EarthCARE MSI L1 performance and vicarious calibration

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2nd ESA-JAXA EarthCARE In-Orbit Validation Workshop
19/Mar-22/Mar 2025

Tasks:

1. L1b/L1c (NOM <->RGR) products consistency verification
2. Data flagging monitoring and statistics
3. MSI L1c radiometric verification
4. Geolocation & co-registration
5. Way forward: Vicarious Calibration(s)

Tasks:

1. L1b/L1c (NOM <->RGR) products consistency verification (accomplished)

2. Data flagging monitoring and statistics (ongoing activity in DISC, no serious issues)

3. MSI L1c radiometric verification

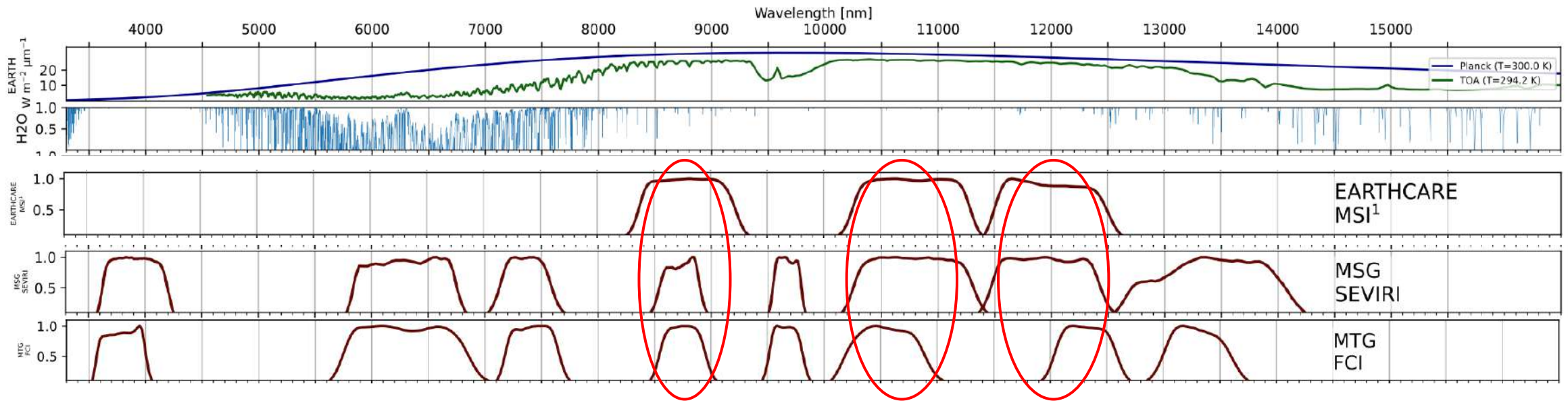
4. Geolocation & co-registration (problems solved, deeper investigations ongoing, see poster Edward Baudrez)

5. Way forward: Vicarious Calibration(s)

- **EarthCARE MSI Level 1 processing baseline AF, deployed and published since 27 Jan 2025****
  - **Update of the diffuser BSDF calibration data and colocation & co-registration calibration data**

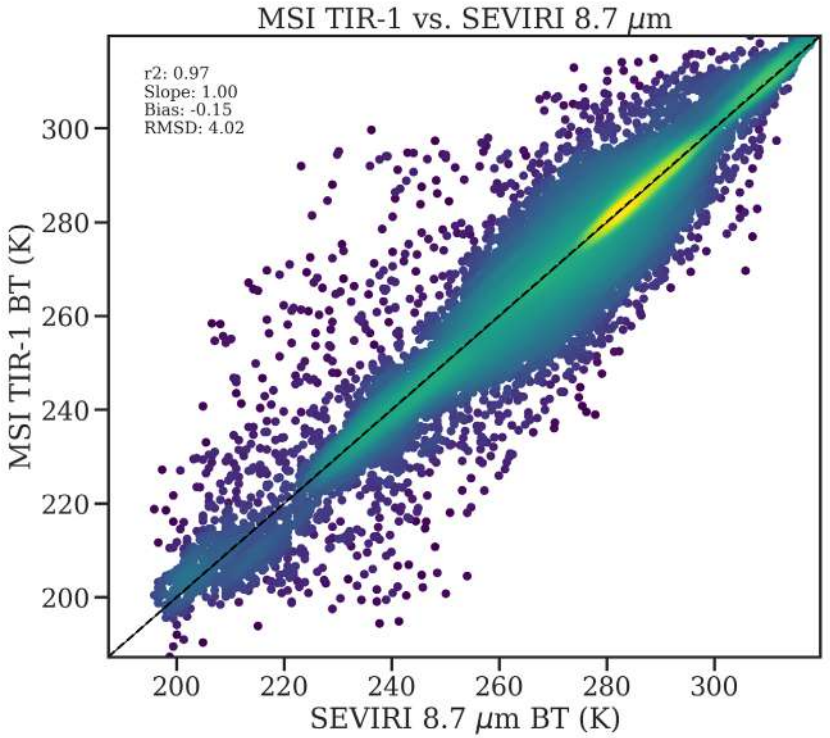
Baseline	Start Date (Frame)	Stop Date	Most important Updates
AF	28 Jan 2025 (03807C)		Coregistration and diffuser BSDF update; CCDB v14
AF	27 Jan 2025 (03790C)	28 Jan 2025 (03807B)	Only coregistration update; CCDB v13
AE	13 Jan 2025 (03569B)	27 Jan 2025 (03790B)	CCDB v13

