Updates on the SEVIRI scene identification

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Comparisons

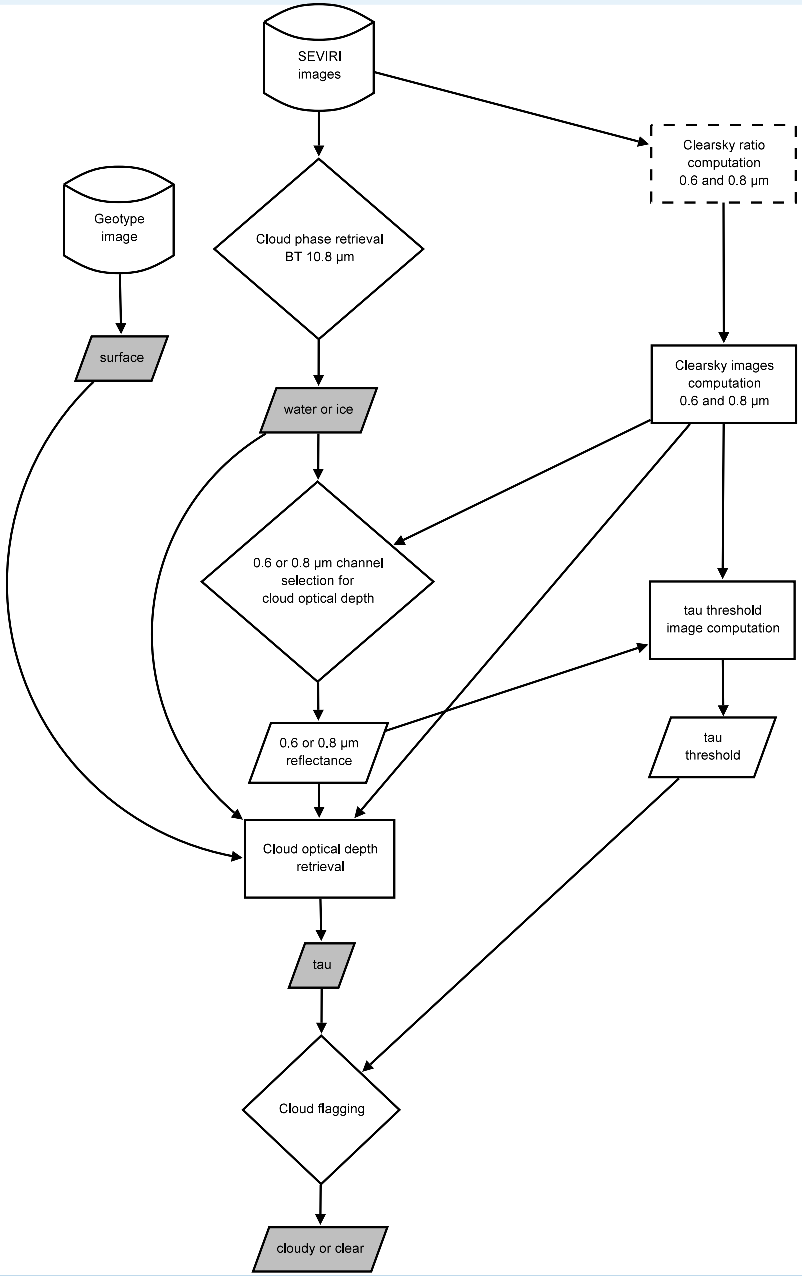
Motivations

- GERB processing based on radiance–to–flux conversions using CERES TRMM ADMs (solar)
- SEVIRI must be used for basic scene identification to select proper ADM:
  - surface type
  - cloud optical depth
  - cloud phase
  - cloud fraction

Algorithm

- Cloud thermodynamic phase retrieved using threshold on 10.8 μm BT
- Cloud optical depth τ retrieved
  - using one visible channel (0.6 or 0.8 μm)
  - through comparisons with reference composite TOA clearsky reflectances
  - using lookup tables from 1D radiative transfer computations (cutoff at 128)
- Cloud flag retrieved through thresholding of τ: cloudy if $\tau \geq\approx 0.6$

Flowchart



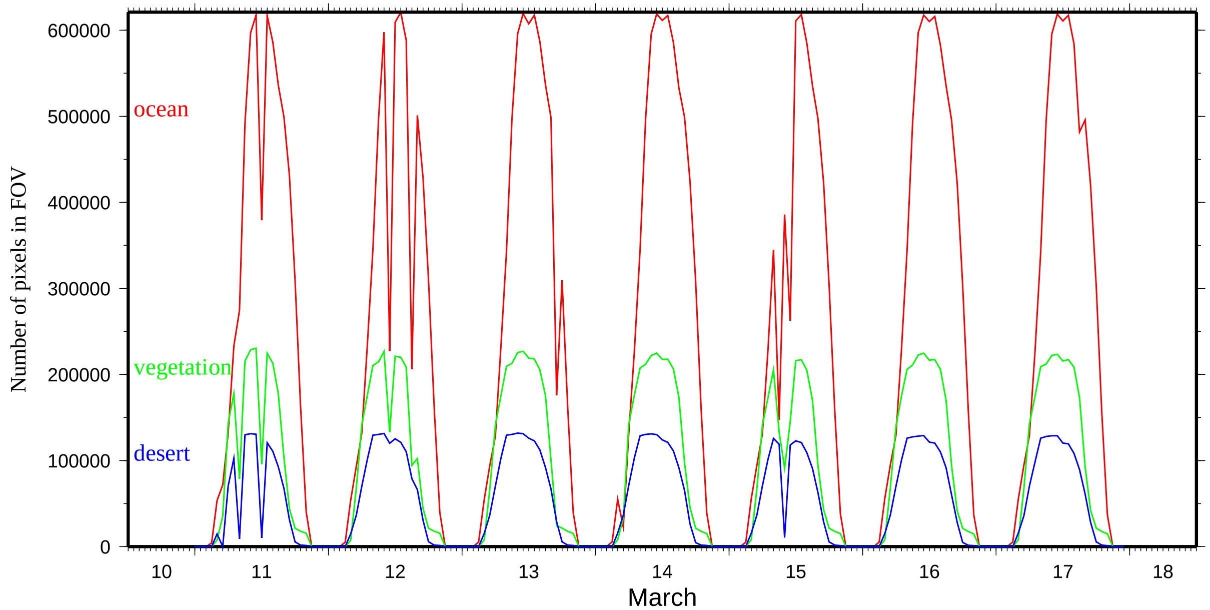
SEVIRI images
Clearsky ratio computation 0.6 and 0.8 µm
Geotype image
Cloud phase retrieval BT 10.8 µm
surface
water or ice
Clearsky images computation 0.6 and 0.8 µm
0.6 or 0.8 µm channel selection for cloud optical depth
tau threshold image computation
0.6 or 0.8 µm reflectance
tau threshold
Cloud optical depth retrieval
tau
Cloud flagging
cloudy or clear

Limitations

- Simplistic cloud thermodynamic phase retrieval
- Reference composite TOA clearsky reflectances images updated weekly
- Restricted number of lookup tables
- Uncertainty in lookup tables (DISORT) for grazing solar and viewing zenith angles
- Large STREAMER bands compared to SEVIRI channels
- Thin clouds with $\tau < 0.6$ falsely detected as clearsky

Datasets

- Data for 11–17 March 2007 on hourly basis
- GERB ED01 SEVIRI processing at 3 km
- CERES VISST SEVIRI processing at 9 km: 1 out of 3 native pixels
- VISST data projected to SEVIRI FOV for one–to–one pixel comparisons

