Outgoing Longwave Radiation Product: Product Guide

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Document Change Record

Issue / Revision	Date	DCN. No	Summary of Changes
1	07/10/2010		Initial release
1A	28/06/2013		Update of images GERB and SEVIRI images
1B	10/2/2014		Version updated to web page
1C	11/2/2014		Updated page 4 to include Meteosat-10 in the list for supported platforms.
1D	19/3/2014		Added reference to document containing tables for flux calculations for Outgoing Longwave Radiation algorithm,
1E	6/5/2015		Changed document name to Product Guide. Review by Staff Scientist.

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1 OUTGOING LONGWAVE RADIATION

The Earth Radiation budget is made up of the incoming solar flux and the outgoing Top-of-the-Atmosphere (TOA) radiative fluxes. The outgoing radiative fluxes consist of the reflected part of the incoming solar flux, as well as the thermal flux emitted by the Earth-atmosphere system. The thermal flux is often referred to as Outgoing Longwave Radiation (OLR).

The OLR is a very important parameter for the Earth's radiation budget study as well as for weather/climate model validation purposes. Variations in the OLR reflect the response of the Earth’s atmosphere to solar diurnal forcing. In particular, those variations can be found in surface temperature, cloud cover, cloud top height, and related quantities like precipitation. The OLR is well suited for validation of global circulation models (GCMs) simulating the diurnal cycle, as it constitutes the combination of different model aspects.

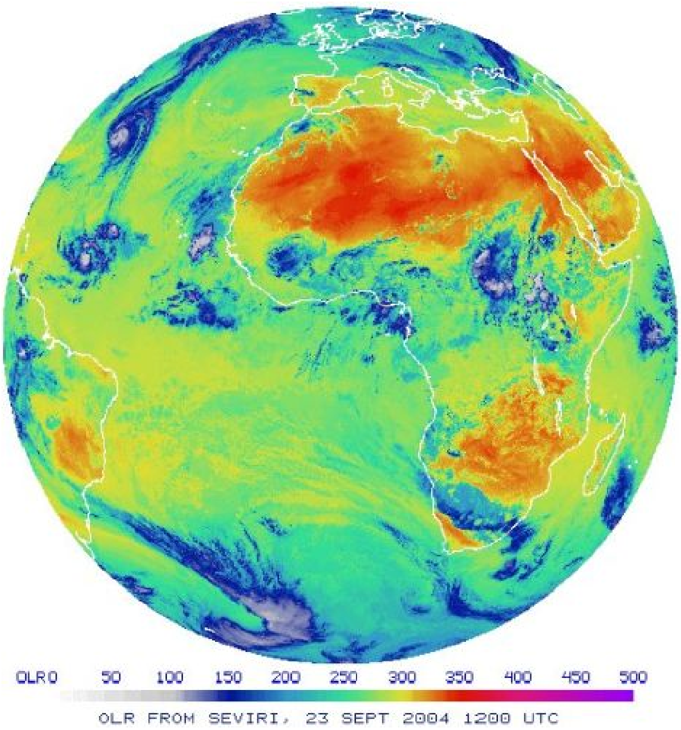

Figure 1: Example of OLR values from the SEVIRI instrument 23 Sept 2004, 1200 UTC.

The OLR can be directly estimated from broadband radiance measurements by a satellite instrument such as the GERB. Alternatively, the OLR can be indirectly inferred from narrowband radiance observations. The SEVIRI OLR is obtained from the IR and WV radiance and the satellite viewing angle via a regression scheme.

2 OUTLINE OF FLUX CALCULATIONS

The regression scheme is based on the algorithm developed for Meteosat First Generation satellites See [RD 3]. It involves two steps: the spectral radiances are first converted into spectral fluxes; this accounts for the effect of the viewing angle using limb-darkening functions. The spectral fluxes are then combined in an appropriate manner to get the total flux. Regression coefficients are determined with a radiative transfer model. The complete algorithm is in [RD 2]. See Section 4.1.

The model calculations provided scene-dependent regression coefficients: these are a special set of coefficients for clear sky, opaque clouds, and semi-transparent clouds. This scene-dependency shows a clear improvement over a single set of coefficients, which would be applicable to any scene type. An application of this scheme thus implies a prior full scenes and cloud analysis of the respective Meteosat image. The underlying radiation model is SBDART [RD 4], and a comprehensive sample of atmospheric profiles is taken from Chevallier, 2002 [RD 5] together with a wide range of possible cloud layers, cloud properties and surface emissivities.

