



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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1 TROPOS, 2 FU Berlin*

Gefördert durch:



Bundesministerium
für Wirtschaft
und Klimaschutz

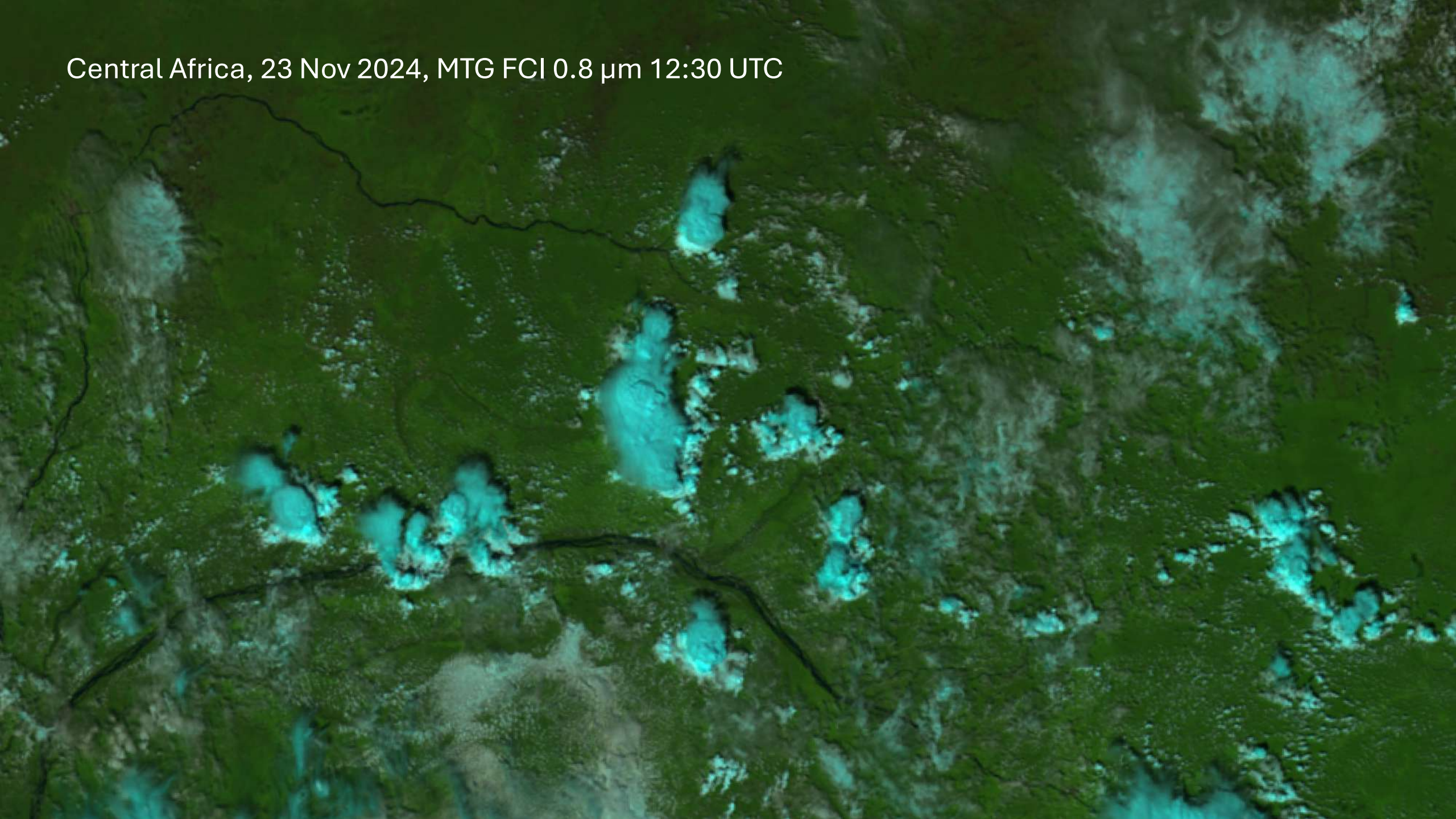
aufgrund eines Beschlusses
des Deutschen Bundestages



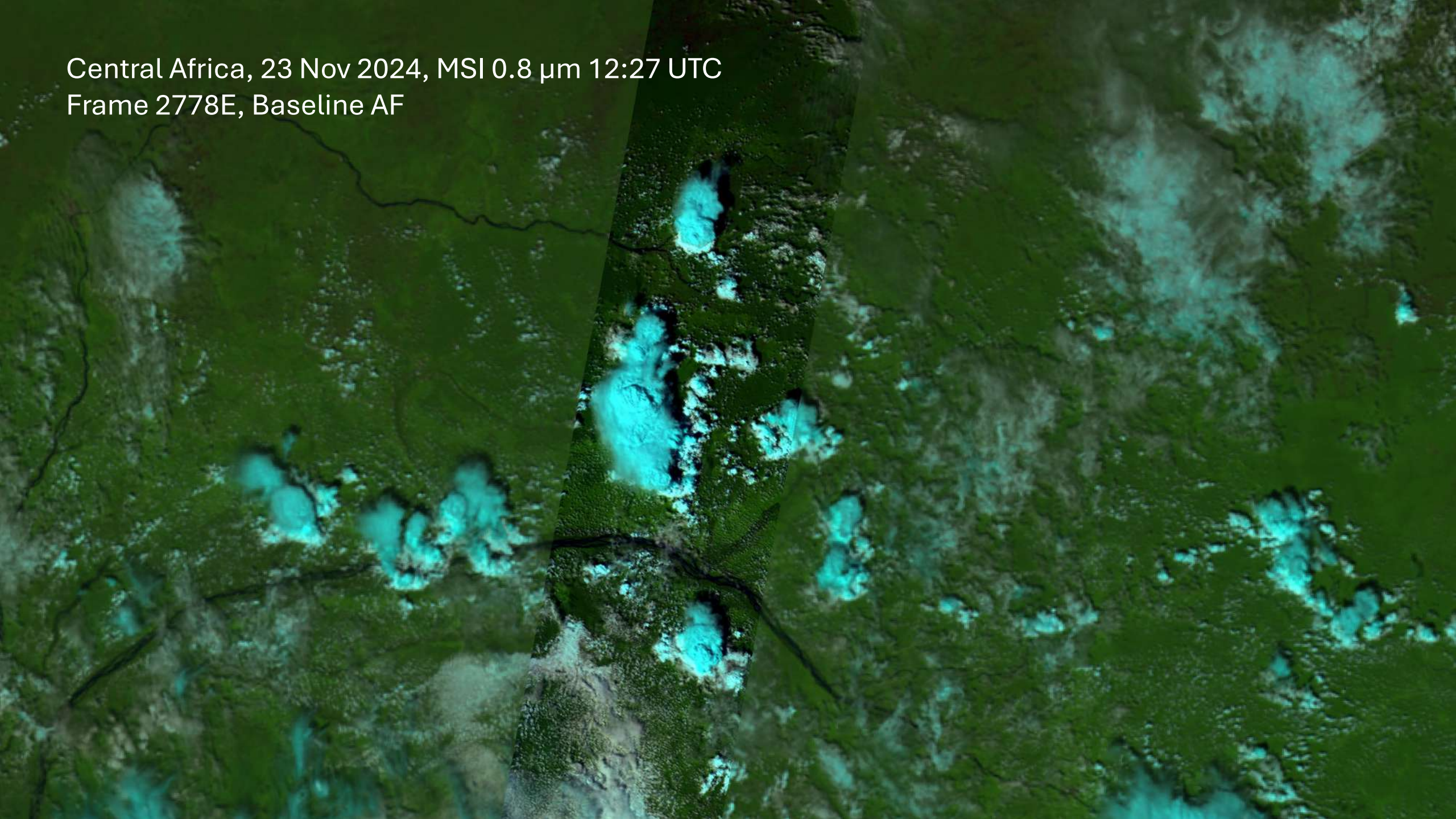
2nd ESA-JAXA EarthCARE In-Orbit Validation Workshop
17 – 20 March 2025 | ESA-ESRIN | Frascati (Rome), Italy



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



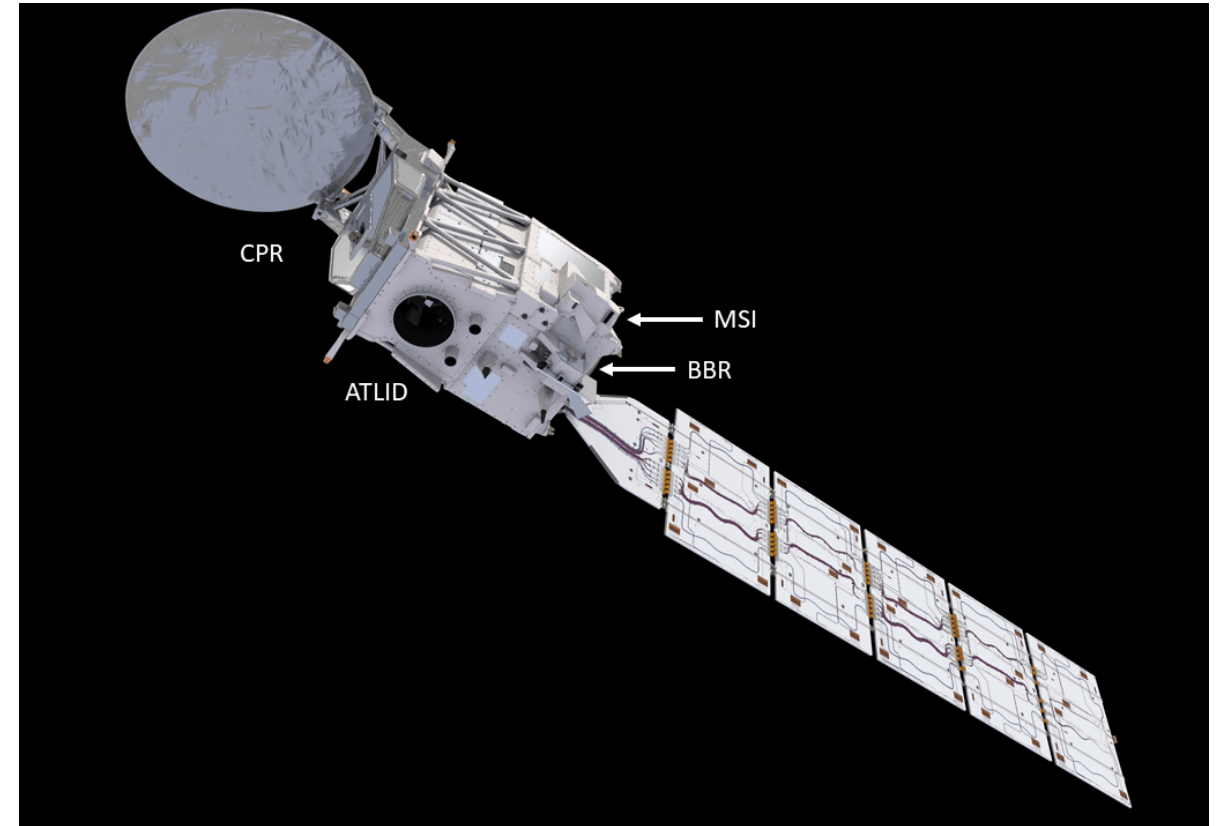
Central Africa, 23 Nov 2024, MSI 0.8 μm 12:27 UTC
Frame 2778E, Baseline AF



