Sunglint filling: status update

E. Baudrez N. Clerbaux I. Decoster S. Dewitte
A. Ipe S. Nevens A. Velázquez

Royal Meteorological Institute of Belgium

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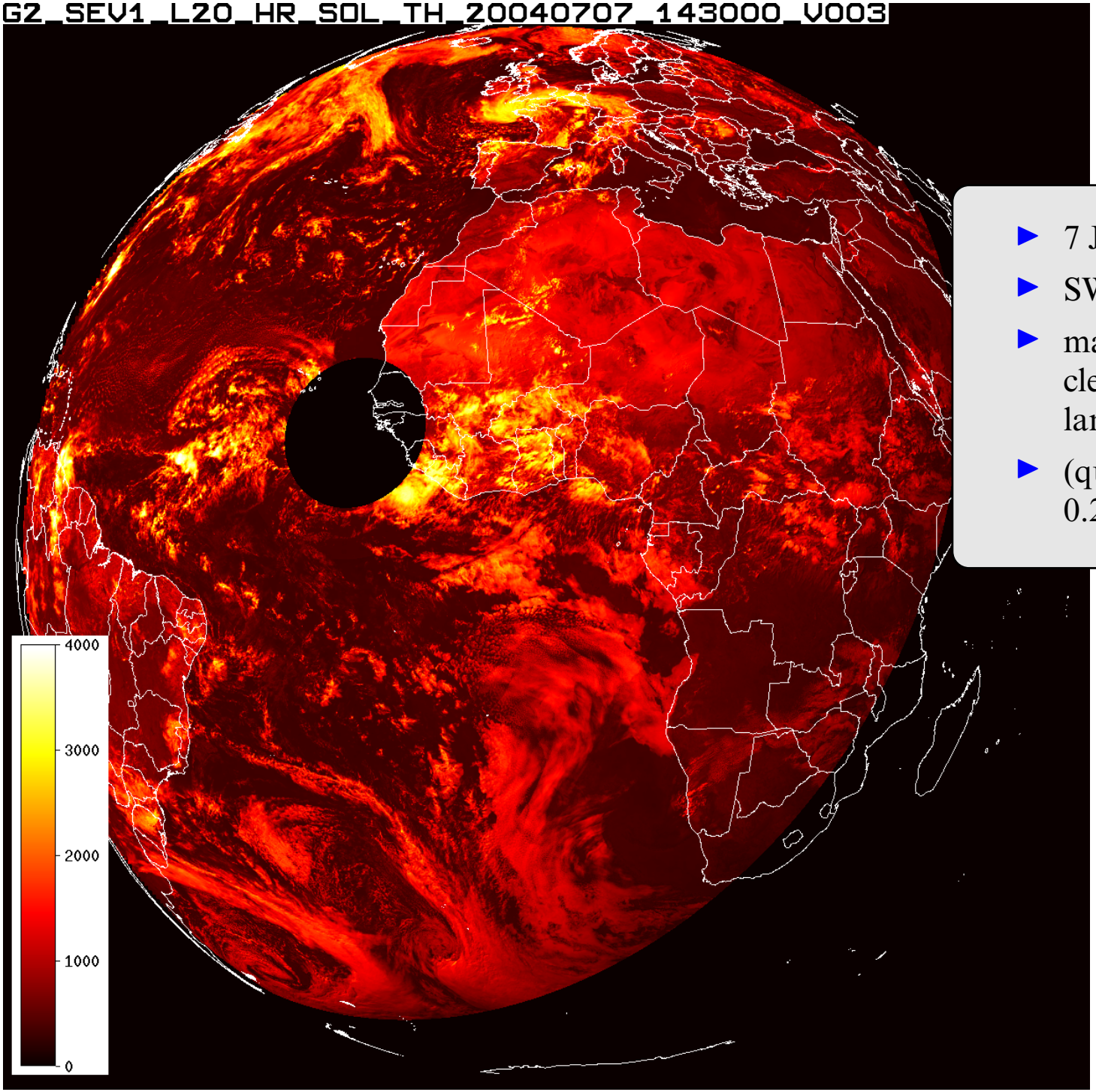
Outline

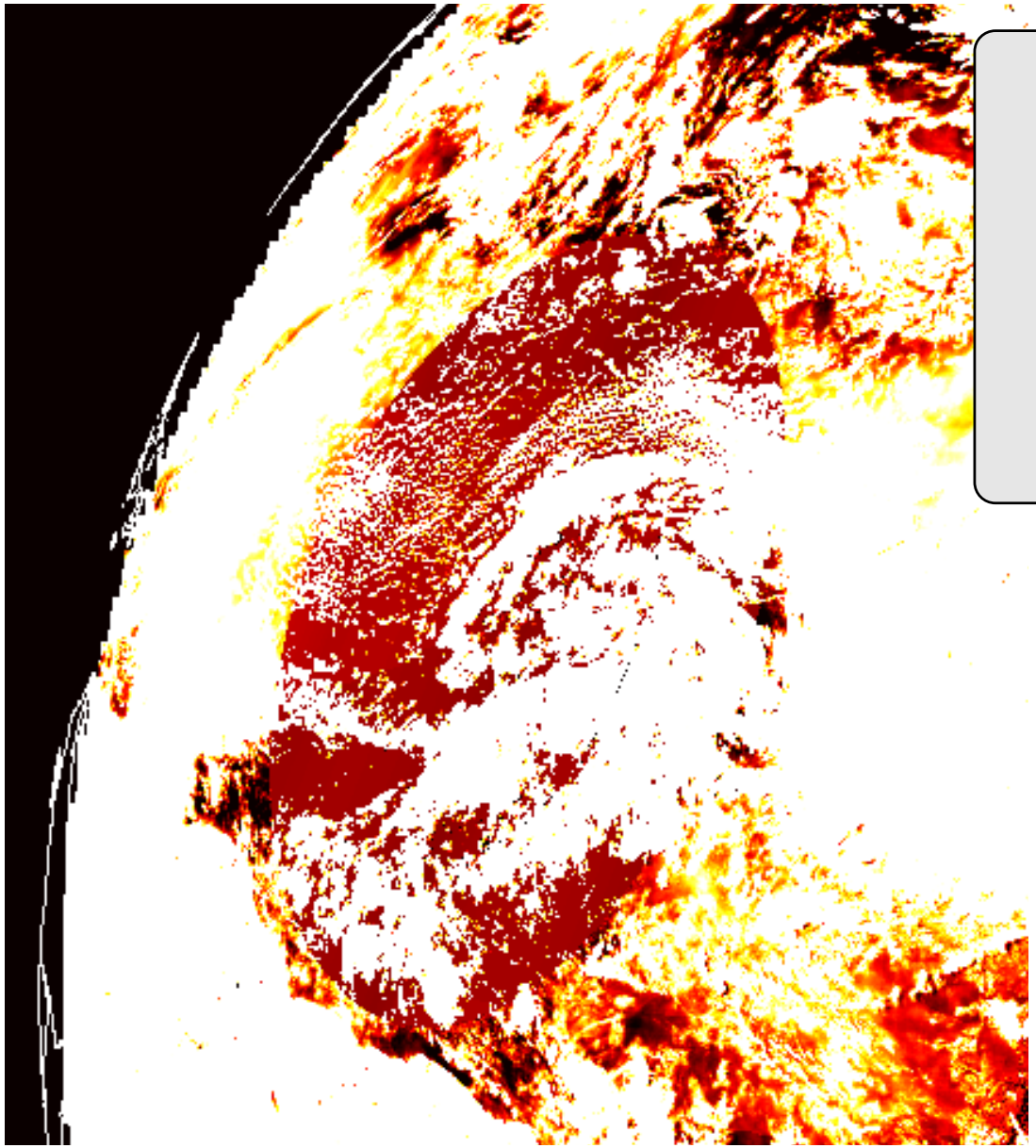
Problem

- Under certain conditions, sun rays are reflected specularly towards the detector
- Scene identification is unreliable → radiance-to-flux conversion unreliable
- Currently there's a black patch over the area defined by the geometric condition SGA $< 15°$
- Step change in flux at SGA $= 25°$



- 7 July 2004, 14:30
- SW flux
- masked out over clear/cloudy ocean + over land
- (quantisation factor = 0.25)

Step change in flux at SGA = 25°



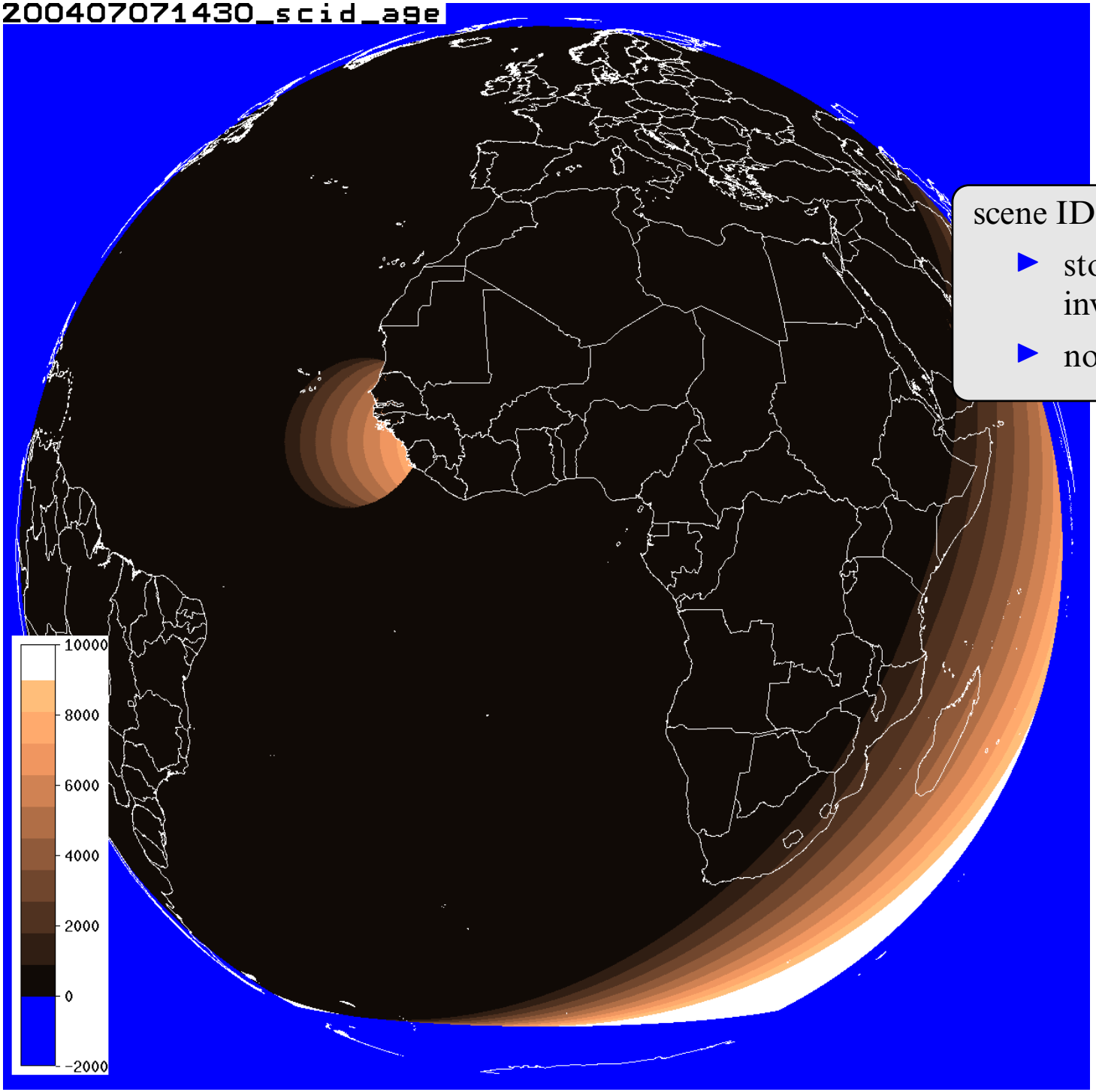
- 7 July 2004, 17:30
- SW flux
- color scale intentionally clipped from 80 to 120 W m^{-2} (clear ocean)
- step change in flux at SGA 25° transition

