

Top-of-Atmosphere Radiative flux from MSG

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Outline

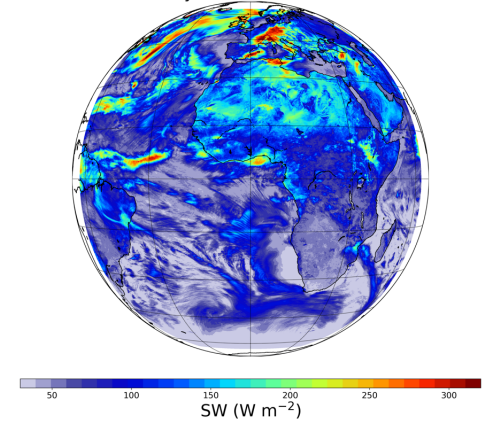
1. Project Introduction
2. LW/SW approaches
3. Preliminary results
4. Conclusions & Outlook

CM SAF project : *Cloud property dAtAset using SEVIRI*

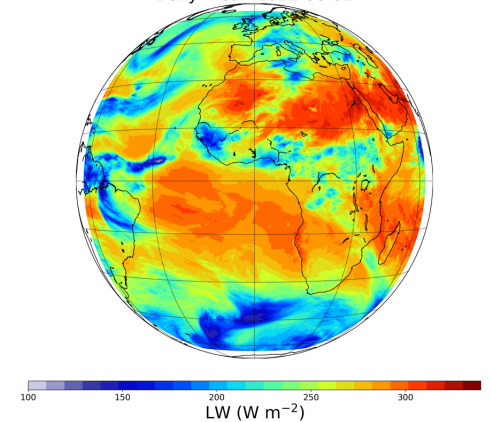
Previous dataset : MVIRI/SEVIRI (Urbain et al., 2015) & SEVIRI/GERB (Clerbaux et al., 2015)

Parameters	SW/LW TOA all and clear-sky
Sensor & Coverage	SEVIRI / Meteosat disk (60°N-60°S; 60°W-60°E)
Spatial resolution	0.05°
Temporal resolution	Monthly mean diurnal cycle, daily and monthly
Period	2005 - 2022

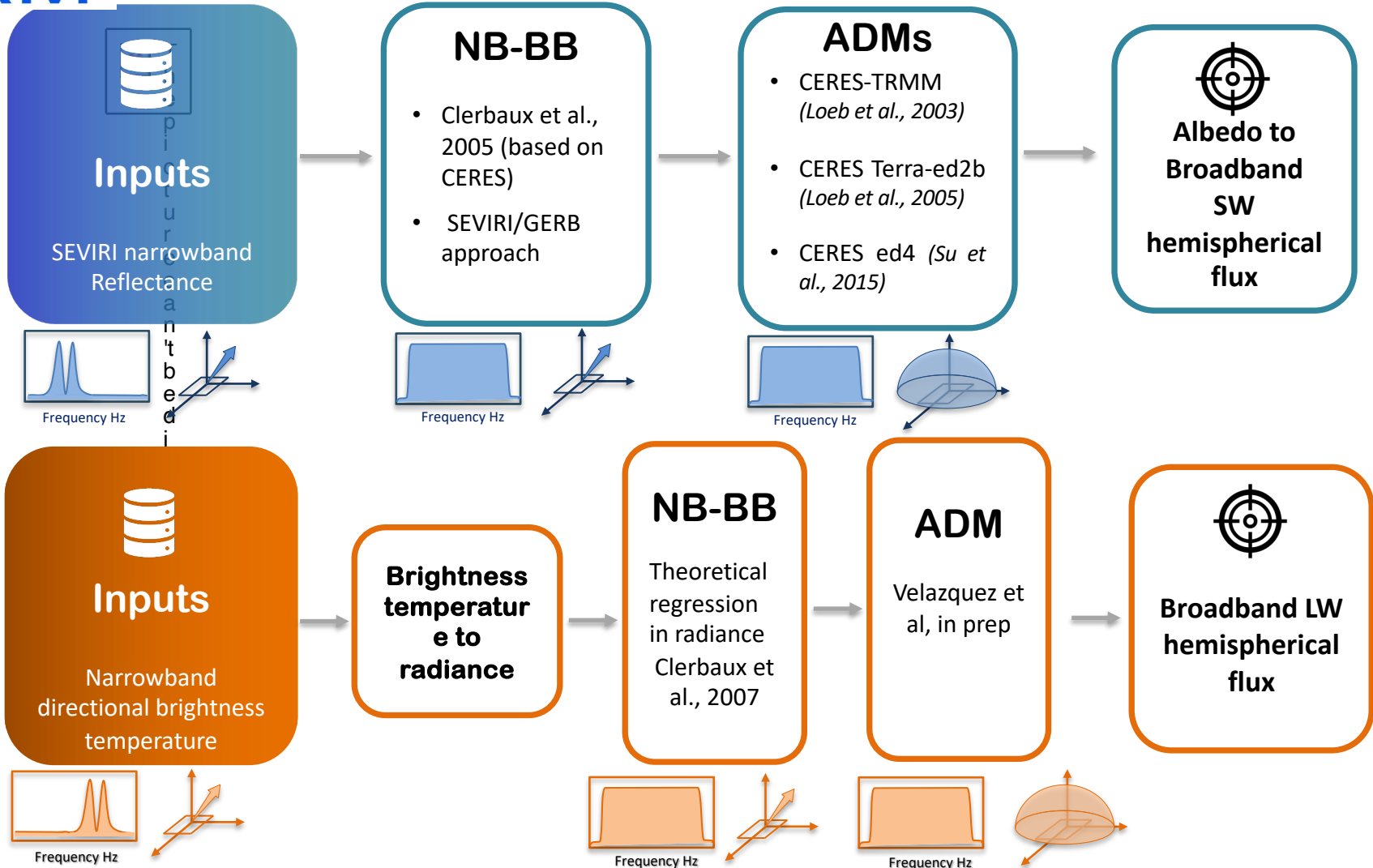
Daily mean 2011-06-01



Daily mean 2011-06-01

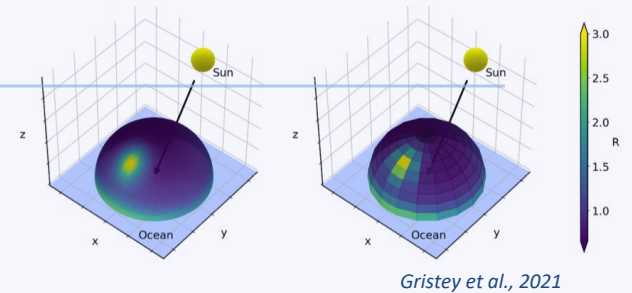


Preliminary processing chain



CERES-TRMM (Tropical Rainfall Measuring Mission)

- 38°S-38°N with a resolution of ~10km
- Up to 592 scene types (from VIRS measurements)
- Discrete angular bins :
 - ☛ θ_0 : 9 angular bins (0° to 90° in 10° steps)
 - ☛ ϕ : 10 angular bins (0° to 180° in 10° or 20° steps)
 - ☛ Full range θ_0 of acquired every 46 days.
- Samples each grid box at all local time of days over a 46 days period



CERES-Terra (Ed2b)

- 2 years of RAPS data from Terra satellite.
- 20km resolution / scene identification via MODIS.
- More scene types and Increase in angular bin resolution :
 - ☛ e.g., 2° in solar zenith, viewing zenith, and relative azimuth angles for cloud-free ocean scenes.
- Add mid-latitude and polar observations.

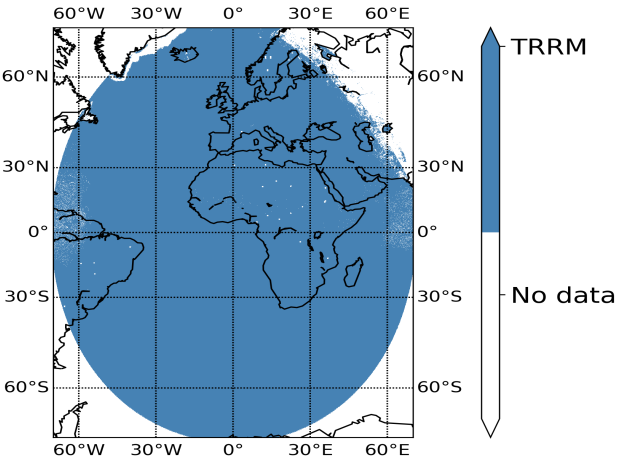
BUT over land :

- Does not provide observation of the angular radiation fields over the full range of θ_0 .
 - ☛ We can't use it due to the limited θ_0 range for each grid-box.