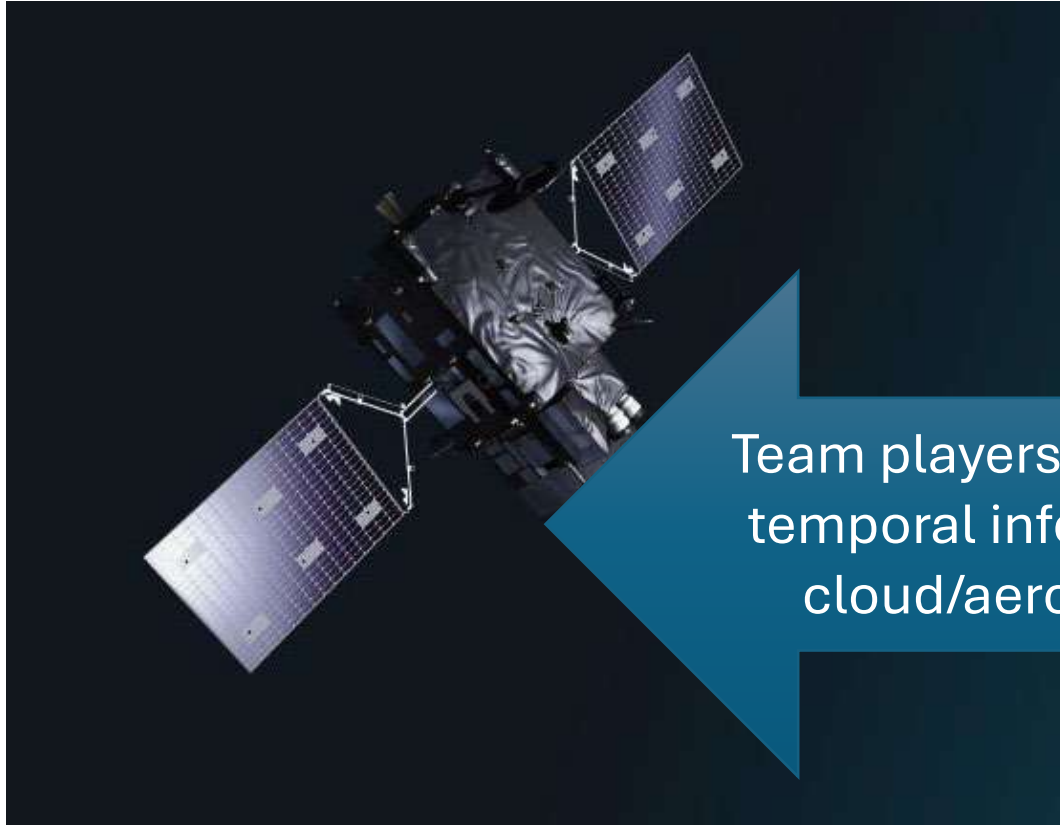
Overview



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

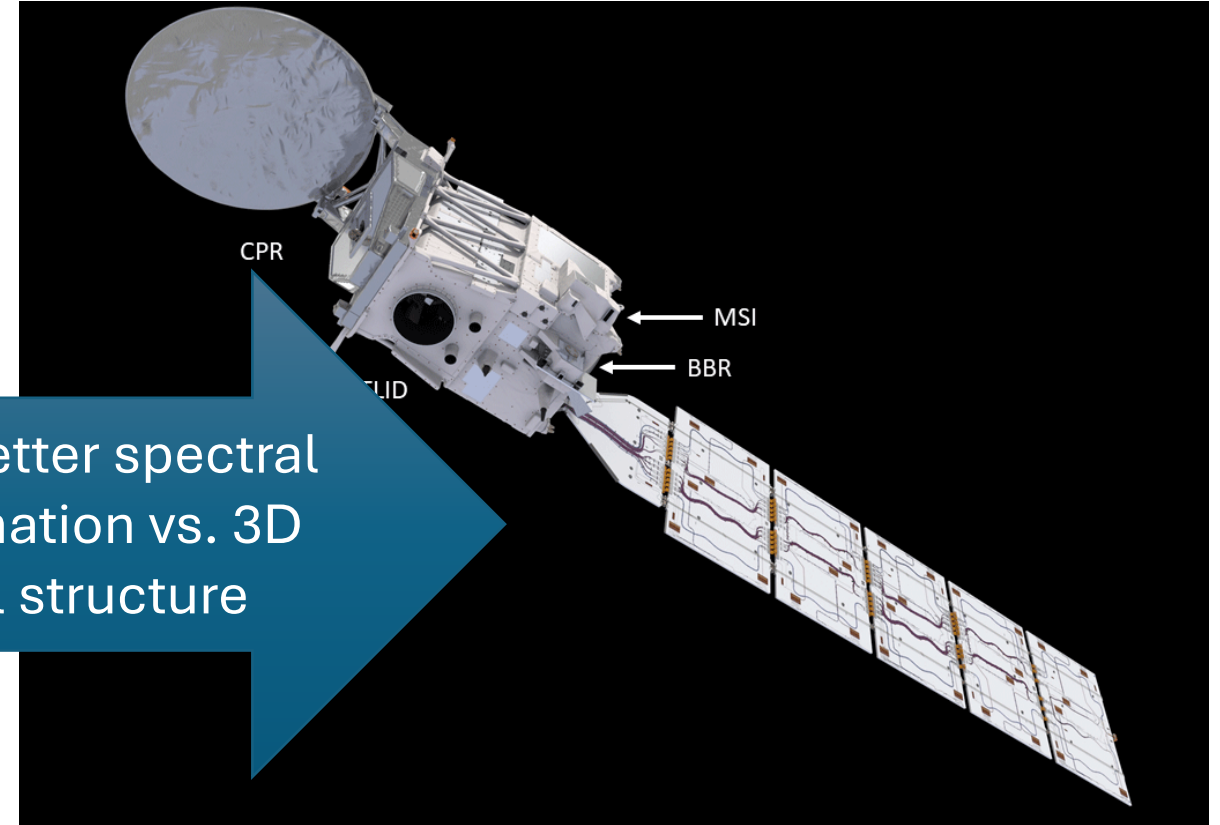


- 7 spectral channels (0.6-12.0 μm)
- 150 km swath with 500 m pixel size
- Every 28 days
- MSI complemented by profile measurements



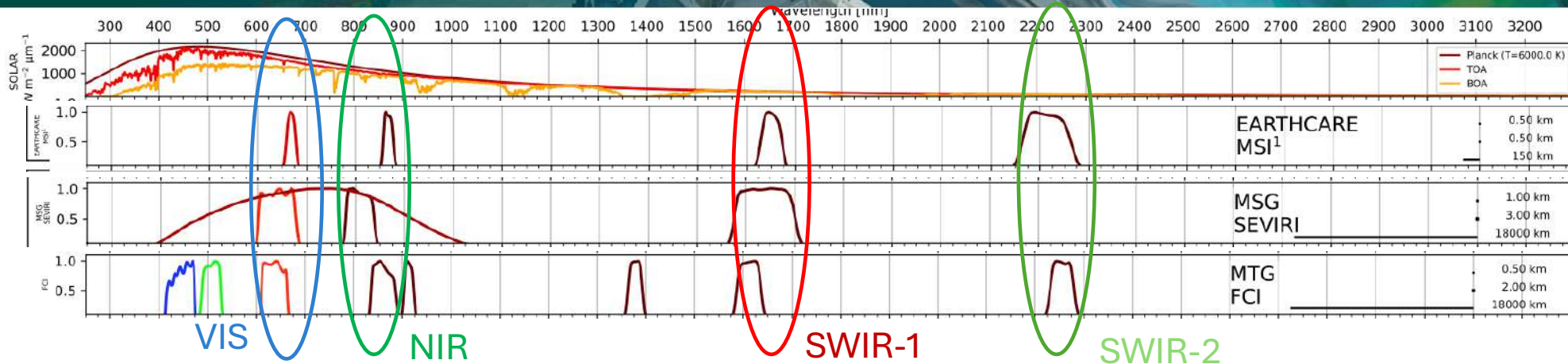
Team players: Better spectral
temporal information vs. 3D
cloud/aerosol structure