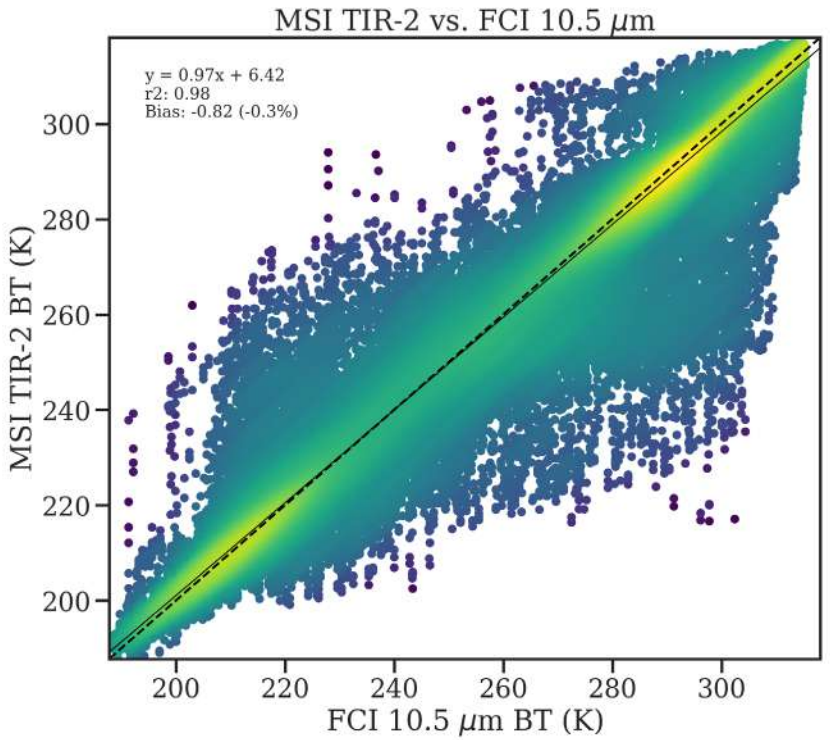
MSI TIR radiometry

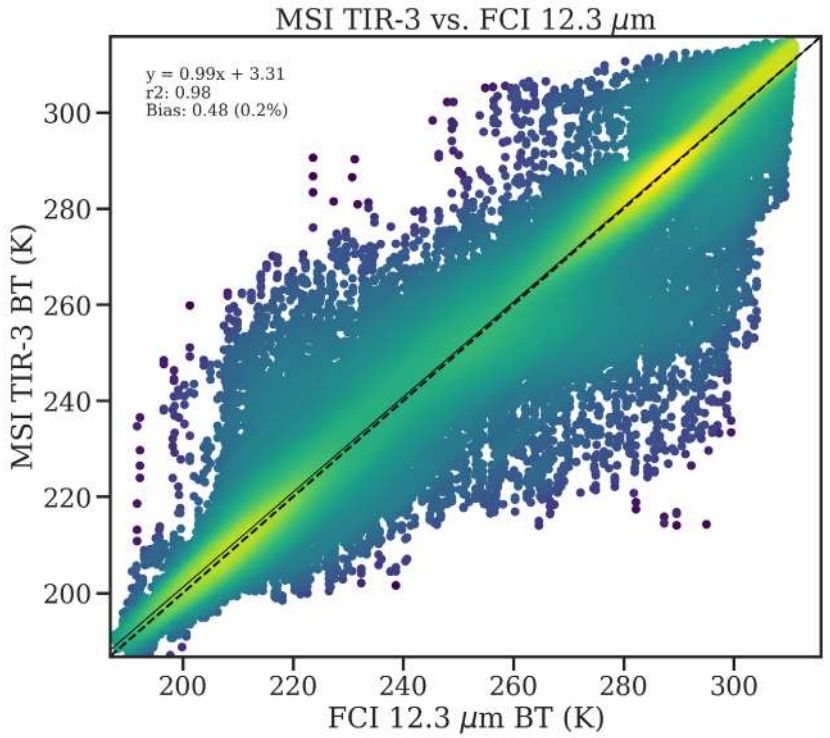


Inter-satellite comparisons allow a fast (rough) verification. However, a precise and accurate approach needs very stringent filtering and transfer (to account for ISRF differences) and accordingly many matchups. But glitches would be seen immediately!

Image: Jan El Kassar, FU-Berlin





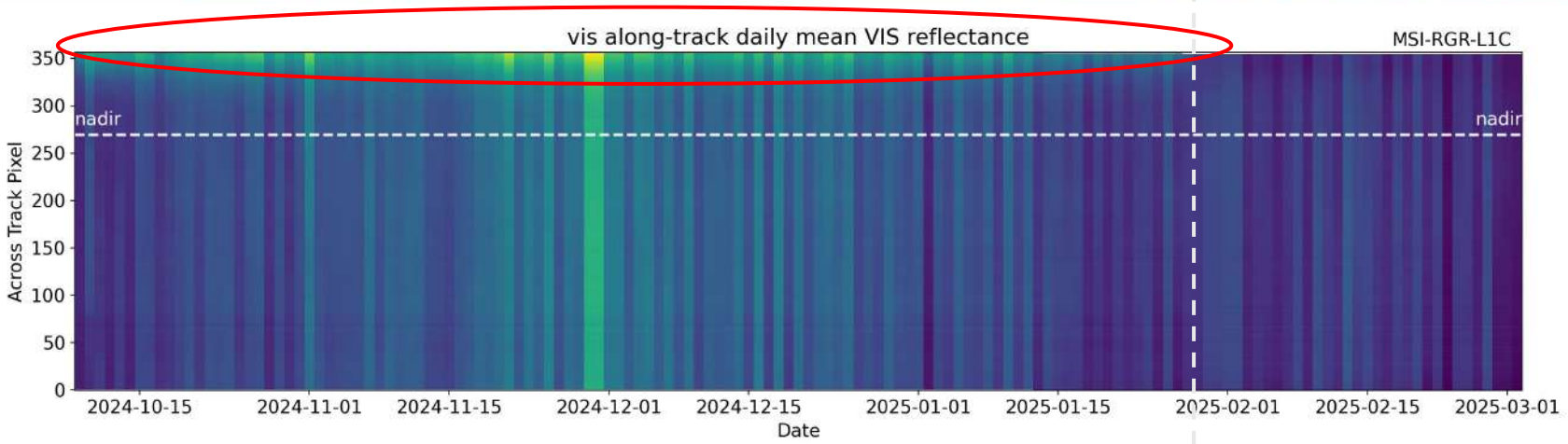


Simple satellite-to-satellite intercomparisons of MSI and FCI / Sevriri. (**Details see next presentation of Sebastian Bley**)

Take home: There are no indications of a serious problem ☺. (The large scatter is result of relaxed matchup filtering. In particular standard deviation, glint filter … which are standard for *ray-matching* vicarious calibration methods have not been applied)

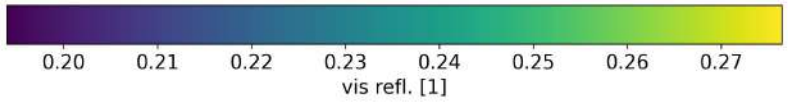
MSI VNS

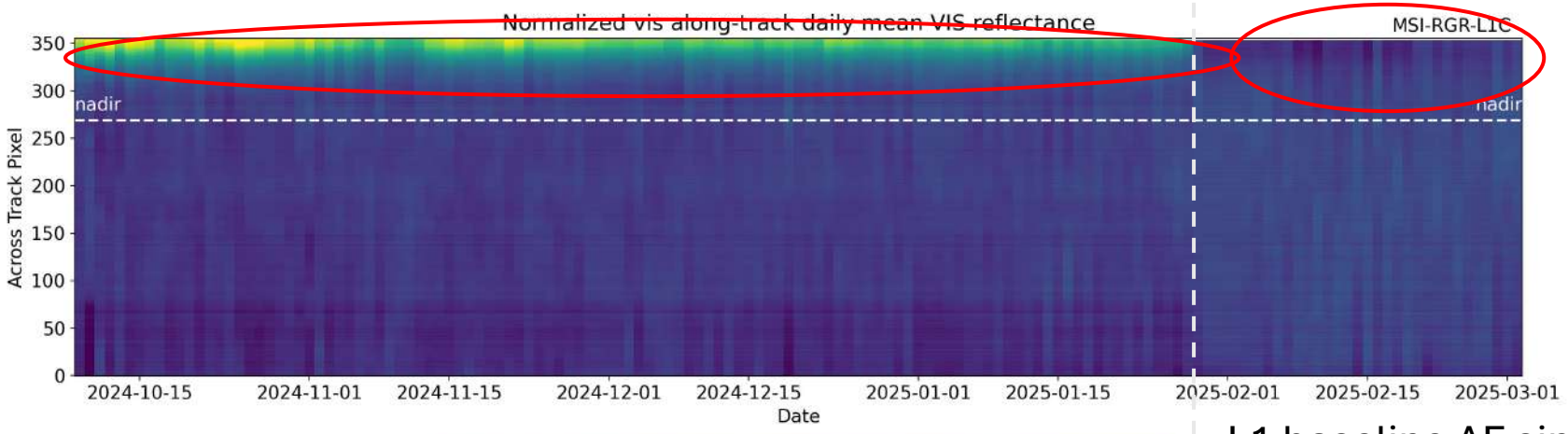
Temporal evolution of **TOA reflectance (VIS)**