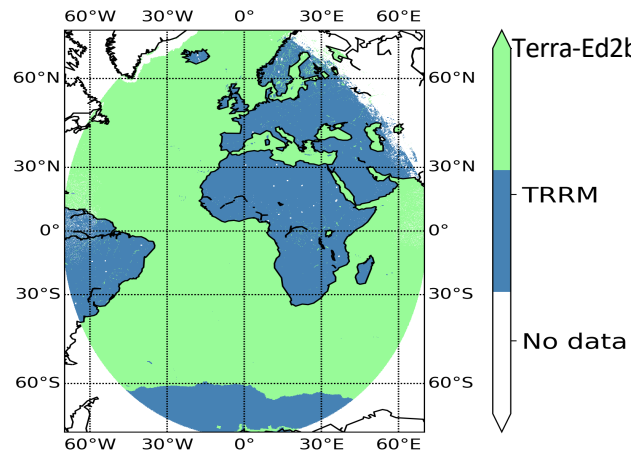
CERES-Terra (Edition 4; v2013-11-30)

- 5 years of RAPS data from the Terra satellite.
- Segregated by :
 - ☛ AOD in glint regions (3 classes).
 - ☛ Both AOD (3 classes) and two aerosol types (rural and urban) in non-glint regions.
- Same method than CERES-Terra Ed2b to develop the ADM cloudy ocean.

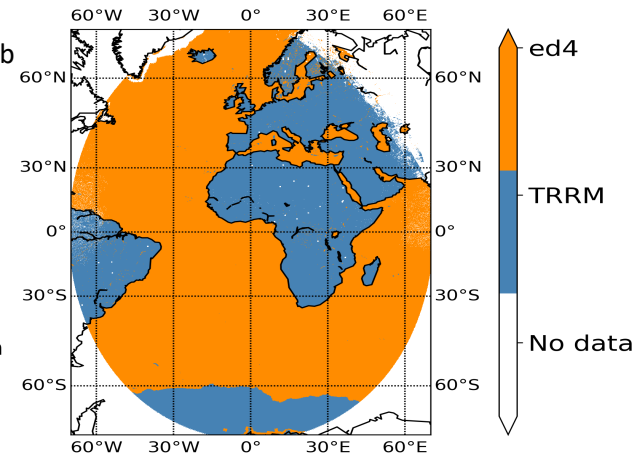
CERES TRMM
(Loeb et al., 2003)



CERES ed2b / Terra
(Loeb et al., 2005)
TRRM for SZA < 20° & Ed4 for Cloudy



CERES ed4
(Su et al., 2015)



➡ Ed2b : Good opportunity to test the impact of AOD inputs from MERRA-2

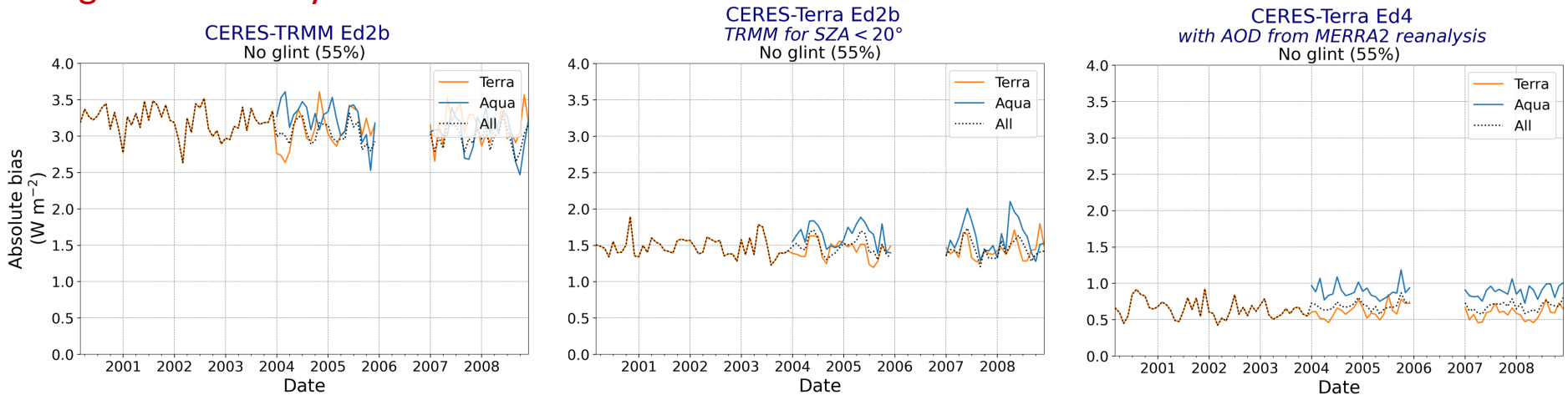
Comparisons with CERES SSF TOA flux

CERES SSF SW TOA flux (Ed4.1)

vs.

TOA flux by applying local ADM implementations on radiance

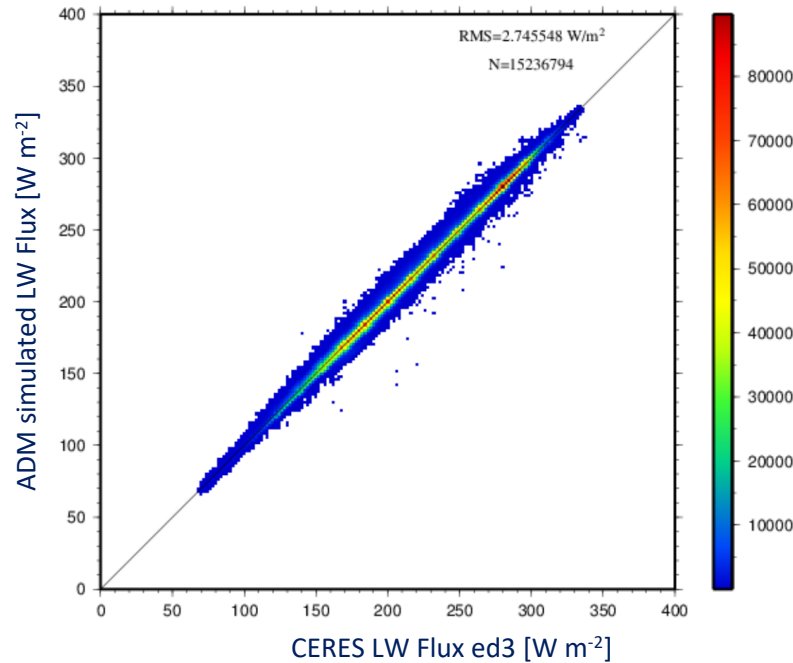
No glint - Clear sky ocean



- Better result with Ed4 while using MERRA-2.
- Higher MAD with Aqua:
 - Not the last ADM version.
- MAD of 0 if the similar AOD case than Ed4 is used (no MERRA-2 anymore).

Night cases

Needed MODIS PSF weighted
BT only available during night



Polynomial fit

- Database : LibRadtran 1.4 and SBDART radiative transfer models

$$R(\theta) = a_0 + a_1 z_1 + a_2 z_2 + a_3 z_1^2 + a_4 z_1 z_2 + a_5 z_2^2$$

- $z_1 = T_b(10.8\mu\text{m})$ and $z_2 = T_b(12\mu\text{m}) - T_b(10.8\mu\text{m})$

- Bins :

- 5° VZA

- 25 \rightarrow 135 $\text{W m}^{-2}\text{sr}^{-1}$; 5 $\text{W m}^{-2}\text{sr}^{-1}$ step

Validation Strategy

Characterize the products in terms of accuracy, precision and stability.
1 month of test data -> June 2011

Today

01

Comparisons of CDR outputs with CERES reference dataset :

- **CERES SYN Ed4.1** (various SW ADMs)
- CERES EBAF Ed4.2

02

Comparisons with other CDRs (CDOP2) :

- SEVIRI/GERB
- MVIRI/SEVIRI

03

Specific analysis of the stability :