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

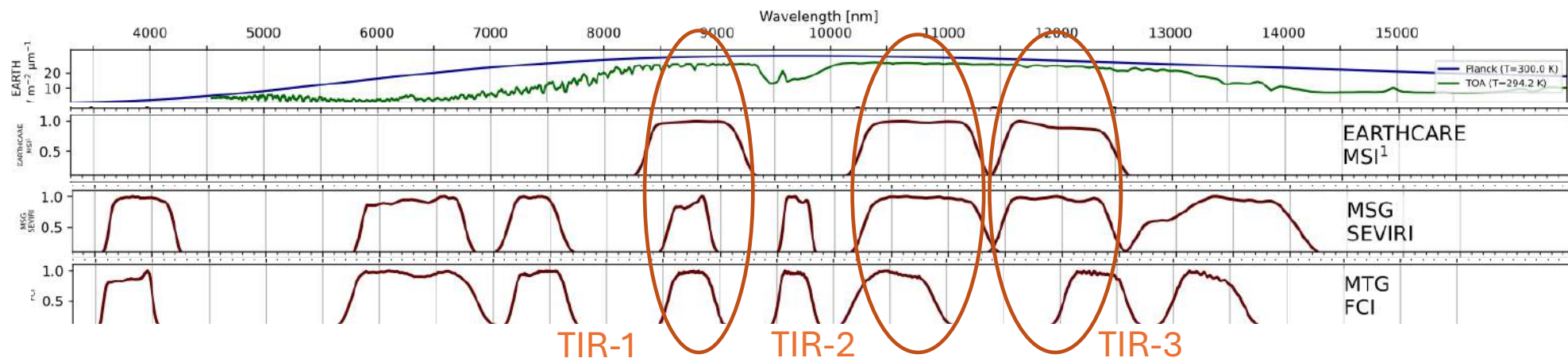


- 7 spectral channels (0.6-12.0 μm)
- 150 km swath with 500 m pixel size
- Every 28 days
- MSI complemented by profile measurements

Overview – Spectral band characteristics



Towards $0.7 \mu\text{m}$,
clouds less
reflective, water
vapor absorption
stronger

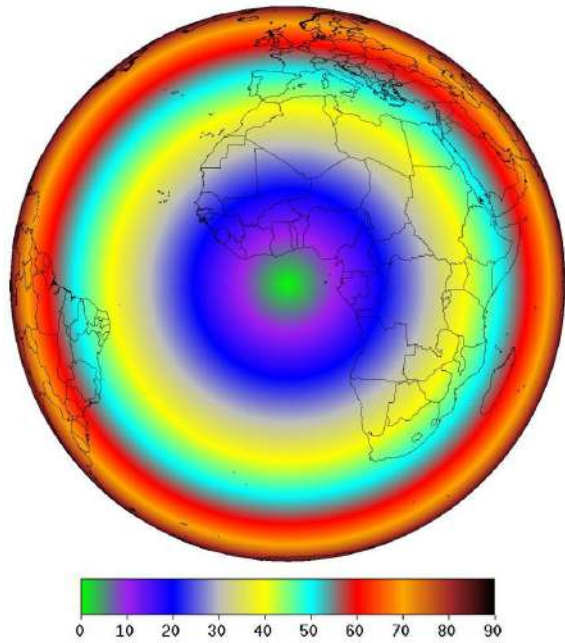


Courtesy of Jan R. El
Kassar (FU Berlin)

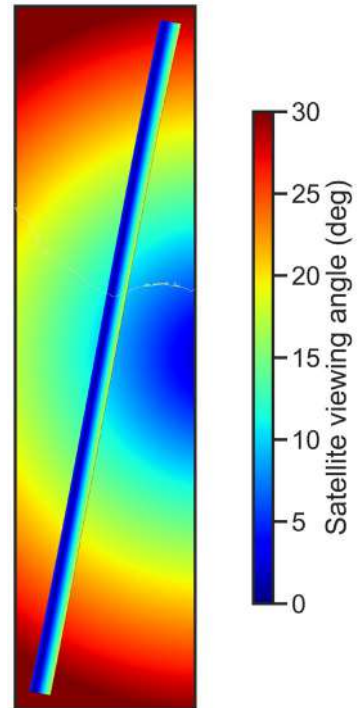
- Very similar filter functions between MSI, SEVIRI and FCI spectral channels
- However, small differences can have big impact for TOA reflectance of clouds, but particularly for aerosol and clear sky surface

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



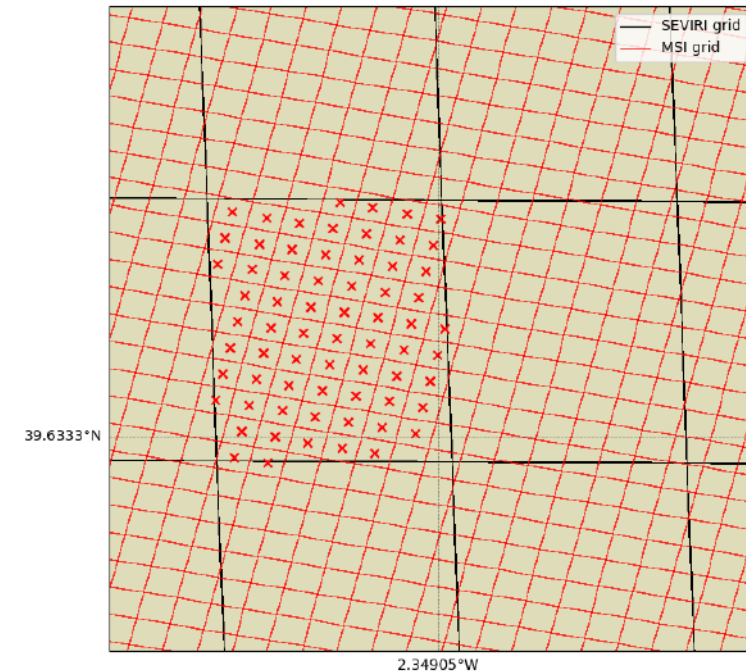
Viewing geometry of SEVIRI on MSG-2 satellite located at 0 deg W, Neukermans, 2012.



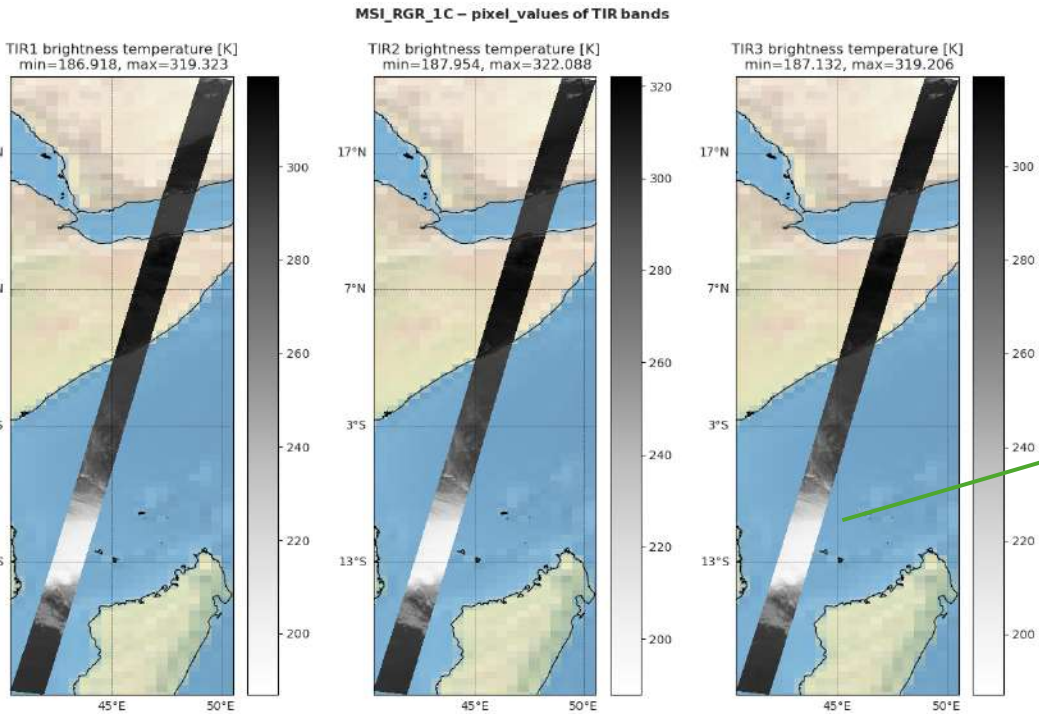
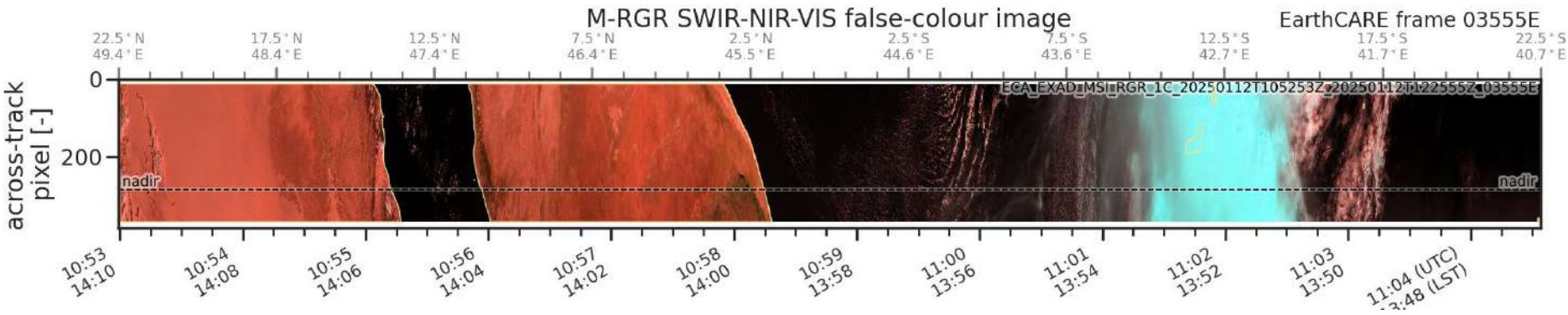
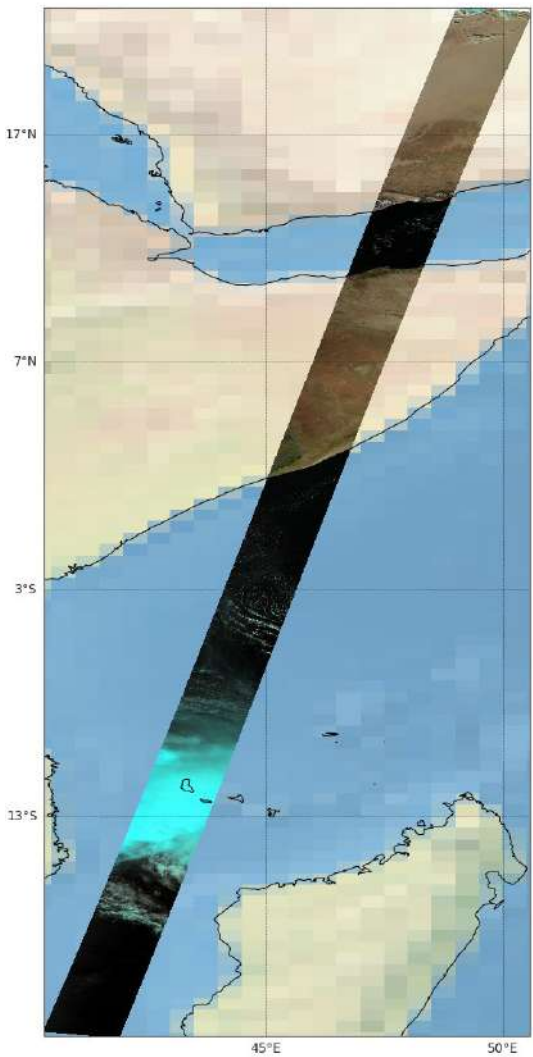
*FCI
viewing
angle
compared
to MSI for
frame E*

