Long-Term Stability of EarthCARE Level-1 Data

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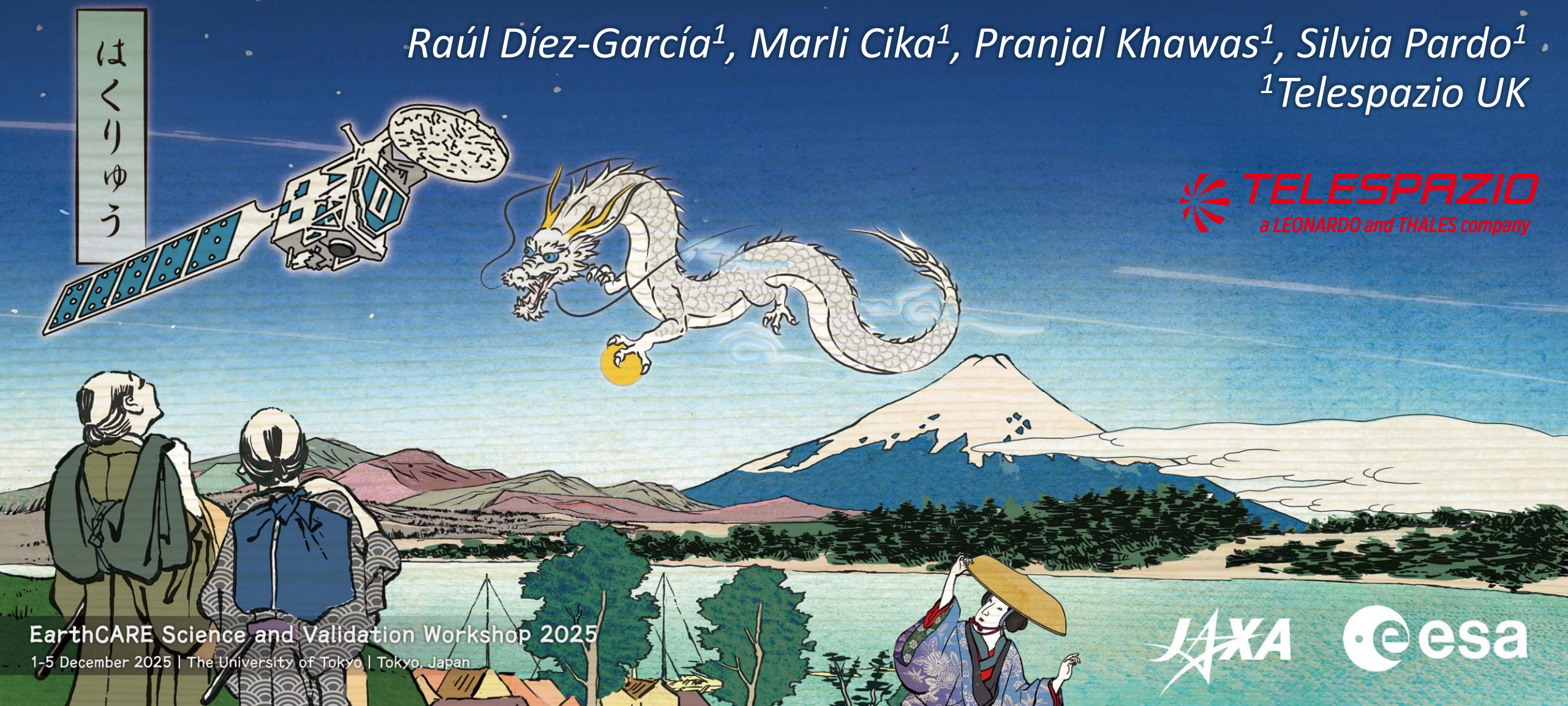

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EarthCARE Science and Validation Workshop 2025
1-5 December 2025 | The University of Tokyo | Tokyo, Japan

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Summary

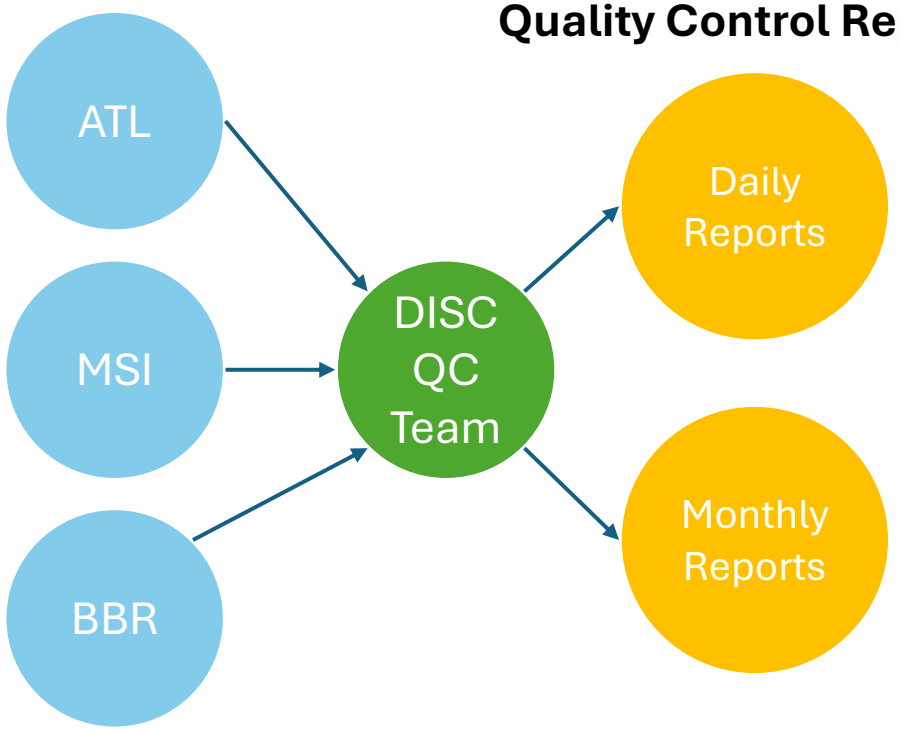
1. EarthCARE Systematic Quality Control activities within the DISC
2. Calibration Trends
   - ATLID Dark Counts and Frequency
   - MSI Solar Irradiance and Dark Signal
3. L1B Retrieval Stability
   - ATLID Attennuated Backscatter
   - MSI Radiance and Reflectance
   - BBR Radiance
4. Conclusions

EarthCARE Systematic Quality Control activities within the DISC

The ESA DISC (Data, Innovation and Science Cluster) has a dedicated task to **independently** monitor the quality of EarthCARE L1B products produced by ESA