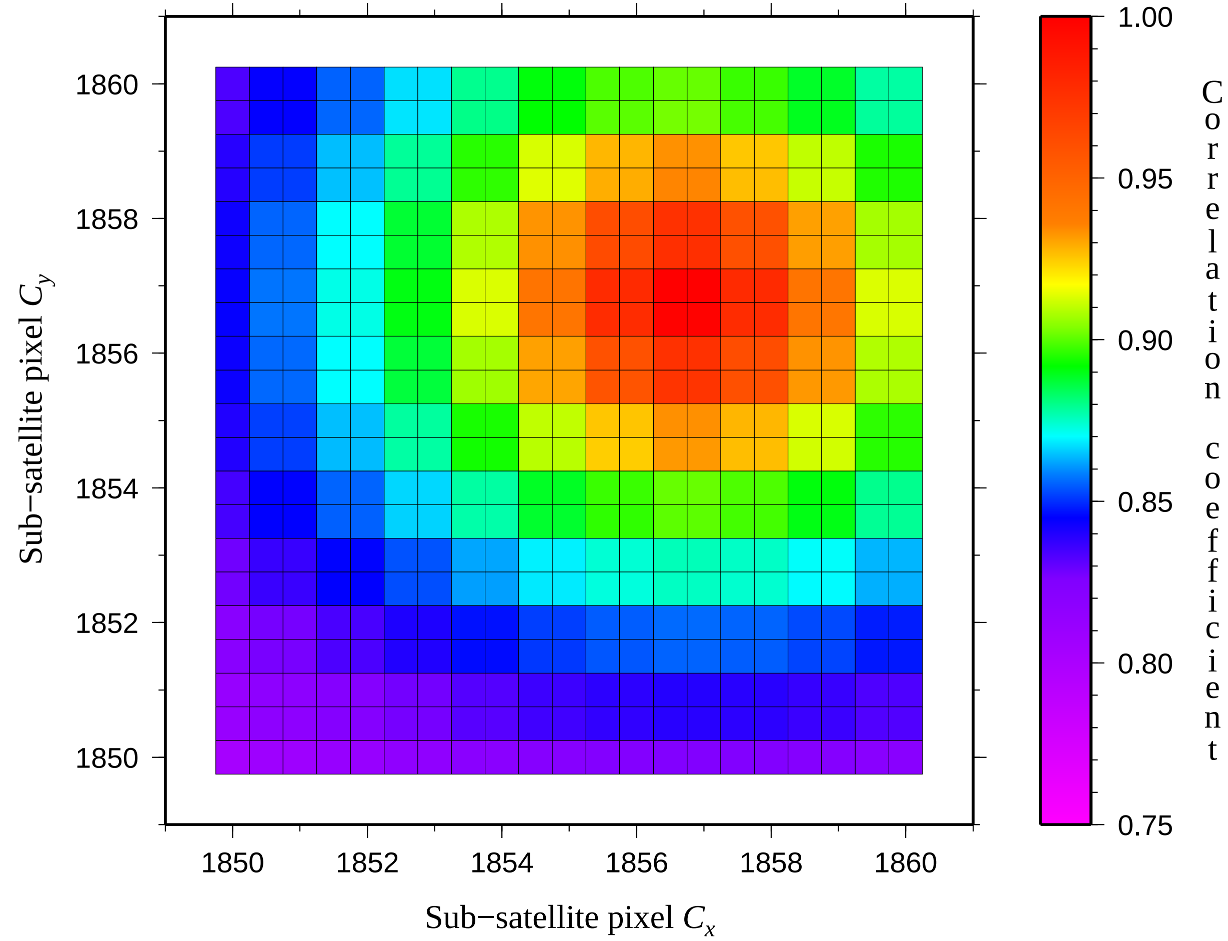


Geolocation

- `MT8V03.0.[NS]H.2007071.1200.PX.09K` VISST 0.65 μm reflectance (1 out of 3 native pixels)
- VISST reflectance projected to SEVIRI FOV according to longitude & latitude within file and EUMETSAT formula
- Correlation coefficient is then computed between GERB and VISST reflectances for varying sub-satellite pixel coordinates (C_x, C_y) for VISST projection

► EUMETSAT prescribed values of $(1856, 1856)$ starting from 0 (upper left corner)

Geolocation

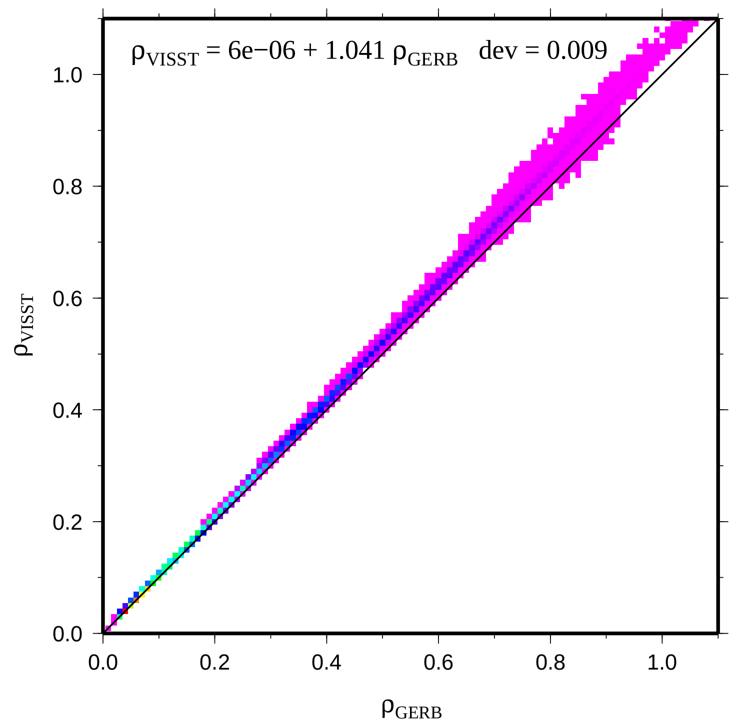


► Maximum correlation for $(1857, 1857)$!

Calibrations offset (0.6 μm)

- GERB processing using EUMETSAT prescribed calibration
- VISST processing using cross–instruments inter–calibration

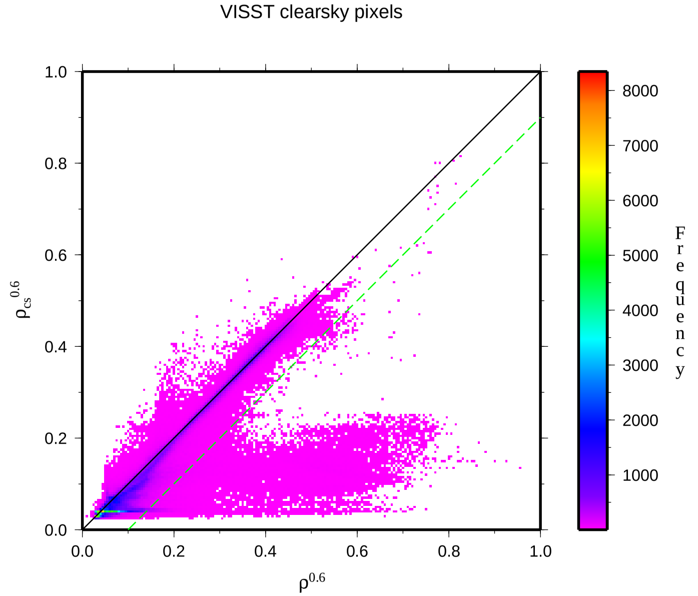
- VISST calibration 4% higher than GERB

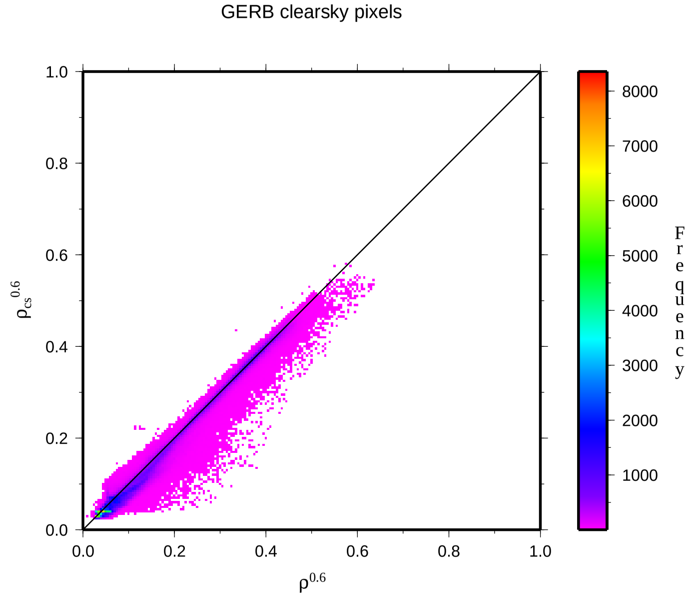


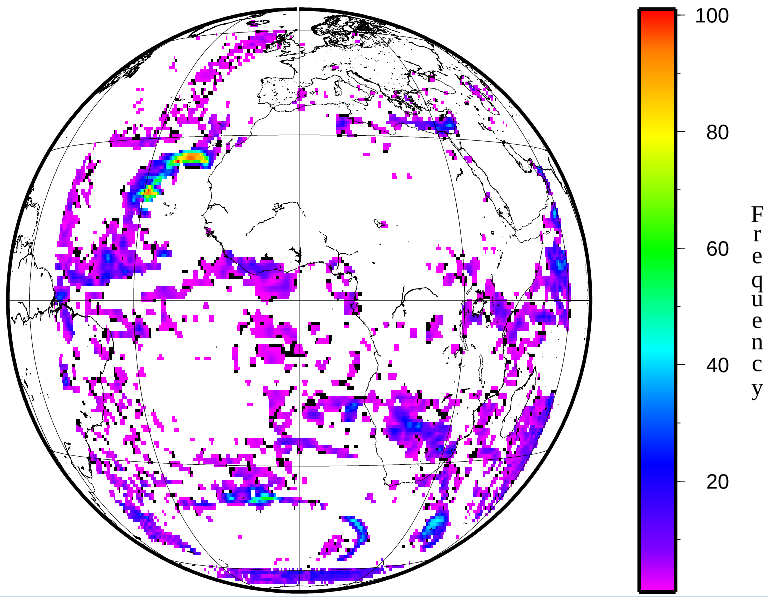
▶ Expected discrepancies between schemes

