Status of the GERB data processing system at launch

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Content

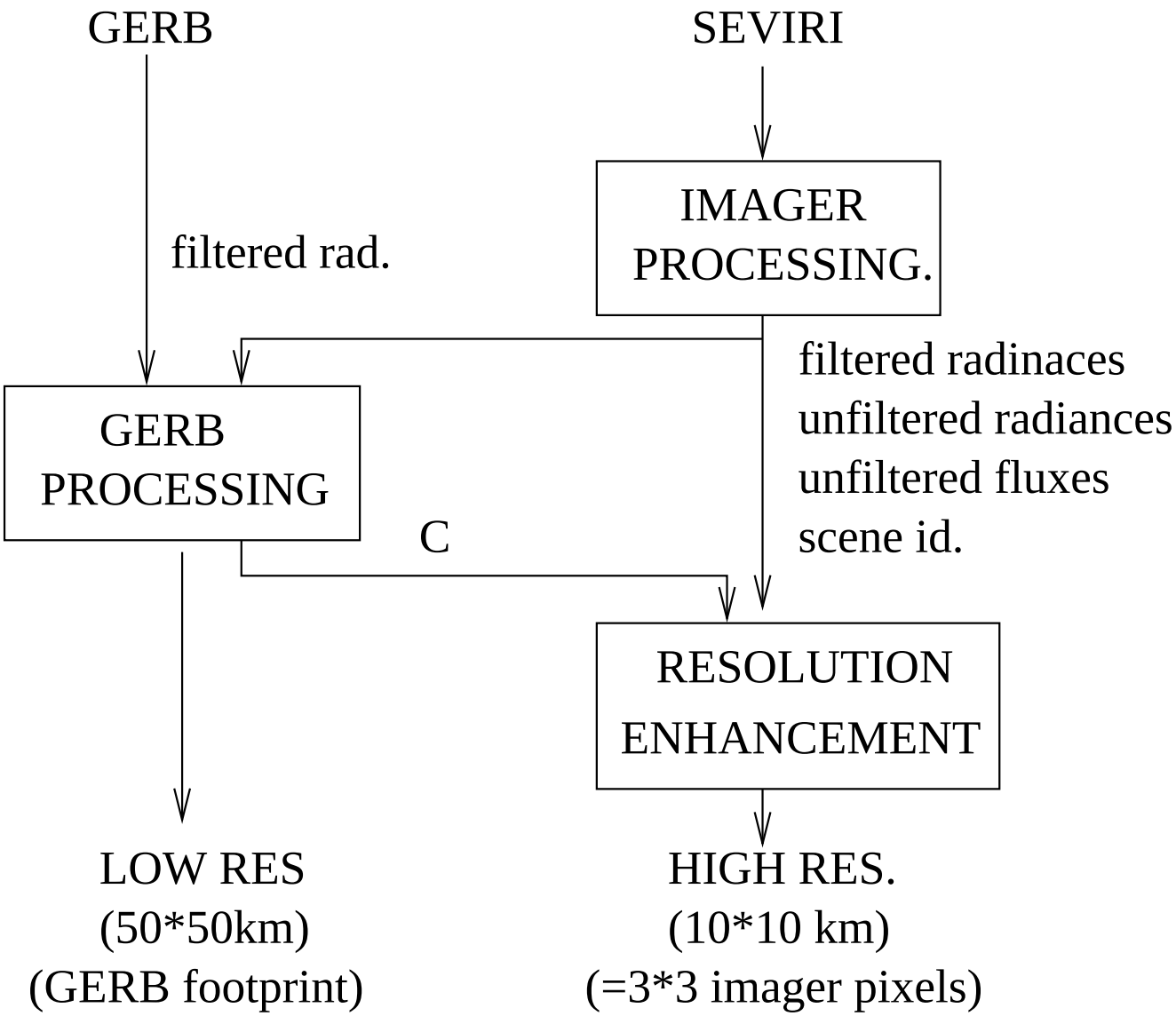
Overview of the (first version of the) processing system that will be used to process in near real time the GERB data.

- Instrument data unfiltering,
- Scene identification,
- Radiance-to-flux,
- Resolution enhancement.

Note: the close future for GERB

- The MSG-1 satellite was successfully launched on 28 August 2002.
- Now on the geostationary orbit over Atlantic Ocean, going to its commissioning position (10.5^oW).
- Second half of October 2002: first SEVIRI and GERB images
- Commissioning period: the GERB data will be processed using Meteosat-7 as imager
- September 2003: start of routine operations for MSG-1 at 0^o.

Data Processing Flow Chart



3 Main Processings

1. Imager Processing (10*10 km res):

- Estimation of BB filtered and unfiltered radiances (NB-to-BB conversions),
- Scene identification,
- Estimation of the BB unfiltered fluxes.

2. GERB processing

- Comparison GERB measurement L_{sw}/imager estimation L'_{sw}

$$C_{sw} = \frac{L_{sw}}{L'_{sw}} \qquad C_{lw} = \frac{L_{lw}}{L'_{lw}}$$

- Apply C to the BB unfiltered radiances and fluxes

3. Resolution enhancement

- Expand the C_{sw} and C_{lw} factors from the GERB to the imager spatial resolution. Apply these factors.

GERB Unfiltering

Method:

$$L_{sol} = (\frac{L_{sw}}{L'_{sw}})\, L'_{sol} = (\frac{L'_{sol}}{L'_{sw}})\, L_{sw}$$

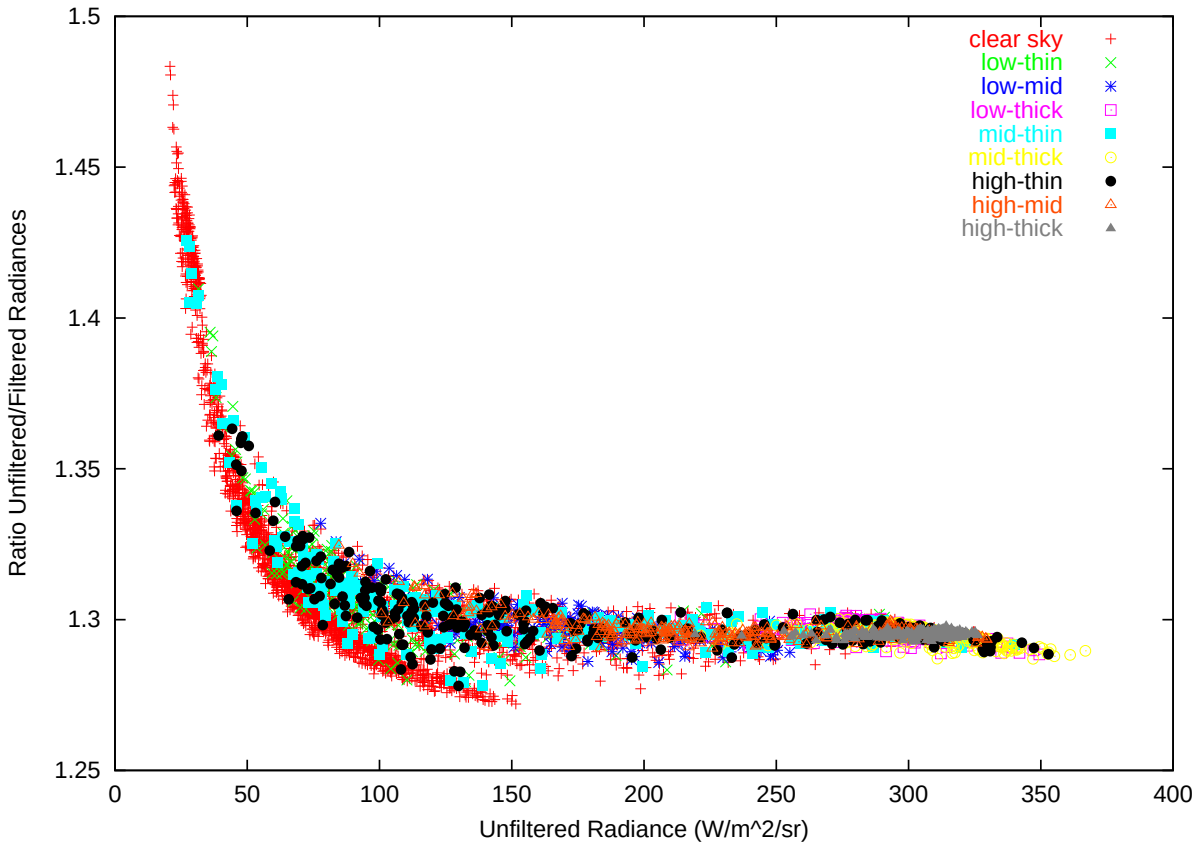
where:

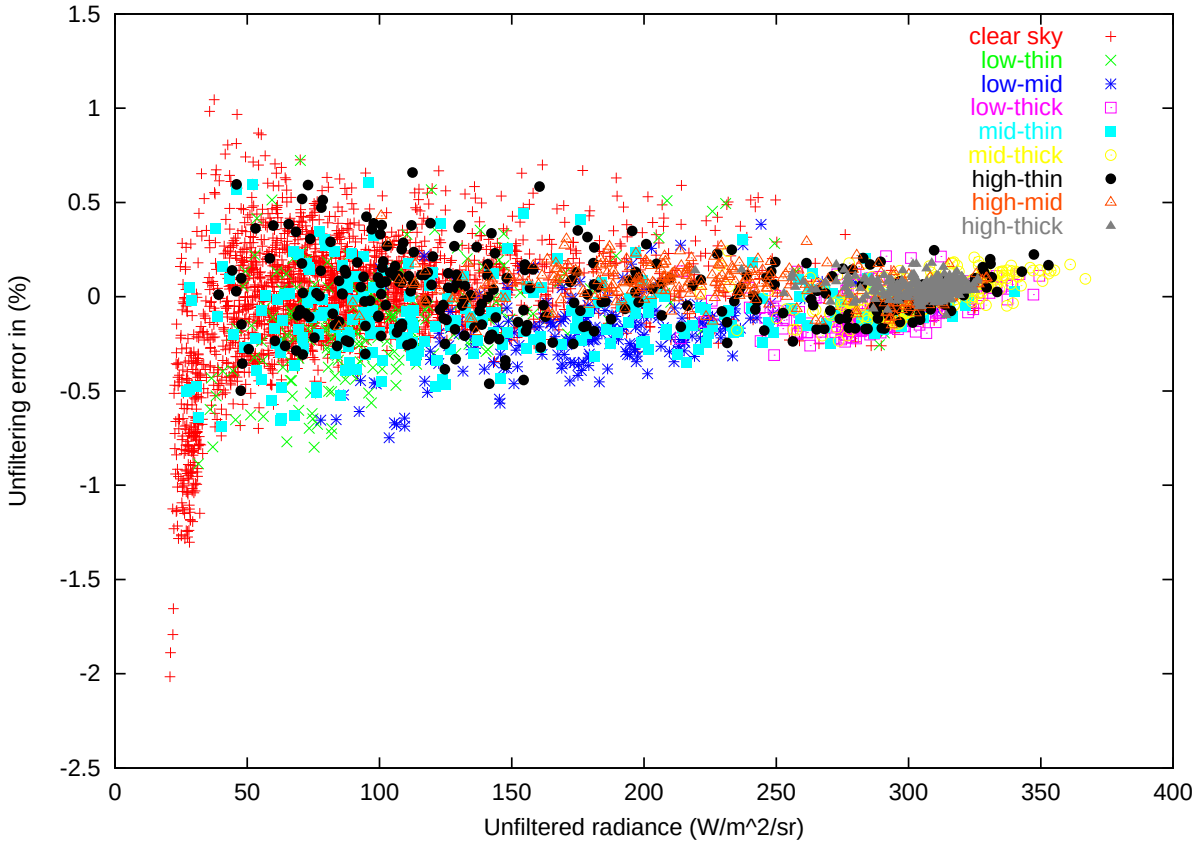
- L_{sw} is the GERB measurement,
- L'_{sol} and L'_{sw} are estimated from SEVIRI by standard NB-to-BB conversions (regressions). Parameterization using a spectral radiance database (RTM). NB-to-BB error (1 σ):

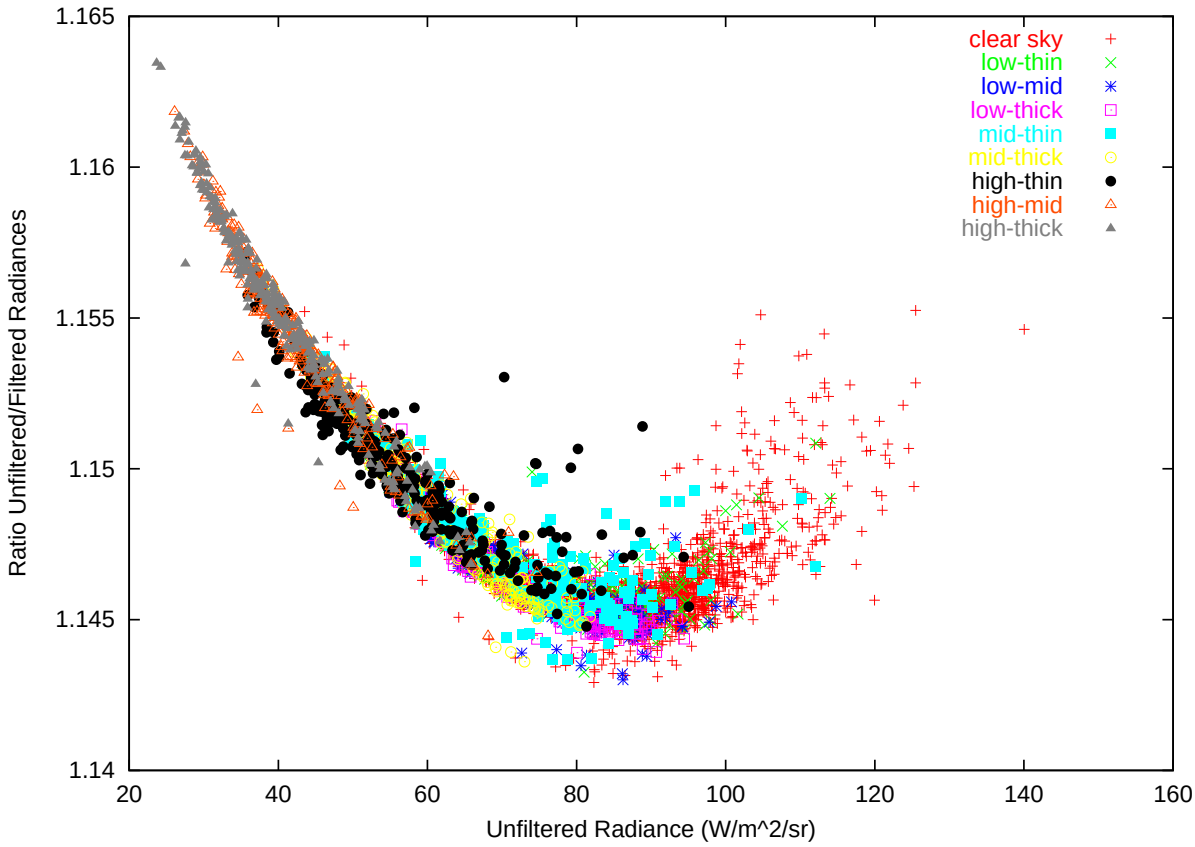
BB quantities	SEVIRI 1th order	SEVIRI 2nd order
L_{sol} and L_{sw}	5.1%	4.7%
L_{th} and L_{lw}	1.4%	1.0%

