IRM

Royal Meteorological Institute

Top-of-Atmosphere Radiative flux from MSG

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EUMETSAT CM SAF CLIMATE MONITORING

Outline

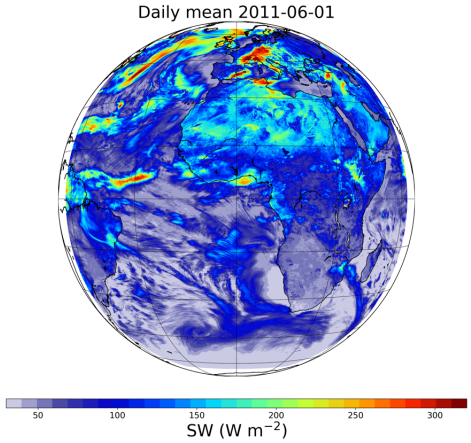
1. Project Introduction
2. LW/SW approaches
3. Preliminary results
4. Conclusions & Outlook

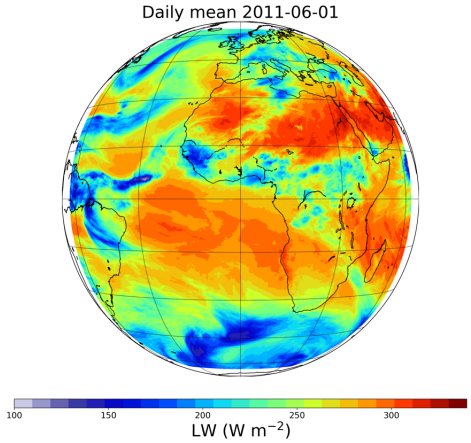
CLAAS-4 TOA project

CM SAF project : *Cloud property dAtAset using SEVIRI*

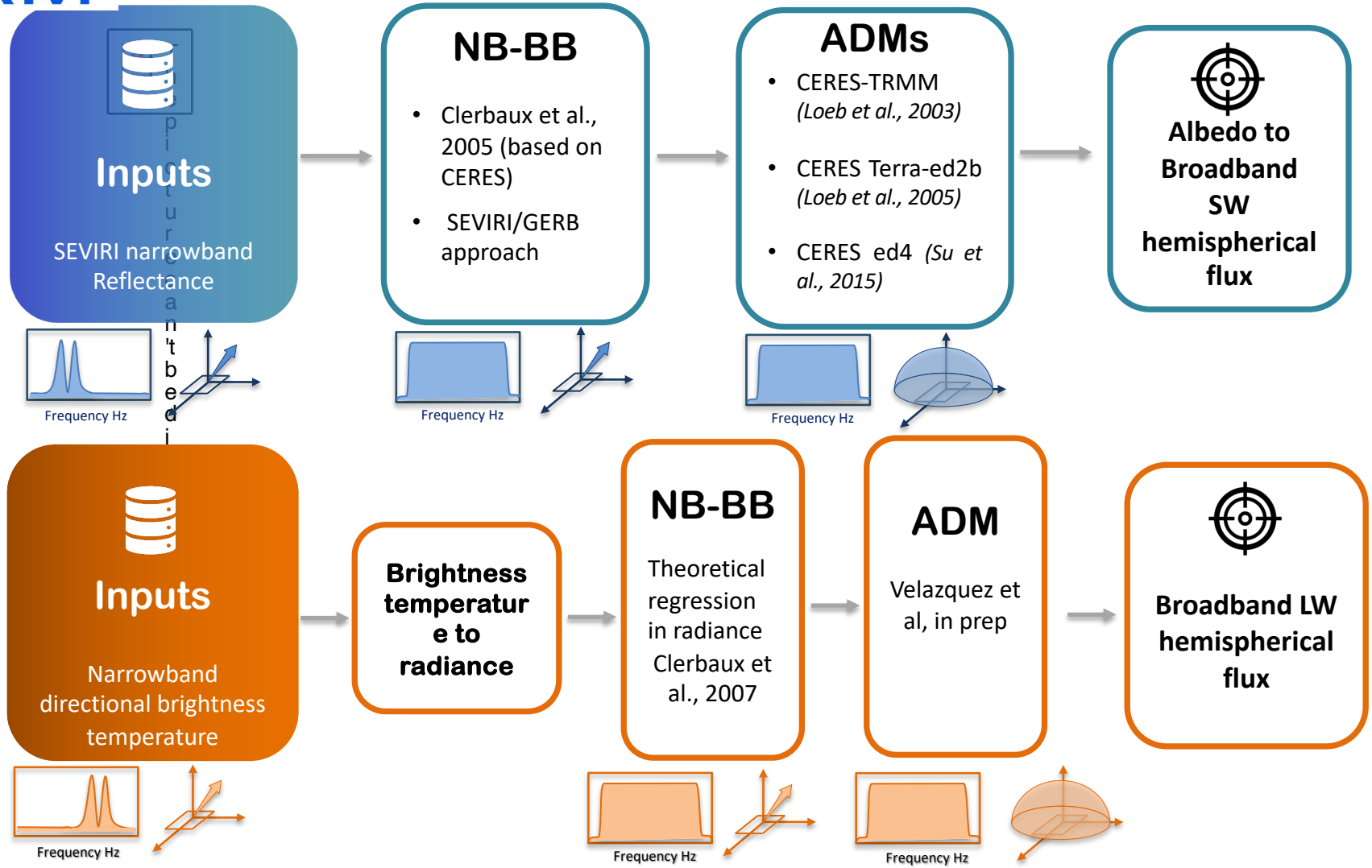
Previous dataset : MVIRI/SEVIRI (Urbain et al., 2015) & SEVIRI/GERB (Clerbaux et al., 2015)

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





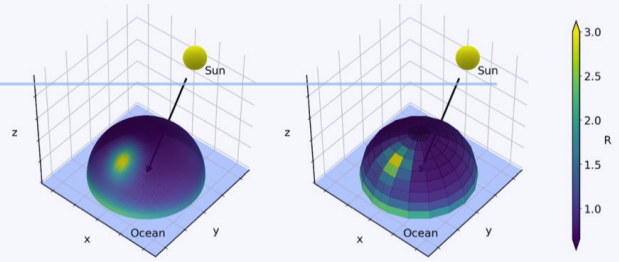
Preliminary processing chain



SW ADMs

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**



Gristey et al., 2021

SW ADMs

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 :

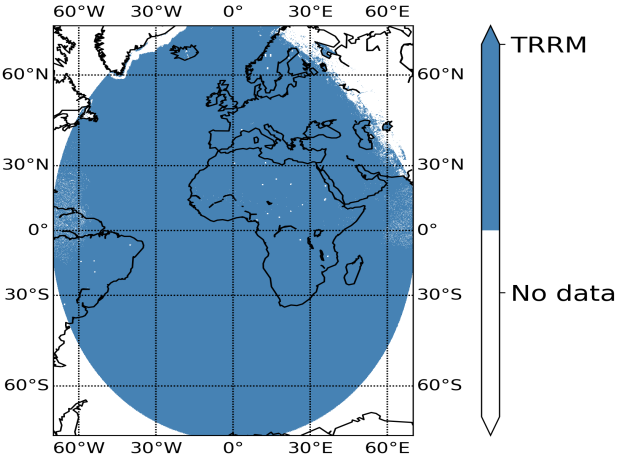
- Does not provide observation of the angular radiation fields over the full range of θ_0.
  - We can't use it due to the limited θ_0 range for each grid-box.

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.