Step 1: Conversion of spectral radiance to spectral flux

$$\text{Spectral Flux} = a(\theta) + \text{Spectral Radiance} \cdot b(\theta)$$

with:

$$a(\theta) = k_1 + k_2 (\sec\theta - 1) + k_3 (\sec\theta - 1)^2$$

$$b(\theta) = k_4 + k_5 (\sec\theta - 1) + k_6 (\sec\theta - 1)^2$$

Note: the Spectral Radiance must be in units $Wm^{-2}ster^{-1}$)

The regression is valid for viewing angles up to 70 degrees.

Step 2: Spectral Fluxes to Total Flux

$$\text{Total flux} = \sum_{k=1}^{7}\sum_{i=1}^{2} c(k,i)\, flux(k)^i + \text{offset}$$

where:

k	refers to the seven fluxes in the seven spectral channels
flux(k)	spectral flux of channel number k
c(k,i)	special coefficients depending on which channels are used

All coefficients referred to in Steps 1 and 2 can be found in [RD 6]. Tables include values for MSG-1 (Meteosat-8), MSG-2 (Meteosat-9), and MSG-3 (Meteosat-10).

3 COMPARISON OF OLR PRODUCT ON SEVIRI AND GERB

The images in Figure Figure 2 through Figure 5 show comparisons of the SEVIRI OLR and the GERB OLR for Meteosat-8 and Meteosat-9.

Note: There are two different observed biases for each Meteosat-8 plot: 1.3 W/m^2 and 1.9 W/m^2.
There are two different observed biases for each Meteosat-9 plot: 0.70 W/m^2 and 3.37 W/m^2.