L1 Daily Production

Quality Control Reports



- Rapid detection of anomalies
- QC Disclaimers
- Unavailability monitoring

- **Long Term Stability**
- Reanalysis of quality and unavailabilities

1. Key Calibration Parameters
2. Retrieval daily averages

QC Reports

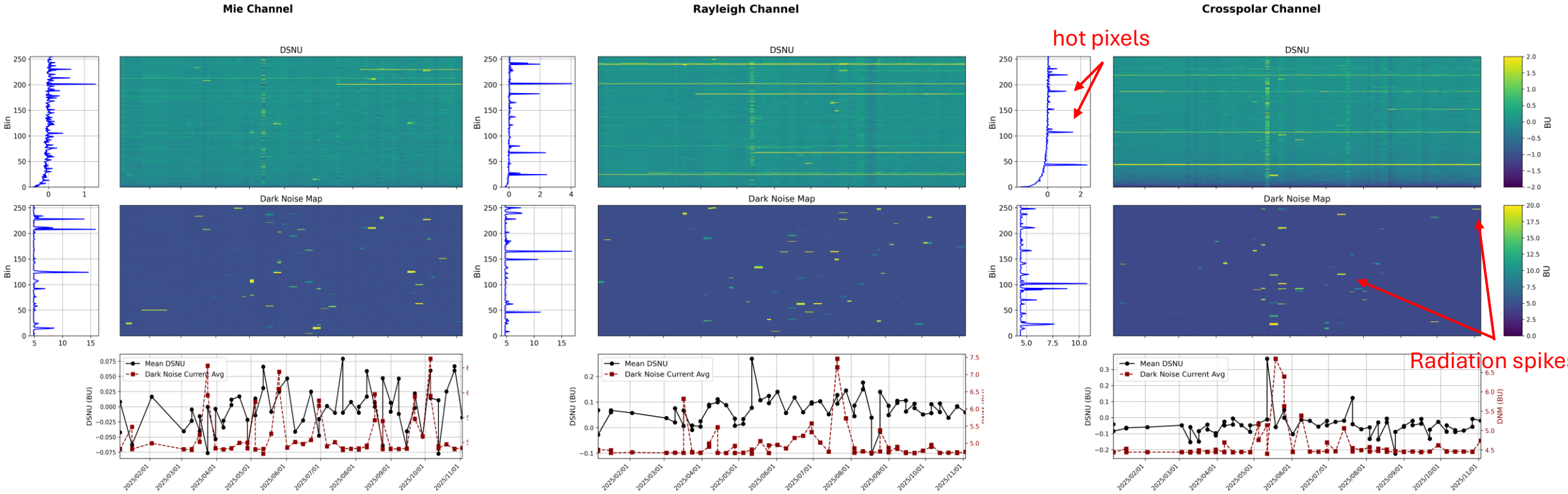
ATLID, MSI
Calibration Trends

ATLID Long Term trends: Calibration

Dark Signal Monitoring

- Dark signal is measured in the Dark Count Calibration (DCC, laser off, at night)

DSNU = “Dark Signal Non-Uniformity” = Avg(DCC)
DNM = “Dark Noise Map” = Std(DCC).



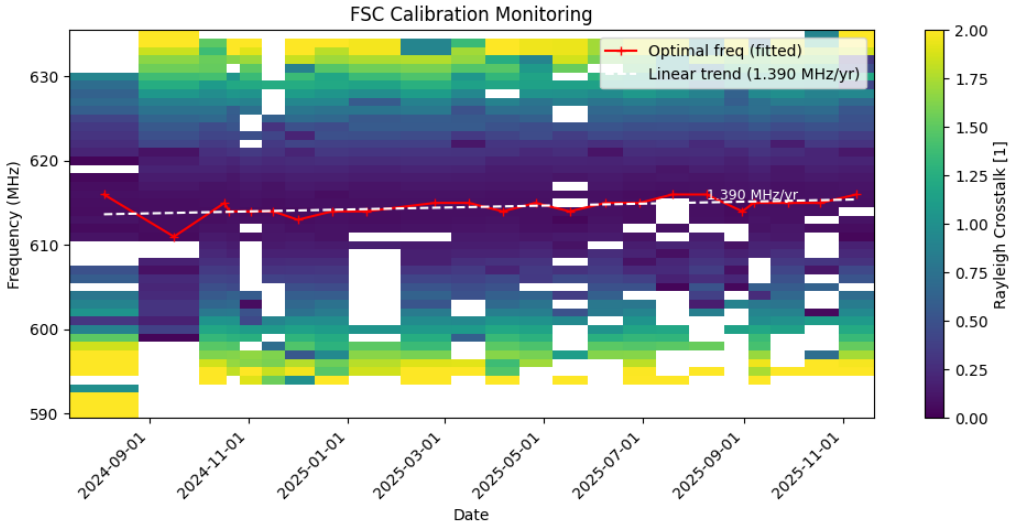
- Several DCC calibrations are dominated by radiation-induced spikes and discarded (see DSM).
- No clear trends in the DSNU/DSM, but the number of “hot pixels” is increasing