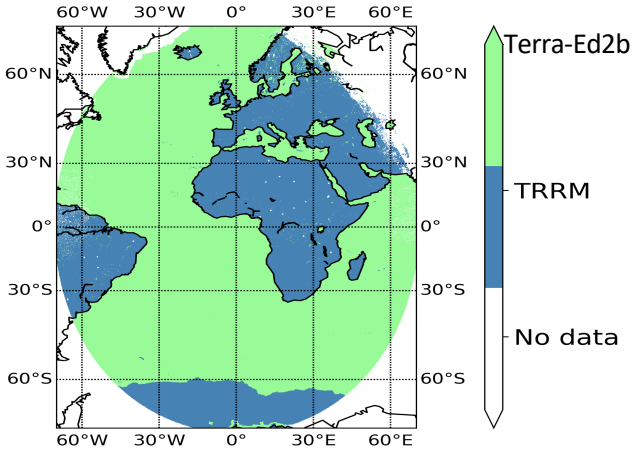
SW ADMs

CERES TRMM
(Loeb et al., 2003)

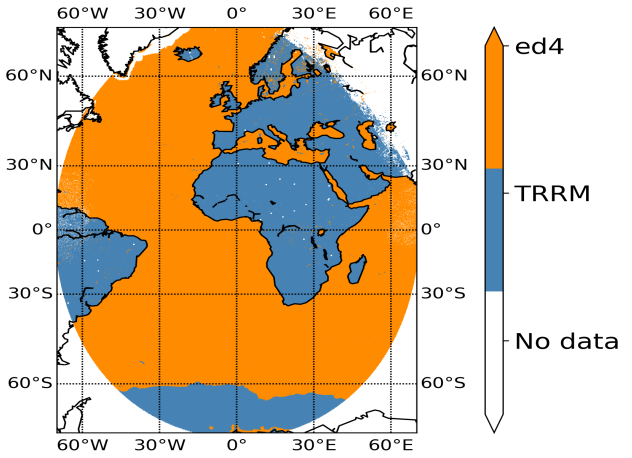


CERES ed2b / Terra
(Loeb et al., 2005)

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

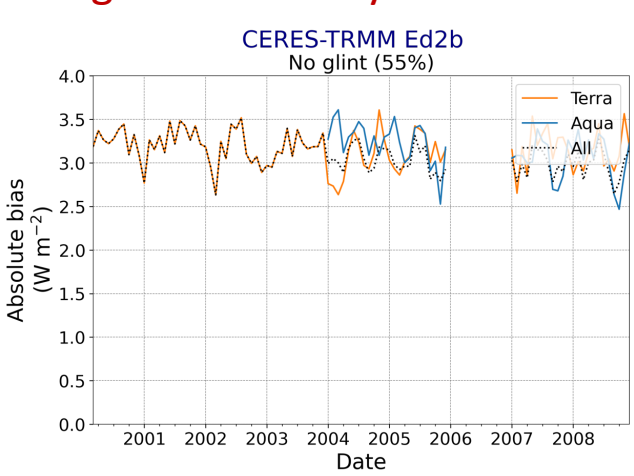
Comparisons with CERES SSF TOA flux

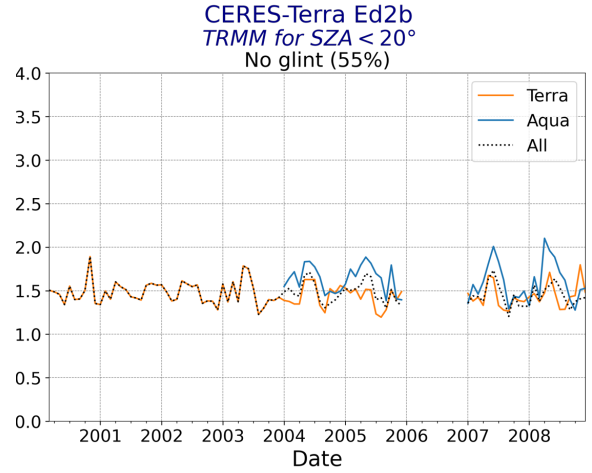
CERES SSF SW TOA flux (Ed4.1)

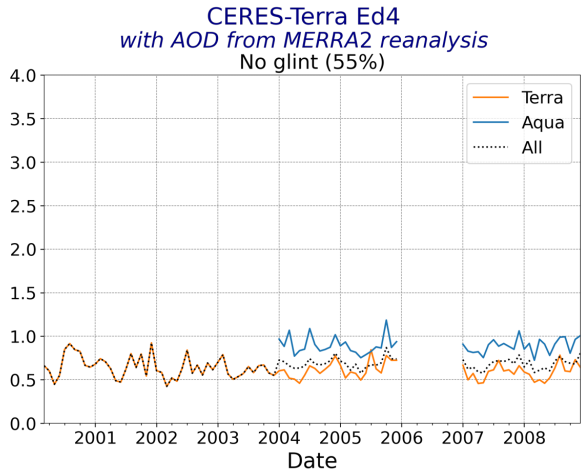
vs.

TOA flux by applying local ADM implementations on radiance

No glint - Clear sky ocean





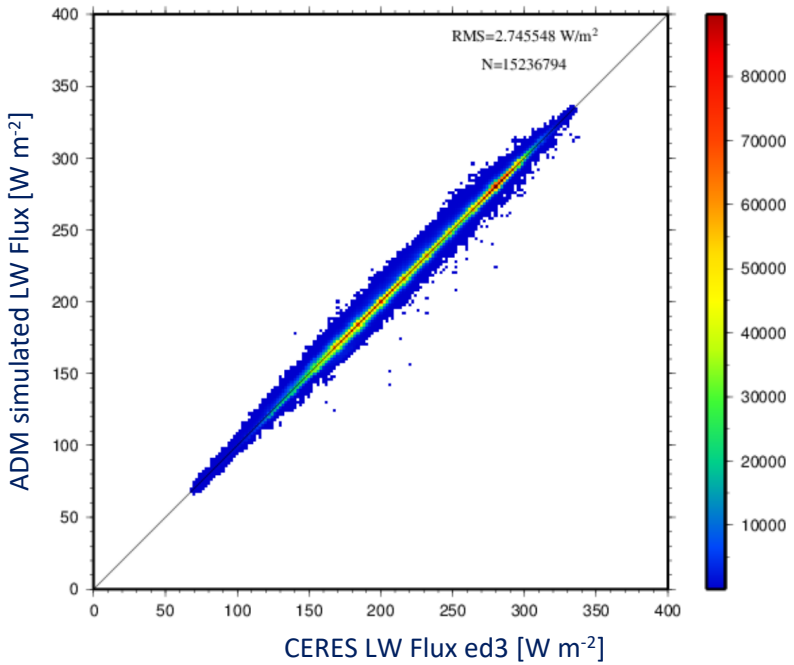


- Better result with Ed4 while using MERRA-2.
- Higher MAD with Aqua:
  - ☛ Not the last ADM version.
- MAD of 0 if the similar AOD case than Ed4 is used (no MERRA-2 anymore).

LW ADM *(Velazquez et al., in prep)*

Night cases

Needed MODIS PSF weighted BT only available during night



Polynomial fit

- Database : LibRadtran 1.4 and SBDART radiative transfer models

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

  - $z_1 = T_b(10.8\mu m)$ and $z_2 = T_b(12\mu m) - T_b(10.8\mu m)$
- Bins :
  - 5° VZA
  - 25 -> 135 $Wm^{-2}sr^{-1}$; 5 $Wm^{-2}sr^{-1}$ 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 :

