Generation of TOA Radiative Fluxes from the GERB Instruments

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GERB = Geostationary Earth Radiation Budget

- Broadband radiometer to be launched on the MSG-1,2,3 satellites,
- 2 channels : TOT ($0.32\mu m < \lambda < 100\mu m$) and SW ($0.32\mu m < \lambda < 4\mu m$),
- Ground segment in UK (RAL) and Belgium (RMIB) to convert the instrument data into radiative fluxes at top of atmosphere:

  -> **reflected solar flux**,

  -> **emitted thermal flux**

- Main interest for GERB: accurate ERB measurement at high temporal sampling rate

RMIB-GERB Ground Segment Overview

Output : solar and thermal radiative fluxes at top of the atmosphere,

Input : data from GERB and SEVIRI (both on MSG),

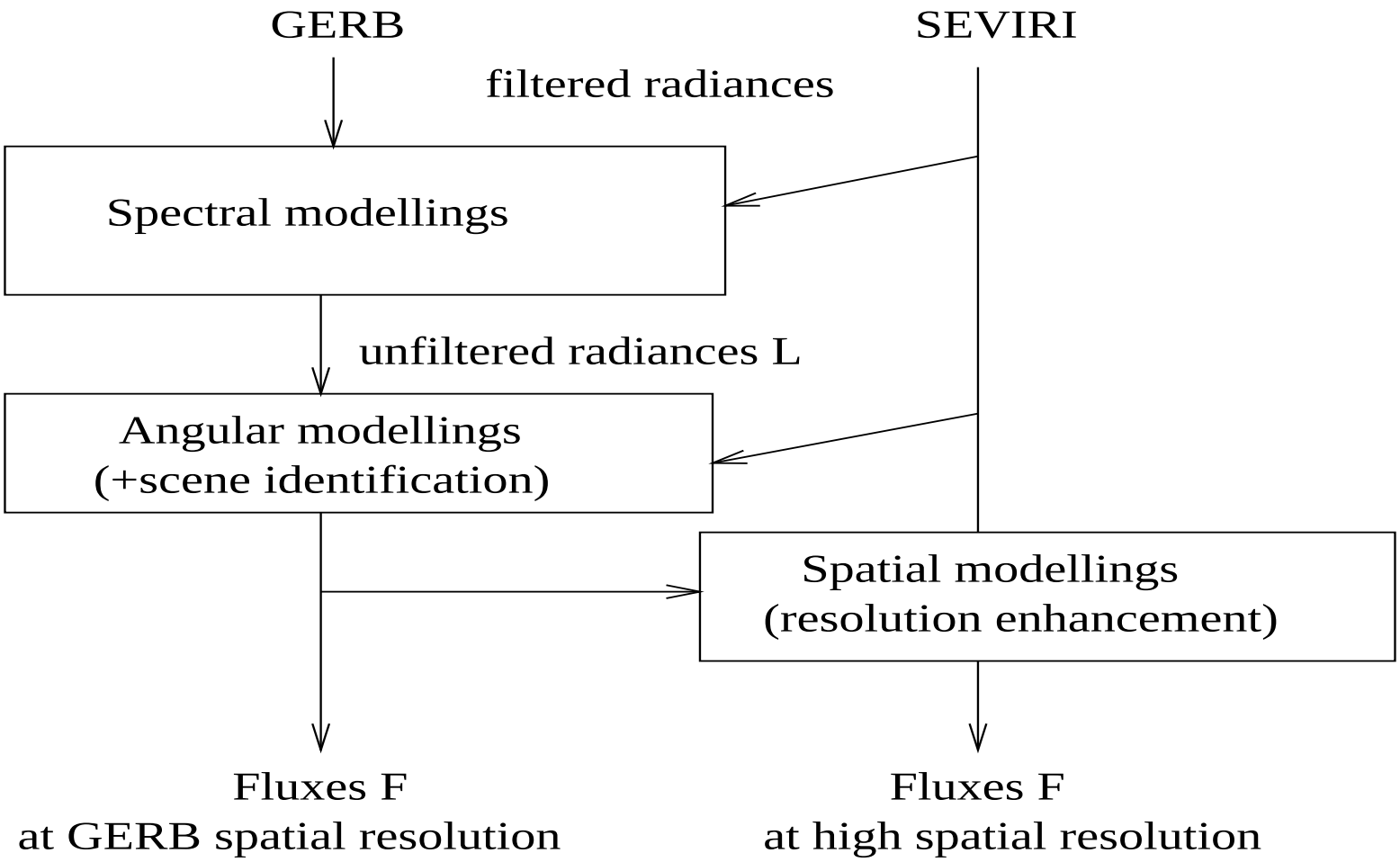
Processing : data fusion from 2 (very) complementary instruments :