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)



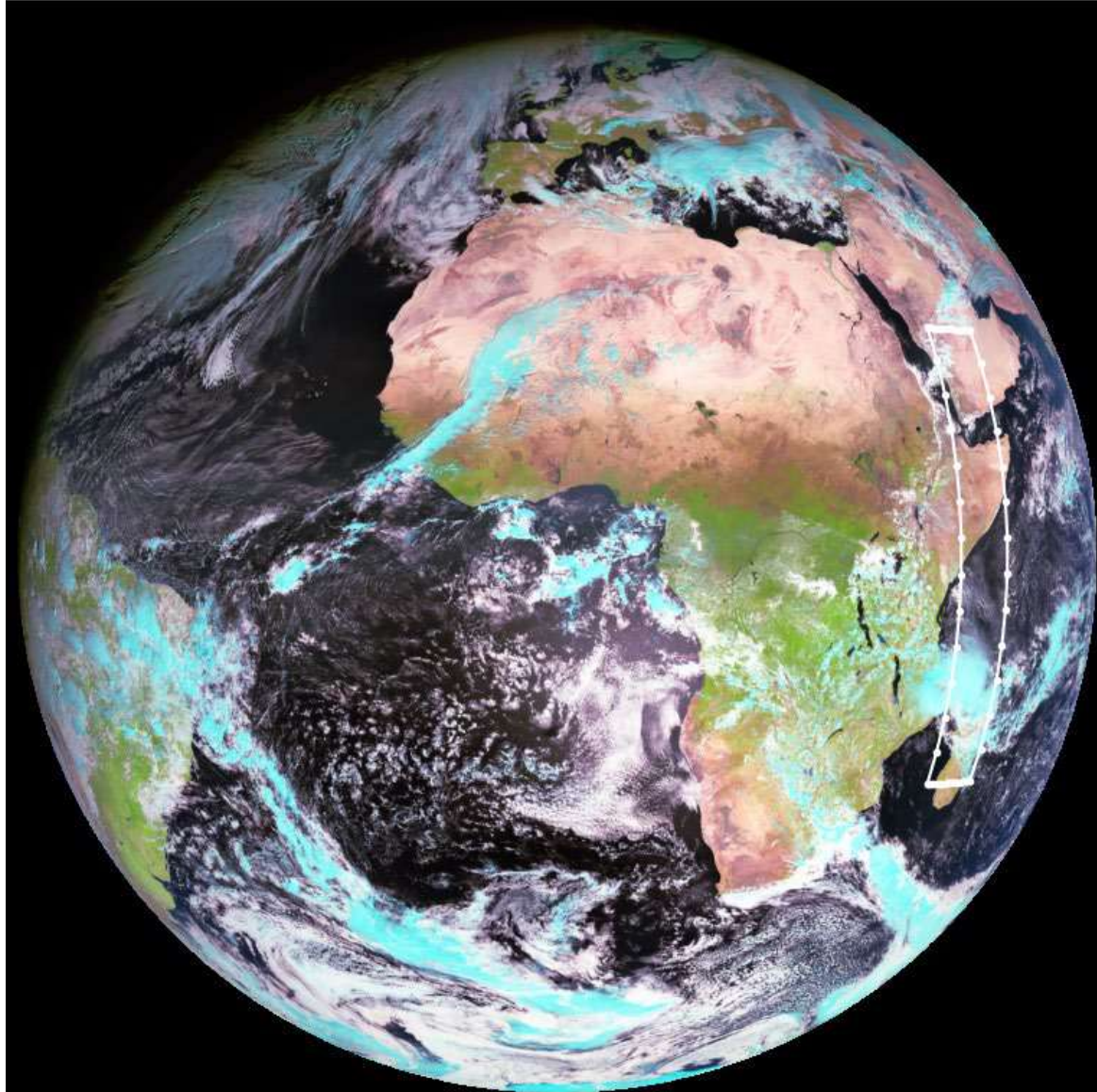
Baseline EXAD

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

Case study on 12 January 2025 (frame 3555E)



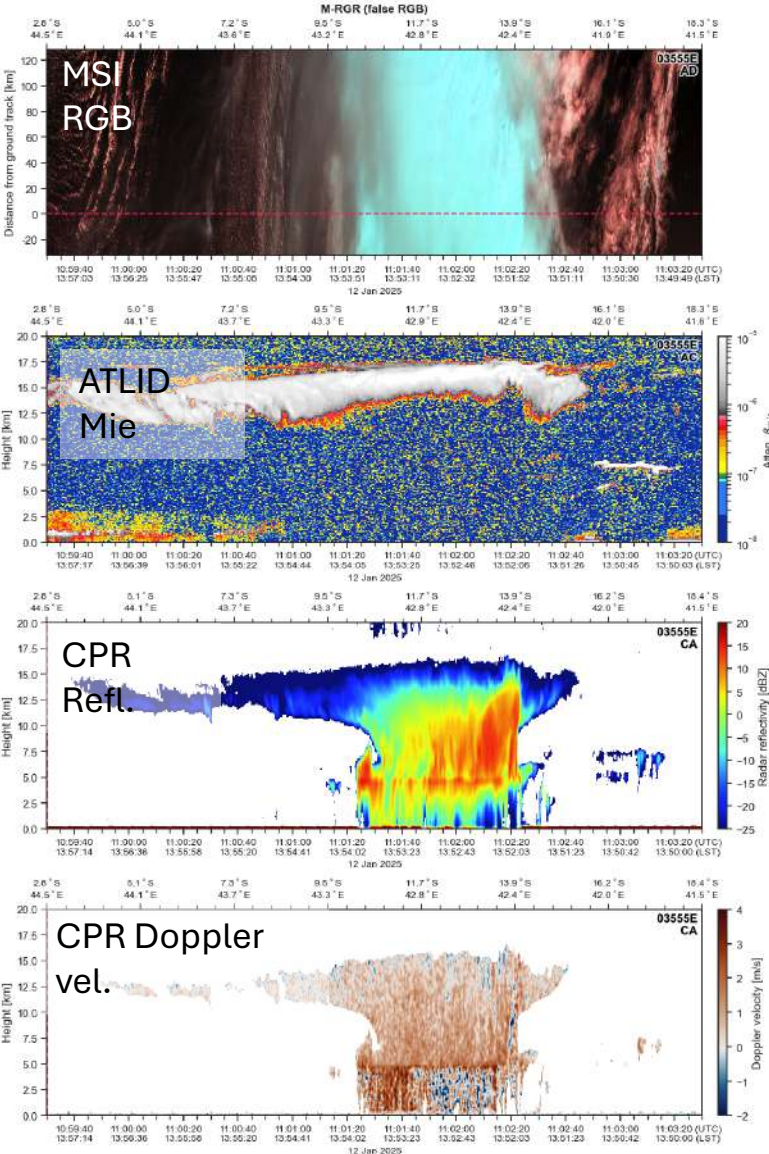
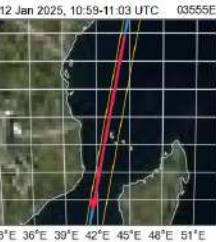
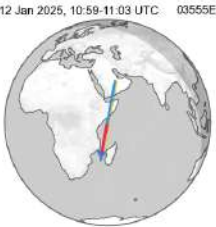
FCI “Natural colour RGB” (1.6, 0.8, 0.6)



FCI “True colour RGB” (0.6, 0.5, 0.4)



Case study on 12 January 2025 (frame 3555E)