Aim

- Estimate or restore flux in sun glint-affected area SGA $< 15°$
- Re-estimate flux in area $15° <$ SGA $< 25°$
- Fluxes applied to high-resolution (HR $= 1237 \times 1237$) GERB and GERB-like images
- But final output should be in BARG ($= 247 \times 247$) resolution (only?)
- Entire GERB archive to be reprocessed

Scene ID determination

- Over land: no problem, use as-is
- Over ocean: scene identification (cloud cover, phase & optical depth) is unreliable
- Solution: time extrapolation of scene ID just before sun glint to sun glint
  - Last valid cloud cover, phase & optical depth are retained as long as pixel is affected by sun glint
  - With a maximum of 2.5 hours (beyond that, scene ID becomes invalid)
  - Stored scene ID replaced with real scene ID as soon as available
- Not an interpolation between pre- and post-glint; it should work in near-real time



scene ID extrapolation

- stored data > 2.5 hours invalid
- not required over land

Radiance-to-flux conversion

- SGA $< 15°$
  - Land: radiance-to-flux conversion using up-to-date scene ID (normal procedure)
  - Clear ocean: CERES TRMM climatology (albedo + incoming solar $\rightarrow$ flux)
  - Cloudy ocean: radiance-to-flux conversion using extropolated scene ID
- $15° <$ SGA $< 25°$
  - Land: no action required
  - Clear ocean: CERES TRMM climatology
  - Cloudy ocean: no action required

CERES TRMM climatology: flux calculation

CERES TRMM "flux" is calculated as follows:

$$F_{\mathrm{TRMM}} = a \frac{F_{\mathrm{solar}} \cos\theta}{\tilde{r}^2}$$

where

$$\begin{aligned} a &= \text{CERES TRMM albedo} \\ F_{\mathrm{solar}} &= 1366\ \mathrm{W\ m^{-2}} \\ \theta &= \text{solar zenith angle} \\ \tilde{r} &= \text{normalized earth–sun distance} \end{aligned}$$

CERES TRMM climatology: flux calculation

GERB flux for clear ocean is then calculated as follows:

$$F_{\mathrm{GERB}} = \Gamma F_{\mathrm{TRMM}}$$

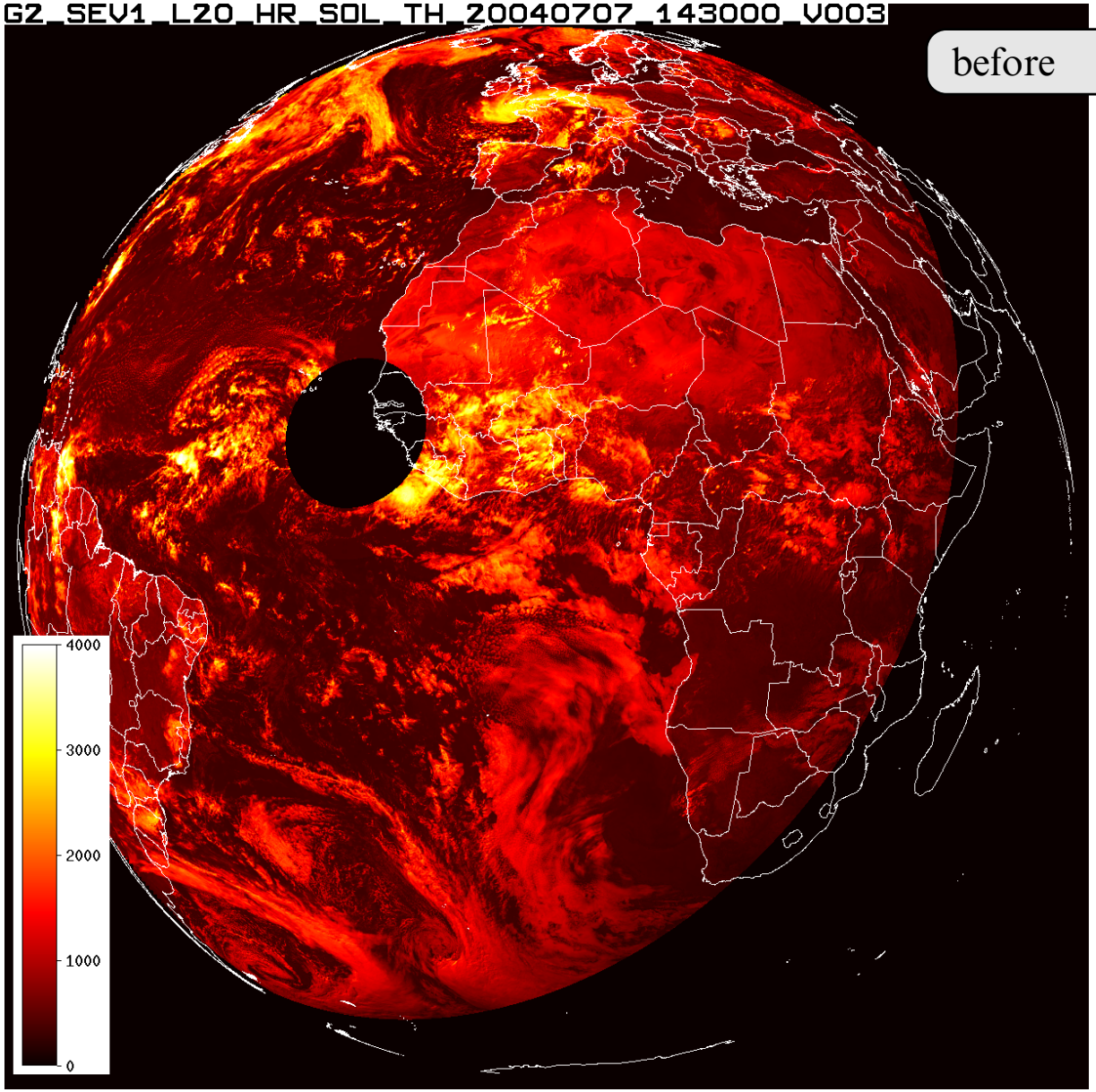
where Γ (= adjustment factor) is GERB–TRMM albedo ratio:

$$\Gamma = f\left(\frac{F_{\mathrm{GERB}}}{F_{\mathrm{TRMM}}}\right)$$

Options for f:

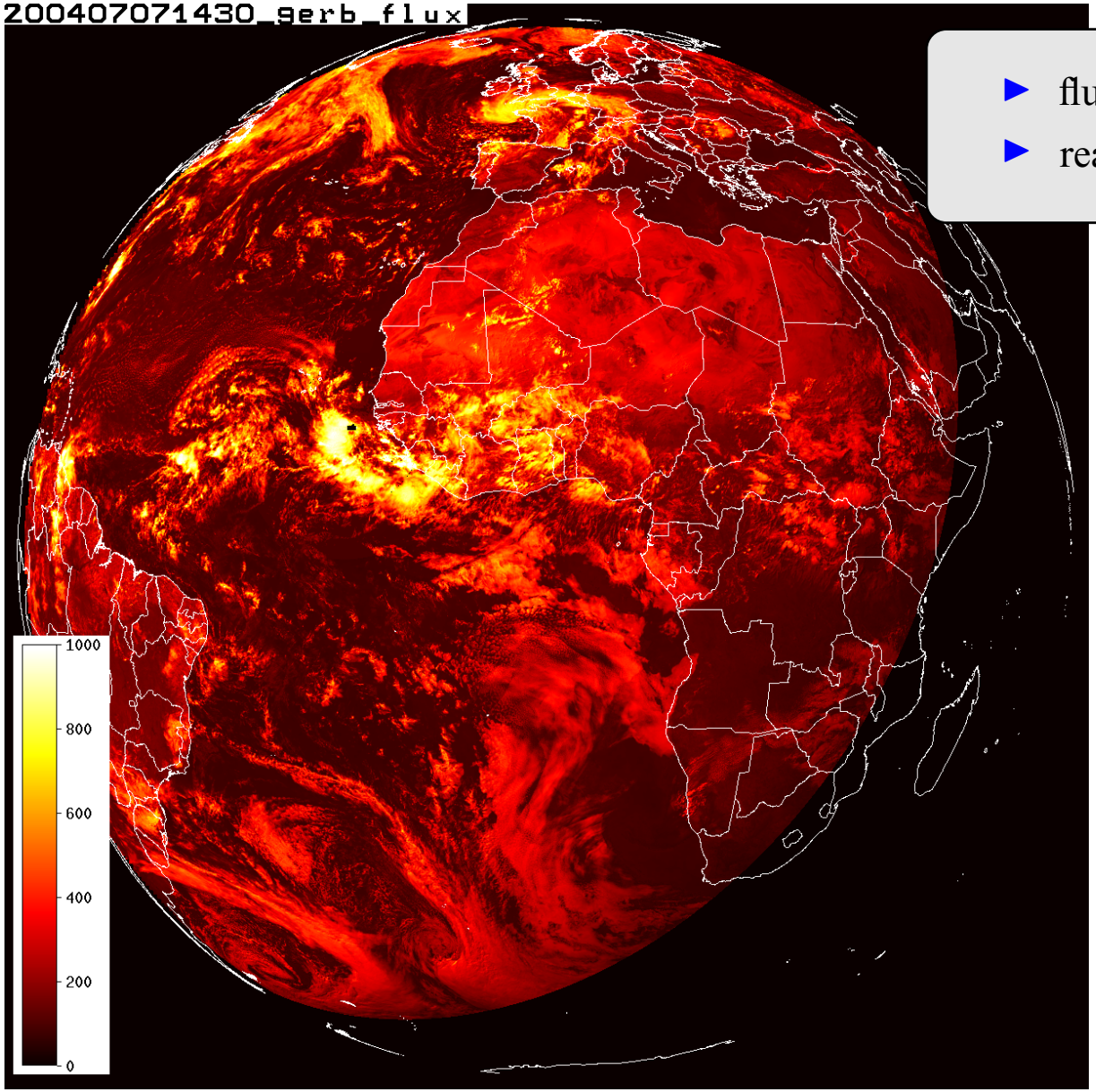
1. Uniform value: $f = 1.07$
2. Time extrapolation similar to scene ID: $f = \left(F_{\mathrm{GERB}}/F_{\mathrm{TRMM}}\right)_{\mathrm{old}}$
3. Monthly average: $f = \left\langle F_{\mathrm{GERB}}/F_{\mathrm{TRMM}}\right\rangle$

