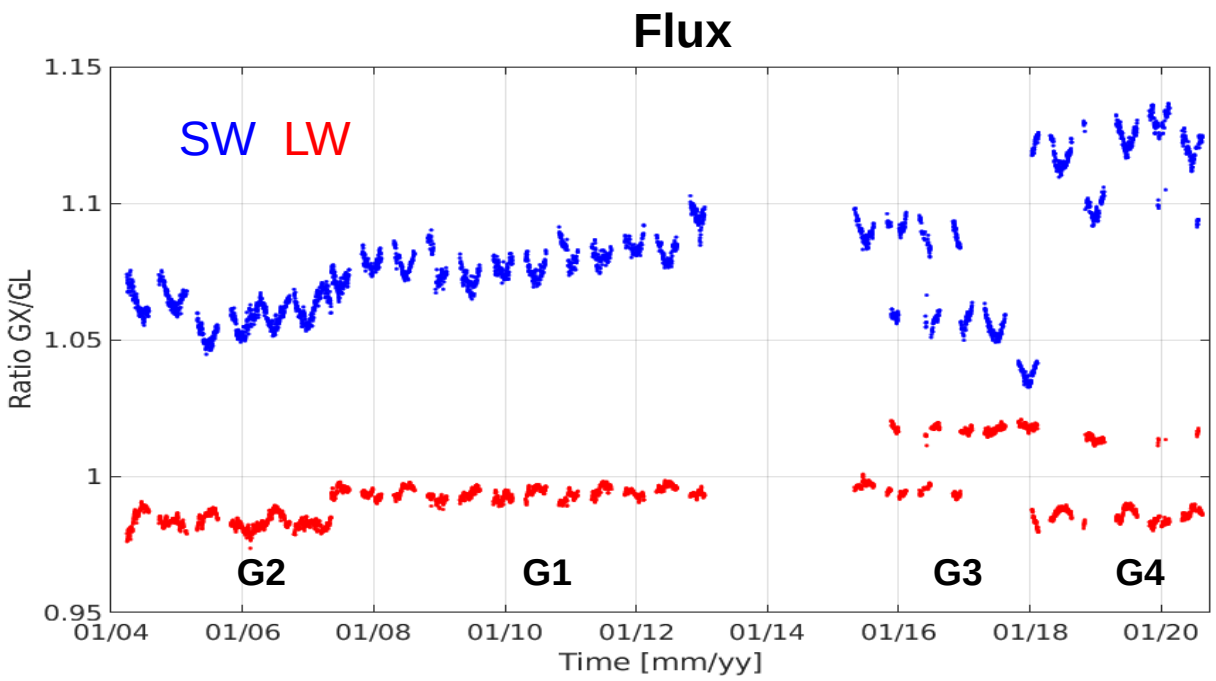
Broadband radiance for SW and LW

Same processing as for GERB

GERB-like

Additional error due to this conversion: SW: 4 %, LW: 1 %.

Validation GERB HR L2 – GL-SEV HR L2, 12 UTC



GERB-1 and GERB-2 data corrected according to Russell et al., 2017.

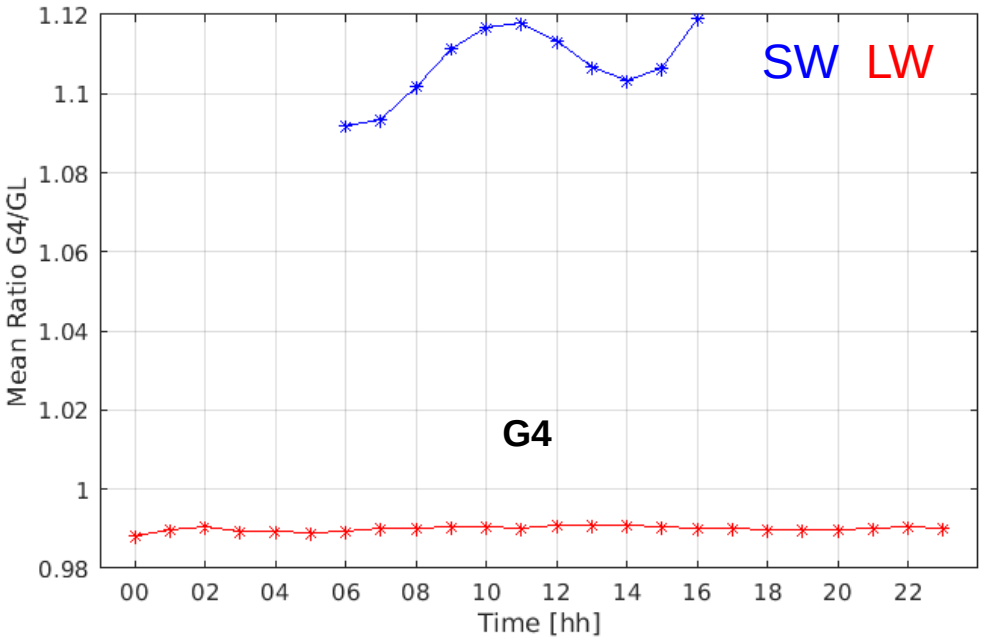
Mean Ratio 12 UTC

	SW	LW
GERB-2/GL-SEV1	1.06	0.98
GERB-1/GL-SEV2	1.08	0.99
GERB-3/GL-SEV3*	1.07	1.01
GERB-4/GL-SEV4*	1.12	0.99

*GERB-3 and GERB-4 have both some noticeable issues in the data sets → be cautious with these numbers.

Validation GERB HR L2 – GL-SEV HR L2

Hourly mean flux



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GERB-4/GL-SEV4*	1.12	0.99

*GERB-3 and GERB-4 have both some noticeable issues in the data sets → be cautious with these numbers.

