Cross-satellite validation of MSI L1 data using collocated SEVIRI and FCI observations

German Initiative for Validation of EarthCARE, EarthCARE DISC

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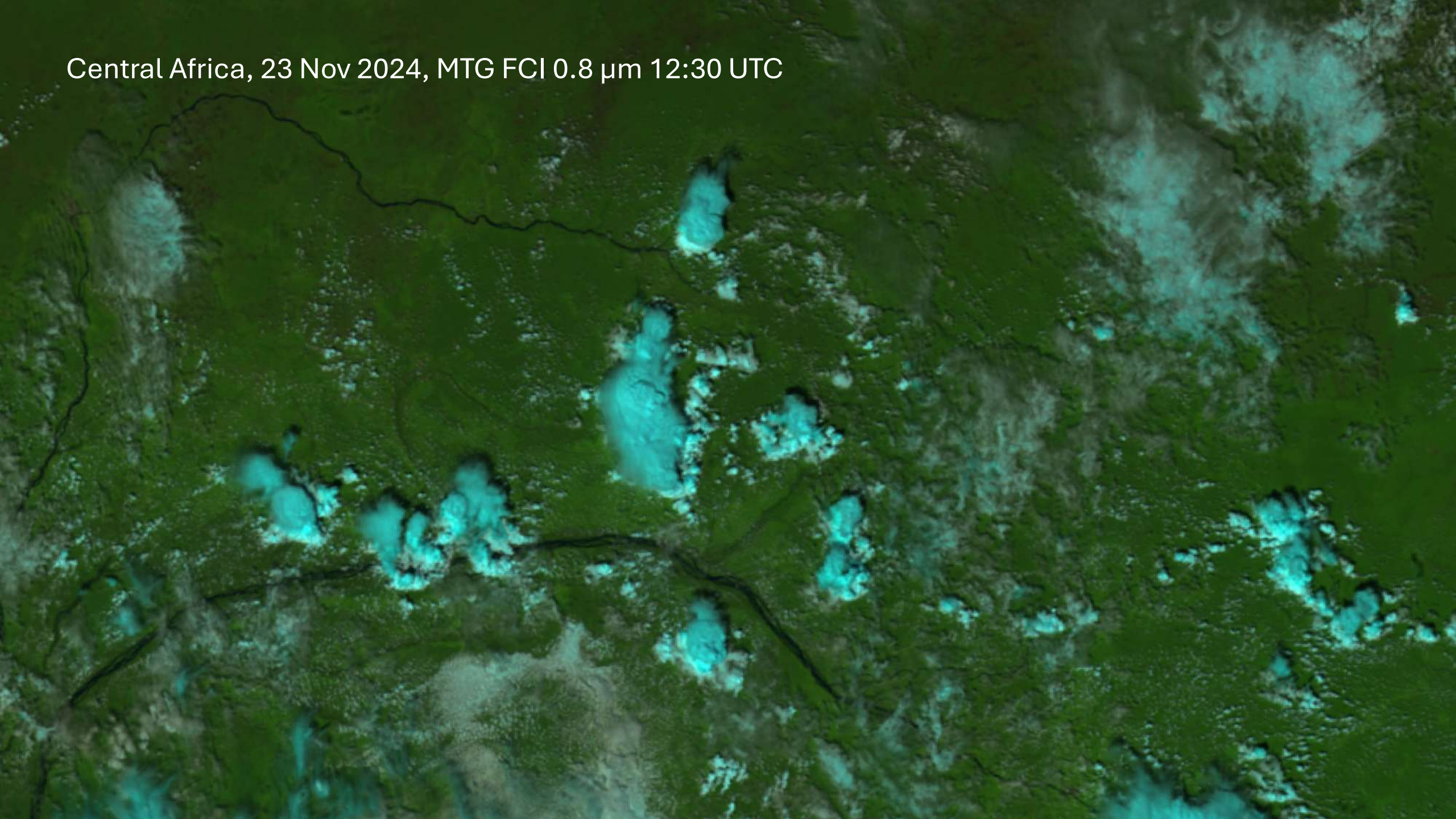
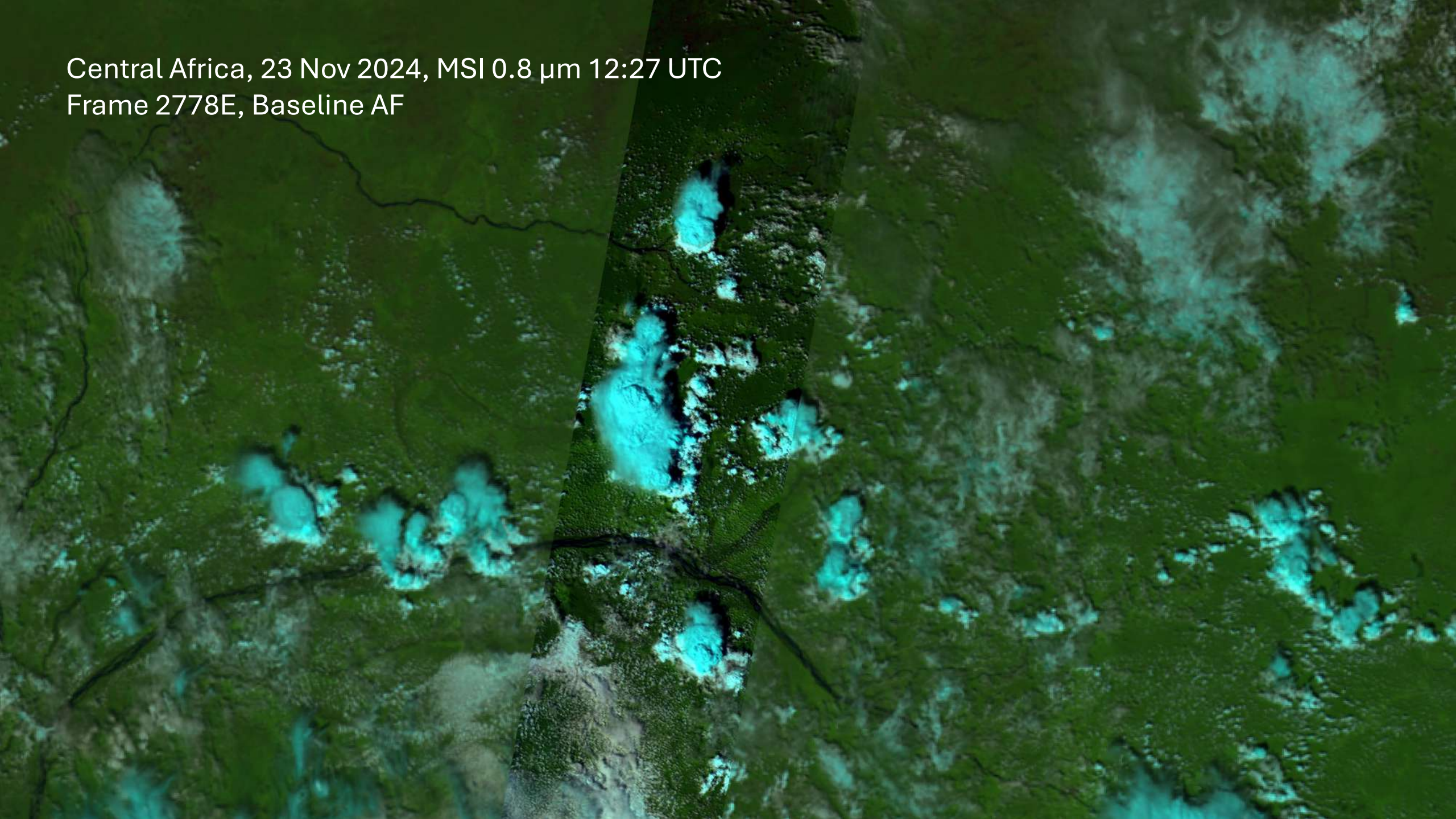
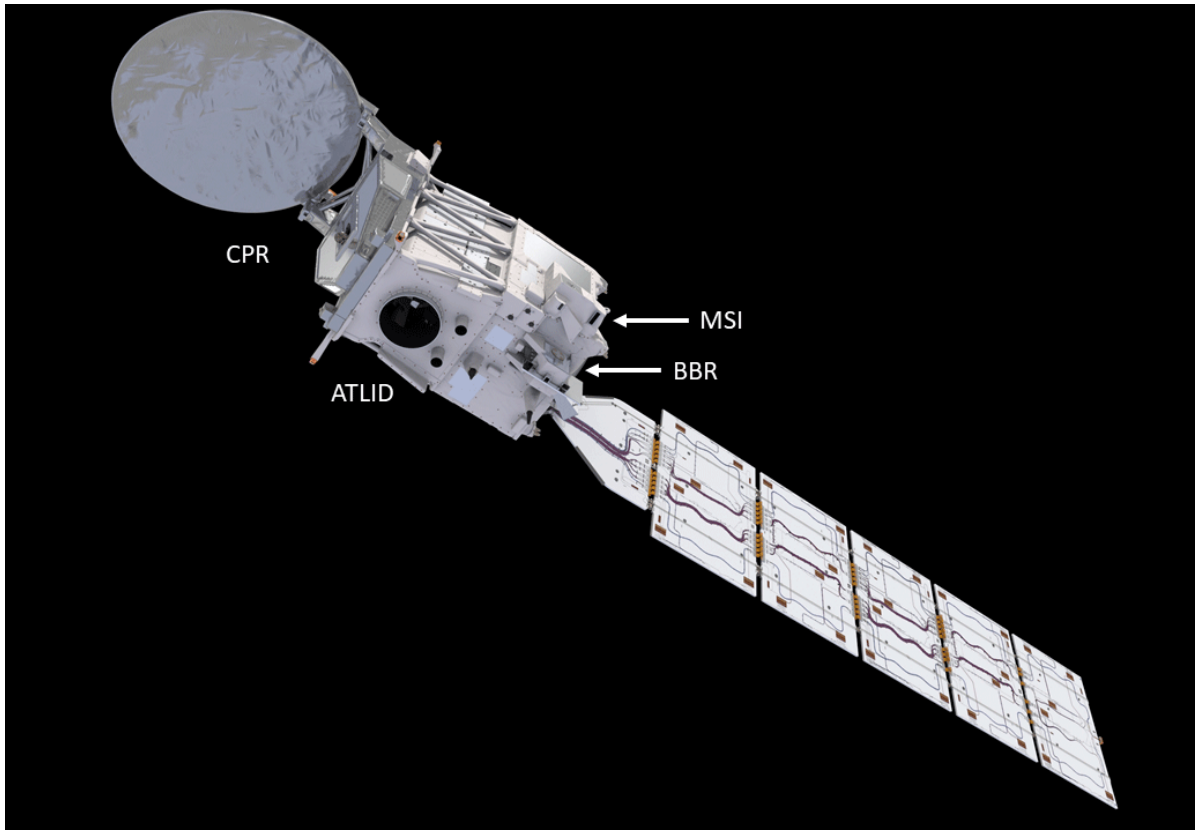