Example: 7 July 2004, 14:30



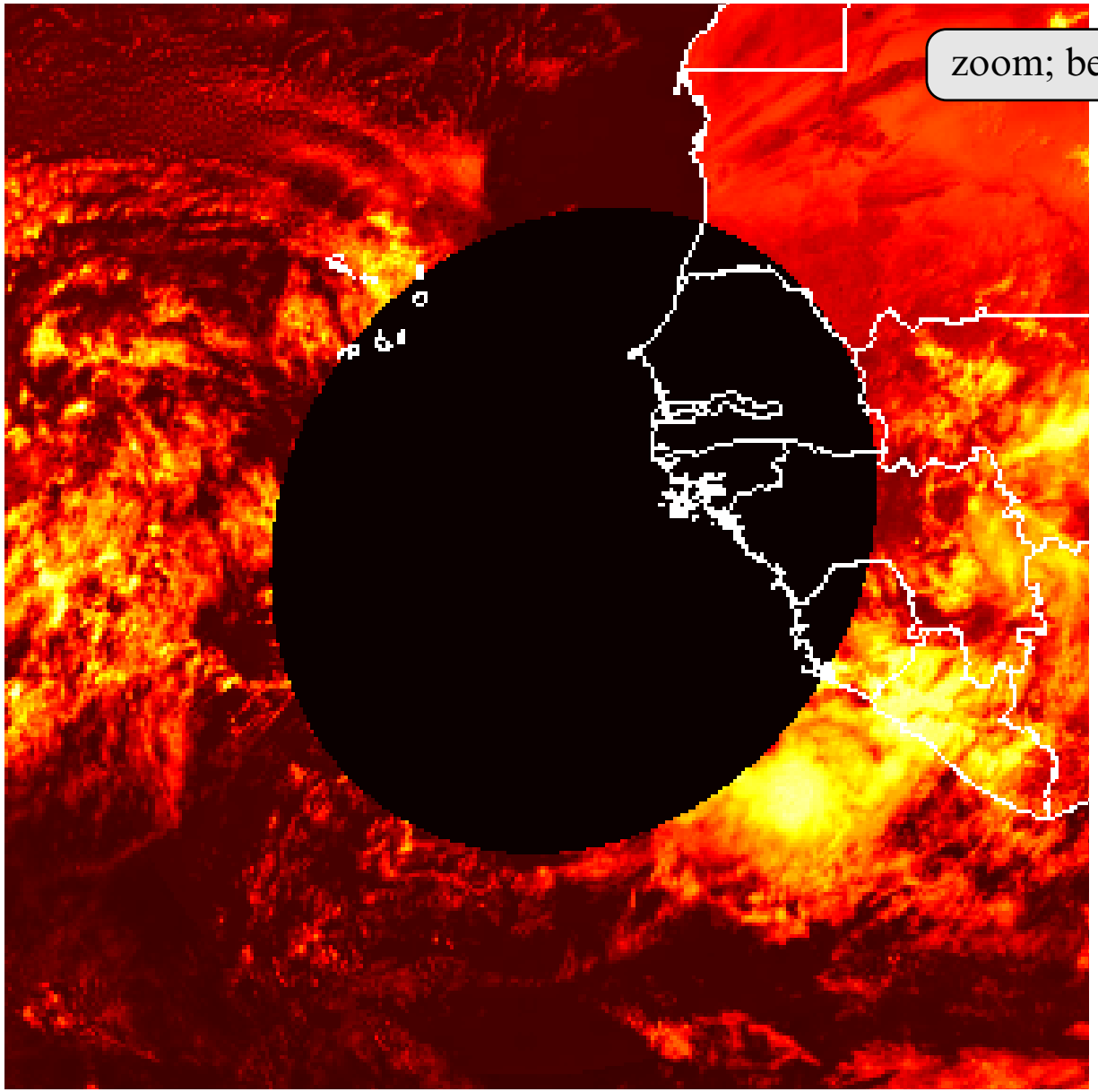
before

Example: 7 July 2004, 14:30



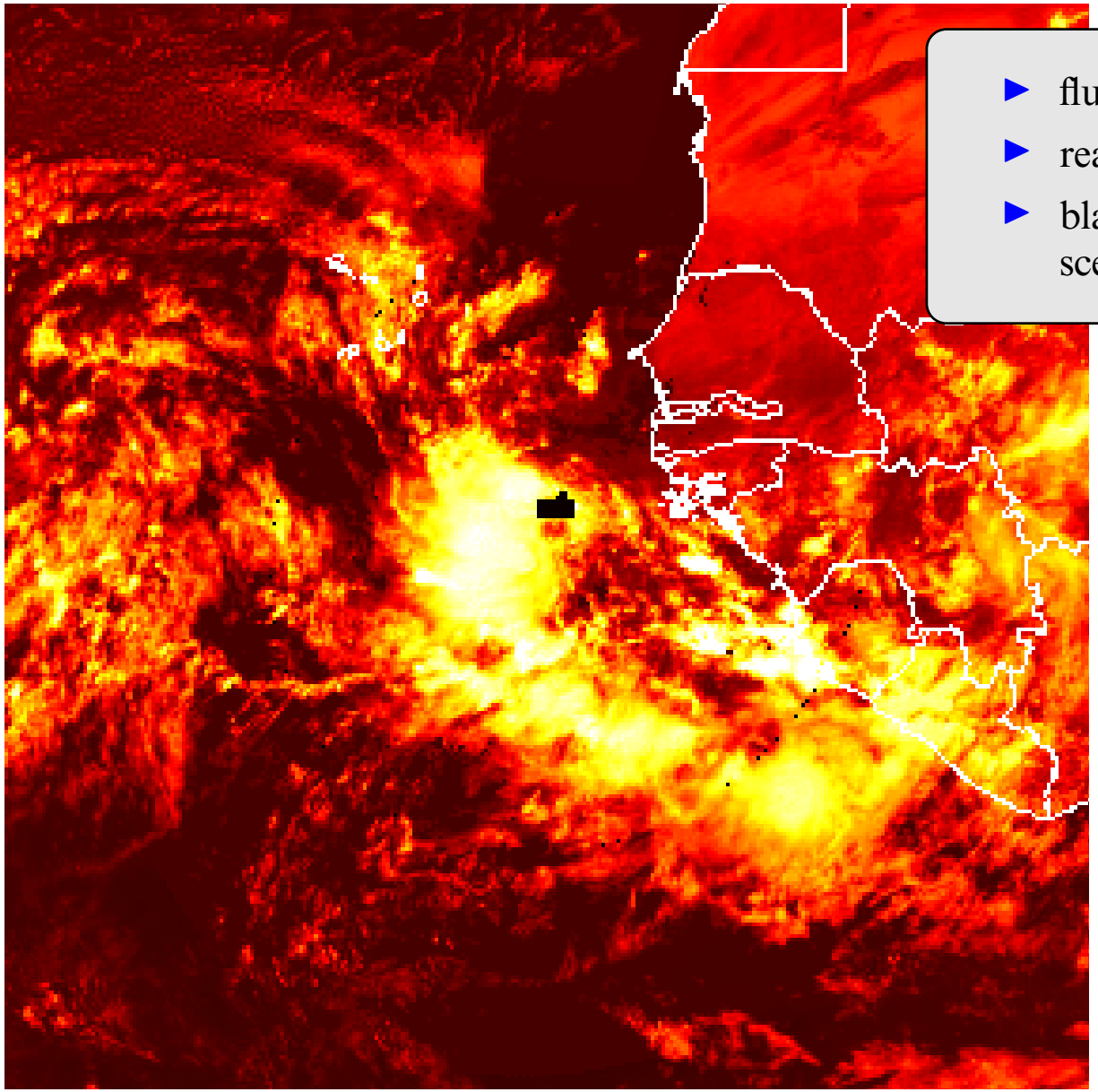
- flux over land restored
- reasonable-looking fill-in