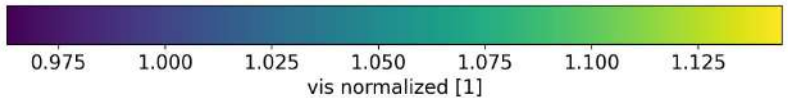


Oct2024

Mar2025







Pure daily mean VIS spectral reflectance for each across-track pixel

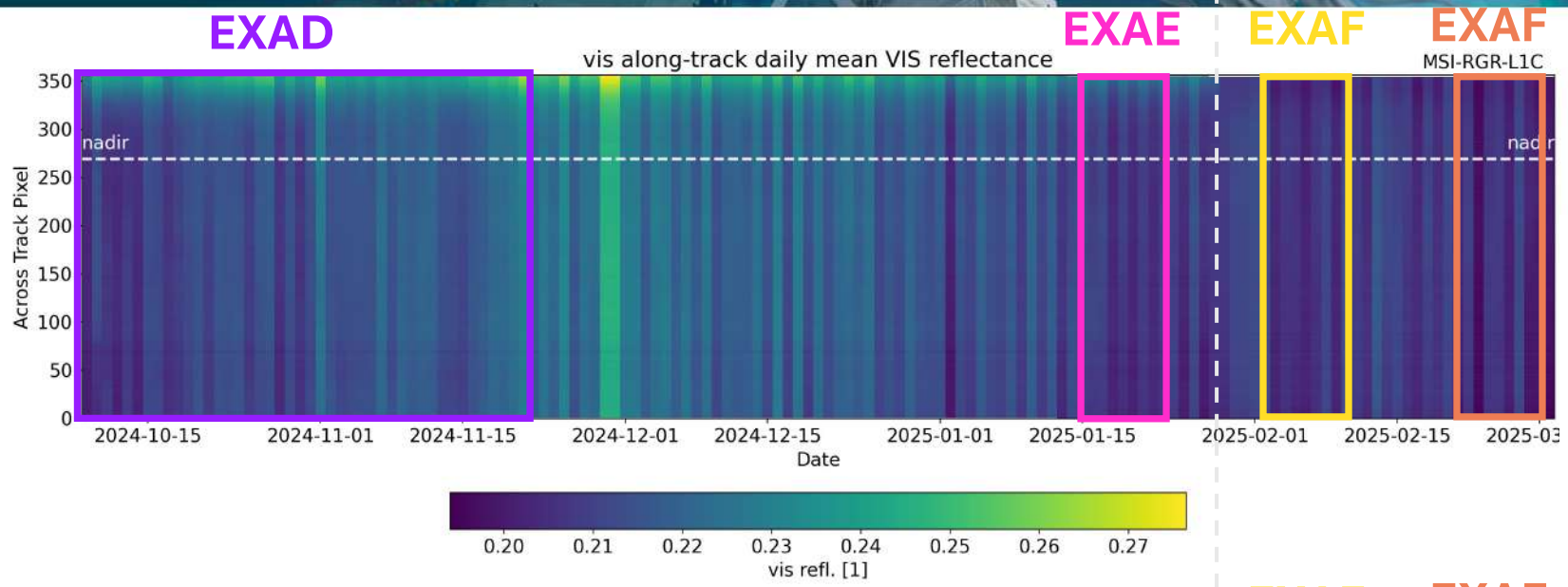
Normalization is done using the daily mean reflectance

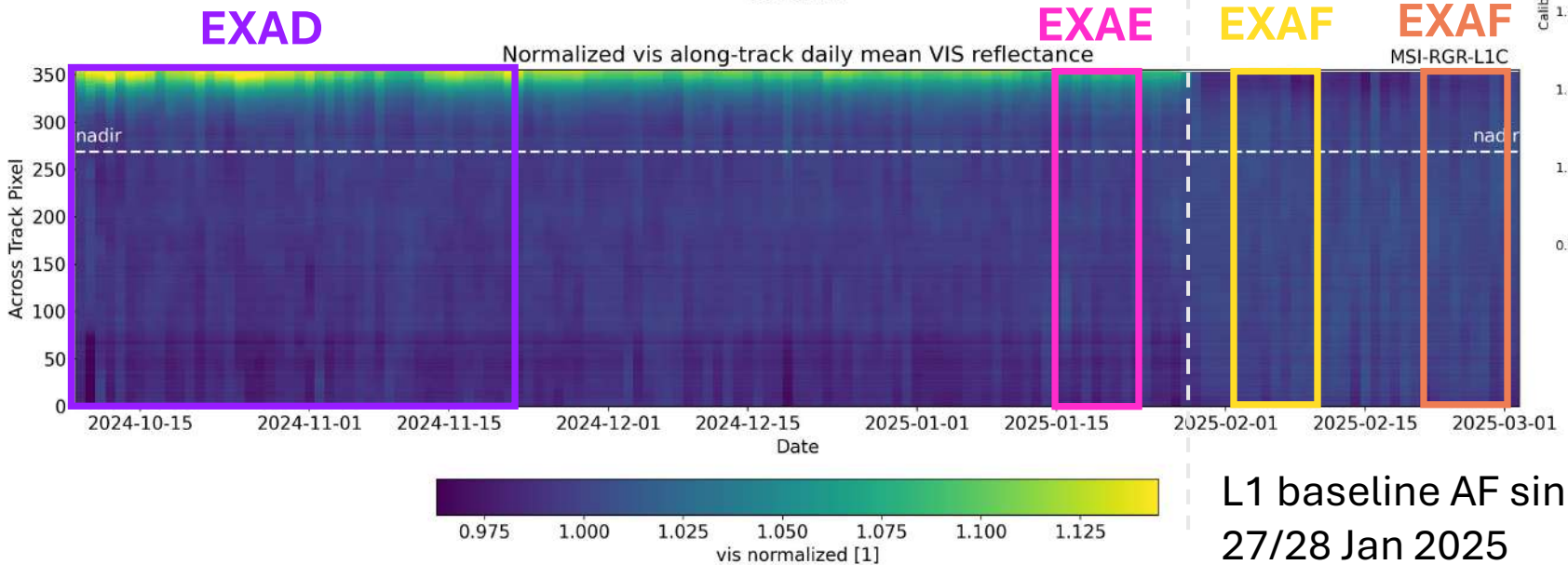
→ Only useful for across-track pixel variability

→ No information left about absolute deviations

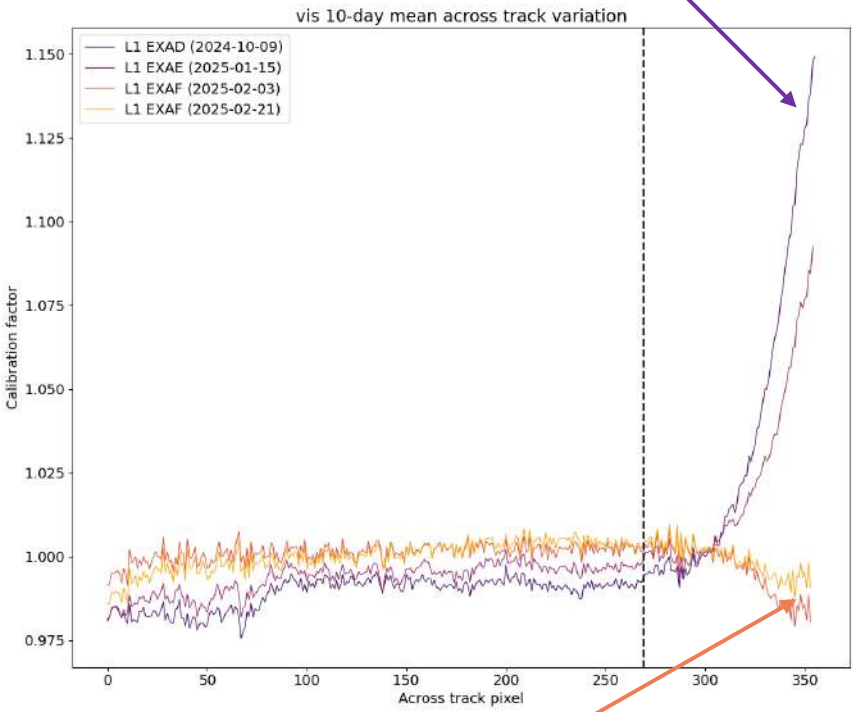
L1 baseline AF since 27/28 Jan 2025

Temporal evolution of TOA reflectance (VIS)