Central Africa, 23 Nov 2024, MTG FCI 0.8 µm 12:30 UTC


Central Africa, 23 Nov 2024, MSI 0.8 µm 12:27 UTC
Frame 2778E, Baseline AF

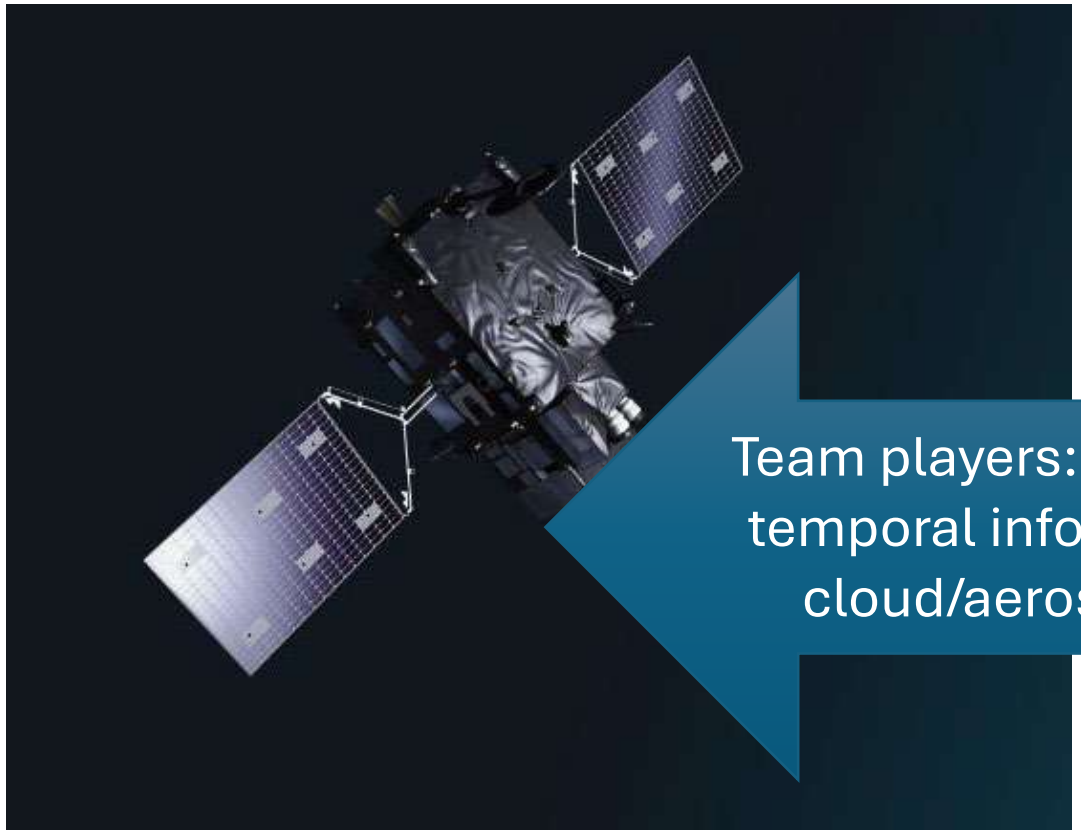
Overview

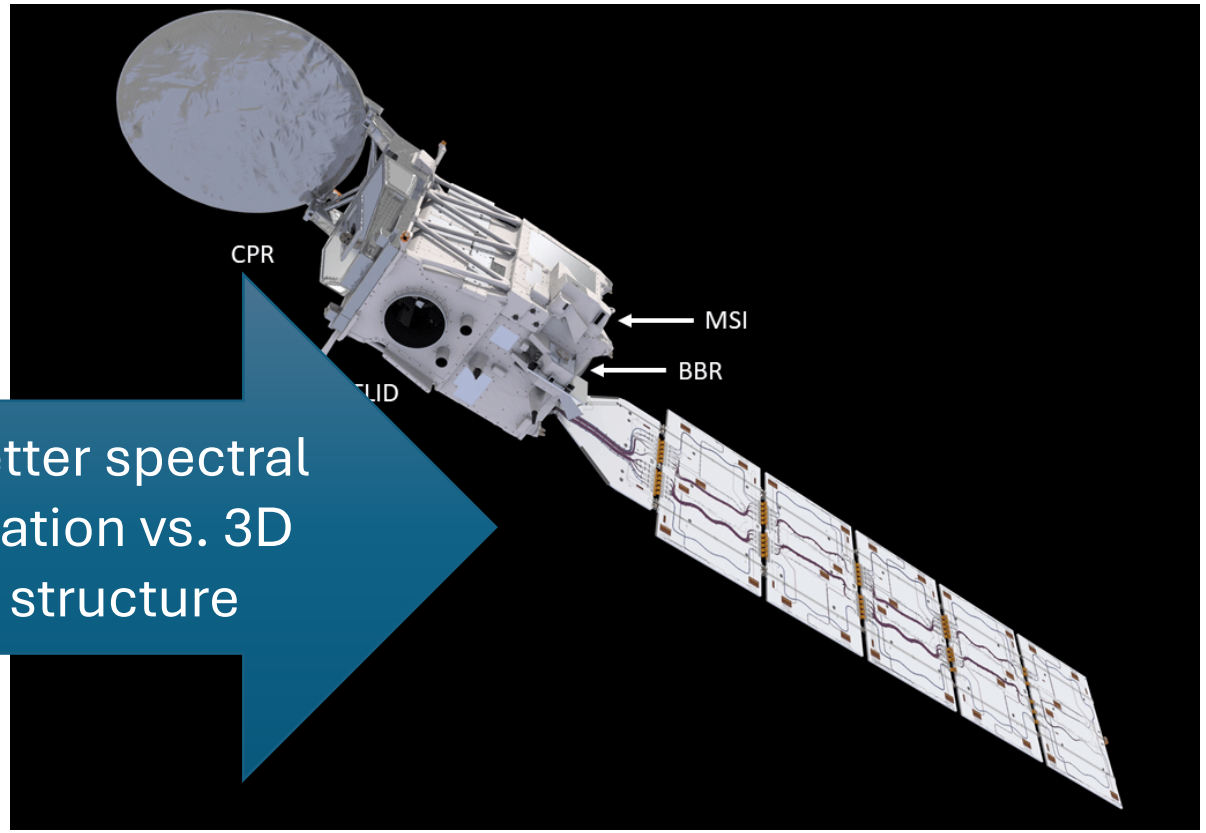
- 16 spectral channels (0.3-13.3 µm)
- Full disc with 0.5-2 km pixel size
- Every 10 min



- 7 spectral channels (0.6-12.0 µm)
- 150 km swath with 500 m pixel size
- Every 28 days
- MSI complemented by profile measurements

Overview





Team players: Better spectral temporal information vs. 3D cloud/aerosol structure

- 16 spectral channels (0.3-13.3 µm)
- Full disc with 0.5-2 km pixel size
- Every 10 min