ATLID Long Term trends: Calibration

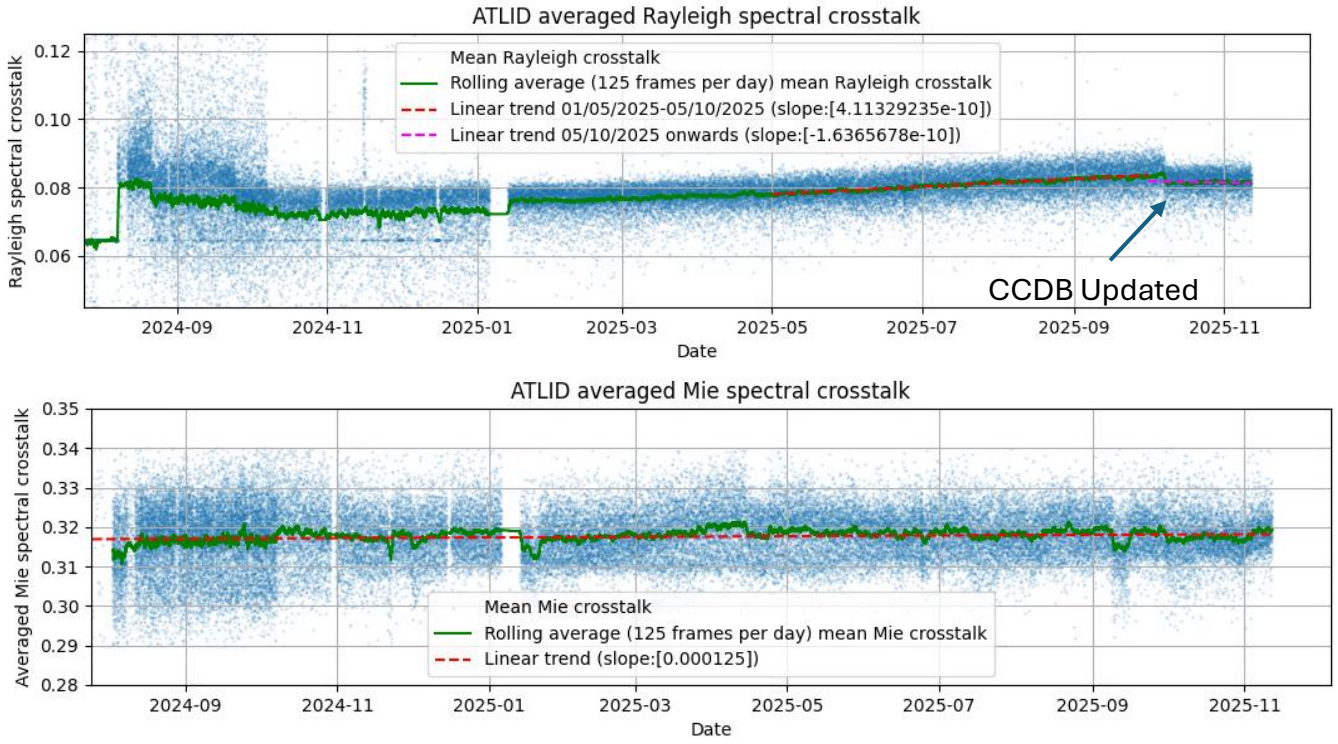
FSC Frequency Monitoring

- Spectral alignment between laser and filter is monitored with the Rayleigh Crosstalk
- Until Oct 2025, a positive trend indicates a progressive drift in the laser frequency, which was updated on the 5th of October

FSC calibration monitoring



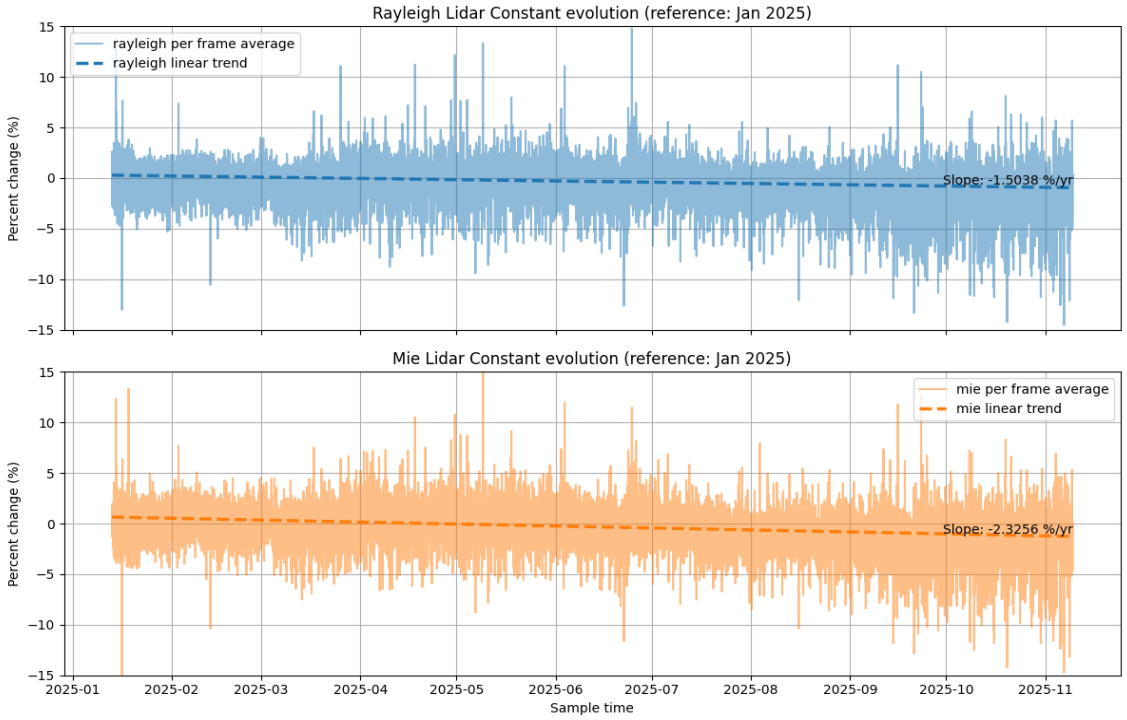
Spectral Crosstalk Monitoring



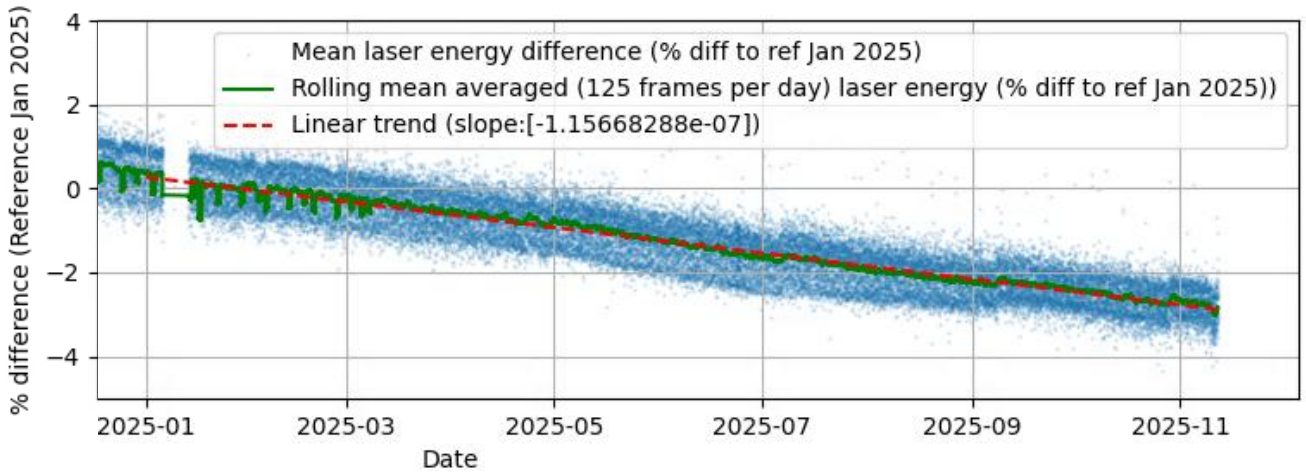
ATLID Long Term trends: Instrumental Health

ATLID average laser energy and Lidar Constants are monitored

Lidar Constant



Laser Energy



- Negative trends of -3%/year in Laser Energy, and -1.5%/year (rayleigh) and -2.3%/year (mie) for Lidar constants
- In line with instrument aging