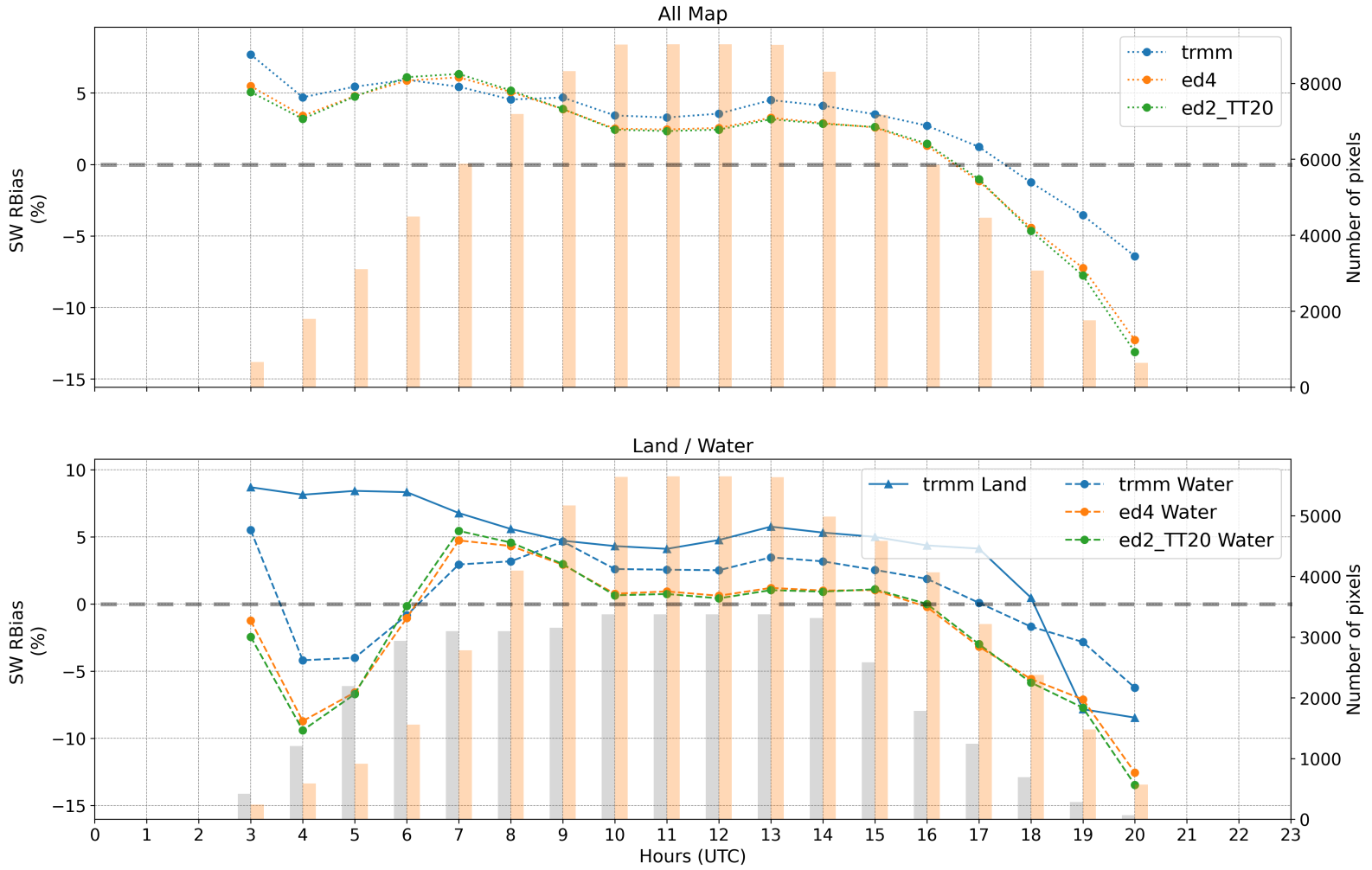
- Monthly mean deseasonal bias

Short-wave flux

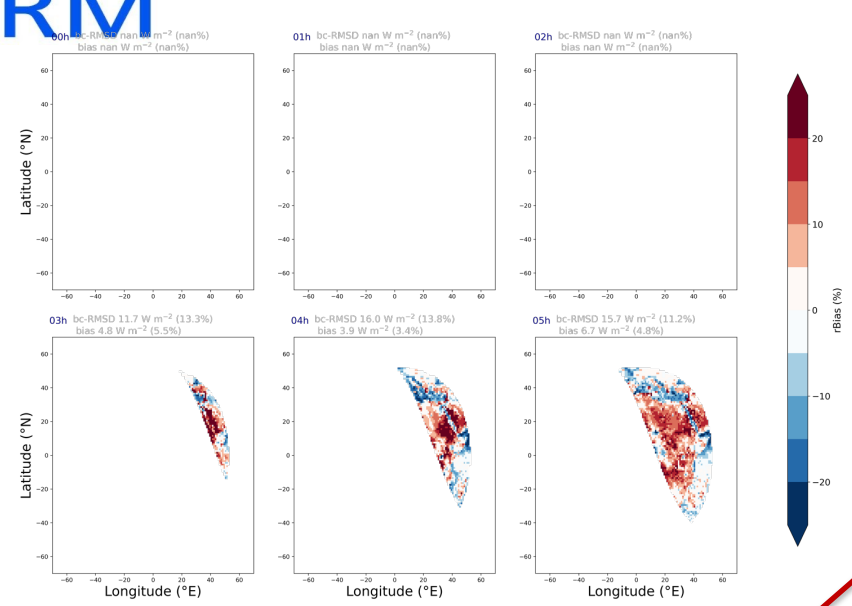
Monthly mean diurnal cycle (FOV < 60° SZA < 84°)

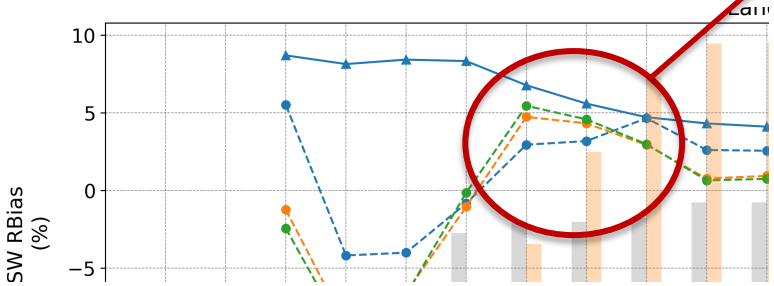
Monthly mean (from daily mean with minimum 27 days)

