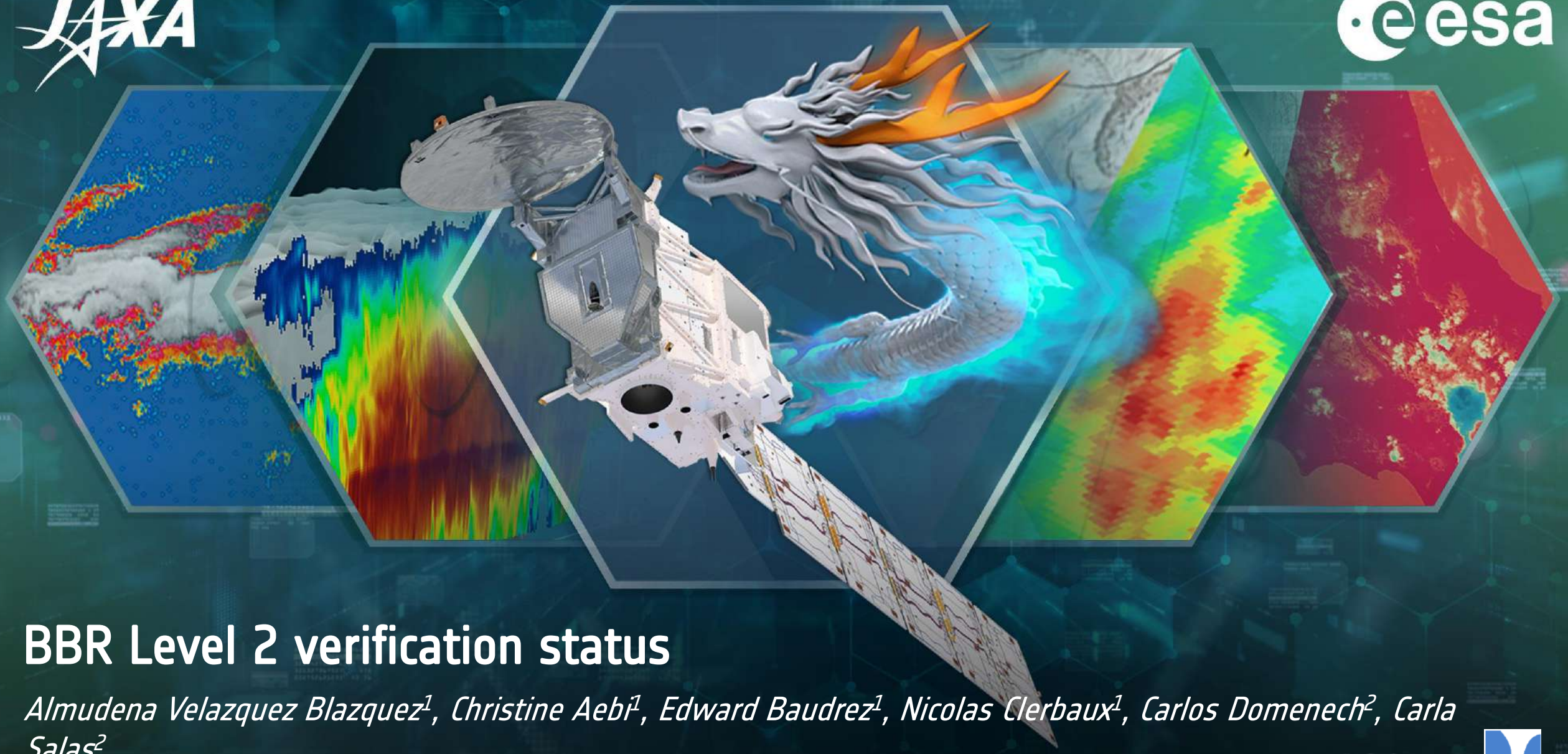


BBR Level 2 verification status

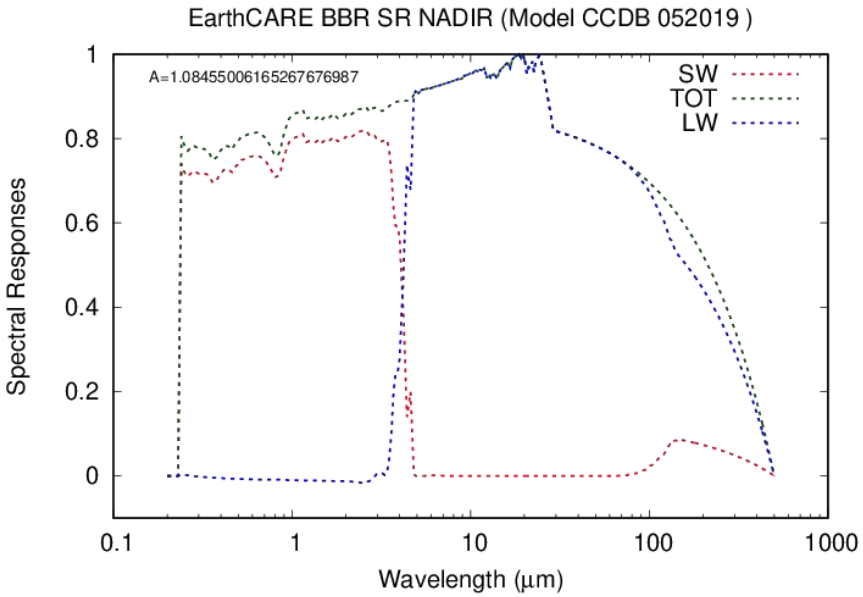
Almudena Velazquez Blazquez[1], Christine Aebi[1], Edward Baudrez[1], Nicolas Clerbaux[1], Carlos Domenech[2], Carla Salas[2].
[1]RMIB, [2]GMV

1st ESA-JAXA EarthCARE In-Orbit Validation Workshop
14 – 17 January 2025 | VIRTUAL EVENT

L2: BM-RAD & BMA-FLX

- **BBR SW** and **TW** measurements are converted into **solar** and **thermal** **unfiltered radiances**

- Two unfiltering algorithms:
  - **Stand-alone** : BBR L1 and land use classification (SW & LW)
  - **SW MSI-based**: SW BBR L1 and MSI cloud mask and cloud phase



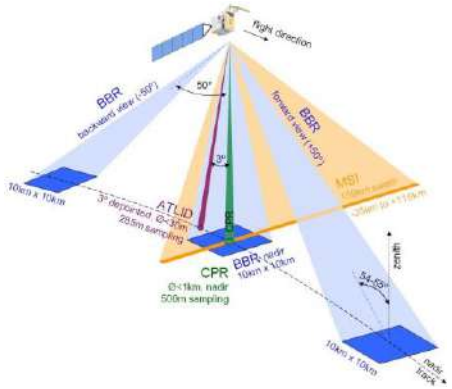
BBR Flux estimation

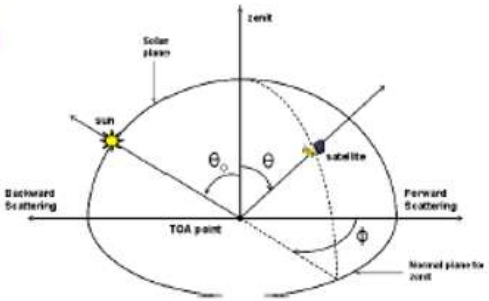
- BBR measure radiances $L(\theta, \phi)$ $[Wm^{-2}sr^{-1}]$ at the TOA but flux is

$$F(\theta_0) = \int_{\theta=0}^{\frac{\pi}{2}} \int_{\phi=0}^{2\pi} L(\theta, \phi) cos(\theta) sin(\theta) d\theta d\phi$$

- Need of Angular Dependency Models (R)

$$F = \frac{\pi L(\theta, \phi)}{R(\theta, \phi)}$$





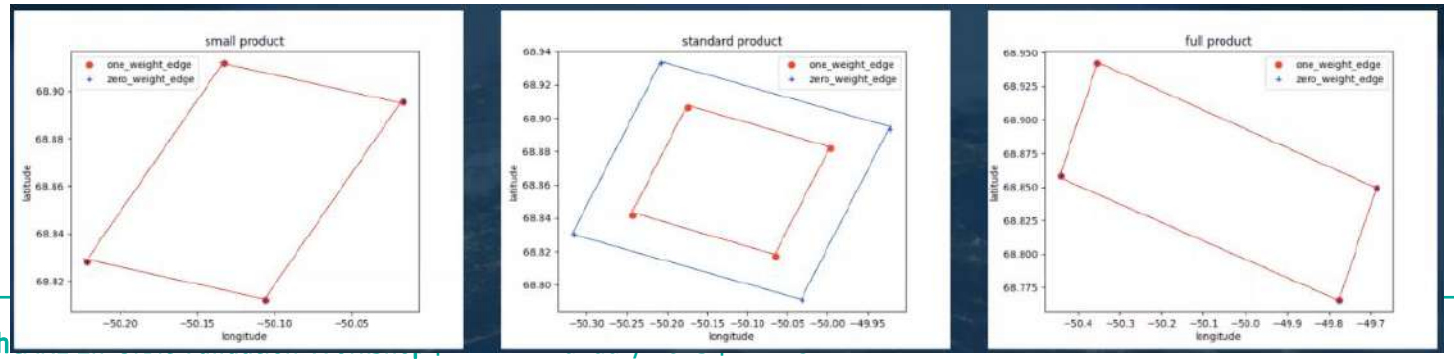
- In the LW: $R(\theta) = a_0 + a_1 z_1 + a_2 z_2 + a_3 z_1^2 + a_4 z_1 z_2 + a_5 z_2^2$

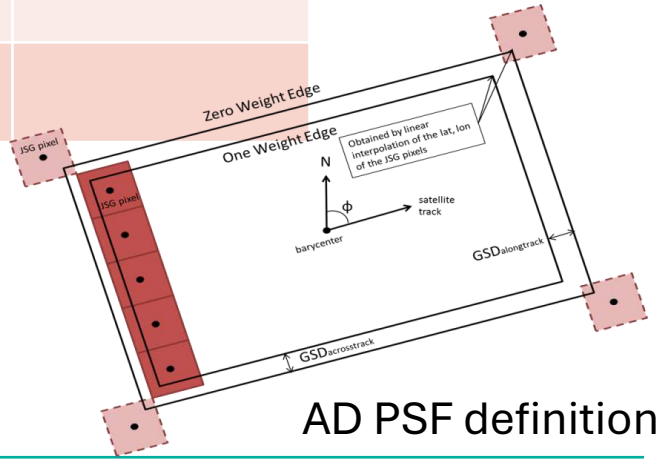
  $z_1 = BT_{10.8\,\mu m}$ and $z_2 = BT_{12.0\,\mu m} - BT_{10.8\,\mu m}$

- In the SW: feed-forward back-propagation ANN using CERES and MODIS data

BM-RAD / BMA-FLX product resolutions

L1 PSF	Size (across x along track)	Reference grid	L1 filtered radiances	BM-RAD unfiltered radiances	BMA-FLX fluxes	BMA-FLX combined flux
Standard	10x10 km2	BBR	B-NOM	✓	✓	✓
Small	5x10 km2	BBR	B-NOM	✓	✓	✓
Full	17x10 km2 (nadir) 28x10 km2	BBR	B-NOM	✓	✓	
Assessment domain	5x21 JSG (configurable)	JSG	B-SNG	✓	✓	✓
JSG*	1x1 JSG (or 3x3 JSG)	JSG	B-SNG	✓		





AD PSF definition

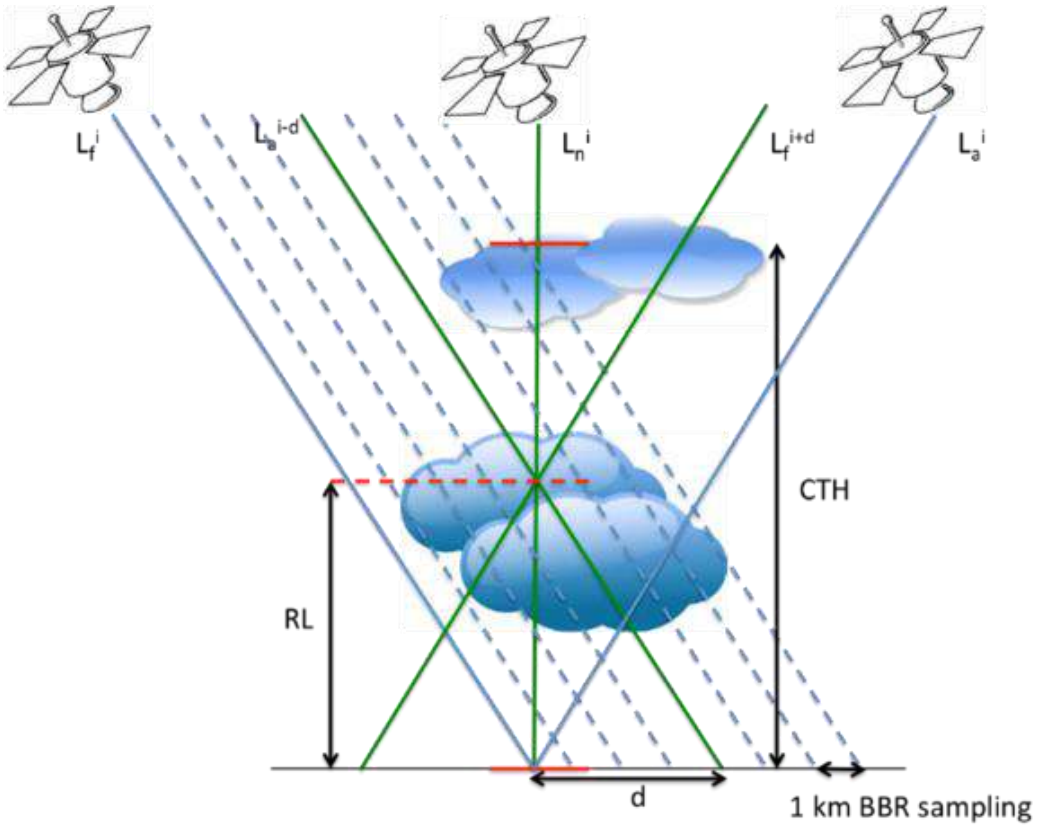
Reference level height for SW and LW radiances

