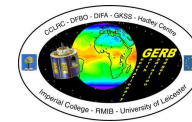


**Validation and Homogenisation of Cloud
Properties Retrievals for RMIB
GERB/SEVIRI
Scene Identification**

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Overview

1. Introduction
2. Motivations
3. Cloud Properties Retrieval Algorithms
4. Analysis of the Retrievals
5. Homogenisation of the Cloud Optical Depths
6. Validation of the Homogenized Retrievals
7. Future Works

1. Introduction

GERB angular conversion, i.e. TOA radiance-to-flux conversions, based on CERES ADMs for solar radiation.

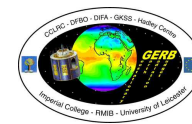
⇒ For best flux estimation, CERES and GERB SIs need to be as close as possible !

According to CERES ADMs, minimal features for RMIB GERB/SEVIRI SI are:

- ▷ cloud optical depth
- ▷ cloud fraction
- cloud phase
- surface type

BUT, CERES and GERB cloud identifications are based on different algorithms and radiative models → discrepancies between both cloud products (CPs).

⇒ Need some corrective scheme to map GERB on CERES CPs.



2. Motivations

1. Detection of possible angular bias in the GERB cloud properties retrieval algorithms.
2. Development of some corrective scheme to map Instrument-1 on Instrument-2 CPs.

3. Cloud Properties Retrieval Algorithms

Cloud optical depth τ

- Simulated radiances L for ocean, vegetation and bare-soil surfaces, ice and water clouds with several τ using SBDART RT code.
- Parametrization (A, B, χ, τ_0) of empirical relation between mean cloud amount C and τ (sigmoid in $\log \tau$) by LSF using those simulated L

$$C \triangleq \frac{L(\tau) - L(0)}{L(128) - L(0)} = \frac{A}{B + \left(\frac{\tau_0}{\tau}\right)^{1/\chi}} \quad (1)$$

where all quantities except τ are $(\theta_0, \theta, \varphi)$ and surface dependent.

- Estimation of τ with measured radiances $L(\tau)$, $L(0)$, simulated $L(128)$ and parameters associated to scene geometry through inversion of (??).

3. Cloud Properties Retrieval Algorithms

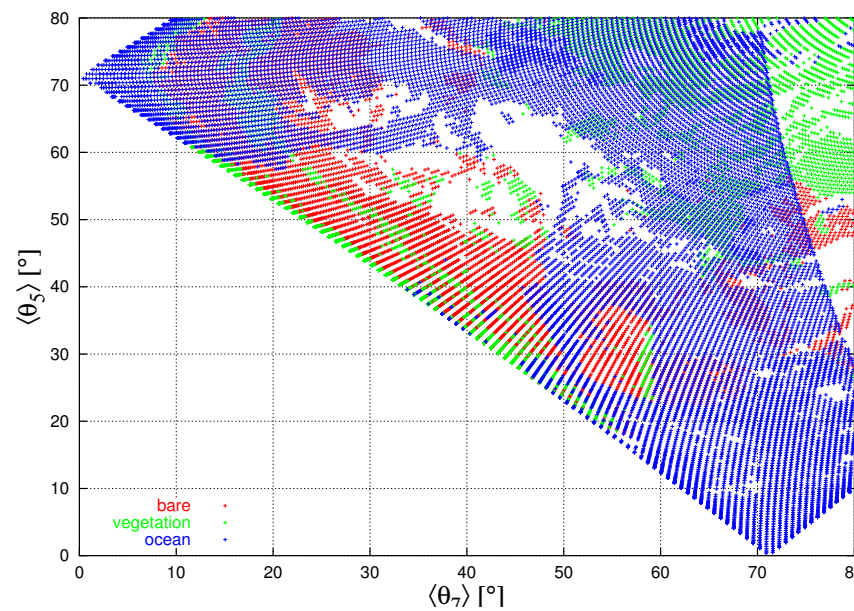
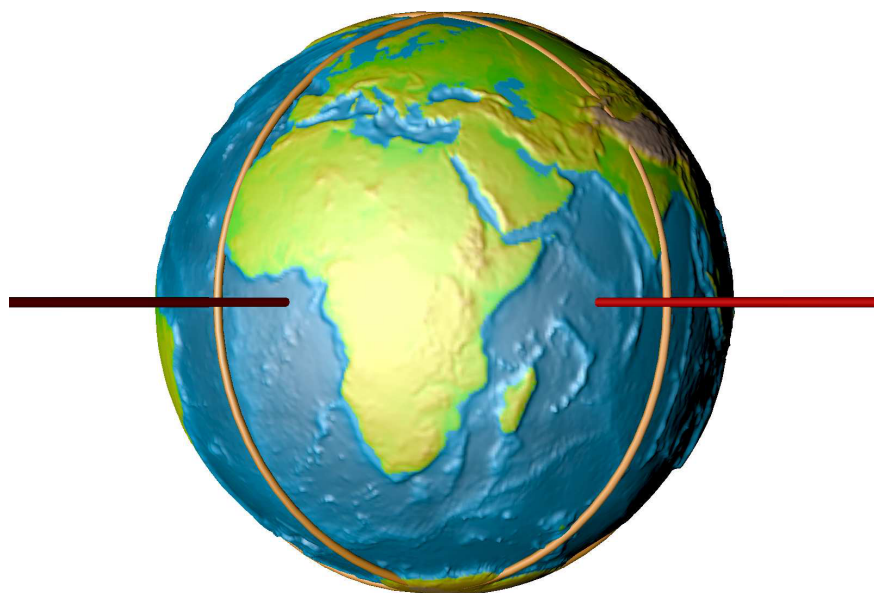
Cloud fraction f

