Outgoing Longwave Radiation Factsheet

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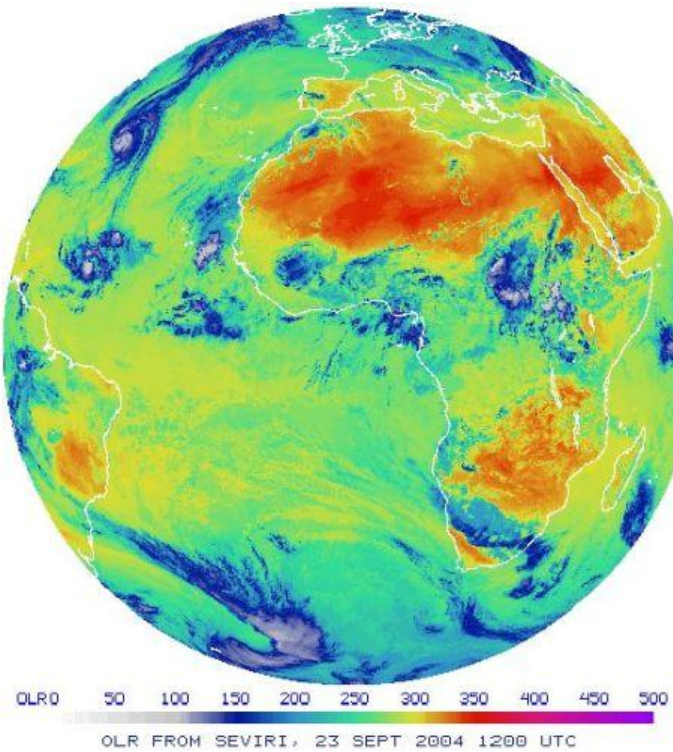
The Earth Radiation budget is made up of the incoming solar flux and the outgoing Top-of-the-Atmosphere (TOA) radiative fluxes. The outgoing radiative fluxes consist of the reflected part of the incoming solar flux, as well as the thermal flux emitted by the Earth-atmosphere system. The thermal flux 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-atmosphere system to solar diurnal forcing. Those variations can be found in particular in surface temperature, cloud cover, cloud top height, and related quantities like precipitation. The OLR is therefore well suited for validation of global circulation models (GCMs) simulating the diurnal cycle, as it constitutes the combination of different modelaspects.



Example of OLR

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.

The OLR is currently not operationally derived - the shown results are the outcome of a feasibility study. This product is a candidate product for a future reprocessing facility within EUMETSAT to support the derivation of climate-relevant parameters. The interested user will find the full algorithm below.

Outline of Flux Calculations

The regression scheme is based on the algorithm for Meteosat First Generation satellites (Schmetz & Liu, 1988), and involves two steps: the spectral radiances are first converted into spectral fluxes, i.e. accounting 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 model calculations provided scene-dependent regression coefficients, i.e. 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[1], and a comprehensive sample of atmospheric profiles is taken from Chevallier, 2002[2], together with a wide range of possible cloud layers, cloud properties and surface emissivities.

[1] SBDART: Santa Barbara DISORT Atmospheric Radiative Transfer, http://www.crseo.ucsb.edu/esrg/sbdart/

[2] Frédéric Chevallier, 2002: Sample databases of 60-level atmospheric profiles from the ECMWF analyses, NWPSAF-EC-TR-004

Step 1: Conversion of spectral radiance to spectral flux

Spectral Flux = $a(\theta)$ + Spectral Radiance · $b(\theta)$
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