Example: 7 July 2004, 14:30

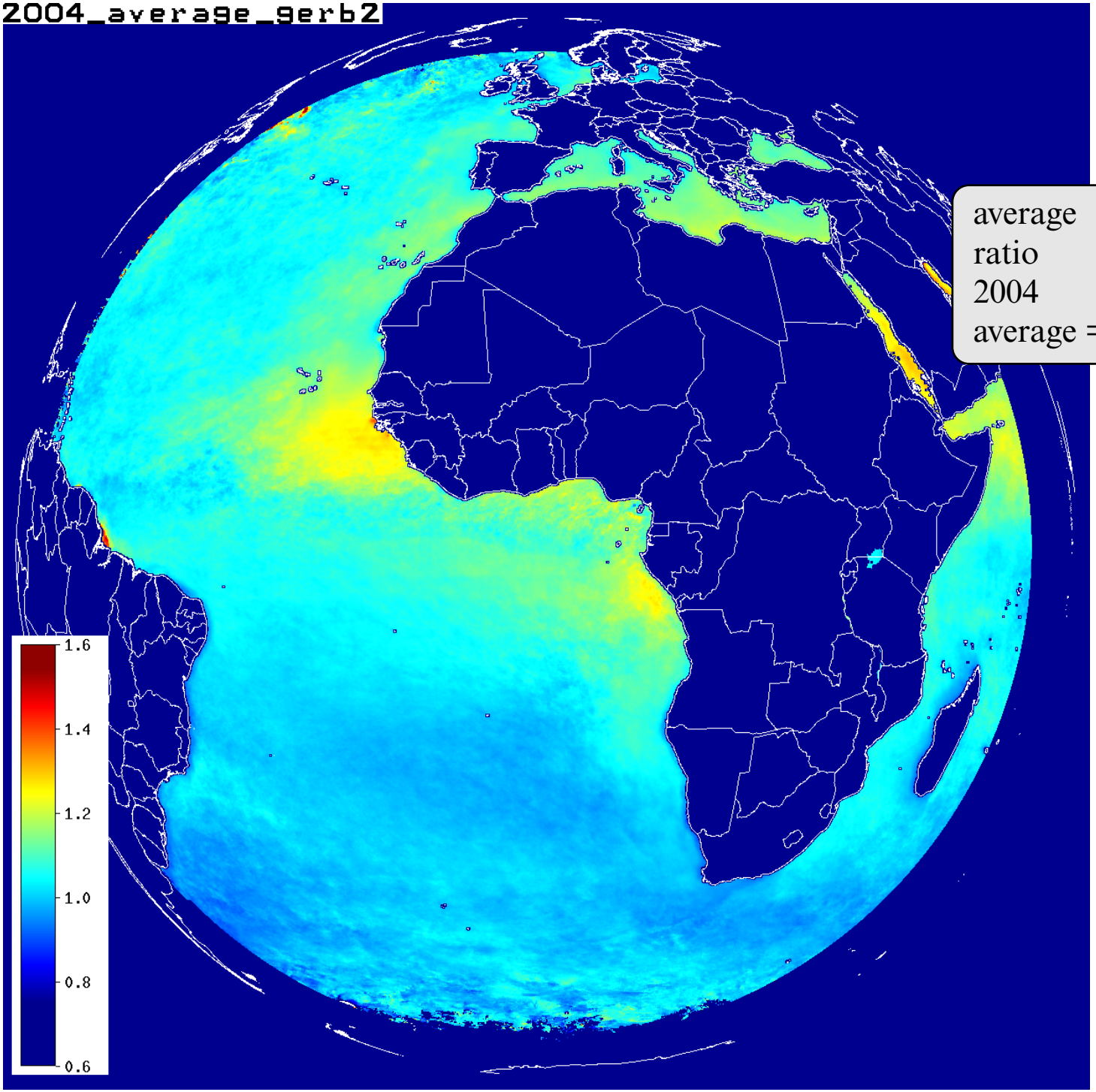


zoom; before

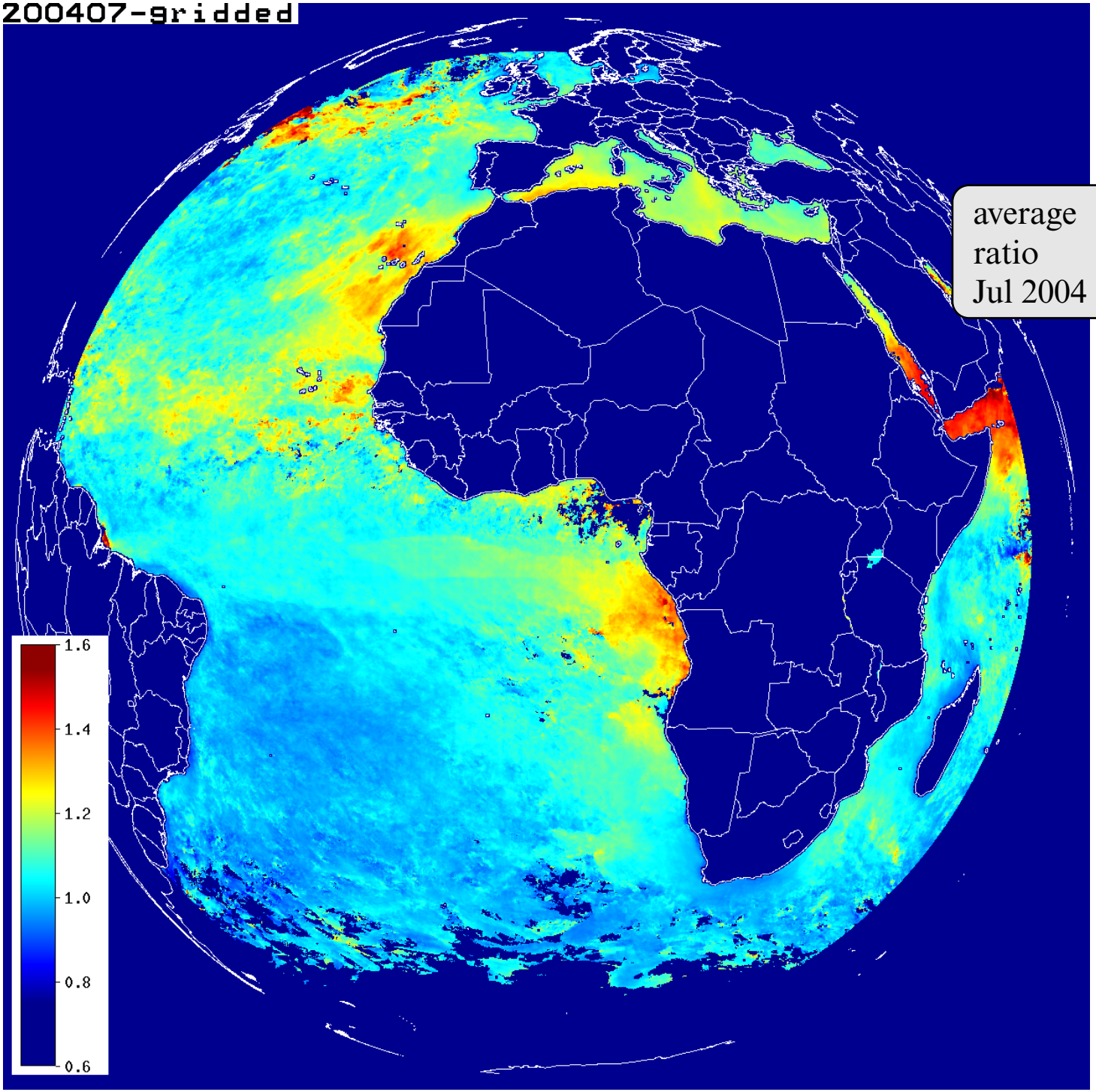
Example: 7 July 2004, 14:30



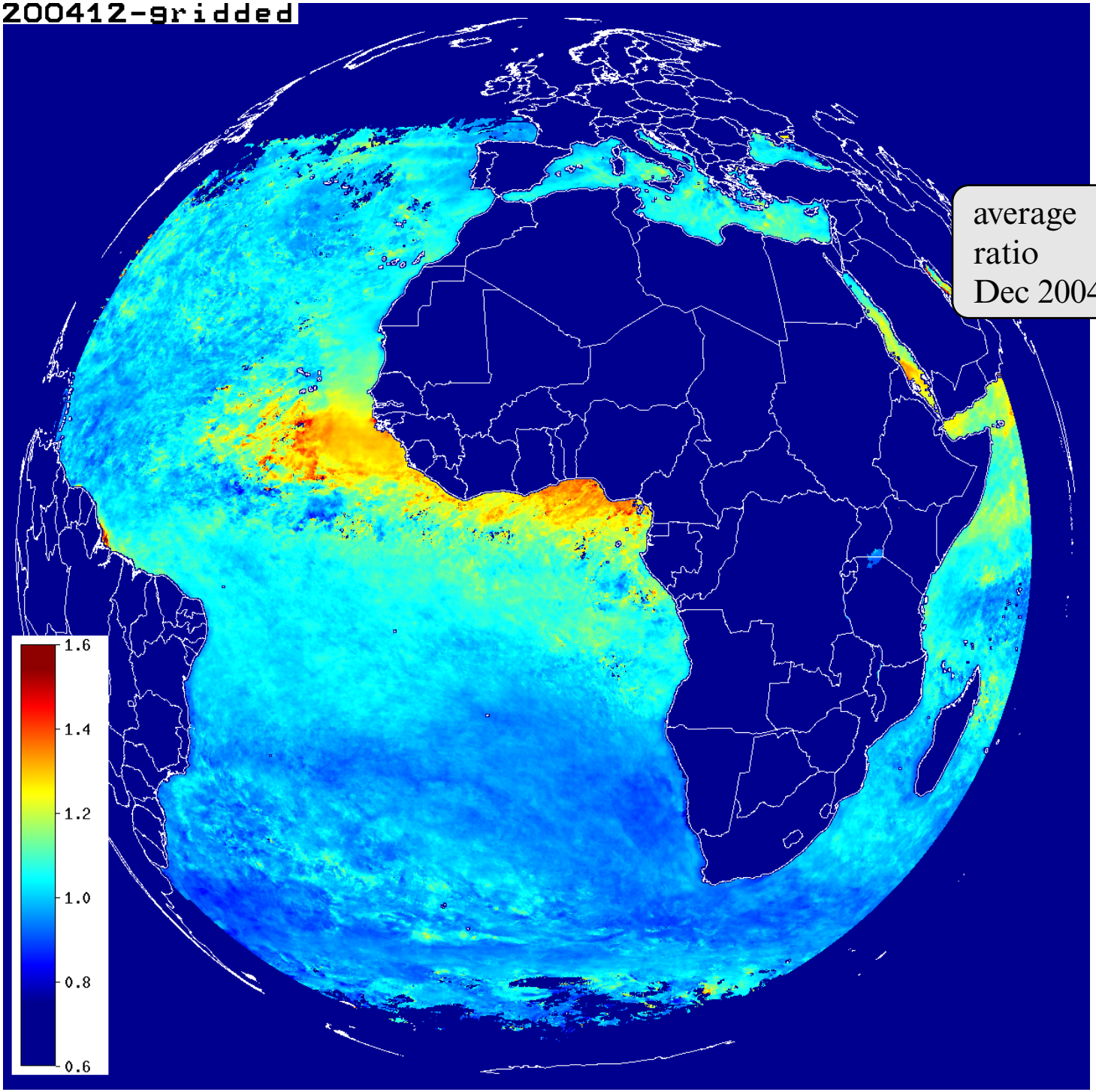
- flux over land restored
- reasonable-looking fill-in
- black spot due to missing scene ID



average GERB–TRMM albedo ratio
2004
average = 1.049



average GERB–TRMM albedo ratio
Jul 2004



average GERB–TRMM albedo ratio
Dec 2004

Average Γ

Month	GERB-2	GERB-1
01	1.02525	0.93628
02	1.02731	0.94522
03	1.04082	0.88675
04	1.02421	0.94901
05	1.03255	0.95449
06	1.04433	0.95677
07	1.05262	0.97051
08	1.04833	0.98032
09	1.05289	0.98131
10	1.03025	0.95118
11	1.01214	0.93965
12	1.01207	0.92570

Year	average
2004	1.0493
2005	1.0290
2006	1.0146
2007 (GERB-2)	1.0215
2007 (GERB-1)	0.9926
2008	0.9661
2009	0.9442
2010	0.9272
2011	0.9189

Current status

- Filling sun glint-affected areas SGA $< 15°$ and $15° <$ SGA $< 25°$
- Using a monthly average adjustment factor
- Available in HR and BARG resolution
- Available in HDF format as supplementary files

Next

- Process entire archive
- Decide on a format
  - output all fields, make self-contained files
  - modified fields only, supplement existing archive files
- Output HDF files
- Twilight: model?