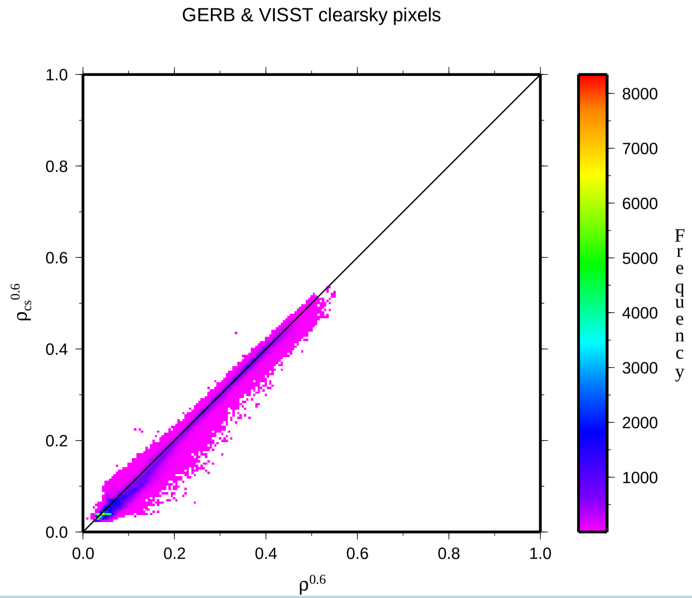
Clearsky reflectances (0.6 μm)

March 12 2007 at 12:00 GMT



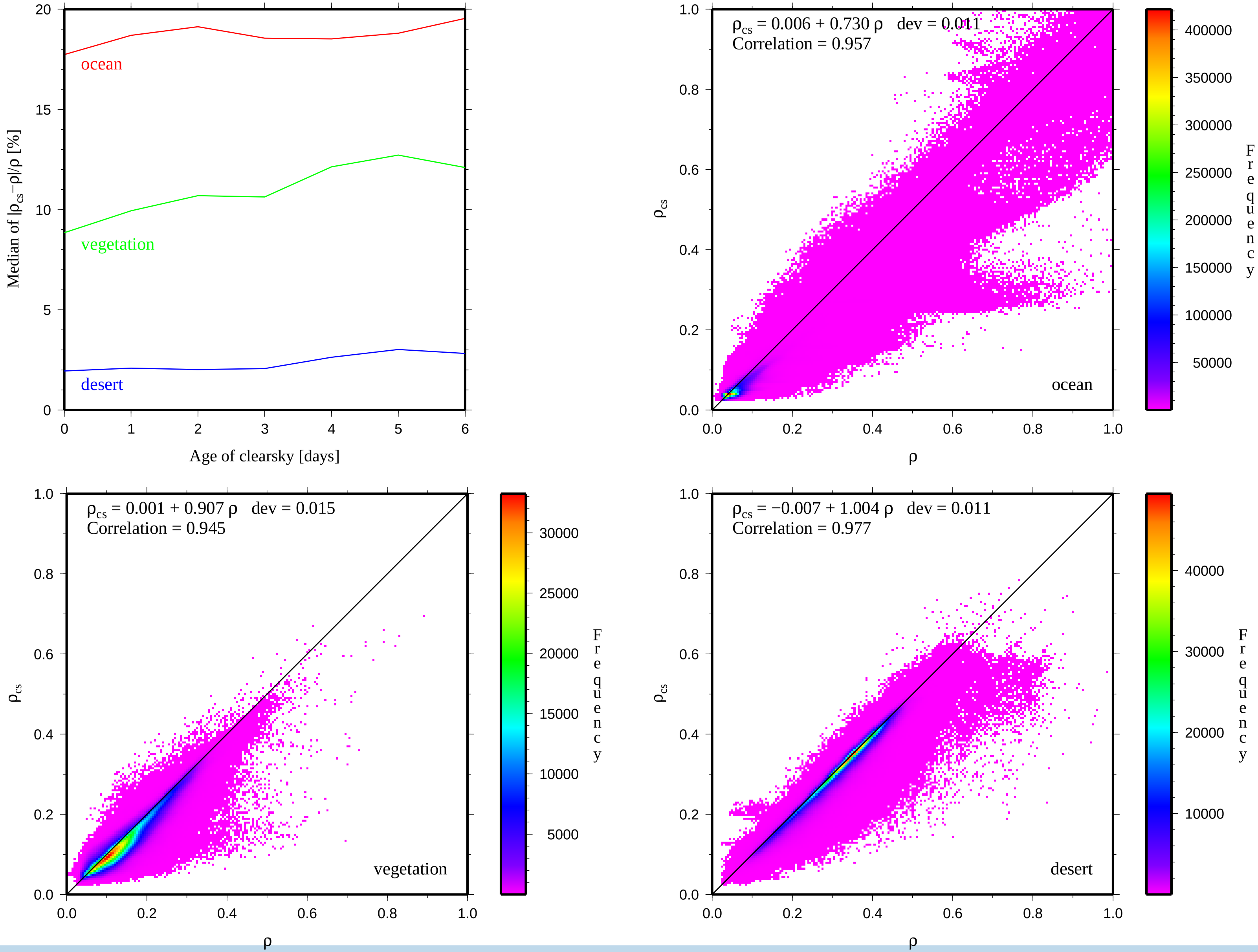






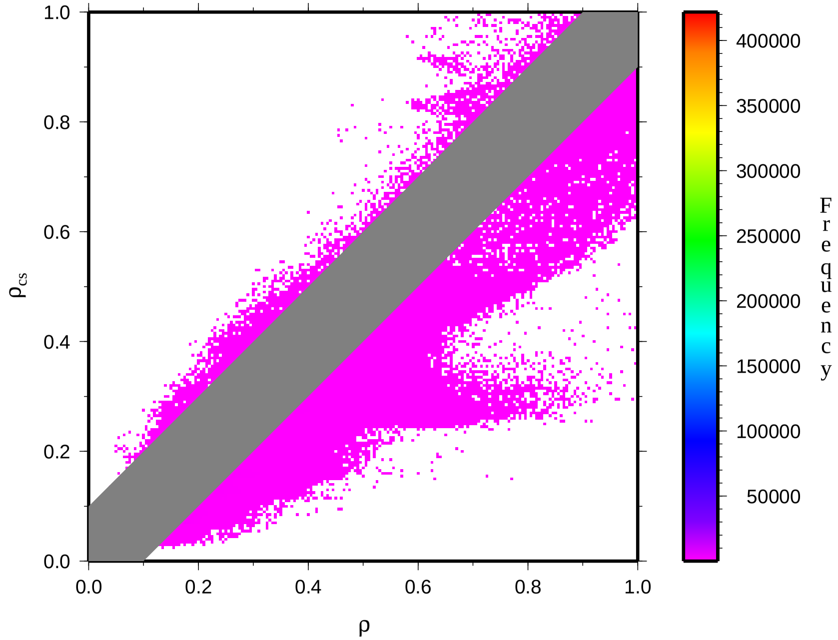
Clearsky reflectances (0.6 μm)

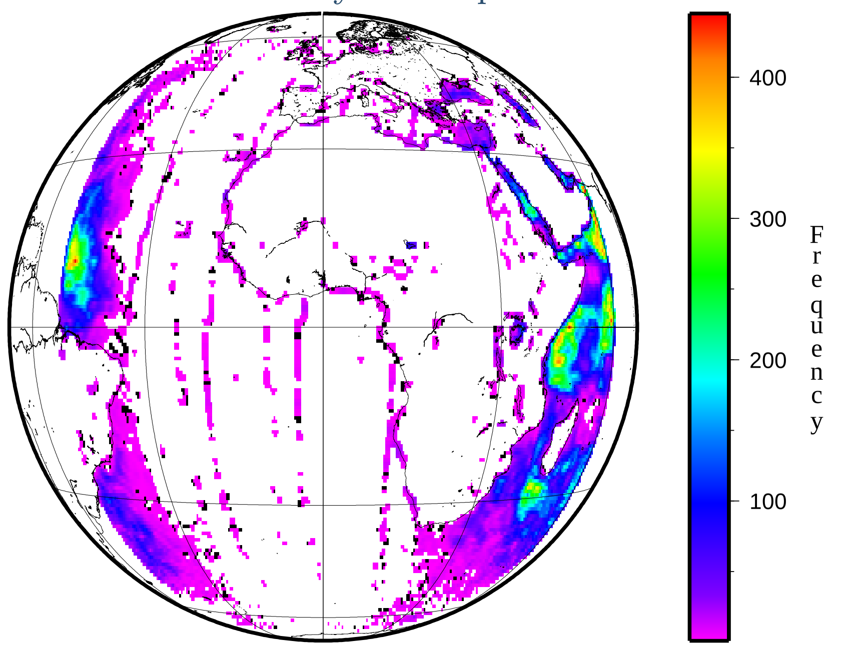
March 11–17 2007, all slots, GERB & VISST clearsky pixels



Clearsky reflectances (0.6 μm)