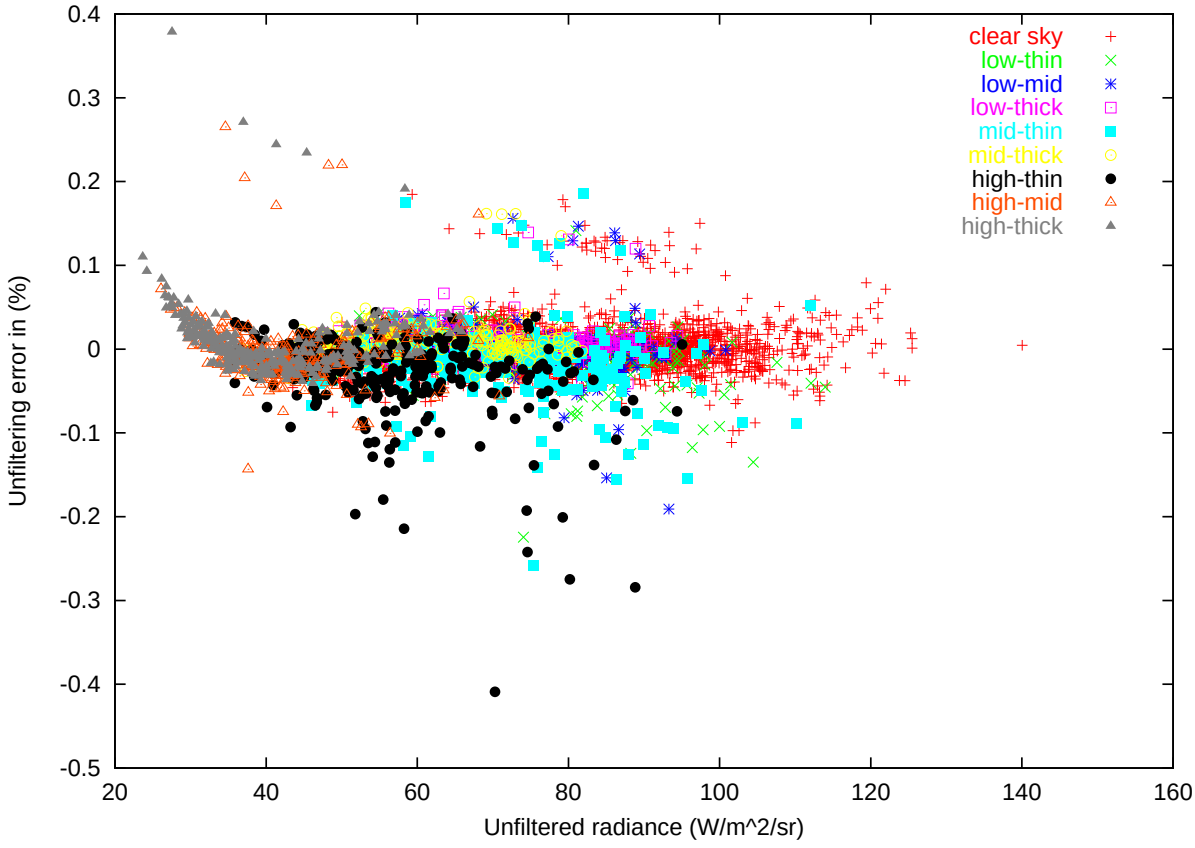
Mean relative error introduced by unfiltering (TN-0034):

$$SW : \ 0.3\%$$
$$LW : \ 0.1\%$$


Ratio Unfiltered/Filtered Radiances
Unfiltered Radiance (W/m^2/sr)
clear sky
low-thin
low-mid
low-thick
mid-thin
mid-thick
high-thin
high-mid
high-thick
1.5
1.45
1.4
1.35
1.3
1.25
0
50
100
150
200
250
300
350
400


Unfiltering error in (%)
Unfiltered radiance (W/m^2/sr)
clear sky
low-thin
low-mid
low-thick
mid-thin
mid-thick
high-thin
high-mid
high-thick
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
0
50
100
150
200
250
300
350
400


clear sky
low-thin
low-mid
low-thick
mid-thin
mid-thick
high-thin
high-mid
high-thick
Ratio Unfiltered/Filtered Radiances
Unfiltered Radiance (W/m^2/sr)
1.165
1.16
1.155
1.15
1.145
1.14
20
40
60
80
100
120
140
160


clear sky
low-thin
low-mid
low-thick
mid-thin
mid-thick
high-thin
high-mid
high-thick
Unfiltering error in (%)
Unfiltered radiance (W/m^2/sr)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
20
40
60
80
100
120
140
160

Scene identification on SEVIRI

- Implementation of a "visible clear sky reflectance" algorithm using the previous 60 measurements for the same hour:

$$\rho_{cs}(x,y) \;=\; A(x,y)\; R(\theta_v,\theta_s,\phi)$$

- Estimation of "cloud amount" in a pixel as:

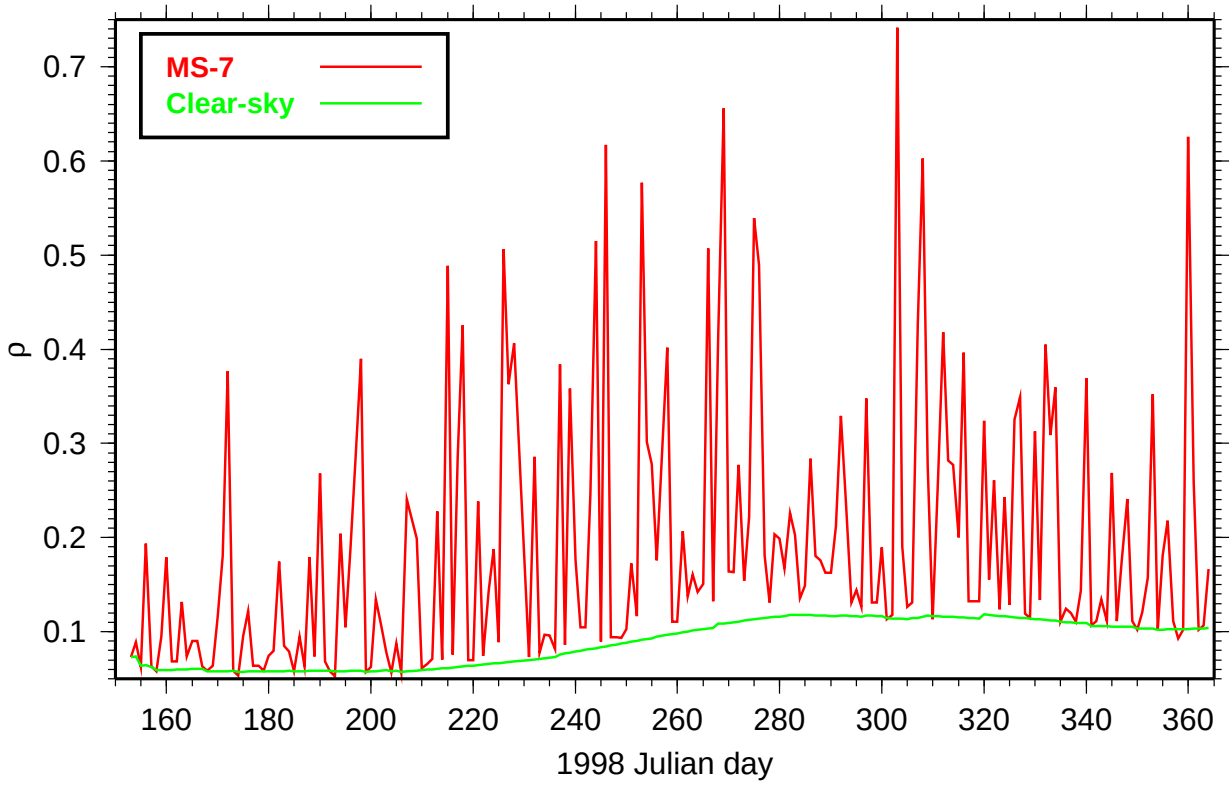
$$C = \frac{\rho - \rho_{cs}}{\rho_{over} - \rho_{cs}}$$