Meteosat-8

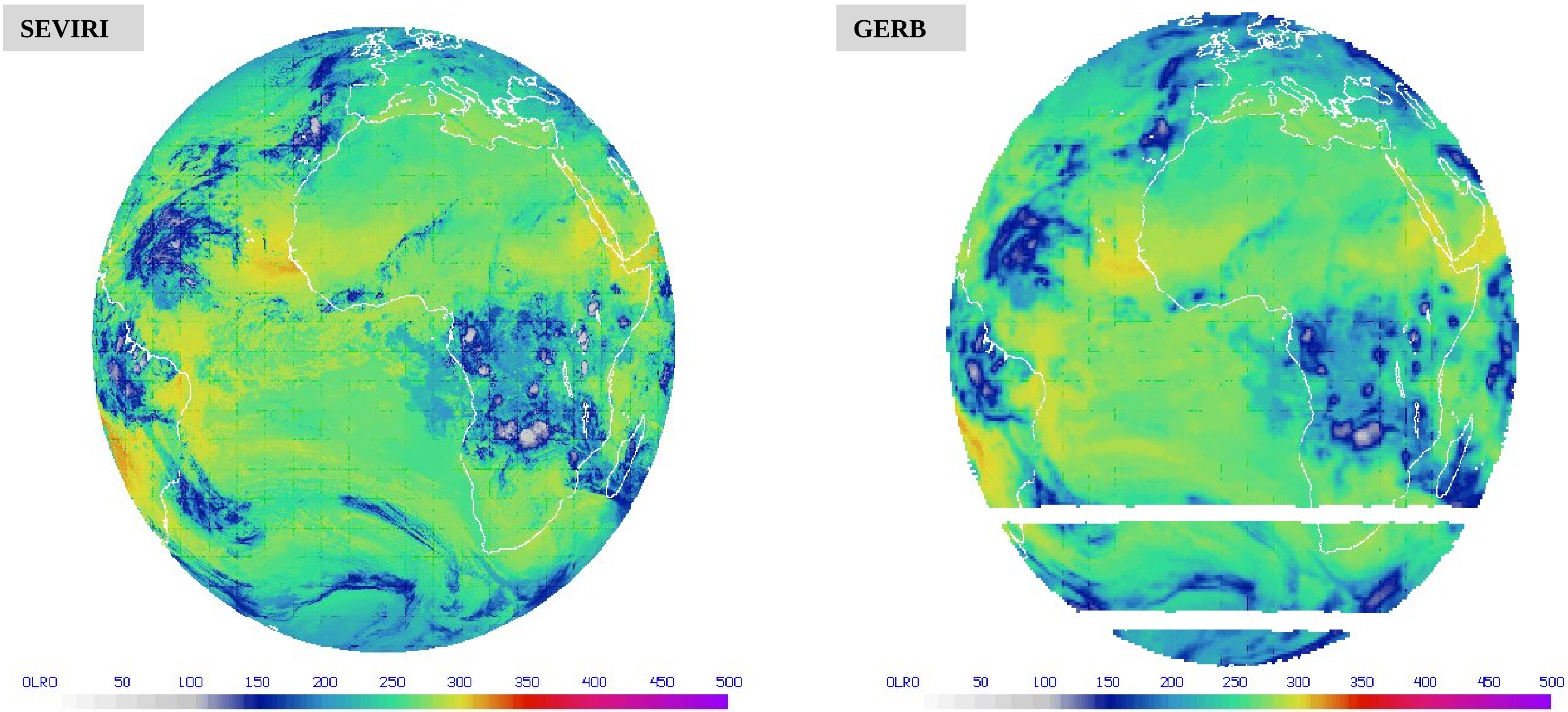

Figure 2: Comparison of the Meteosat-8 SEVIRI OLR and the GERB OLR for 06 November 2006, 00:00 UTC, with an observed bias of 1.3 W/m^2 The SEVIRI OLR is slightly higher.

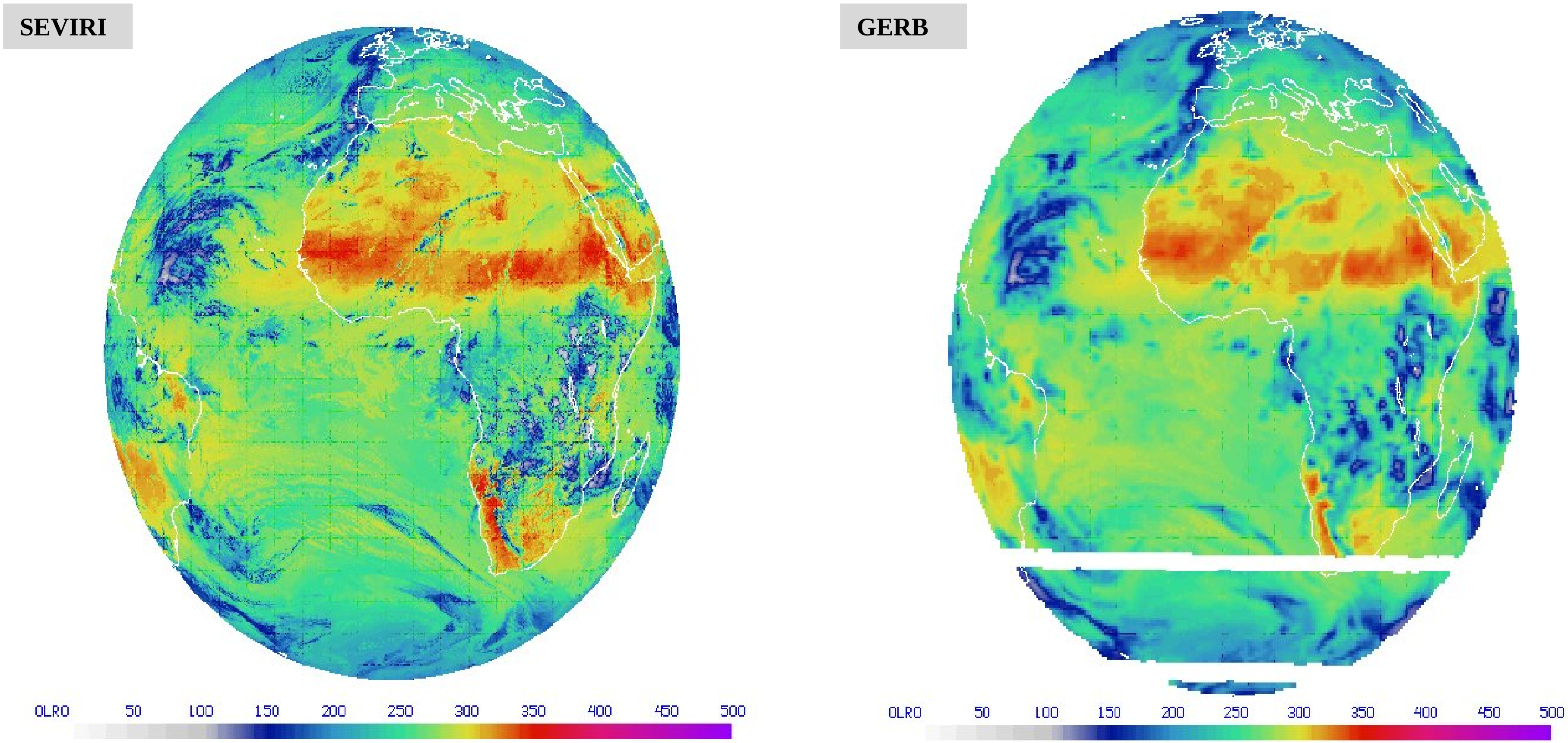

Figure 3: Comparison of the Meteosat-8 SEVIRI OLR and the GERB OLR for 06 November 2006, 12:00 UTC, with an observed bias of 1.9 W/m^2
The SEVIRI OLR is slightly higher.