- Defined on some footprint, i.e. a set of pixels.
- Relative fraction of *cloudy* pixels within the footprint.
- *Cloudy* pixel if its $\tau > 1$ (this limit leads to approx. half of cloudy pixels in MS7 & 5 FOVs).

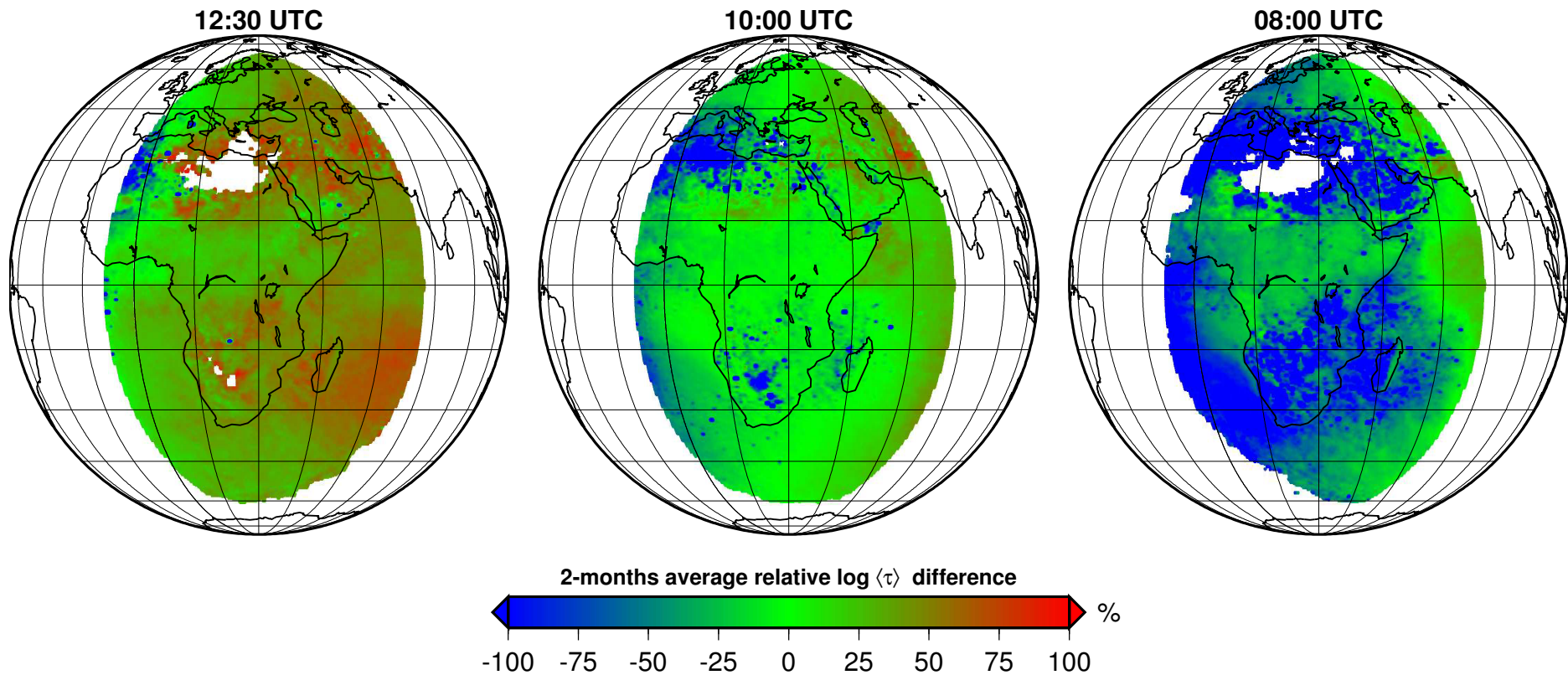
4. Data Description

- visible MS7 and MS5 images from July+August 1998 at 12:30, 10:00 and 8:00 UTC.
- Intersection of both FOVs provides identical scenes with different geometries $(\theta_0, \theta_7, \varphi_7)$ & $(\theta_0, \theta_5, \varphi_5)$.
- To avoid cloud shadowing and cloud parallax sensitivity in FOVs \implies footprint-basis mean comparisons with nearly identical projected sizes on surface (2500 km^2 and $50 \times 50 \text{ km}^2$ at $\pm 45^\circ$ of latitude)
- For each footprint and satellite, we estimate $(\langle \theta_0 \rangle, \langle \theta_i \rangle, \langle \varphi_i \rangle)$, mean surface, f_i , $\langle \tau_i \rangle$ where $i = 5, 7$.