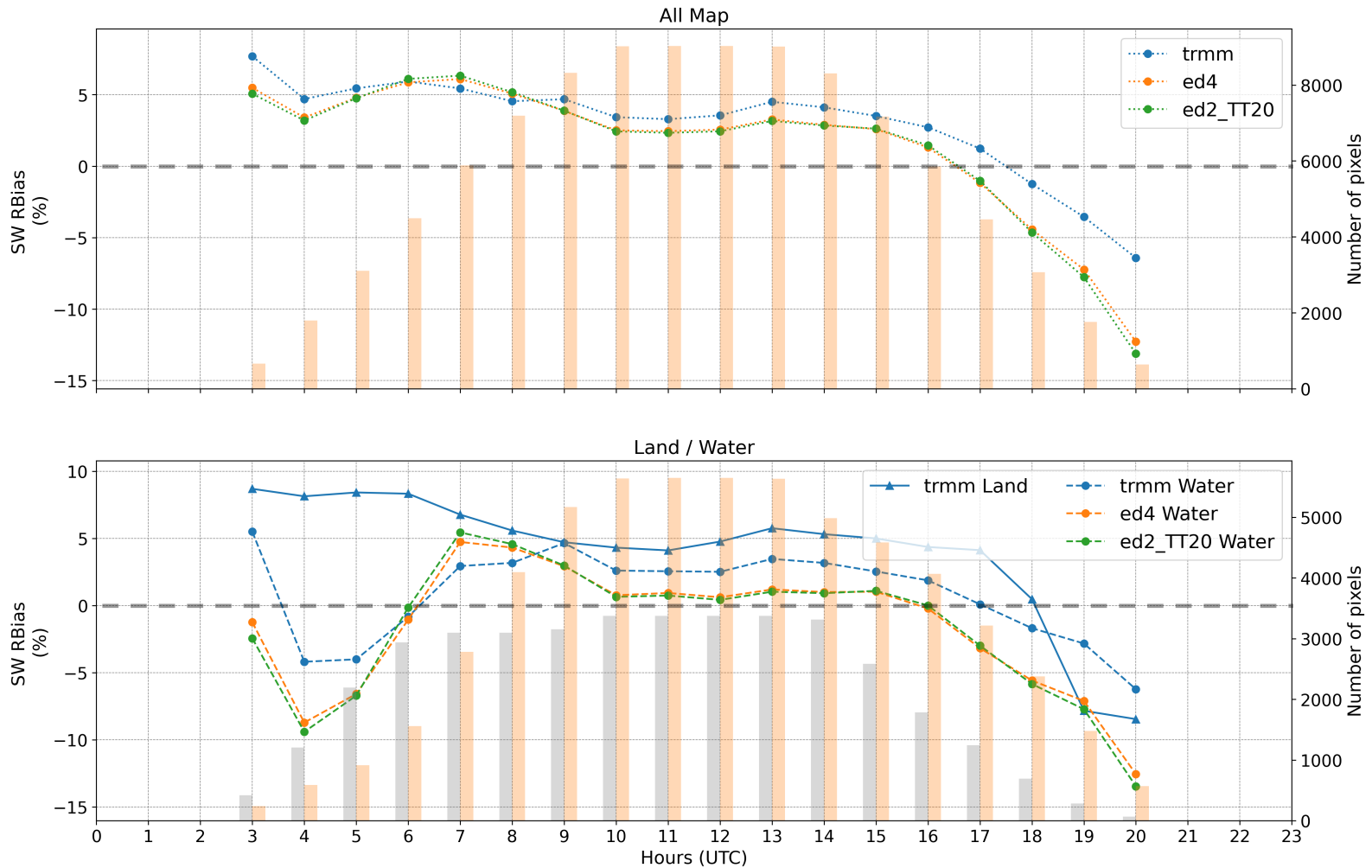
- Monthly mean deseasonal bias



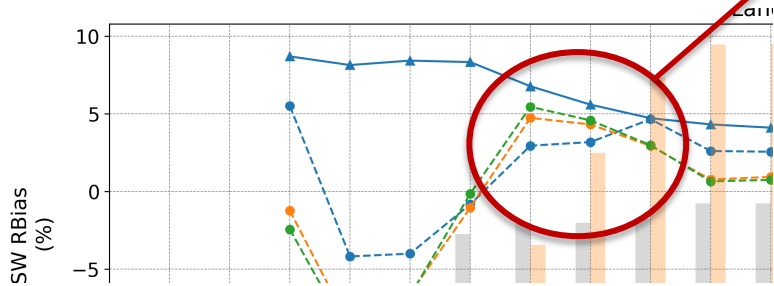
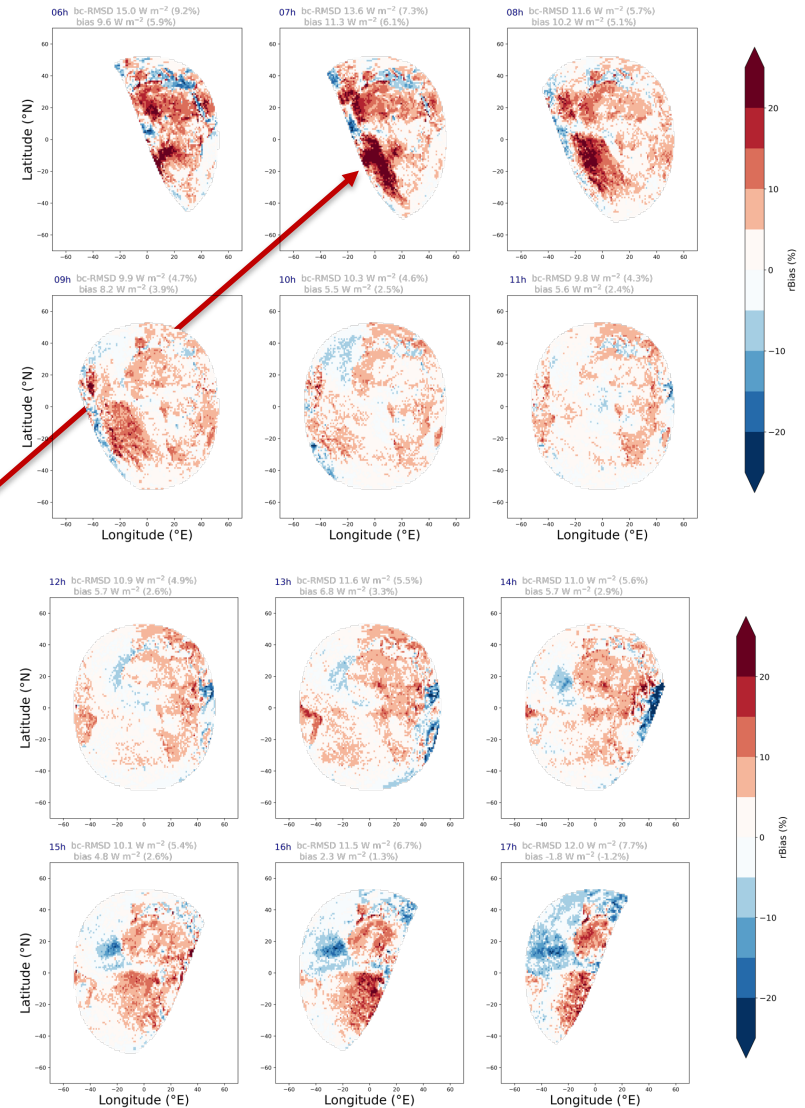
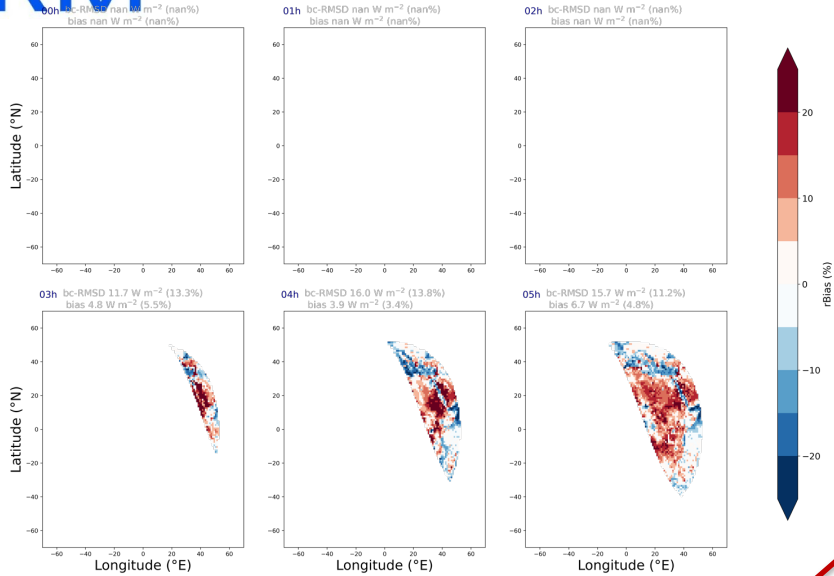
Short-wave flux

Monthly mean diurnal cycle (FOV < 60° SZA < 84°)
Monthly mean (from daily mean with minimum 27 days)