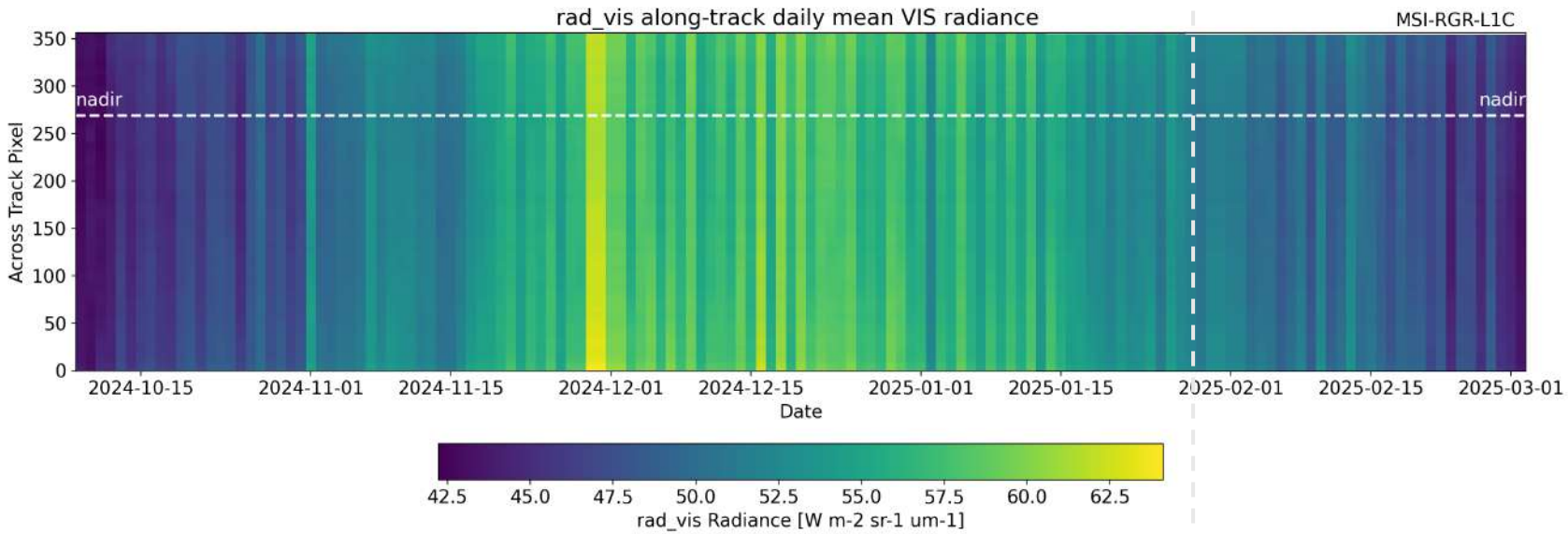
40-day period as reference for BSDF calculation/ normalisation/ 'fix'