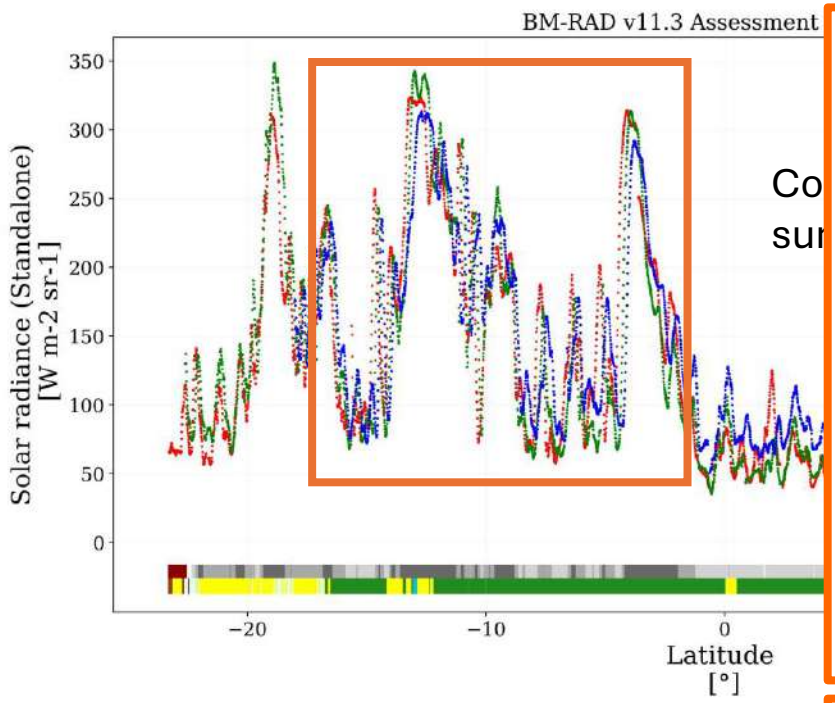
Co-registration of LW radiances

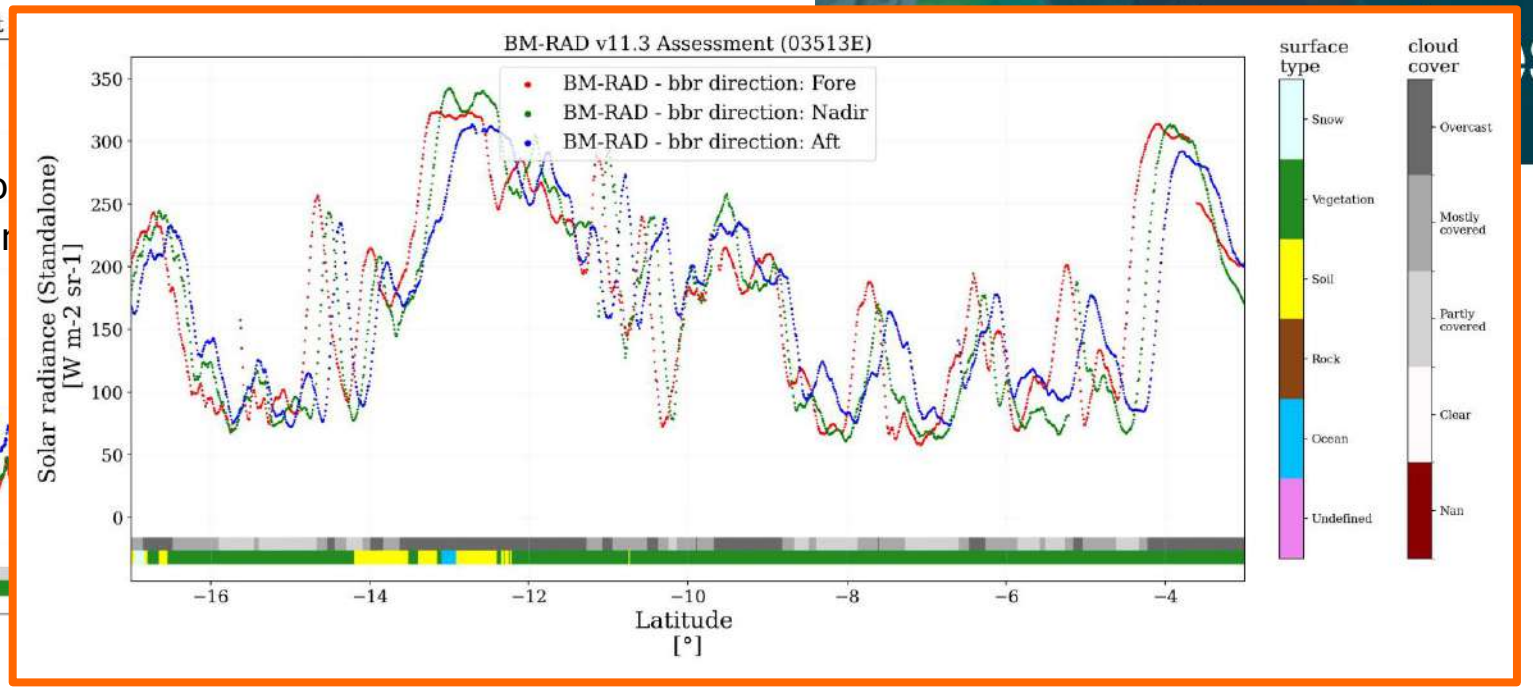
- The height defined by the CTH derived from brightness temperature (M-COP) is a good estimator to co-register the BBR radiances in LW.
- RL is defined as the 90th percentile of the altitude of the highest cloud in the BBR domain.

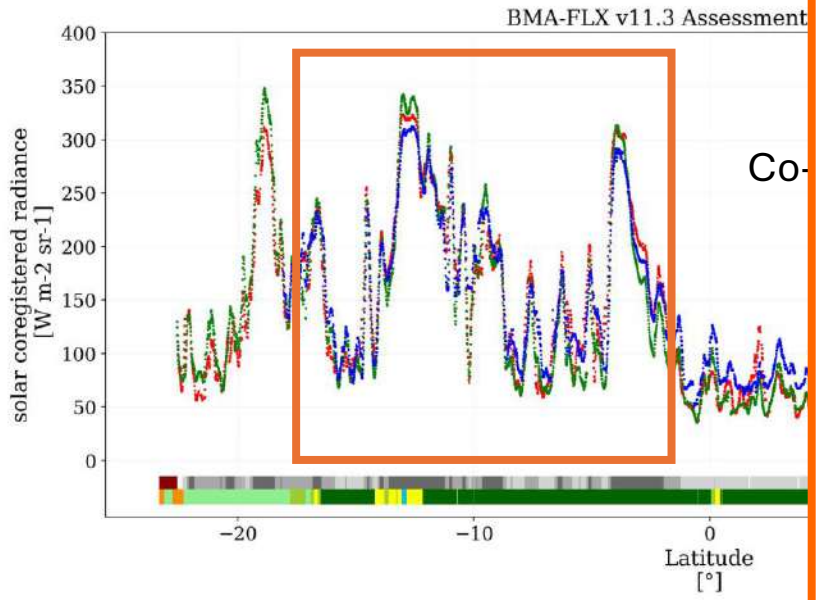
Co-registration of SW radiances

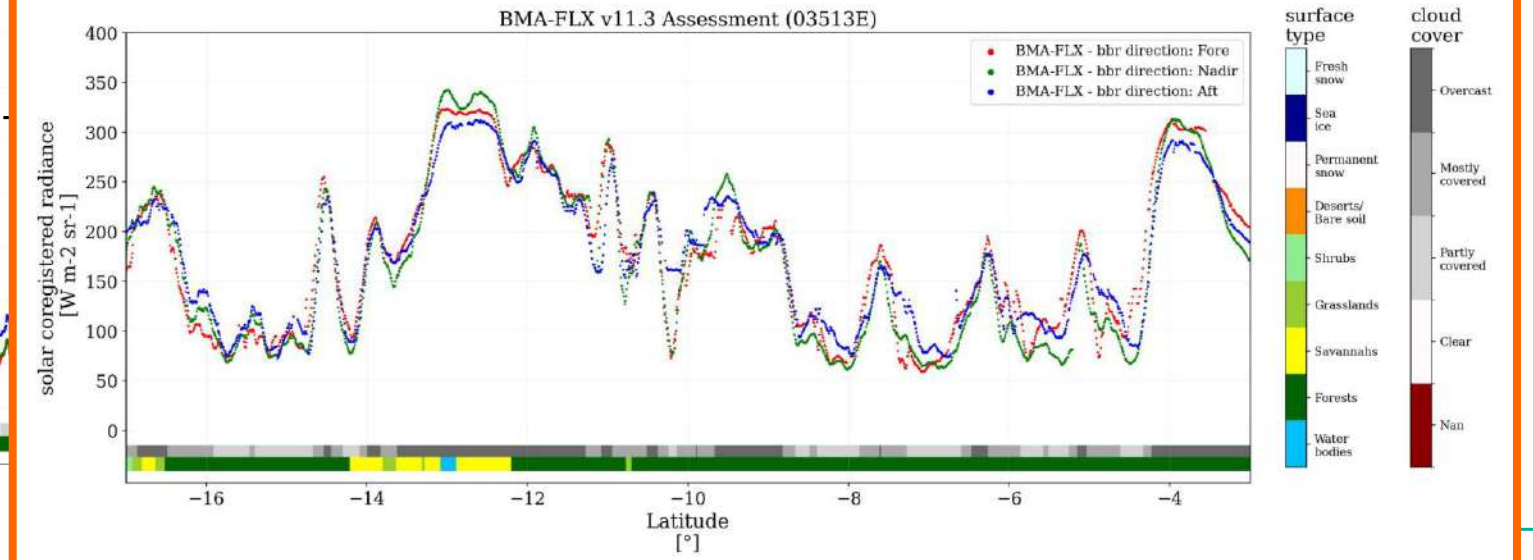
- SW radiances cannot be co-registered using BT-based CTH. In average co-registration errors are higher than using the default surface co-registration.
- Views are co-registered at a RL defined as the vertical level in the nadir domain that minimizes the flux differences between the nadir, aft and fore flux retrievals
- All oblique radiances crossing the optical path between the surface and the MSI CTH of the BBR nadir observation are selected for the flux processing. RL is obtained by minimization of errors in the fluxes.

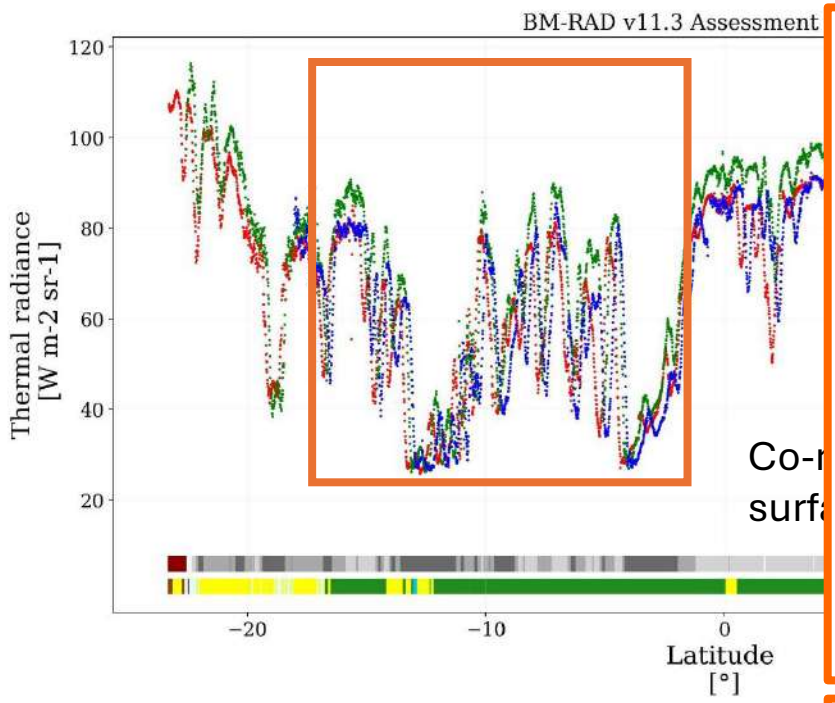



BM-RAD v11.3 Assessment
Solar radiance (Standalone) [W m-2 sr-1]
Latitude [°]

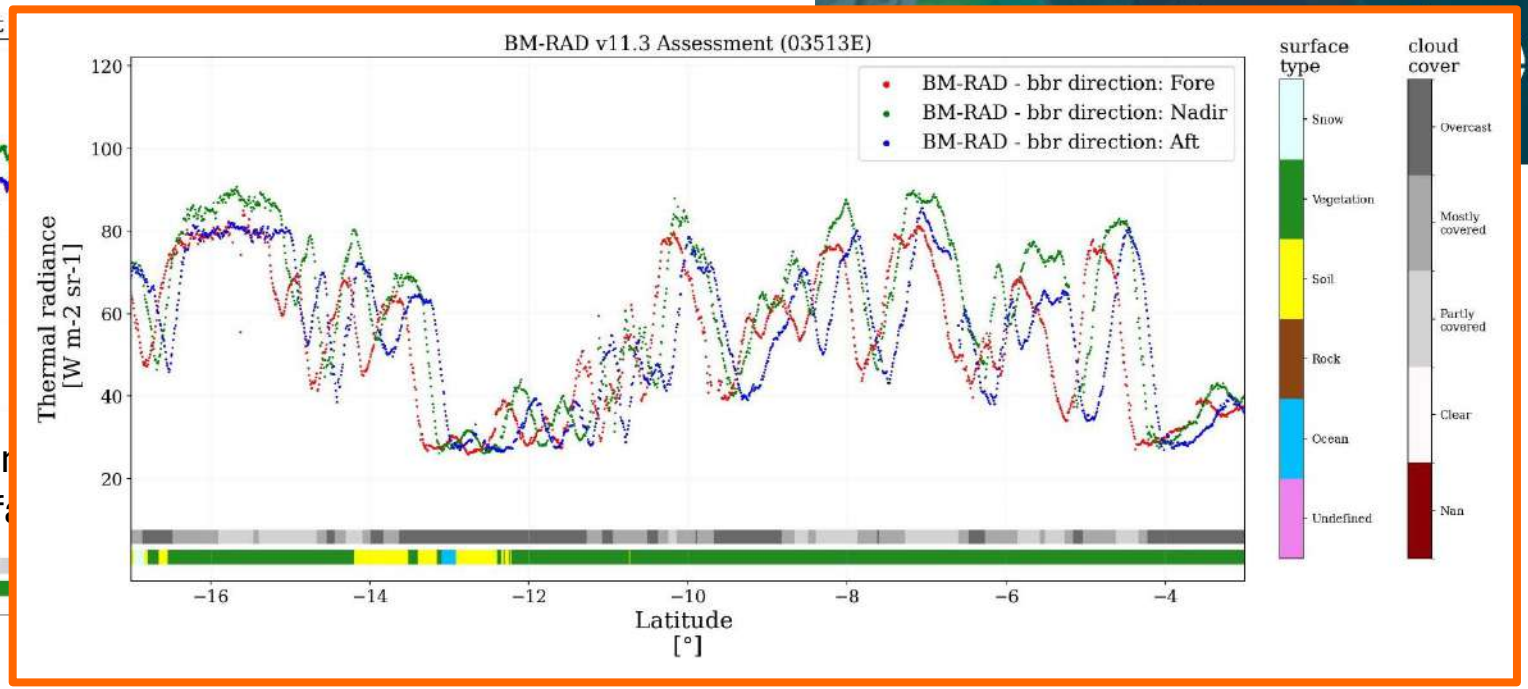

BM-RAD v11.3 Assessment (03513E)
BM-RAD - bbr direction: Fore
BM-RAD - bbr direction: Nadir
BM-RAD - bbr direction: Aft
Solar radiance (Standalone) [W m-2 sr-1]
Latitude [°]
surface type
Snow
Vegetation
Soil
Rock
Ocean
Undefined
cloud cover
Overcast
Mostly covered
Partly covered
Clear
Nan