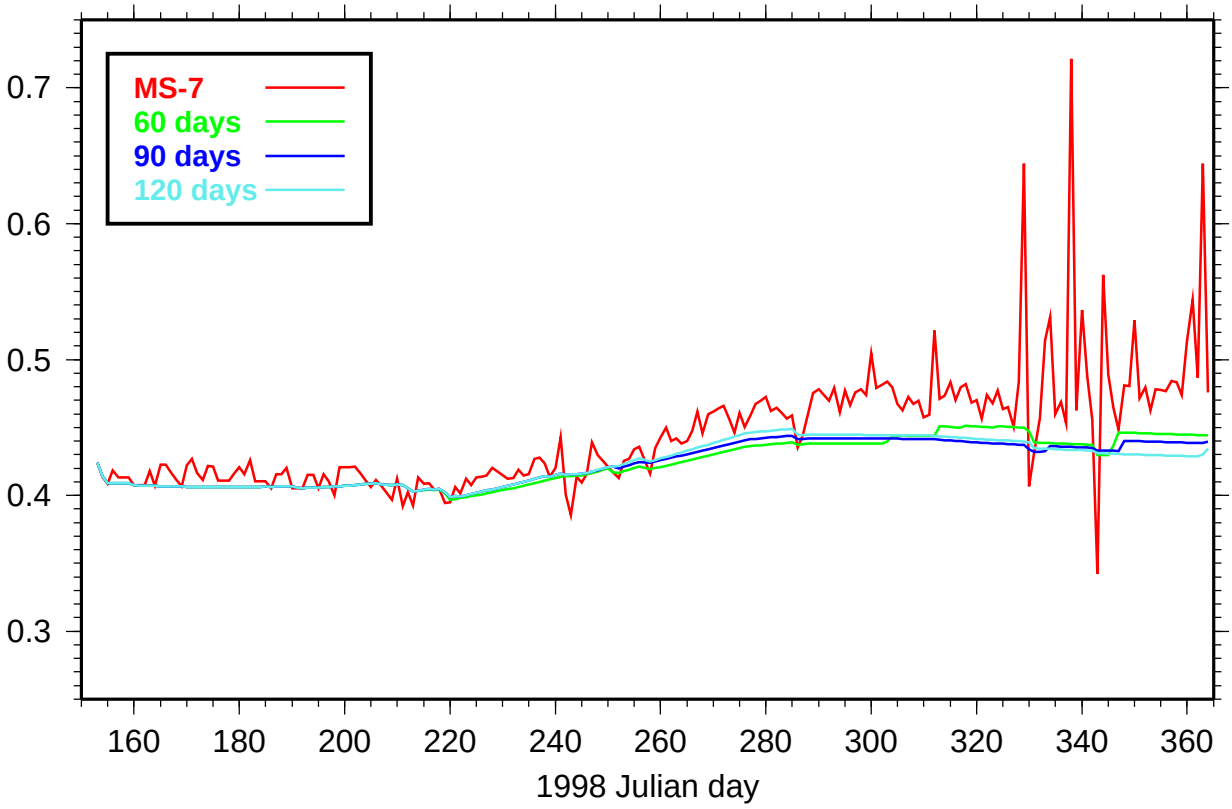
- Look Up Table (STREAMER)

$$\tau \;=\; \tau(C,\, phase,\, surf,\, \theta_v,\, \theta_s,\, \phi)$$

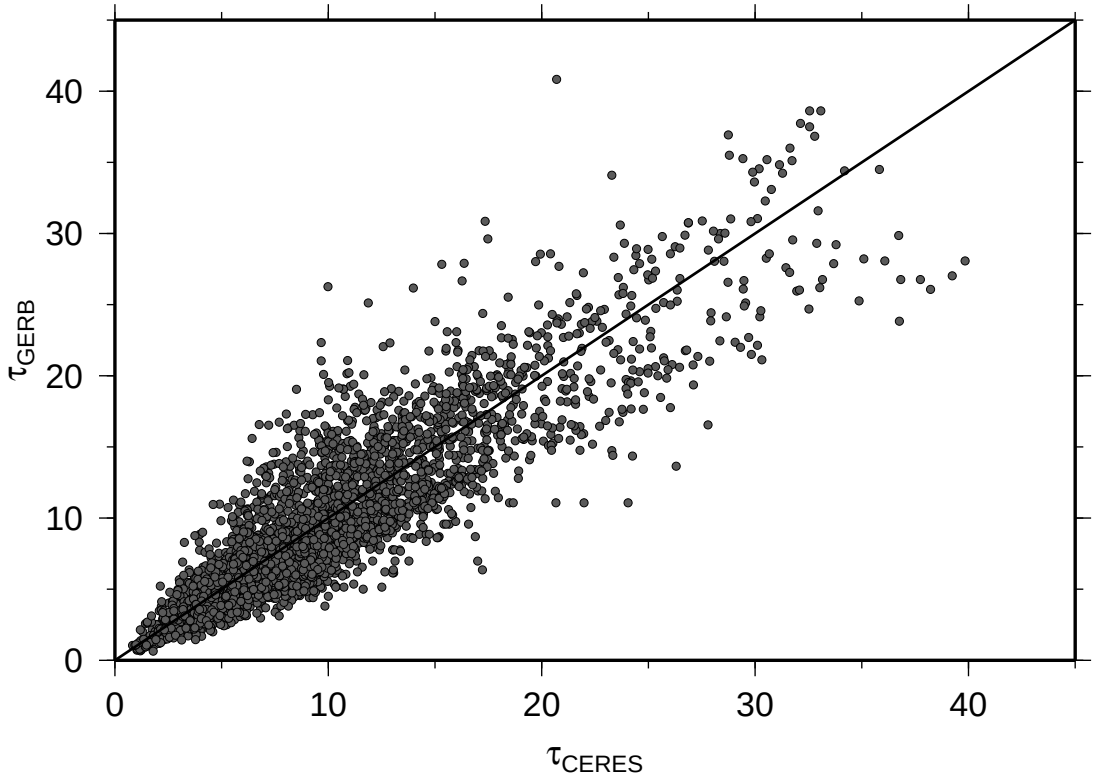
- Thresholding at $\tau_{th} = 0.6$ leads to similar cloud fraction than "CERES-VIRS"

- Phase from $L_{10.8\mu m}$ and ratio $L_{1.6\mu m}/L_{0.8\mu m}$ (Nakajima)