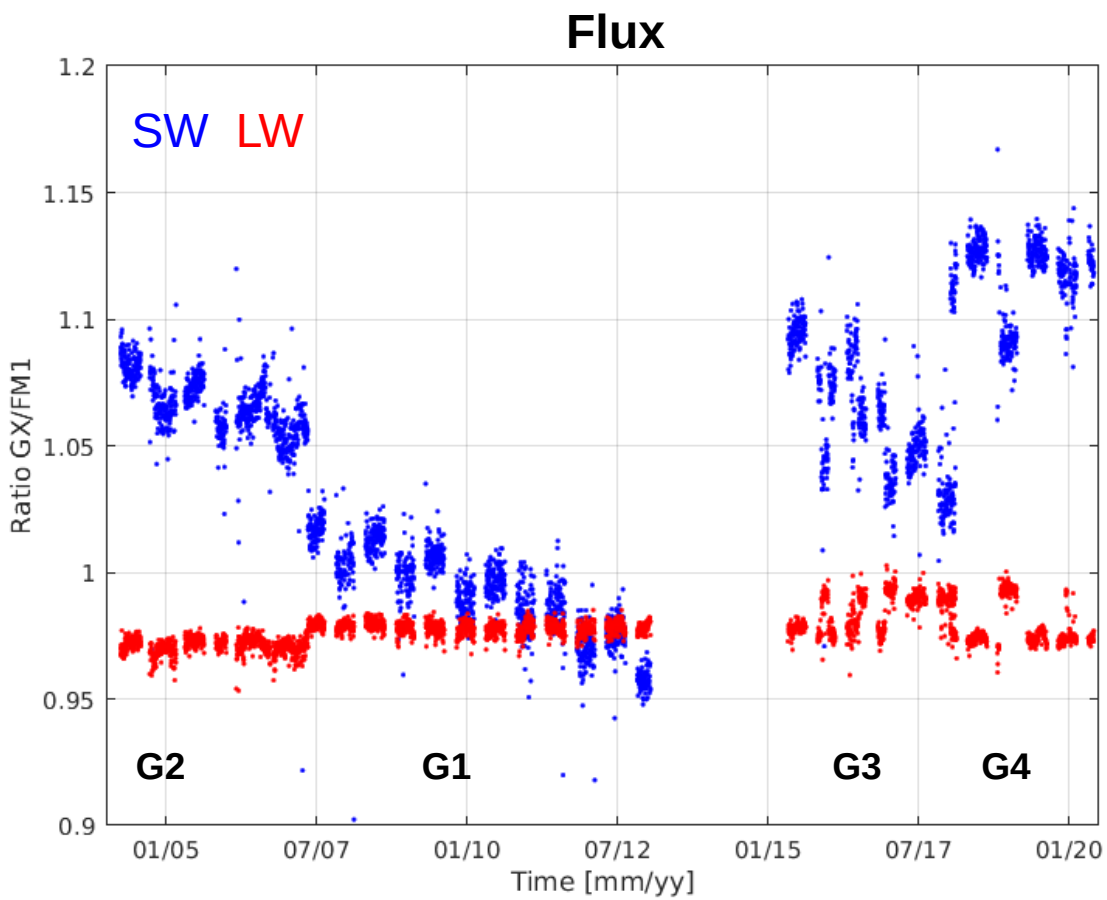
- For LW, no significant differences in the mean ratios between day- and nighttime.
- The variation in the SW is within the uncertainty of the GERB-like product.

Validation GERB HR L2 – CERES SSF FM1 Ed. 4A, daily mean

Footprint matching between GERB and CERES:

- Taking into account the CERES PSF
- Max. difference in time: 300 s
- VZA < 80°

Validation GERB HR L2 – CERES SSF FM1 Ed. 4A, daily mean



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GERB-1 and GERB-2 data are not corrected for ageing.

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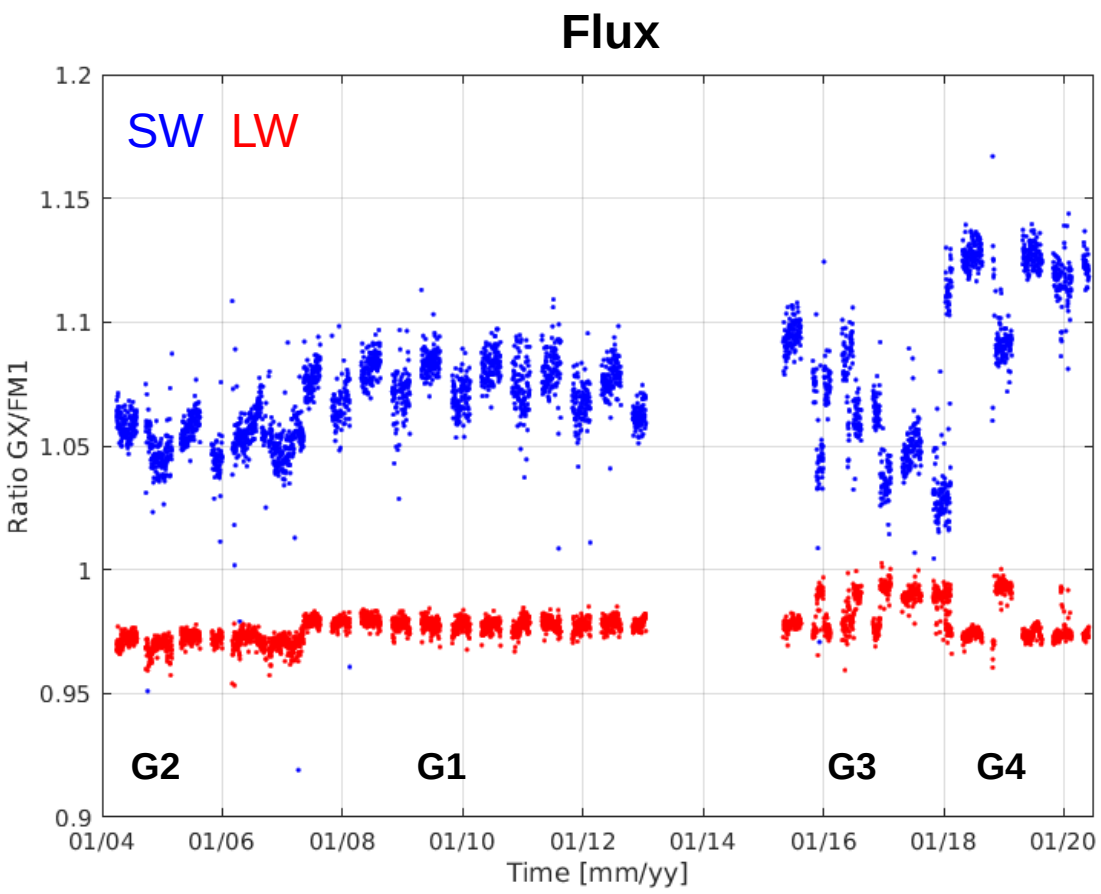

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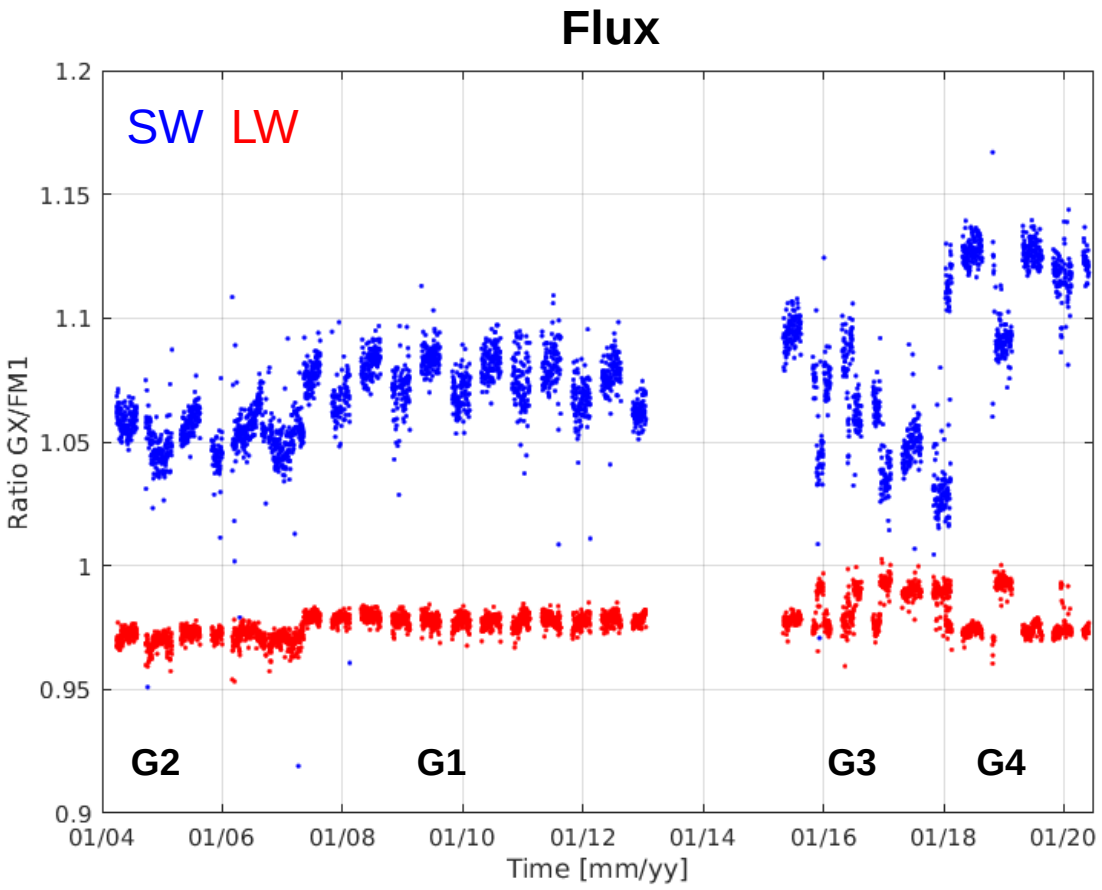