MSI Long Term trends: Calibration

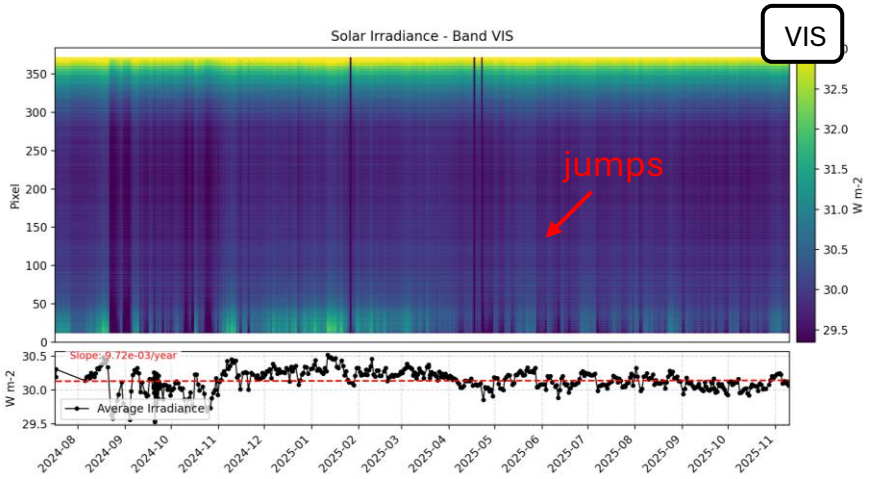
MSI Diffuser Solar Irradiance Monitoring

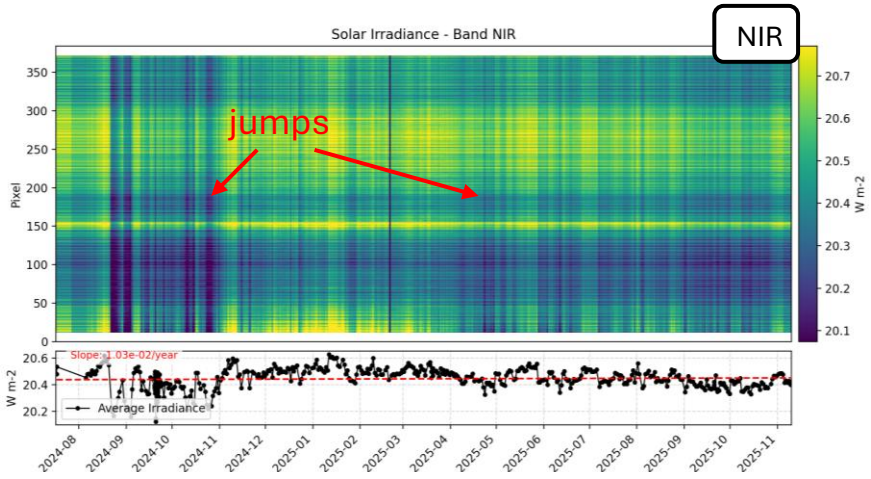
(corrected for annual cycle)

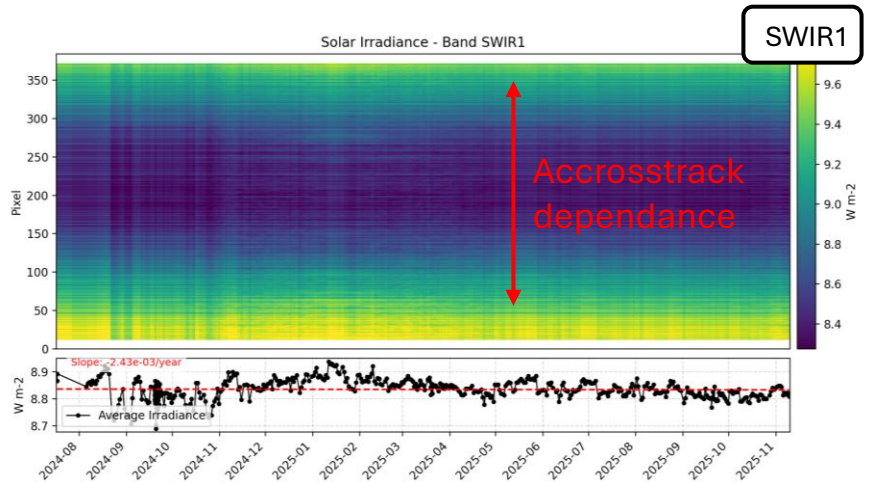
MSI Solar Irradiance exhibits some signatures which are under investigation by the instrument team:

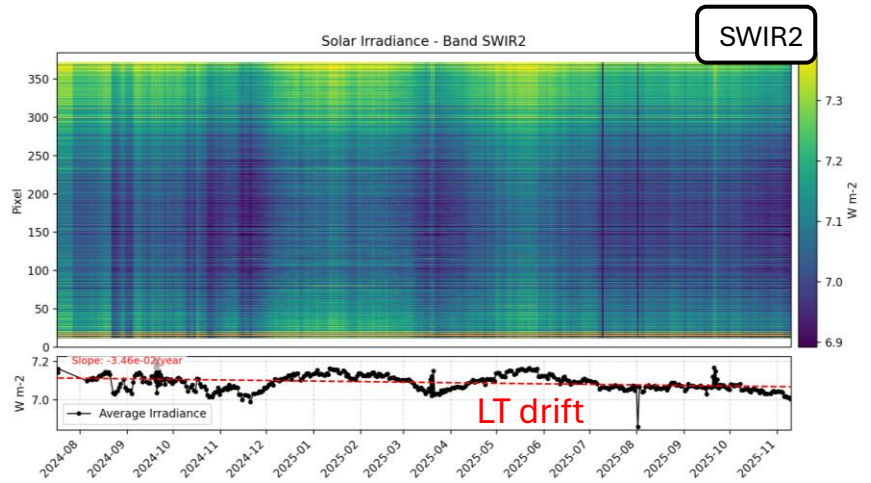
1. Across track dependence
2. “jumps” of solar irradiance larger than the expected natural variability of the sun (0.1%)
3. Seasonal? cycles (mainly in SWIR2)