Meteosat-9

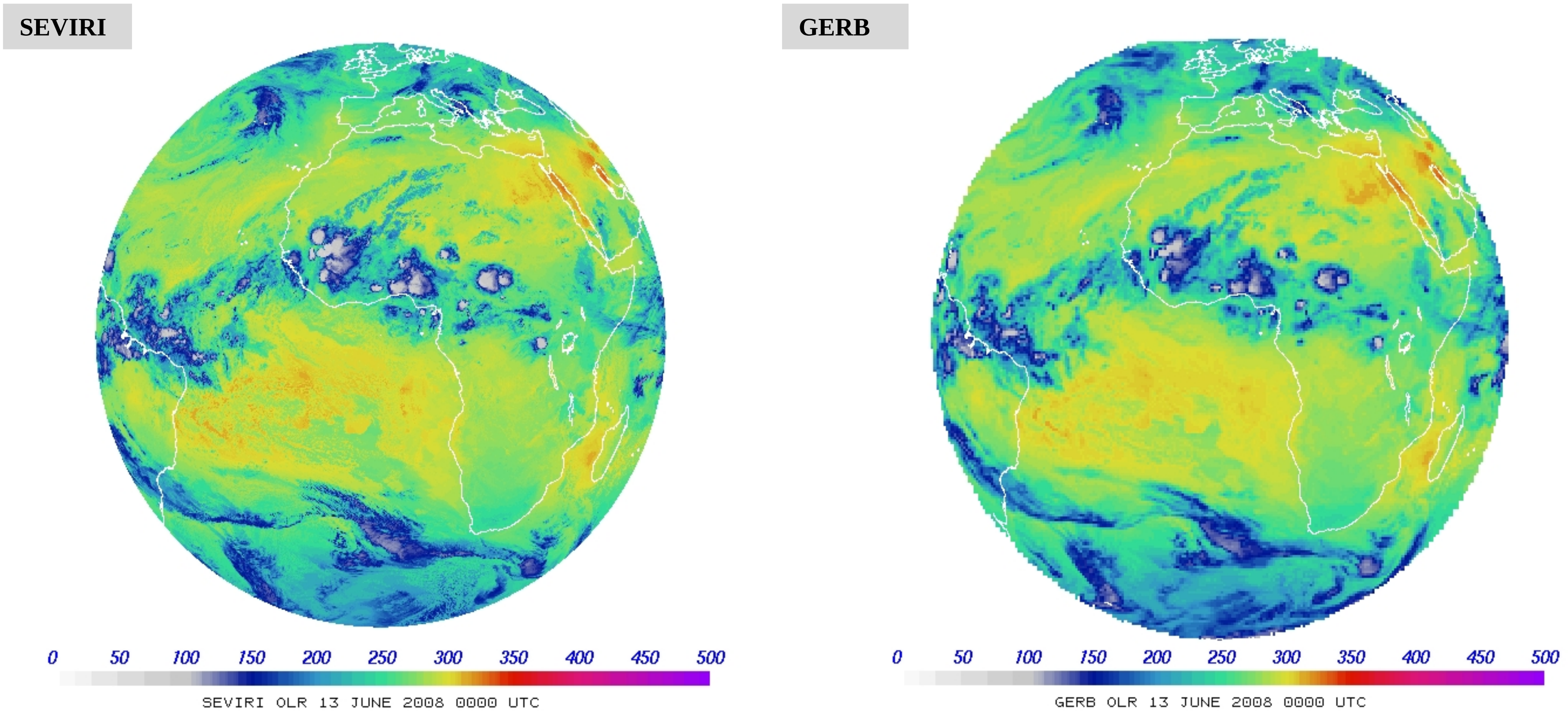

Figure 4: Comparison of the Meteosat-9 SEVIRI OLR and the GERB OLR for 13 June 2008, 00:00 UTC, with an observed bias of 0.70 W/m^2
The SEVIRI OLR is slightly lower.