Outline

Conversion tool: HDF to netCDF

- A software tool to convert existing HDF files to netCDF format
- Why netCDF? Arguably easier format for end users
- netCDF libraries from version 4.0 onwards can read and write netCDF files in HDF format, but
  - incompatibility with HDF version used by GERB processing (1.6.5, netCDF requires 1.8.0)
  - HDF support for netCDF does not always come standard: many users may be stuck with older netCDF libraries
  - the HDF files would need to be tuned before they can be read by the netCDF library (netCDF won't just read any HDF file)
- Could be coupled with regridding onto latitude-longitude grid (see further)

Conversion algorithm (Prototype version)

- (Optionally) uncompresses .hdf.gz files on the fly
- Scans the HDF file
- Creates a CDL description corresponding to the structure of the HDF file, but without the data
- Generates the netCDF file from the CDL description, with dimensions and attributes, but without the data
- Transfers the data from the HDF file to the netCDF file
- (Optionally) compress .nc files on the fly (no internal compression in netCDF classic format)
- (Currently outputs in netCDF classic format.)

Conversion tool

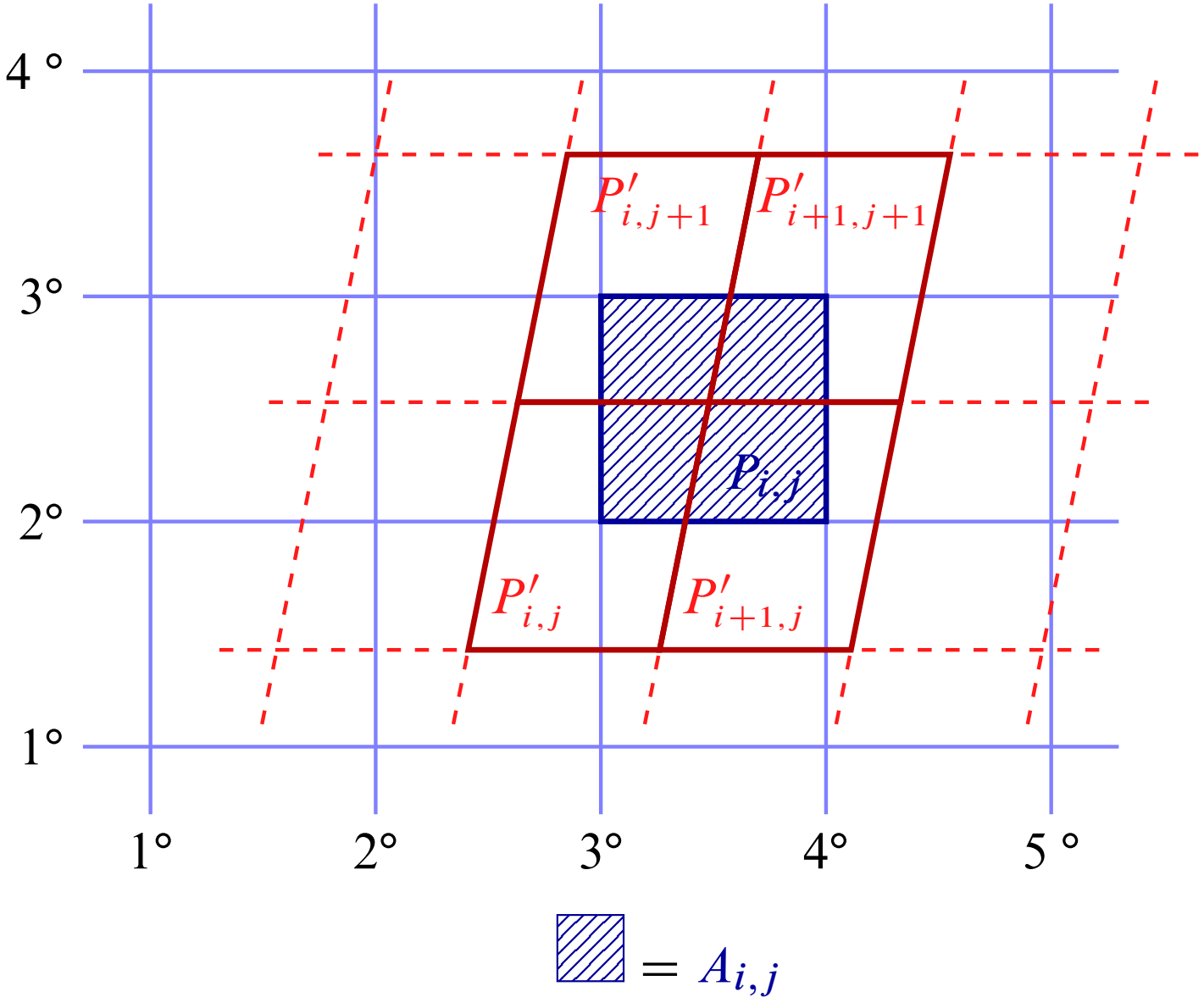
- Written in Perl as a stand-alone distribution (with embedded C code)
- Could be released as open-source software
- Does not assume much about the structure of the HDF file, so could be extended to provide a general-purpose HDF-to-netCDF conversion tool

Outline

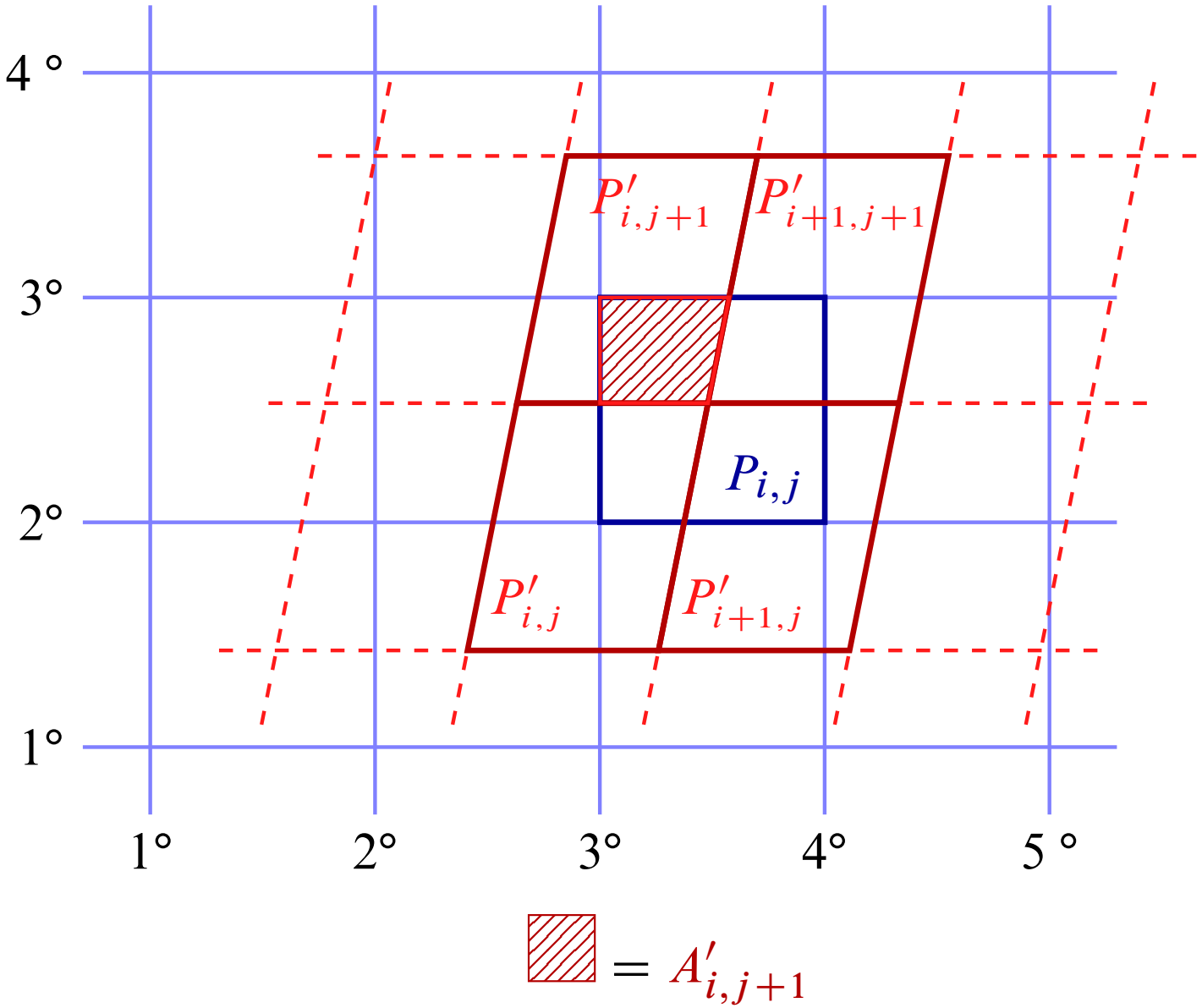
Regridding tool

- To convert data to and from
  - Sinusoidal grid
  - Regular latitude–longitude grid
  - Geostationary grid (Meteosat field of view)
- Could be used with HDF to netCDF conversion tool
- End goal: latitude–longitude projected GERB data in netCDF for end users