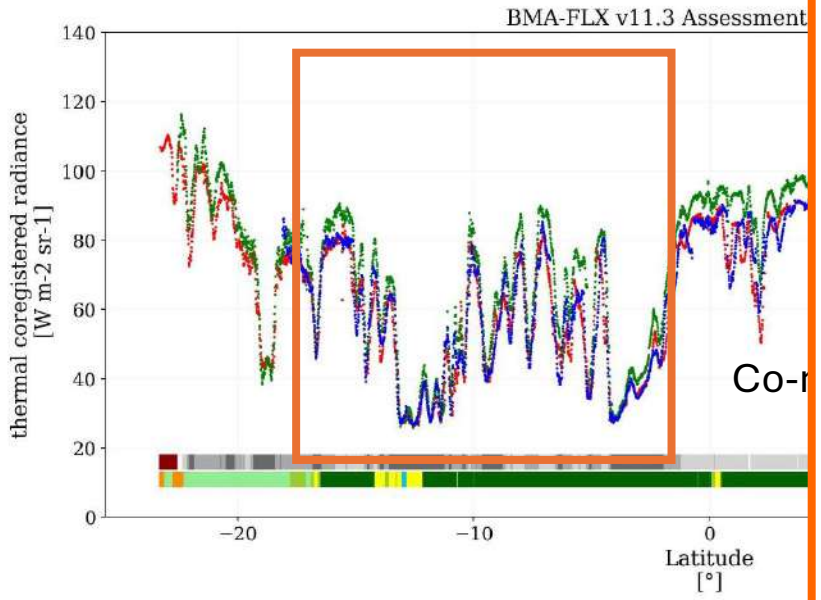

BMA-FLX v11.3 Assessment
solar coregistered radiance [W m-2 sr-1]
Latitude [°]


BMA-FLX v11.3 Assessment (03513E)
BMA-FLX - bbr direction: Fore
BMA-FLX - bbr direction: Nadir
BMA-FLX - bbr direction: Aft
solar coregistered radiance [W m-2 sr-1]
Latitude [°]
surface type
Fresh snow
Sea ice
Permanent snow
Deserts/ Bare soil
Shrubs
Grasslands
Savannahs
Forests
Water bodies
cloud cover
Overcast
Mostly covered
Partly covered
Clear
Nan