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

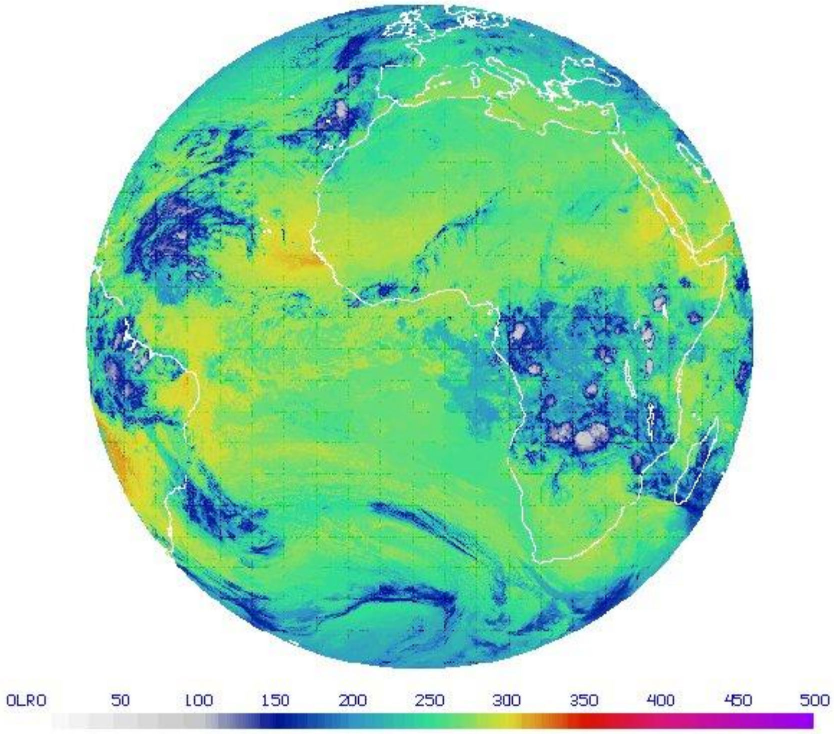
where

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

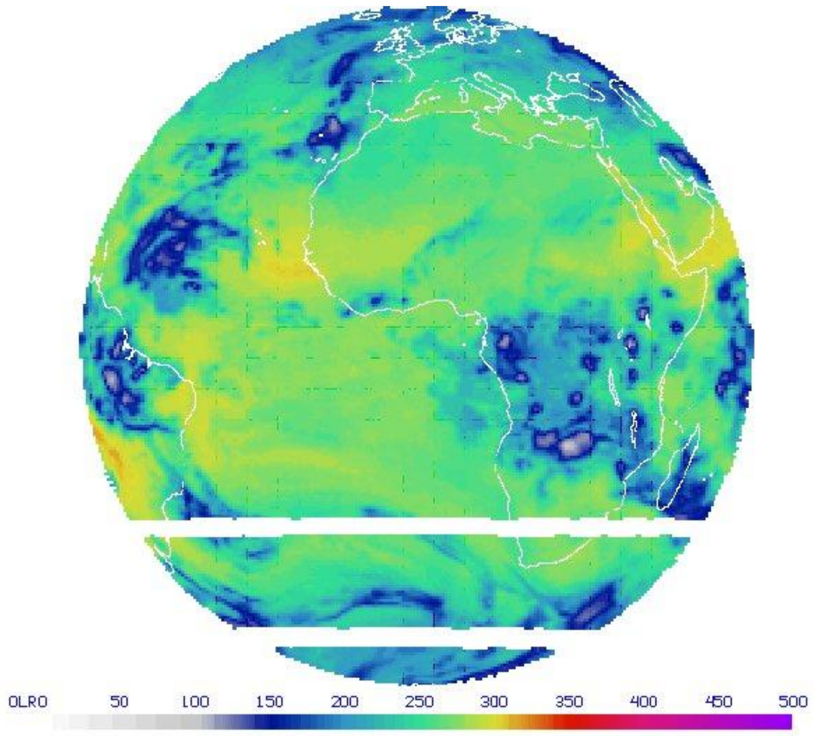
All coefficients referred to in Steps 1 and 2 can be downloaded here (PDF, 29 KB) in ASCII format: Meteosat-8, Meteosat-9.

The following images show comparisons of the SEVIRI OLR and the GERB OLR for Meteosat-8 and Meteosat-9.