Currently (BA baseline), annotated irradiance is based on TSIS-2 retrievals









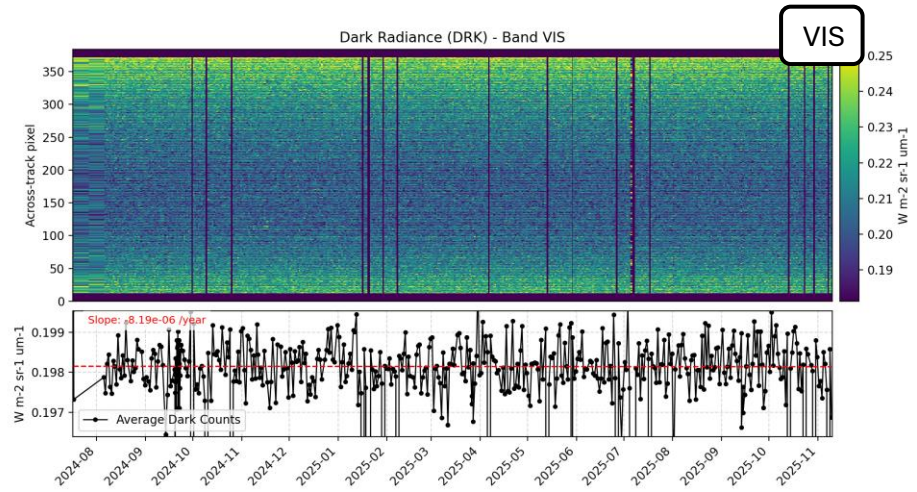
MSI Long Term trends: Calibration

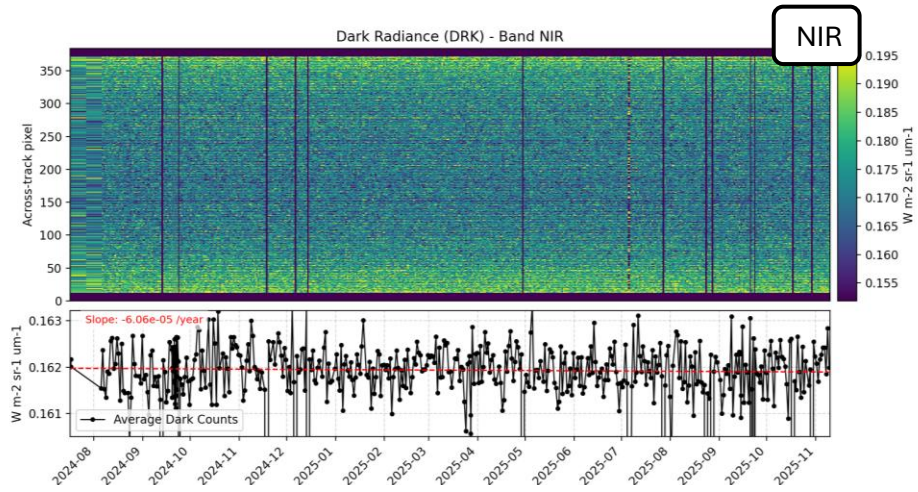
MSI Dark Count Monitoring

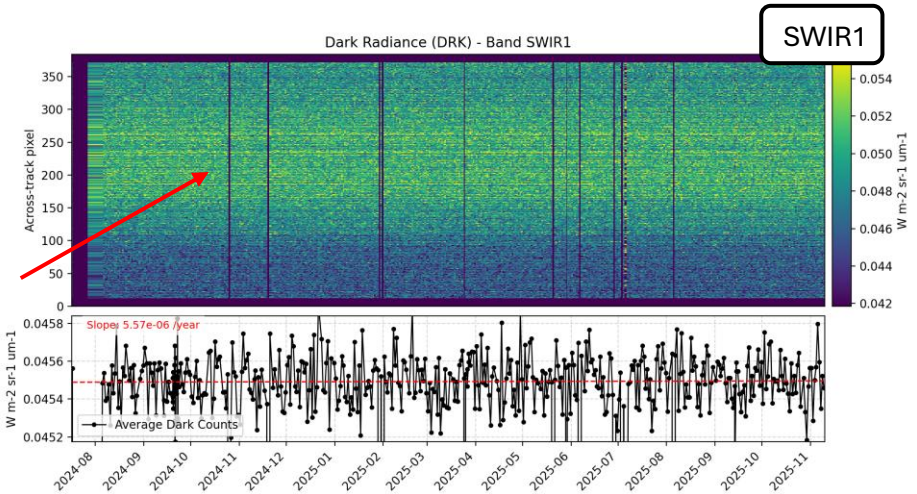
Dark signal is measured daily in the Dark Calibration (DRK, at night)

Average DRK signal is represented along time and across pixel / track

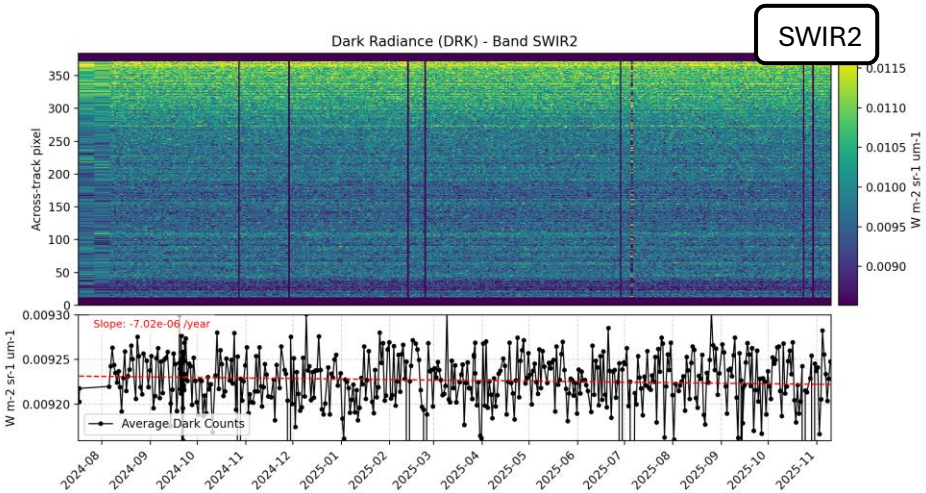
- Some across track dependence
- No drift in the DRK
- Some DRK files badly annotated