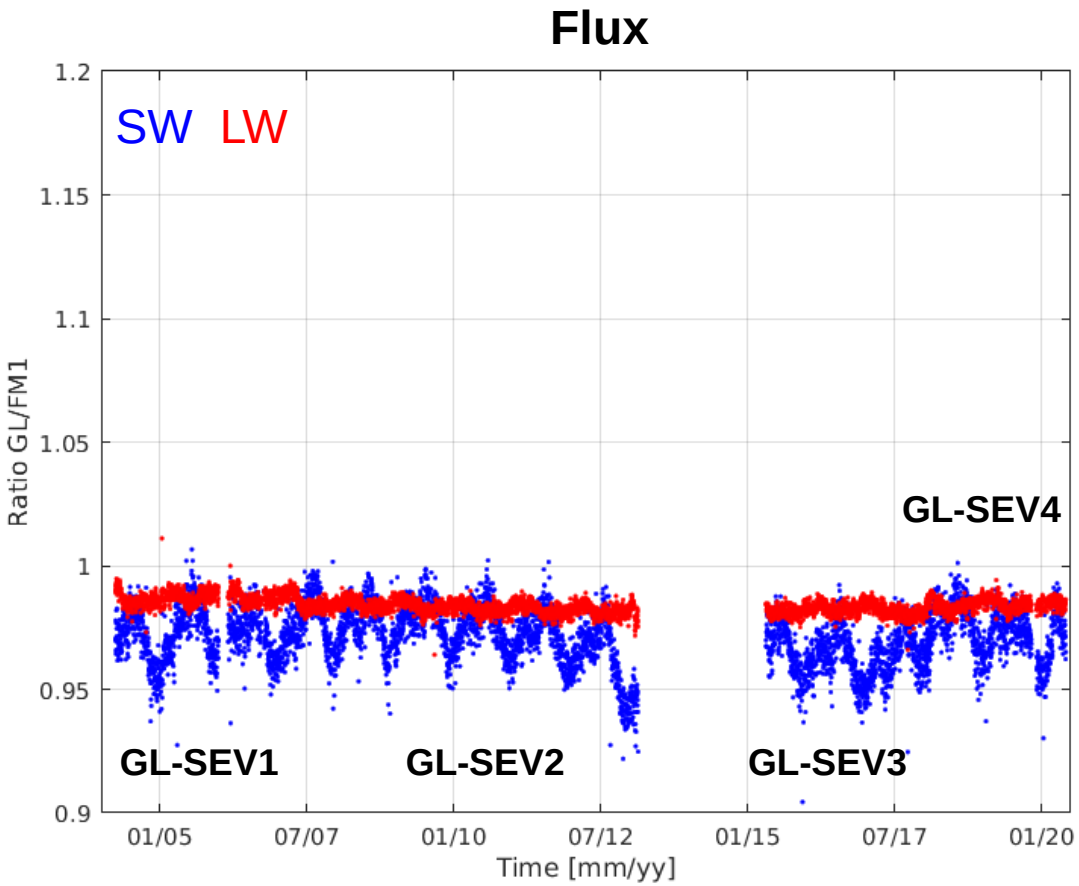
Mean Ratio

	SW	LW
GERB-2/FM1	1.06	0.97
GERB-1/FM1	1.07	0.98

- GERB-2 and GERB-1 overestimate the SW flux of CERES by 6 % and 7%, respectively.
- GERB-2 and GERB-1 underestimate the LW flux of CERES by 3 % and 2 %, respectively.

GERB-1 and GERB-2 data are corrected according to Russell et al., 2017.