MSI L1
RGB

MSI L2a M-CM
Cloud phase

MSI L2a M-COP
COT

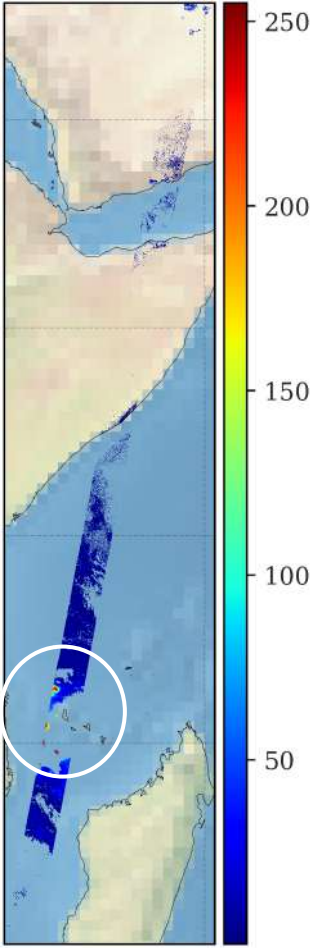
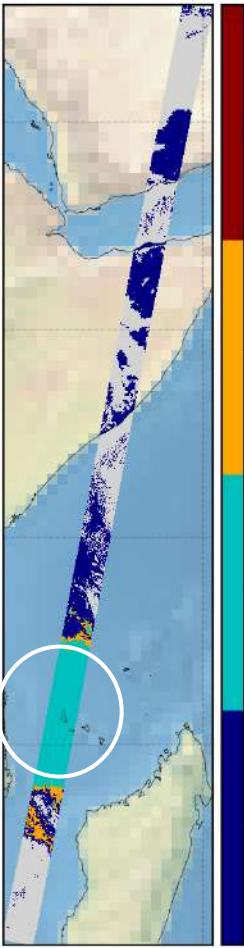
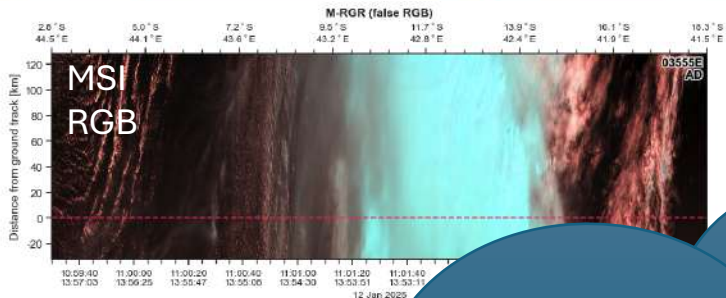
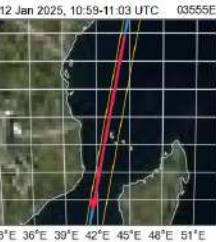
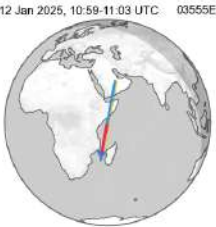


Image created by
Leonard König,
TROPOS

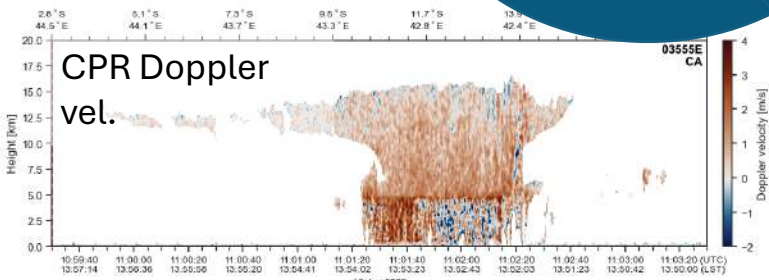
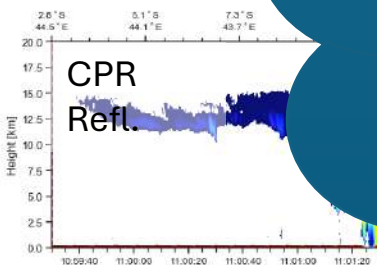
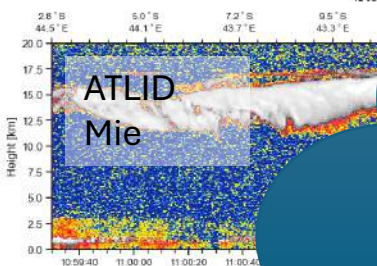
Case study on 12 January 2025 (frame 3555E)



MSI L1
RGB

MSI L2a M-CM
Cloud phase

MSI L2a M-COP
COT



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

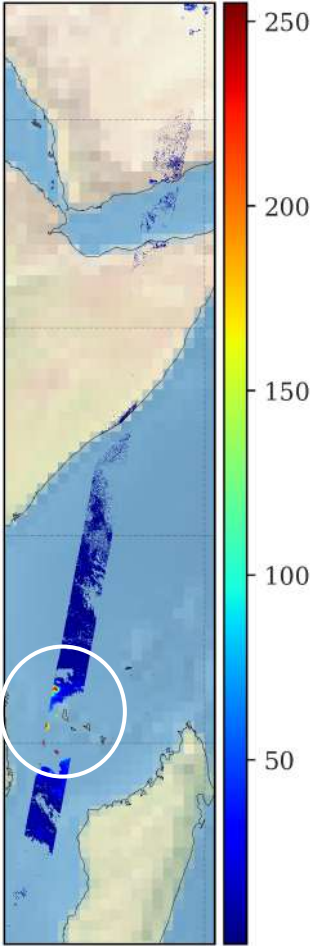
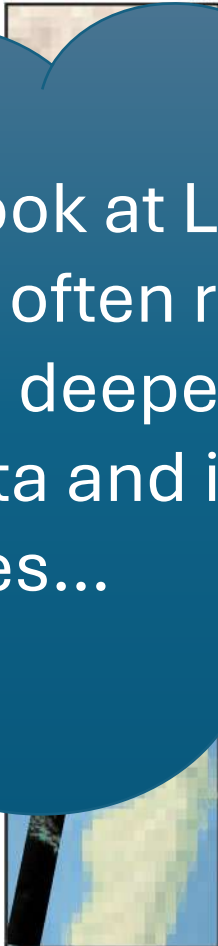


Image created by
Leonard König,
TROPOS

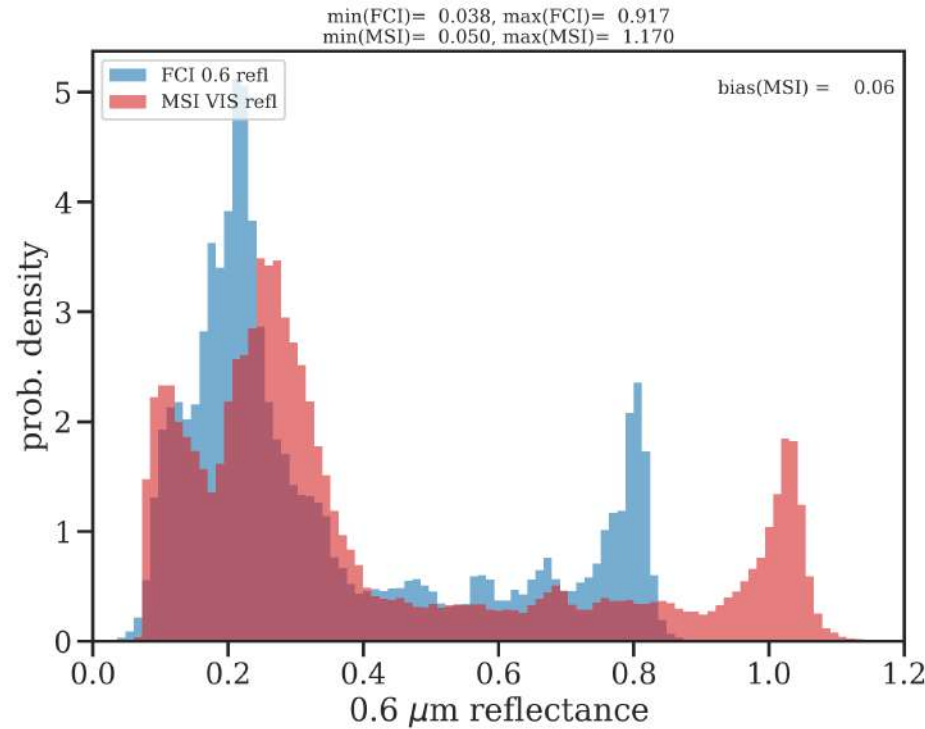
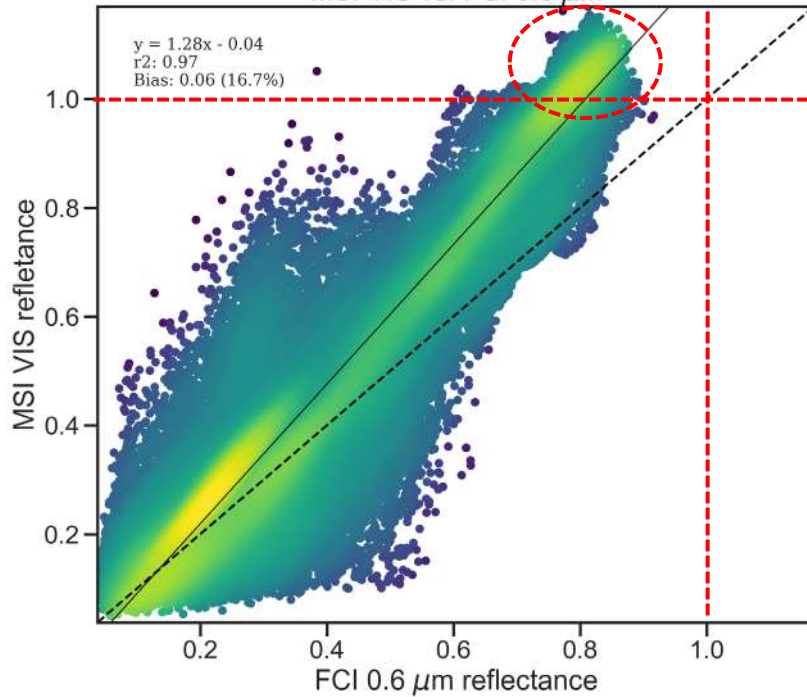
Case study on 12 January 2025 (frame 3555E)