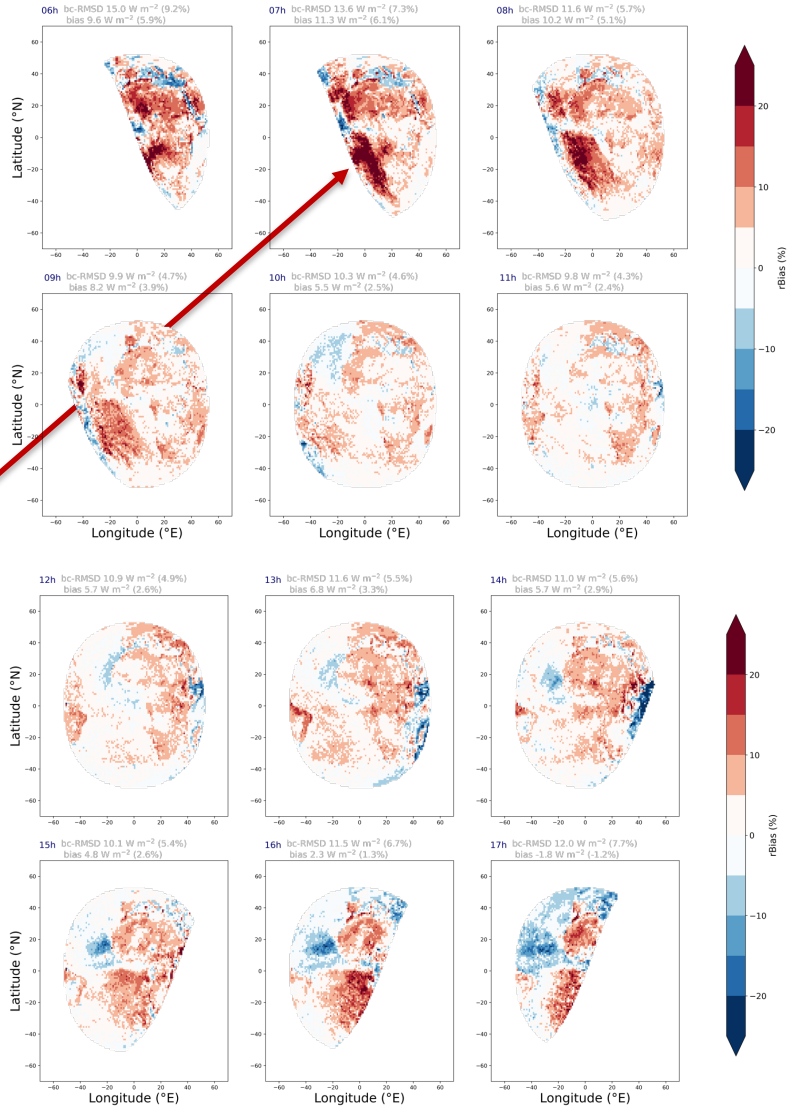
$SW_{CERES\ SYN}$ relative bias



$SW_{CERES\ SYN}$ relative bias



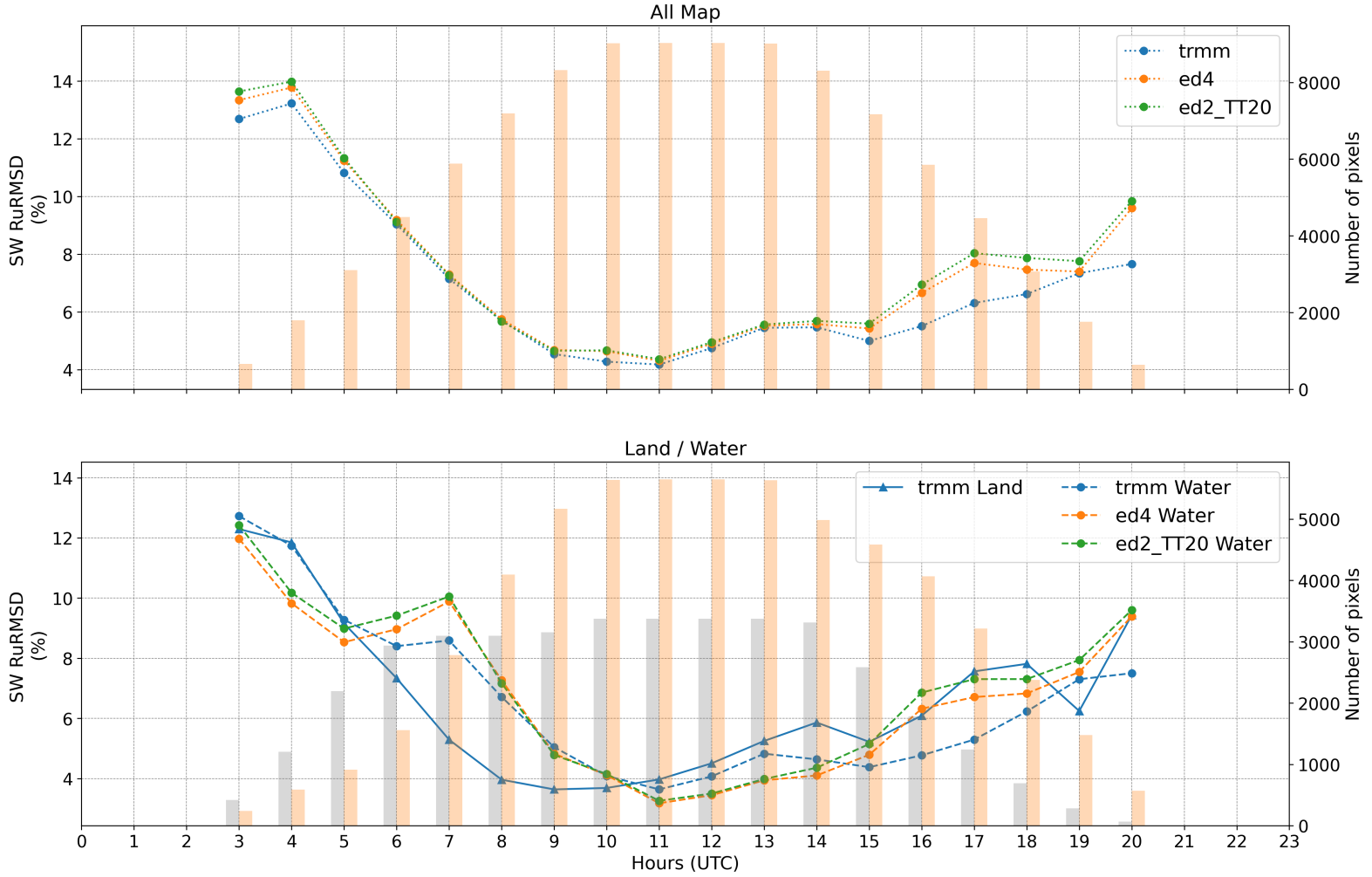




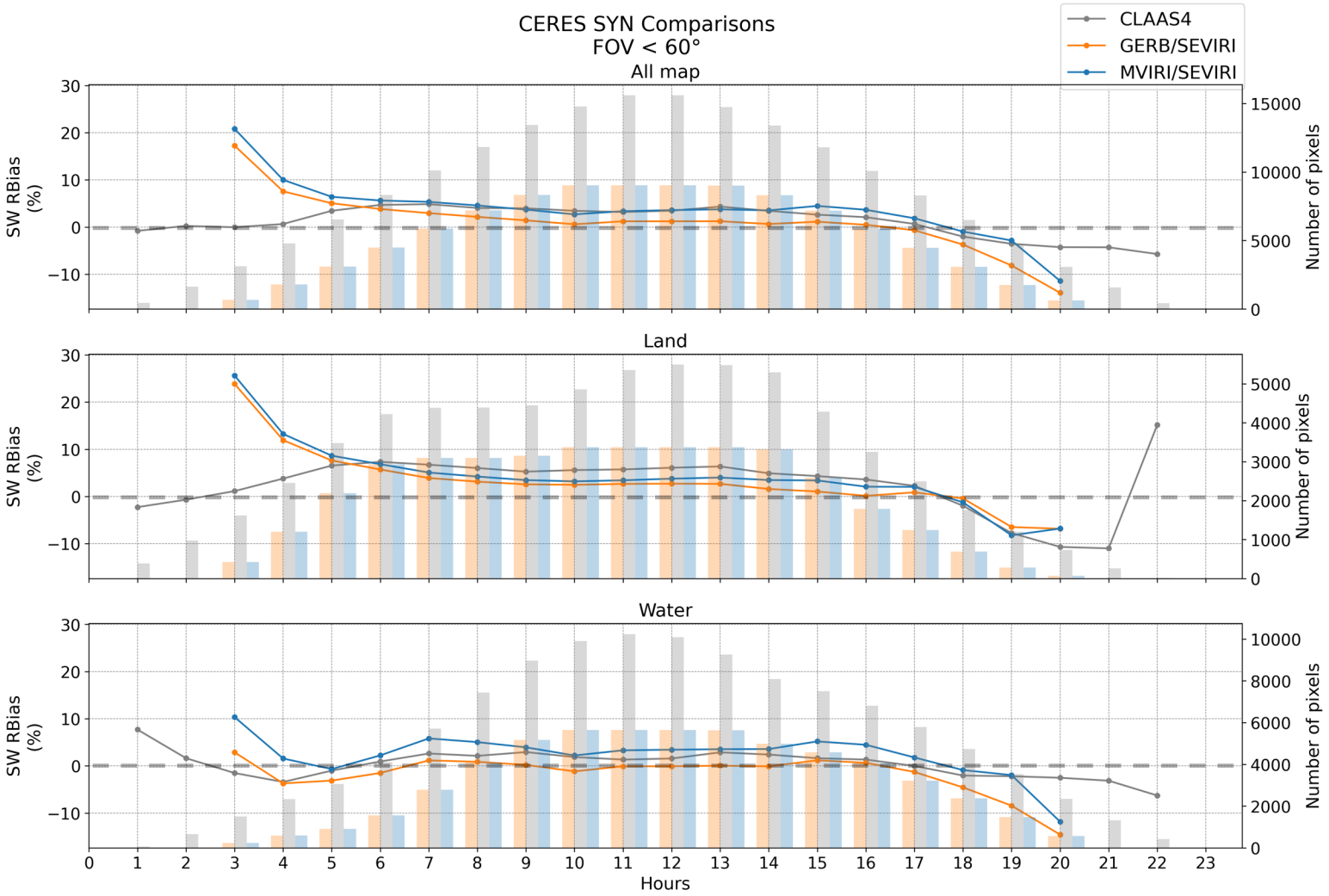
Hypothesis :