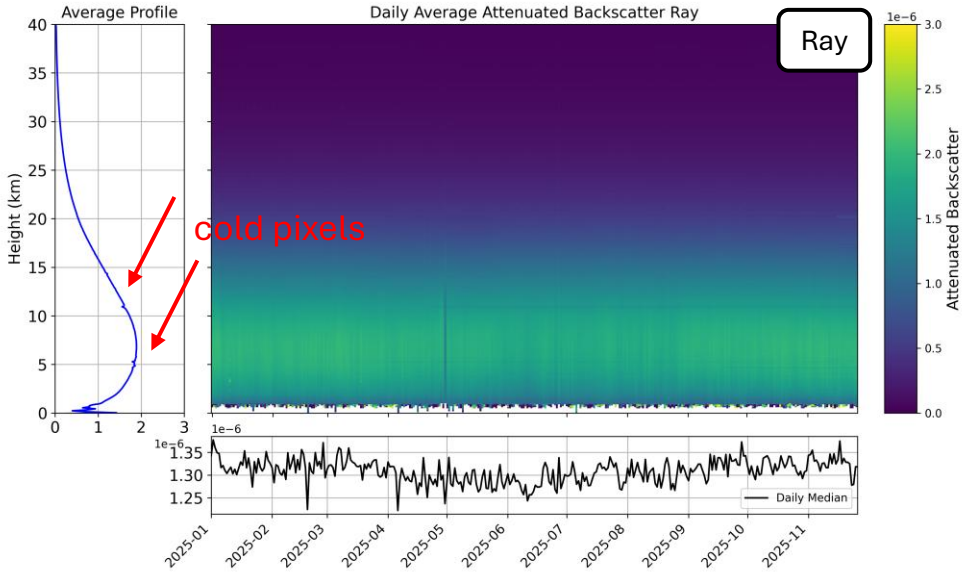


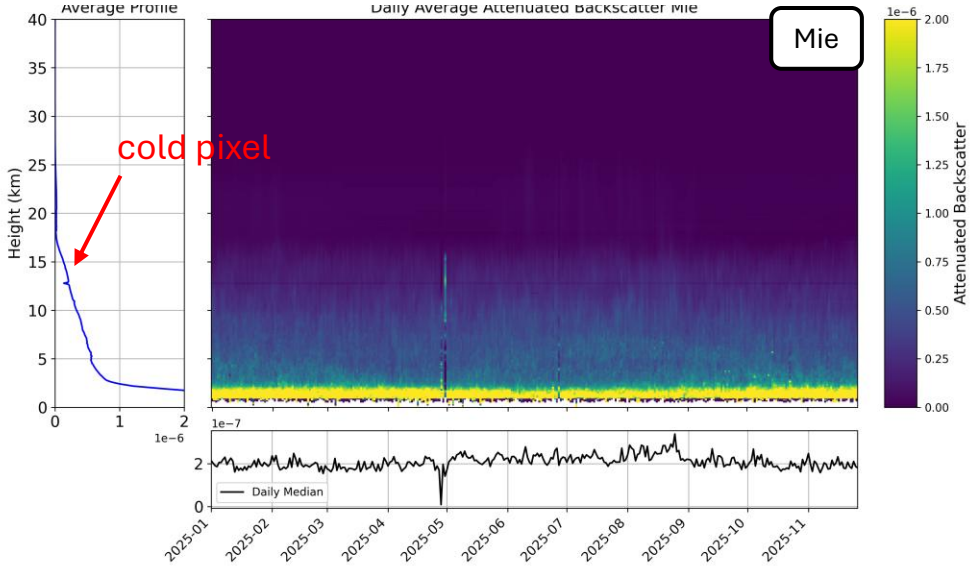
Bad annotation

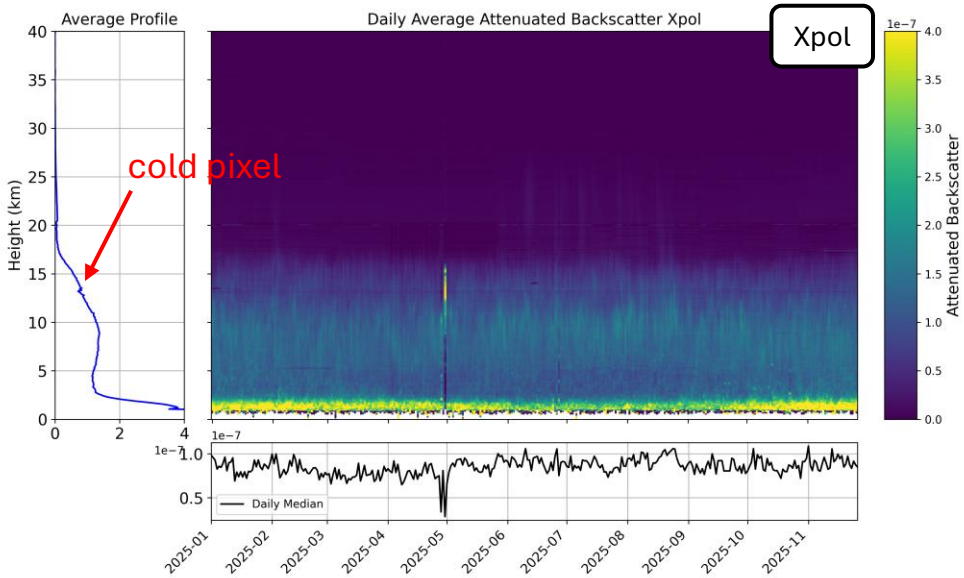


ATLID, MSI, BBR
L1B Retrieval Stability

ATLID Retrieval Stability: Attenuated Backscatter







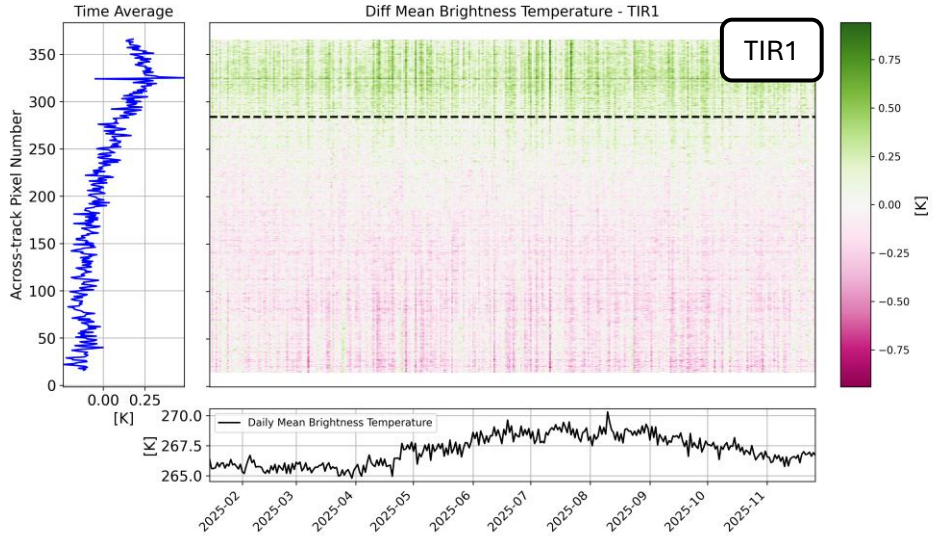
Attenuated Backscatter Stability

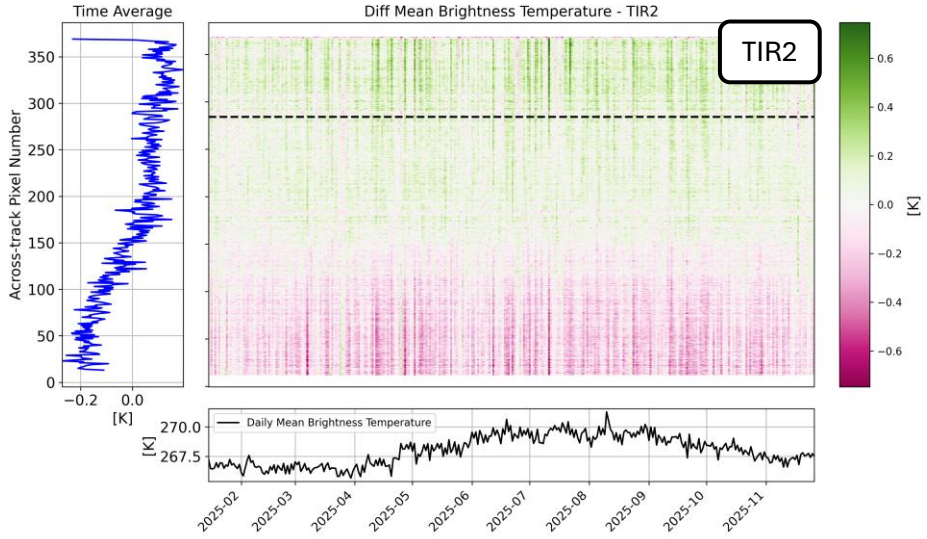
- All-sky, daily global averages of Attenuated Backscatter may also be used to identify long term trends and anomalous height signatures
- Average profile in function of reveals some uncorrected cold pixels
- Long term appears stable, without any relevant trend