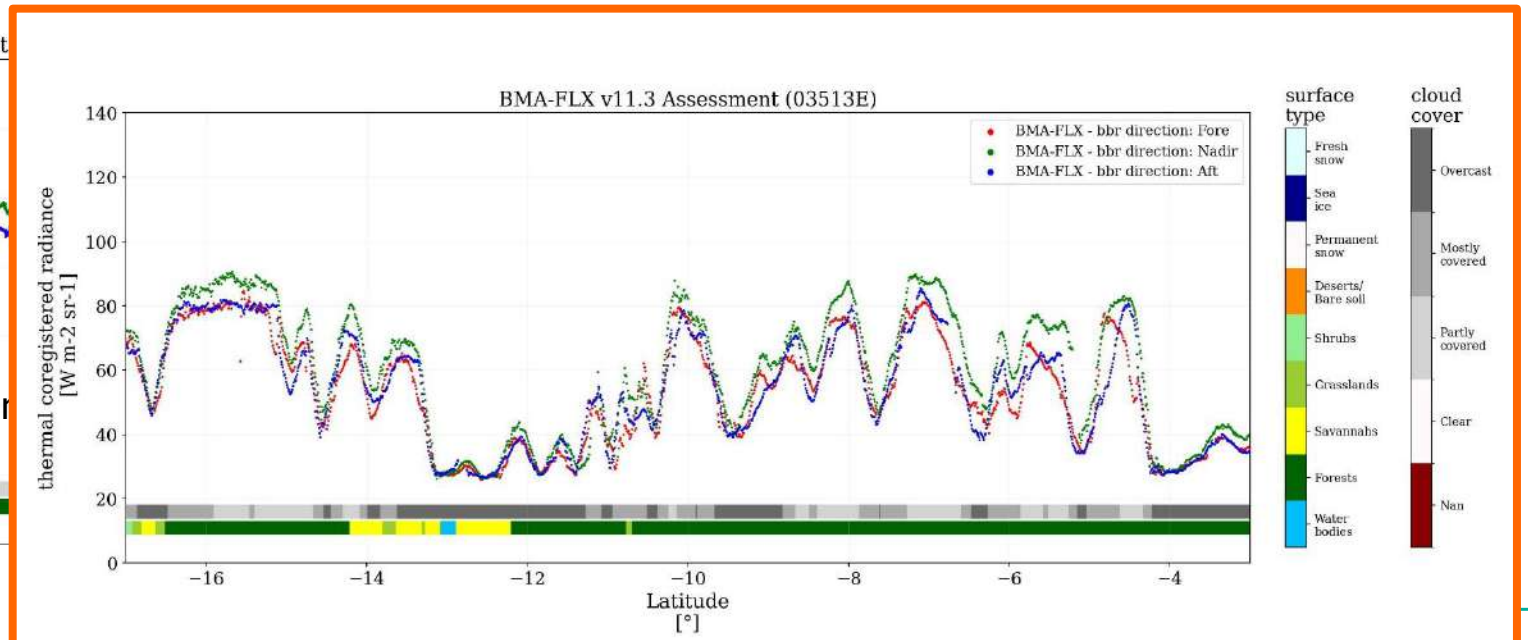


Co-r
surfa

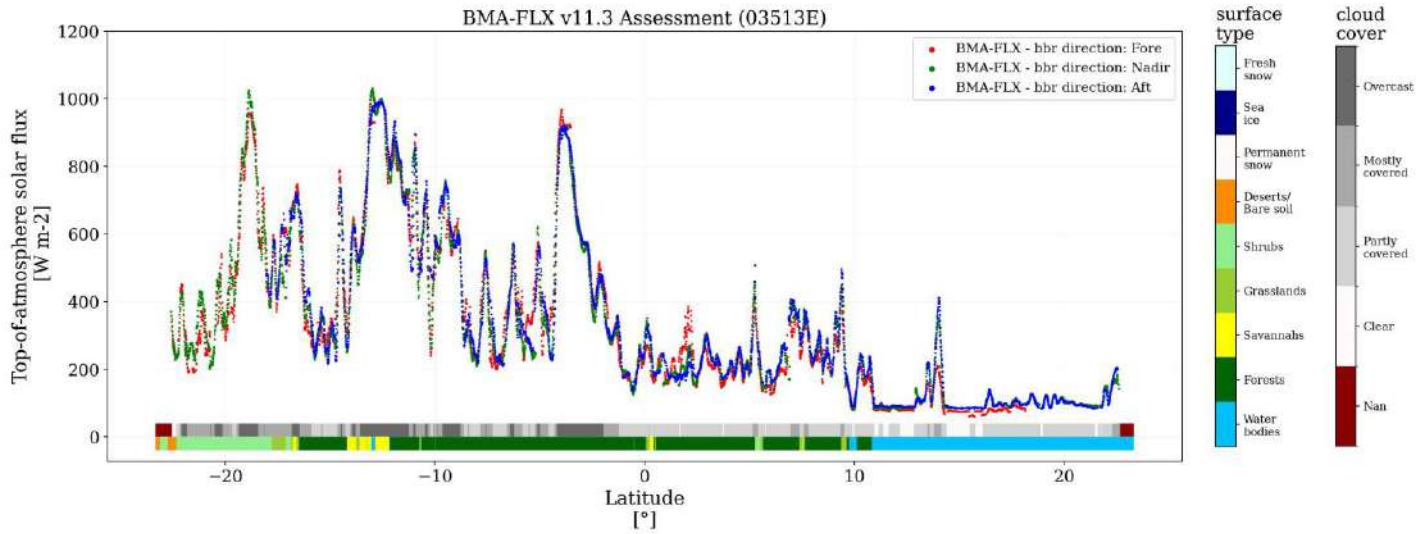




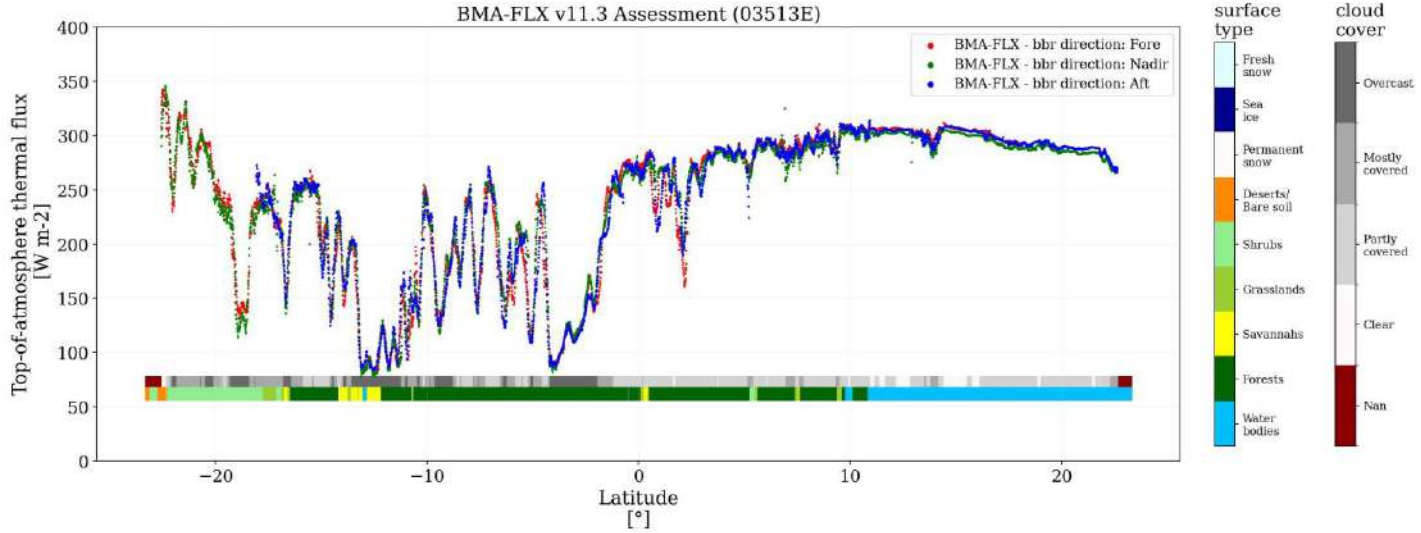
Co-r

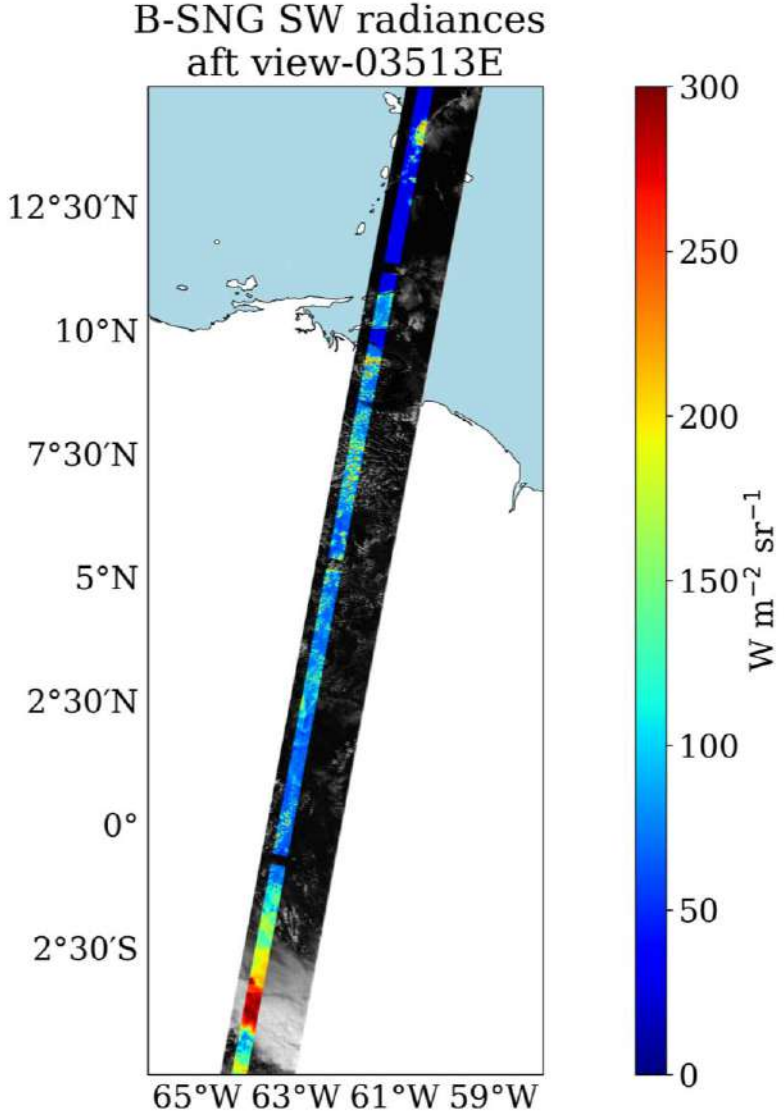


SOLAR

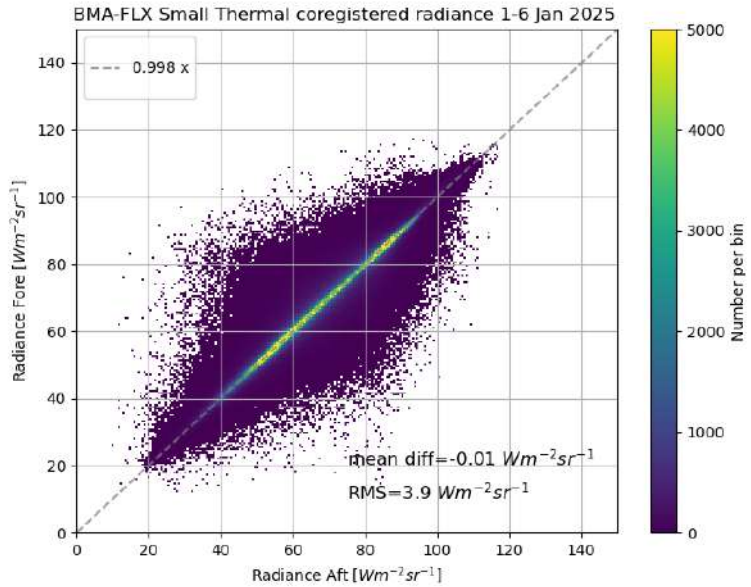


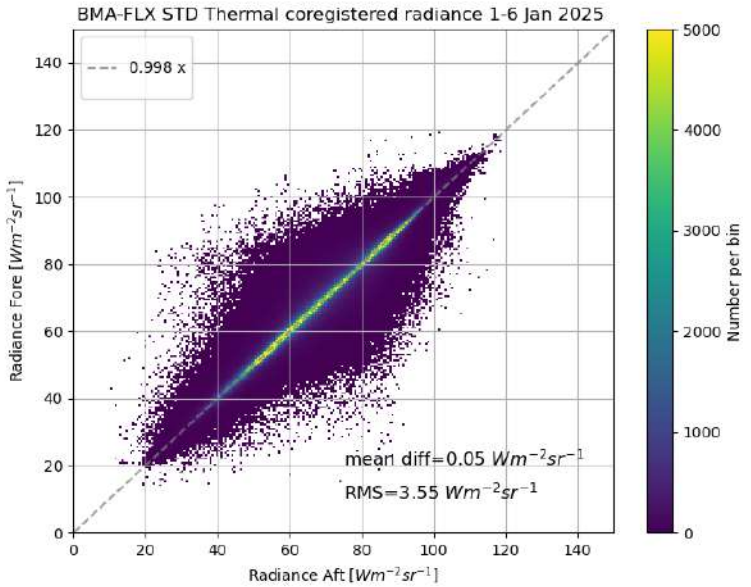
THERMAL

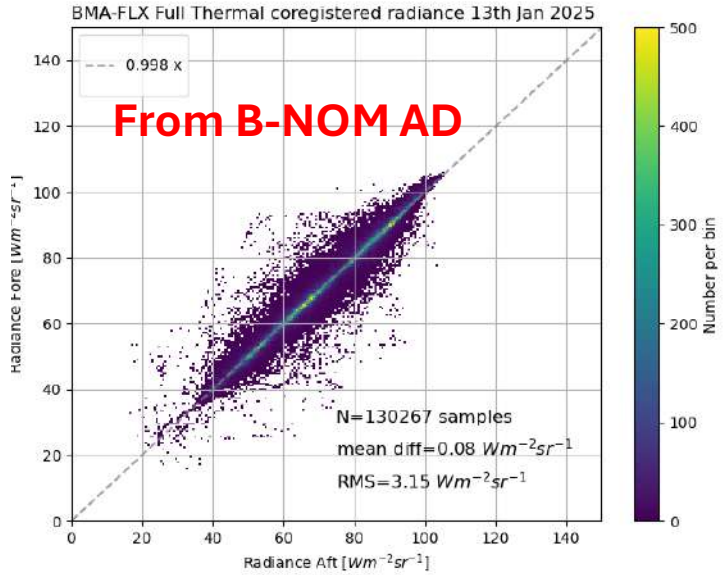


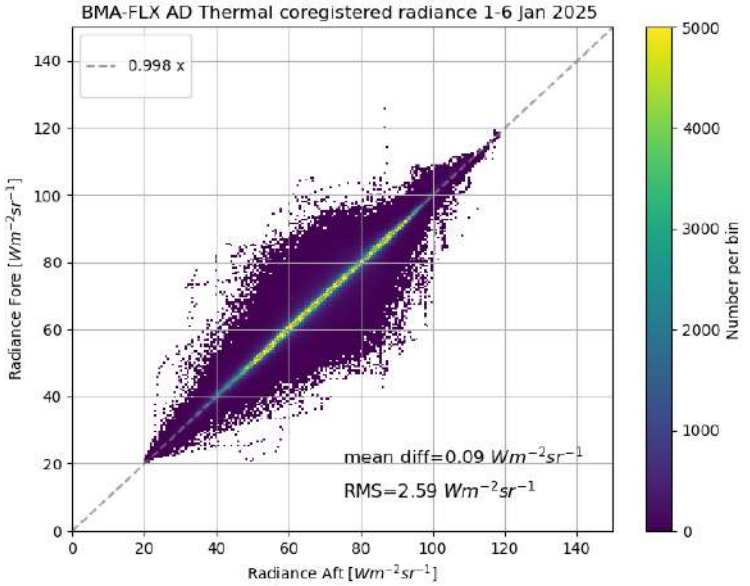


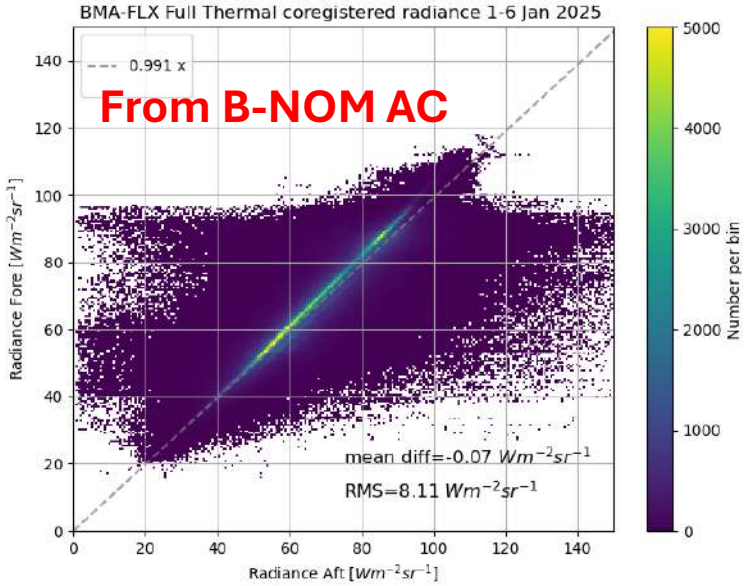
Off-nadir thermal radiances verification









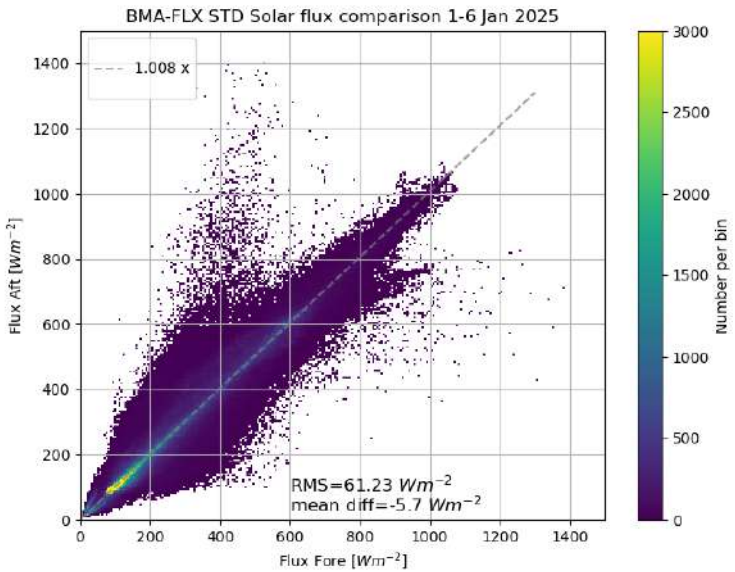


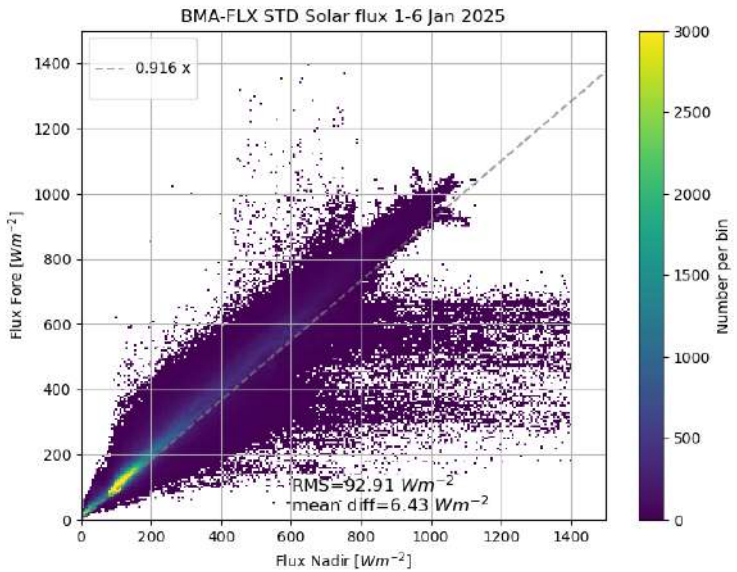
Dead pixel(6th) in the FORE view is integrated B-NOM AC Full resolution -> BM-RAD -> BMA-FLX