Meteosat-8:

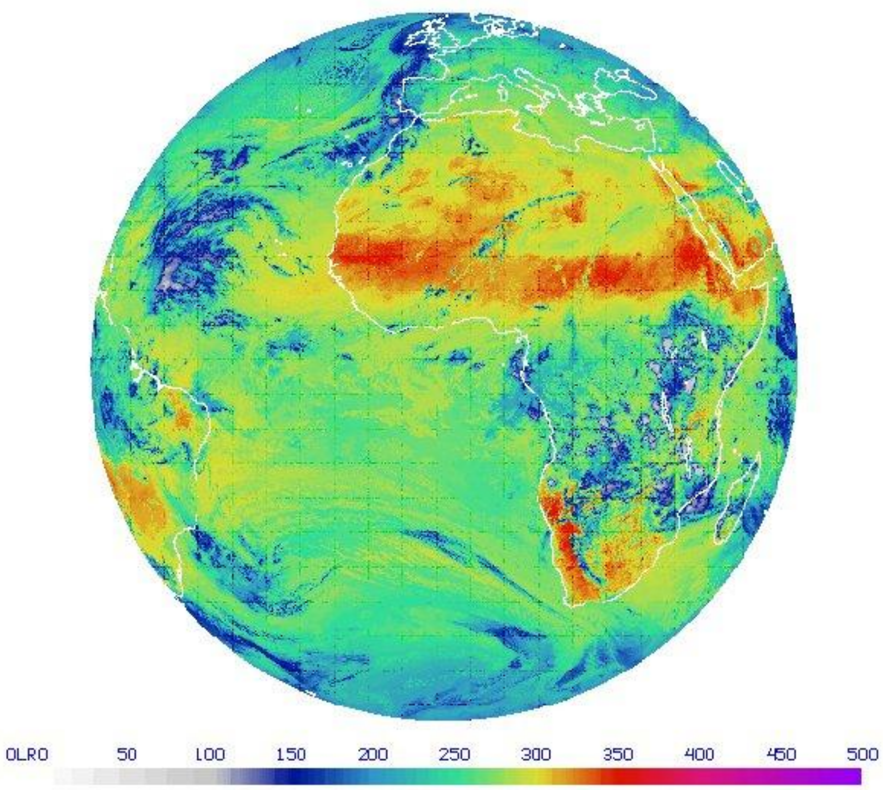


SEVIRI image

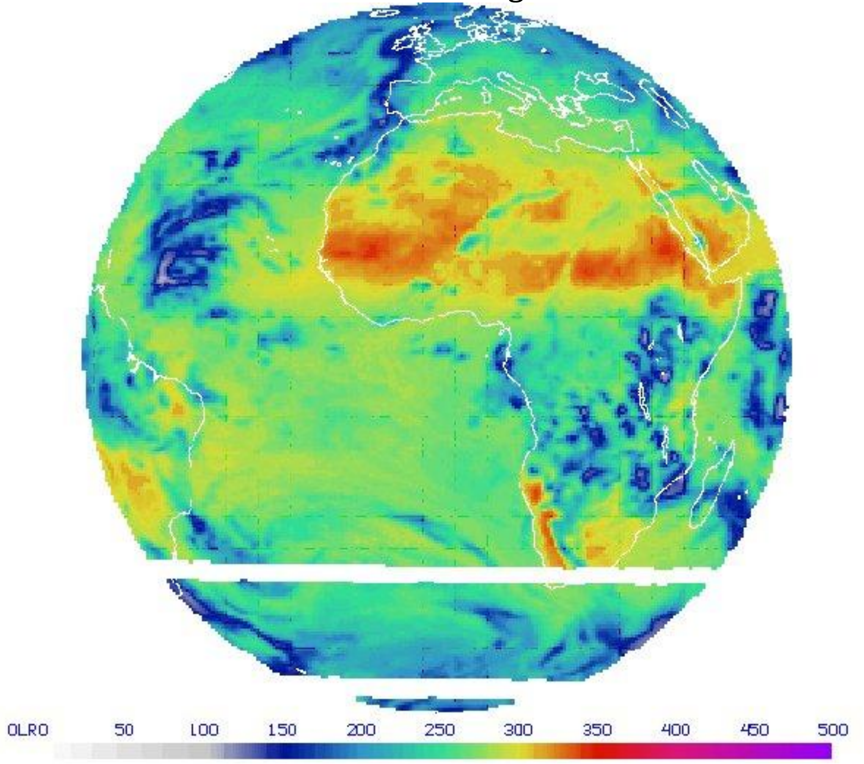


GERB image

Above: 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/m2 (SEVIRI OLR is slightly higher).