SW_{CERES SYN} relative bias

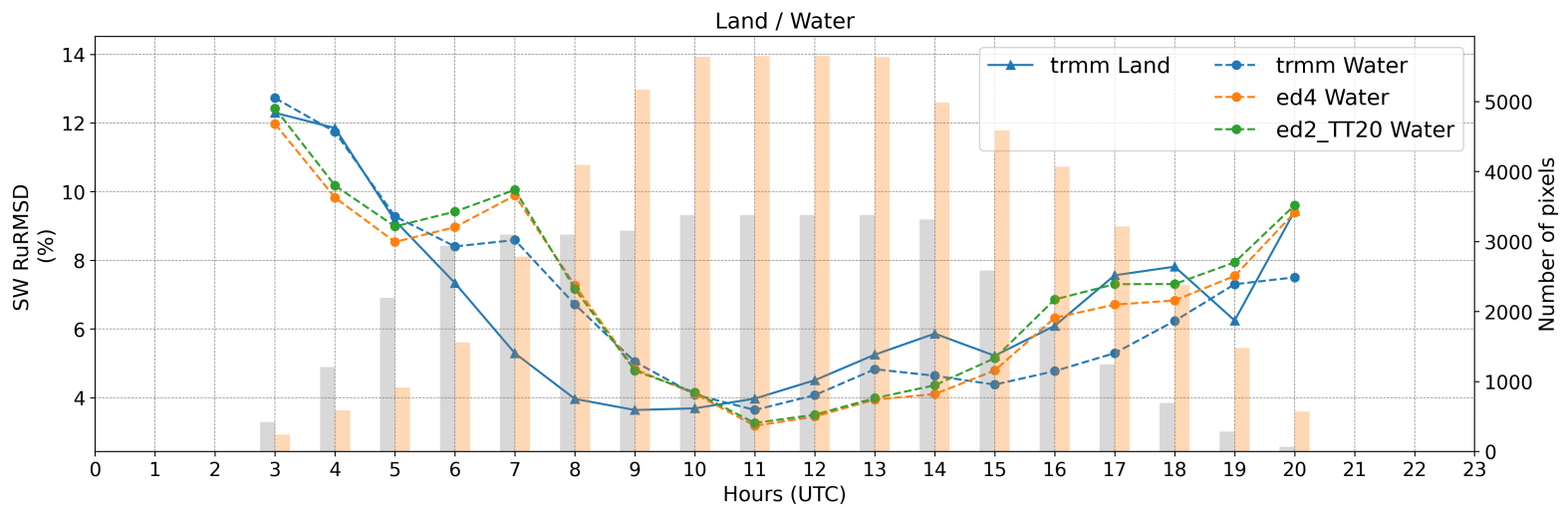
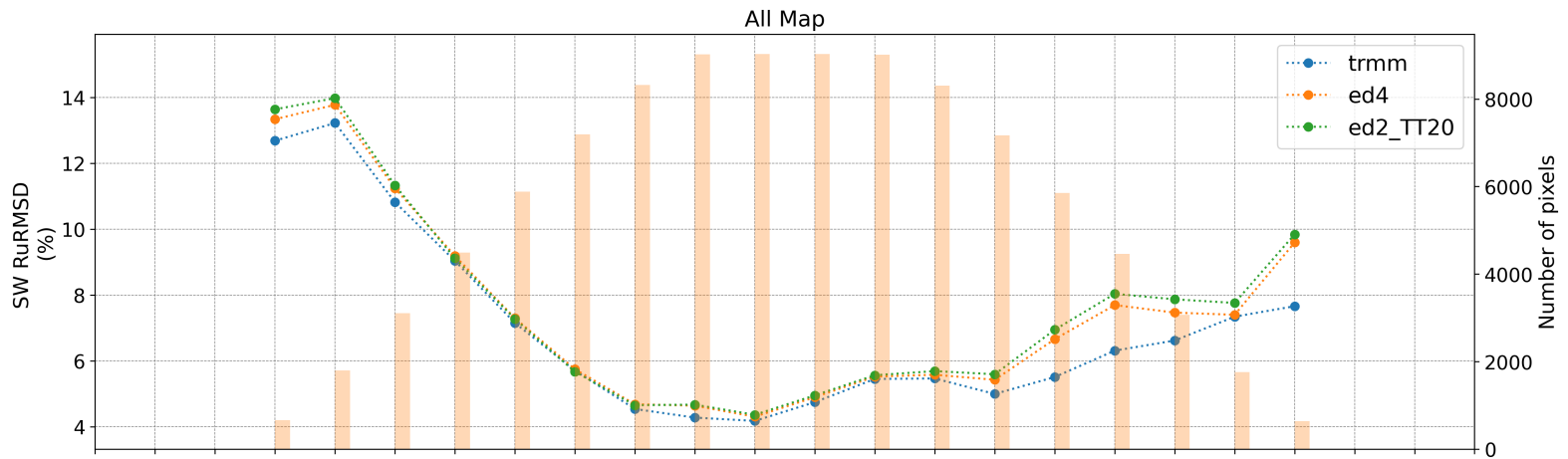


SW CERES SYN relative bias



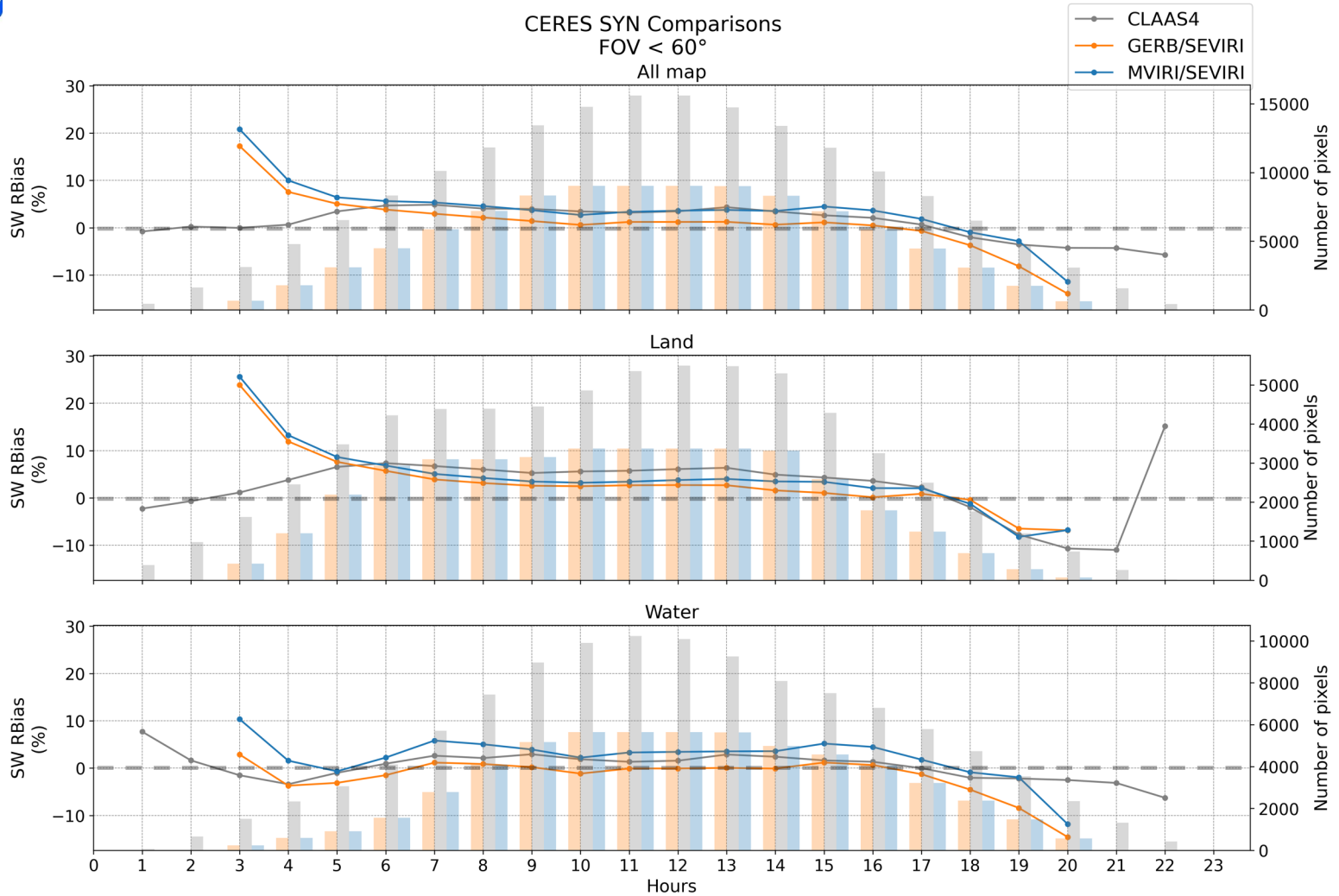
Hypothesis :

SEVIRI underestimates the impact of absorbing aerosols over SEA persistent mid-level clouds and so induces an overestimation.