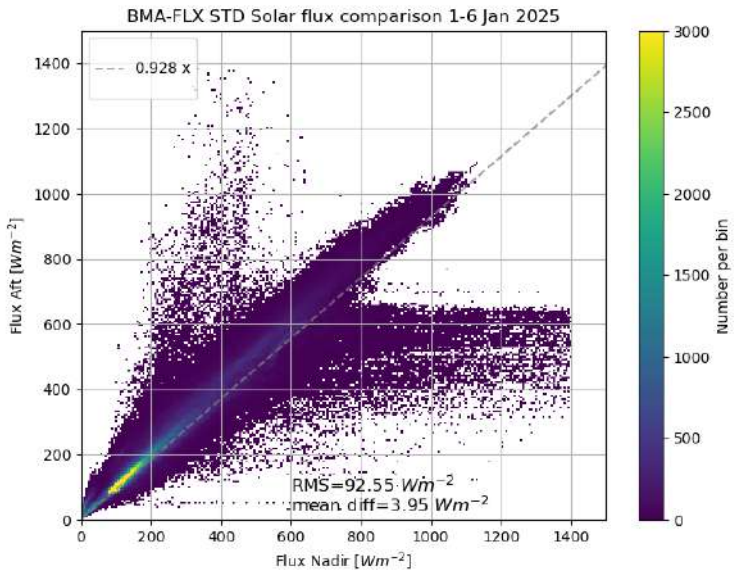
B-NOM AD corrected since 13/01/2025

BBR FLUXES COMPARISON: STD RESOLUTION

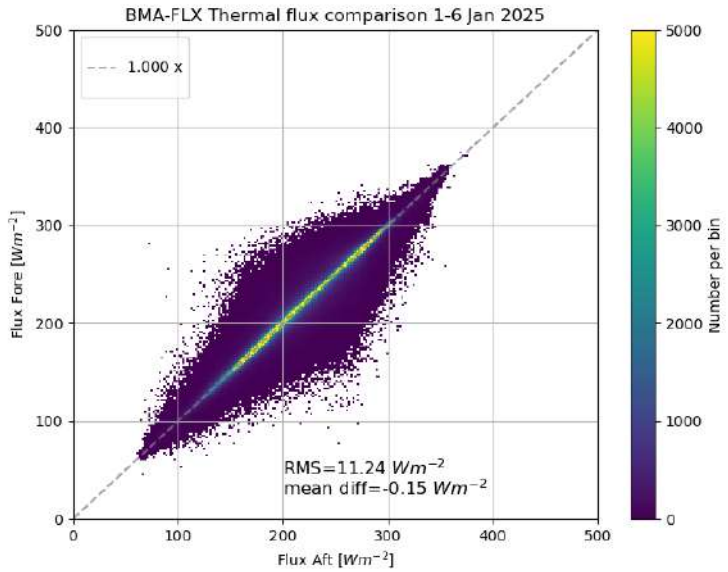
SOLAR

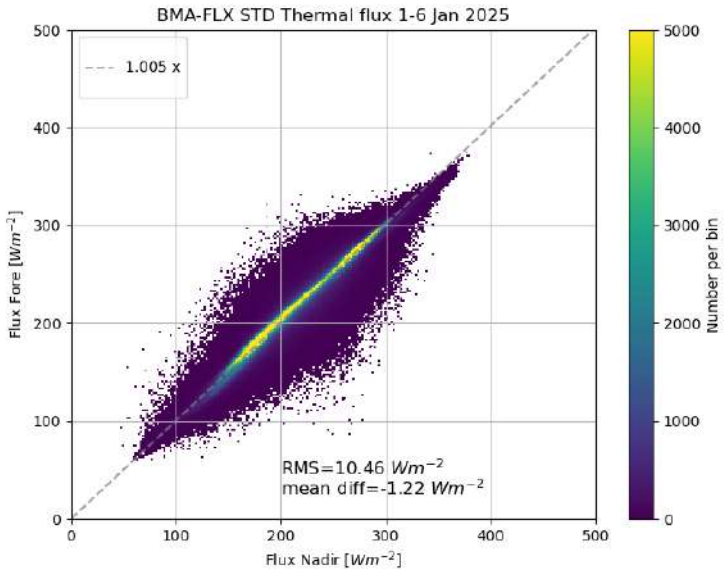


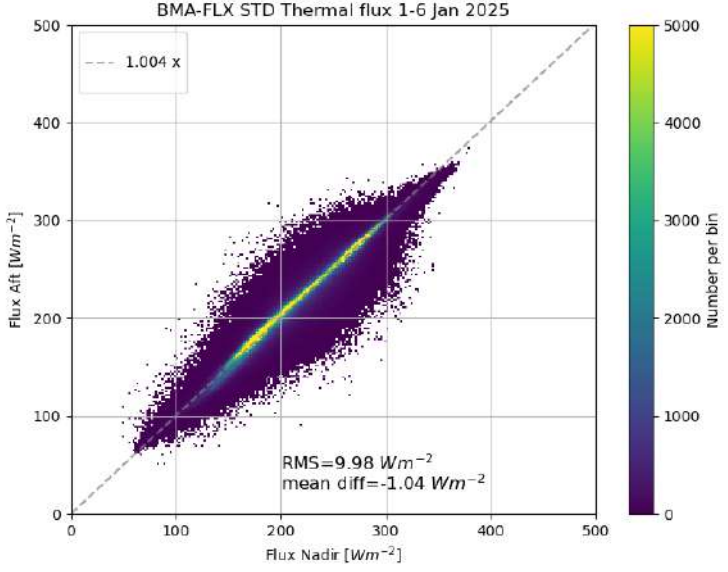




THERMAL

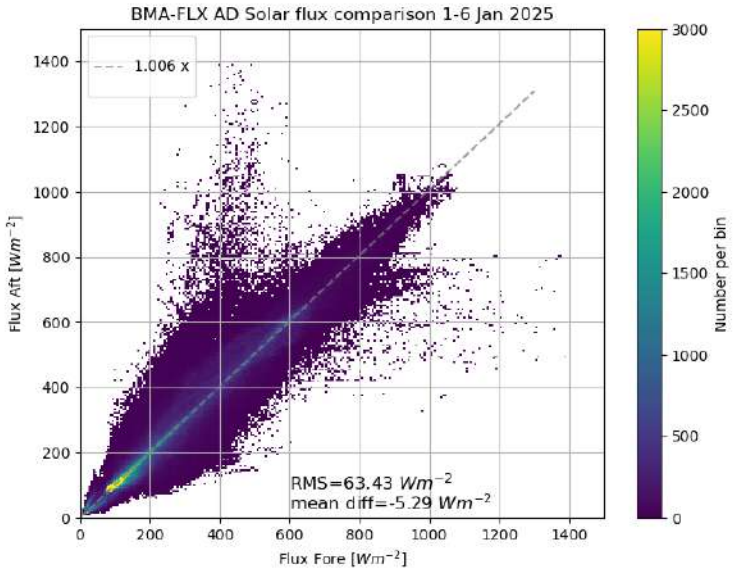


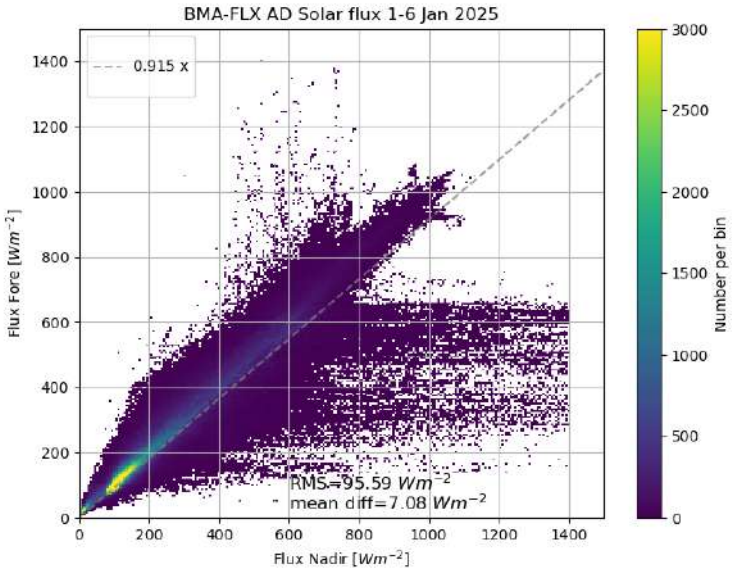


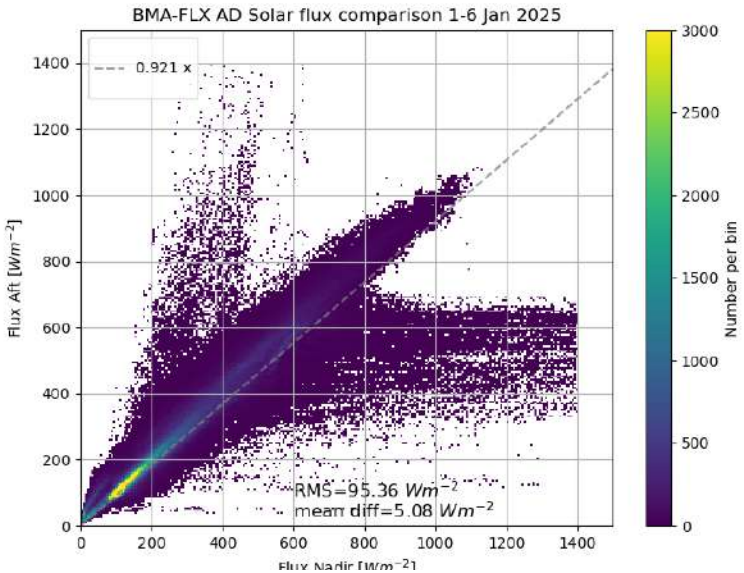


BBR FLUXES COMPARISON: AD RESOLUTION

SOLAR







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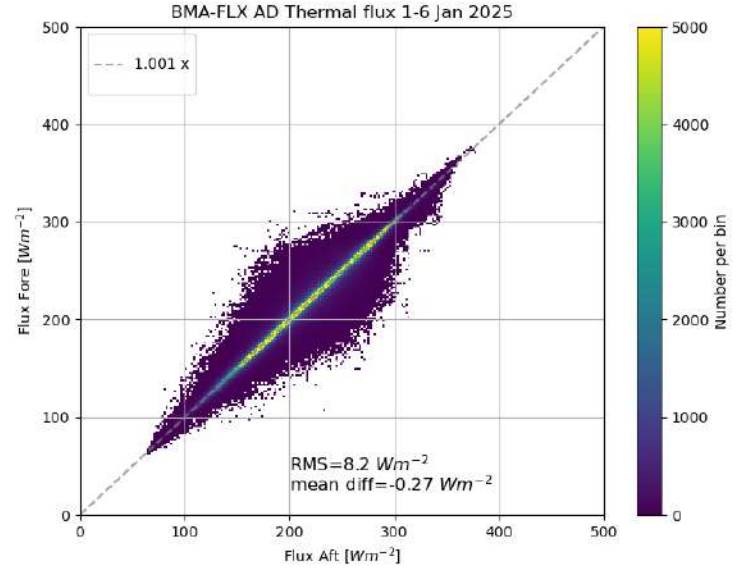
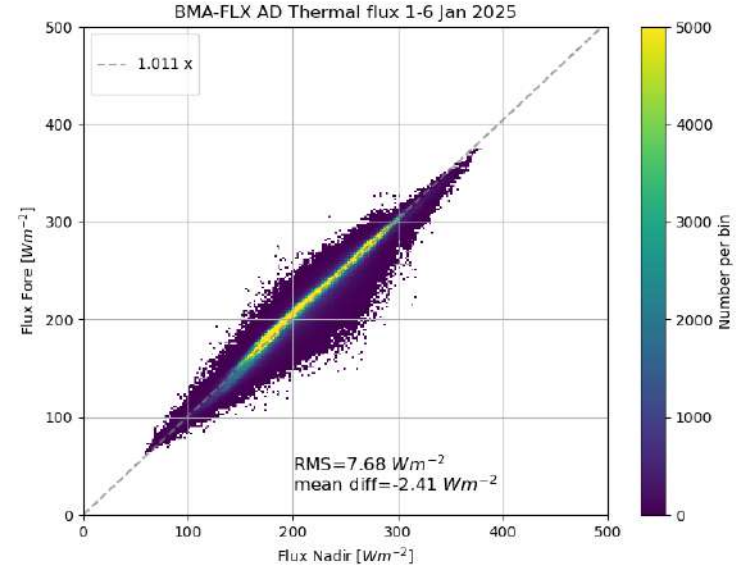
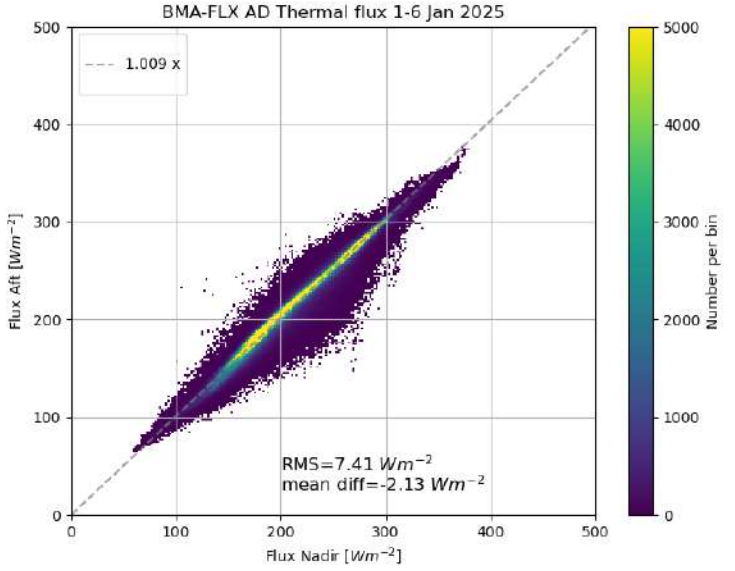
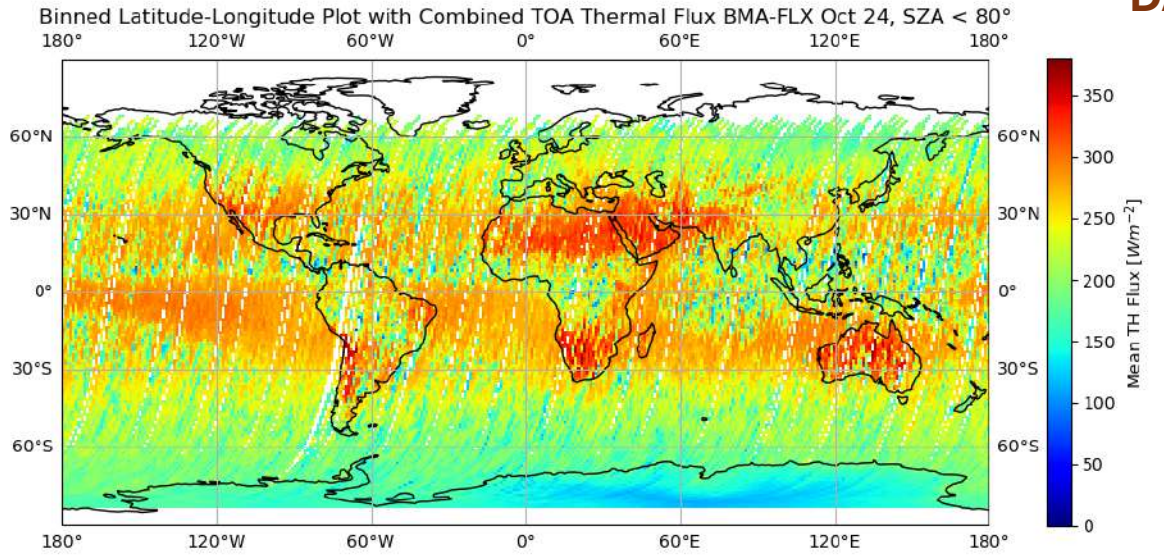