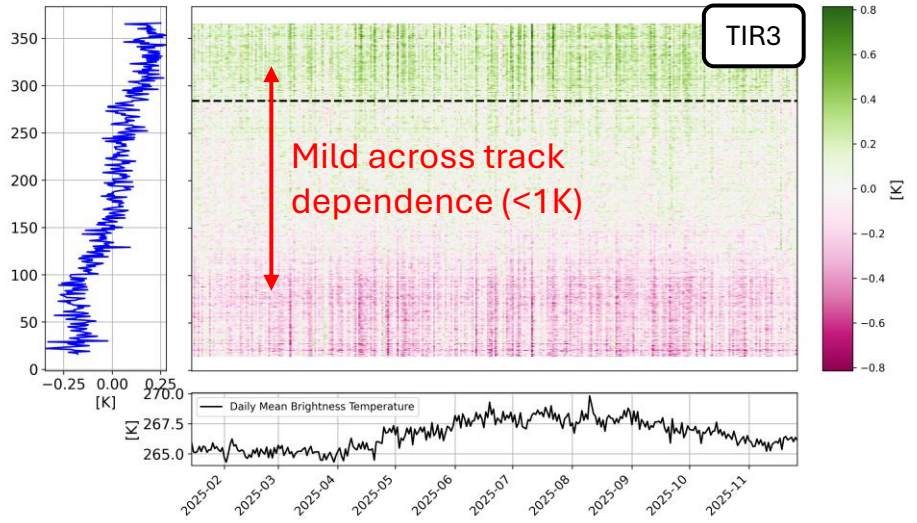
MSI Retrieval Stability: Radiance (TIR)

Average daily MSI Radiance Monitoring

- All-sky, daily global averages of TIR Radiance are used to identify long term trends and anomalous across-track signatures
- Mild (<1K) stable across-track signature
- Long Term evolution in line with seasonal cycles



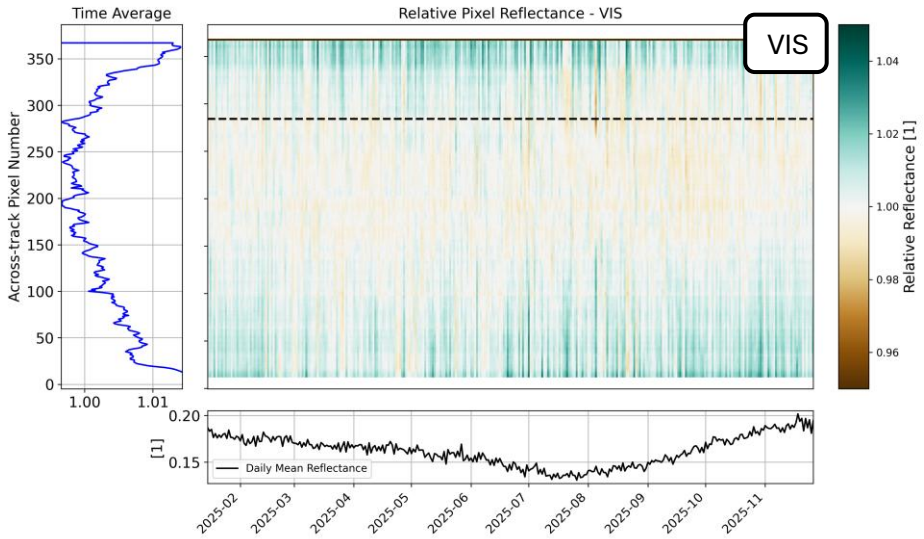


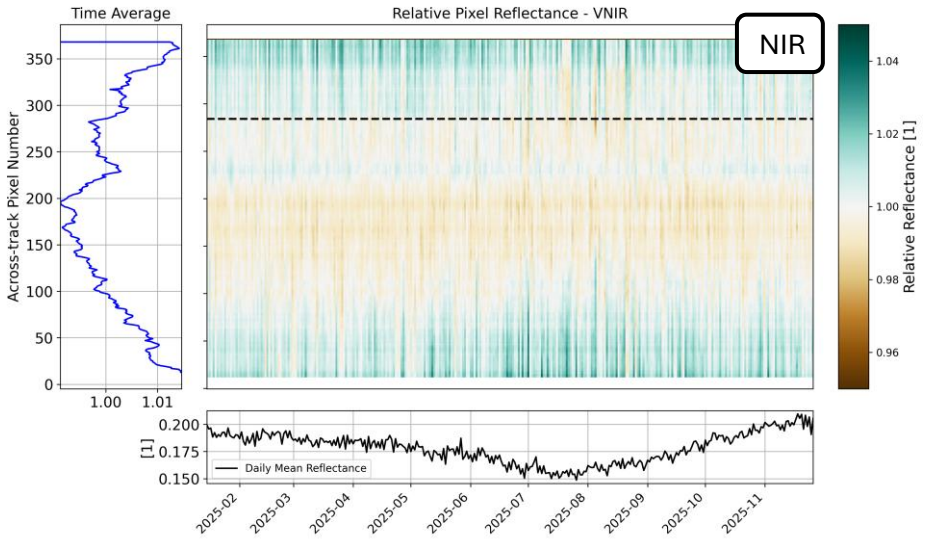


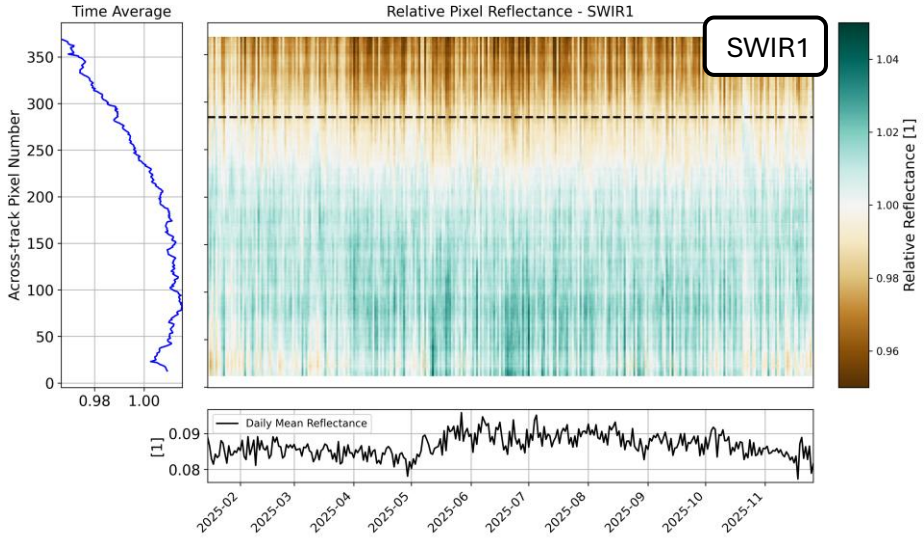
MSI Retrieval Stability: Reflectance (VNS)