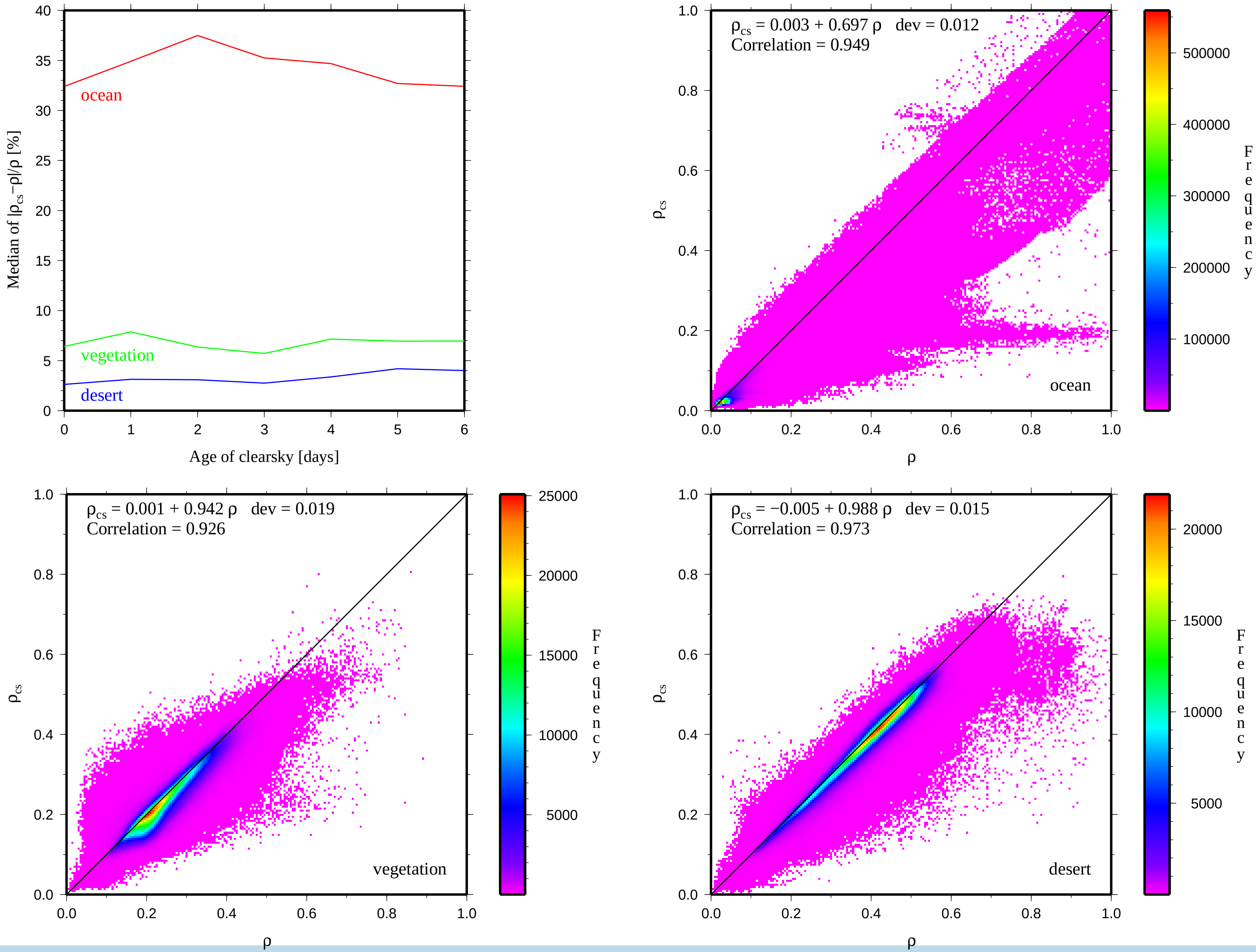
March 11–17 2007, all slots, GERB & VISST clearsky ocean pixels





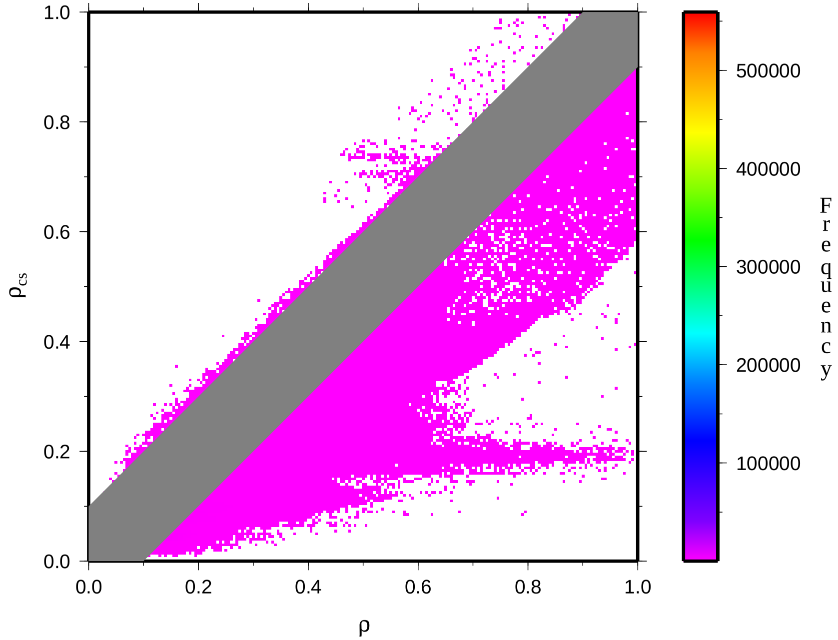
Clearsky reflectances (0.8 μm)

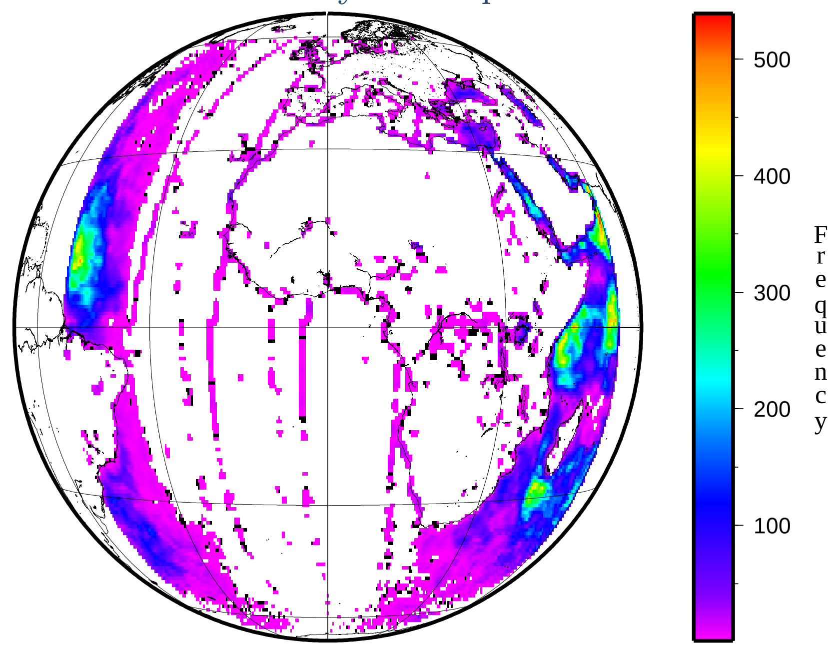
March 11–17 2007, all slots, GERB & VISST clearsky pixels



Clearsky reflectances (0.8 μm)

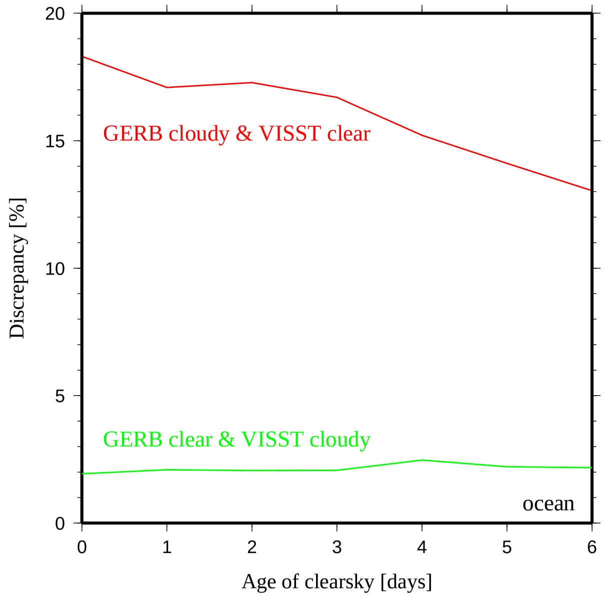
March 11–17 2007, all slots, GERB & VISST clearsky ocean pixels