Instrument	Advantages	Drawbacks
GERB (broadband radiometer)	- radiometric accuracy - broadband filters (=> extended λ range).	- coarse spatial resolution - only 2 channels
SEVIRI (meteorological imager)	- multispectral (12 channels) (=> scene spectral signature) - fine spatial resolution	- narrow-band filters - limited radiometric accuracy for the solar channels

Instruments Main Characteristics

characteristics	GERB	SEVIRI
spatial resolution (at nadir)	48 km	3 km
temporal sampling	15'	15'
radiometric accuracy (solar)	1 %	5 %
radiometric accuracy (thermal)	0.5 %	1 %
# channels	2	12
channel type	broadband	narrow band

Same field of view (Atlantic, Africa, Europe).

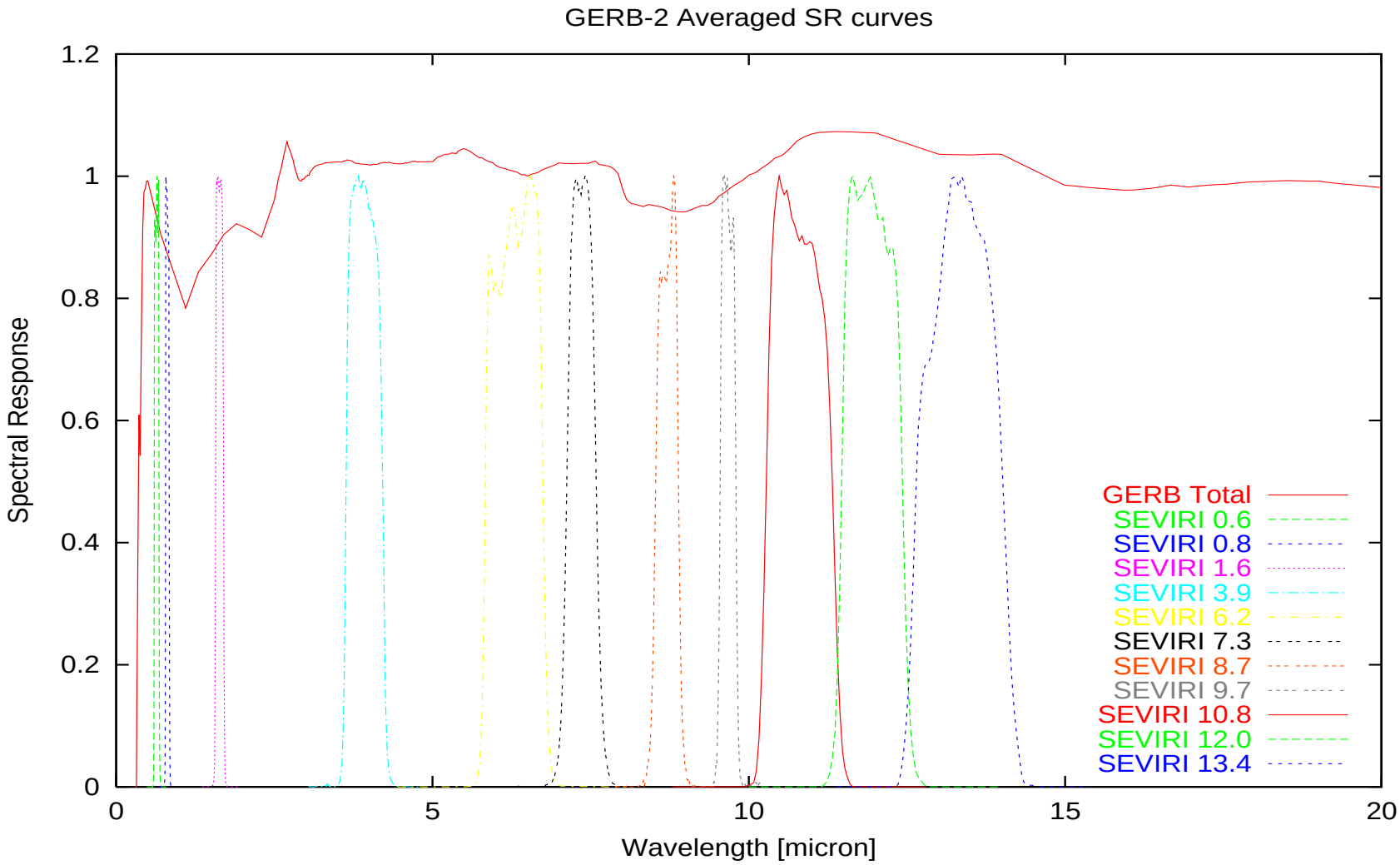

GERB
SEVIRI
filtered radiances
Spectral modellings
unfiltered radiances L
Angular modellings
(+scene identification)
Spatial modellings
(resolution enhancement)
Fluxes F
at GERB spatial resolution
Fluxes F
at high spatial resolution

Instrument data unfiltering

$$L^f = \int L(\lambda)\,\phi(\lambda)\,d\lambda \quad \rightarrow \quad L = \int L(\lambda)\,d\lambda$$

Method:

Exploitation of spectral information (*spectral signature*) from the 12 SEVIRI channels.


GERB-2 Averaged SR curves
Spectral Response