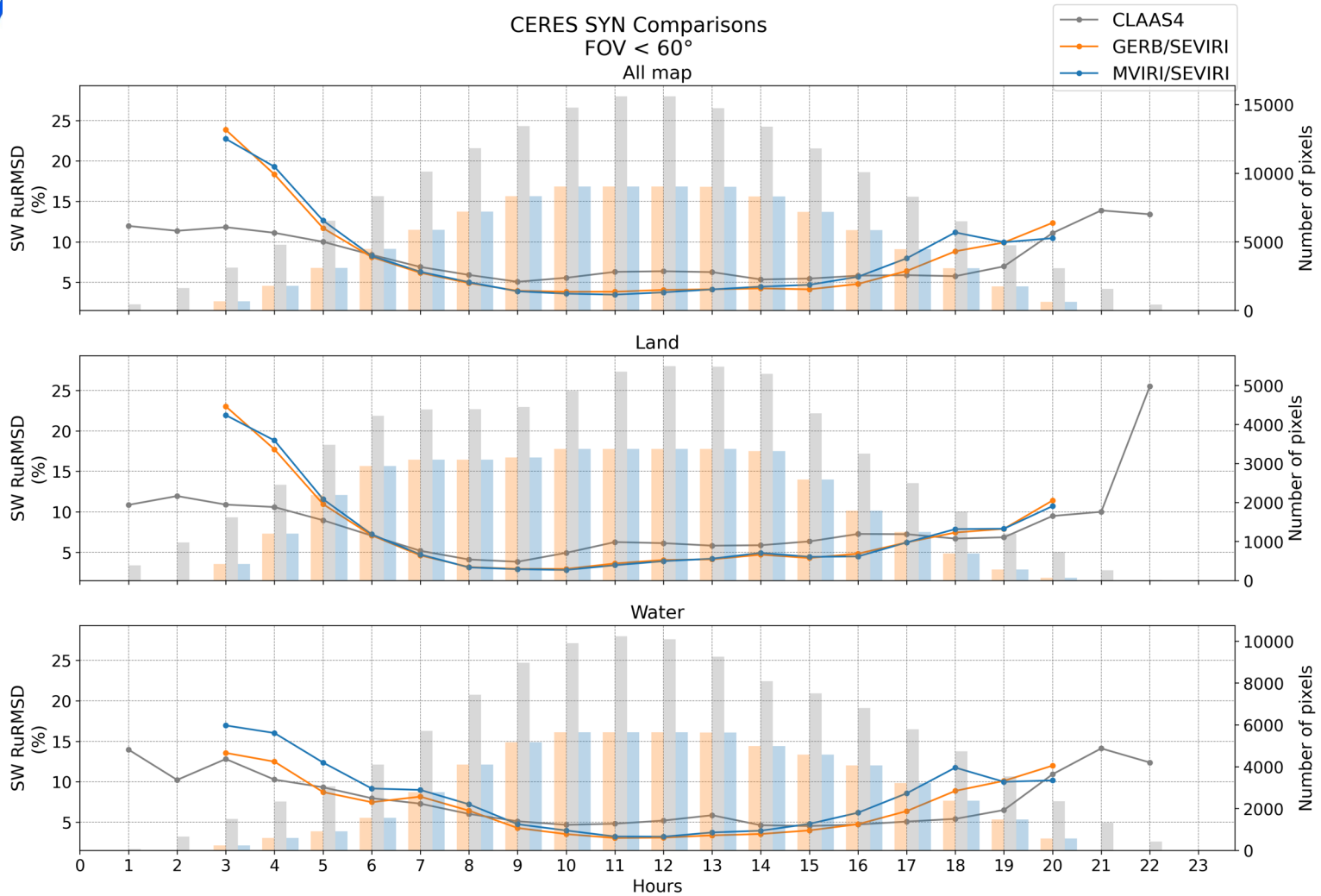




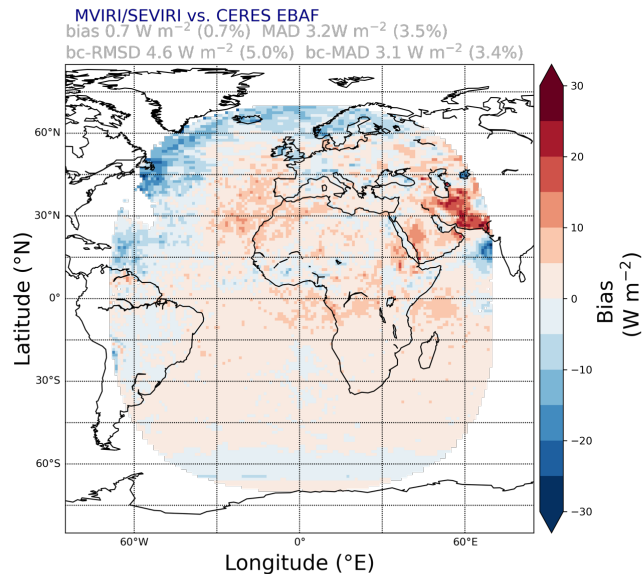
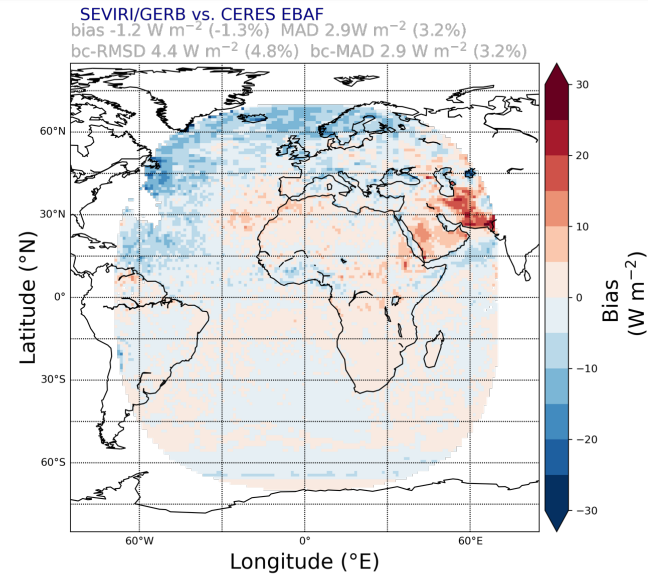
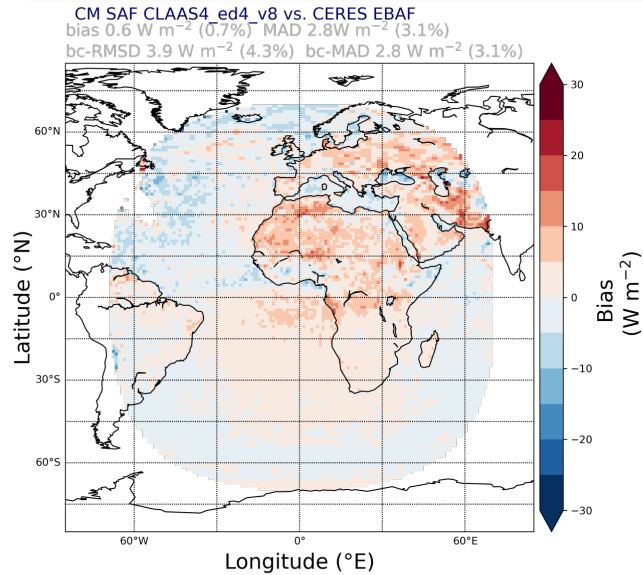
SW_{CERES SYN} vs. CDRs



SW_{CERES SYN} vs. CDRs



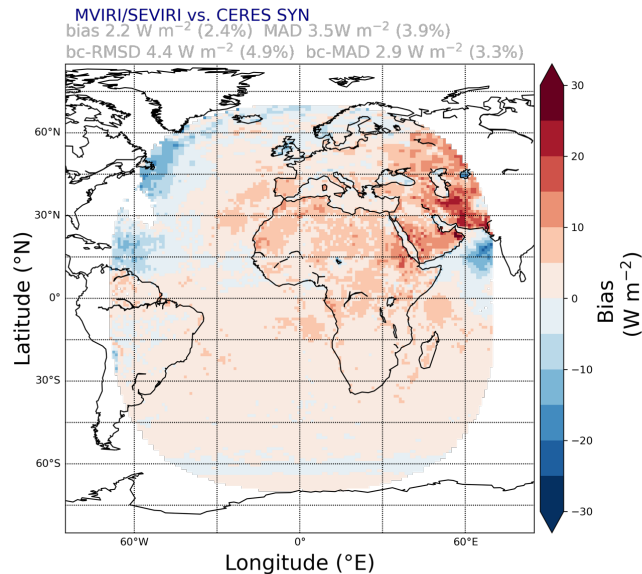
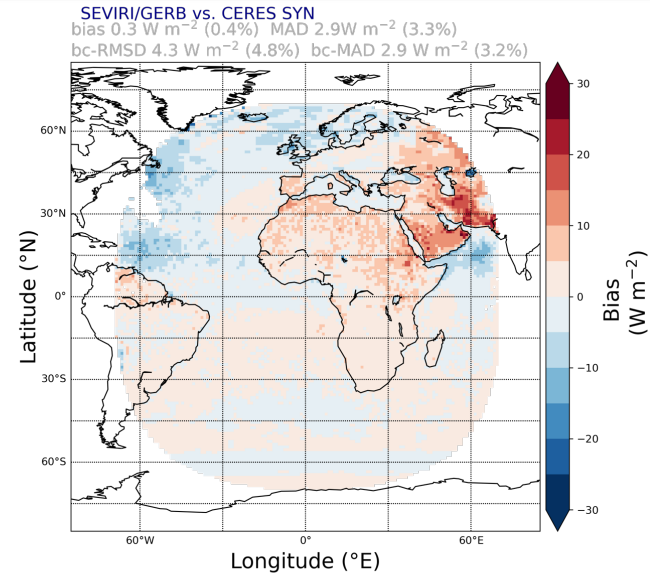
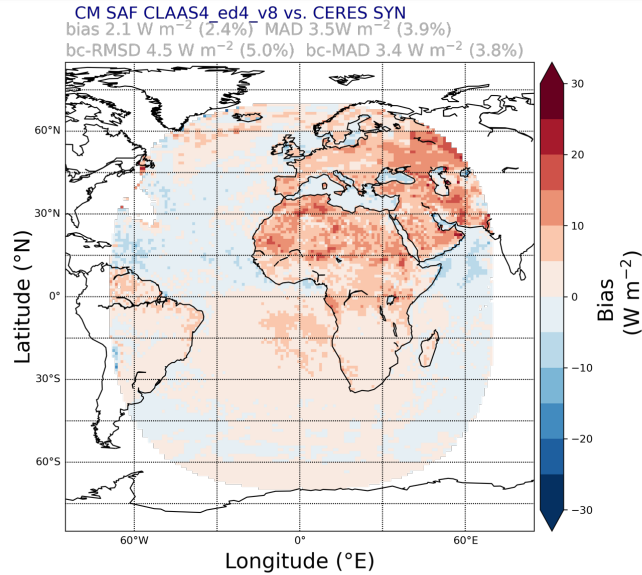
Monthly bias with SW_{CERES-EBAF}



CLAAS4

- Improvement as compared to previous CM SAF versions at the border of the disk.
- Overestimation over land
 - Need to improve the NB to BB relation ?