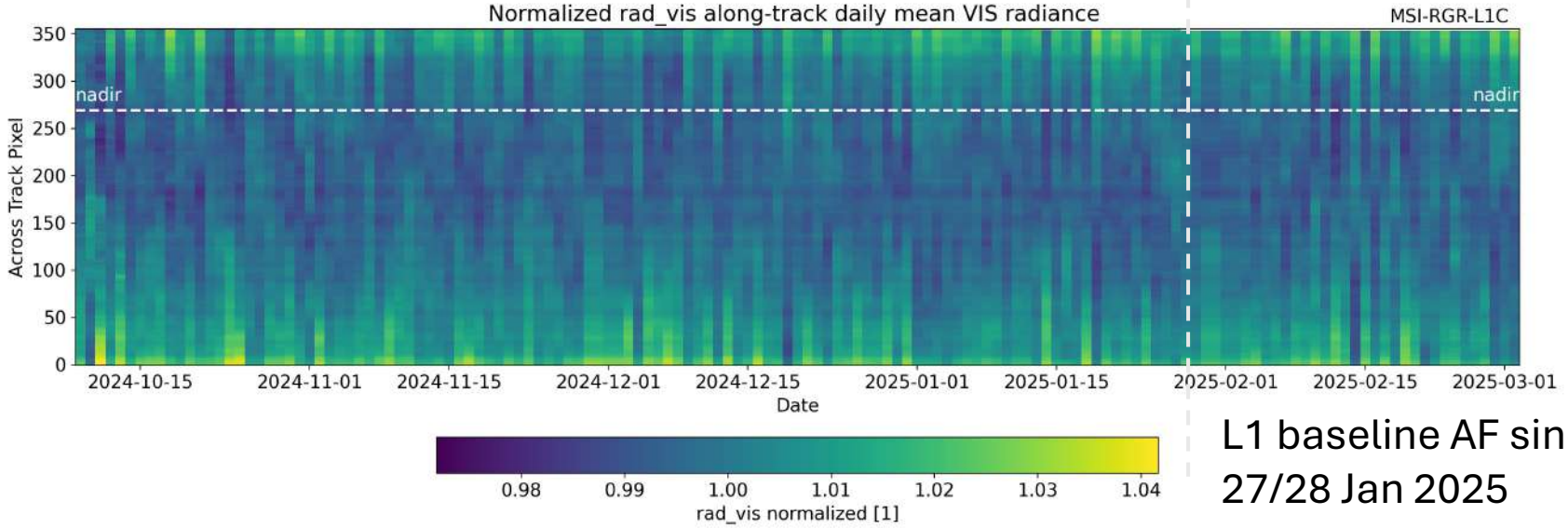


Overcorrection is temporally not constant

L1 baseline AF since 27/28 Jan 2025

Temporal evolution of **TOA spectral radiance (VIS)**

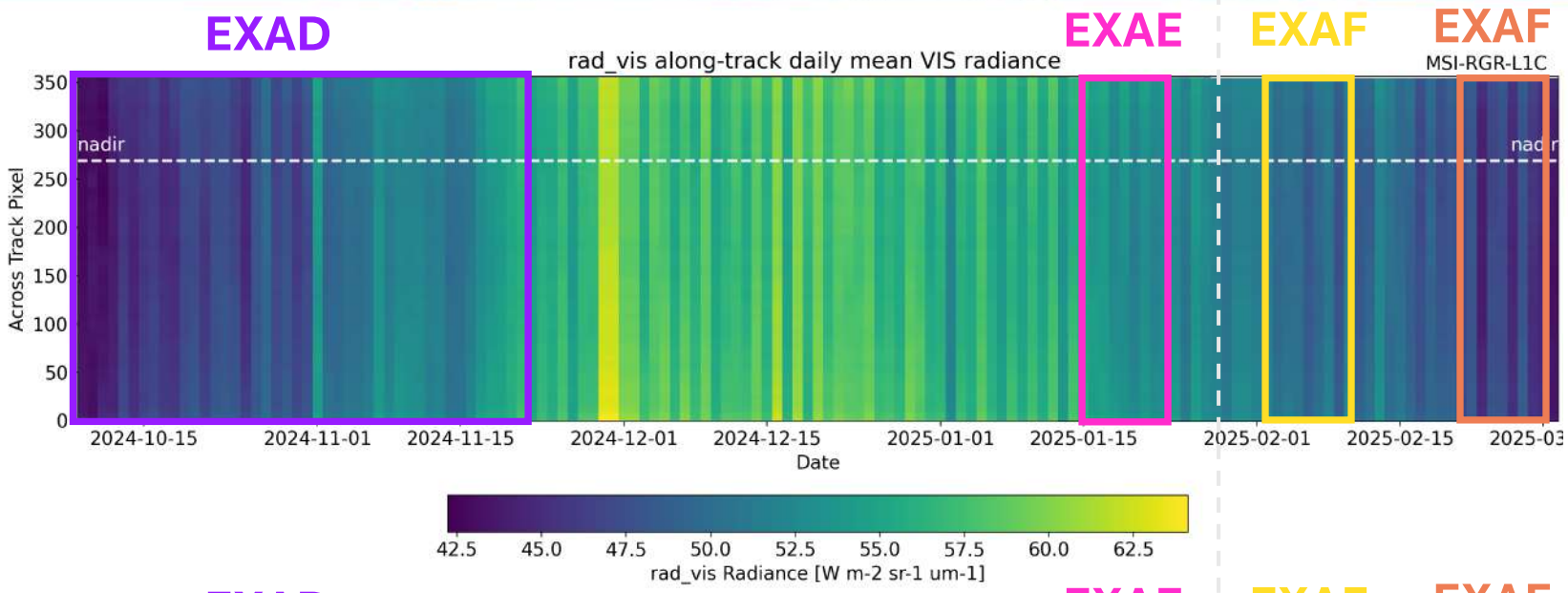


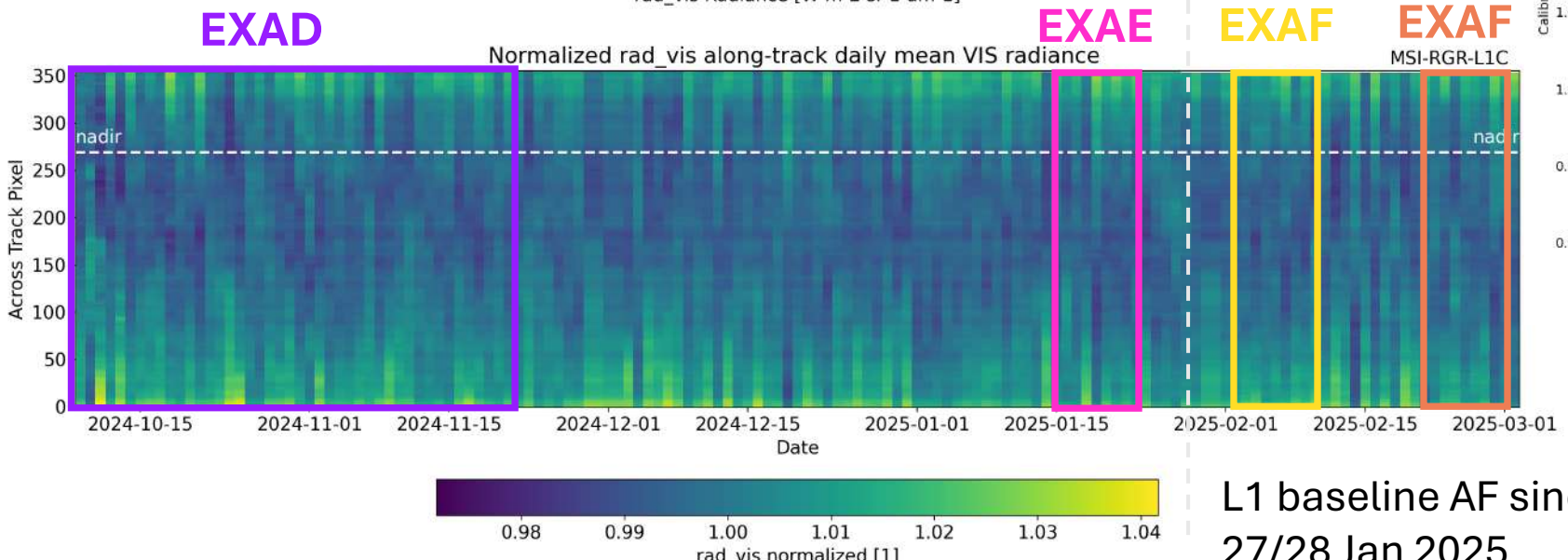


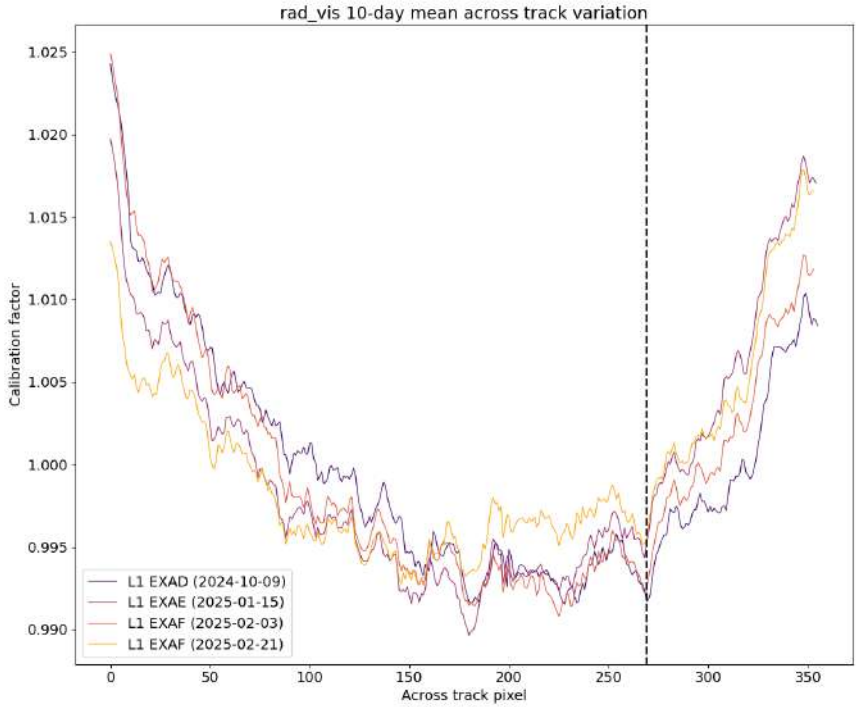
Spectral radiances certainly not effected from BSDF update.

L1 baseline AF since 27/28 Jan 2025

Temporal evolution of **TOA spectral radiance (VIS)**







Different shape of across-track variability.