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

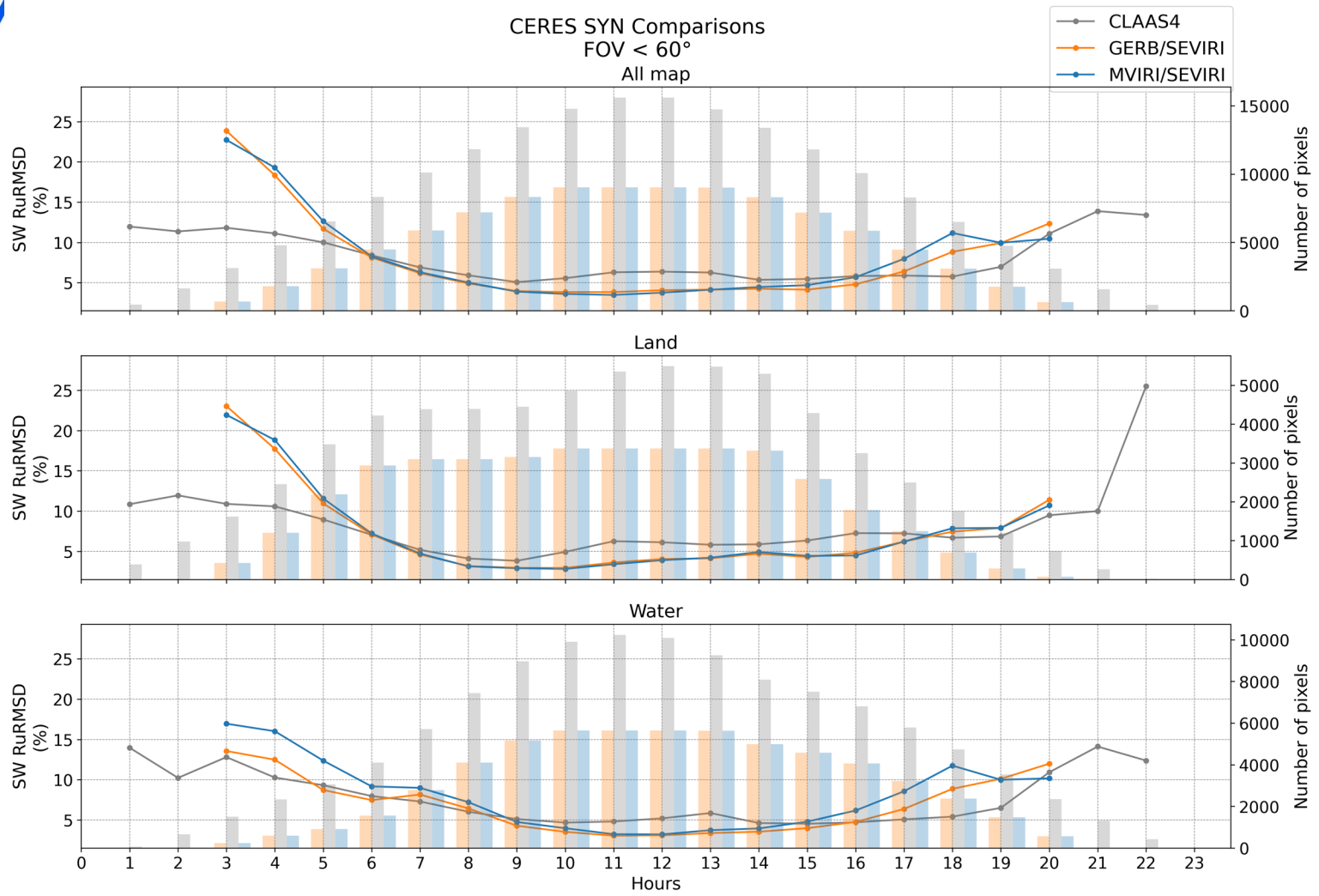
$SW_{CERES\ SYN}$ relative uRMSD



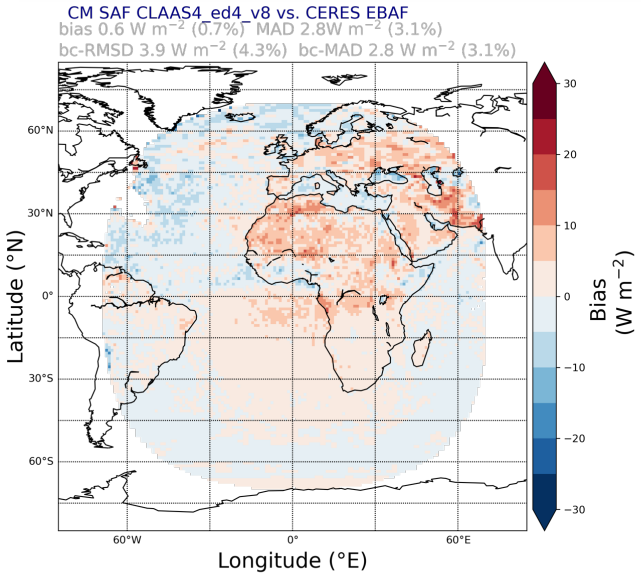
SW *CERES SYN* vs. CDRs

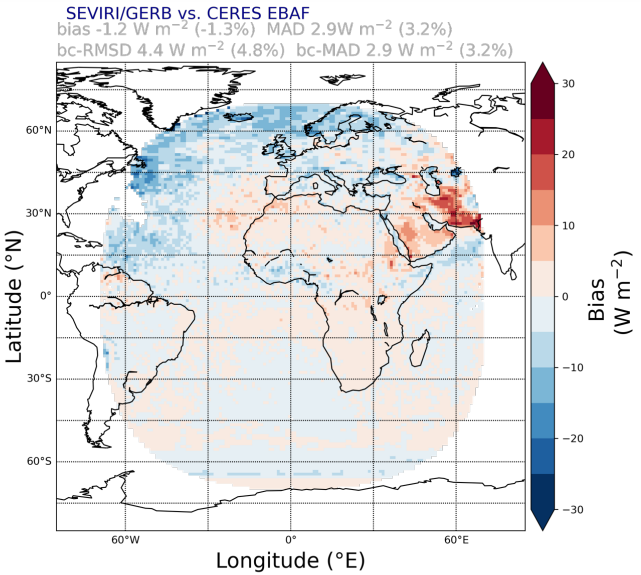


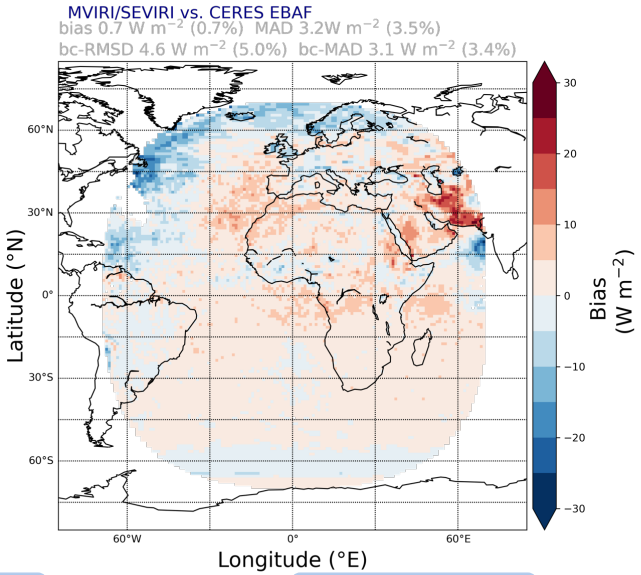
SW *CERES SYN* vs. CDRs



Monthly bias with $SW_{CERES\text{-}EBAF}$



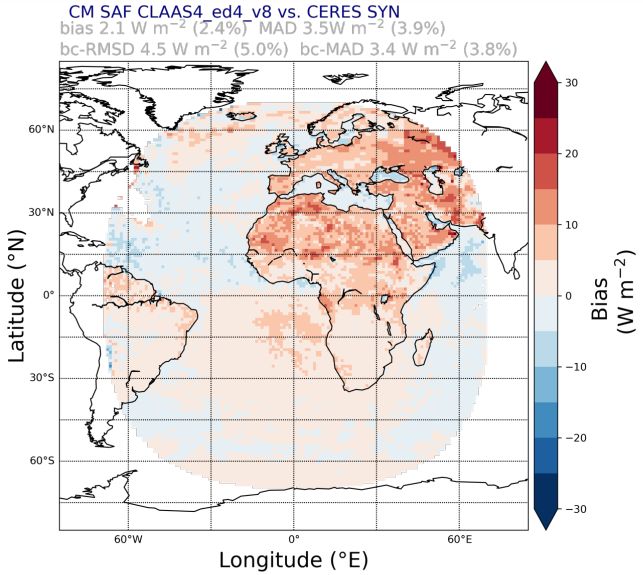