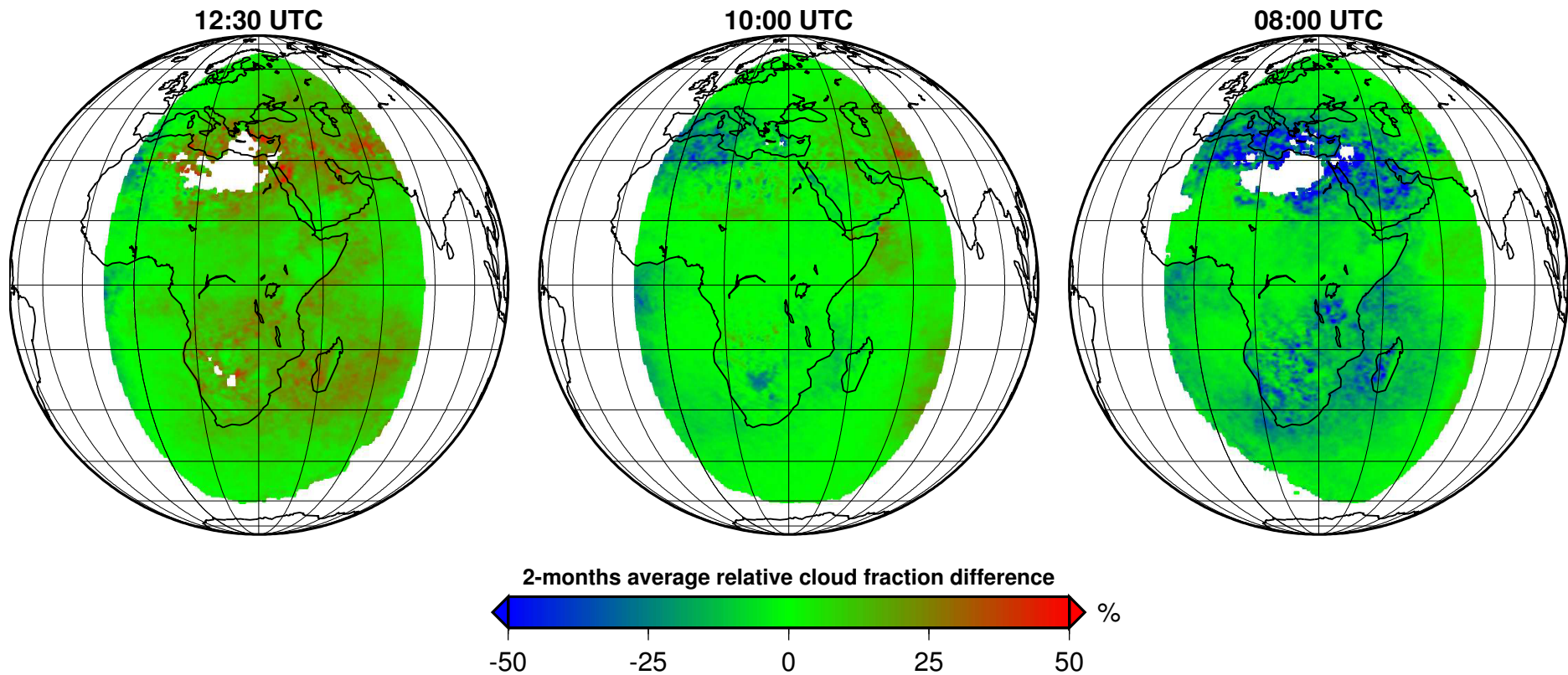
4. Data description



5. Analysis of the Retrievals



6. Analysis of the Retrievals

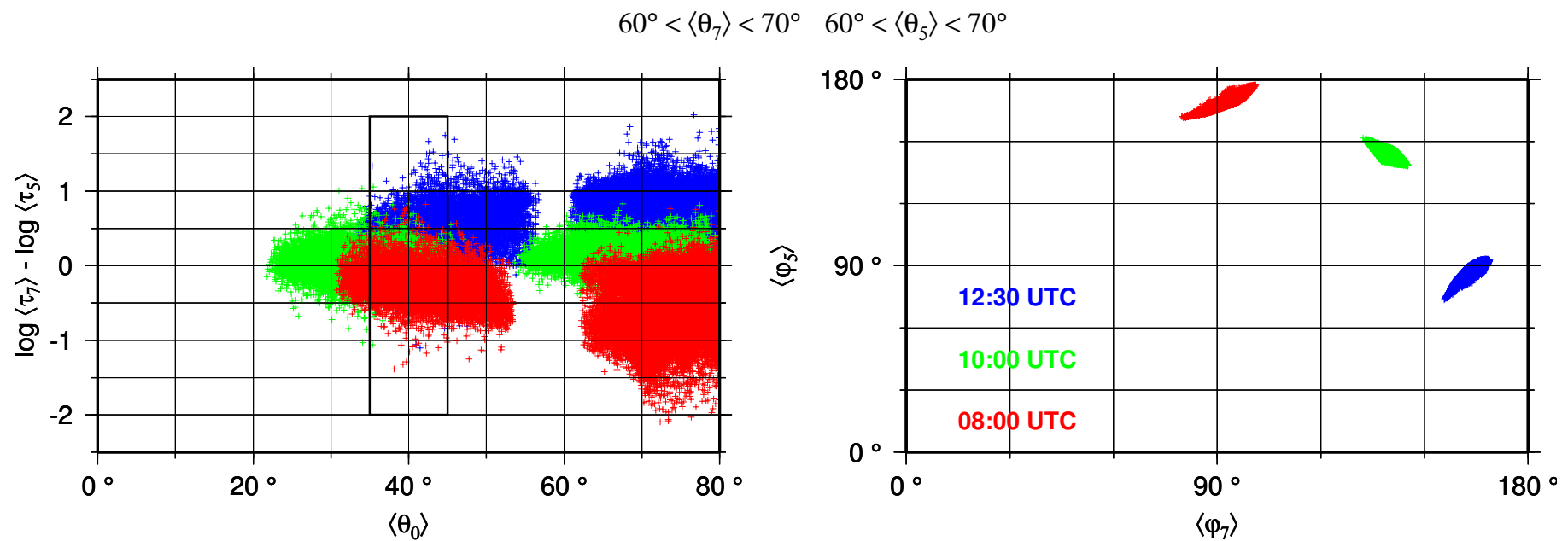


6. Analysis of the Retrievals

- τ variations according to surface type resolved by our algorithm.
- ▷ Sensitivity of τ retrievals according to all 3 angles $(\theta_0, \theta, \varphi)$?
- Due to the *cloudy* pixel boolean test, cloud fraction retrievals are less affected by scene geometry angles.