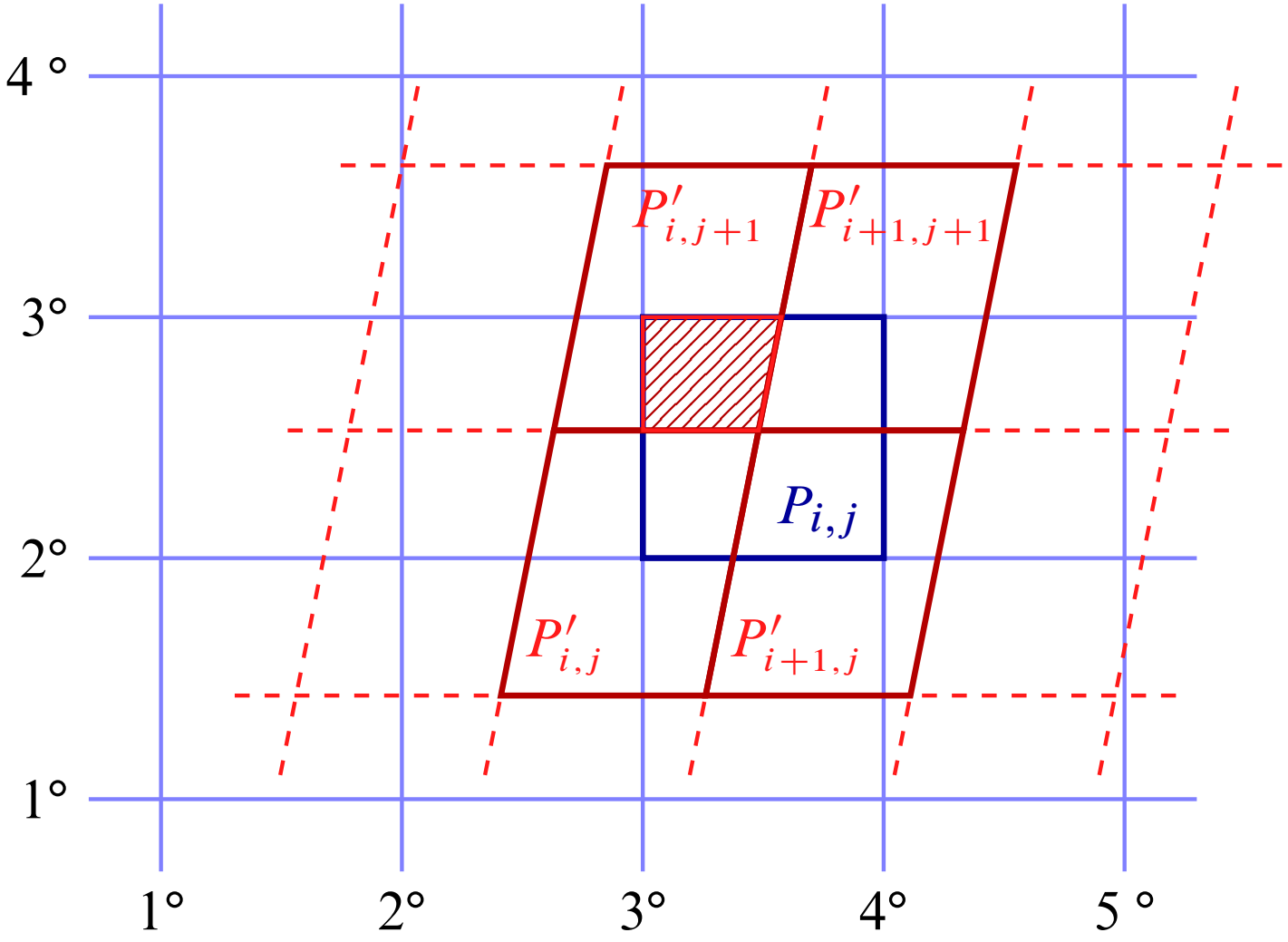
Regridding algorithm



Regridding algorithm

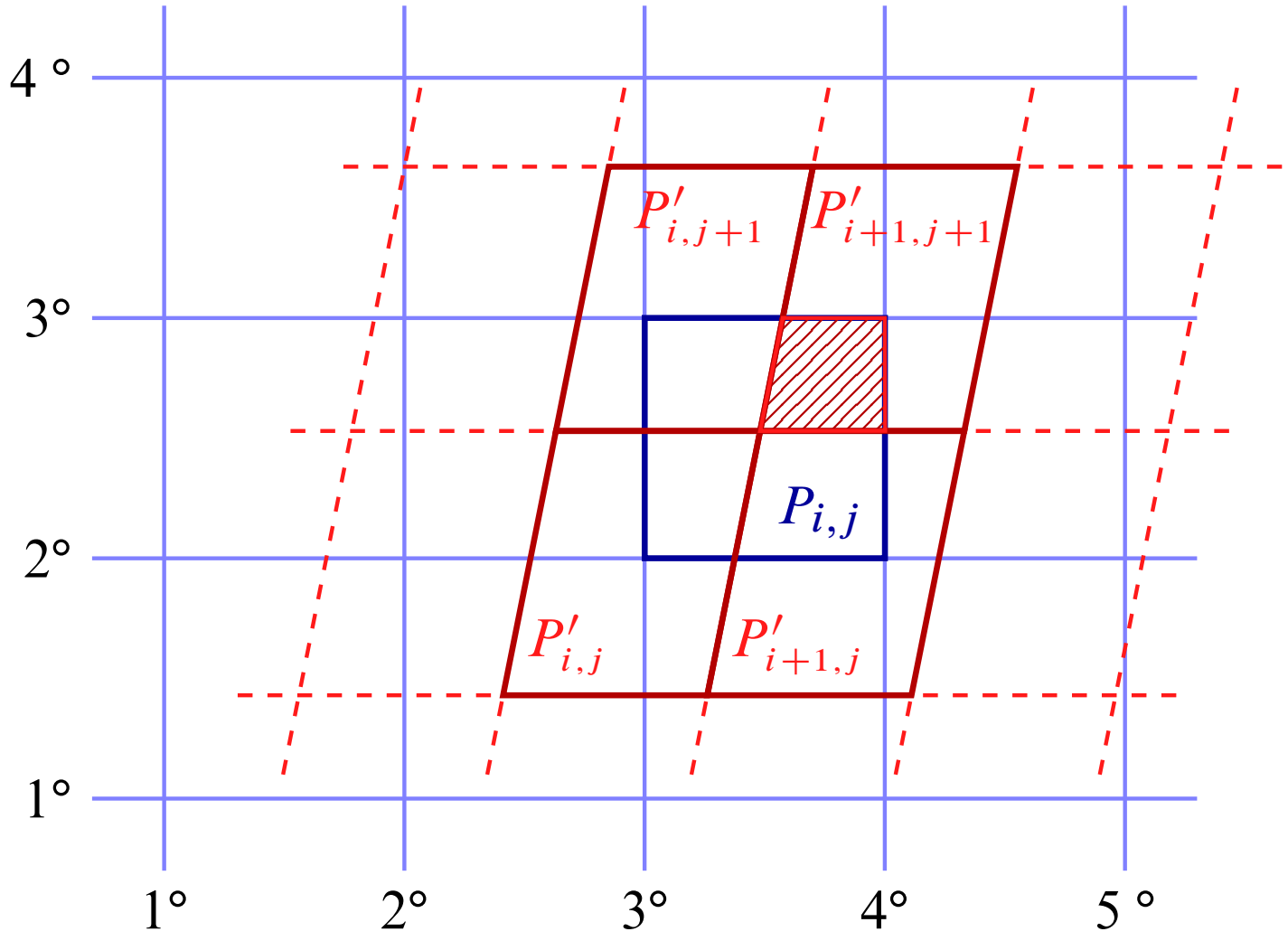


Regridding algorithm



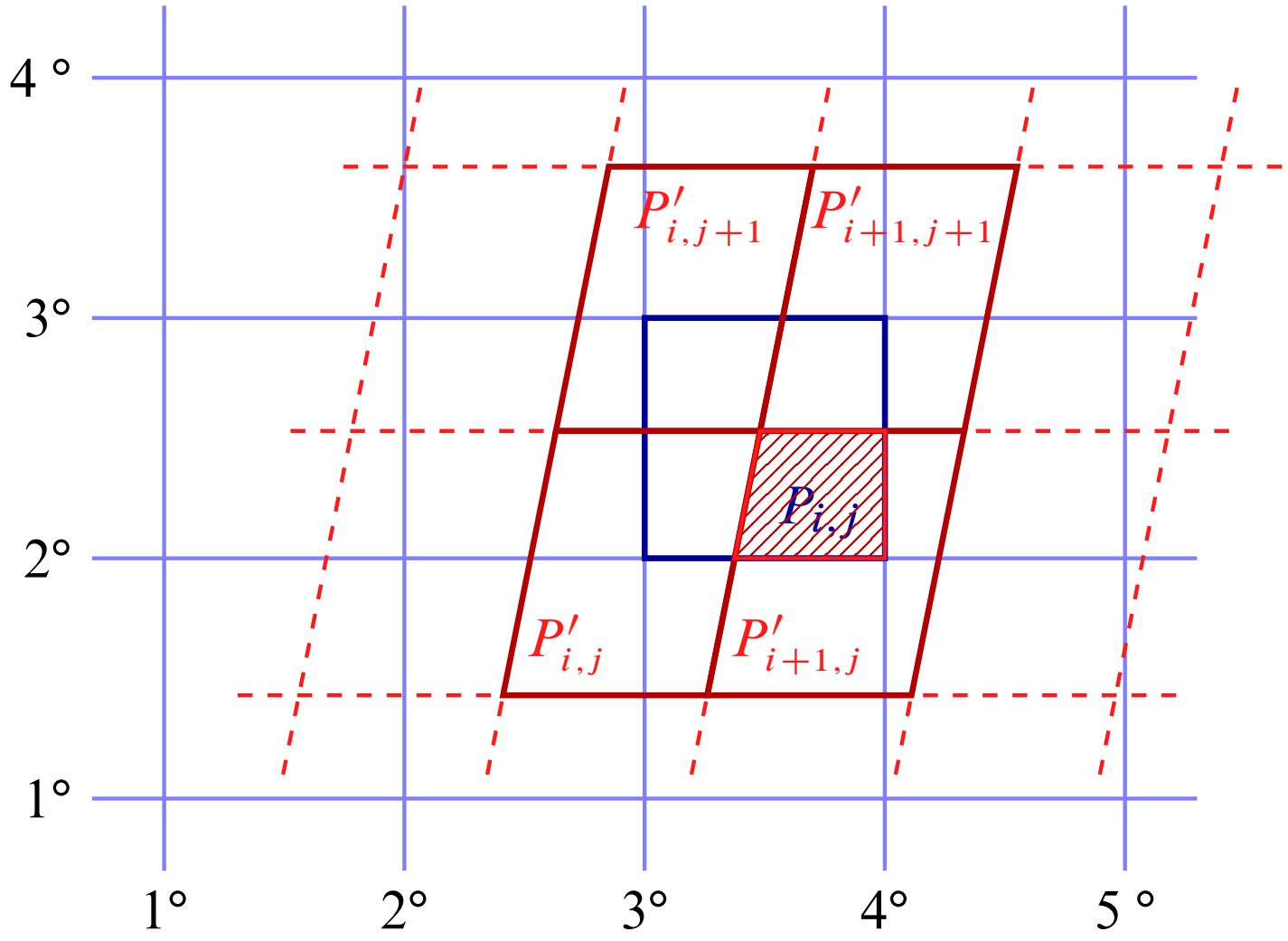
$$A_{i,j}\, f_{i,j} = \boxed{A'_{i,j+1}}\, f_{i,j+1} + A'_{i+1,j+1}\, f_{i+1,j+1} + A'_{i+1,j}\, f_{i+1,j} + A'_{i,j}\, f_{i,j}$$