- 7 spectral channels (0.6-12.0 µm)
- 150 km swath with 500 m pixel size
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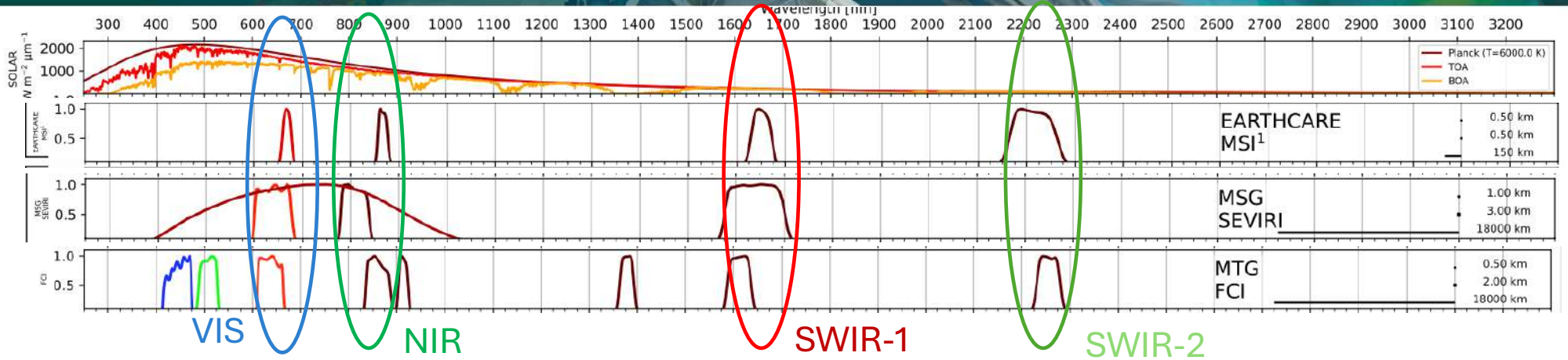
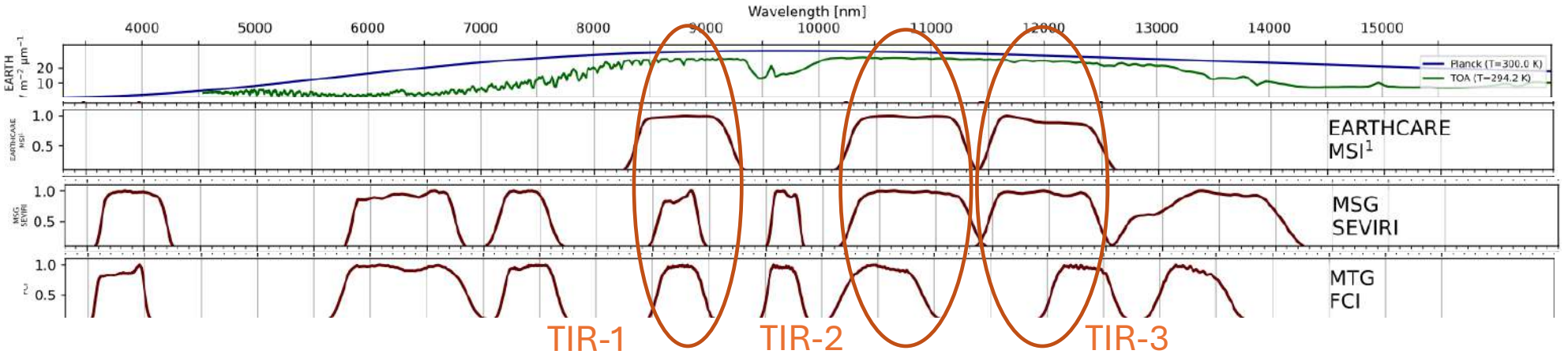
- MSI complemented by profile measurements

Overview – Spectral band characteristics





Towards 0.7 µm, clouds less reflective, water vapor absorption stronger

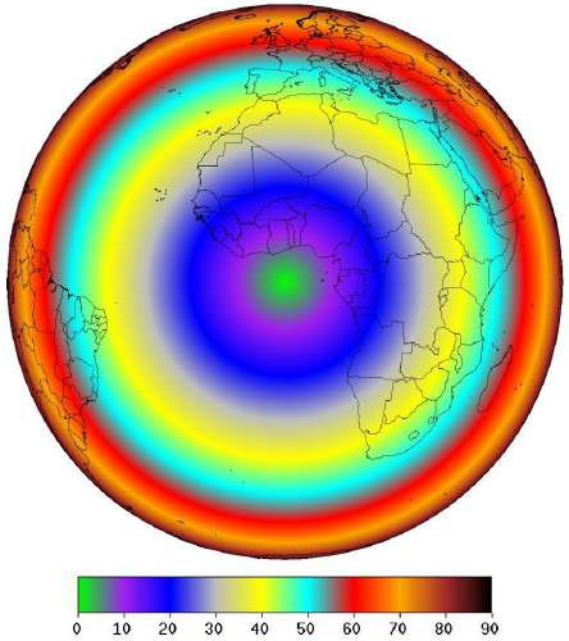
Courtesy of Jan R. El Kassar (FU Berlin)

- Very similar filter functions between MSI, SEVIRI and FCI spectral channels
- However, small differences can have big impact for TOA reflectance of clouds, but particularly for aerosol and clear sky surface

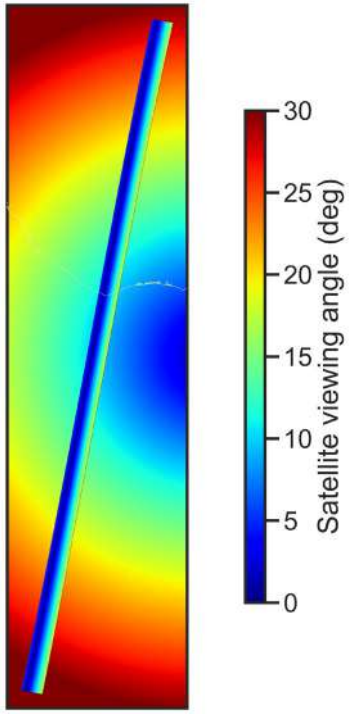
Overview – Challenges

Viewing geometry

- Limit validation to similar viewing geometry
- FCI/SEVIRI sub-satellite point (Tropics-ITCZ) covers warm ocean, very bright and cold clouds, vegetation and desert → suitable for L1 validation



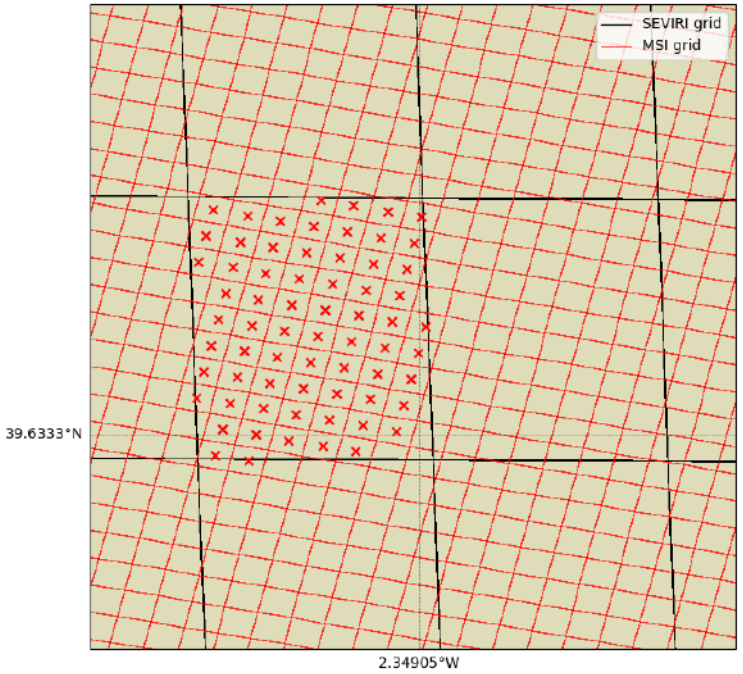
Viewing geometry of SEVIRI on MSG-2 satellite located at 0 deg W, Neukermans, 2012.



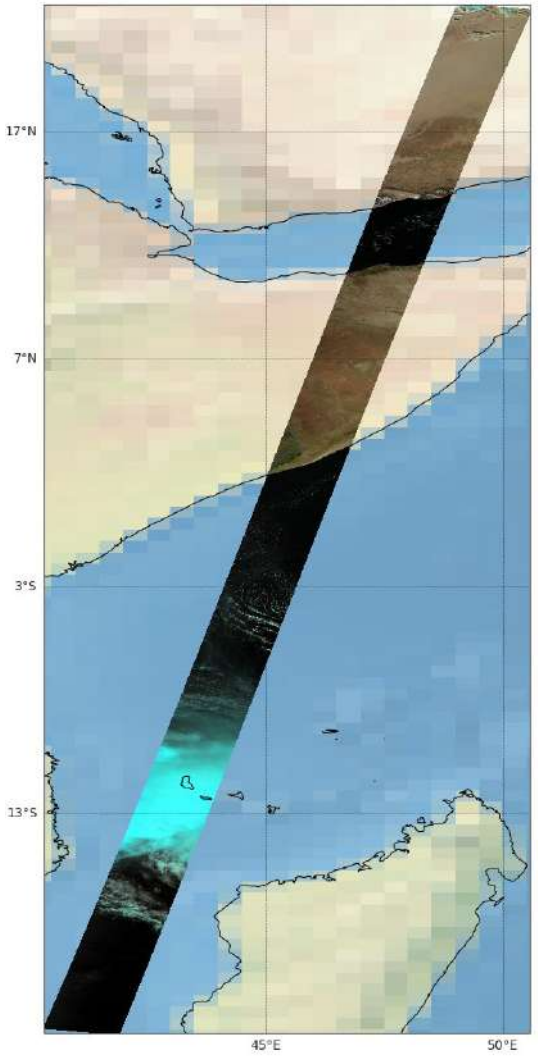
FCI viewing angle compared to MSI for frame E