Validation GL HR L2– CERES SSF FM1 Ed. 4A, daily mean

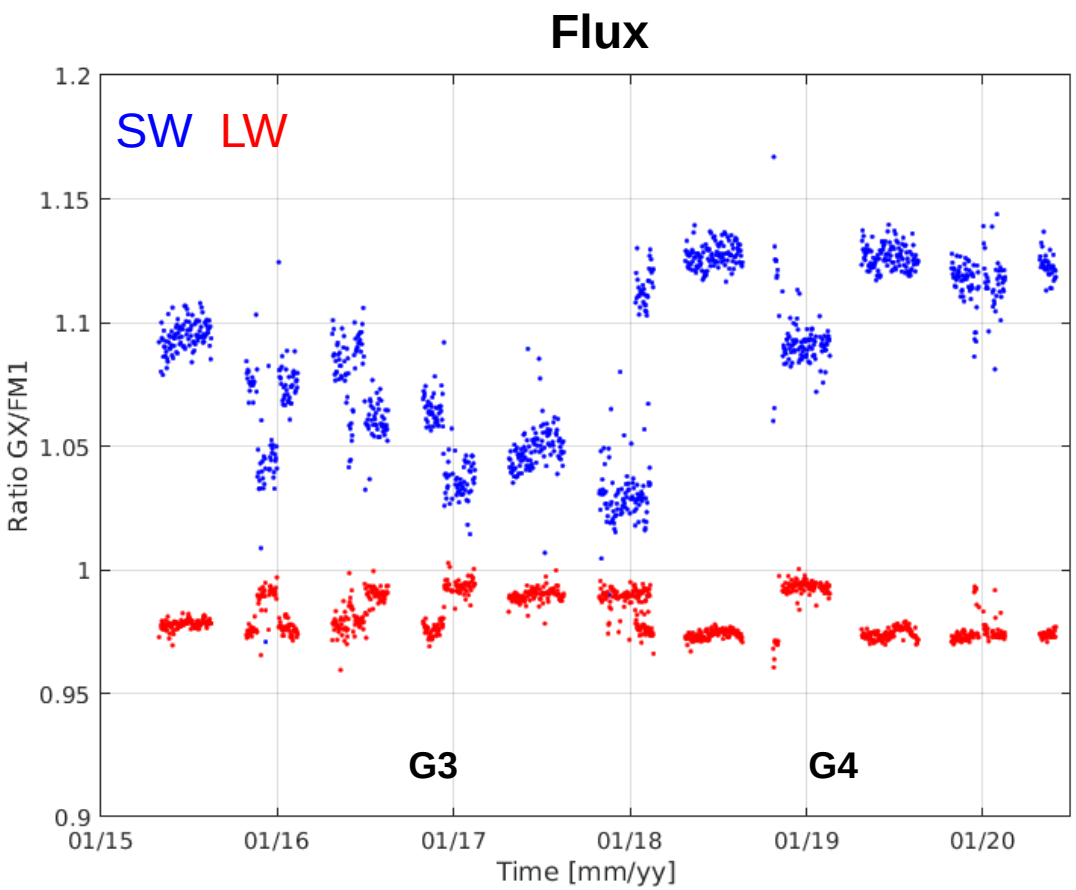


Mean Ratio

	SW	LW
GL-SEV1/FM1	0.97	0.99
GL-SEV2/FM1	0.97	0.98
GL-SEV3/FM1	0.96	0.98
GL-SEV4/FM1	0.97	0.98

- GERB-like SW flux from all SEVIRI instruments is 3 – 4 % lower than the one from FM1.
- GERB-like LW flux is 1 – 2 % lower than the one from FM1.

Quartz Filter Anomaly



- GERB-3 has different levels in the ratio.
- GERB-4 has one period (Nov 2018 – Jan 2019) with a lower level in the SW ratio and a higher level in the LW ratio.
- Reason: Quartz filter anomaly.

Quartz Filter Anomaly

Problem:

- In some periods the quartz filter was not perfectly placed.

→ Reduced SW fluxes
→ Enhanced LW fluxes (during daytime; because LW is derived from total minus SW)

Solution:

- Trying to find a correction in order to have the full GERB-3 and GERB-4 data sets available.