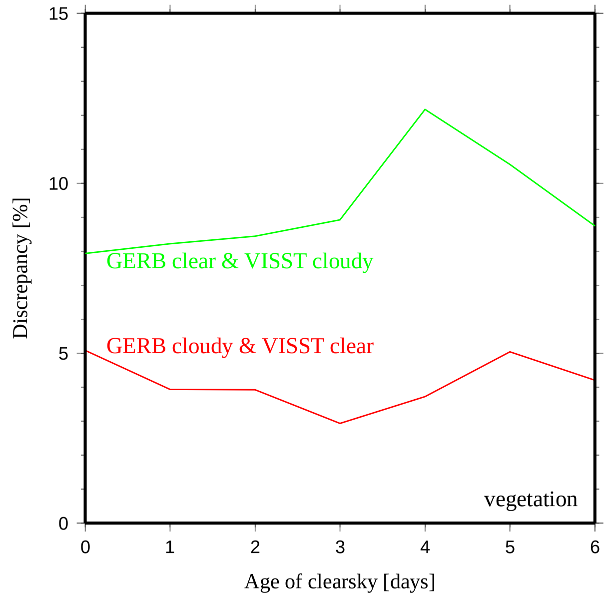


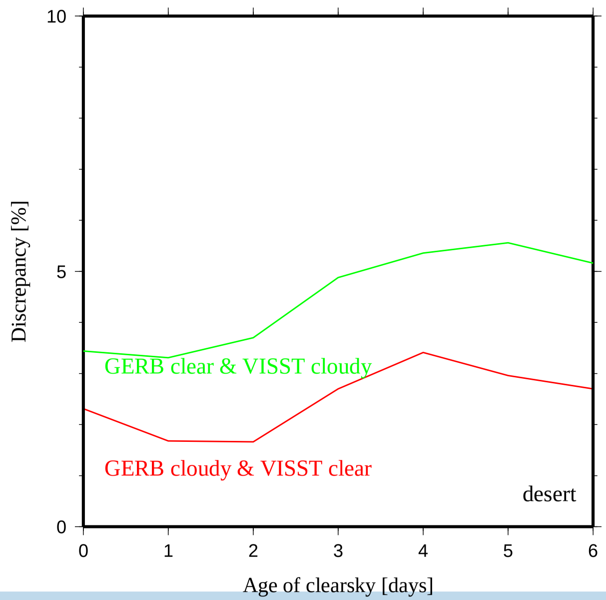


Cloud flag

March 11–17 2007, all slots

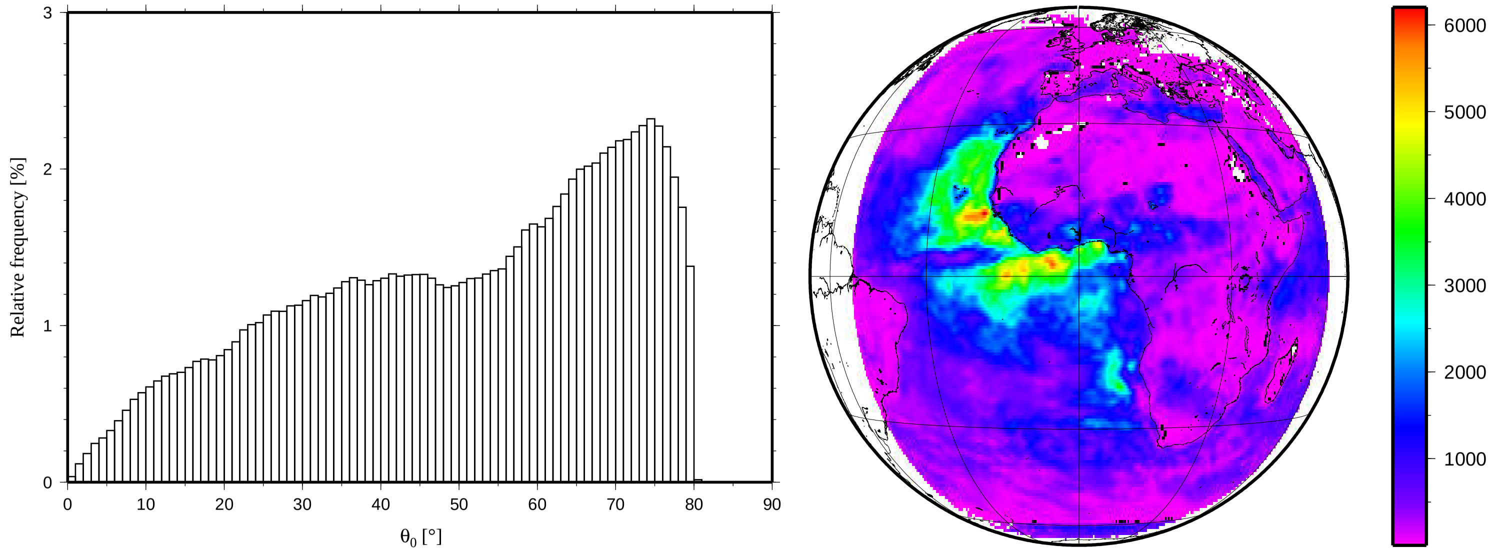




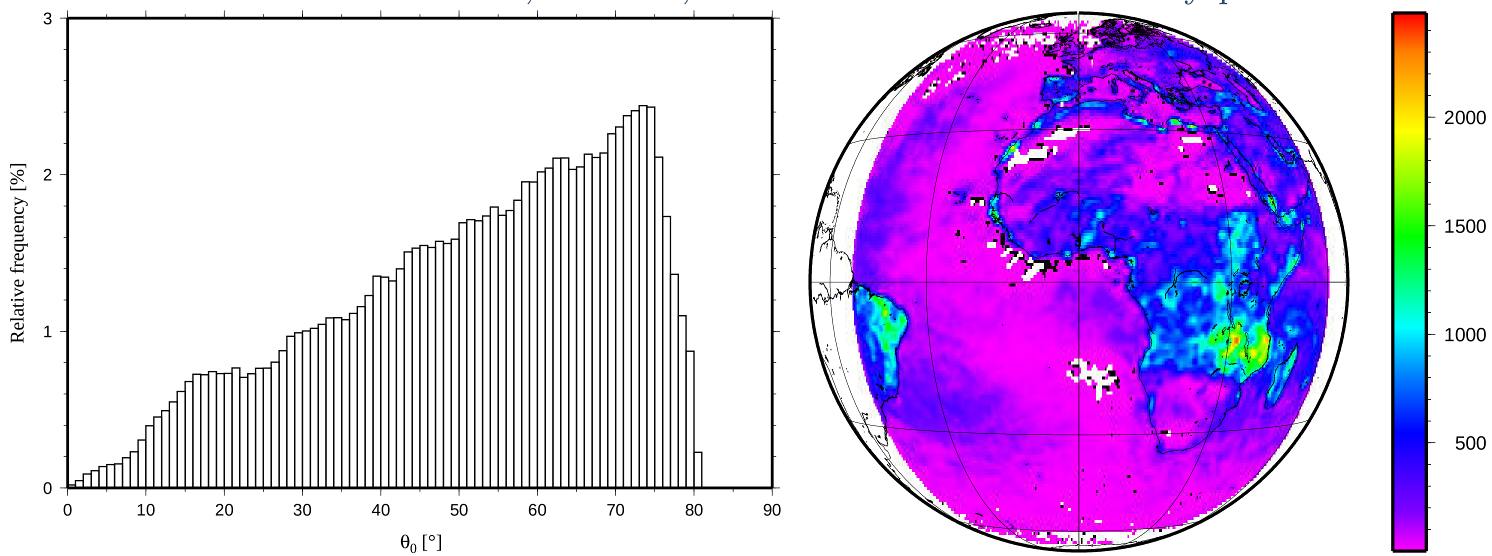


Cloud flag

March 11–17 2007, all slots, GERB cloudy & VISST clear pixels

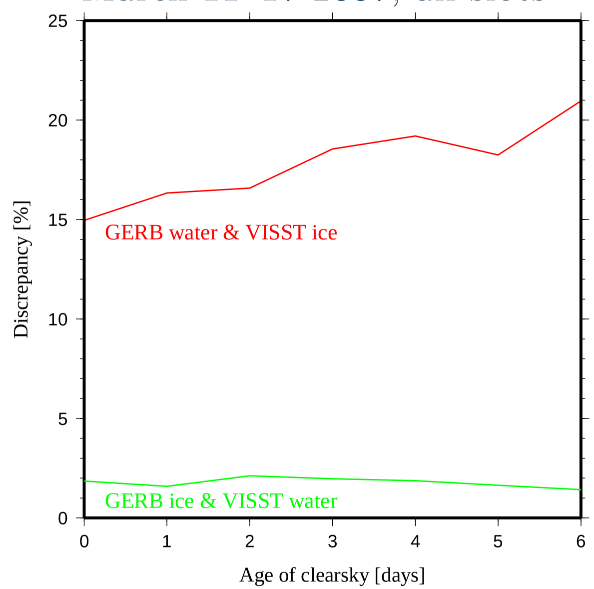


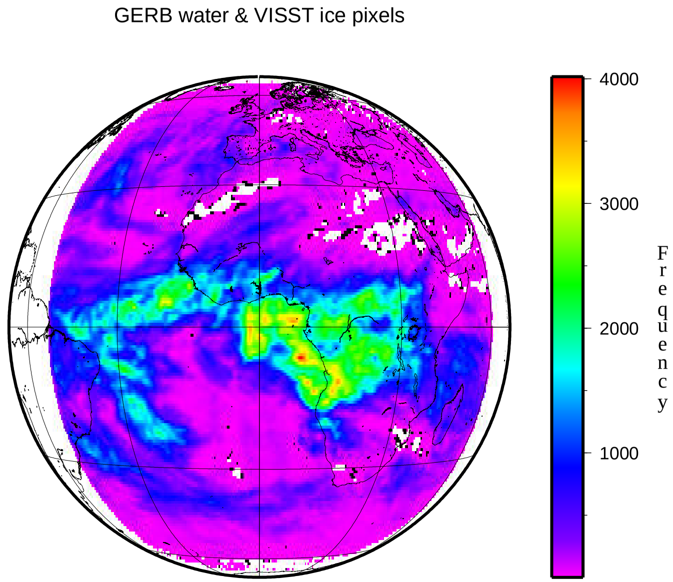
March 11–17 2007, all slots, GERB clear & VISST cloudy pixels