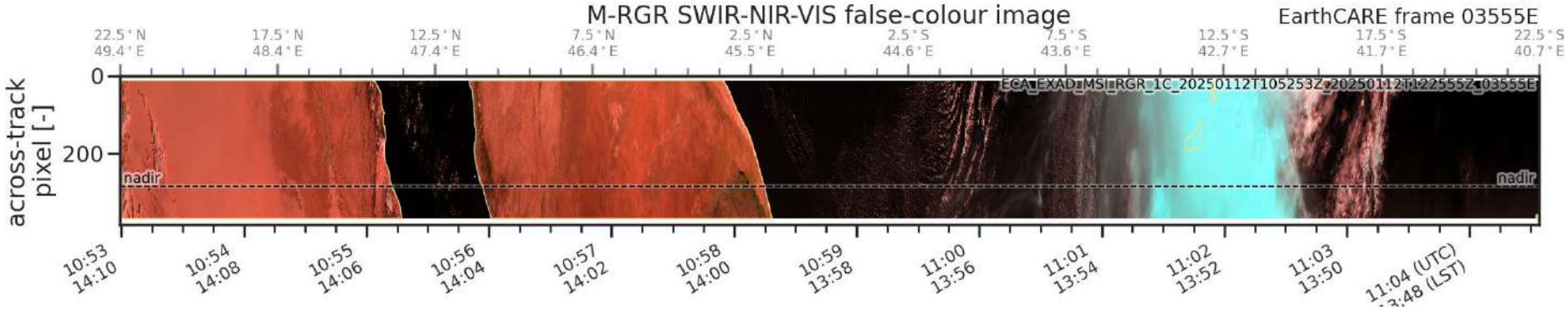
Spatial resolution

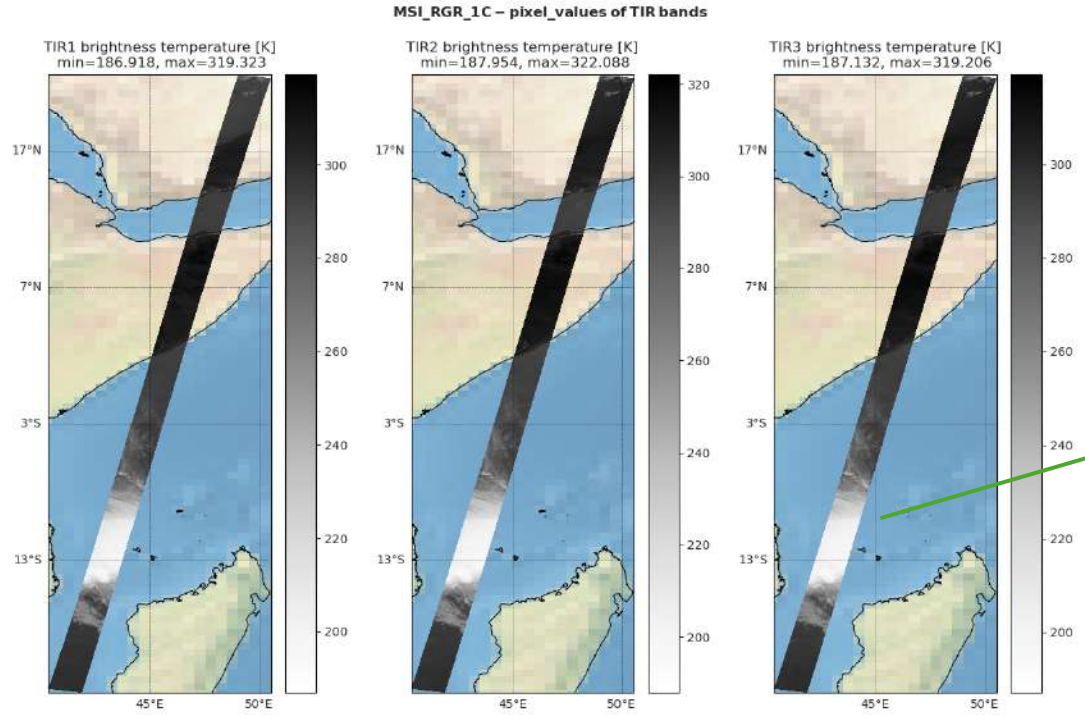
- 3x3 km for SEVIRI versus 0.5x0.5 km for MSI
- Minimum of 36 MSI pixels within one SEVIRI pixel → sub-pixel inhomogeneity



Case study on 12 January 2025 (frame 3555E)





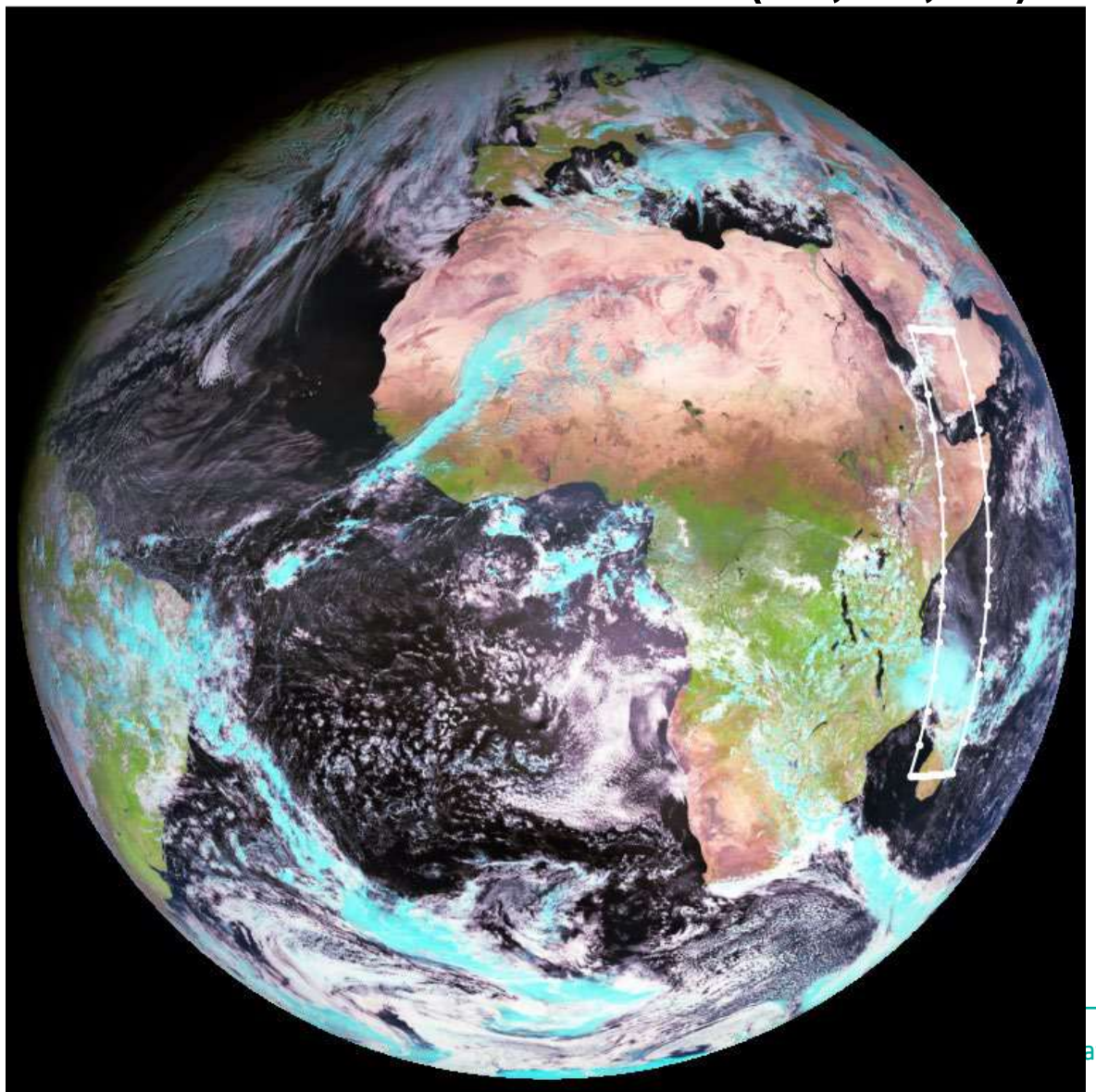


Baseline EXAD

Tropical cyclone Dikeledi north of Madagascar – EarthCARE crossing time 11:02 UTC

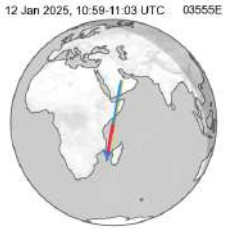
Case study on 12 January 2025 (frame 3555E)

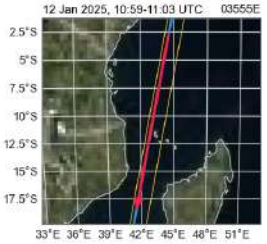
FCI “Natural colour RBG” (1.6, 0.8, 0.6)



FCI “True colour RBG” (0.6, 0.5, 0.4)

Case study on 12 January 2025 (frame 3555E)