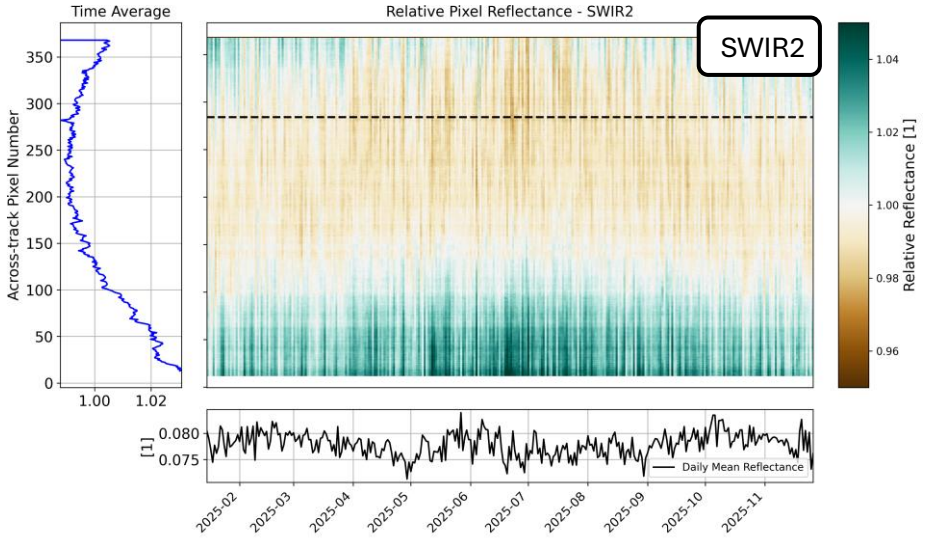
Average daily MSI Reflectance Monitoring

- Similar plots for VNS bands, for reflectance
- Across-track signatures are significant (under investigation)
- Possibly related to the irradiance across-track
- Long Term evolution in line with seasonal cycles





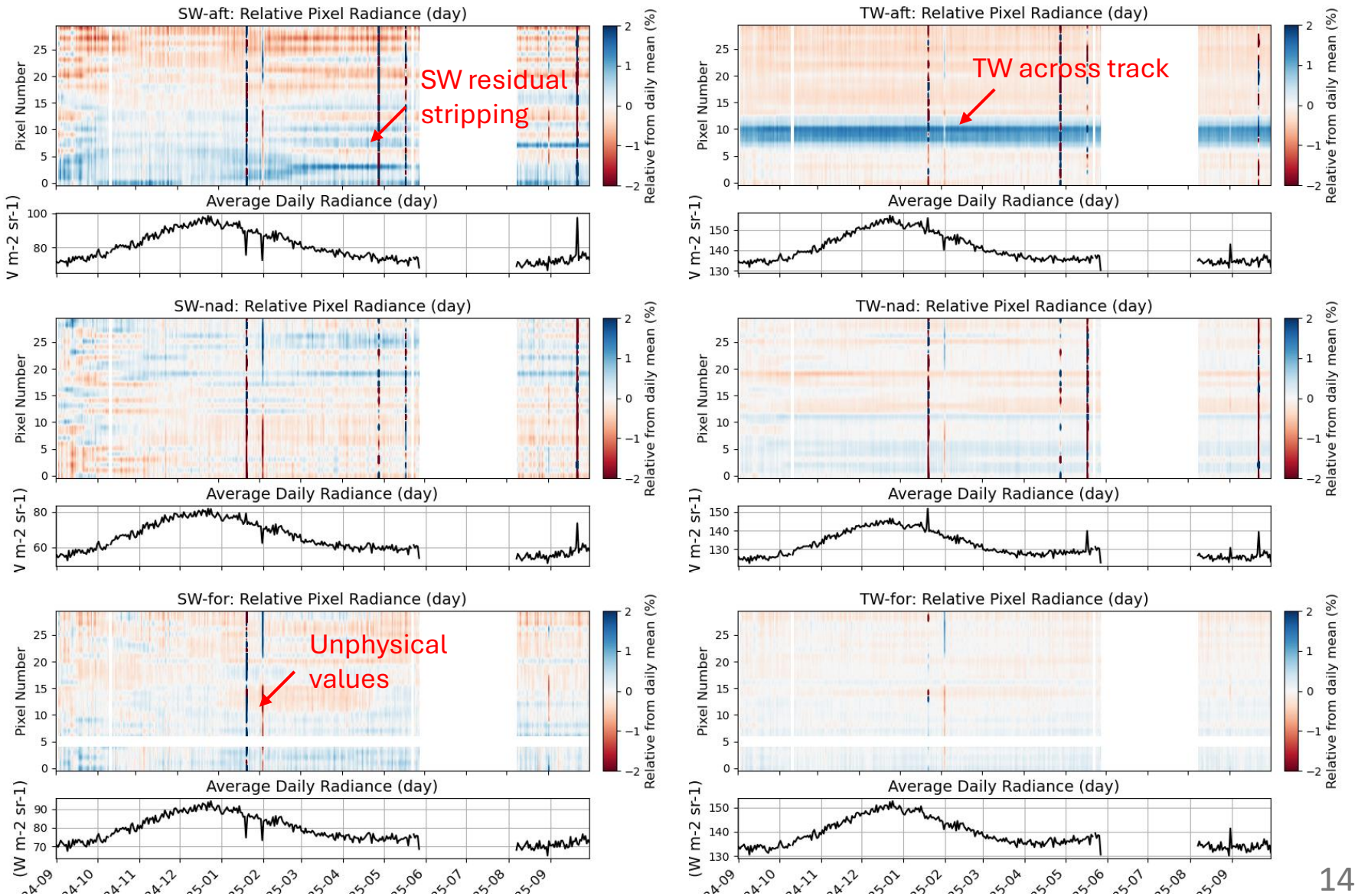




BBR Retrieval Stability: Radiance

Day all-sky L1B Averaged Radiances (L1B)

- Long Term evolution in line with radiance annual cycle (maximum in January)
- SW original across-track was corrected in BA. Still, some residual stripping
- TW across-track signatures are compensated in LW
- Some unphysical values in BA dataset (under investigation)



Conclusions

Main conclusions regarding Stability and Data Quality:

1. L1B ATLID
   - High stability, without detected trends so far in attenuated backscatter. Main concern is hot/cold pixels
   - Slight drift in laser frequency but seems stabilized (TBD)
   - Laser and LIDAR constants decreasing due to instrument aging, but under the expectation
2. L1B MSI
   - Solar irradiance exhibits some signatures yet to be understood. Under investigation by instrument team
   - Significant across-track signatures in VNS (up to 4%). They seem related to solar irradiance signatures
   - TIR is only mildly affected and appears very stable
3. L1B BBR
   - SW presents some residual stripping after the correction introduced in BA.

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Thank you!

ありがとうございます!

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