Monthly bias with SW_{CERES-SYN}

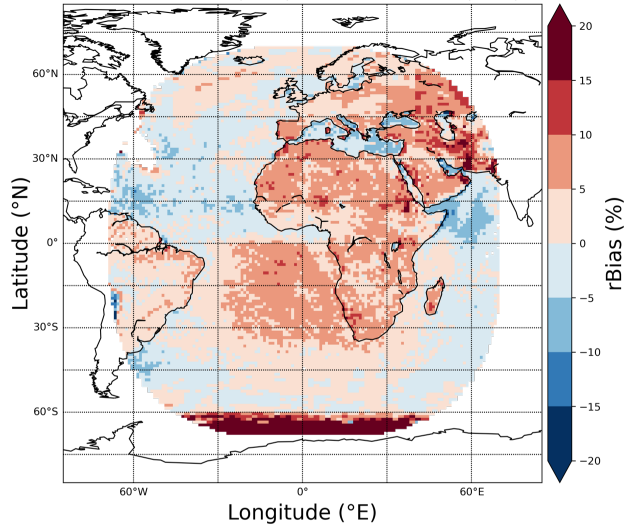


CLAAS4

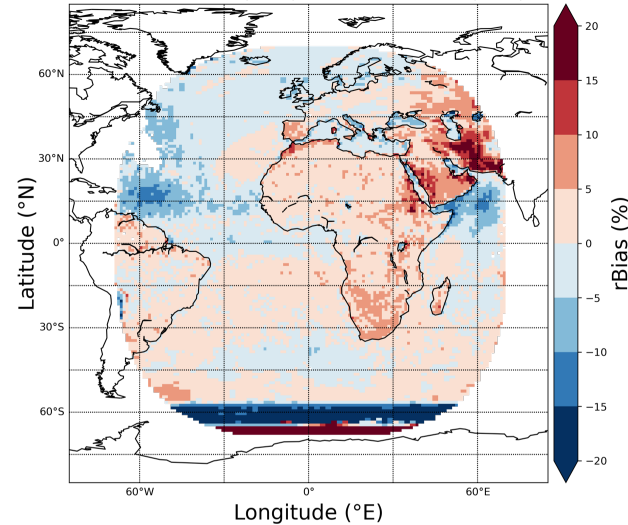
- Same conclusions than for EBAF
- Larger overestimation as compared to CERES_{EBAF}

Monthly rBias with SW_{CERES-SYN}

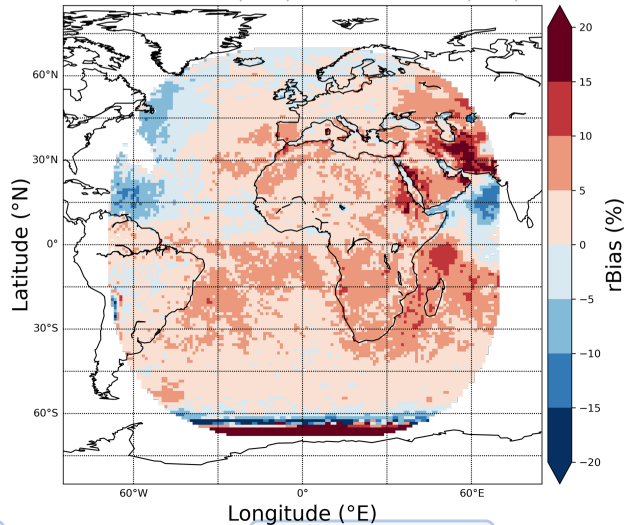
CM SAF CLAAS4_ed4_v8 vs. CERES SYN
 bias 2.1 W m⁻² (2.4%) MAD 3.5W m⁻² (3.9%)
 bc-RMSD 4.5 W m⁻² (5.0%) bc-MAD 3.4 W m⁻² (3.8%)



SEVIRI/GERB vs. CERES SYN
 bias 0.3 W m⁻² (0.4%) MAD 2.9W m⁻² (3.3%)
 bc-RMSD 4.3 W m⁻² (4.8%) bc-MAD 2.9 W m⁻² (3.2%)



MVIRI/SEVIRI vs. CERES SYN
 bias 2.2 W m⁻² (2.4%) MAD 3.5W m⁻² (3.9%)
 bc-RMSD 4.4 W m⁻² (4.9%) bc-MAD 2.9 W m⁻² (3.3%)