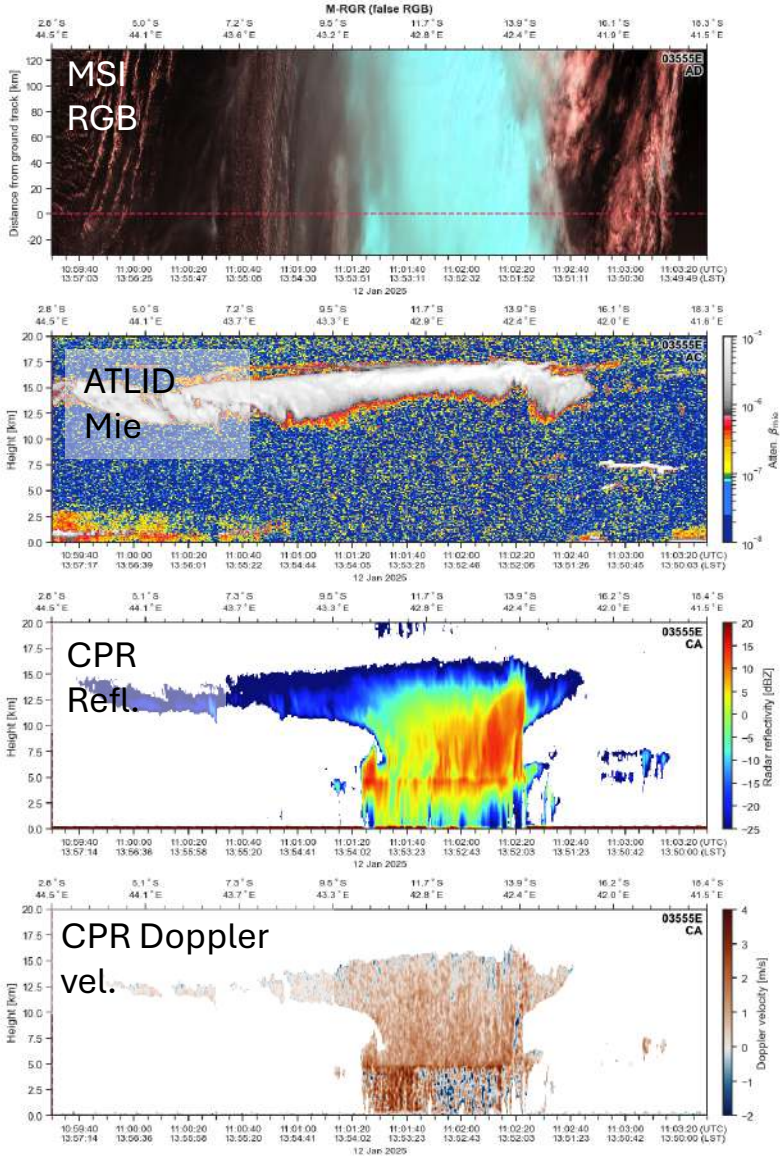
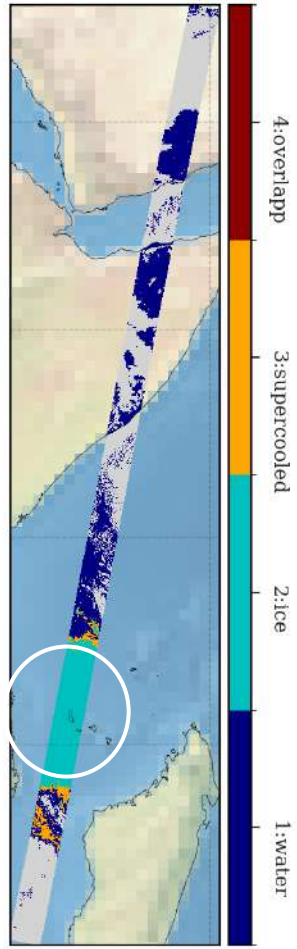


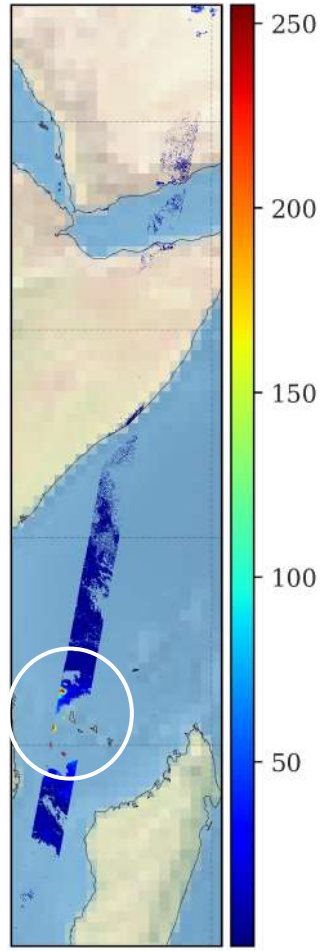
Image created by Leonard König, TROPOS

MSI L1 RGB

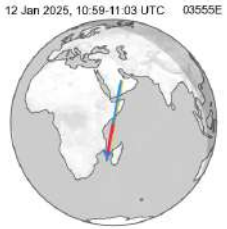
MSI L2a M-CM Cloud phase



MSI L2a M-COP COT



Case study on 12 January 2025 (frame 3555E)



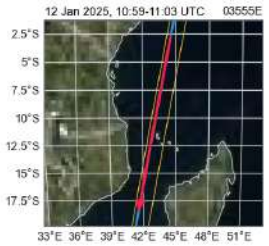
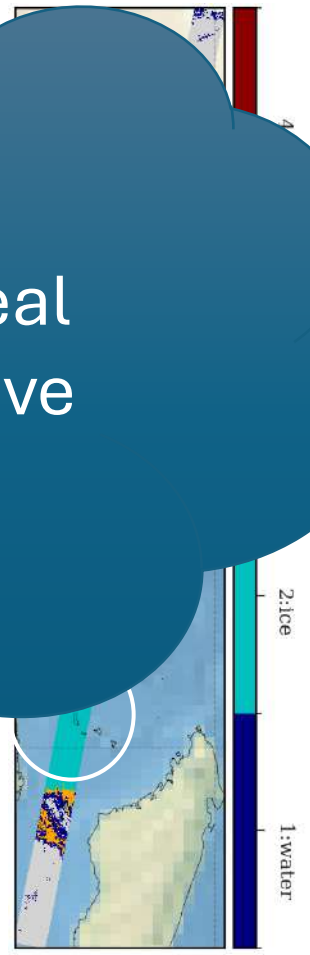


Image created by Leonard König, TROPOS

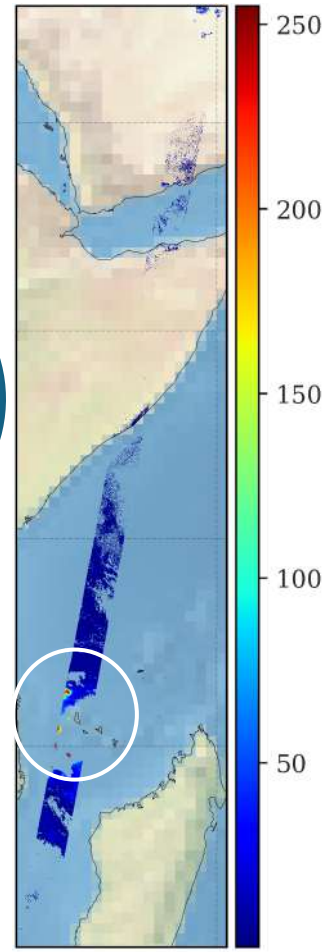
A quick look at L2 products can often reveal the need for a deeper dive into L1 data and its issues...