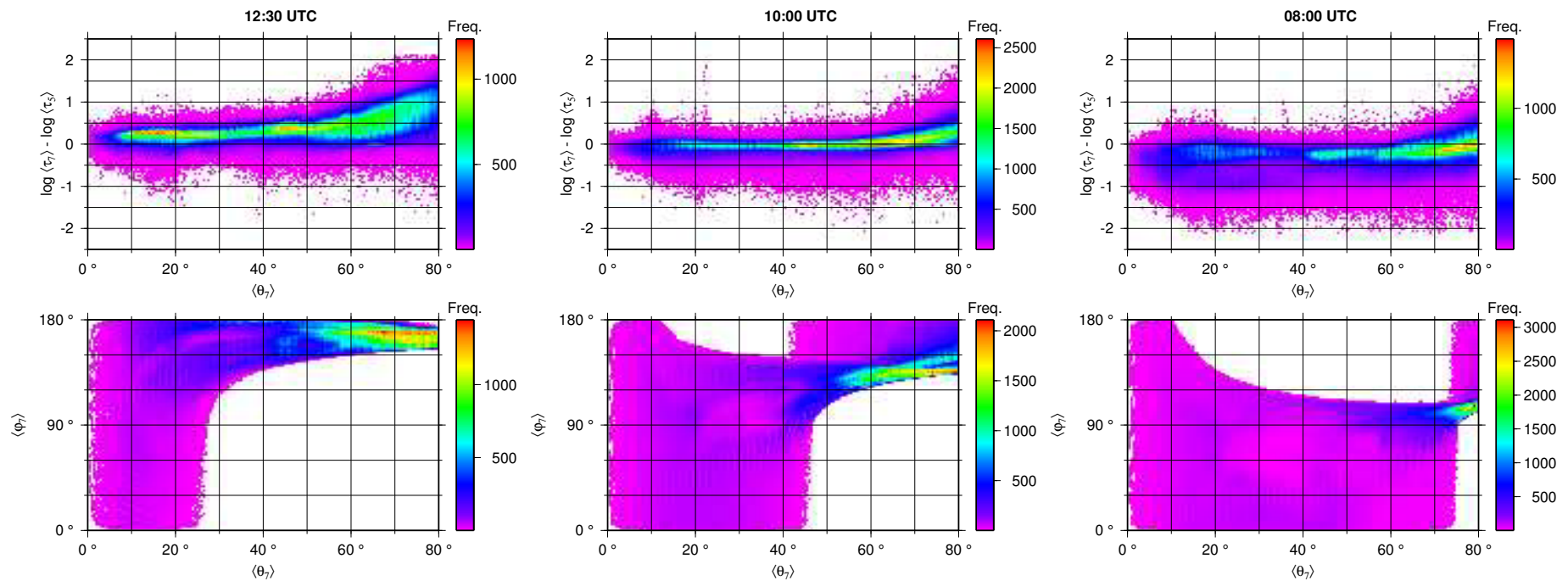
6. Analysis of the Retrievals

Sensitivity of τ retrievals



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Sensitivity of τ retrievals



6. Analysis of the Retrievals

Sensitivity of τ retrievals

τ retrieval errors are dependent of (θ, φ) (SBDART = plane-parallel code).

BUT, due to satellites configuration, each MS SLOT has a limited φ variation.

\implies Homogenisation according to θ will be performed for each SLOT separately !

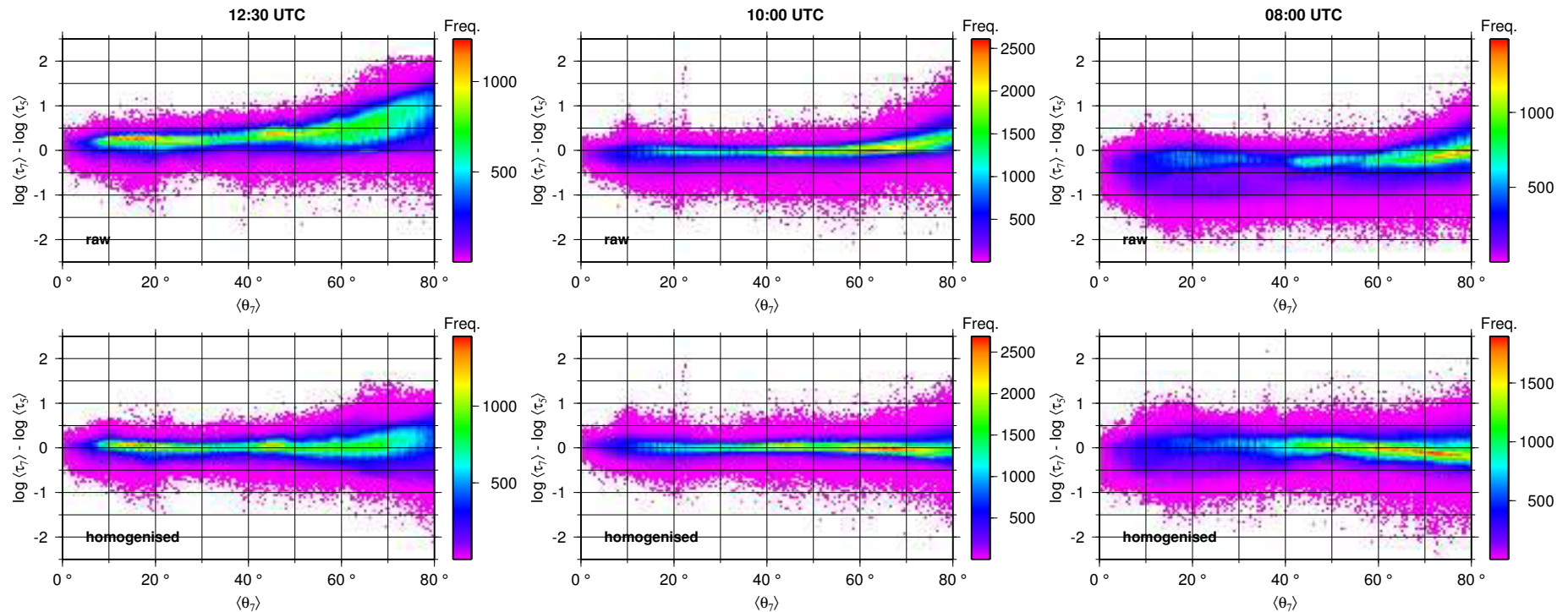
7. Homogenisation of the Cloud Optical Depths