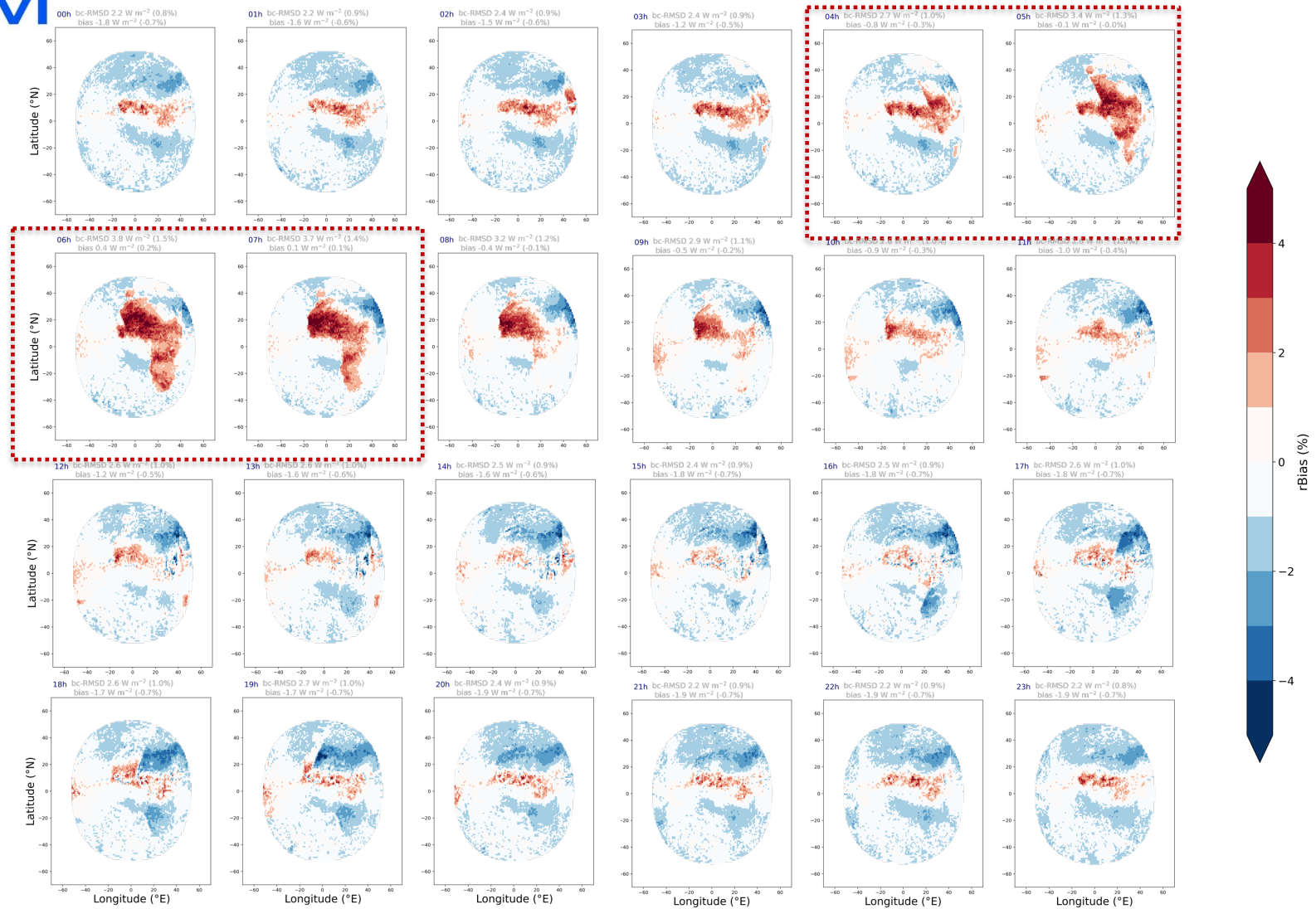




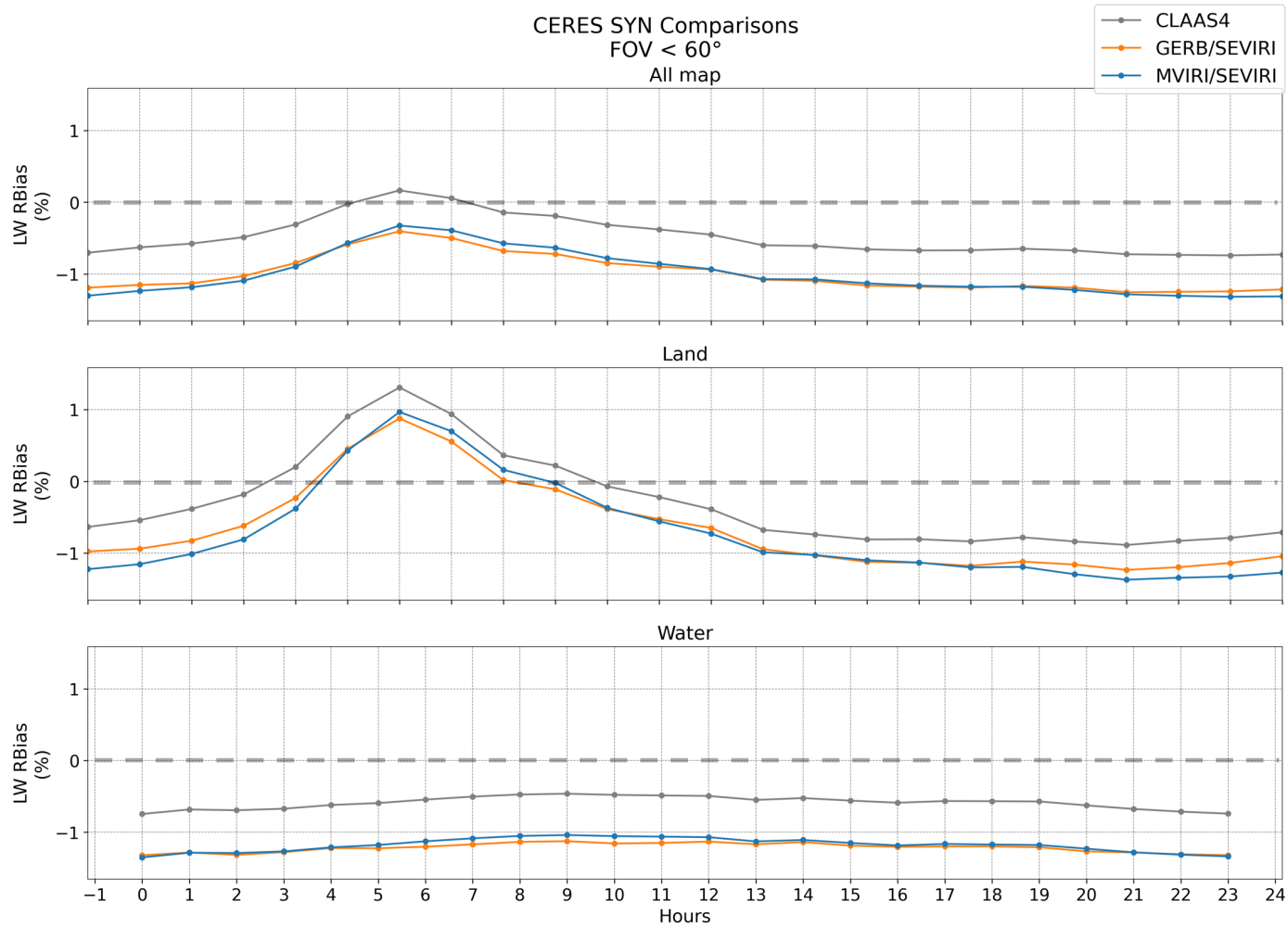
Long-wave flux

Monthly mean diurnal cycle

Monthly mean

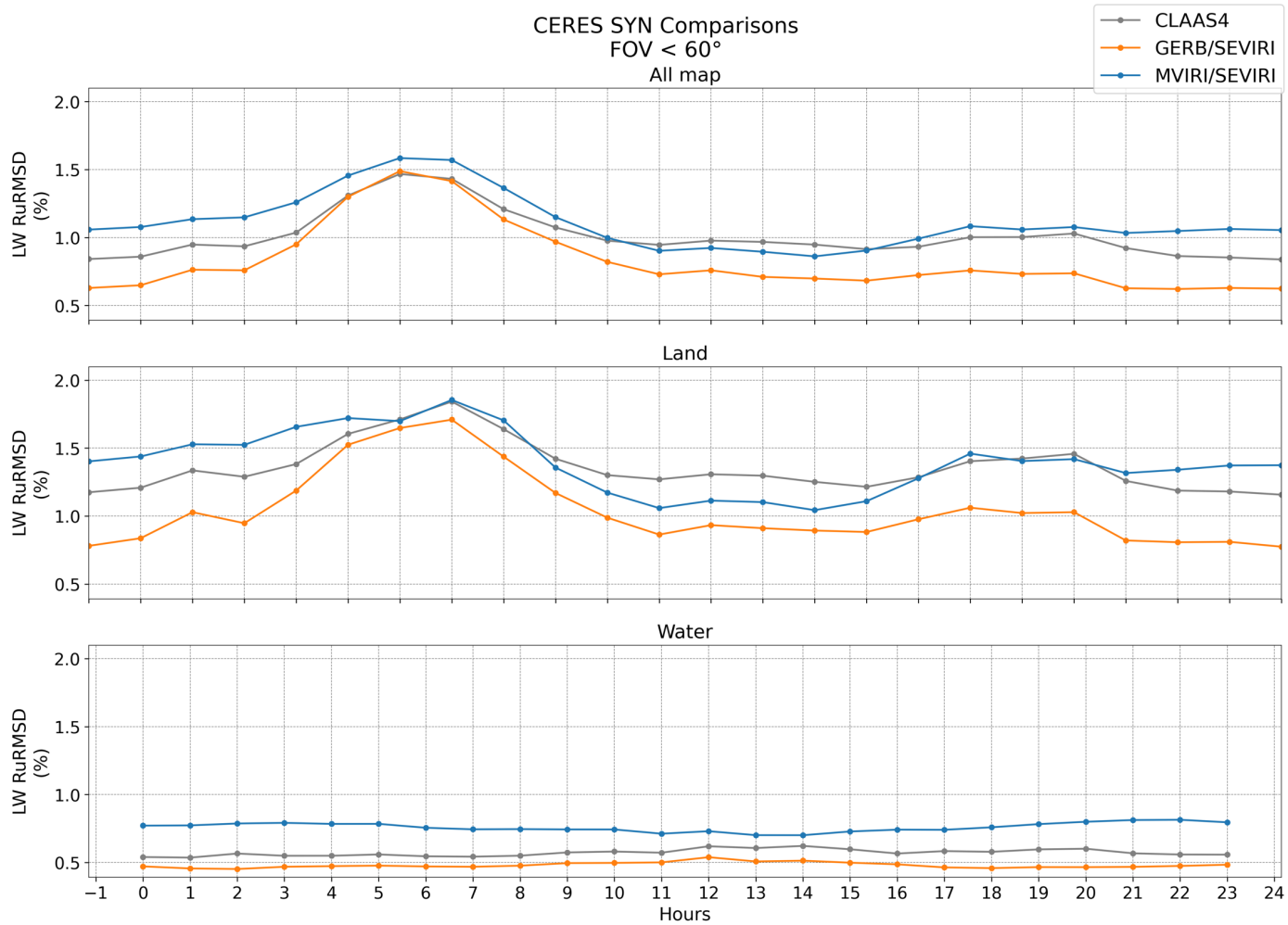


LW_{CERES SYN} vs. CDRs



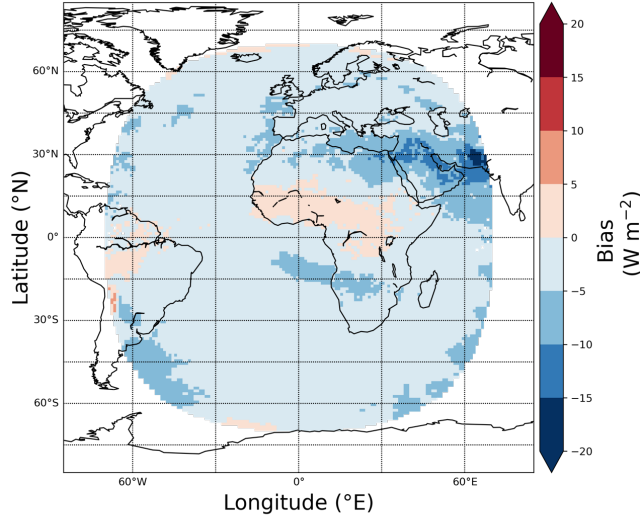


LW CERES SYN vs. CDRs

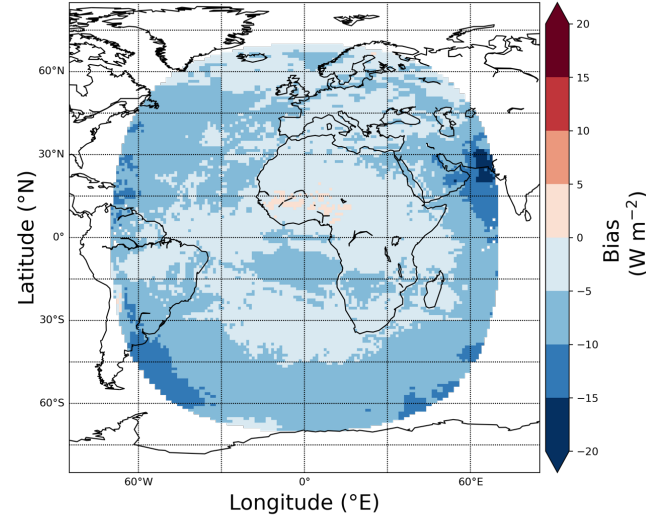


Monthly bias with LW_{CERES-EBAF}

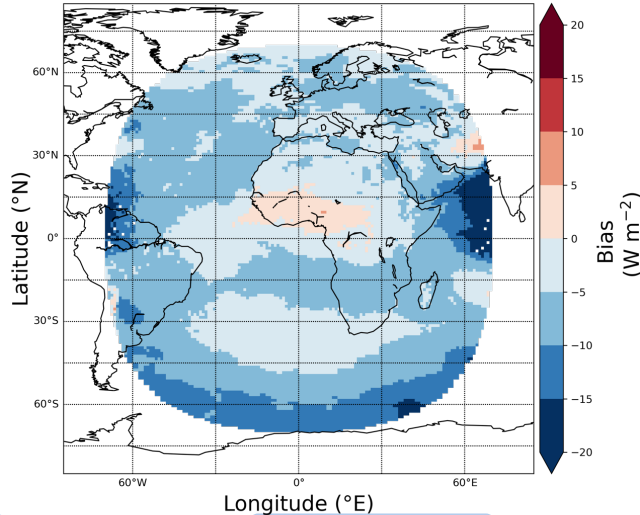
CM SAF CLAAS4 ed4_v8vs. CERES EBAF
 bias -3.4 W m^{-2} (-1.4%) MAD 3.6 W m^{-2} (1.4%)
 bc-RMSD 2.2 W m^{-2} (0.9%) bc-MAD 1.5 W m^{-2} (0.6%)



SEVIRI/GERB vs. CERES EBAF
 bias -5.6 W m^{-2} (-2.2%) MAD 5.6 W m^{-2} (2.2%)
 bc-RMSD 2.4 W m^{-2} (1.0%) bc-MAD 1.8 W m^{-2} (0.7%)



MVIRI/SEVIRI vs. CERES EBAF
 bias -6.1 W m^{-2} (-2.4%) MAD 6.2 W m^{-2} (2.5%)
 bc-RMSD 3.7 W m^{-2} (1.5%) bc-MAD 2.6 W m^{-2} (1.1%)

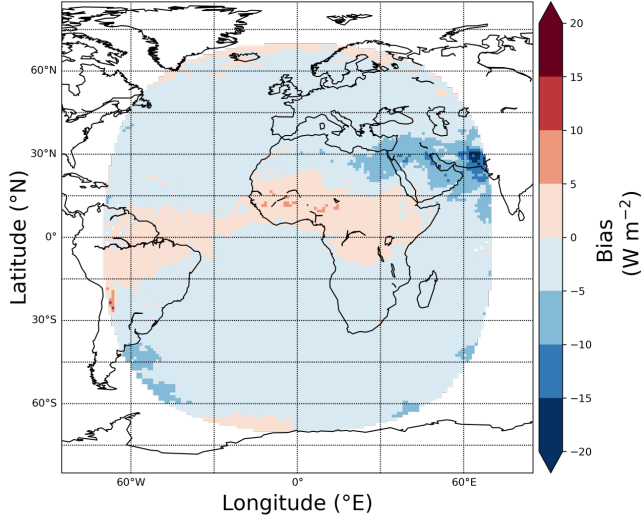


CLAAS4

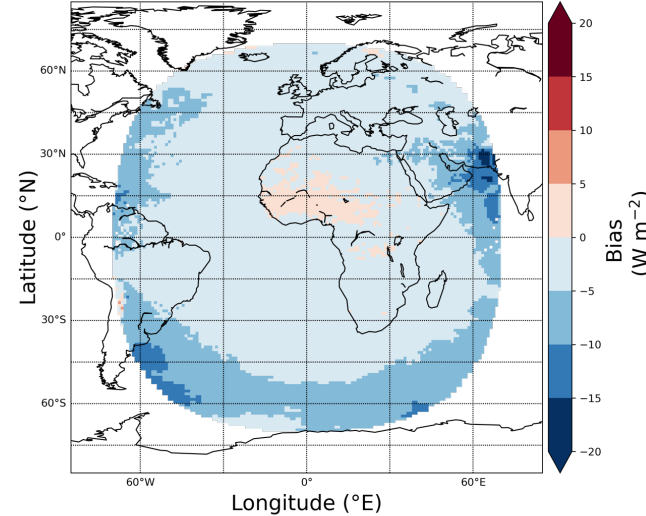
- Global Underestimation
 - Lower impact of the VZA
- Improvement as compared to previous CM SAF versions over water*

Monthly bias with LW_{CERES-SYN}

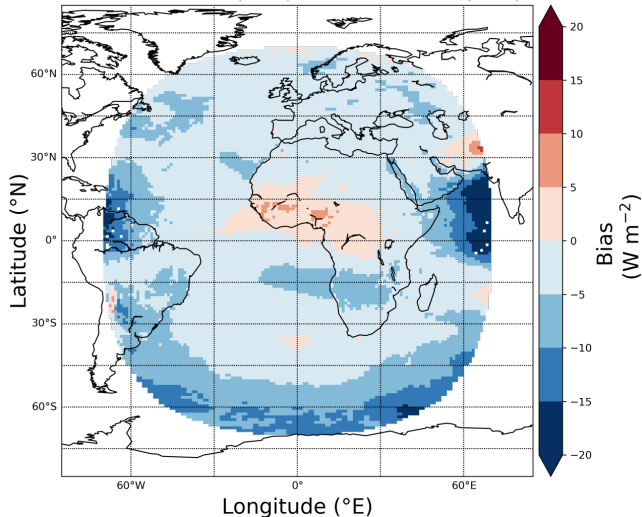
CM SAF CLAAS4_ed4_v8vs. CERES SYN
 bias -1.7 W m^{-2} (-0.7%) MAD 2.2 W m^{-2} (0.9%)
 bc-RMSD 2.2 W m^{-2} (0.9%) bc-MAD 1.5 W m^{-2} (0.6%)



SEVIRI/GERB vs. CERES SYN
 bias -3.9 W m^{-2} (-1.6%) MAD 4.0 W m^{-2} (1.6%)
 bc-RMSD 2.5 W m^{-2} (1.0%) bc-MAD 1.8 W m^{-2} (0.7%)