Quartz Filter Anomaly

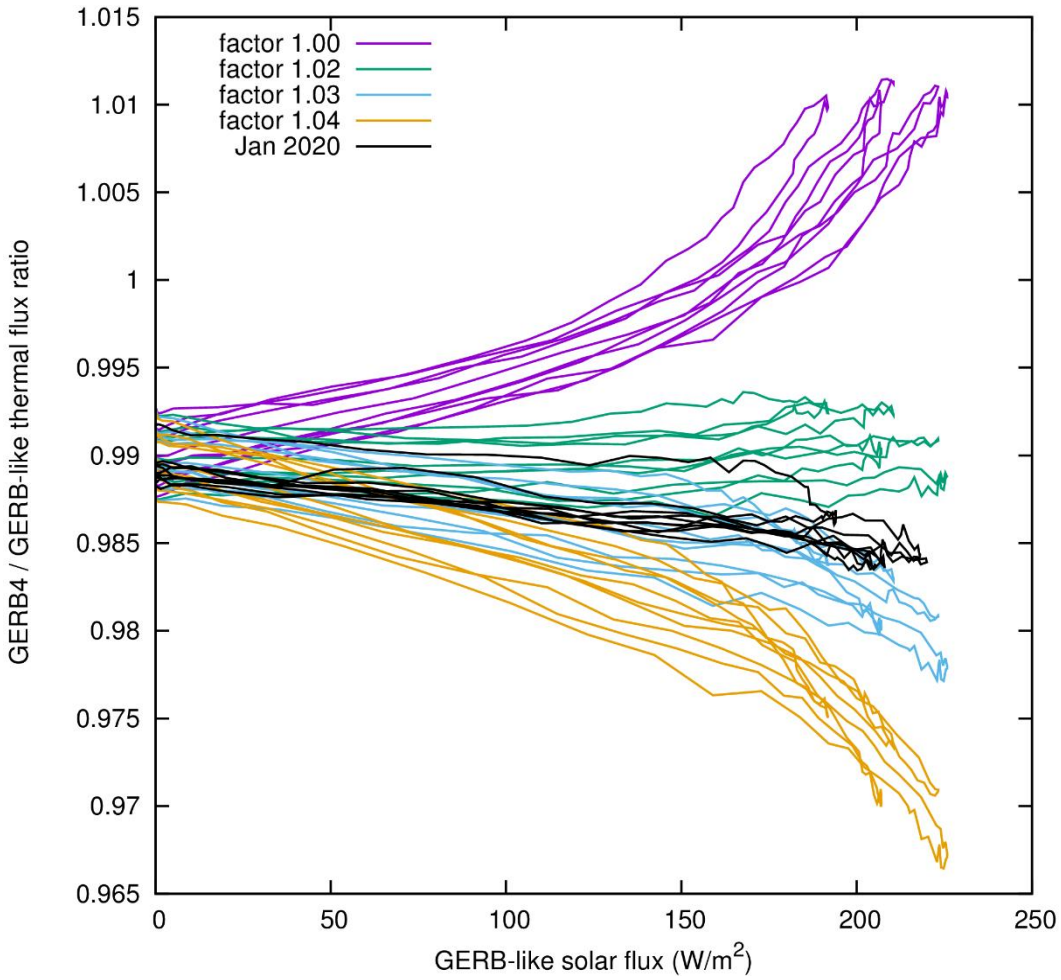


Figure: N. Clerbaux

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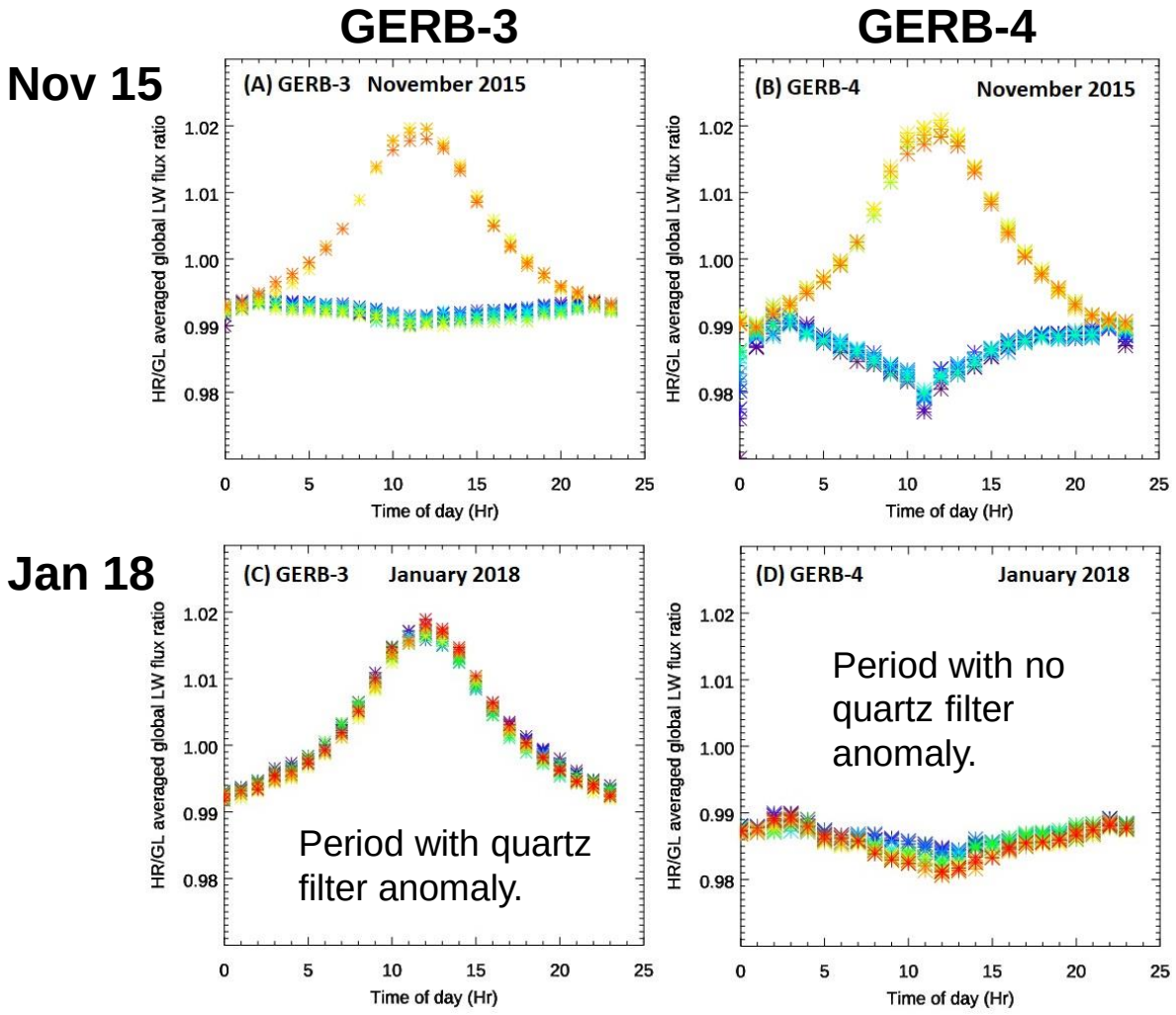
The diurnal cycle of the ratio GERB-4/GL-SEV4 LW flux vs. GL-SEV4 SW flux for different correction factors and days:

15 – 19 January 2019 (colours): Anomaly
08 – 12 January 2020 (black): No anomaly

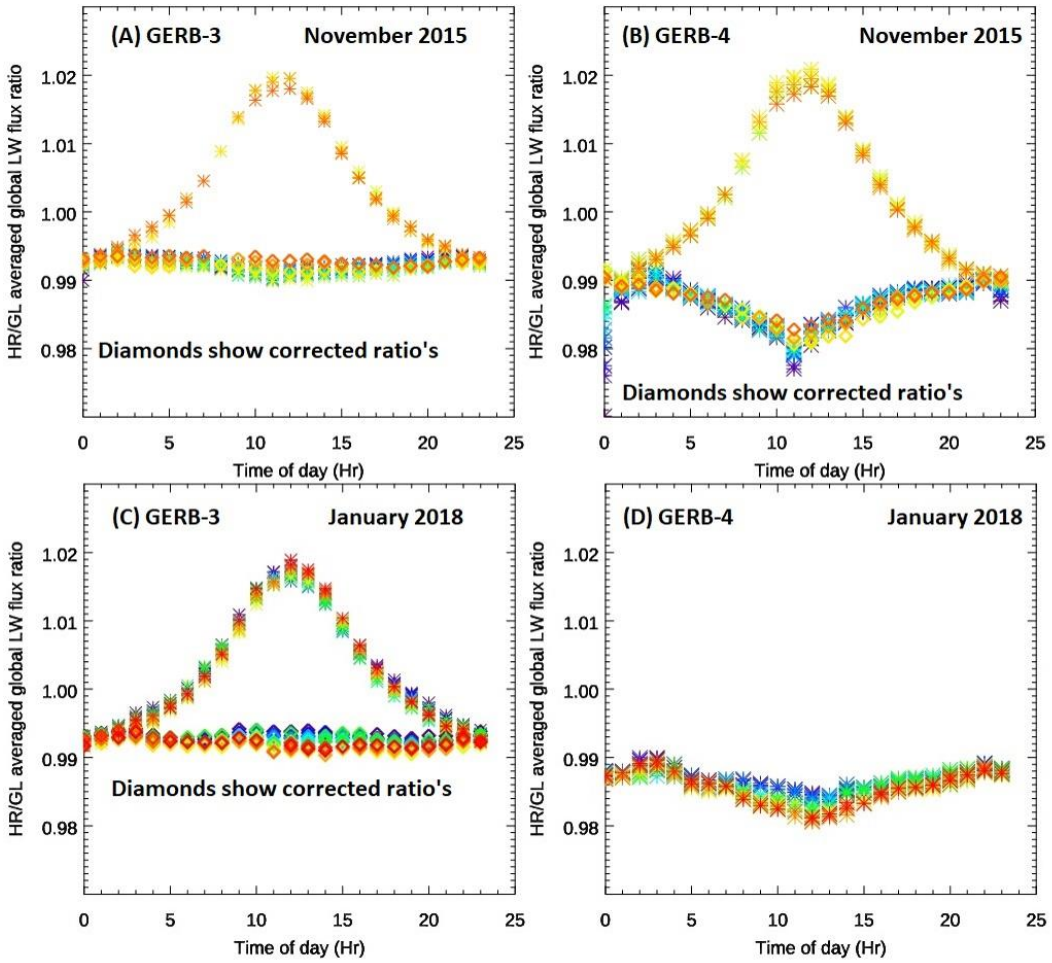
Quartz Filter Anomaly



Analysis: J. Murray

- Global averaged LW flux ratios GX/GL.
- Different colours, different days (05/11/2015 – 22/11/2015 and 11/01/2018 – 31/11/2018).
- In November 2015, not all days suffer from the anomaly.
- Days with the quartz filter anomaly show a pronounced diurnal cycle in the ratio.
- Days with no quartz filter anomaly show almost no diurnal differences.

Quartz Filter Anomaly



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- Days with the quartz filter anomaly show a pronounced diurnal cycle in the ratio.
- Days with no quartz filter anomaly show almost no diurnal differences.
- Diamonds: corrected ratios with values:
  - GERB-3: 0.0225
  - GERB-4: 0.0300
- Analysis of regional differences.

Validation GERB HR L2 – CERES SSF FM1 Ed. 4A, daily mean

Mean Ratio, Flux

	FM1		FM2		FM3	
	SW	LW	SW	LW	SW	LW
G2/FMX	1.06	0.97	1.04	0.97	1.05	0.97
G1/FMX	1.07	0.98	1.07	0.98	1.07	0.98
G3/FMX*	1.06	0.98	1.05	0.98	1.06	0.98
G4/FMX**	1.12	0.97	1.12	0.97	1.12	0.98

* Periods with quartz filter anomalies included.
** From 25/04/2019 onwards → No periods with quartz filter anomalies.

- LW flux of GERB is 2 - 3 % higher in comparison to the CERES SSF LW flux and there are almost no differences between the different FM.
- For the SW flux, largest difference with 12 % for GERB-4 and lowest difference of 4 % for GERB-2 in comparison to FM2.