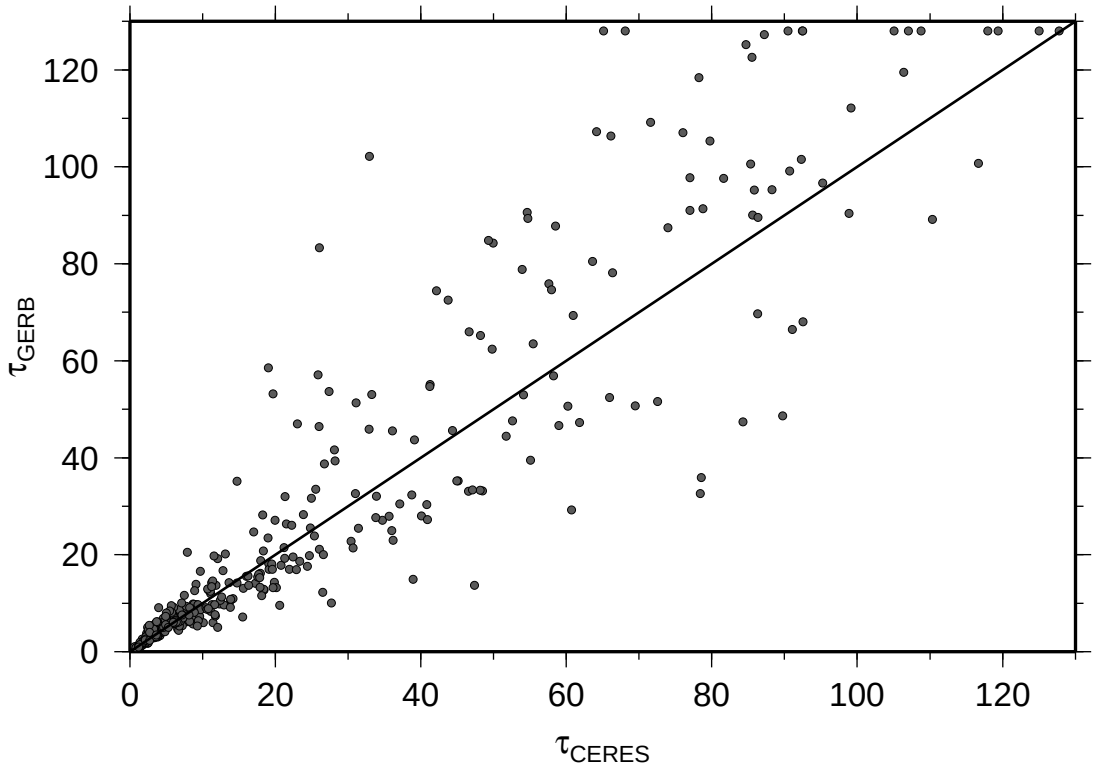

MS-7
Clear-sky
ρ
0.7
0.6
0.5
0.4
0.3
0.2
0.1
160
180
200
220
240
260
280
300
320
340
360
1998 Julian day


MS-7
60 days
90 days
120 days
0.7
0.6
0.5
0.4
0.3
160
180
200
220
240
260
280
300
320
340
360
1998 Julian day