L1 baseline AF since 27/28 Jan 2025

Why does the across track variability of reflectance and radiance differ for VNS ??? (its just a 150km swath)

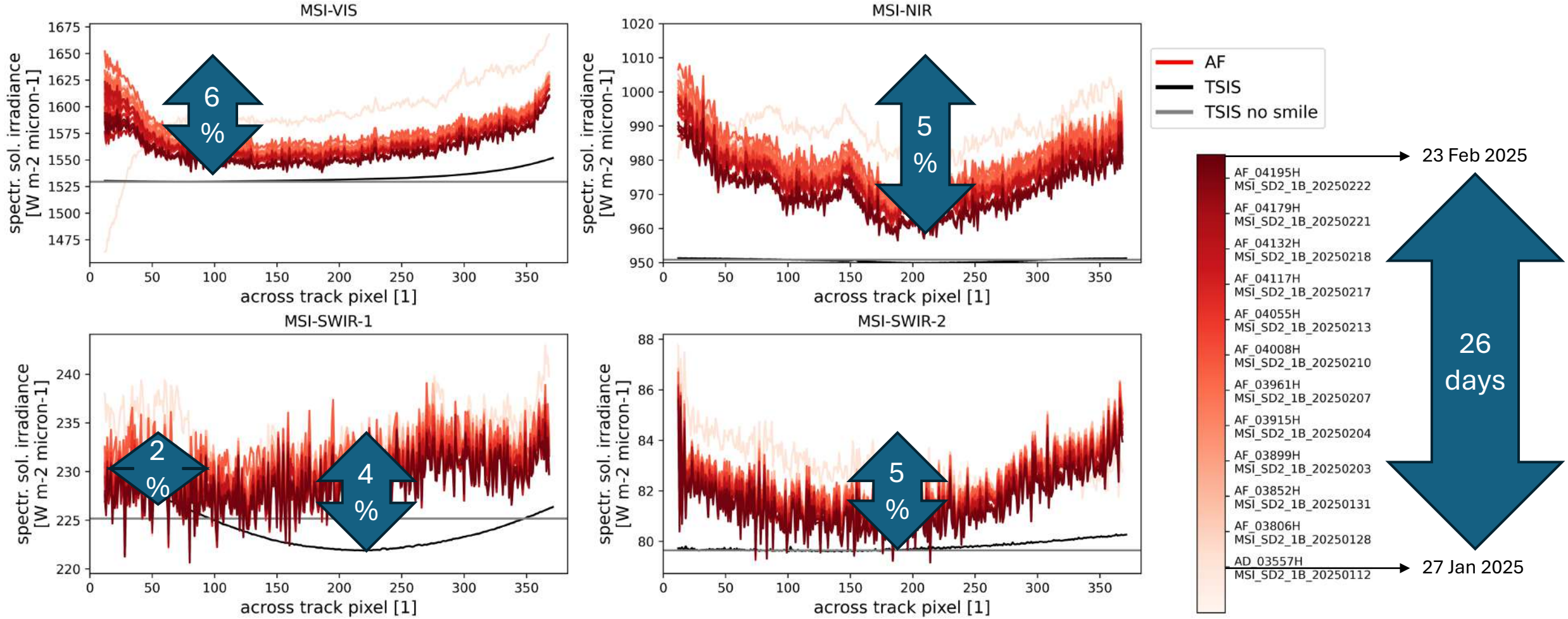
Because the used ‘solar irradiance’ is the one ‘pixel-by-pixel measured’ by MSI

→

There is an issue with the diffusor!

Spectral solar irradiance in AF baseline across track behaviour and its temporal evolution

Spectral solar irradiance as reported in MSI_RGR_1C baseline **AF**, reddish colours list corresponding MSI_SD2_1B; curve shown whenever there is a change reported in underlying MSI_SD2_1B file used

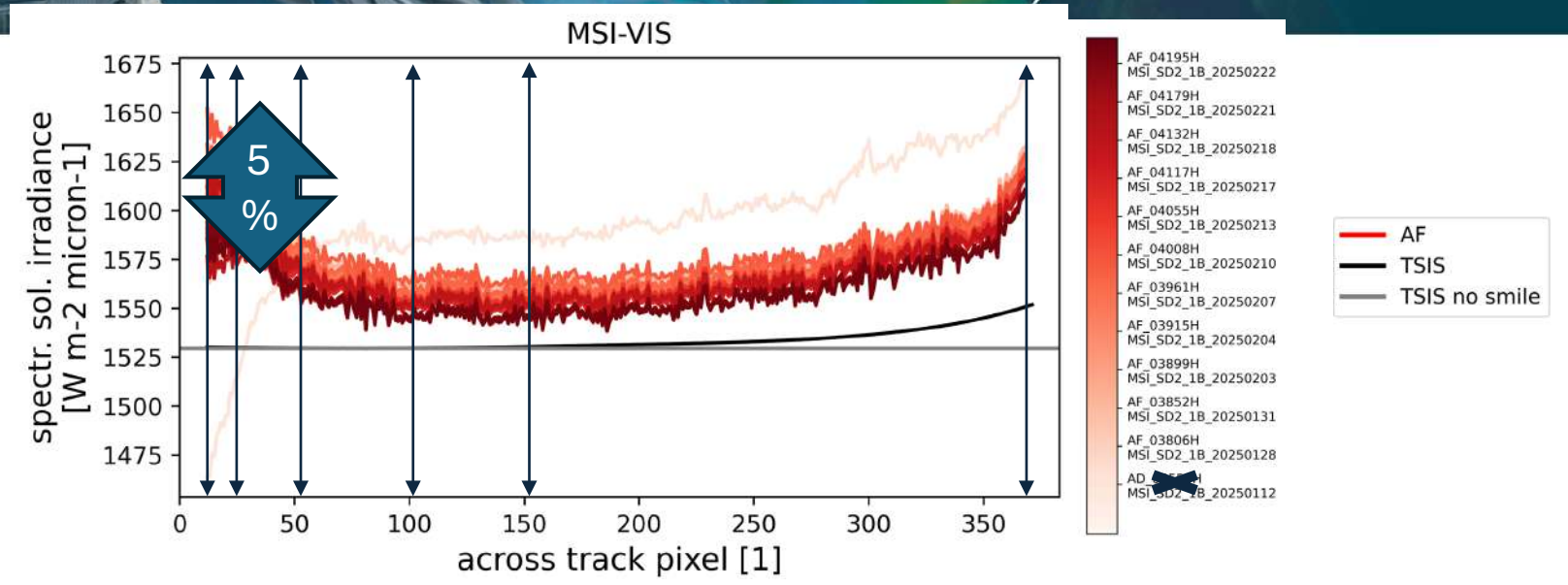


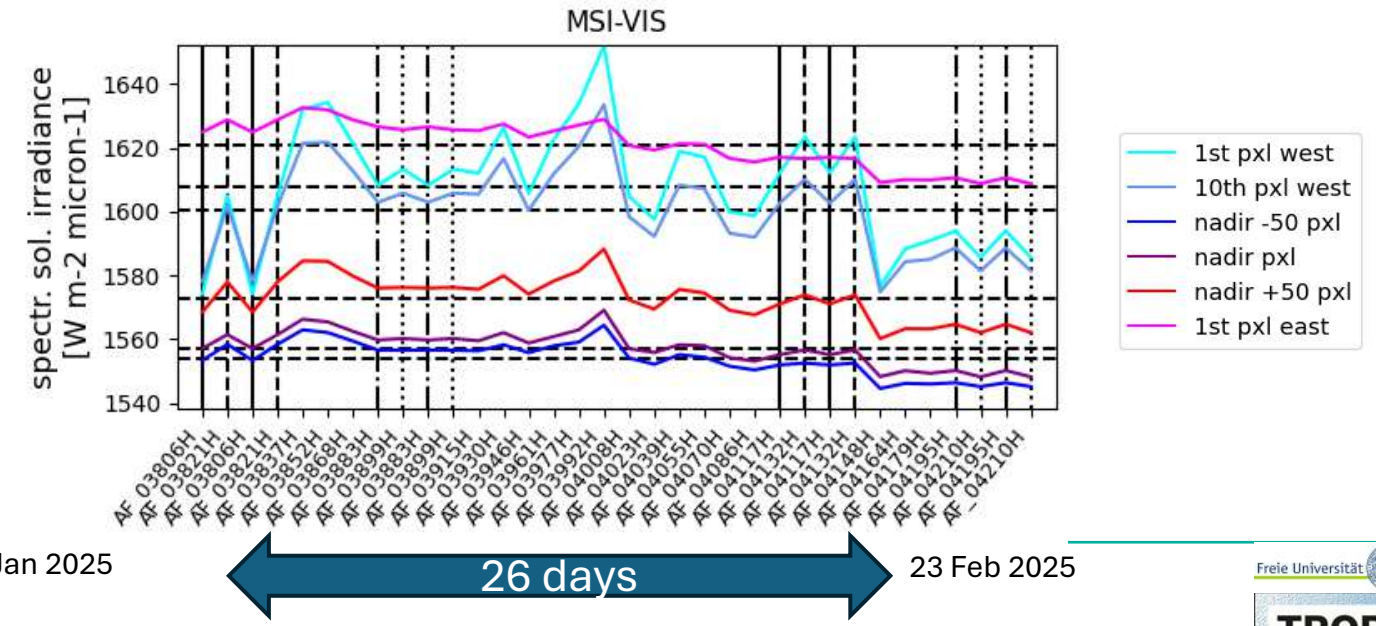
Spectral solar irradiance in AF baseline across track behaviour and temporal evolution