Wavelength [micron]
0
0.2
0.4
0.6
0.8
1
1.2
0
5
10
15
20
GERB Total
SEVIRI 0.6
SEVIRI 0.8
SEVIRI 1.6
SEVIRI 3.9
SEVIRI 6.2
SEVIRI 7.3
SEVIRI 8.7
SEVIRI 9.7
SEVIRI 10.8
SEVIRI 12.0
SEVIRI 13.4

Radiance-to-flux conversion

$L(\theta, \phi) \quad \rightarrow \quad F = \int_{2\pi} L(\theta, \phi)\, cos\theta\, d\Omega$

Method: Use of **Angular Dependency Models (ADMs)**

$$R(\theta, \phi) = \frac{\pi}{F} L(\theta\, \phi)$$

- **Solar radiation** : CERES-TRMM models $R(\theta, \phi)$ for about 200 different scenes. Model selection need scene identification (see after),

- **Thermal radiation** : models $R(\theta)$ taking into account spectral information from SEVIRI and parameterized using RTM (SBDART, STREAMER, MODTRAN4).

Shortwave ADM selection - Scene Identification

- **Surface Identification** : maps of *IGBP* geotype from the *Global 1km data set project*.

- **Cloud identification :** from SEVIRI $L_{0.6\mu}$, $L_{0.8\mu}$, $L_{1.6\mu}$, the associated clear sky values *(see poster of Alessandro Ipe*), $L_{12\mu}$ and radiative transfer computations:

  -> cloud fraction in the radiometer footprint,

  -> cloud optical depth τ,

  -> cloud phase (water/ice).

Sufficient for the CERES-TRMM ADMs selection.