Regridding algorithm



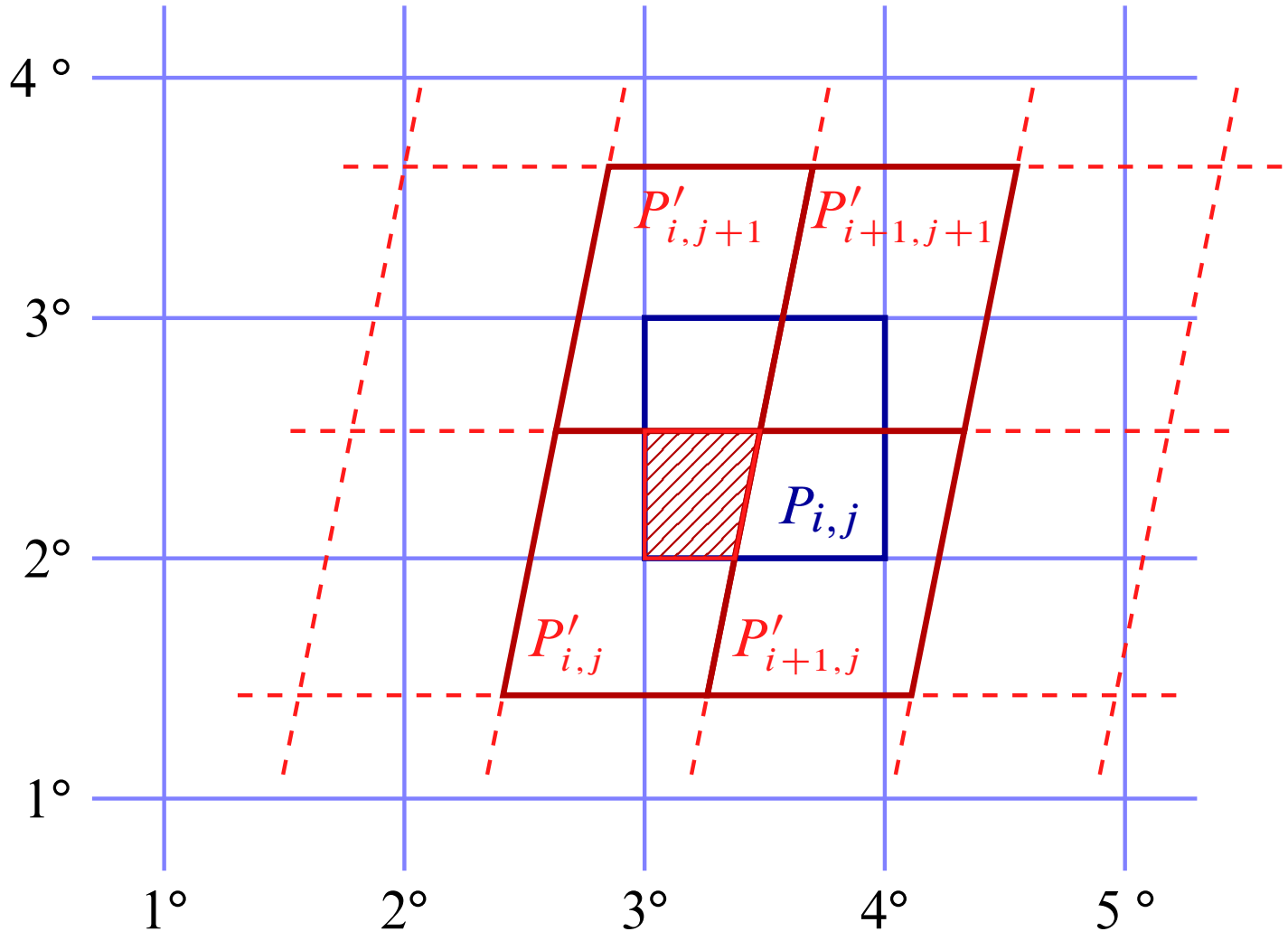
$$A_{i,j}\, f_{i,j} = A'_{i,j+1}\, f_{i,j+1} + \boxed{A'_{i+1,j+1}}\, f_{i+1,j+1} + A'_{i+1,j}\, f_{i+1,j} + A'_{i,j}\, f_{i,j}$$

Regridding algorithm



$$A_{i,j}\, f_{i,j} = A'_{i,j+1}\, f_{i,j+1} + A'_{i+1,j+1}\, f_{i+1,j+1} + \boxed{A'_{i+1,j}}\, f_{i+1,j} + A'_{i,j}\, f_{i,j}$$

Regridding algorithm



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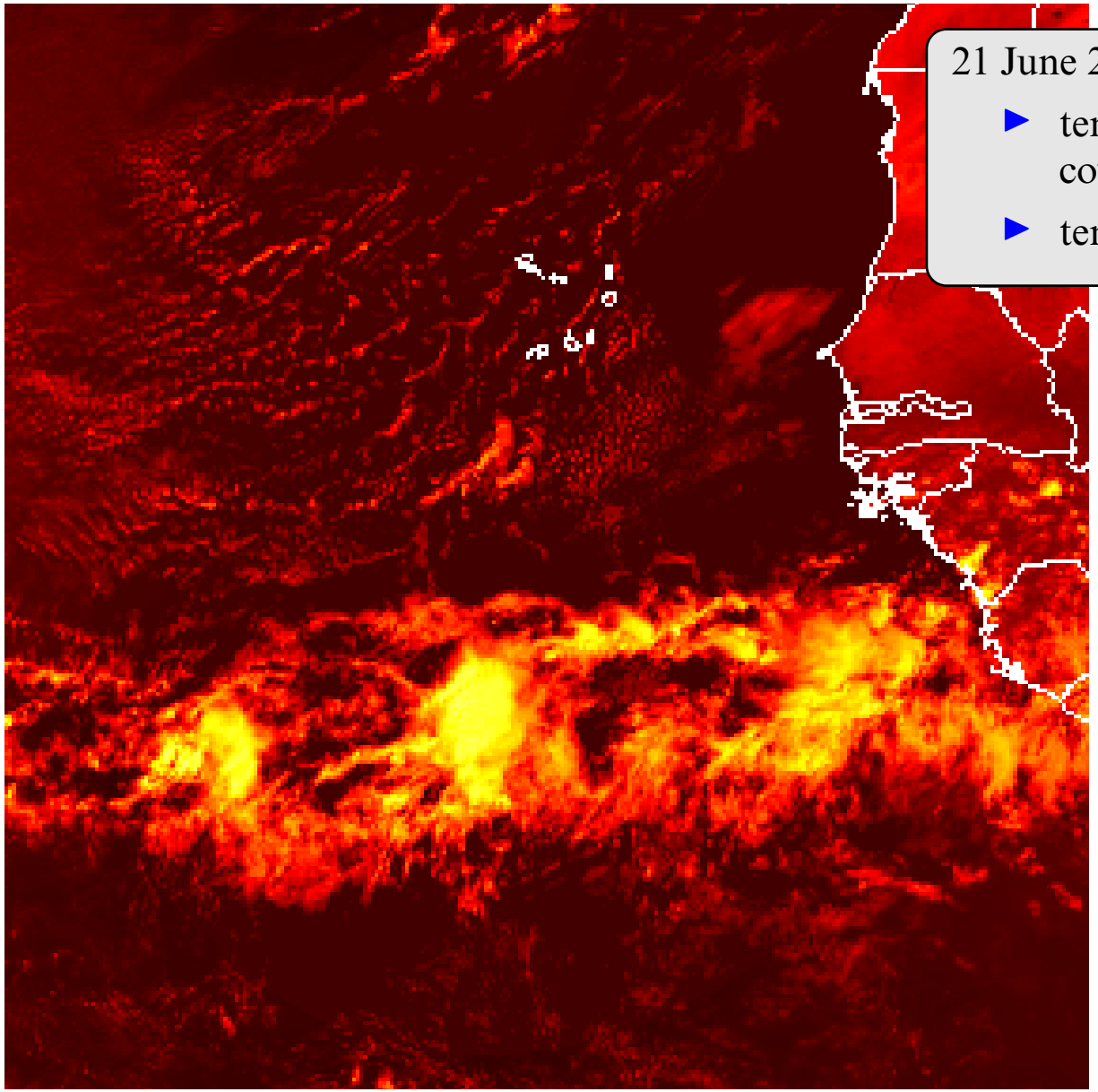
Acknowledgements