→ Outlook: Comparison of GERB HR L2 data with FM5 on S-NPP data.

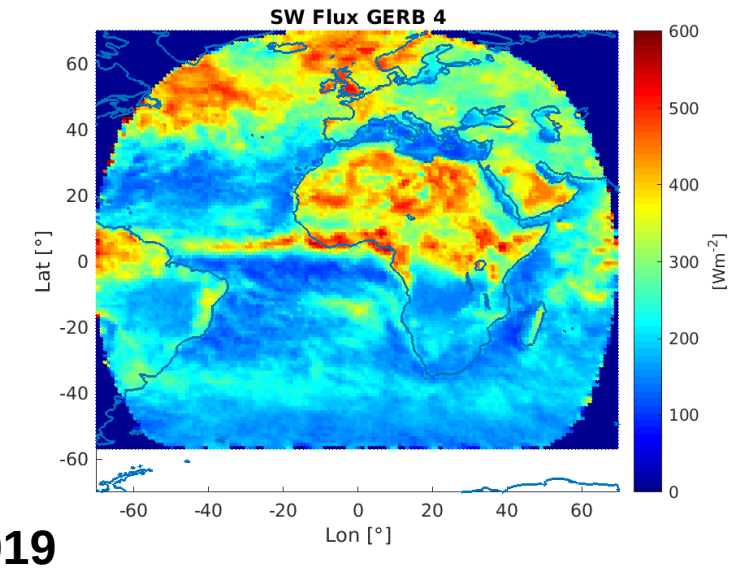
Validation G4 HR L2 – CERES SSF FM1 Ed. 4A, monthly mean