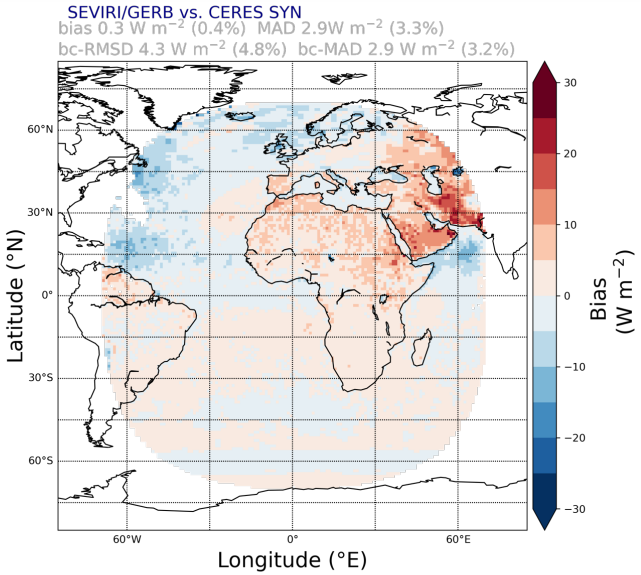


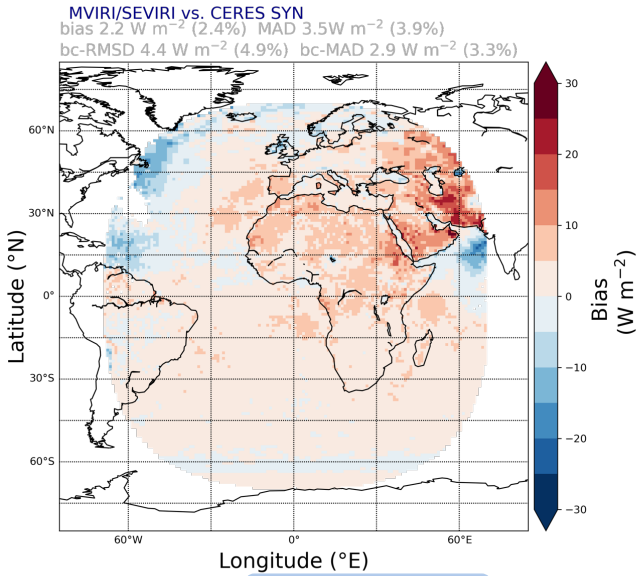
CLAAS4

- 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 $SW_{CERES\text{-}SYN}$



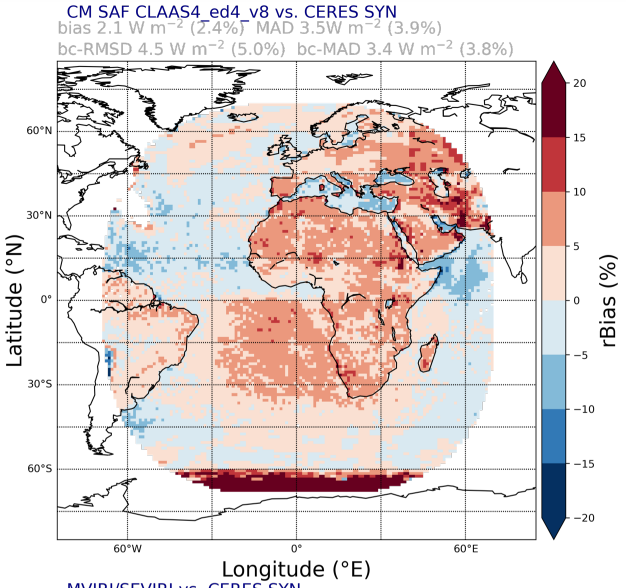


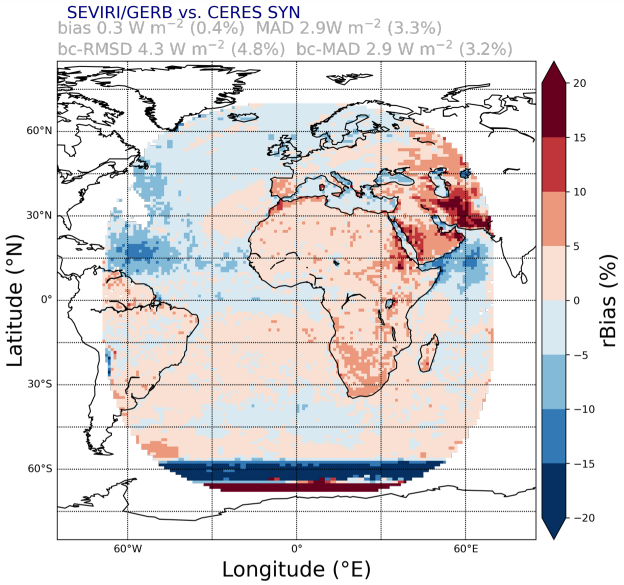


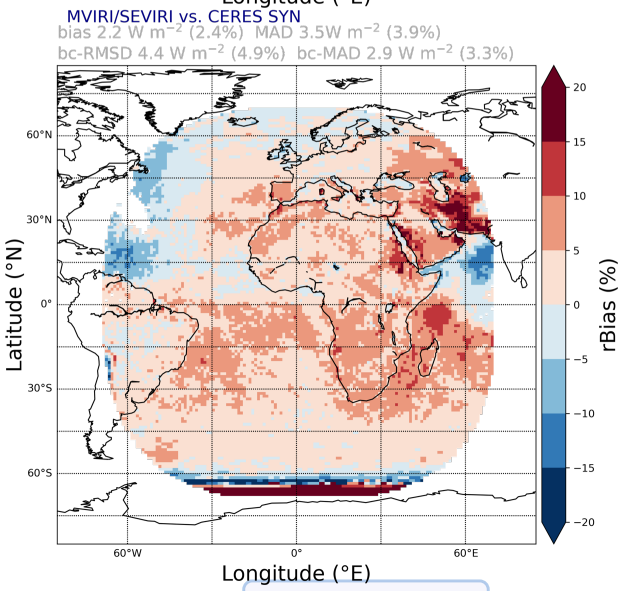
CLAAS4

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

Monthly rbias with $SW_{CERES-SYN}$

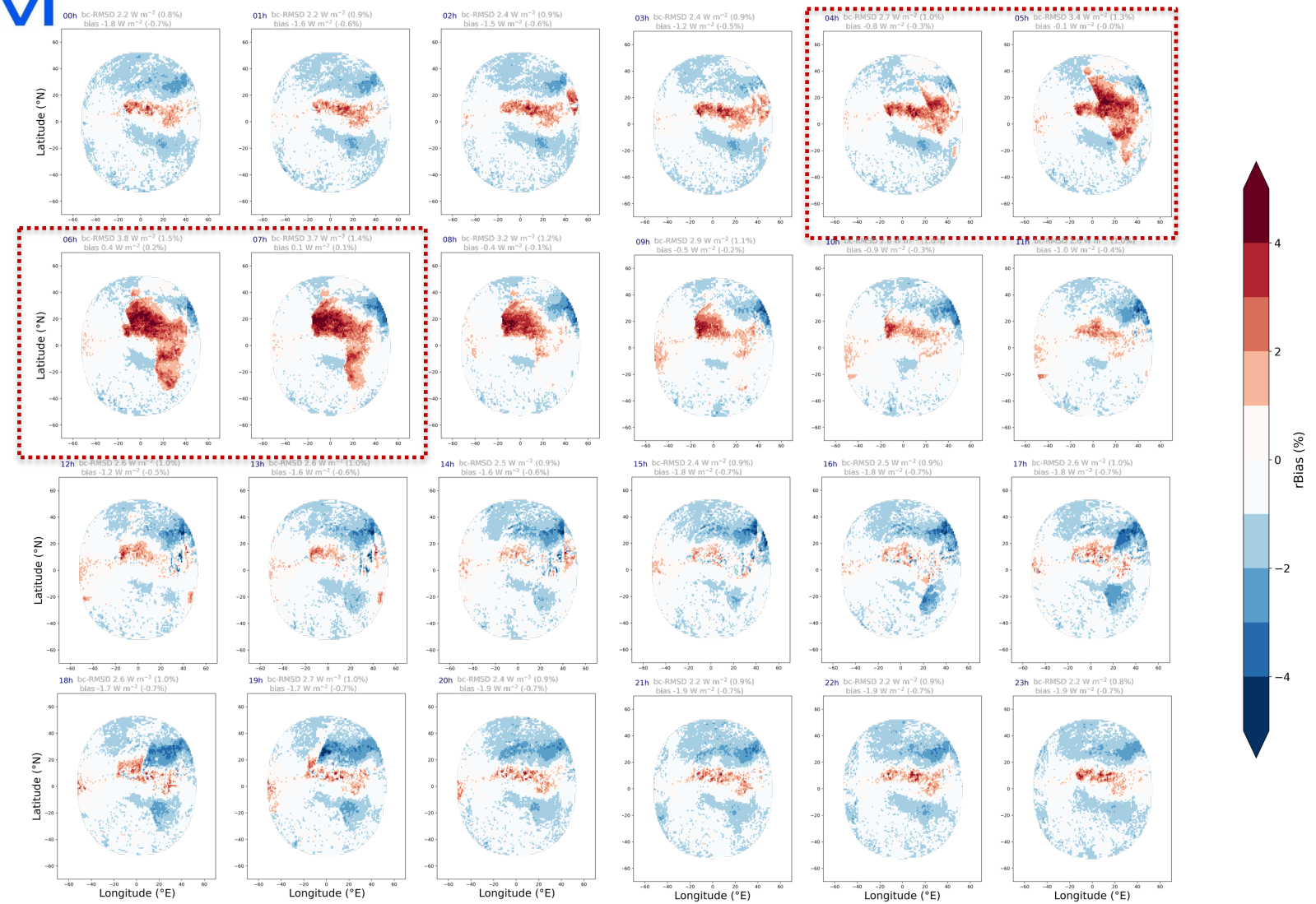