MSI L1 RGB

MSI L2a M-CM Cloud phase



MSI L2a M-COP COT



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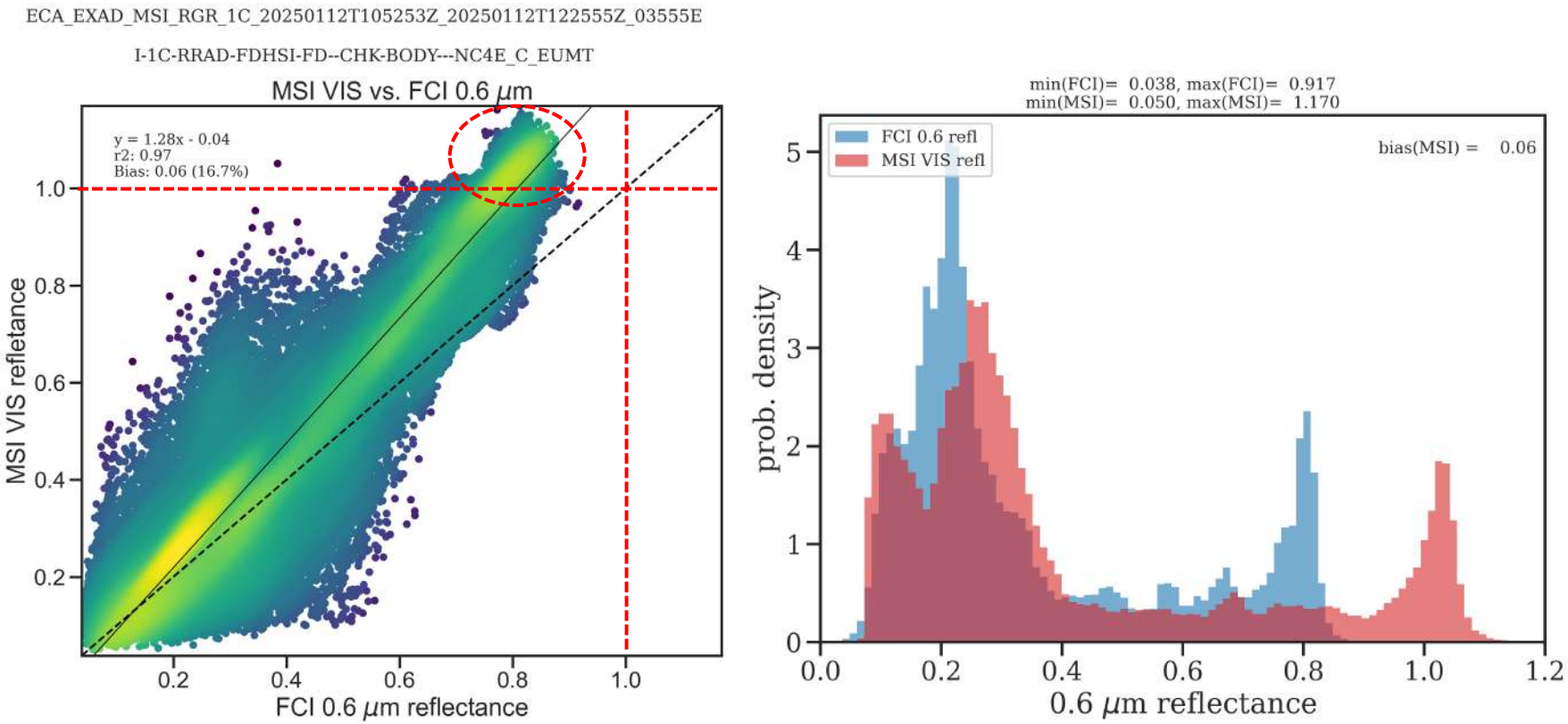
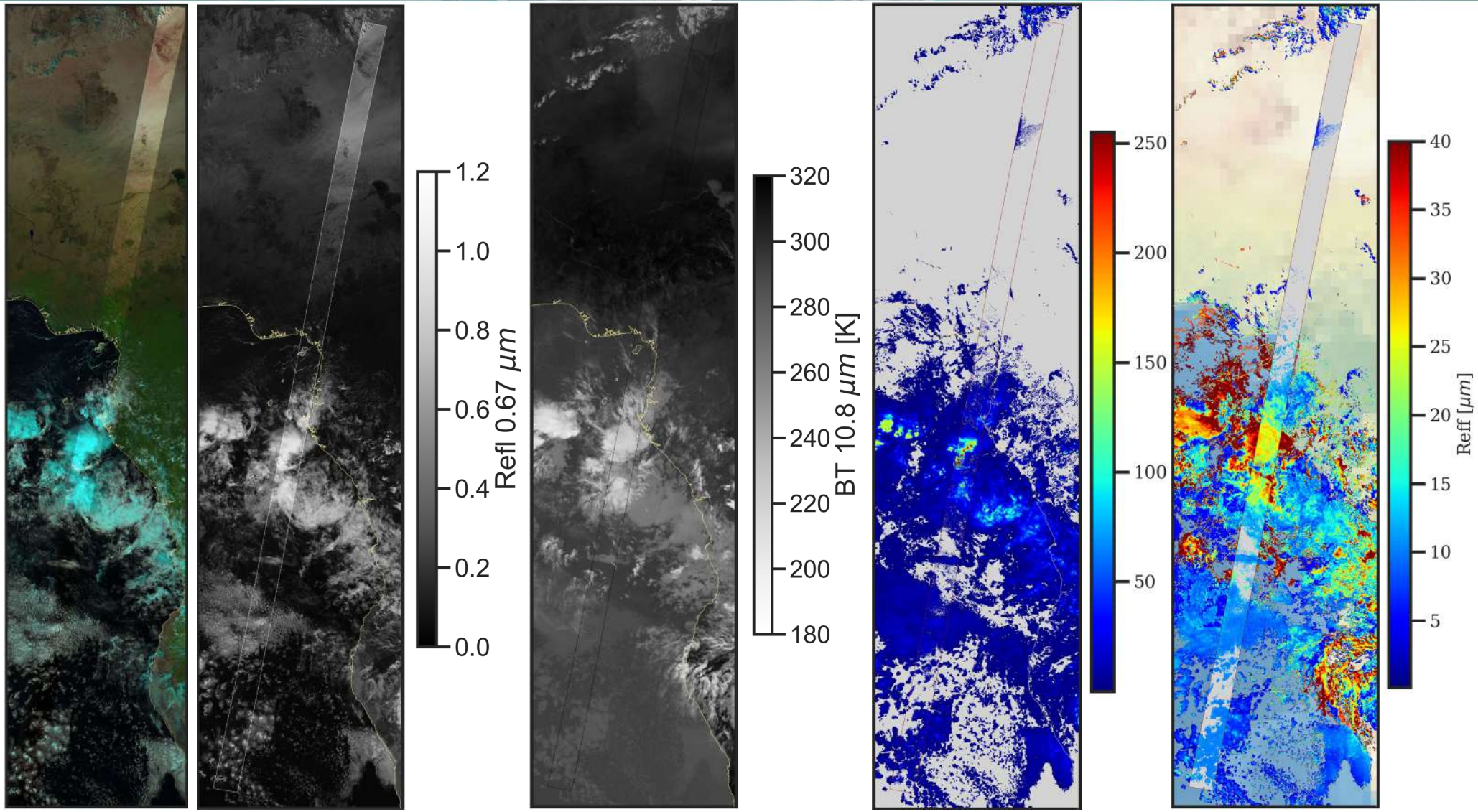


- 17 % higher MSI VIS reflectance compared to FCI
- Many MSI values above 1
- But different viewing geometry

Case study on 2 Jan 2025 (frame 3401E)

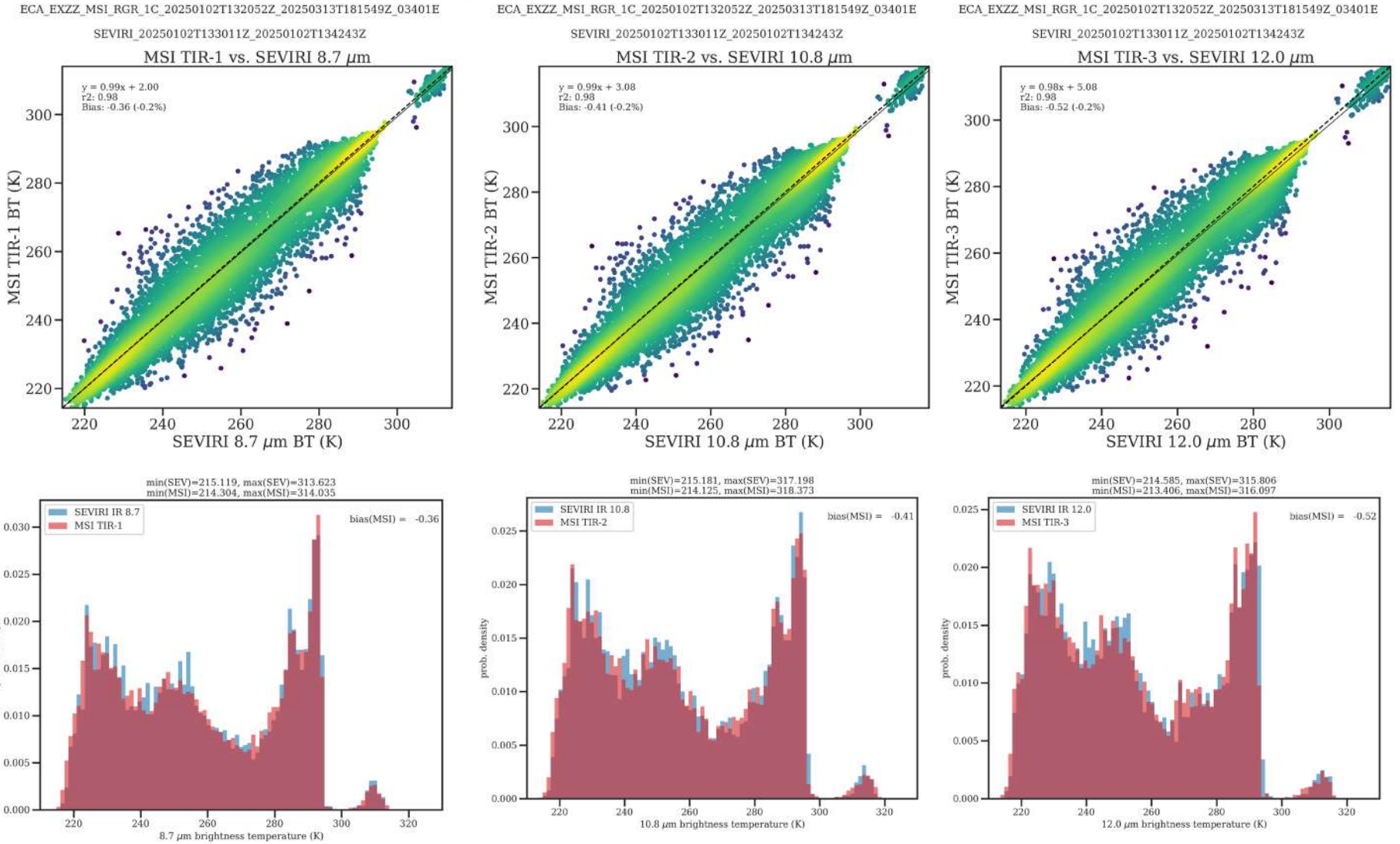
MSI vs. FCI



MSI M-COP vs. KNMI Cloud Physical Properties Retrieval (CPP)