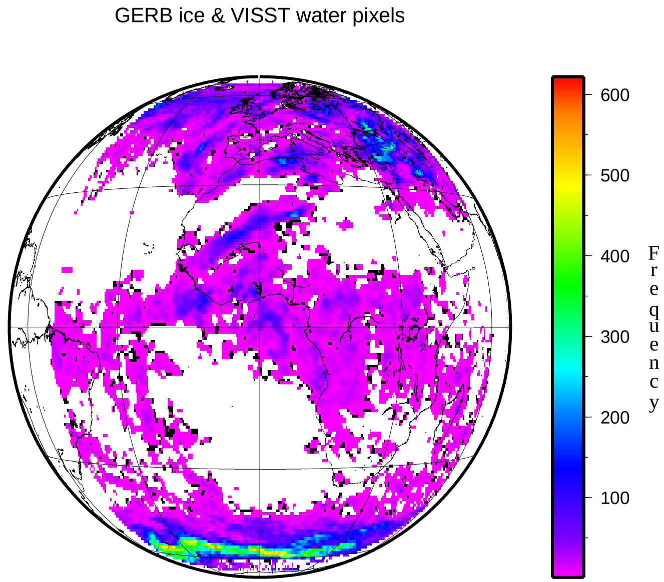


Cloud phase

March 11–17 2007, all slots

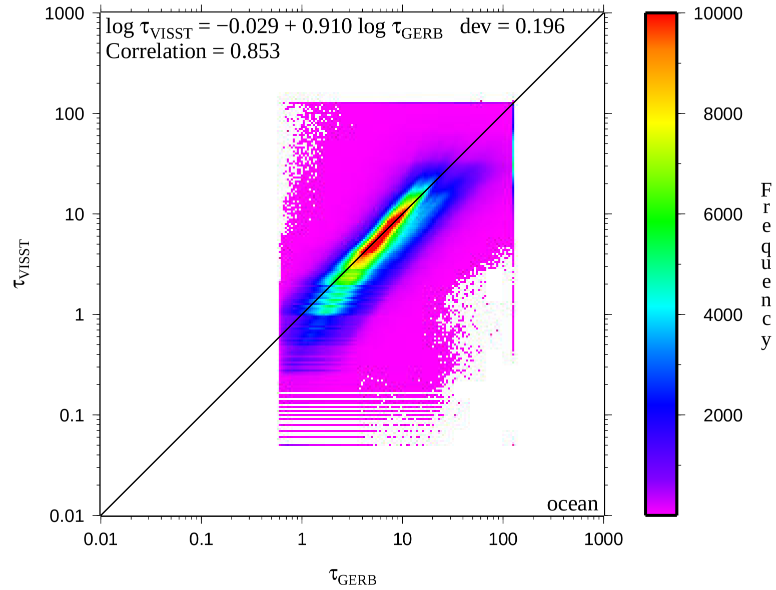


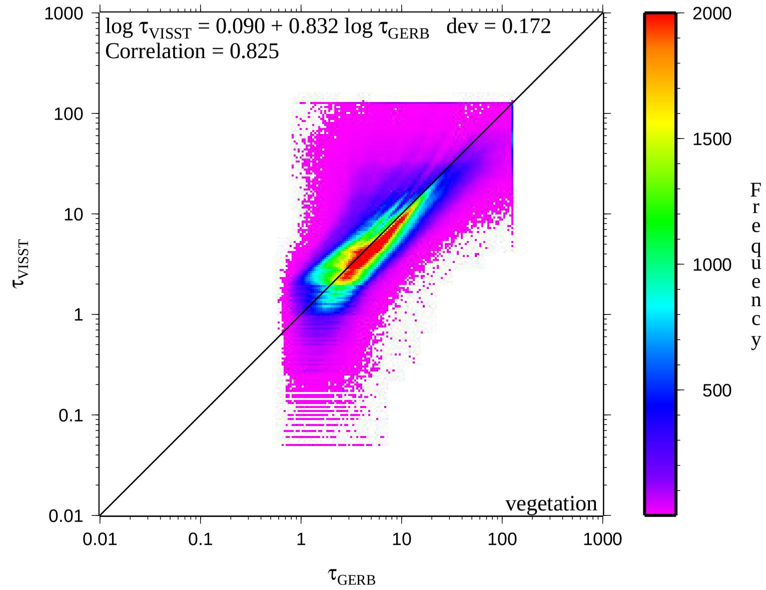


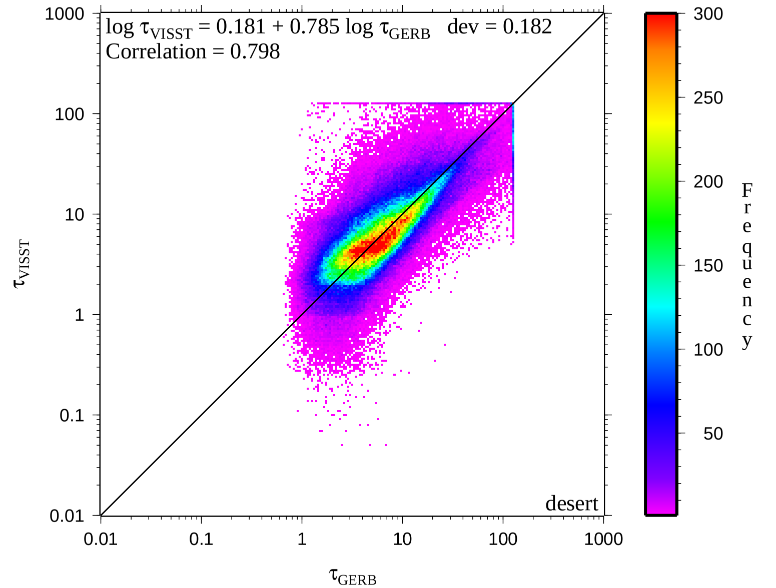


Cloud optical depth

March 11–17 2007, all slots, GERB & VISST water phase pixels

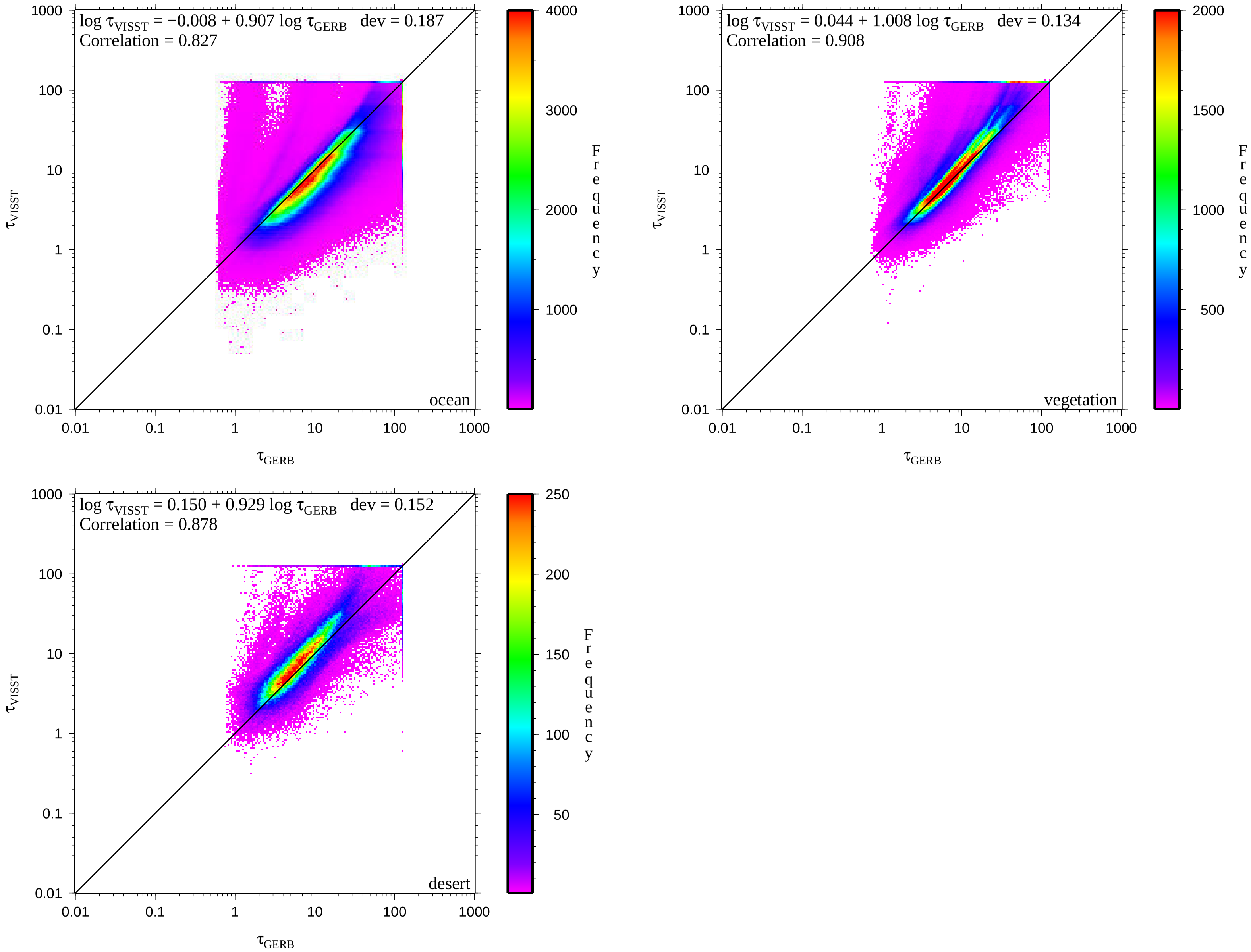






Cloud optical depth

March 11–17 2007, all slots, GERB & VISST ice phase pixels



Further work

- Re–compare with complete and possibly updated VISST dataset
- Study the impact of discrepancies between GERB and VISST scene identifications on GERB–like TOA fluxes:
  - VISST dataset at SEVIRI native resolution (3 km) would be valuable

Further work for Edition 2

- Clearsky:
  - Benefit of realtime computation ?
  - Tuning of parameters to decrease error
- Cloud phase:
  - Multispectral detection (1.6 μm)
- Cloud flag:
  - Retrieve dust and aerosols from cloudy flagged pixels (Helen's method)

IR cloud detection

Overview

IR cloud detection

- Motivations
- Physics
- Algorithm
- Results
- Further work

Motivations

- SEVIRI data affected by sun glint over ocean
- Sun glint can saturate 0.6 & 0.8 μm channels
- Scene identification only relying on visible channels

- ▶ Degraded cloud mask within sun glint area
- ▶ Request of users for cloud mask at nighttime

- ▶ Implementation of an IR cloud detection scheme

Physics

- SEVIRI IR 10.8, 8.7 & 12.0 μm channels are the most sensitive to clearsky & clouds
- Clouds are characterized by lower IR radiances (temperatures) than clearsky surfaces (warmer)
- IR radiances are varying with viewing zenith angle, history (precipitation, cloud shadow) and state of atmosphere (profiles)

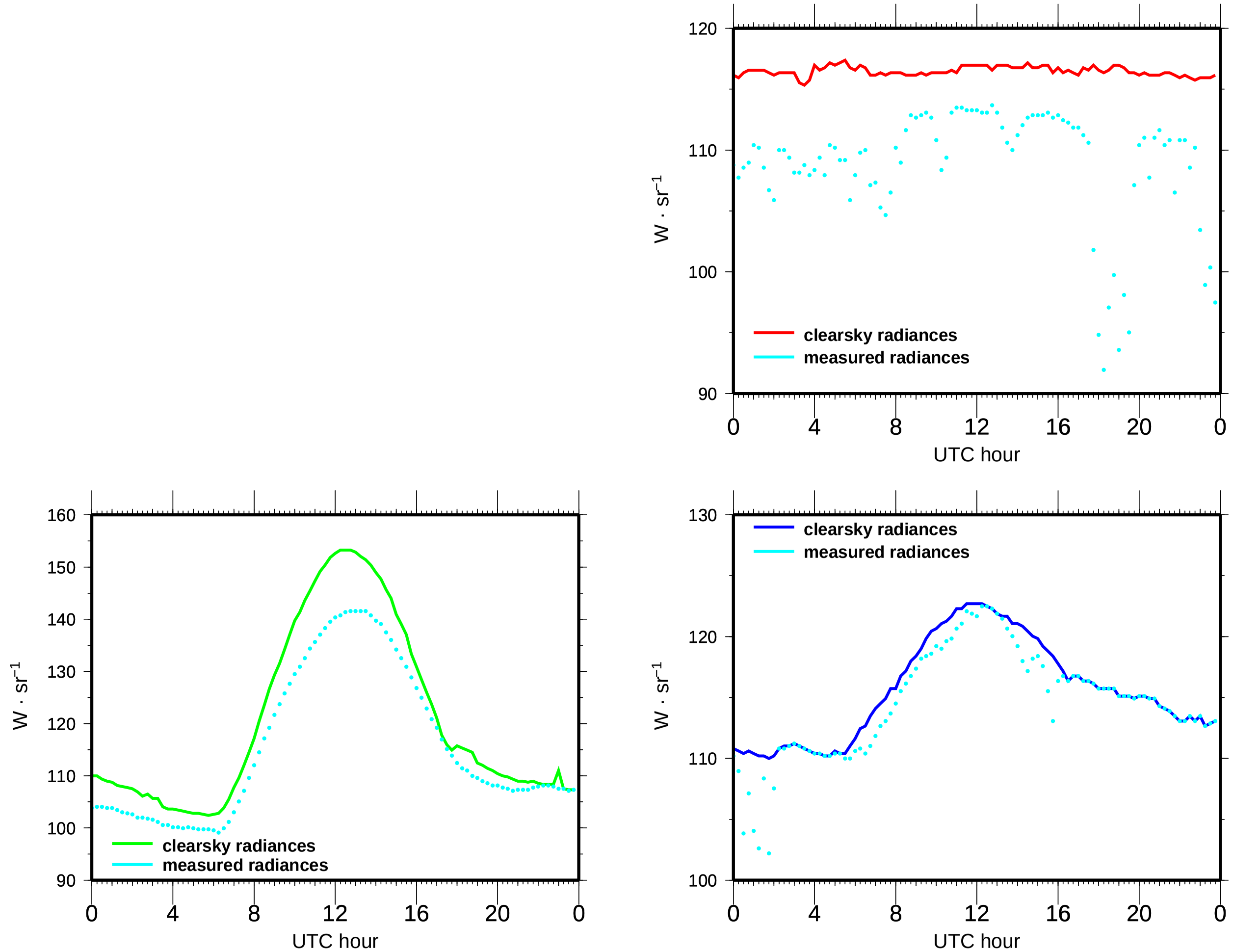