MVIRI/SEVIRI vs. CERES SYN
 bias -4.4 W m^{-2} (-1.8%) MAD 4.7 W m^{-2} (1.9%)
 bc-RMSD 3.8 W m^{-2} (1.5%) bc-MAD 2.7 W m^{-2} (1.1%)



CLAAS4

- Same trend than comparison with CERES_{EBAF}
- Lower global bias

Conclusions

- Good agreements with CERES data :
 - ☛ Monthly Bias of -1.7 W m^{-2} (LW) and 2.1 (SW) with CERES SYN.
 - ☛ Overestimation over land for the SW.
- Improvement as compared to previous CDR for the LW.
 - ☛ Better bias and no clear impact of the VZA anymore.

Future tasks

- Test with 2 years of data.
- New NB to BB relation will be tested.
- Test CERES-LW ADM
- Test for the CS with a time windows of 61 days.

An aerial photograph of a university campus. The image shows a mix of modern and traditional architecture. In the foreground, there are several large green lawns separated by paved walkways. A prominent building features a large, golden, dome-shaped structure on its roof. Another building has a smaller, similar dome. A large, multi-story brick building with a white dome is visible in the middle ground. The campus is surrounded by dense trees with autumn foliage in shades of green, yellow, and orange. In the background, a residential neighborhood with multi-story apartment buildings is visible. The text "Thank you for your attention" is overlaid in white, sans-serif font in the upper-middle part of the image.

Thank you for your attention