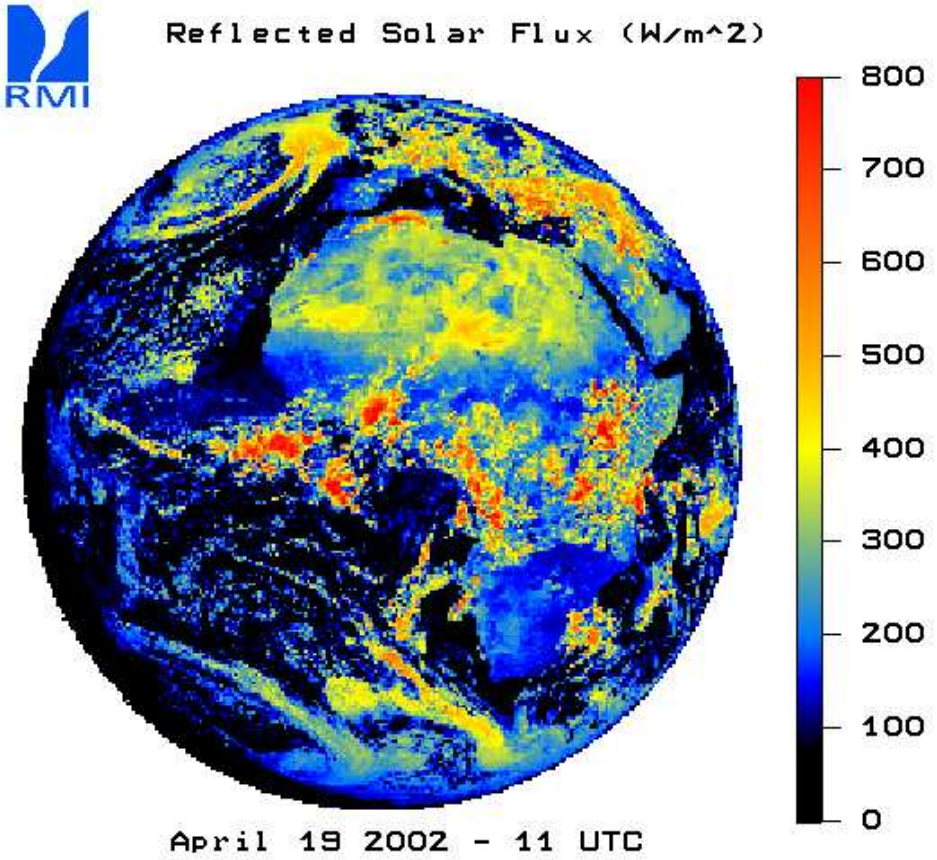
Spatial Resolution Enhancement

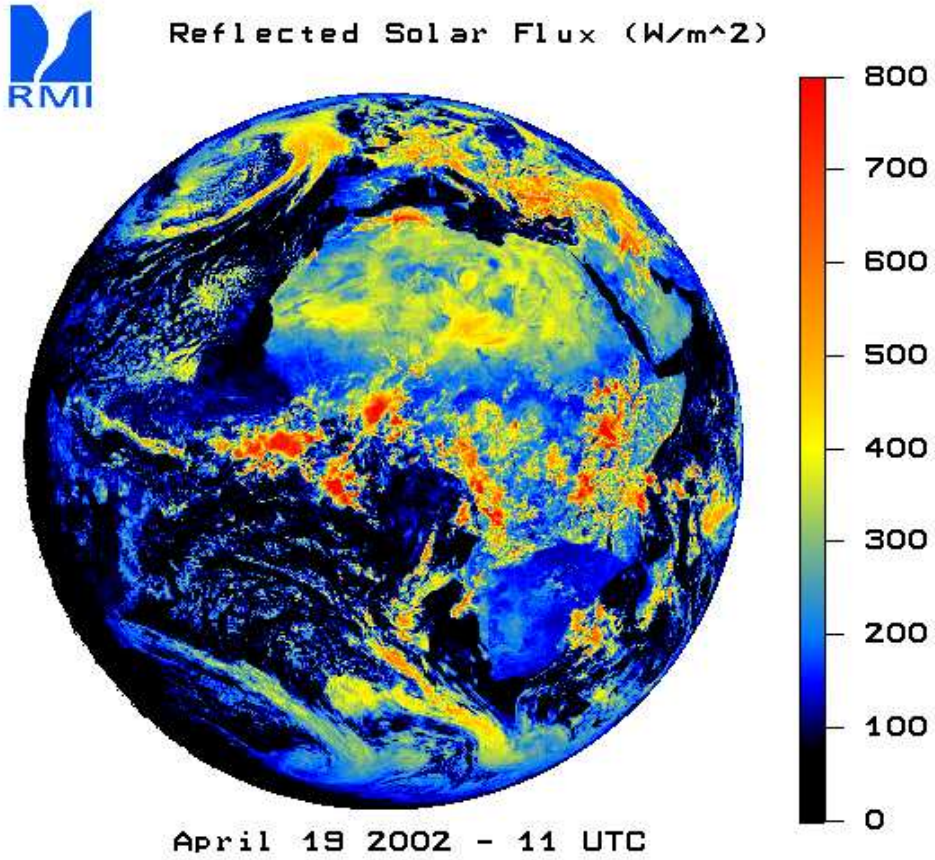
Problem: GERB footprint (50*50 km) is sufficient for climatological studies but interest for fluxes at finer spatial resolution for "Meteorology", for example for comparison with NWP fluxes (presentation of Cédric Bertrand),

Method:

- Estimate of high spatial resolution (10*10 km) fluxes from the SEVIRI instrument **alone** (NB-2-BB and angular conversion),