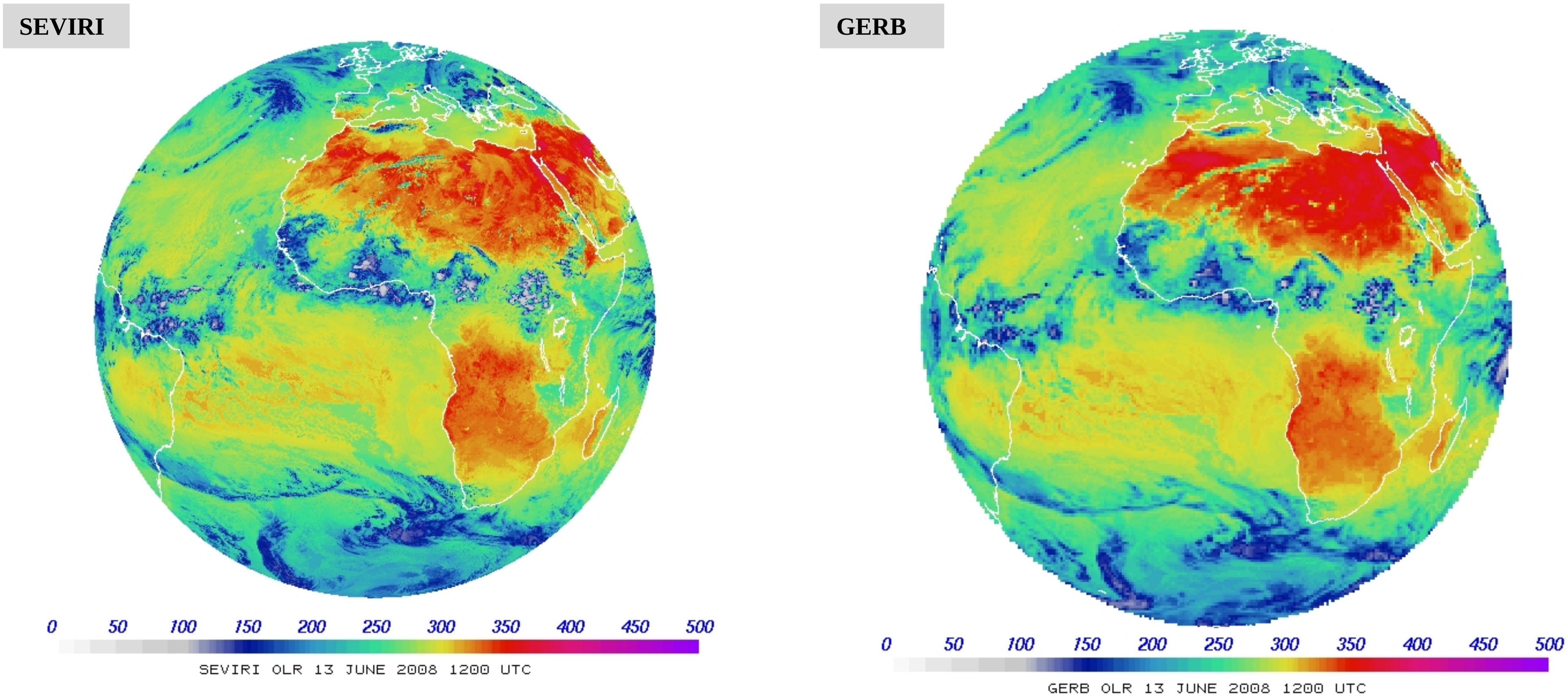

Figure 5: Comparison of the Meteosat-9 SEVIRI OLR and the GERB OLR for 13 June 2008, 12:00 UTC, with an observed bias of 3.37 W/m^2 (SEVIRI OLR is slightly lower).

4 ONLINE RESOURCES AND ASSISTANCE

4.1 Reference Documents

Ref	Type	Document Name	Reference
RD 1	Validation	MSG-3 System Commissioning Product Validation Test Report	EUM/MSG/REP/12/0190
RD 2	Research	Outgoing longwave radiation and its diurnal variation at regional scales derived from Meteosat (Schmetz and Liu, 1988)	doi: 10.1029/88JD03035
RD 3	Detailed Algorithm	ATBD for Outgoing Longwave Radiation Product	EUM/OPS/DOC/09/5176
RD 4	Research	SBDART: Santa Barbara DISORT Atmospheric Radiative Transfer	http://www.crseo.ucsb.edu/esrg/sbdart/
RD 5		Frédéric Chevallier, 2002: Sample databases of 60-level atmospheric profiles from the ECMWF analyses,	NWPSAF-EC-TR-004
RD 6	Research	OLR Product: Conversion Tables for Spectral Radiance	EUM/TSS/DOC/14/751621

4.2 Online Resources and Assistance

All of the reference documents listed above are on the EUMETSAT Technical Documents page.

www.eumetsat.int > Satellites > Technical Documents > Meteosat Services
> 0° Meteosat Meteorological Products

Information about the service status of EUMETSAT satellites and the data they deliver is this EUMETSAT web page:

www.eumetsat.int > Data > Service Status

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