- Dr. Jacqueline E. Russell, Imperial College
- GERB team at RMIB
- RMIB

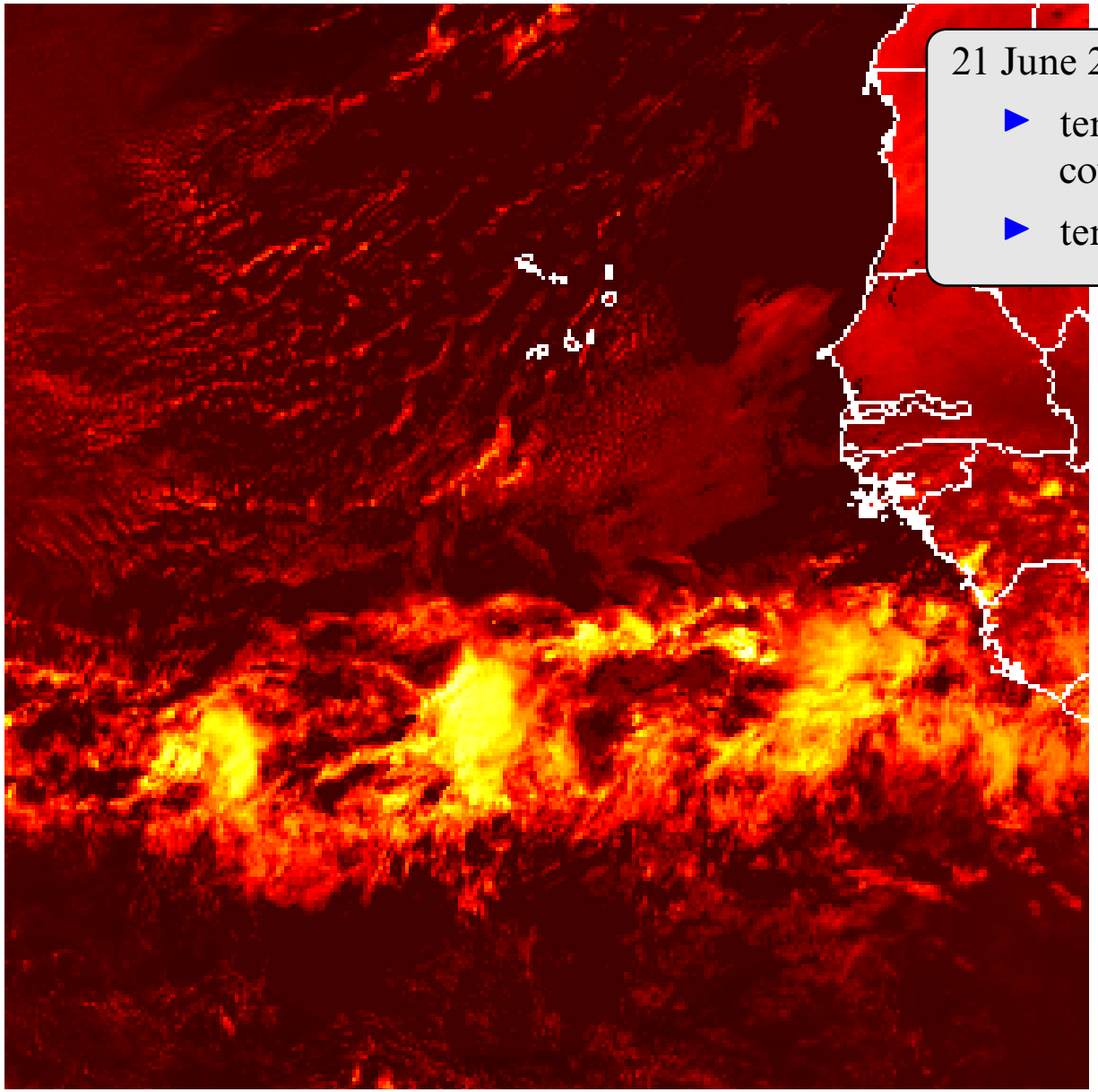
GERB-like



21 June 2004: **before**

- tends to increase cloud cover
- tends to decrease crispness

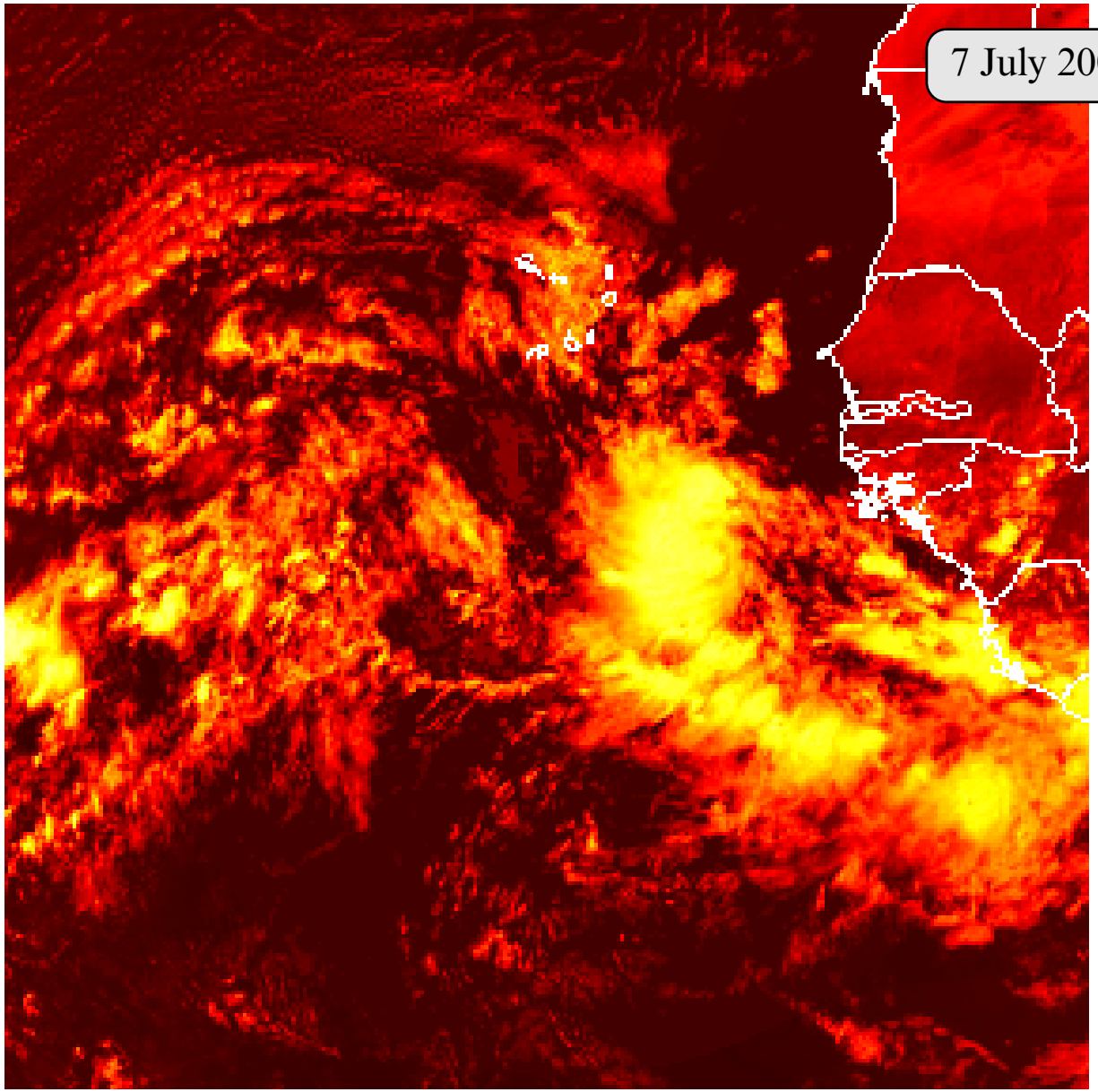
GERB-like



21 June 2004: **after**

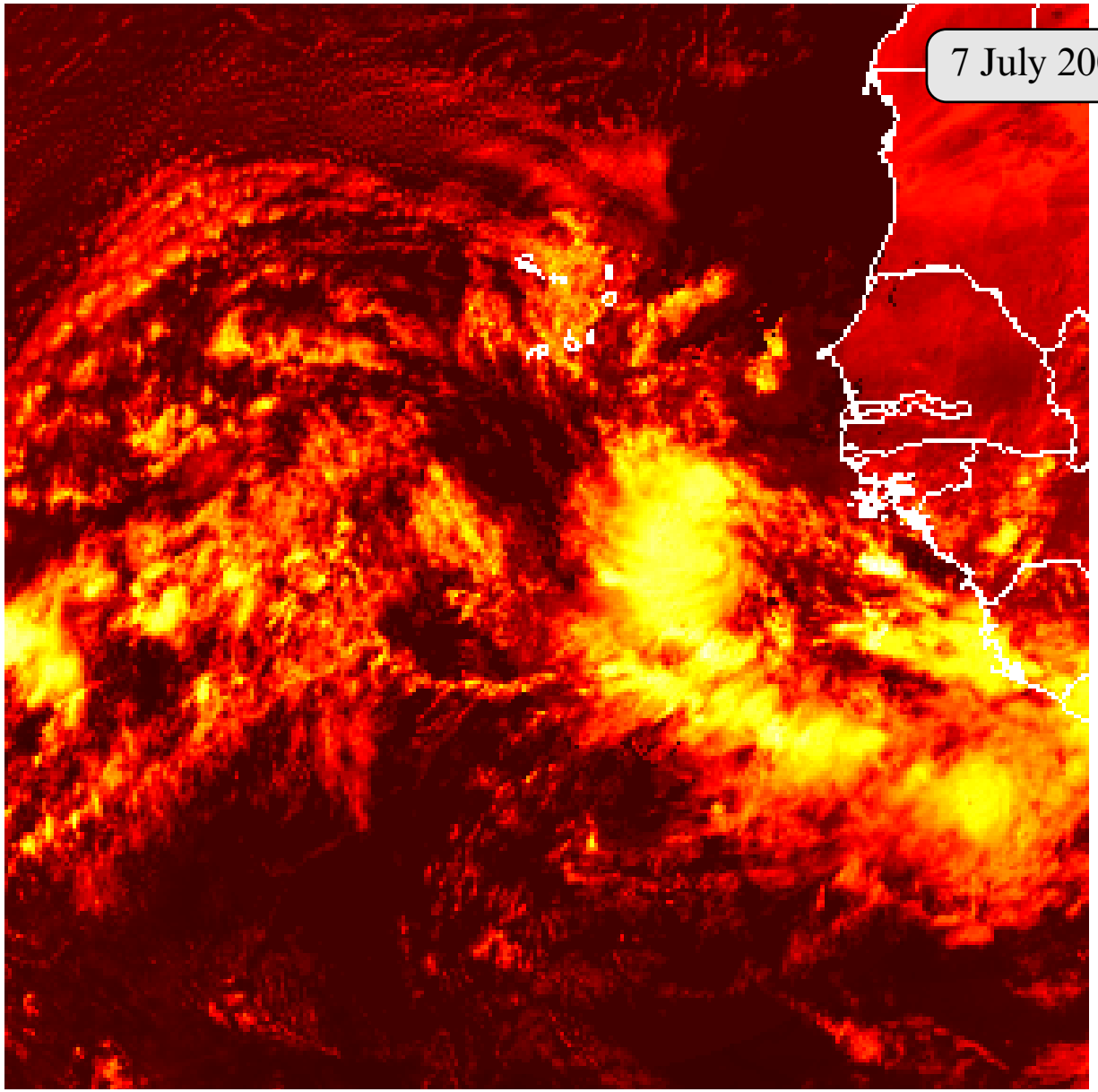
- tends to increase cloud cover
- tends to decrease crispness

GERB-like



7 July 2004: **before**

GERB-like



7 July 2004: **after**