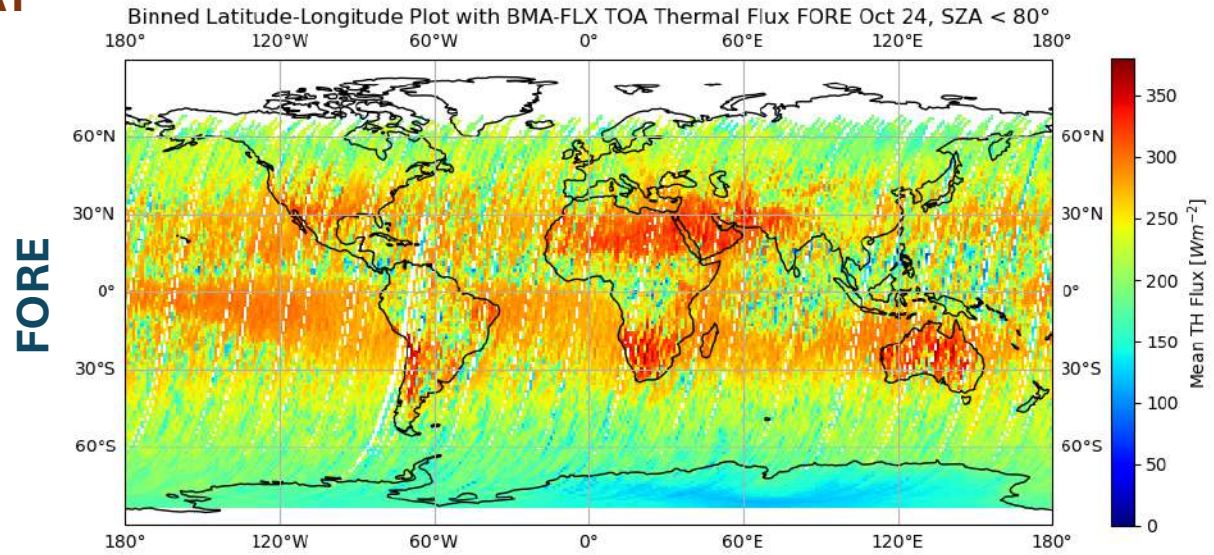


DAY

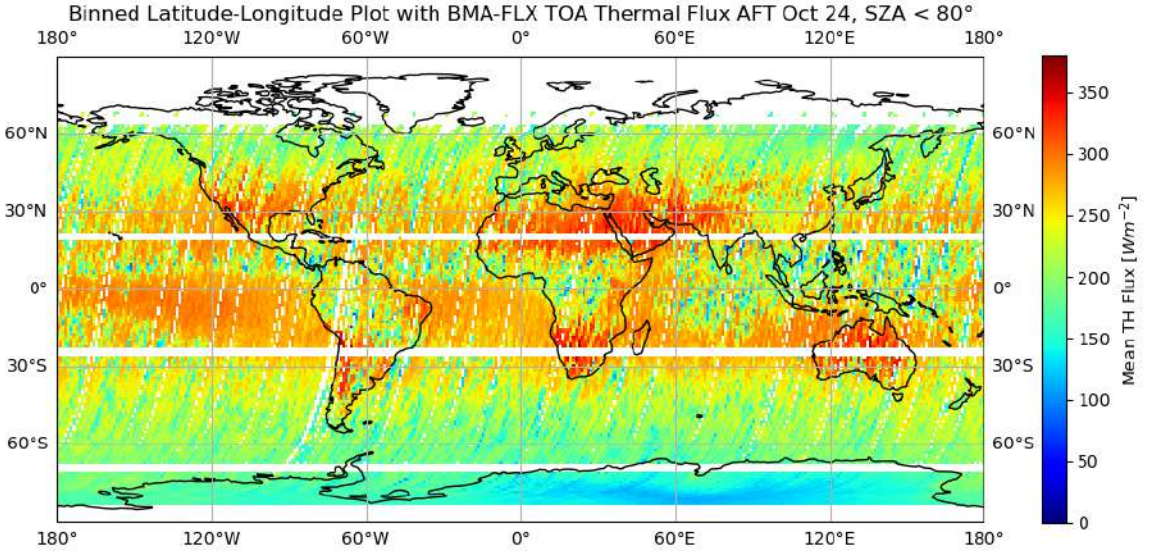
COMBINED



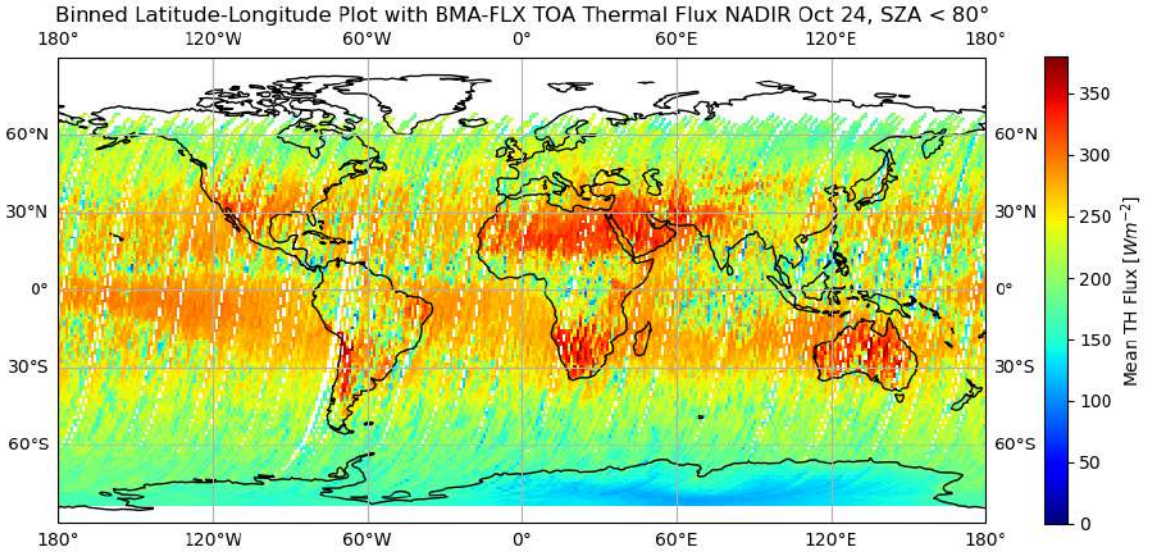
FORE



AFT

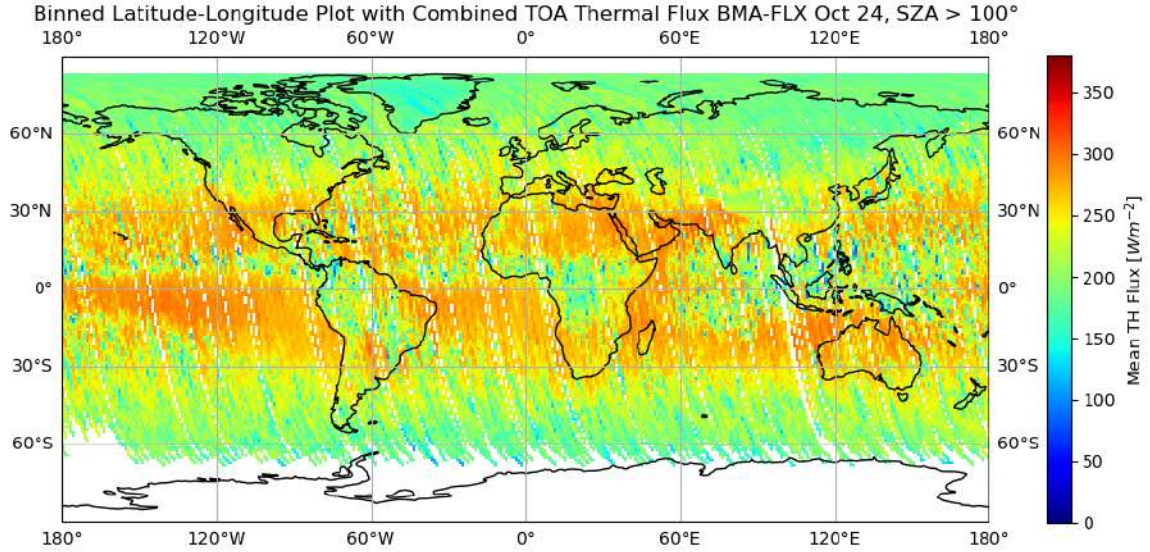


NADIR

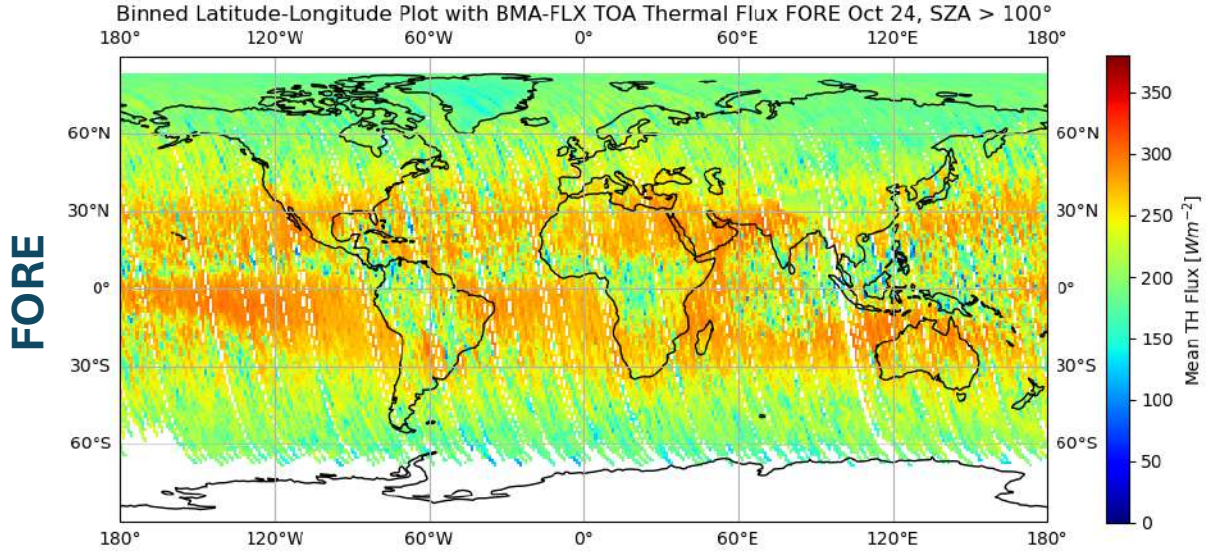


NIGHT

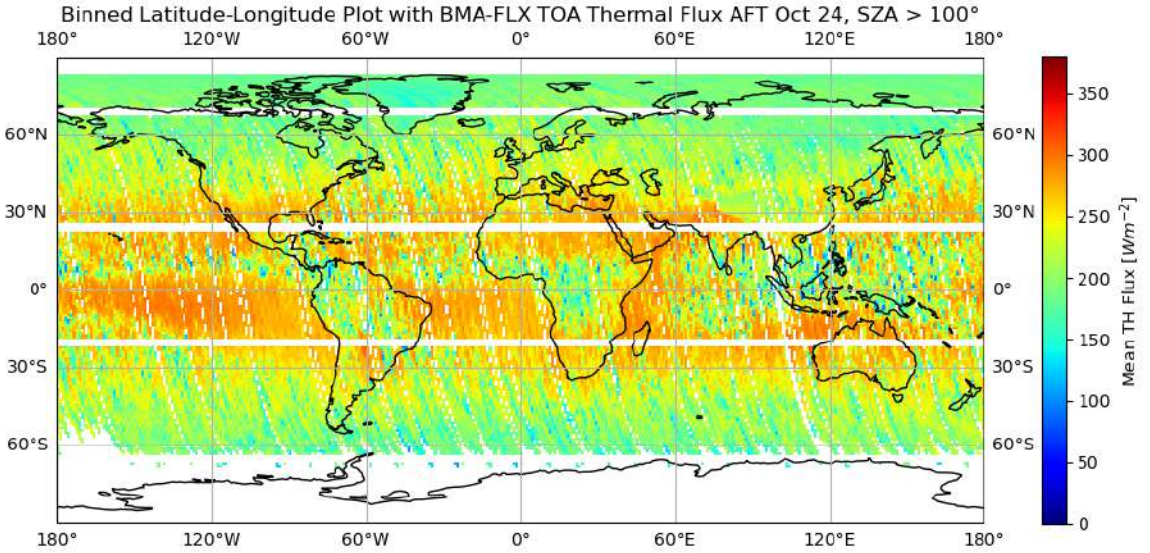
COMBINED



FORE



AFT



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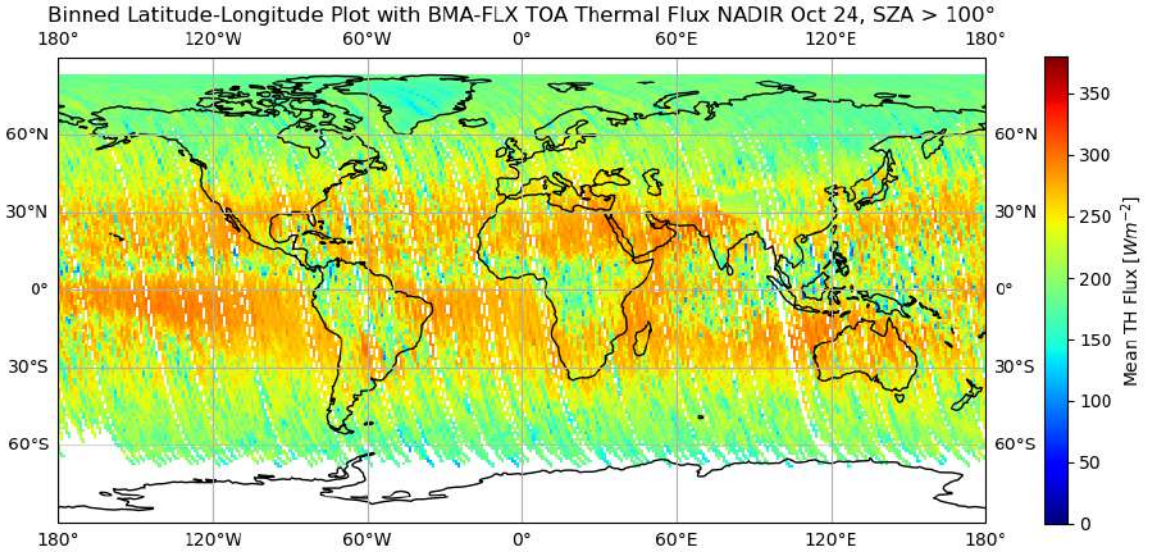
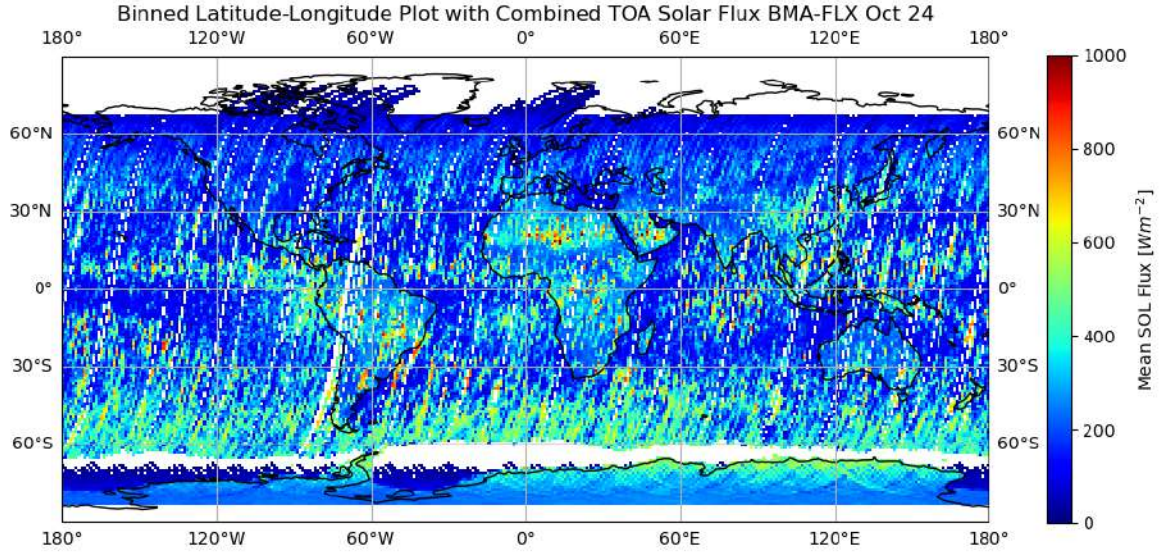
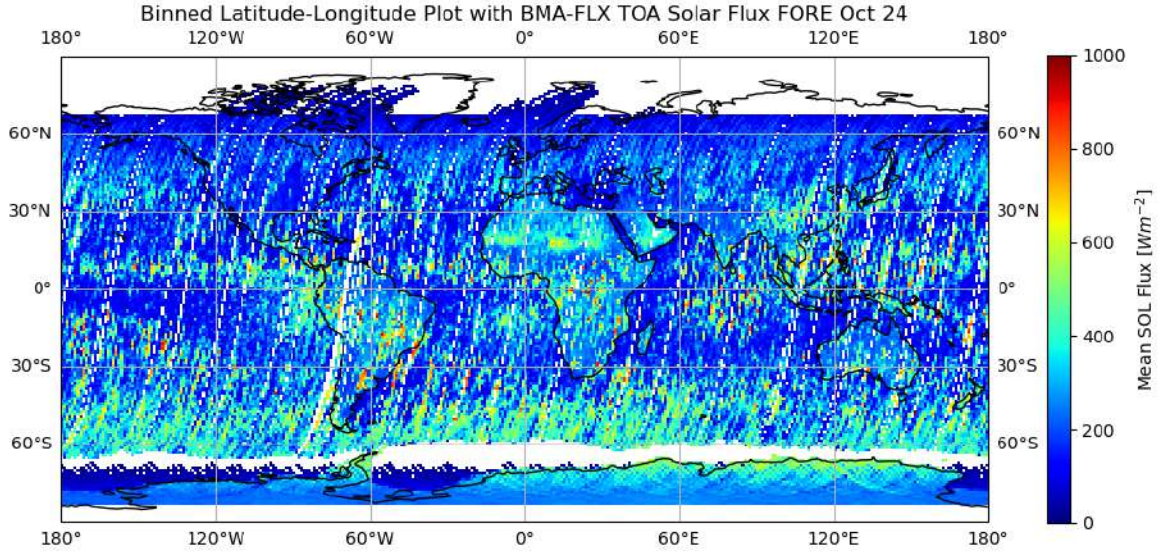