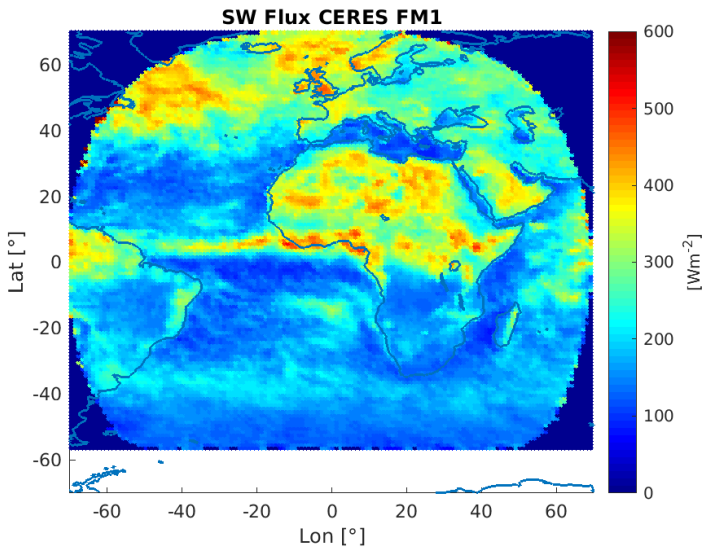
Flux

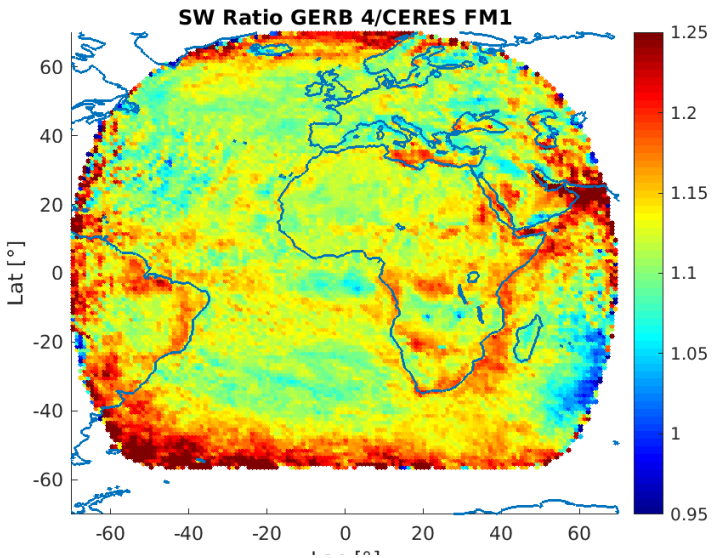
SW

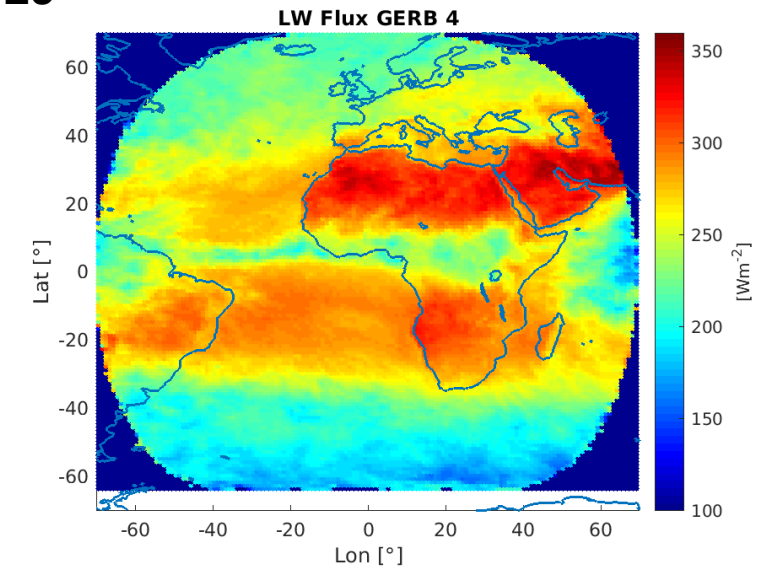
June 2019

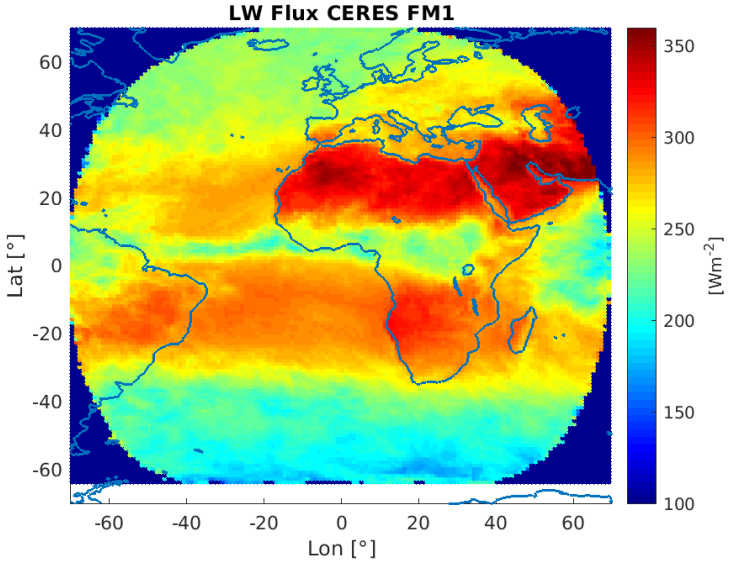
LW

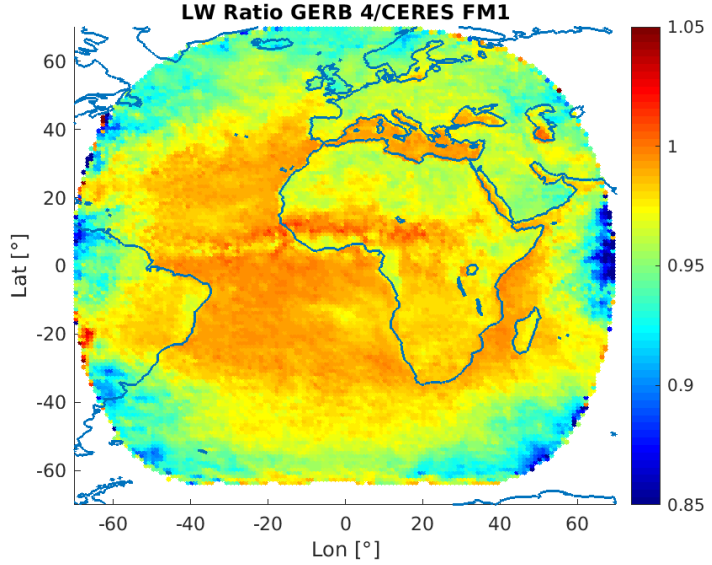












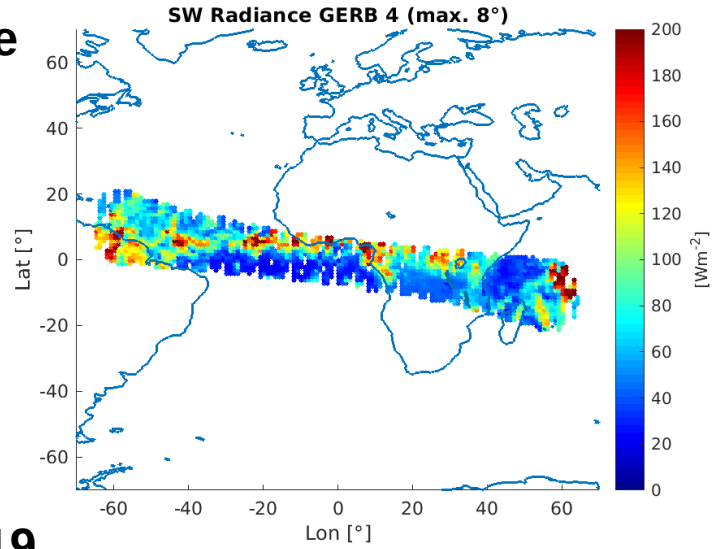
Validation G4 HR L2 – CERES SSF FM1 Ed. 4A, monthly mean