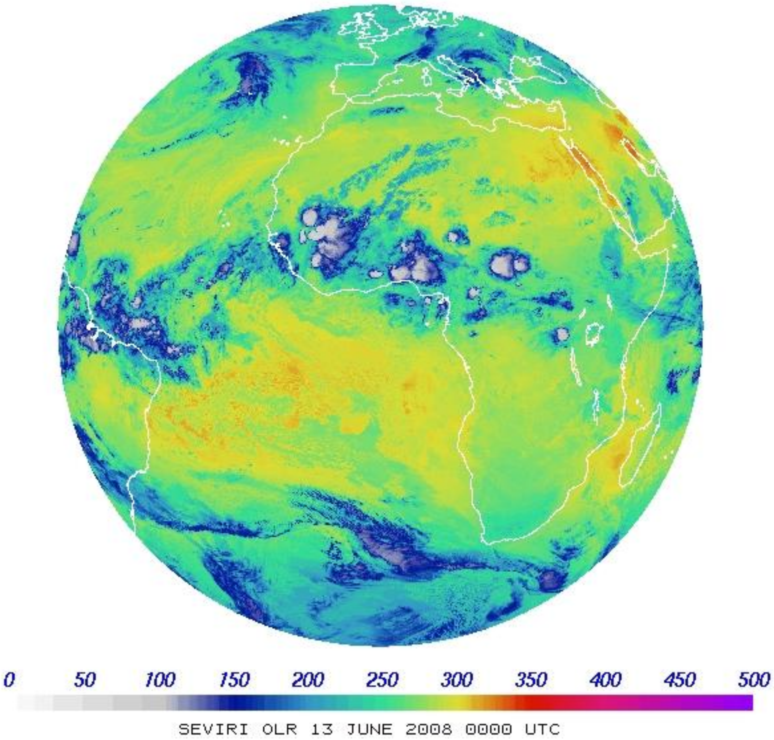
SEVIRI image



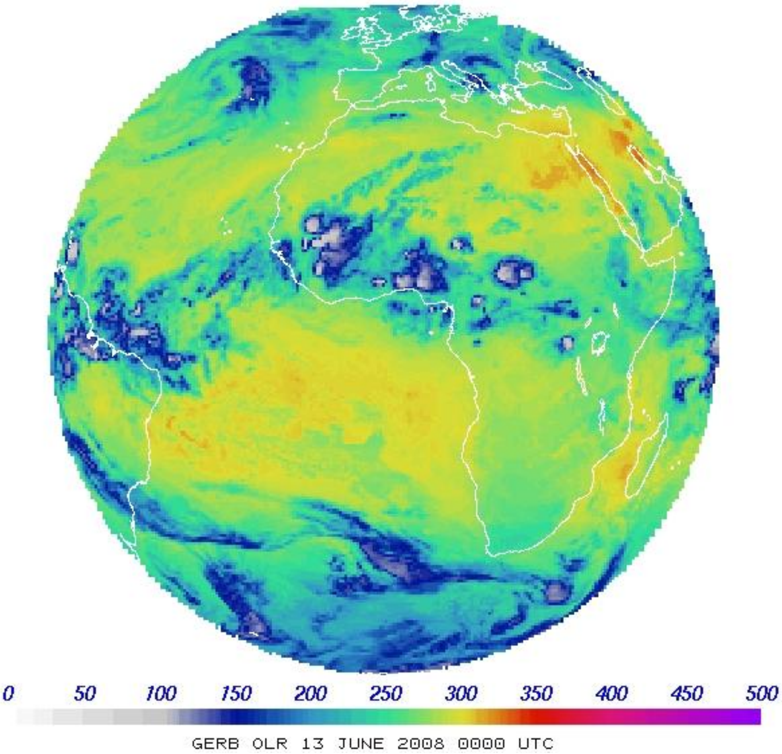
GERB image

Above: 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/m2 (SEVIRI OLR is slightly higher).