1. Define a reference point which fixes values of one satellite compared to the other:
 - ▷ Selection of footprints with $60^\circ \leq \langle \theta_5 \rangle \leq 70^\circ$
 - ⇒ $\langle \tau_5 \rangle$ retrievals independent of $\langle \theta_5 \rangle$ due its restricted variation.
 - ⇒ scatter plot entirely explained by the $\langle \theta_7 \rangle$ dependency of $\langle \tau_7 \rangle$.
2. Modelize this dependency by LSF: $\log \langle \tau_7 \rangle - \log \langle \tau_5 \rangle = \mathcal{P}_3(\langle \theta_7 \rangle)$.
3. MS5 is the reference, thus $\langle \tau_5 \rangle \rightarrow \langle \tau \rangle$ can be seen as the MS7 homogenized value relative to the selected $\langle \theta_5 \rangle$ range:

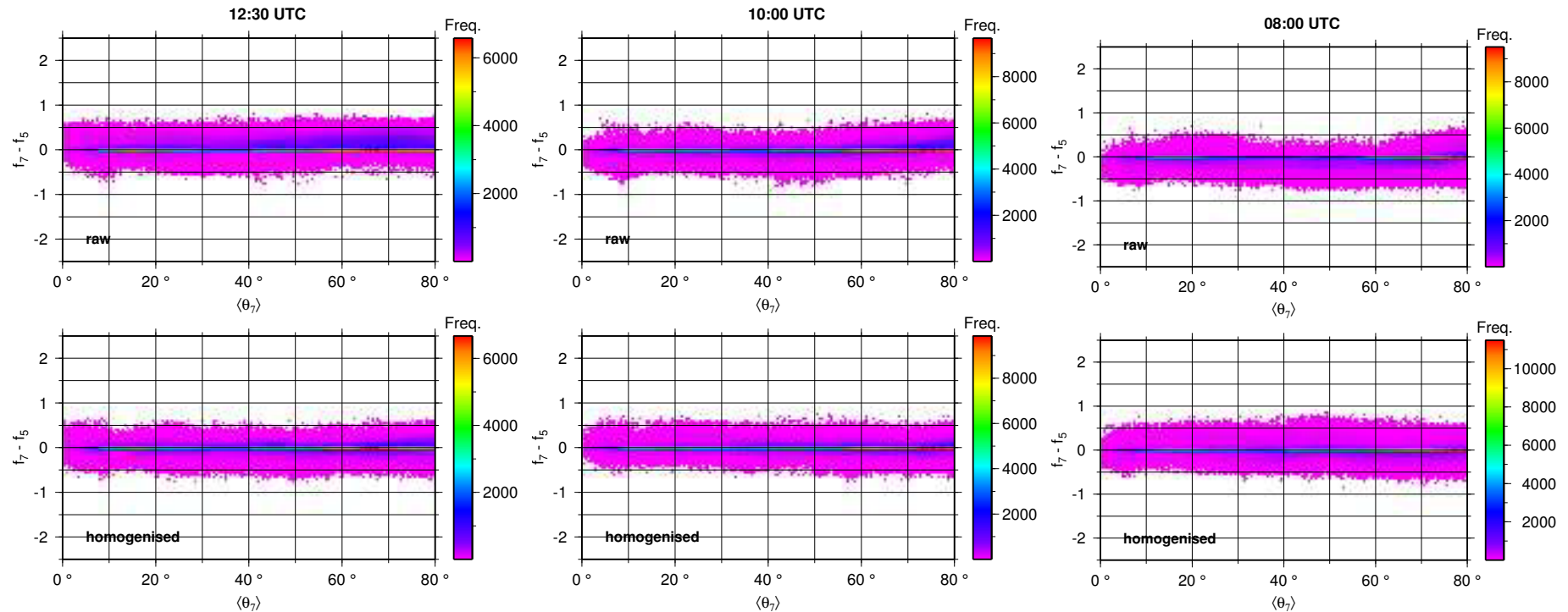
$$\langle \tau \rangle = \langle \tau_7 \rangle \cdot 10^{-\mathcal{P}_3(\langle \theta_7 \rangle)}.$$

Similar results hold when choosing MS7 as reference ($60^\circ \leq \langle \theta_7 \rangle \leq 70^\circ$).