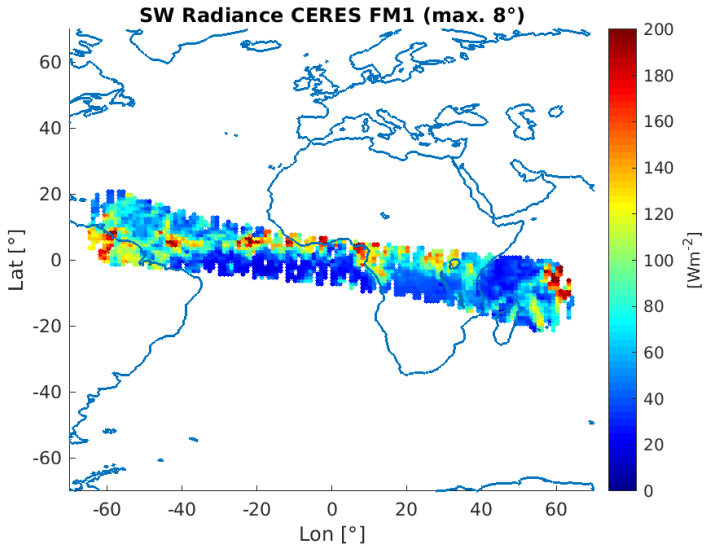
Radiance

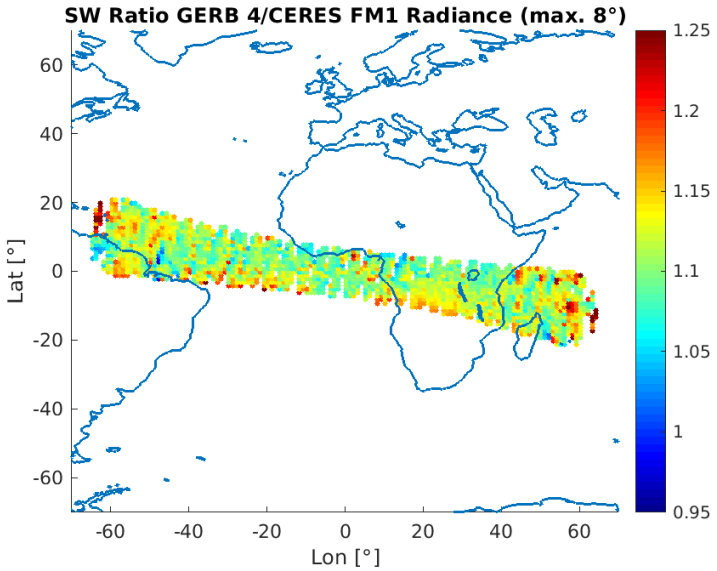
SW

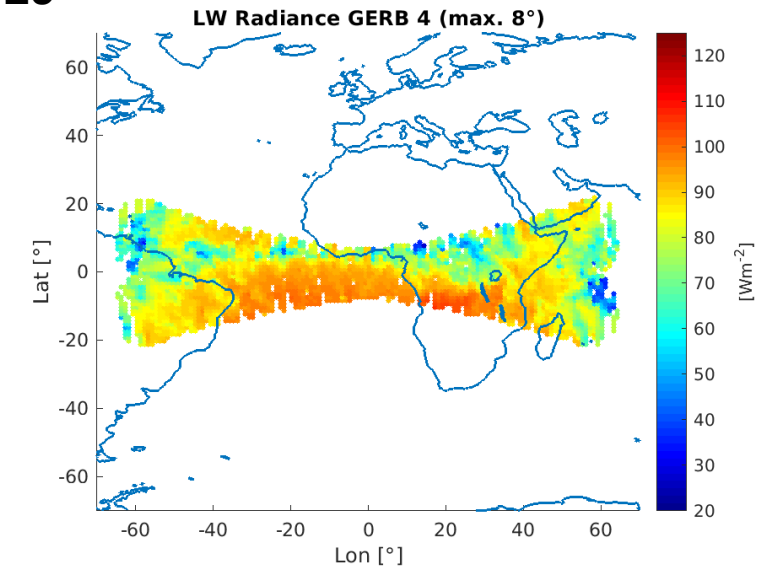
June 2019

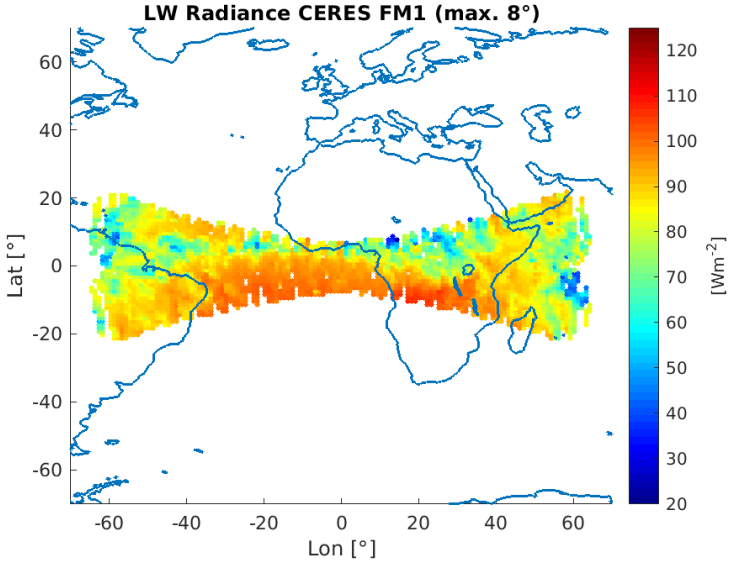
LW

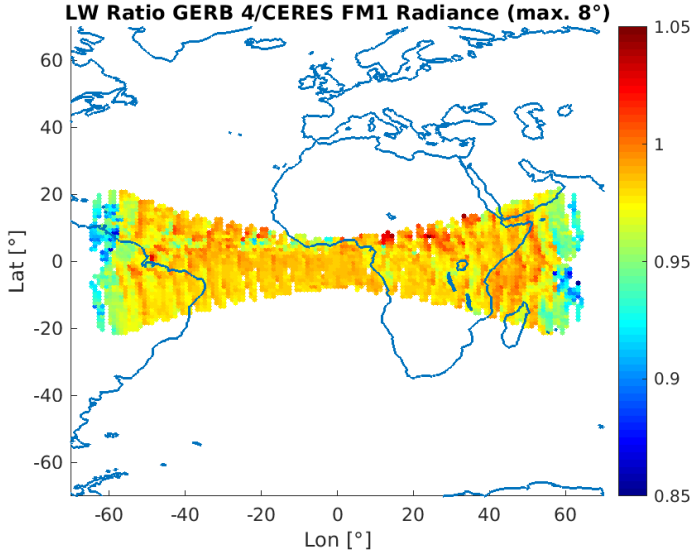




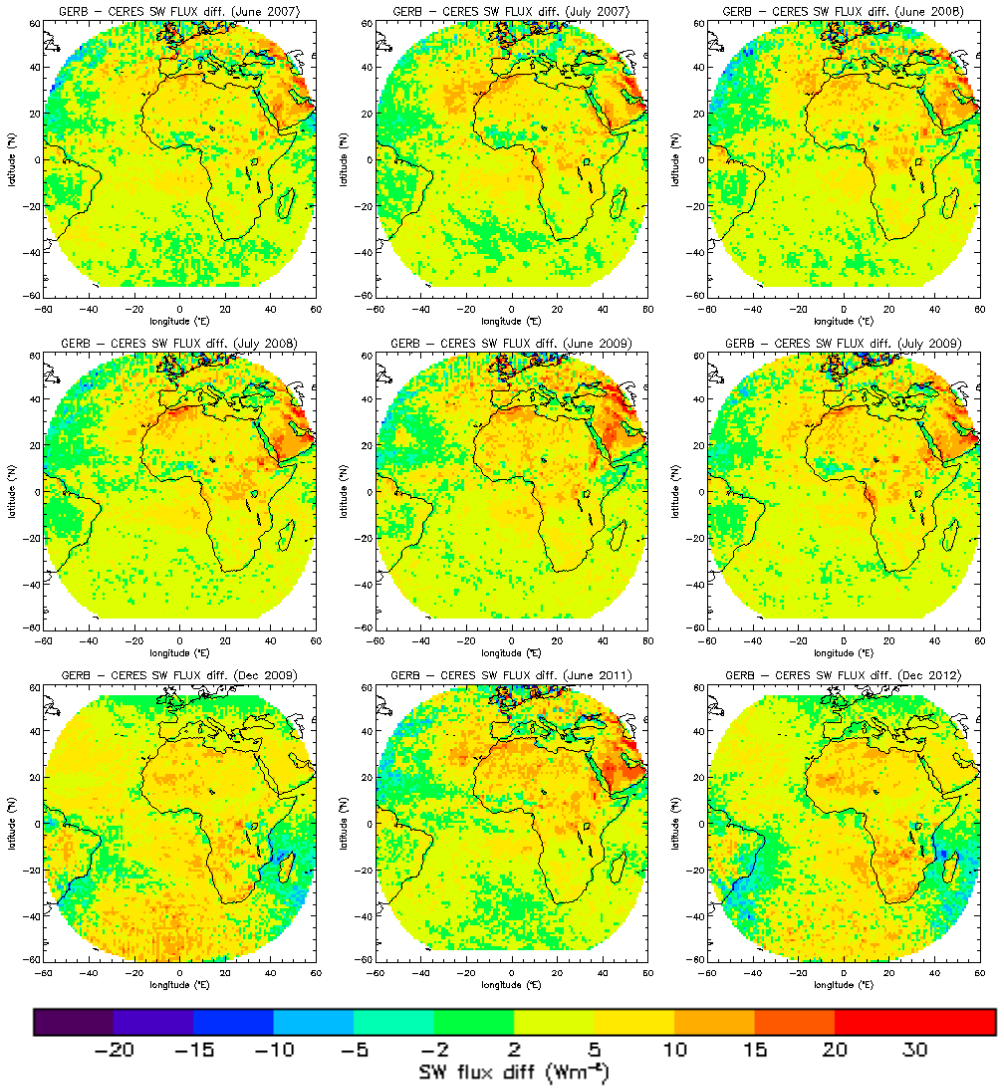








GERB obs4MIPS Product Status



- Observations for Model Intercomparisons Project (obs4MIPS)
- Hourly monthly mean flux data (SW and LW) from GERB-1 (2008 – 2012).

→ Technical report and data available (in the coming weeks) on https://ceda.ac.uk.

- Figure shows comparisons of GERB-1 SW fluxes with CERES EBAF Ed. 4.1

Analysis: R. Bantges

Summary and Outlook

- GERB-1 and GERB-2 SW fluxes are within max. 7 % and LW fluxes are within max. 3 % differences to GERB-like or CERES SSF Ed. 4A data.
- GERB-3 and GERB-4 suffer both from the issue with the quartz filter anomaly. Additionally, GERB-3 has either some strong ageing issues and/or problems with the mirror correction.
- In the periods with no quartz filter anomaly, GERB-4 has differences in the SW and LW fluxes in comparison to GERB-like and CERES SSF Ed. 4A within 12 % and 3 %, respectively.

Outlook:

- Soon, there should be a correction for the periods with the quartz filter anomalies.
- Edition 1 for GERB-3 and GERB-4 is in preparation (first priority).
- Edition 2 for GERB-1 and GERB-2 is in preparation.

Thank you !

GERB data availability:
https://gerb.oma.be*

*GERB-3 and GERB-4 not released for science yet.