The ‘measured solar irradiance’ does:

- not follow our expectation (using TSIS standard and pixel by pixel ISRF)
- varies by 5 % within 26 days on the westside

Monitoring of 6 fixed across track position regarding spectral solar irradiance





Spectral solar irradiance in AF baseline temporal evolution

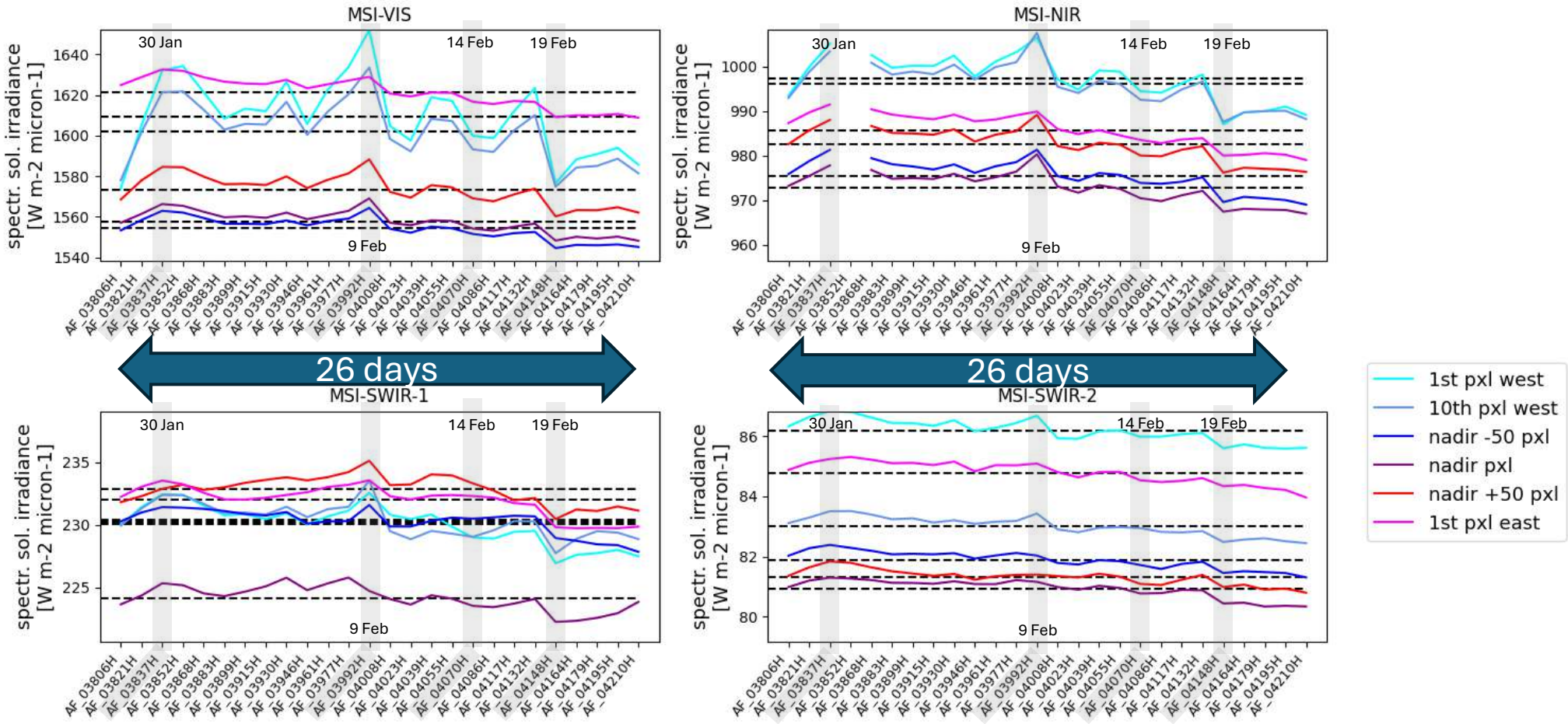
There appears to be a rather **strong correlation between bands**

What are the cause(s) for variations?

Are there differences in calibration time slots / positions?

Are they related to some potential strange additional
– currently unaccounted –
light sources or sinks?

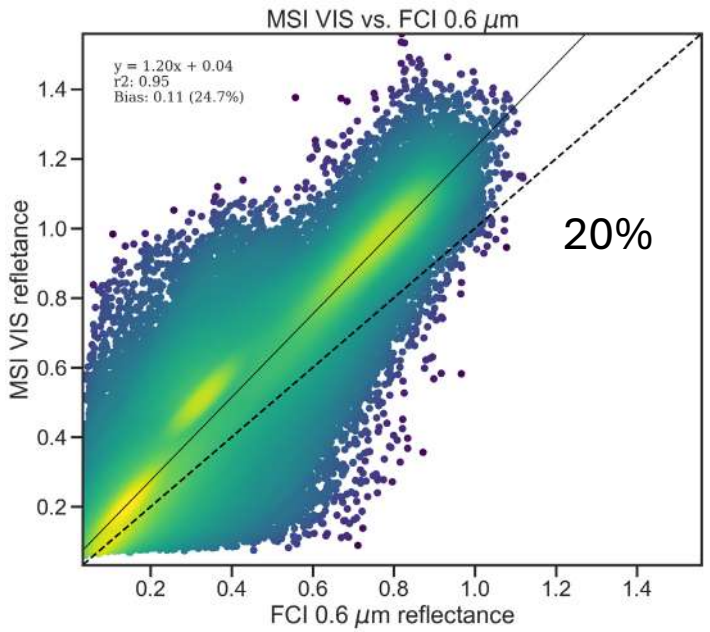
Are there other, already known, explanations?

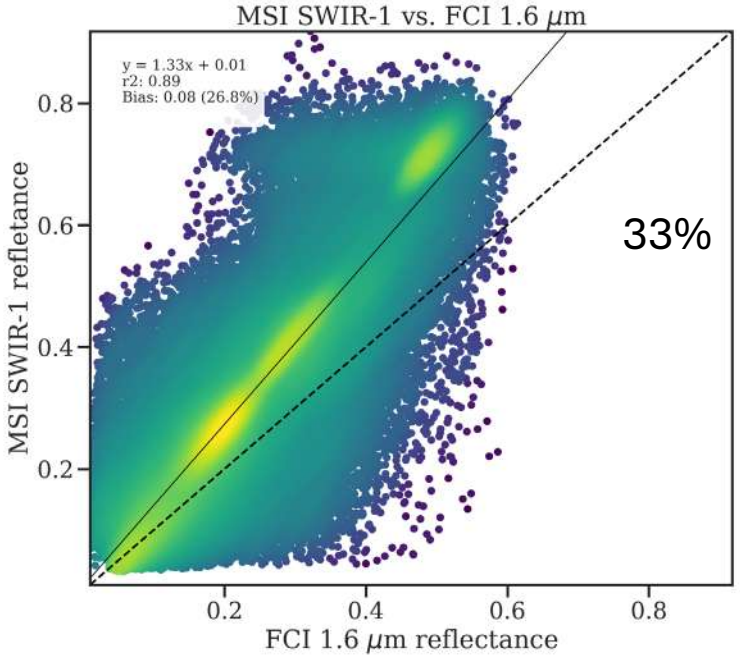


28 Jan 2025

23 Feb 2025

Validation of MSI L1c EXAF using collocated data from the Flexible Combined Imager onboard MTG