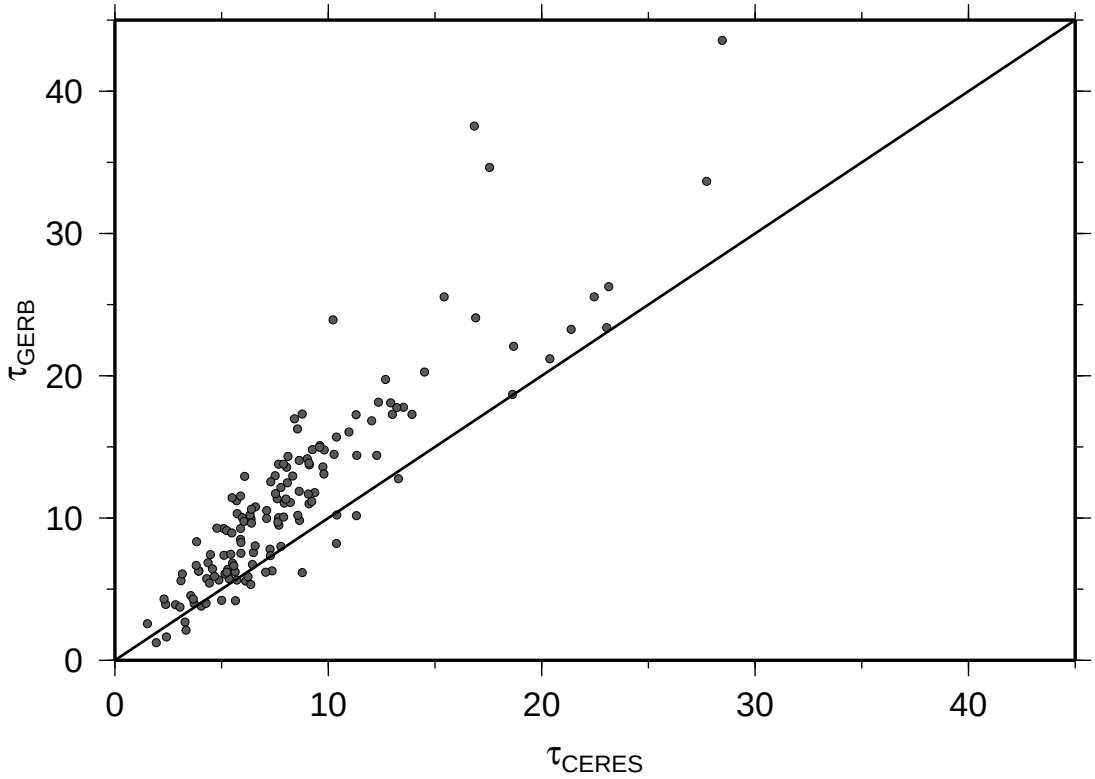
Ocean with water clouds



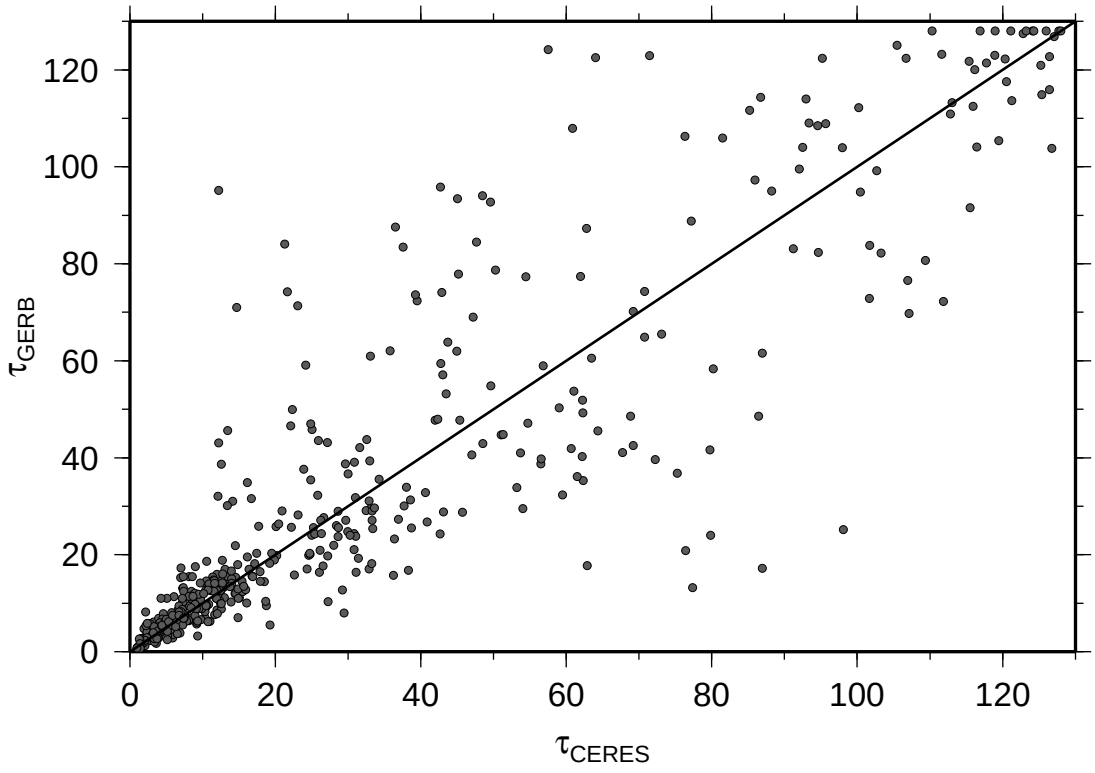
Ocean with ice clouds

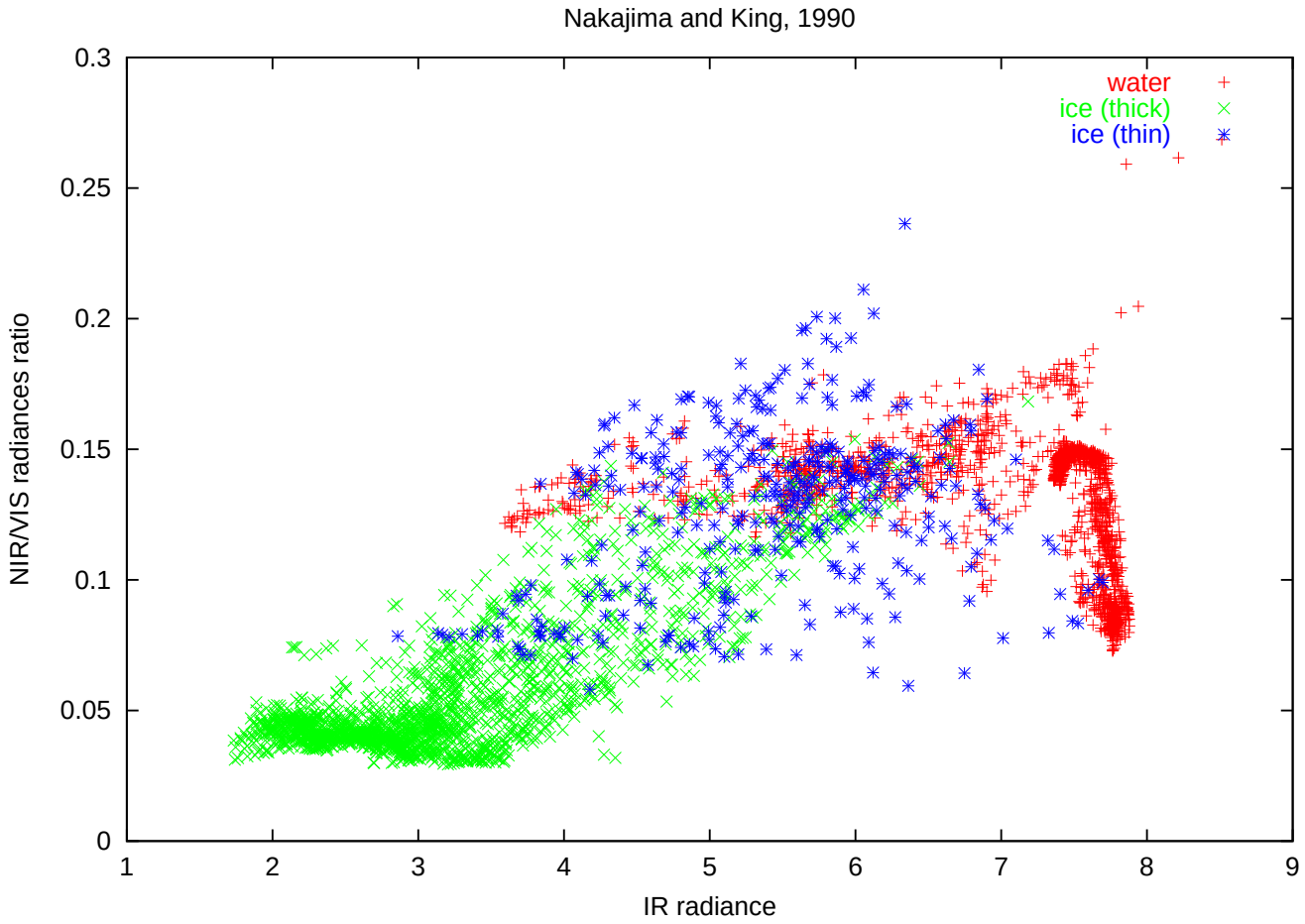


Vegetation with water clouds



Vegetation with ice clouds




Nakajima and King, 1990
water
ice (thick)
ice (thin)
NIR/VIS radiances ratio
IR radiance
0.3
0.25
0.2
0.15
0.1
0.05
0
1
2
3
4
5
6
7
8
9

Radiance-to-flux

- Shortwave: CERES-TRMM models (implemented),
- Longwave:"spectral model"