ECA_EXAD_MSI_RGR_1C_20250112T105253Z_20250112T122555Z_03555E

I-1C-RRAD-FDHSI-FD--CHK-BODY---NC4E_C_EUMT

MSI VIS vs. FCI 0.6 μm

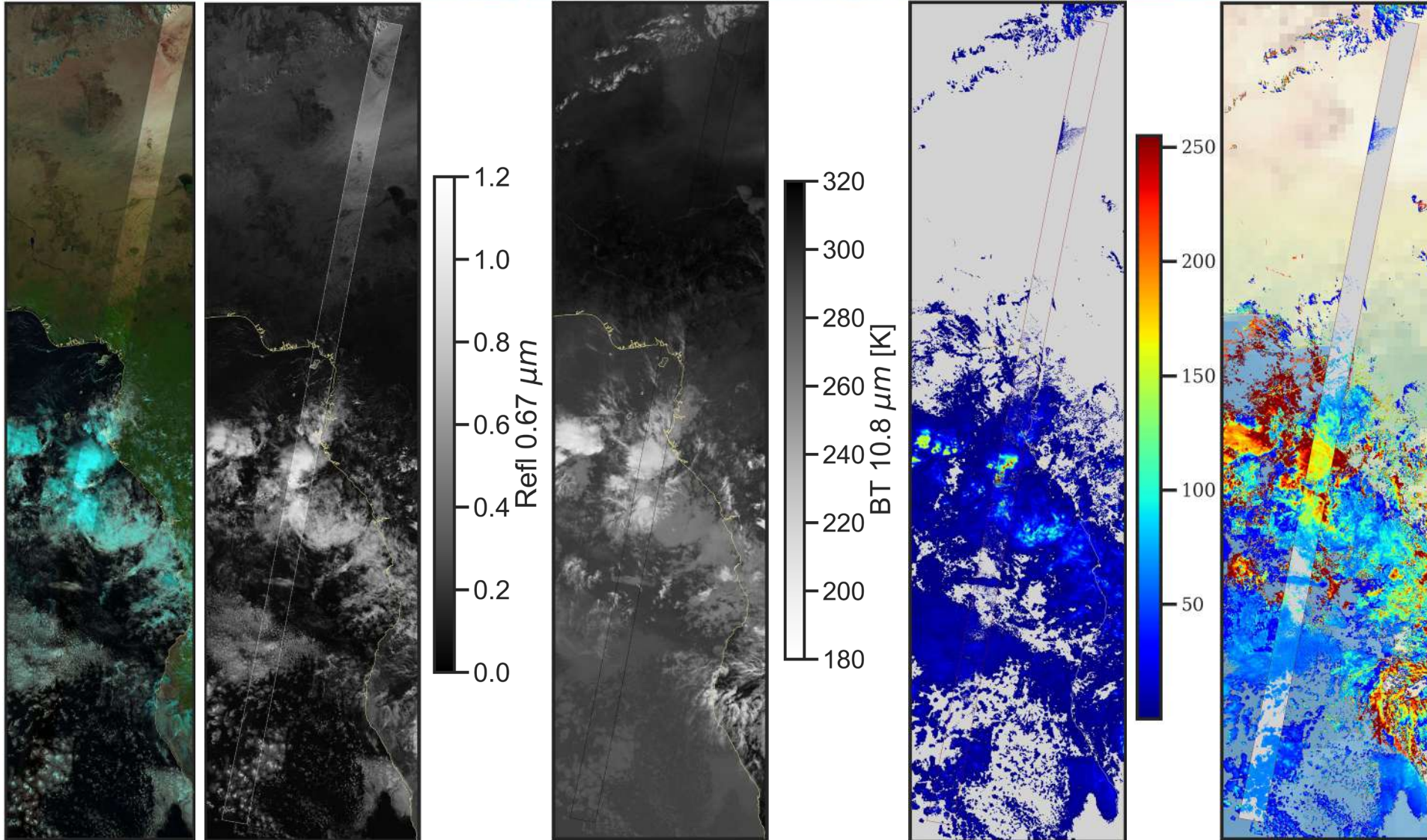


- 17 % higher MSI VIS reflectance compared to FCI
- Many MSI values above 1
- But different viewing geometry

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

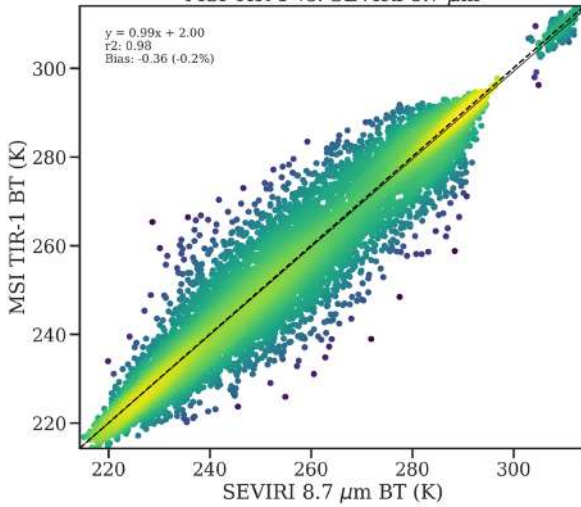
Case study on 2 Jan 2025 (frame 3401E)



ECA_EXZZ_MSI_RGR_1C_20250102T132052Z_20250313T181549Z_03401E

SEVIRI_20250102T133011Z_20250102T134243Z

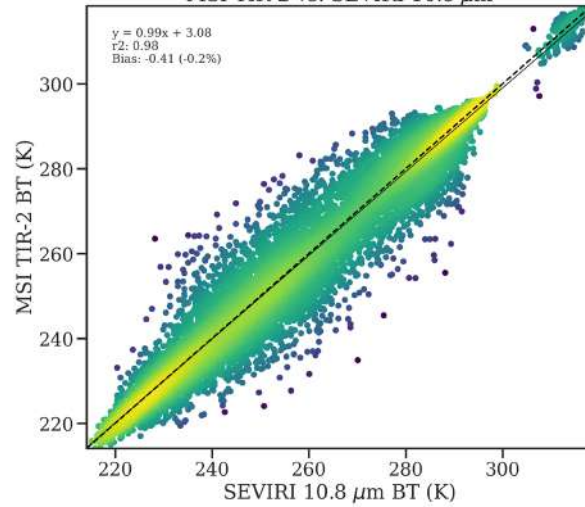
MSI TIR-1 vs. SEVIRI 8.7 μm



ECA_EXZZ_MSI_RGR_1C_20250102T132052Z_20250313T181549Z_03401E

SEVIRI_20250102T133011Z_20250102T134243Z

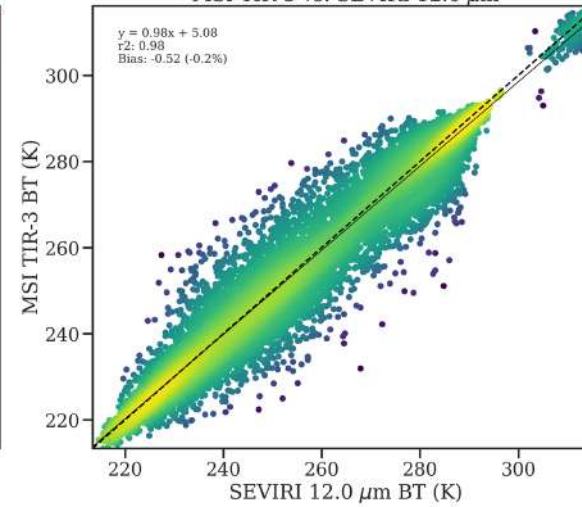
MSI TIR-2 vs. SEVIRI 10.8 μm



ECA_EXZZ_MSI_RGR_1C_20250102T132052Z_20250313T181549Z_03401E

SEVIRI_20250102T133011Z_20250102T134243Z

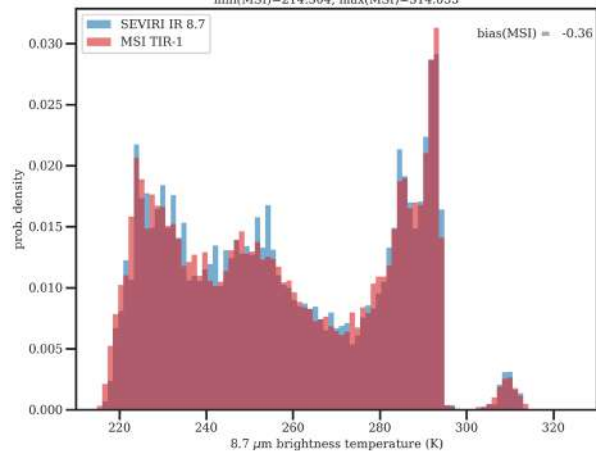
MSI TIR-3 vs. SEVIRI 12.0 μm



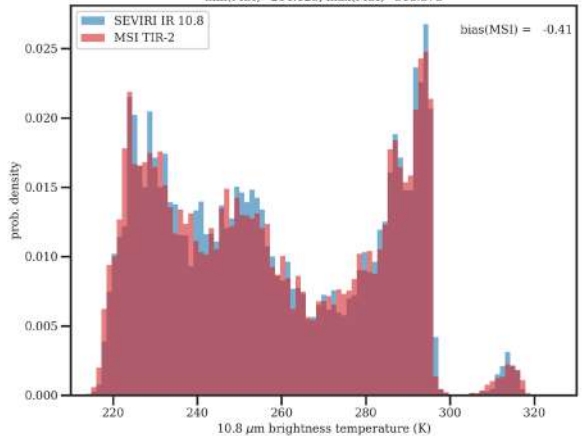
MSI L1 baseline AF compared to SEVIRI

- Excellent agreement for TIR bands
- Bias less than 1K
- $r^2 = 0.98$

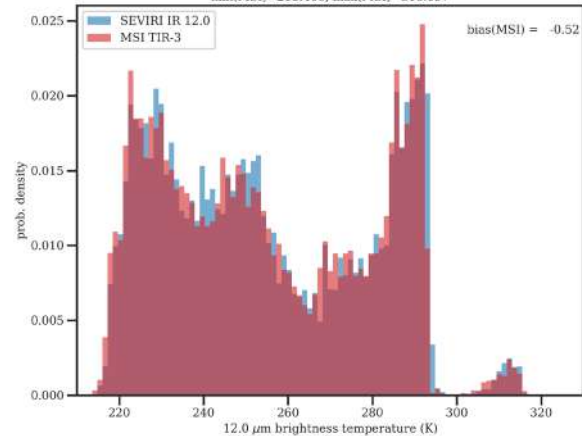
min(SEV)=215.119, max(SEV)=313.623
min(MSI)=214.304, max(MSI)=314.035



min(SEV)=215.181, max(SEV)=317.198
min(MSI)=214.125, max(MSI)=318.373



min(SEV)=214.585, max(SEV)=315.806
min(MSI)=213.406, max(MSI)=316.097



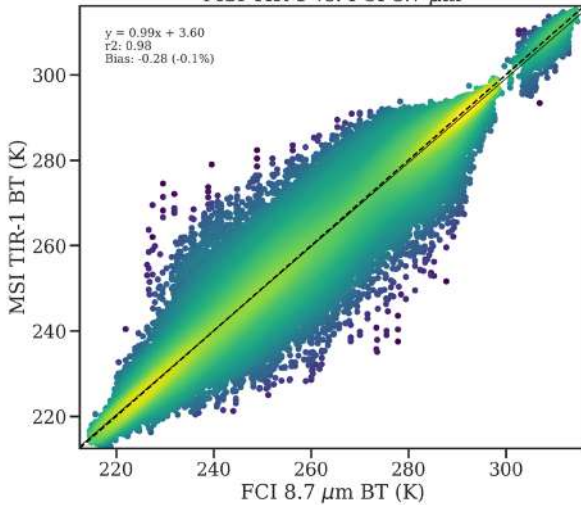
Case study on 2 Jan 2025 (frame 3401E)