- "Renormalization" of these estimate using the low-resolution GERB fluxes


RMI
Reflected Solar Flux (W/m^2)
800
700
600
500
400
300
200
100
0
April 19 2002 - 11 UTC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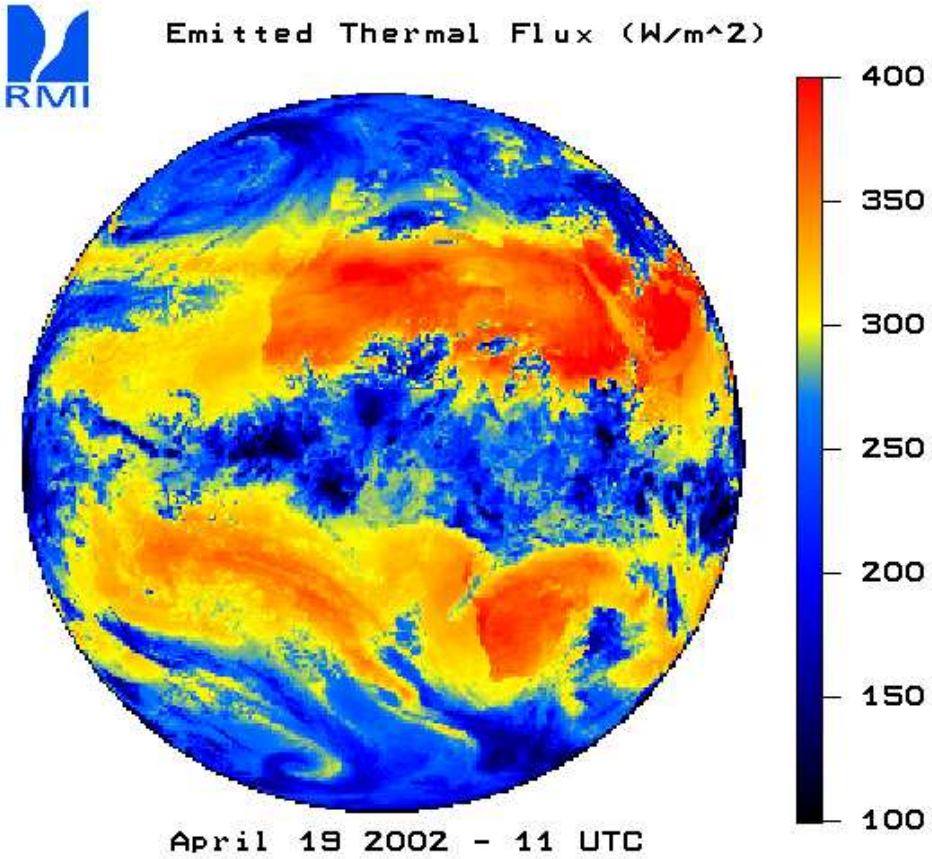
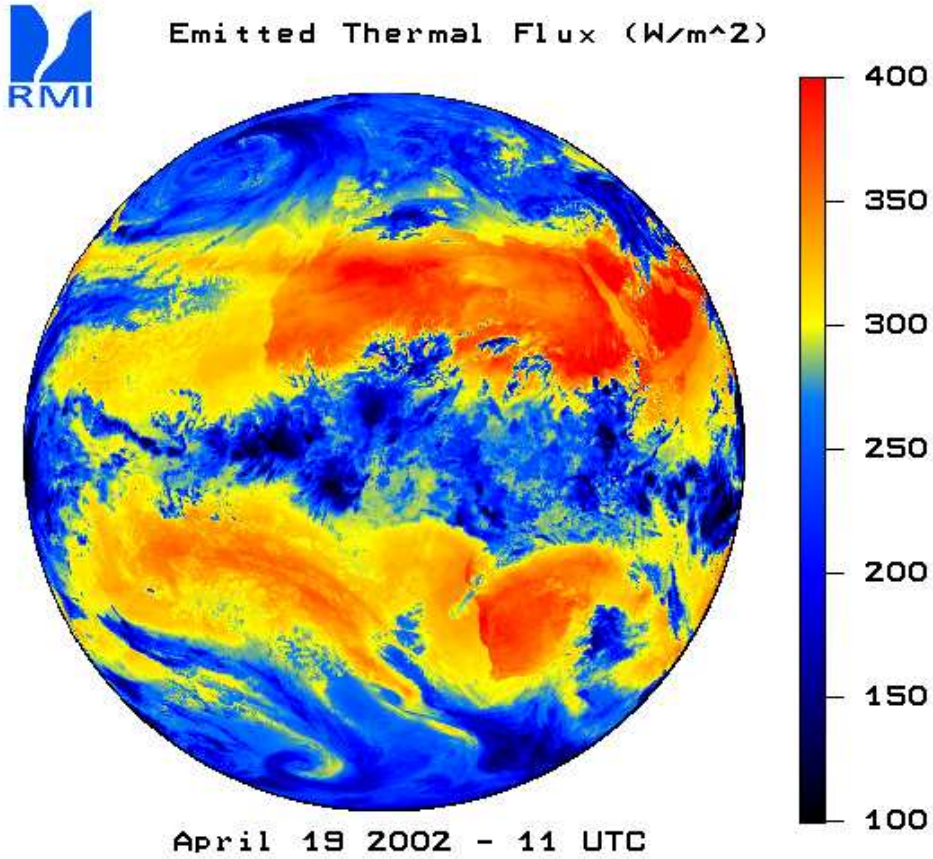

RMI
Emitted Thermal Flux (W/m^2)
400
350
300
250
200
150
100
April 19 2002 - 11 UTC


RMI
Emitted Thermal Flux (W/m^2)
400
350
300
250
200
150
100
April 19 2002 - 11 UTC

Conclusions

- The first GERB data will be available soon (MSG launch August 2002),
- Synergetic use of SEVIRI for the GERB data processing (unfiltering, radiance-to-flux and resolution enhancement).

Web resources:

http://www.ssd.rl.ac.uk/gerb/

http://gerb.oma.be/ (documentation)

ftp://gerb.oma.be/ (data)