▶ Visible & IR cloud masks will have discrepancies due to different physics

Algorithm - previous attempt

- Transpose visible clearsky estimation to 10.8 μm channel:
  - Using time–series of pixel-based IR radiances
  - Clearsky IR radiances is the maximum envelope curve of the time-series for each time of day
  - Temporal window for maximum search is function of ISCCP cloud cover climatology
- Cloud detection using threshold test for pixel p: $(L_{10.8}(p) < L^{cs}_{10.8}(p) - \Delta(p)\ )$? cloudy : clear

Algorithm - previous attempt

- Over–estimation of clearsky IR radiances



January 9 2007

Algorithm - new attempt

From numerous brainstorming sessions with Luis:

- Still using time–series of pixel-based BTs
- Temporal window for time–series is set to 60 days (TBC)
- No realtime ancillary data such as NWP fields

Main assumption:

- Samples in time–series can be grouped into 3 classes:
  - thick cold clouds (contrasted)
  - thin or low clouds (uncontrasted)
  - clearsky conditions

Algorithm - new attempt

- Perform a *modified* k–means clustering:

  1. Initialize the μ_n and σ_n for the 3 clusters
  2. Classify all 60 BTs according to their "nearest" cluster's center μ_n
  3. Update μ_n and σ_n
  4. Repeat from step 2 until all μ_n do not significantly change ($\Delta\mu_n < 1$ K)

- Re–perform clustering with minus one classes if μ_n are not separated by at least ΔBT
- Cloud mask value for pixel is given according to the class of the most recent sample in time–series

Algorithm - new attempt

Modification lies in:

- distance $d(\mathrm{BT}, \mu_n) = (\mathrm{BT} - \mu_n)^2/\sigma_n^2 + \ln \sigma_n^2$ if samples in each class follow $N(\mu_n, \sigma_n)$
- initialization scheme driven by physics

Initialization scheme:

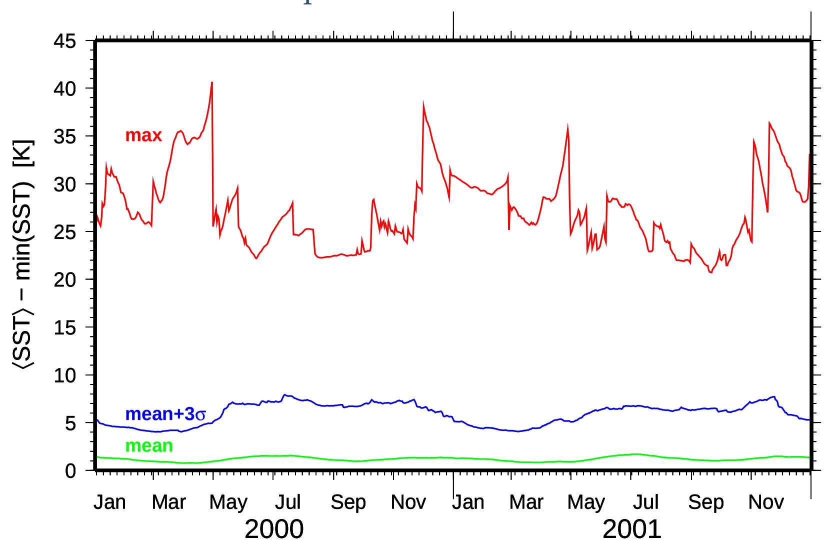
1. Assign μ_0 as the minimum, μ_1 the median and μ_2 the maximum of the samples
2. Assume that all classes are ΔBT wide and shift μ_n accordingly

Algorithm - new attempt

Pixel dependent ΔBT is estimated from 2 years of 6–hourly ERA–40 SSTs:

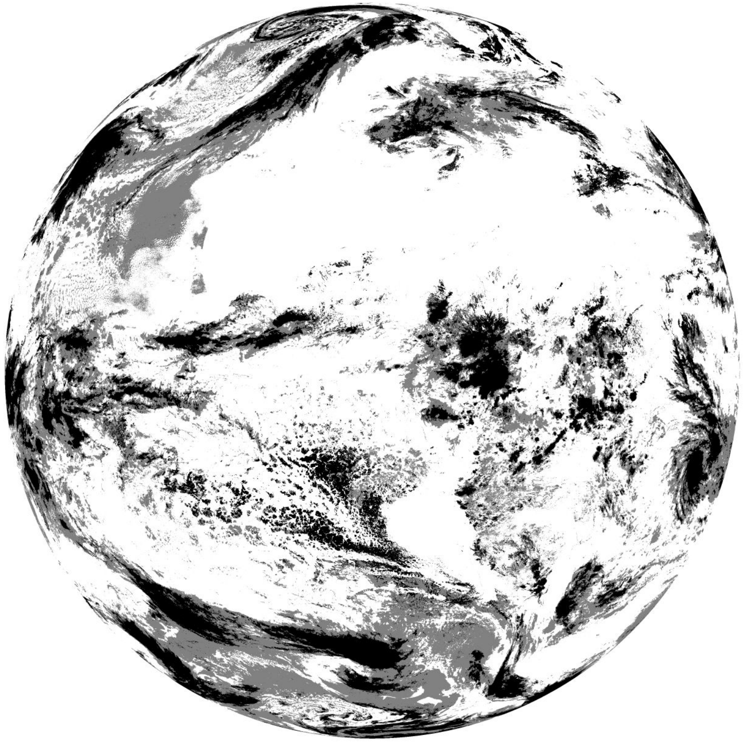
- estimate $\langle SST \rangle - \min(SST)$ over 60–days period at pixel level
- compute statistics for pixels with the same surface type in FOV
- Average of mean+3σ over time for each surface type (crude)

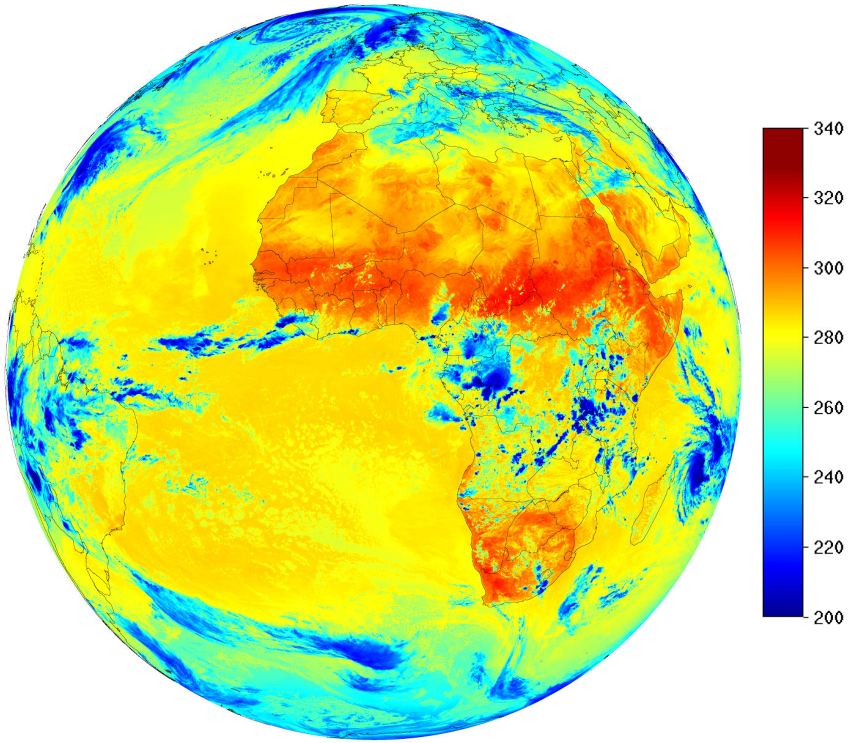
Ocean pixels at 12:00 GMT



Preliminary results

Cloud mask and associated 8.7 μm BT for March 11 2007 at 12:00 GMT



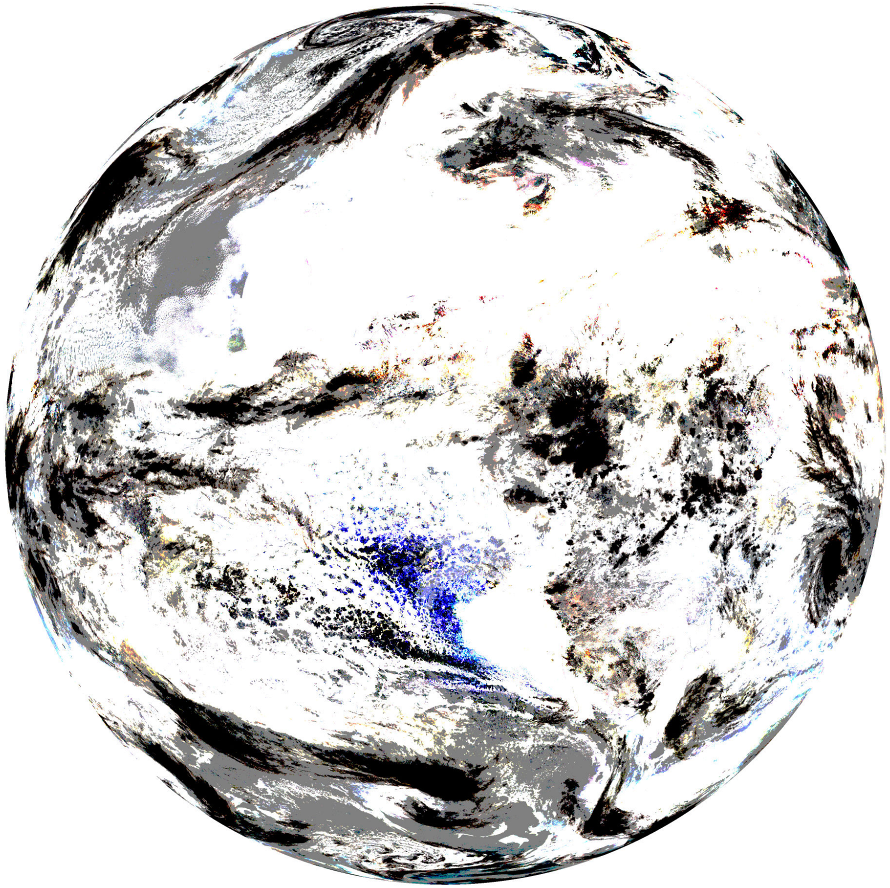


- 3 classes for each IR channel:
  contrasted cloud, uncontrasted cloud, clearsky

Preliminary results

False–color composite from 8.7, 10.8 & 12.0 μm cloud masks:

March 11 2007 at 12:00 GMT



Further work

- Combine independent cloud masks in a synthetic product:
  - criteria when classes do not match (fuzzy logic or probabilistic decision theory)
- ΔBT for each surface type according to date and time of day and possibly geographic location:
  - use of 10 years of ERA–40 SSTs to build up statistics
- Compare with NWCSAF and MPEF cloud masks during night time