ECA_EXZZ_MSI_RGR_1C_20250102T132052Z_20250313T181549Z_03401E

I-1C-RRAD-FDHSI-FD--CHK-BODY--NC4E_C_EUMT

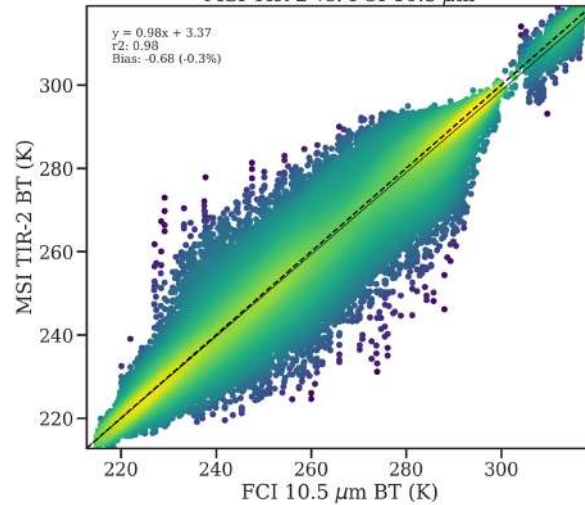
MSI TIR-1 vs. FCI 8.7 μm



ECA_EXZZ_MSI_RGR_1C_20250102T132052Z_20250313T181549Z_03401E

I-1C-RRAD-FDHSI-FD--CHK-BODY--NC4E_C_EUMT

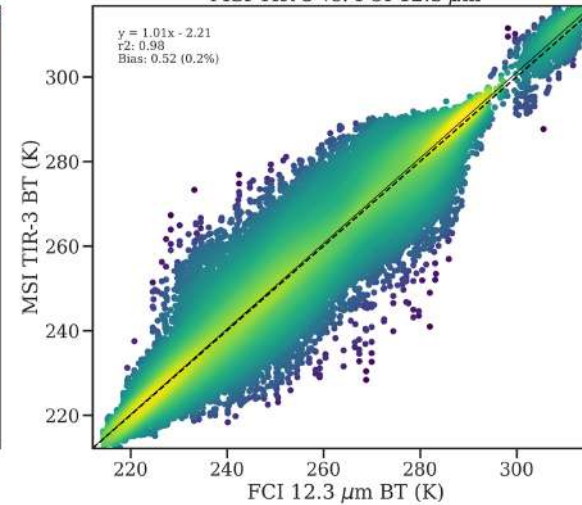
MSI TIR-2 vs. FCI 10.5 μm



ECA_EXZZ_MSI_RGR_1C_20250102T132052Z_20250313T181549Z_03401E

I-1C-RRAD-FDHSI-FD--CHK-BODY--NC4E_C_EUMT

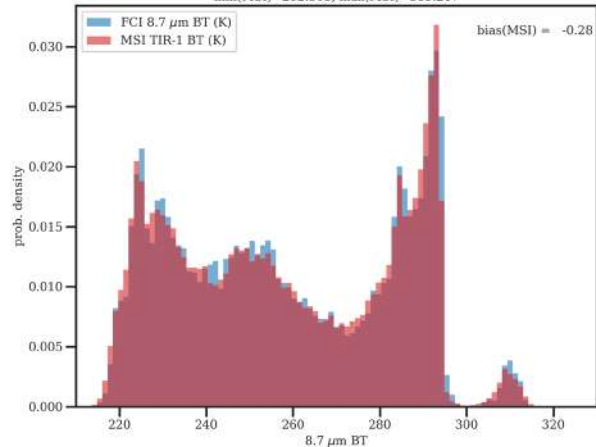
MSI TIR-3 vs. FCI 12.3 μm



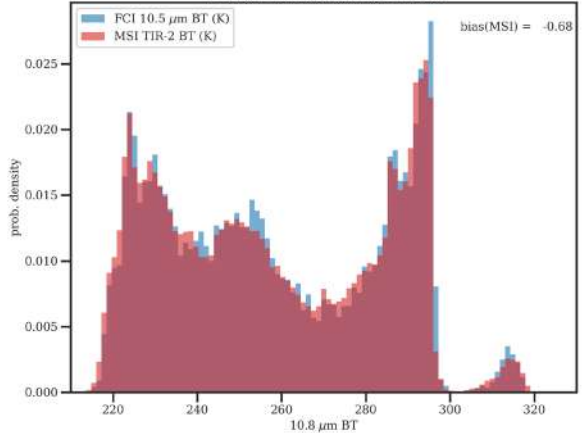
MSI L1 baseline AF compared to FCI

- Excellent agreement for TIR bands
- Bias less than 1K
- $r^2 = 0.98$
- Higher variability for FCI \rightarrow Ray matching not considered

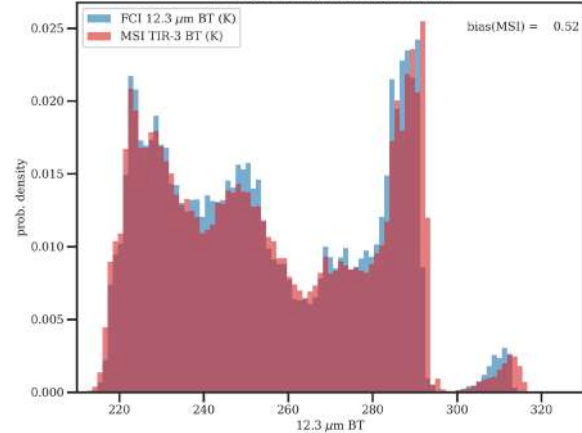
min(FCI)=214.569, max(FCI)=316.113
min(MSI)=212.503, max(MSI)=315.217



min(FCI)=214.844, max(FCI)=318.531
min(MSI)=212.786, max(MSI)=318.967



min(FCI)=214.338, max(FCI)=314.000
min(MSI)=212.177, max(MSI)=316.754



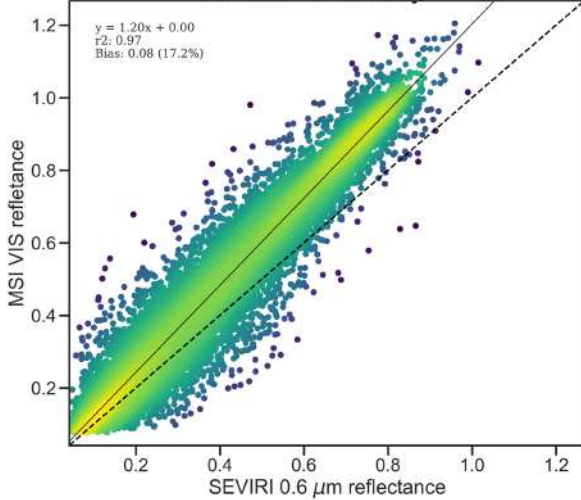
Case study on 2 Jan 2025 (frame 3401E)