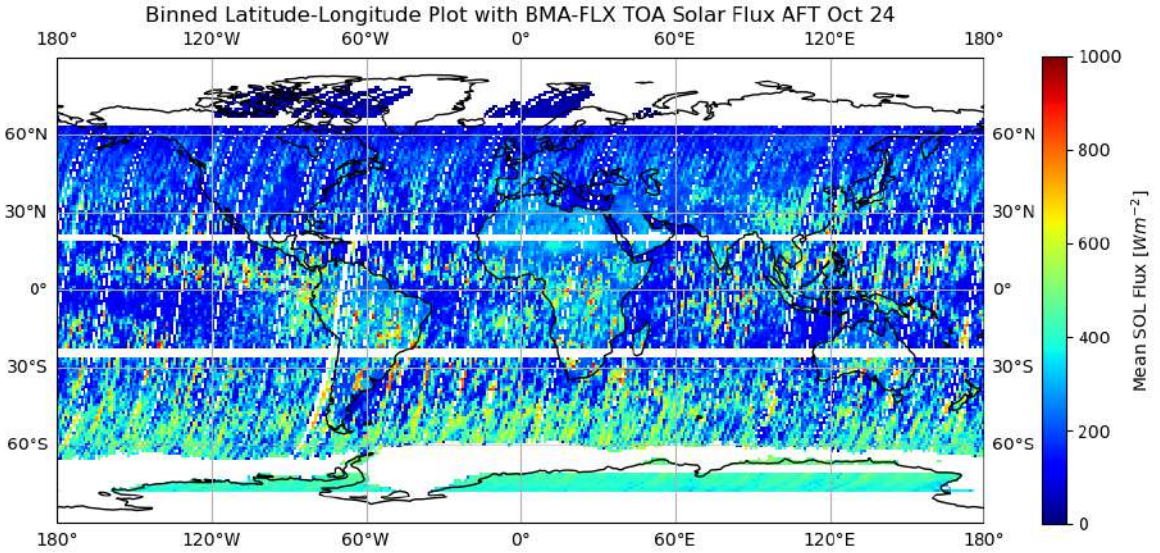
COMBINED



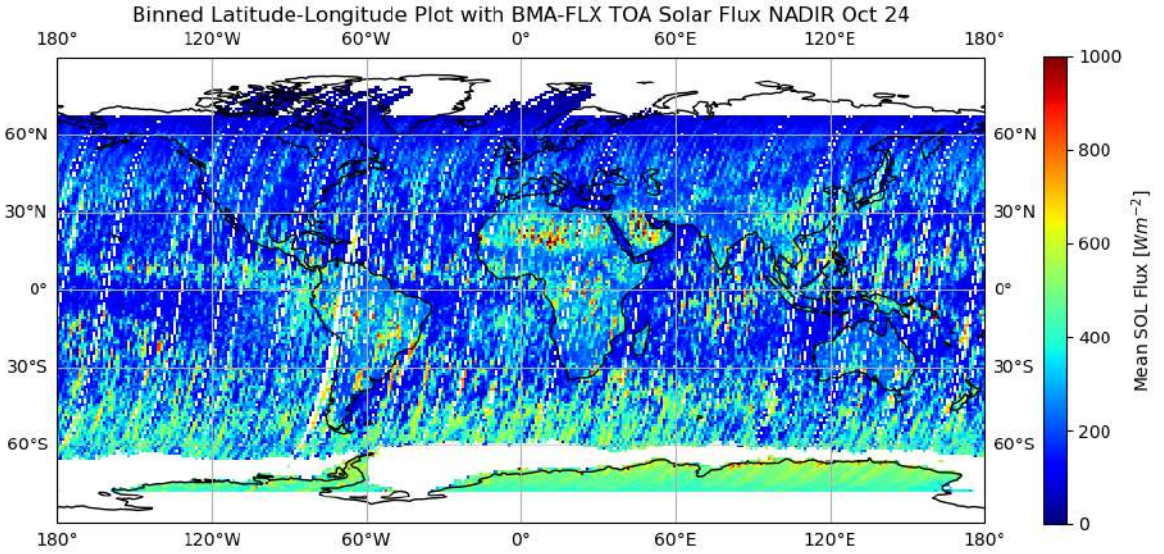
FORE



AFT

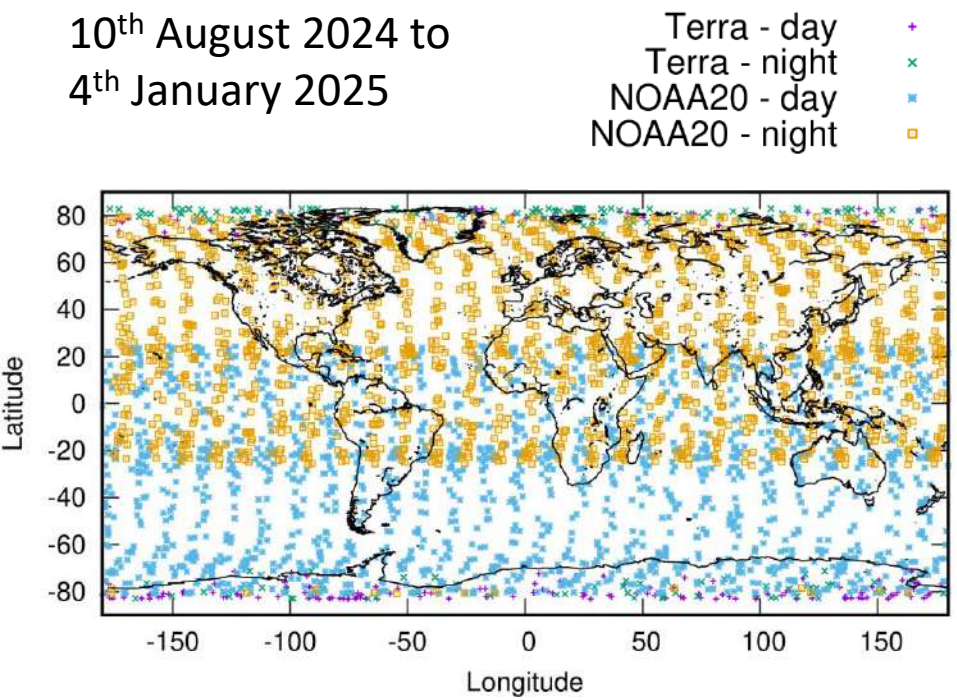


NADIR

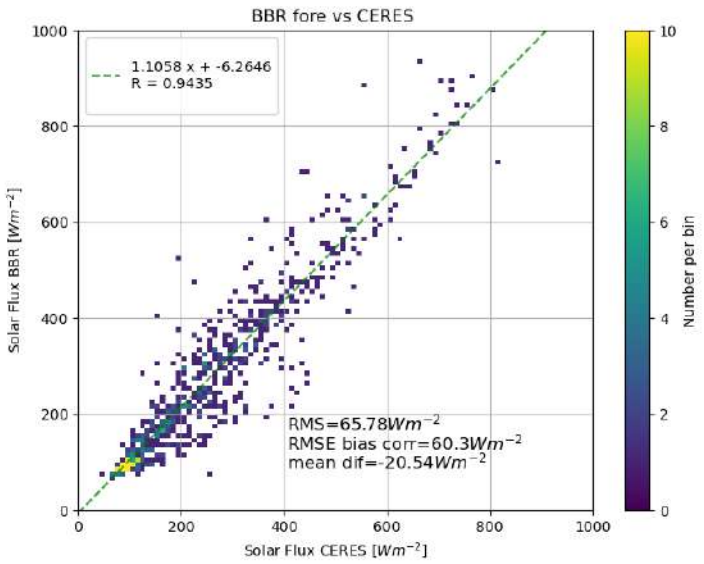


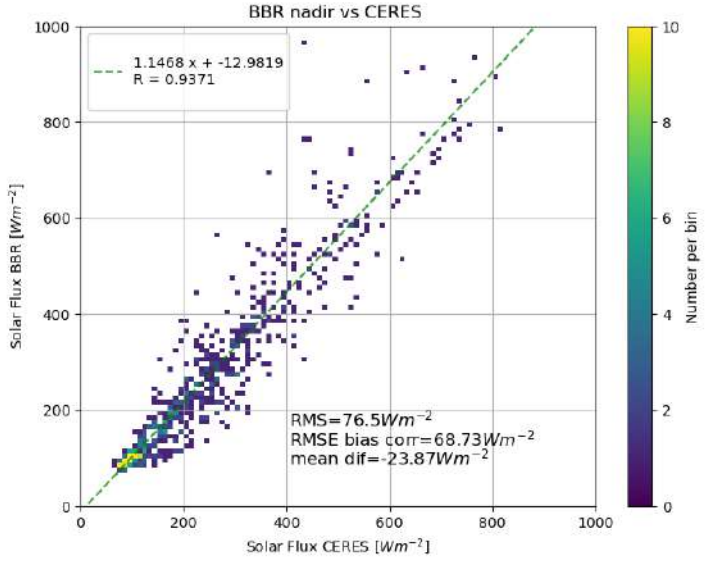
CERES FLASHflux comparison: SW

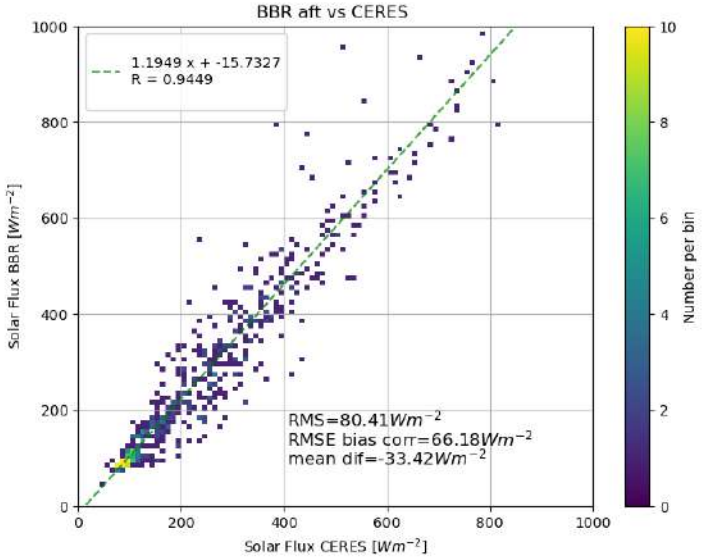
10th August 2024 to
4th January 2025

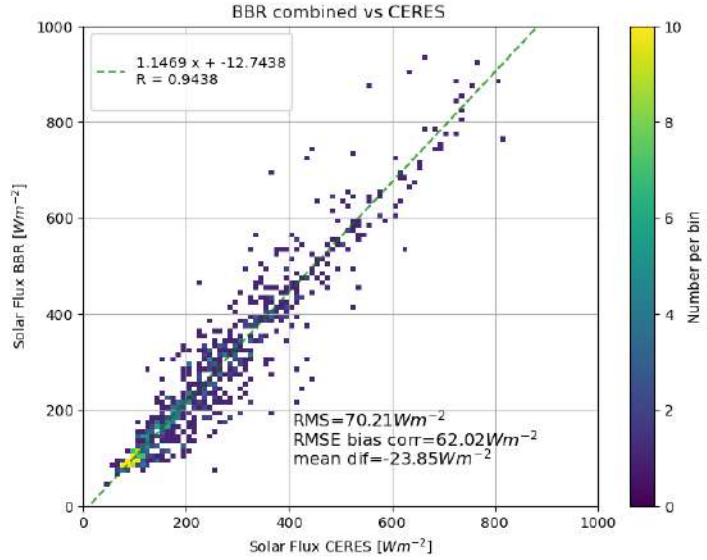


CERES VZA < 50 deg
Δdist < 3 km
Δtime < 5 min



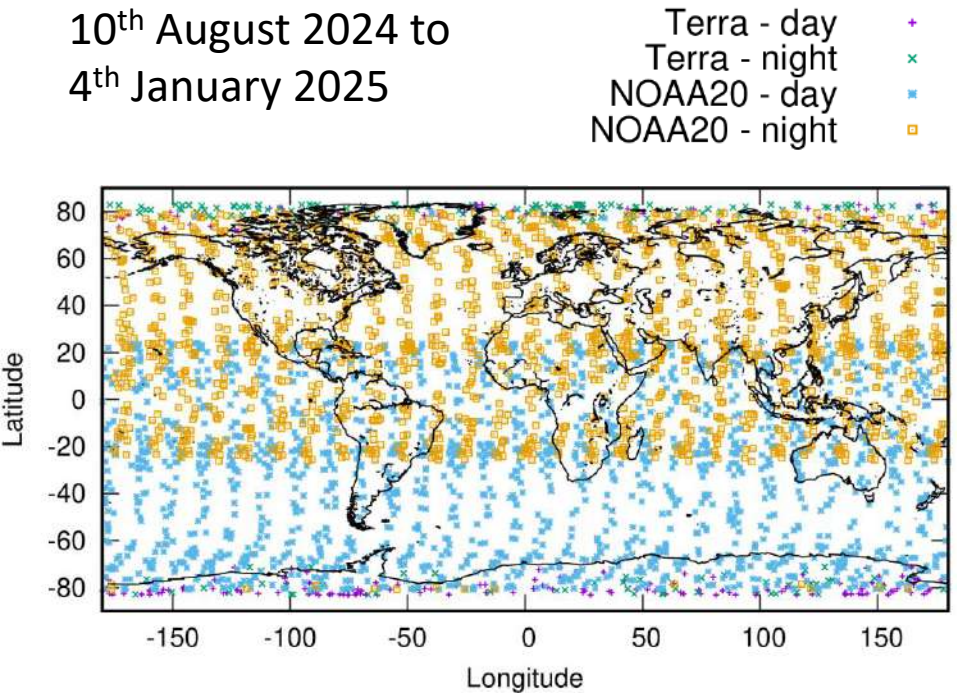




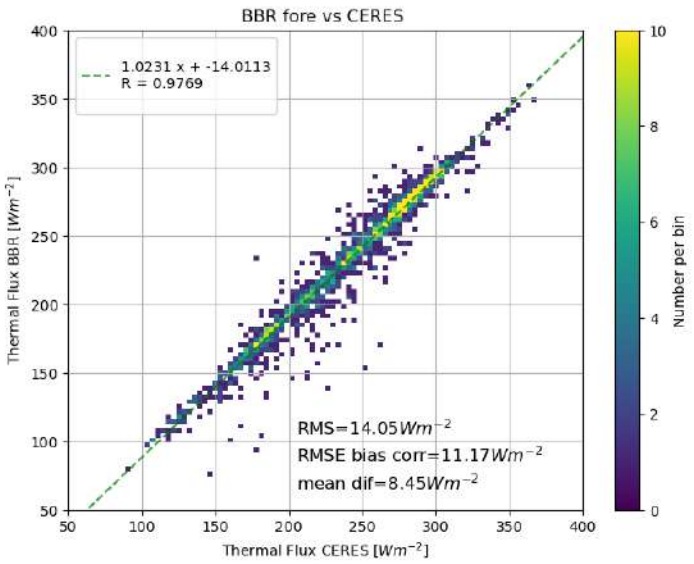


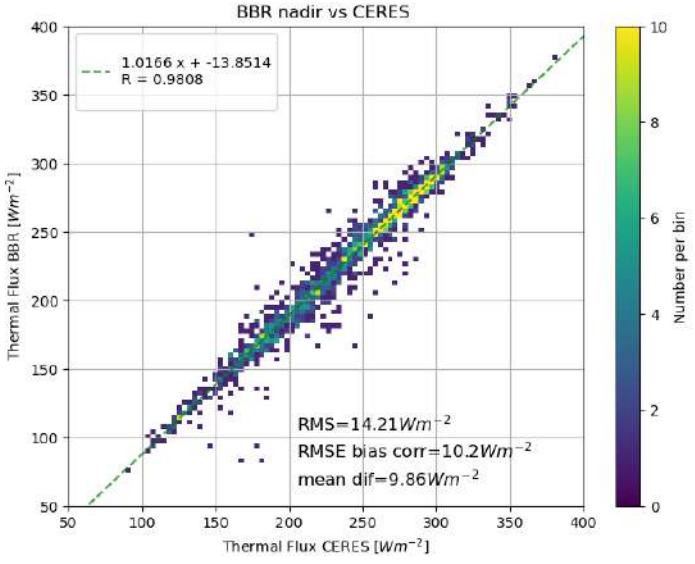
CERES FLASHflux comparison: LW

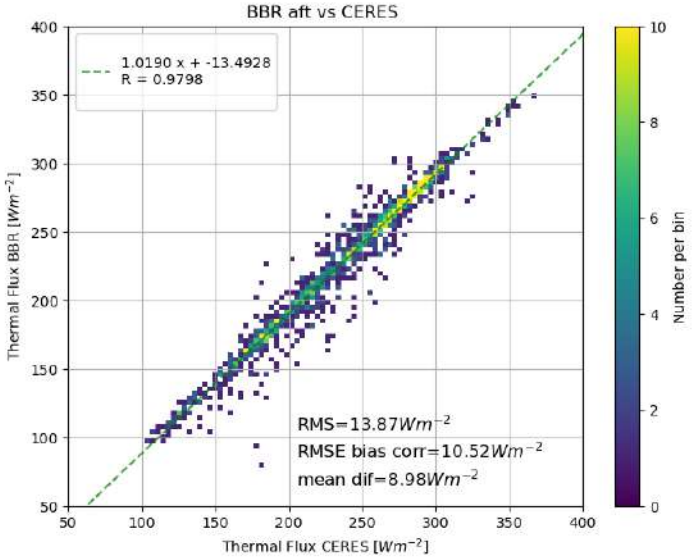
10th August 2024 to
4th January 2025

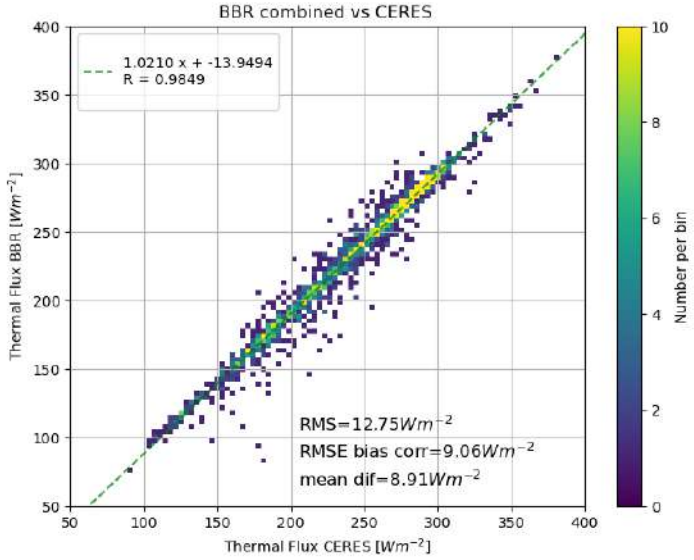


CERES VZA < 50 deg
Δdist < 3 km
Δtime < 5 min



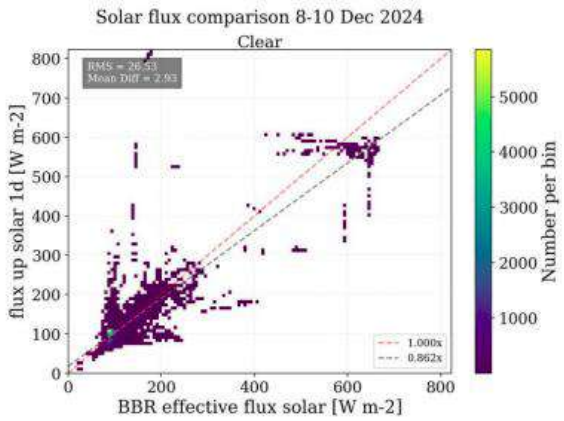


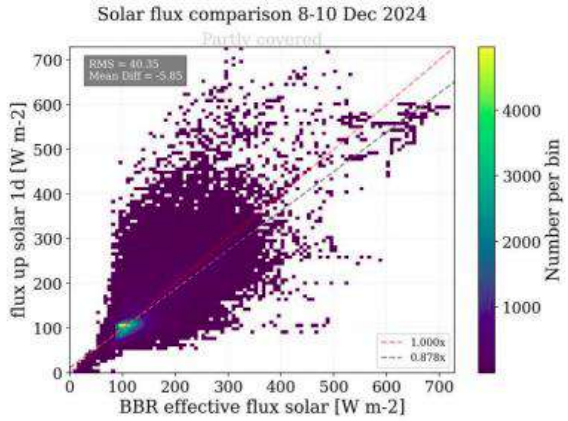


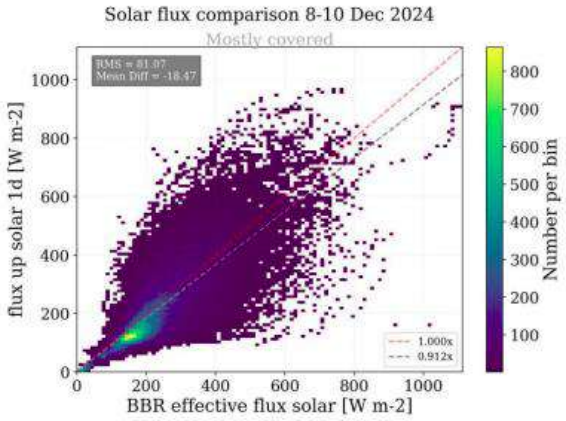


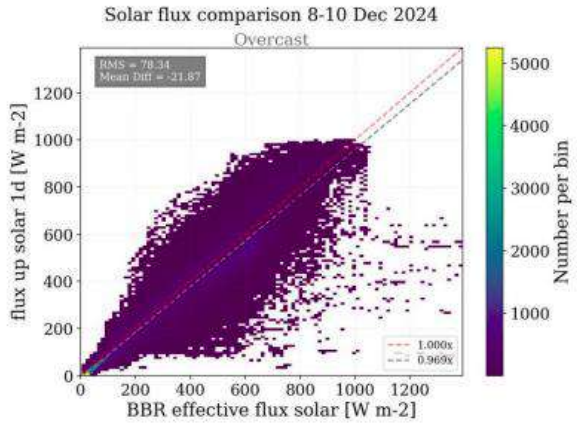
CLOSURE assessment with ALL-DF 1D

SOLAR

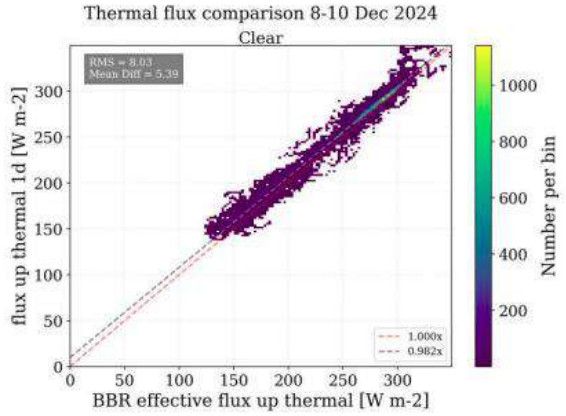