$$R = R(\theta_v, L_{6.2\mu m}, ..., L_{13.4\mu m})$$

- Validation using colocated CERES data

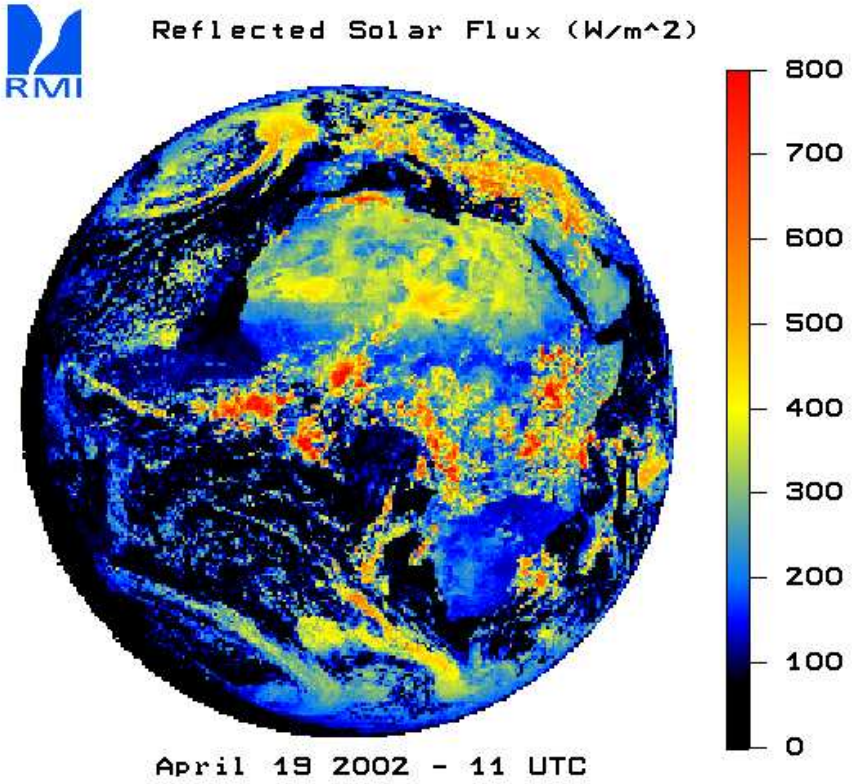
Resolution Enhancement

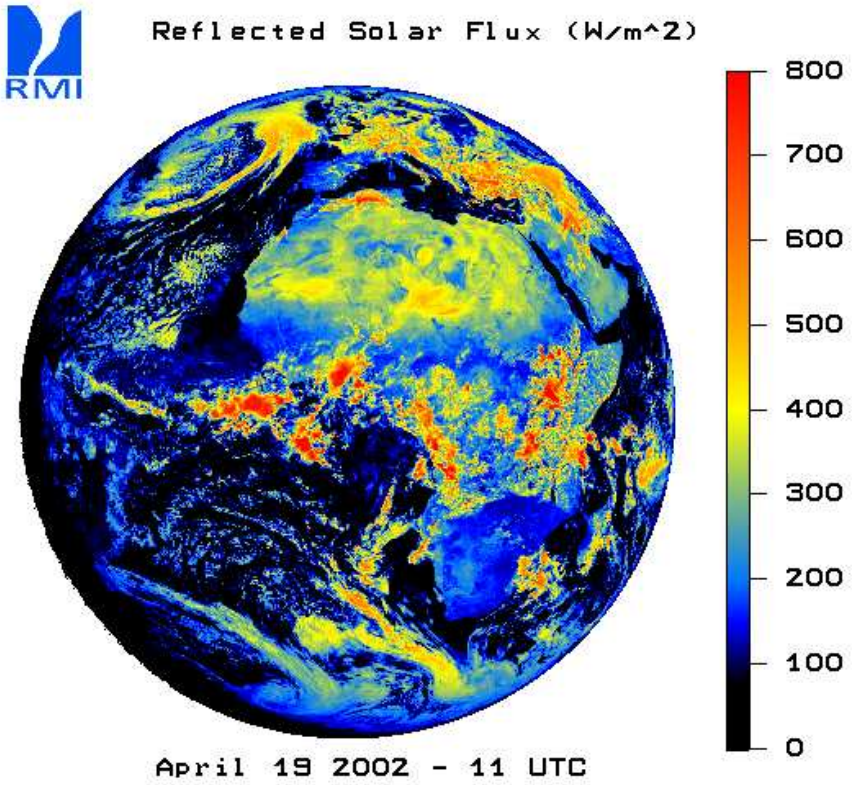
Goal: expand the C_{sw} and C_{lw} factors from the GERB footprint resolution to the imager spatial resolution -> c_{sw} and c_{lw}.

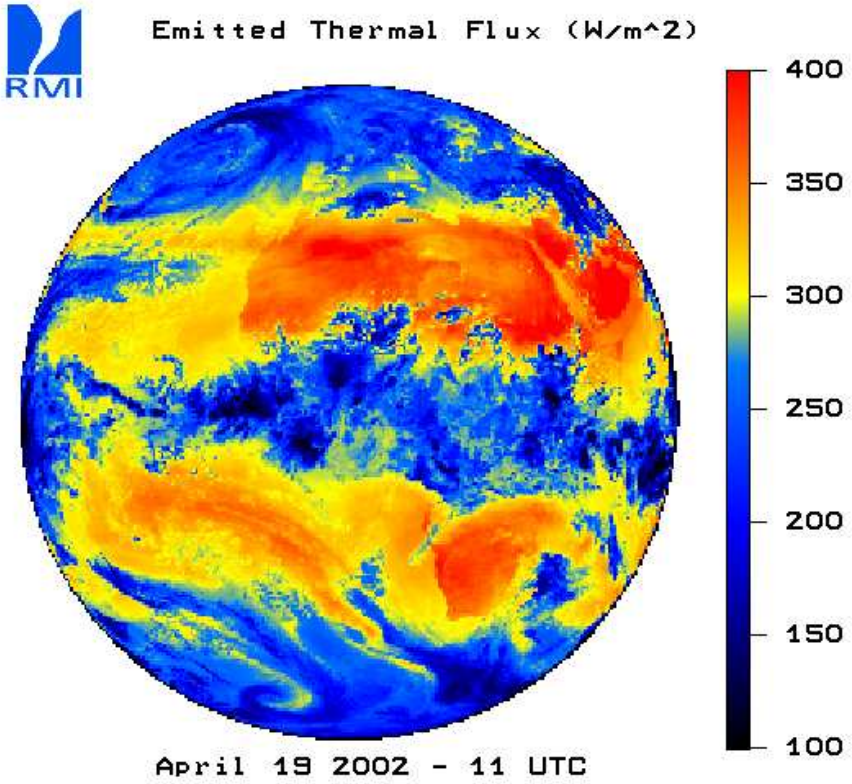
Method: find the smoothest spatial variations of c_{sw} and c_{lw} with the constraints

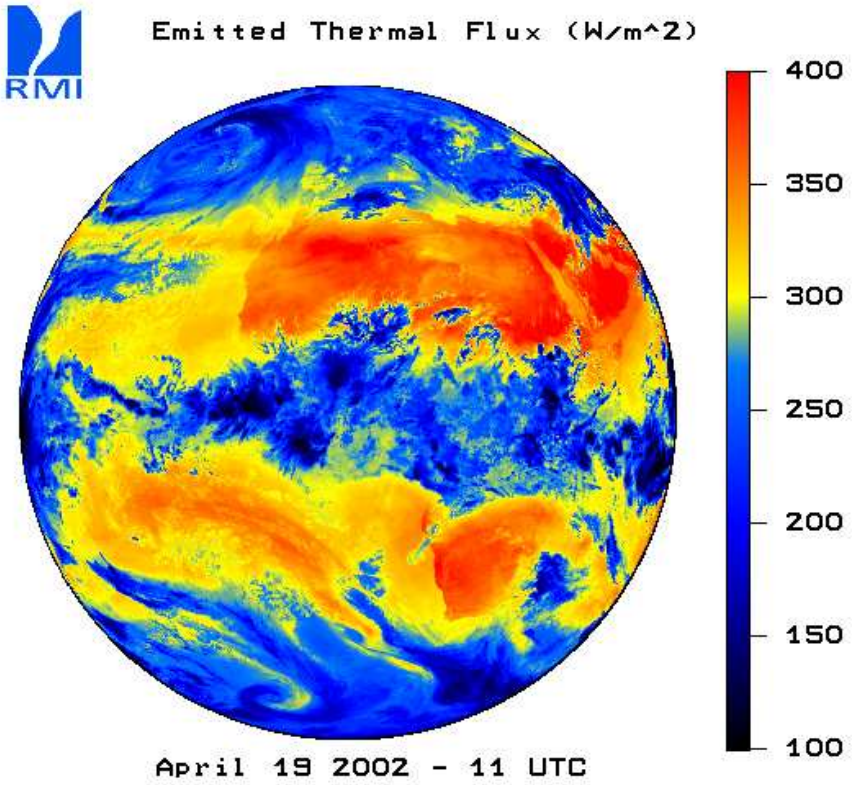
$$F = \int_{footprint} PSF(x,y)\, c(x,y)\, F'(x,y)\; dx\, dy$$

The convolutions of the corrected high resolution fluxes $c(x,y)\, F'(x,y)$ with the GERB PSF should provide the GERB fluxes.