→ Talk by Anja Hünerbein on Tuesday

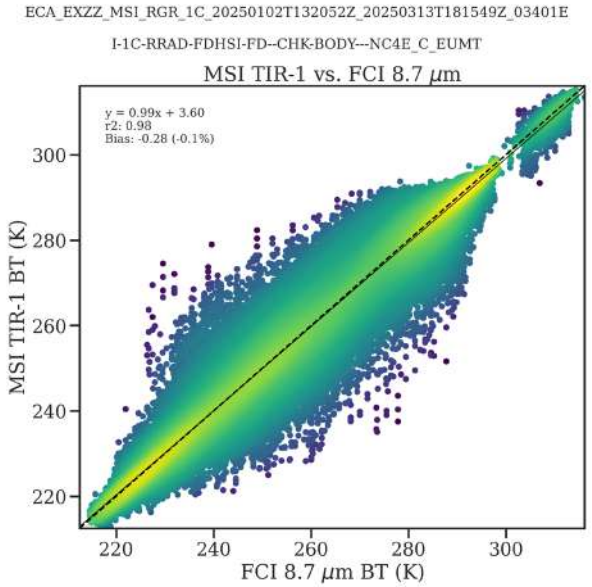
Case study on 2 Jan 2025 (frame 3401E)

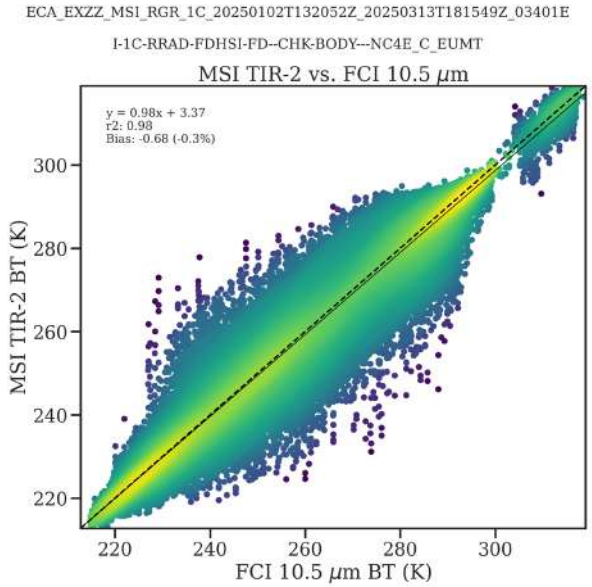


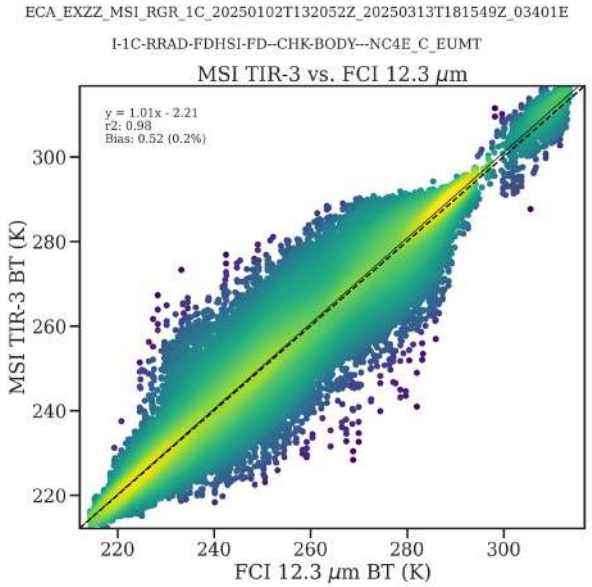
MSI L1 baseline AF compared to SEVIRI

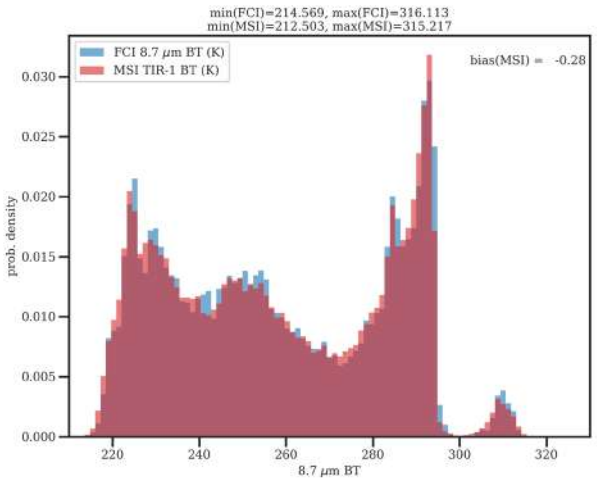
- Excellent agreement for TIR bands
- Bias less than 1K
- r2 = 0.98

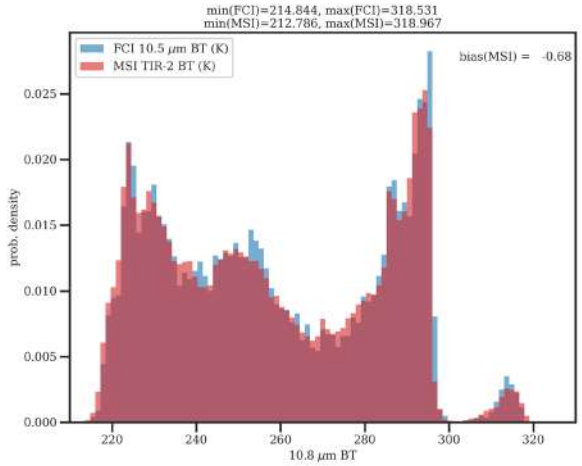
Case study on 2 Jan 2025 (frame 3401E)

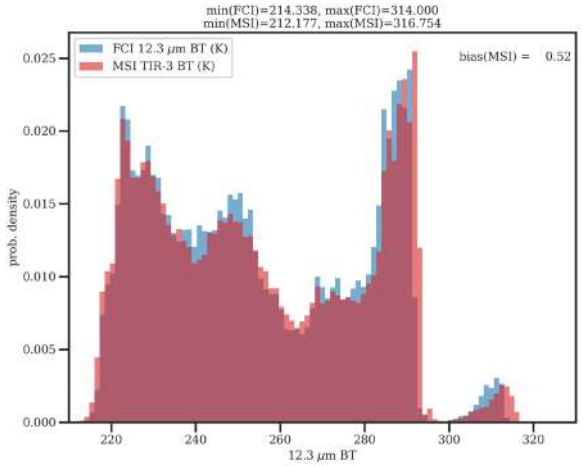








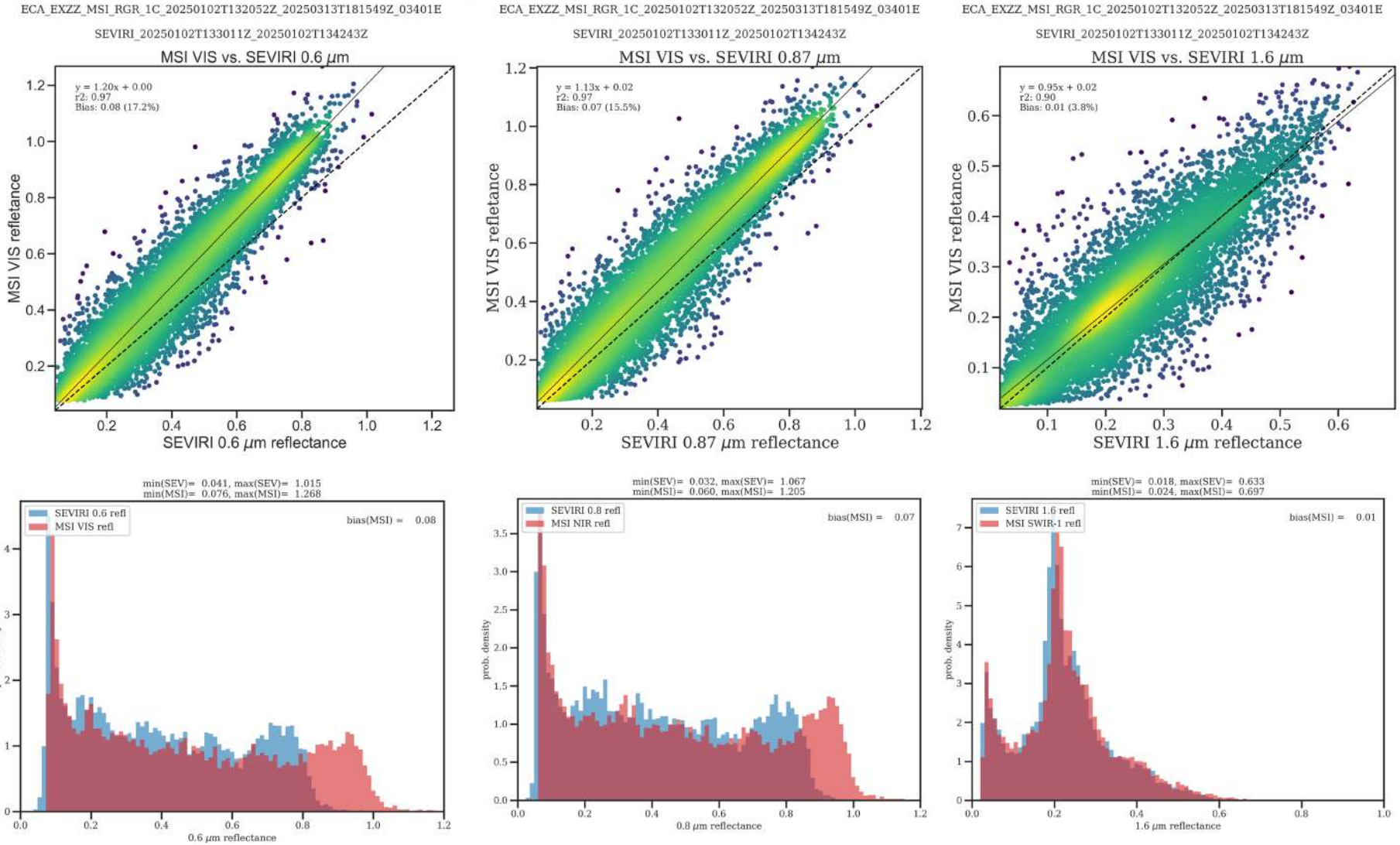




MSI L1 baseline AF compared to FCI

- Excellent agreement for TIR bands
- Bias less than 1K
- r2 = 0.98
- Higher variability for FCI → Ray matching not considered