Meteosat-9:

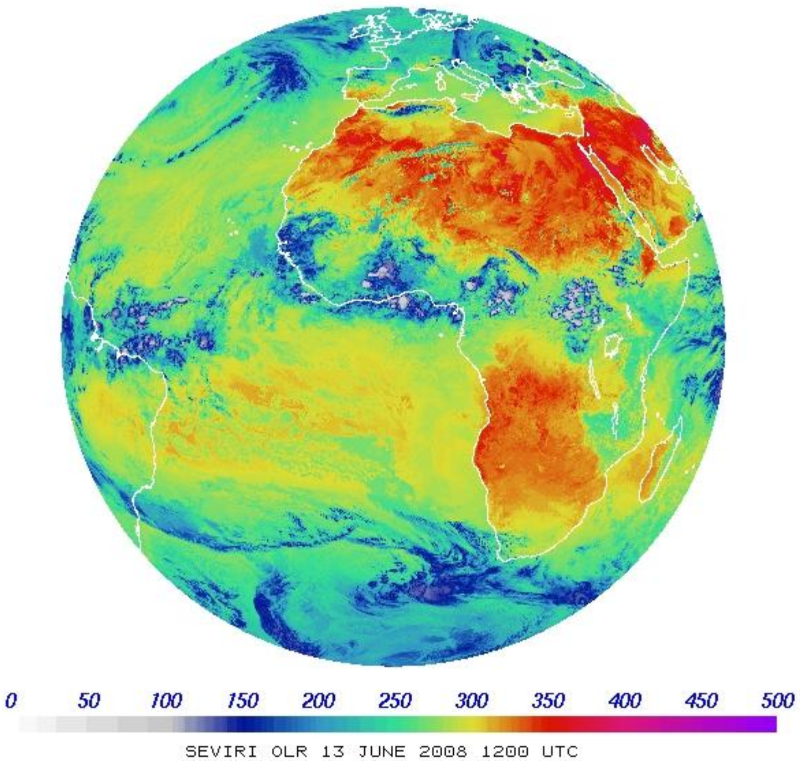


SEVIRI image

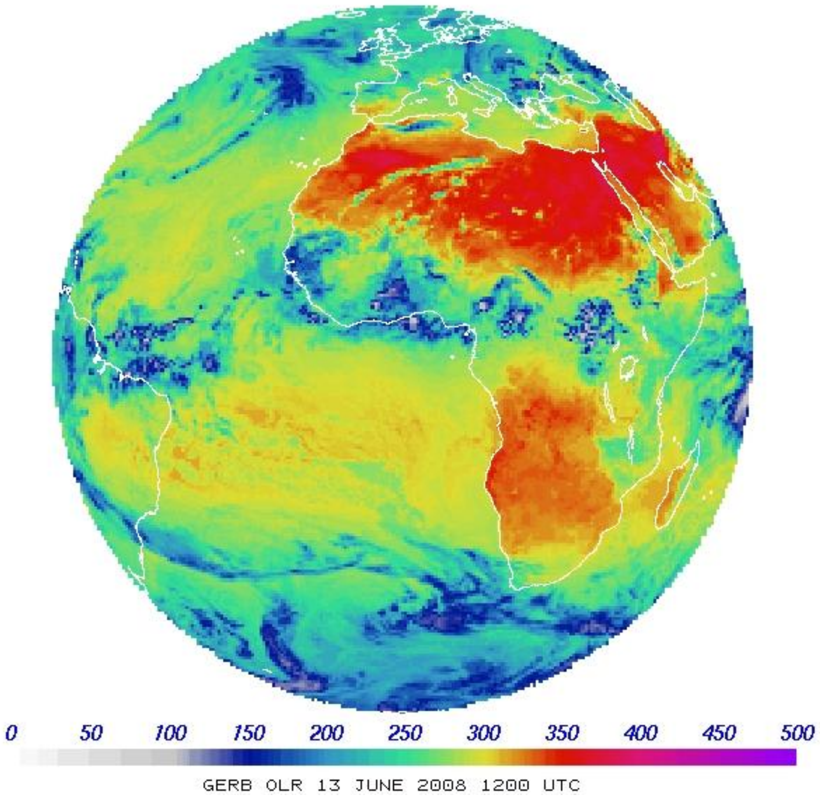


GERB image

Above: 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/m2 (SEVIRI OLR is slightly lower).



SEVIRI image



GERB image

Above: 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/m2 (SEVIRI OLR is slightly lower).