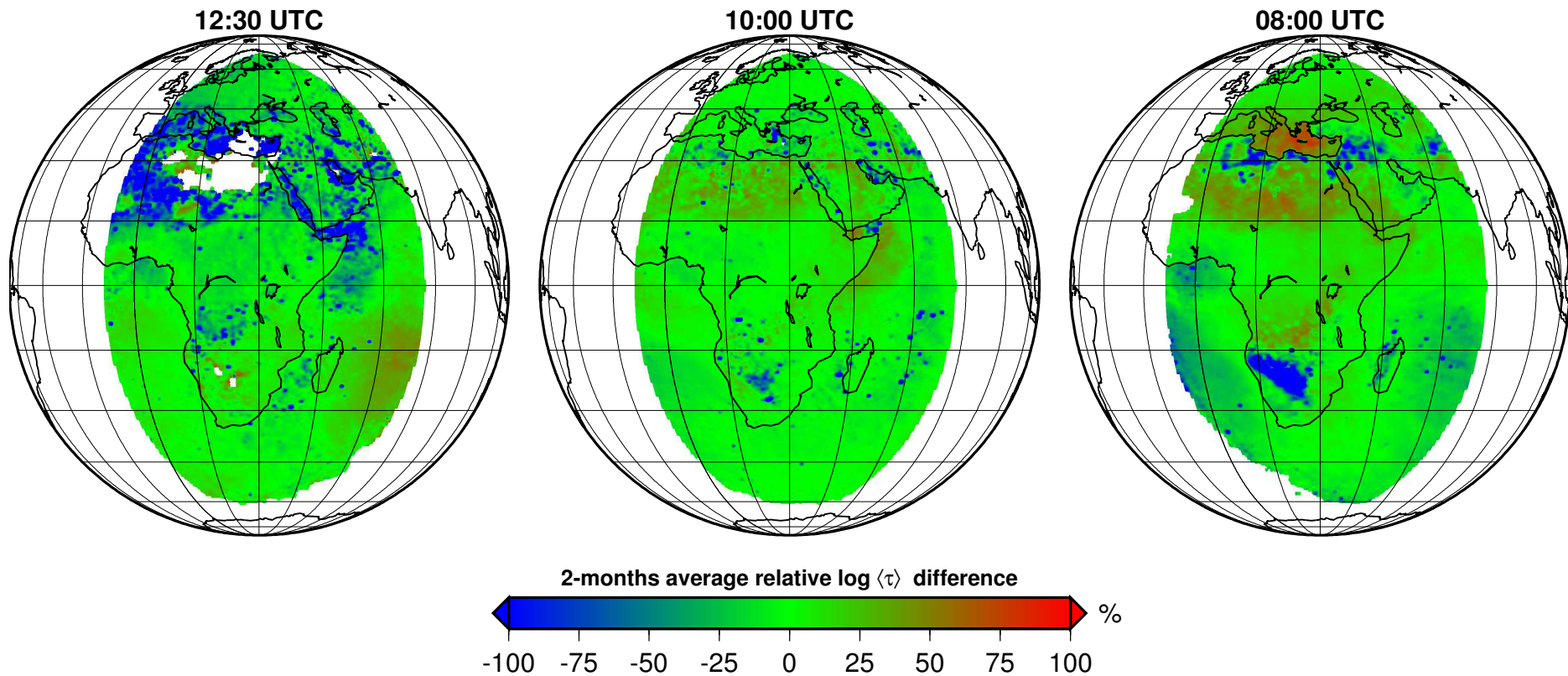
8. Validation of the Homogenized Retrievals