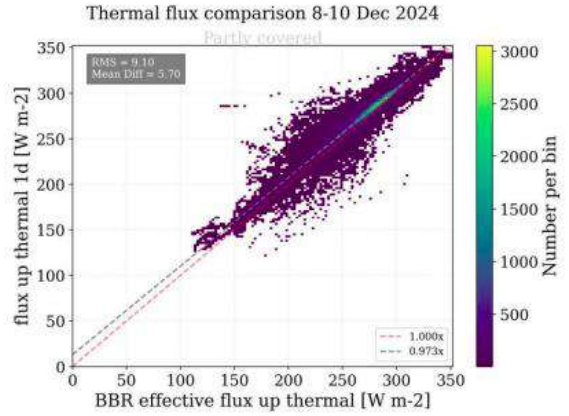


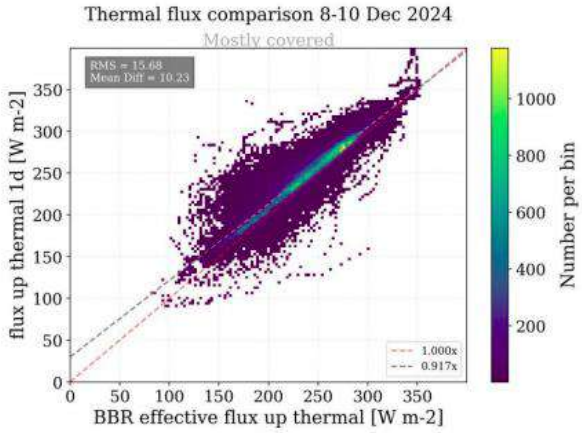


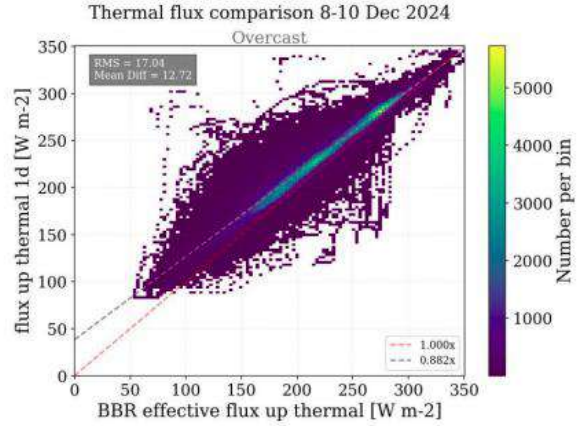


THERMAL









Summary

- Very good agreement for the BBR LW off-nadir radiances in all the resolutions (STD, Small and AD) except the Full (dead pixel problem in L1 baseline AC)
  - New baseline available (AD) for BBR L1 since 13/01/2025 frame 3571B masking the dead pixel

- LW fluxes show very good agreement between the 3 views

- SW fluxes comparison is more complicated→Sensitive to co-registration of the off-nadir views, cloud mask/properties, CTH, MSI radiances, ADMs, etc.

- Preliminary comparisons with CERES FLASHflux suggest that BBR SW fluxes are brighter than CERES (~11%) and BBR LW fluxes are lower (~8Wm^{-2}) → to be verified when CERES SSF data is available

- RMSE in the SW likely affected by collocation and not representative of the instantaneous combined flux error

- Closure comparisons to be consolidated using
  - Products using pdated cloud mask from M-CM (after 19th Dec)
  - 3D simulations from ALL-DF