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

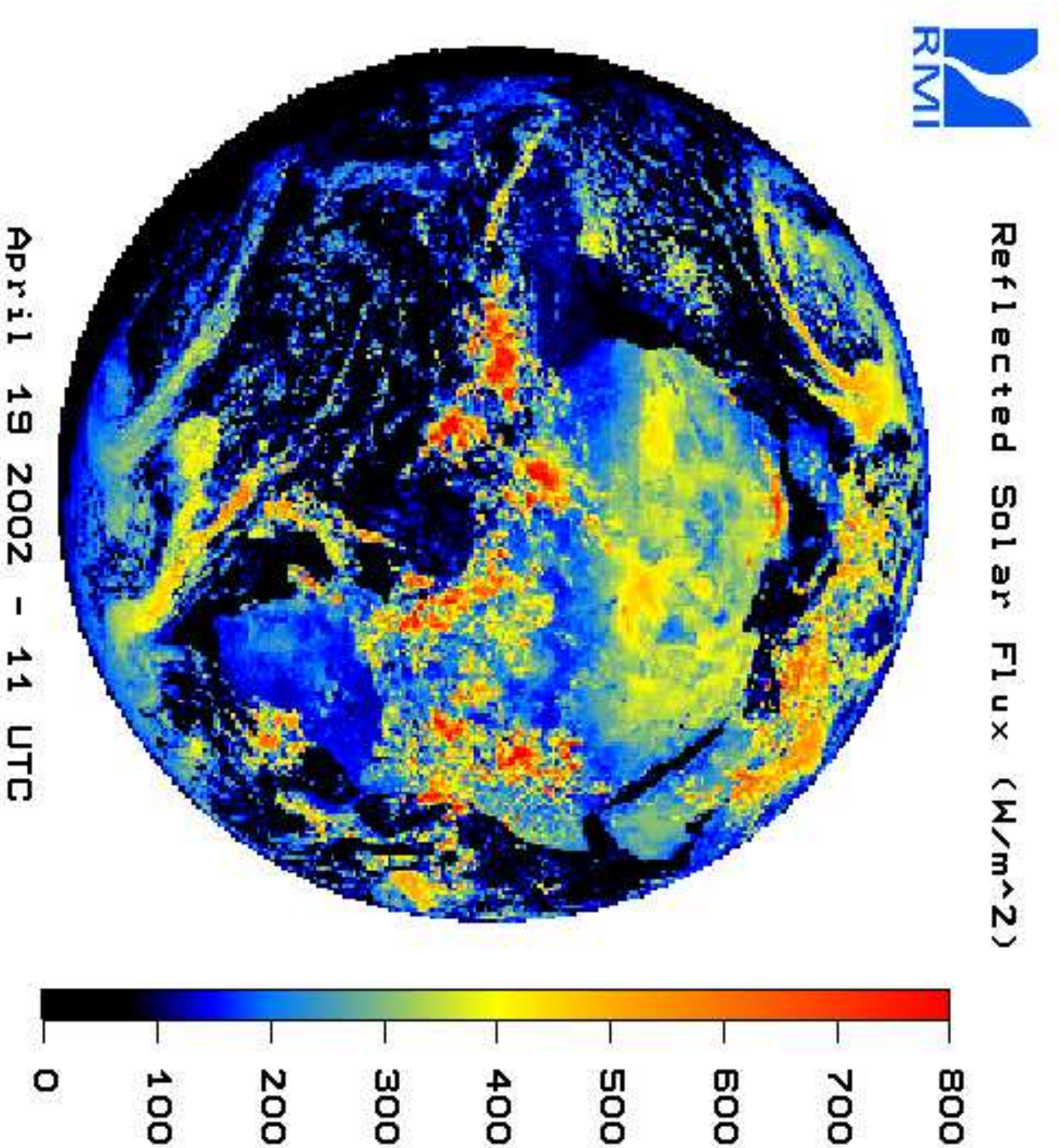

RMI
Reflected Solar Flux (W/m^2)
800
700
600
500
400
300
200
100
0
April 19 2002 - 11 UTC

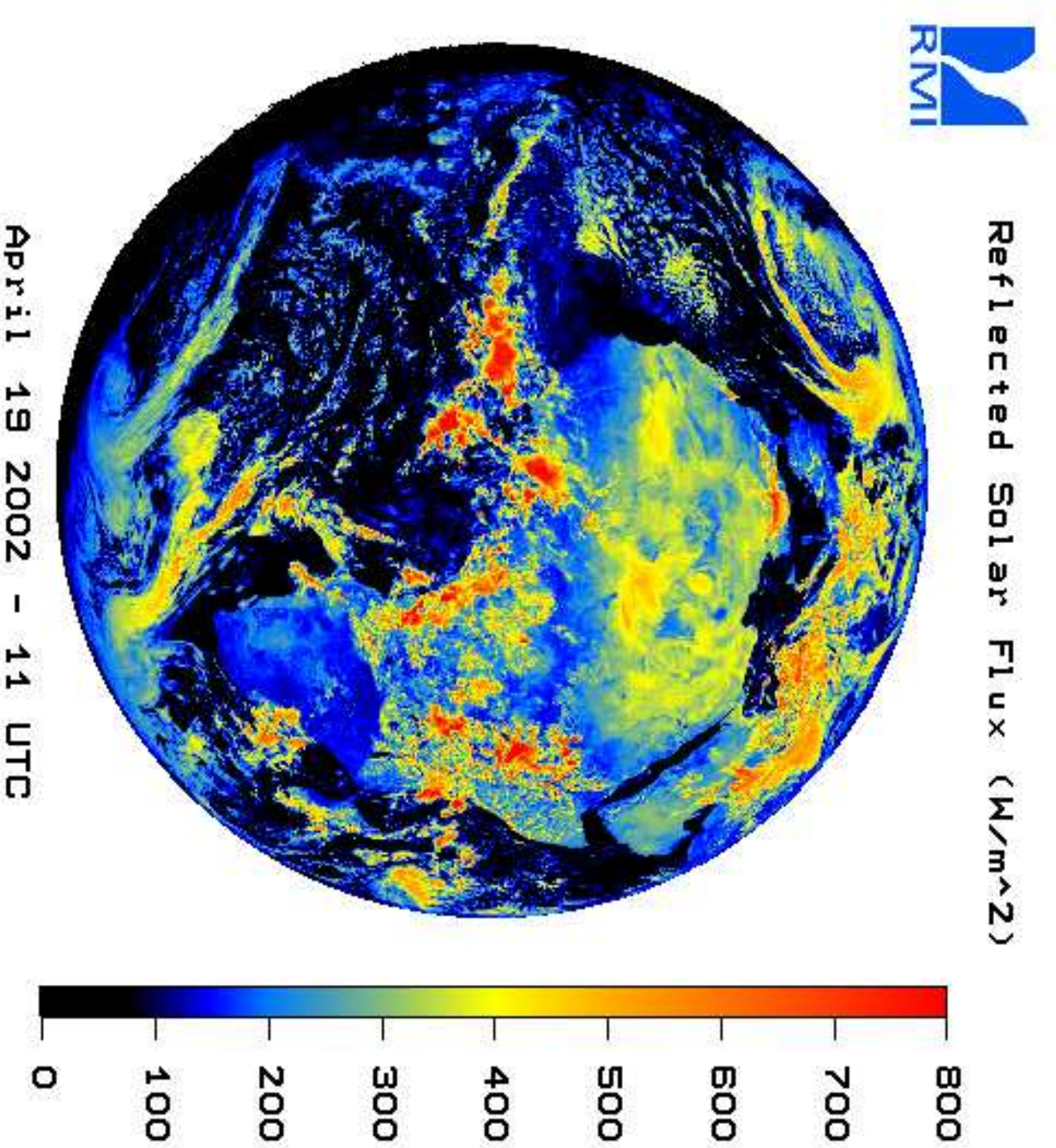

Emitted Thermal Flux (W/m^2)
400
350
300
250
200
150
100
April 19 2002 - 11 UTC


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

Conclusions

- Implementation "as simple as possible",
- Use knowledge from ERBE and CERES experiments (e.g. CERES-TRMM models for SW),
- There remain some missing algorithms/models that will be implemented during the SEVIRI commissioning: fresh snow detection, snow/ice ADM, cloud phase for optically thin cloud, ...
- Some parts of the processing need further "research and/or validation" before being implemented in the real time processing (e.g. thermal anisotropy for thin and high cloud, longwave azimuthal anisotropy).


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


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