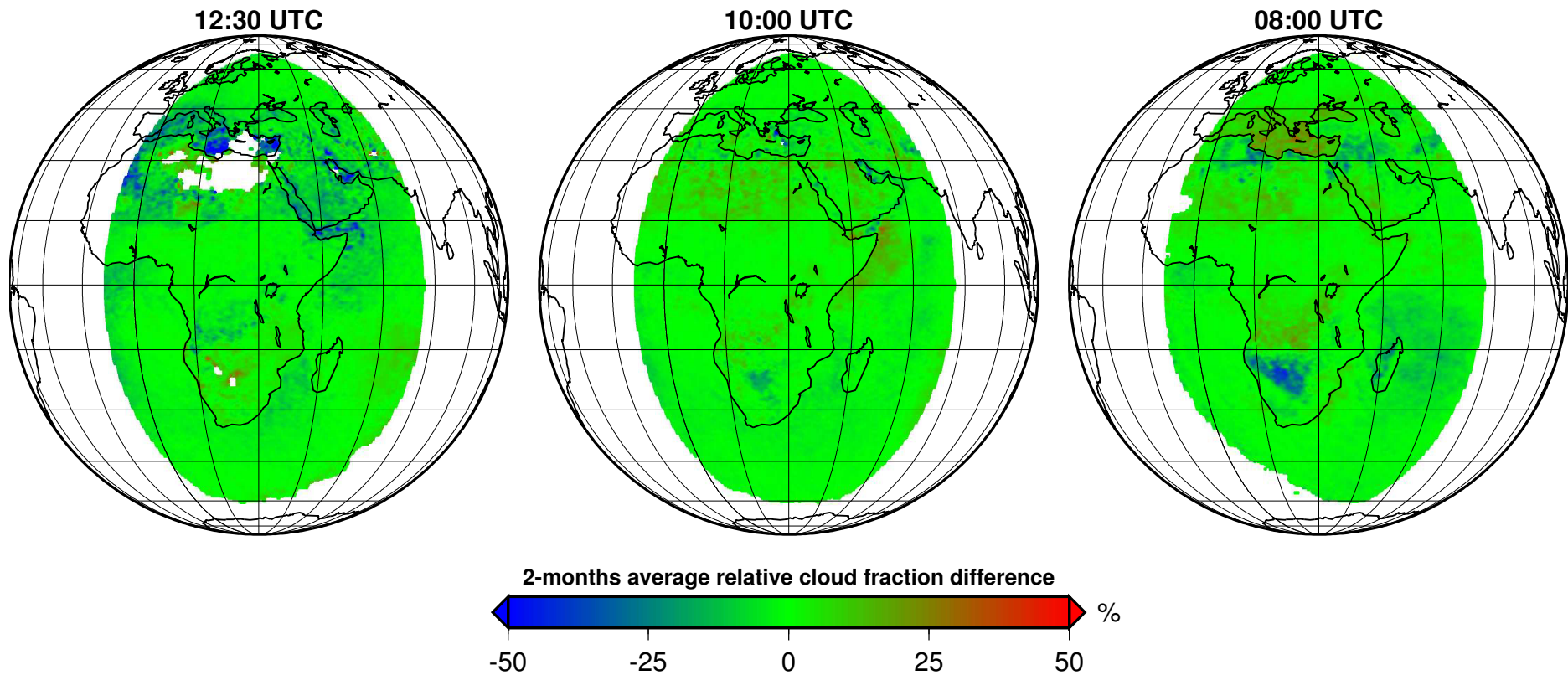
8. Validation of the Homogenized Retrievals



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8. Validation of the Homogenized Retrievals

- τ angular dependency significantly decreased.
- No more over/under-estimation of $\langle \tau_7 \rangle$ compared to $\langle \tau_5 \rangle$, as shown in $f_7 - f_5$ plot.
- Decrease of the scattering in both comparison plots.

Fitting laws	$\log \langle \tau_7 \rangle - \log \langle \tau_5 \rangle$		$f_7 - f_5$	
	hom.	raw	hom.	raw
constant	0.2353	0.3343	0.0958	0.1281
linear	0.2334	0.2707	0.0957	0.1258
quadratic	0.2318	0.2601	0.0955	0.1257
cubic	0.2317	0.2587	0.0954	0.1257

9. Future Works

- Homogenised values are SLOT dependent ($f(\varphi)$):
 - ▷ Need one more corrective step.
 - ▷ Test if φ dependence is decreased with use of non-Lambertian surfaces in RTM.
- Need to understand the source of scattering:
 - ▷ Detection of calibration errors by building thick-cloud radiance fields from MS7 & MS5 images and comparing them.
 - ▷ Use of these experimental $L(\tau = 128)$ to compute mean cloud amount $\implies C$ computed using only measured radiances.
 - ▷ Apply a phase retrieval scheme to cloudy pixels and use the associated SBDART phase thick-cloud radiance to compute C .