ECA_EXZZ_MSI_RGR_1C_20250102T132052Z_20250313T181549Z_03401E

SEVIRI_20250102T133011Z_20250102T134243Z

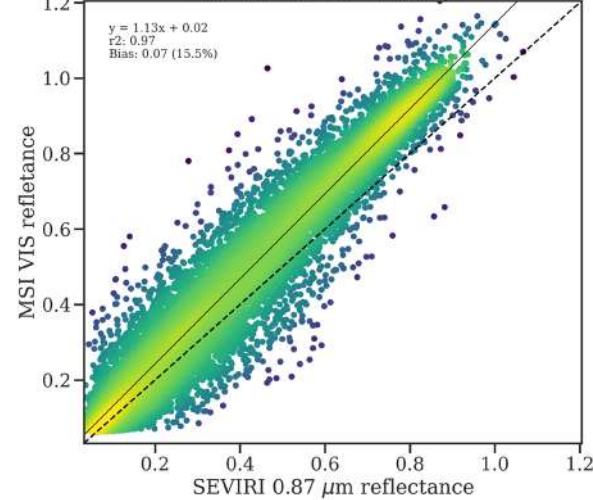
MSI VIS vs. SEVIRI 0.6 μm



ECA_EXZZ_MSI_RGR_1C_20250102T132052Z_20250313T181549Z_03401E

SEVIRI_20250102T133011Z_20250102T134243Z

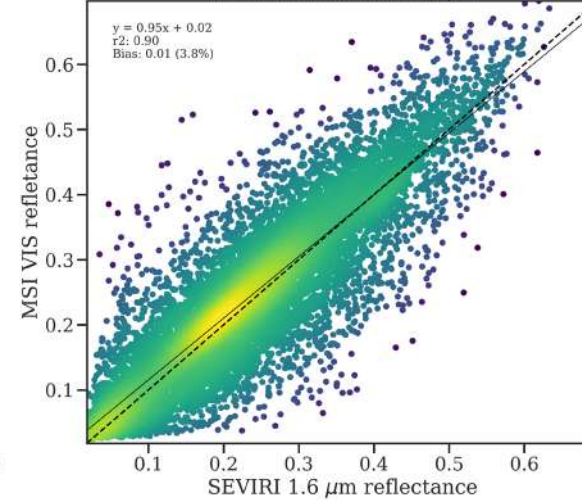
MSI VIS vs. SEVIRI 0.87 μm



ECA_EXZZ_MSI_RGR_1C_20250102T132052Z_20250313T181549Z_03401E

SEVIRI_20250102T133011Z_20250102T134243Z

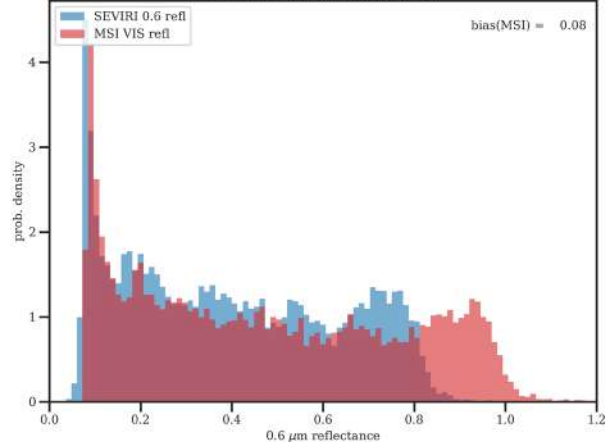
MSI VIS vs. SEVIRI 1.6 μm



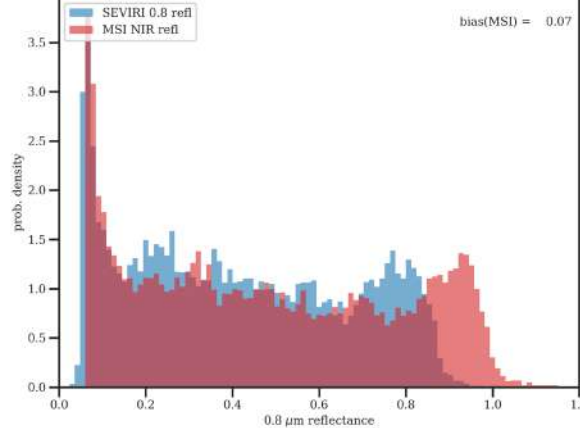
MSI L1 baseline AF compared to SEVIRI

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

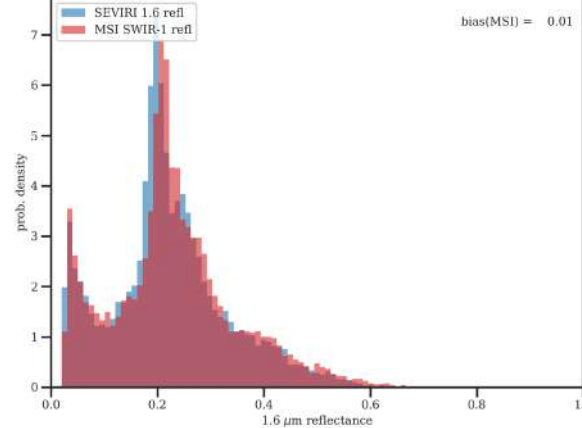
min(SEV)= 0.041, max(SEV)= 1.015
min(MSI)= 0.076, max(MSI)= 1.268



min(SEV)= 0.032, max(SEV)= 1.067
min(MSI)= 0.060, max(MSI)= 1.205



min(SEV)= 0.018, max(SEV)= 0.633
min(MSI)= 0.024, max(MSI)= 0.697



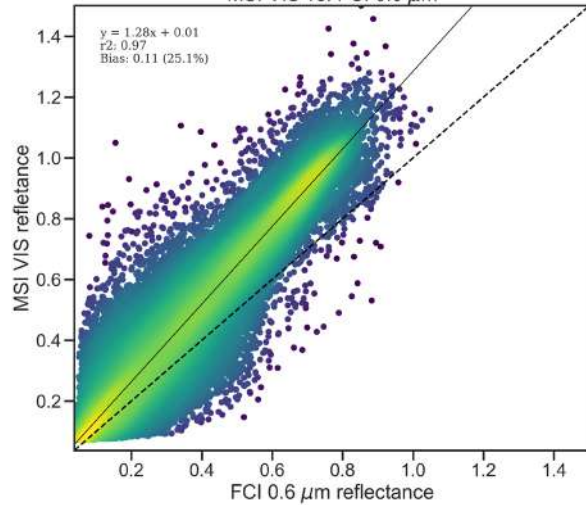
Case study on 2 Jan 2025 (frame 3401E)



ECA_EXZZ_MSI_RGR_1C_20250102T132052Z_20250313T181549Z_03401E

I-1C-RRAD-FDHSI-FD--CHK-BODY--NC4E_C_EUMT

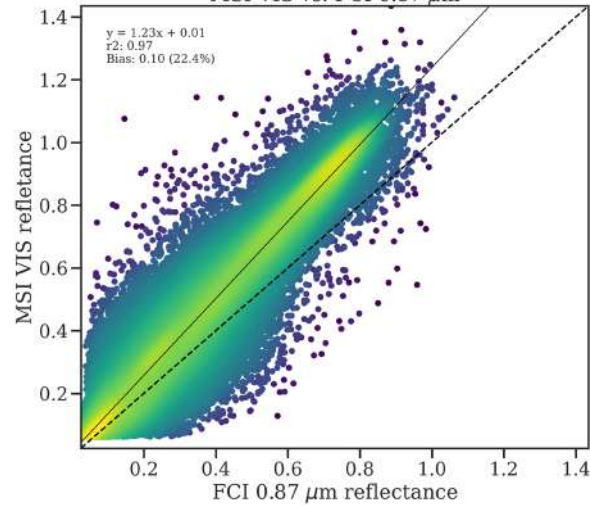
MSI VIS vs. FCI 0.6 μm



ECA_EXZZ_MSI_RGR_1C_20250102T132052Z_20250313T181549Z_03401E

I-1C-RRAD-FDHSI-FD--CHK-BODY--NC4E_C_EUMT

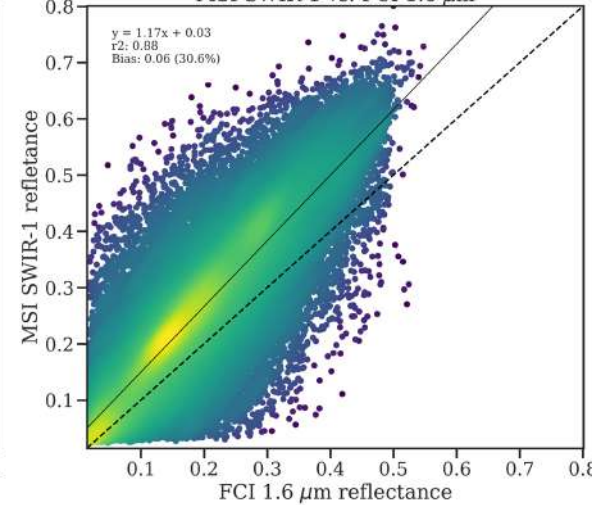
MSI VIS vs. FCI 0.87 μm



ECA_EXZZ_MSI_RGR_1C_20250102T132052Z_20250313T181549Z_03401E

I-1C-RRAD-FDHSI-FD--CHK-BODY--NC4E_C_EUMT

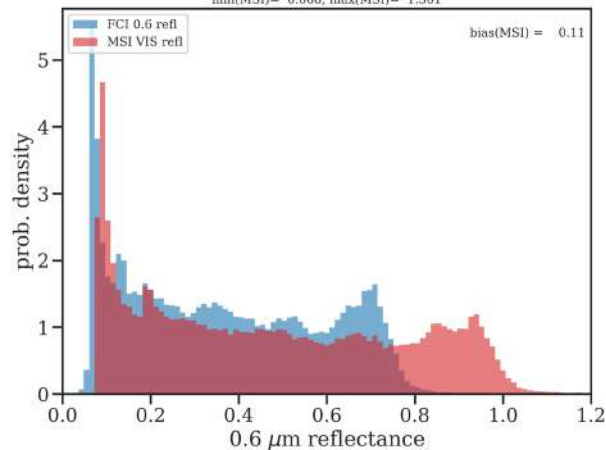
MSI SWIR-1 vs. FCI 1.6 μm



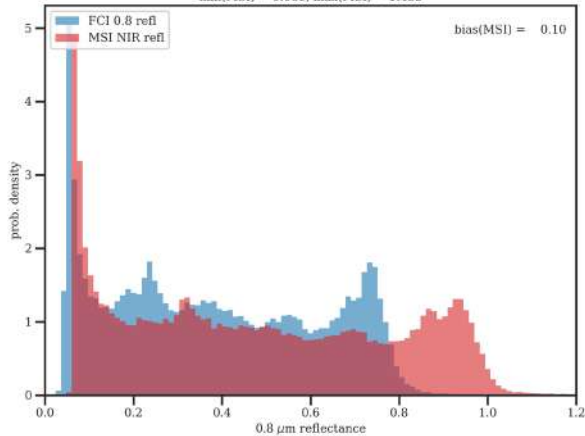
MSI L1 baseline AF compared to FCI

- 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

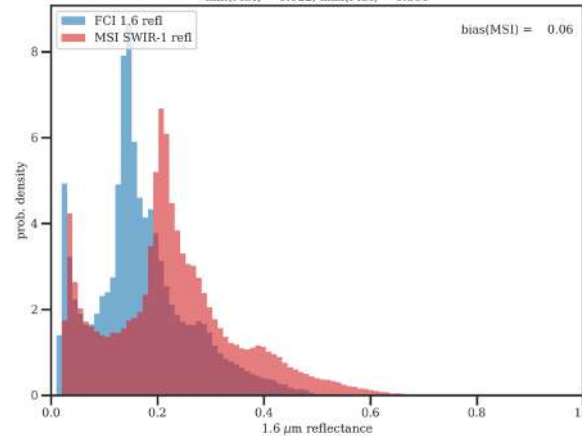
min(FCI)= 0.038, max(FCI)= 1.049
min(MSI)= 0.068, max(MSI)= 1.501



min(FCI)= 0.025, max(FCI)= 1.062
min(MSI)= 0.060, max(MSI)= 1.435



min(FCI)= 0.014, max(FCI)= 0.548
min(MSI)= 0.022, max(MSI)= 0.801





- 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 Hünnerbein](#))
- Transfer functions are needed to predict MSI reflectances with colocated 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 colocated EarthCARE scenes.

A black and white photograph of a forest floor. A central path, defined by two white dashed lines, leads from the bottom center towards the top of the frame. The path is flanked by dense, textured foliage and trees, creating a sense of depth and perspective. The lighting is dramatic, with strong highlights and deep shadows.

Thank you.