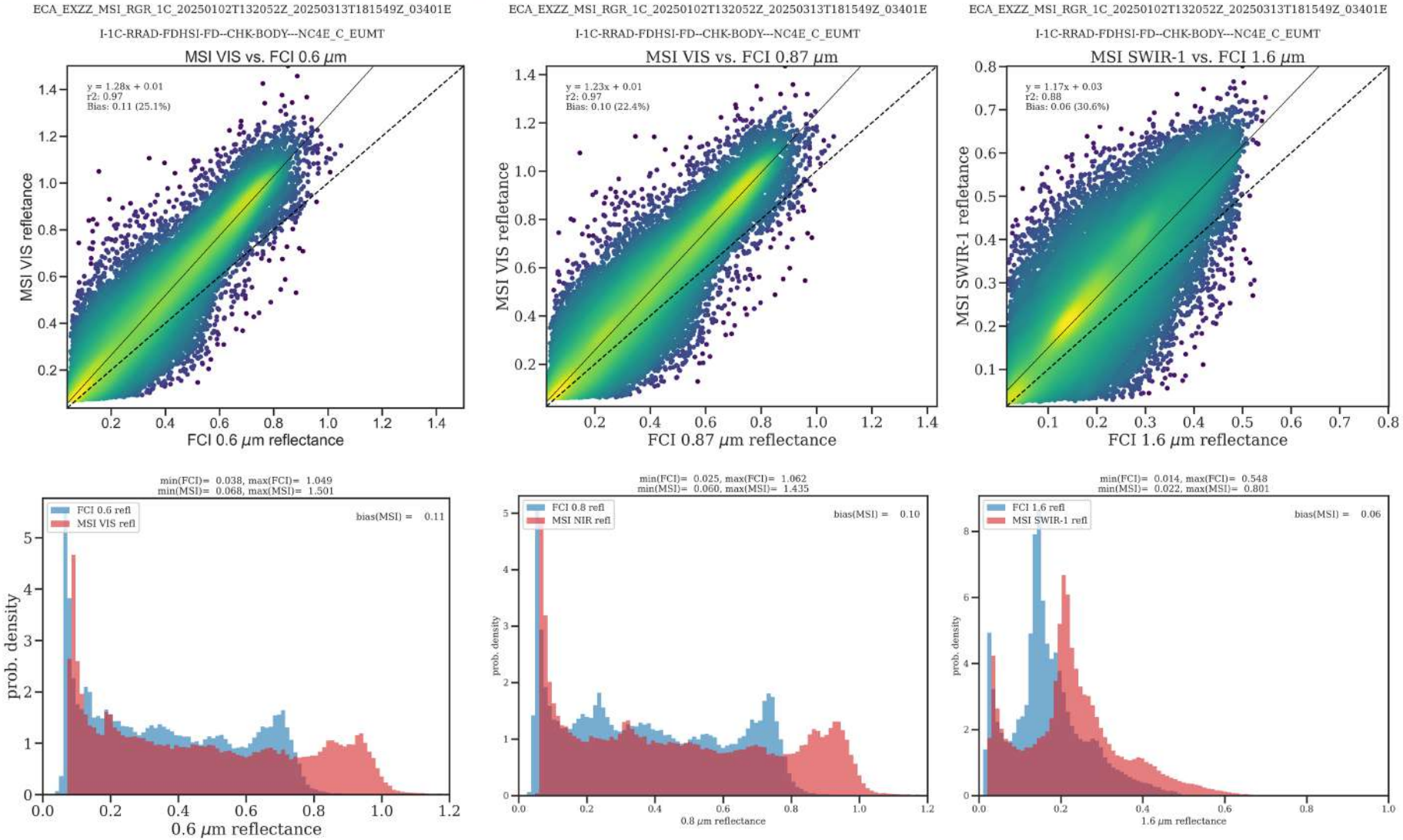
Case study on 2 Jan 2025 (frame 3401E)



MSI L1 baseline AF compared to SEVIRI

- VNS bands too bright in contrast to SEVIRI (17 % for VIS)

Case study on 2 Jan 2025 (frame 3401E)

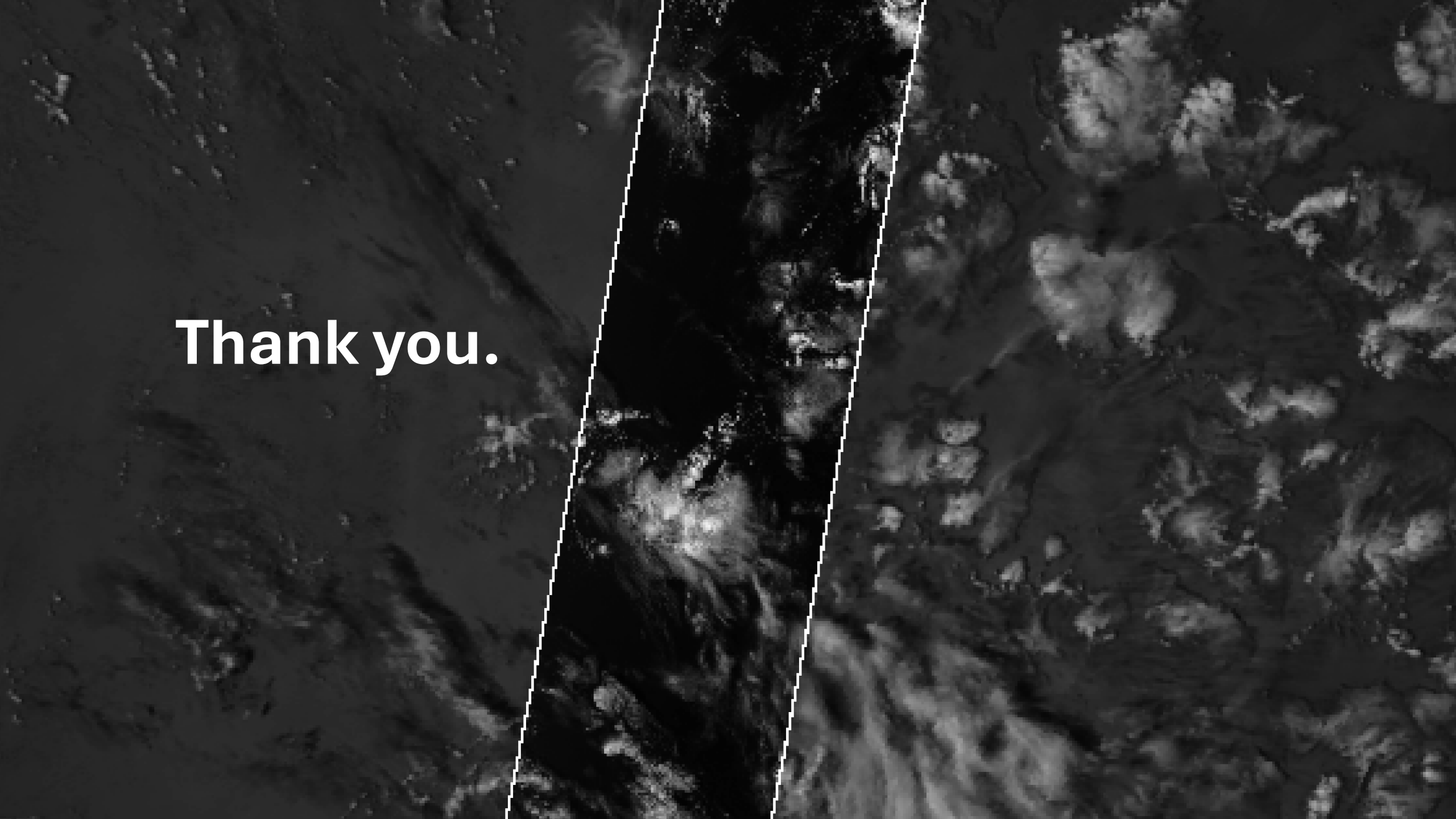


MSI L1 baseline AF compared to FCI

- VNS bands too bright in contrast to FCI (25 % for VIS)
- Differences in SWIR-1, which cannot be seen for SEVIRI.
- After filtering via Ray matching STD will decrease, but systematic difference expected to be stable

Summary

- Validation of MSI L1 using FCI/SEVIRI has confirmed the correct calibration of MSI thermal infrared bands, but reveals systematic differences for VNS bands (while data is highly correlated → suitable for vicarious calibration)
- Uncertainties in L1 data will directly effect L2 products! (→ Talk Anja Hünerbein)
- Transfer functions are needed to predict MSI reflectances with collocated FCI observations.
- MSI tool can support assessment of differences in filter function and viewing geometry (→ Poster Nils Madenach)
- Ongoing work: Apply MSI L2 cloud processor (M-CLD) to FCI data for selected collocated EarthCARE scenes.


Thank you.