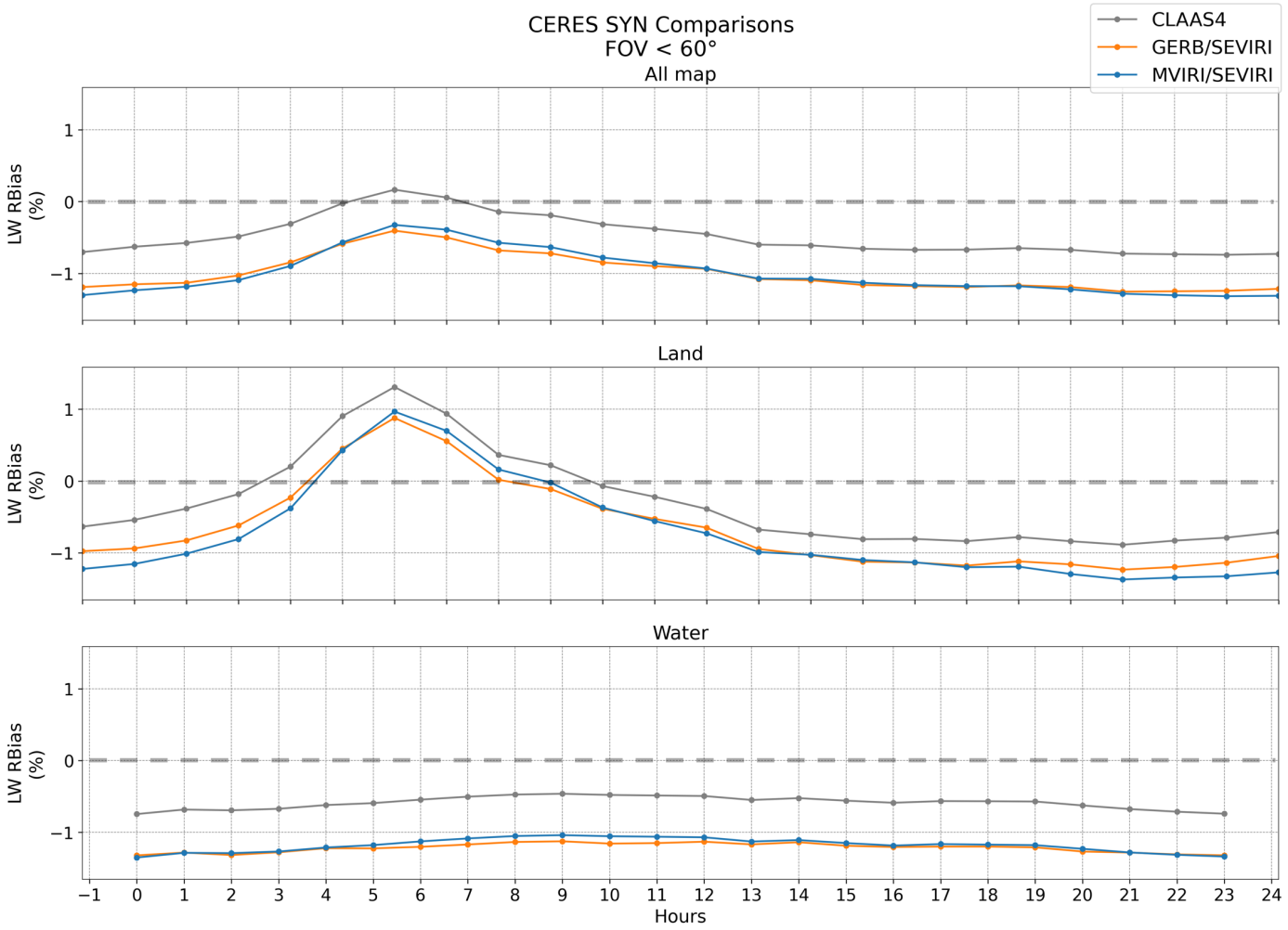


Long-wave flux
Monthly mean diurnal cycle
Monthly mean

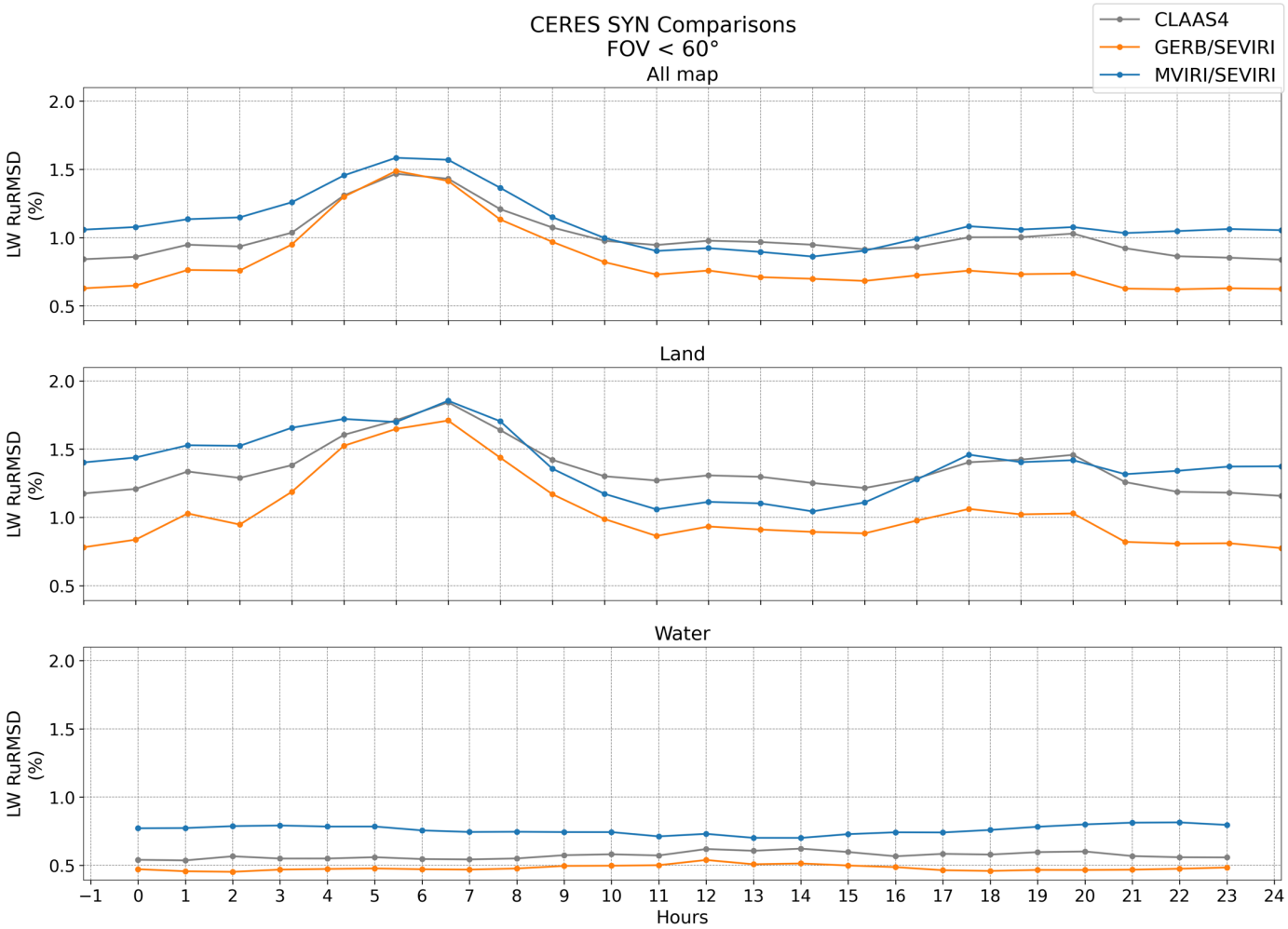
$LW_{CERES\ SYN}$ MMDC



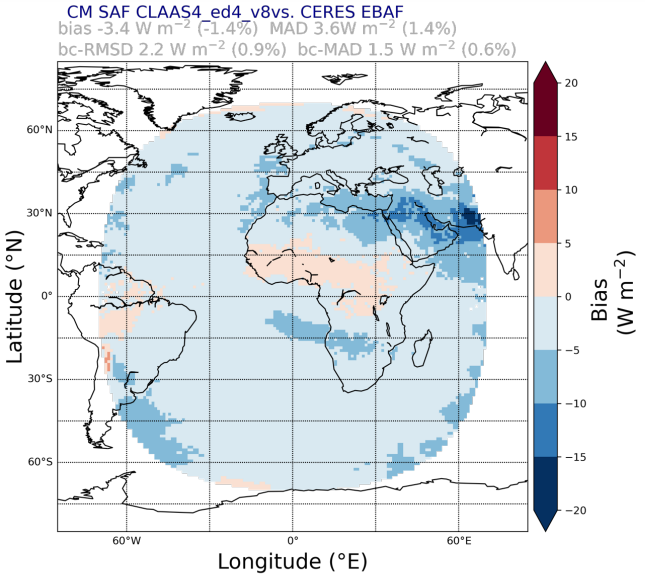
LW *CERES SYN* vs. CDRs

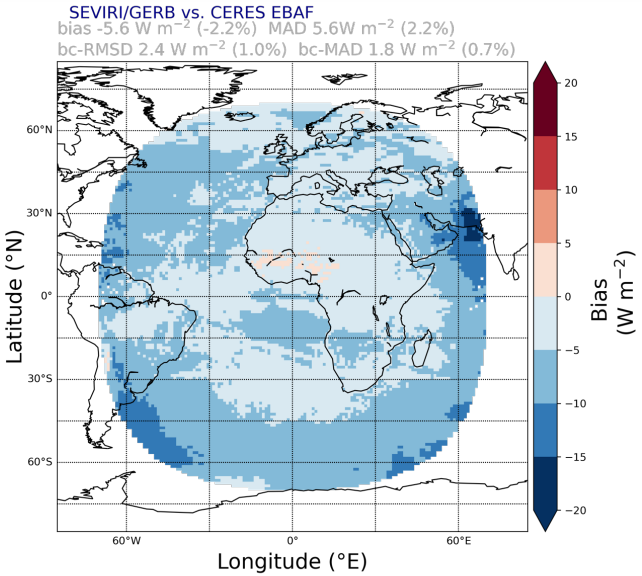


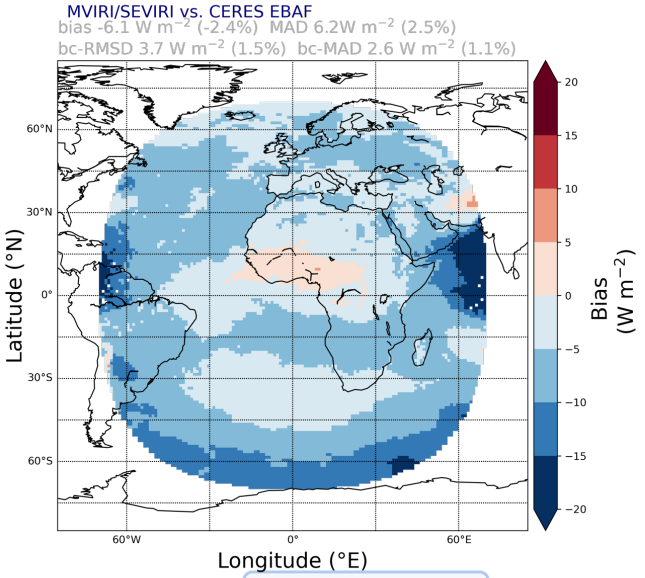
LW *CERES SYN* vs. CDRs



Monthly bias with LW$_{CERES-EBAF}$