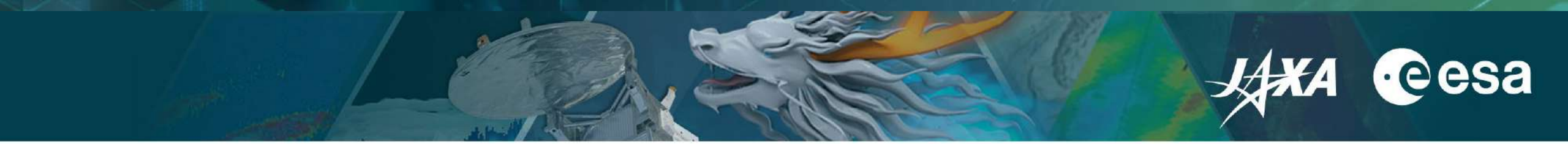
- MSI VNS bands systematically too high compared to SEVIRI and FCI (~25 %)
- **Radiometric Calibration suffers from severe deficits in Ground Characterisation and further unknown glitches**

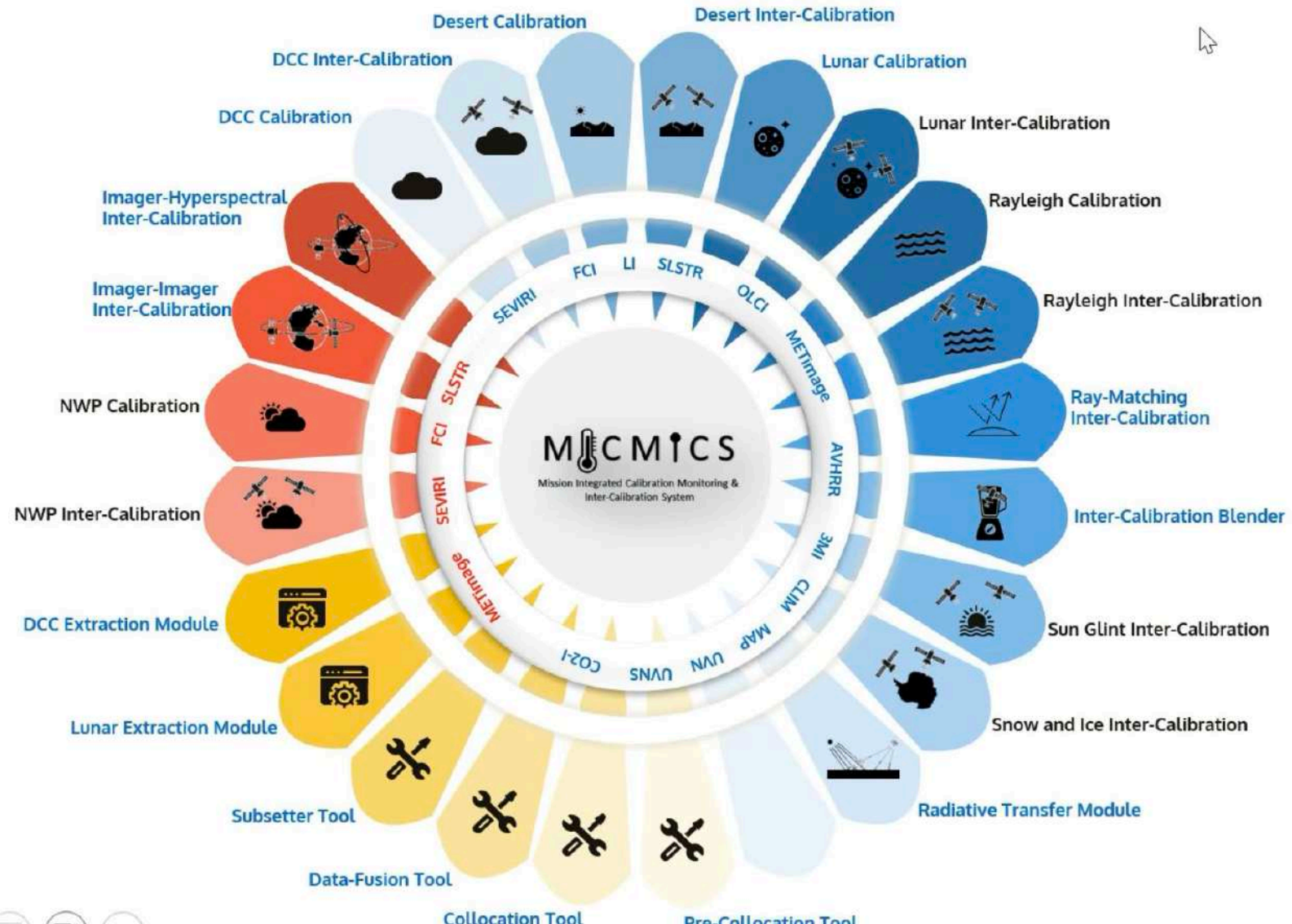
Although the 'solar irradiance measurement' is only 5-6% off, the reflectance is **20% too high** in VIS and **33% higher** at 1.6μm (inter-band is difficult at 1.6μm because of cloud microphysics, but 33% is under all circumstances un-physical)

Take home:

We can not trust the diffusor (ground) characterisation → the VNS calibration

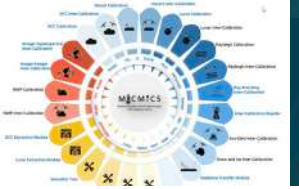
Way forward: vicarious calibration





There are plenty of vicarious (**inter-**) **calibration** methods. Each has its advantages and limitations. In any case it:

- requires manpower and takes time
- needs stable L1 (or an independent path from L0 to L1), since many matchups are needed, that are consistent!!
- must not ignore precise IRSR. This is particularly difficult for MSI, since it has a large spectral shift across track. (→ **simple *Spectral Band Adjustment Factors* (SBAF) will not be enough**)
- Close collaboration with L2 teams: we must be fast and agile
- …
- …



Promising Candidates (but I am not an expert…!!!):

- **Deep convective clouds (DCC) inter-calibration** following *ray-matching* best practises with
  - FCI. Attention:
    - 1.6µm and 2.2µm are quite sensitive to cloud microphysics, ISRF will play a significant role
    - Glint must be carefully filtered since it may change very fast.
  - Seviri:
    - 0.83µm band of seviri is tainted by WV (why it is not at 0.86 µm is unclear for me)
- **DCC calibration** needs rigorous filtering, trustable RTM and trustable ISRF … and time for robust statistics
- **Glint inter calibration**: Good for inter band relative (but it needs glint, only part of swath)
- **Desert Calibration (PICS)**: Long time series and large experience exists. But needs time (small swath → probability of matchup is small)
- **Rayleigh Calibration** for VIS (may complement glint)
- …
- smart L2 based methods for SWIR bands (e.g. cloud microphysics in trade wind zones …)

Important:

- We will need 'unused' methods, to validate independently
- All methods must take the **spectral mislocation** into account. This is a very specific additional difficulty (the **MSI tool** (RTM tailored to MSI, see poster of Nils Madenach) can serve as important component