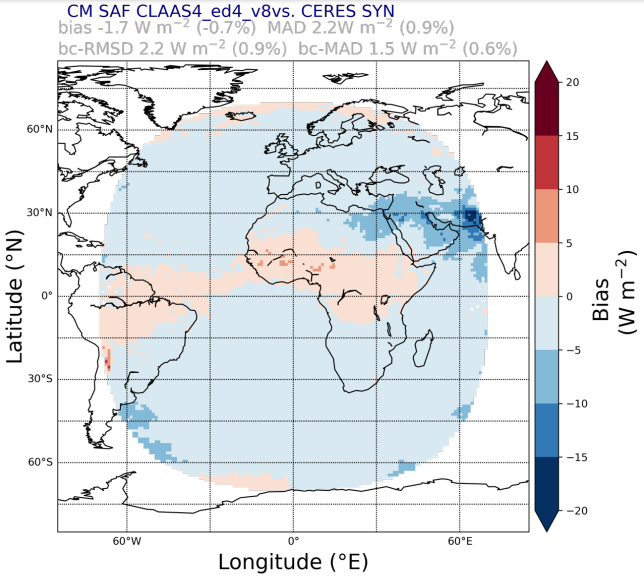


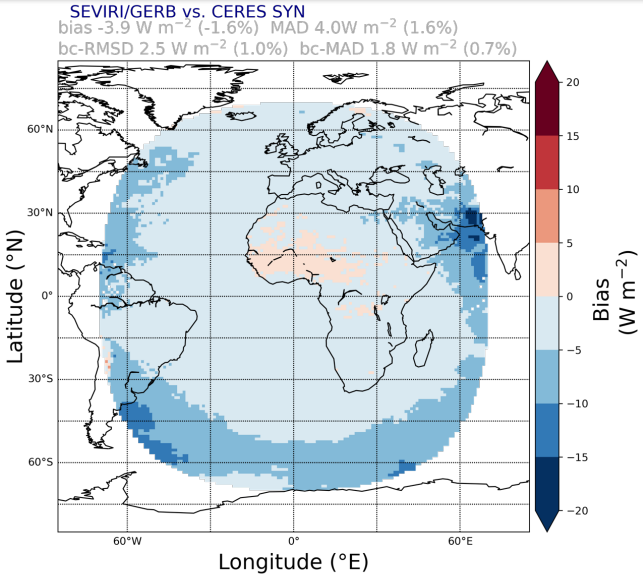
CLAAS4

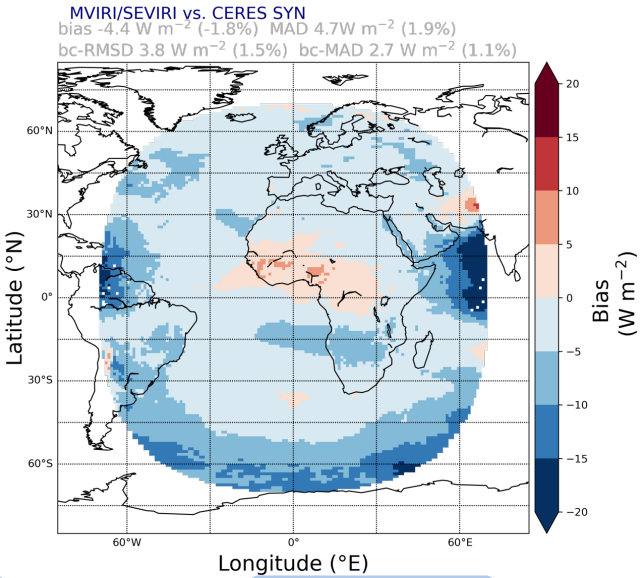
- Global Underestimation
- Lower impact of the VZA

Improvement as compared to previous CM SAF versions over water

Monthly bias with $LW_{CERES-SYN}$







CLAAS4

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

Conclusions & Outlook

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.