Intercomparison of Cloud Products between MSI and Himawari-9/AHI

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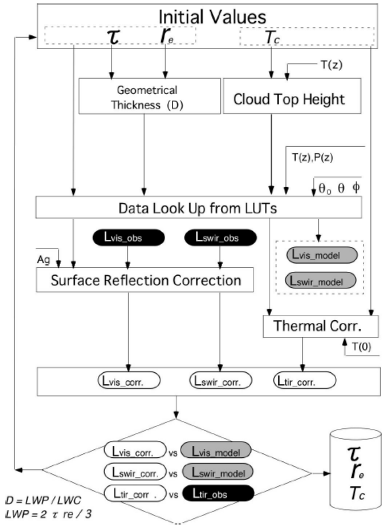
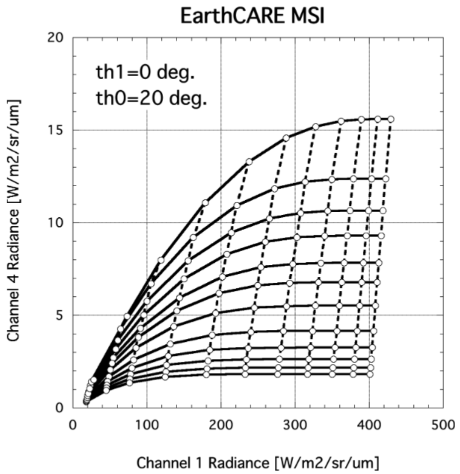
MSI vs Himawari-9/AHI

- Advanced Himawari Imager (AHI)
  - Resolution : 2km for L1 and 5km for L2
  - Observation frequency: every 10mins
- CLAUDIA and CAPCOM (Nakajima et al.,2019), which are the same algorithms as those of MSI cloud product (MSI_CLP).





CAPCOM algorithm flow and LUT
(Nakajima et al.,2019)

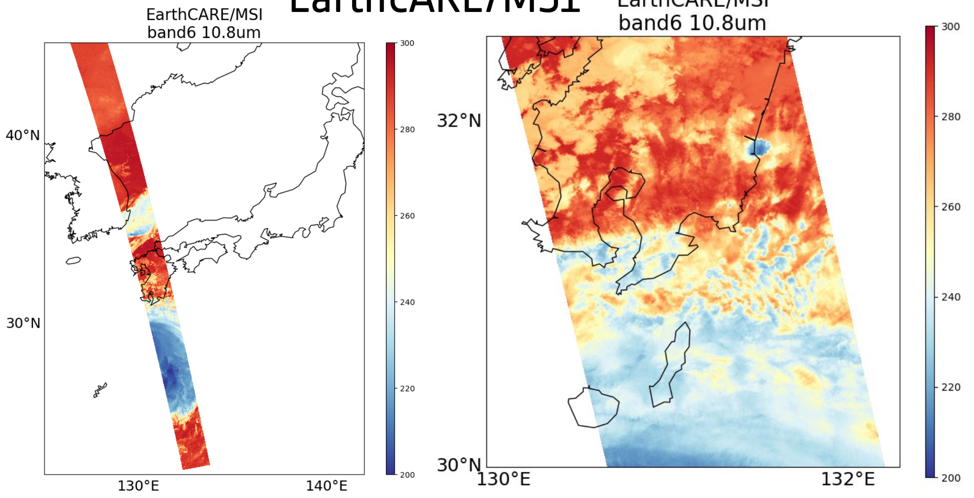
Himawari-9

https://www.mitsubishielectric.co.jp/society/space/satellite/observation/himawari8-9.html

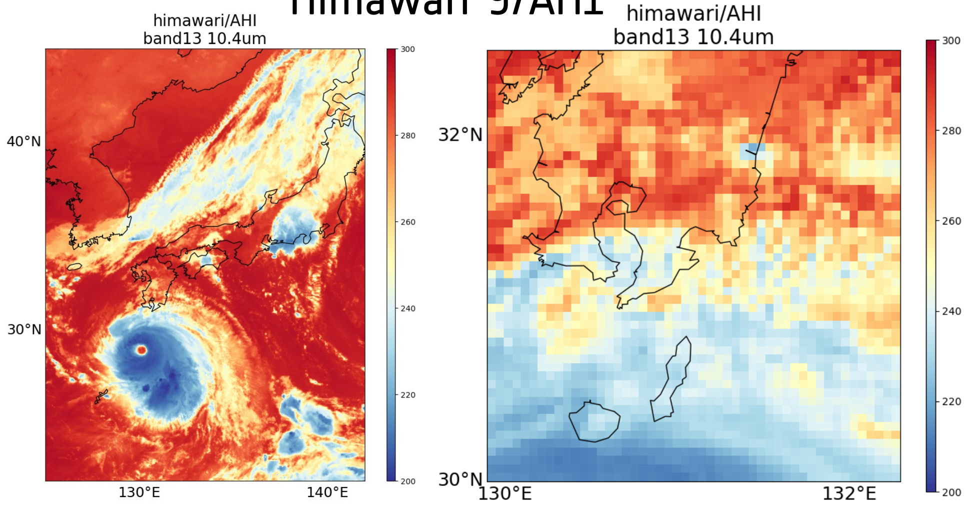
Central wavelength

	MSI	AHI
VIS	0.67μm	0.64μm
NIR	0.865μm	0.86μm
SWIR	1.65μm	1.6μm
	2.2μm	2.3μm
TIR	8.8μm	8.6μm
	10.8μm	10.4μm
	12.0μm	12.4μm

EarthCARE/MSI

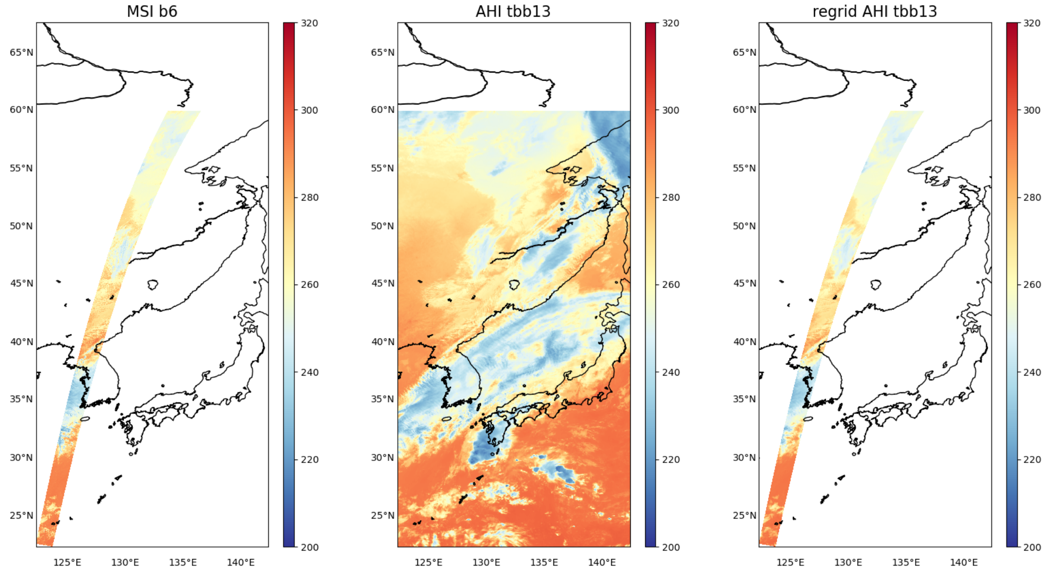


Himawari-9/AHI



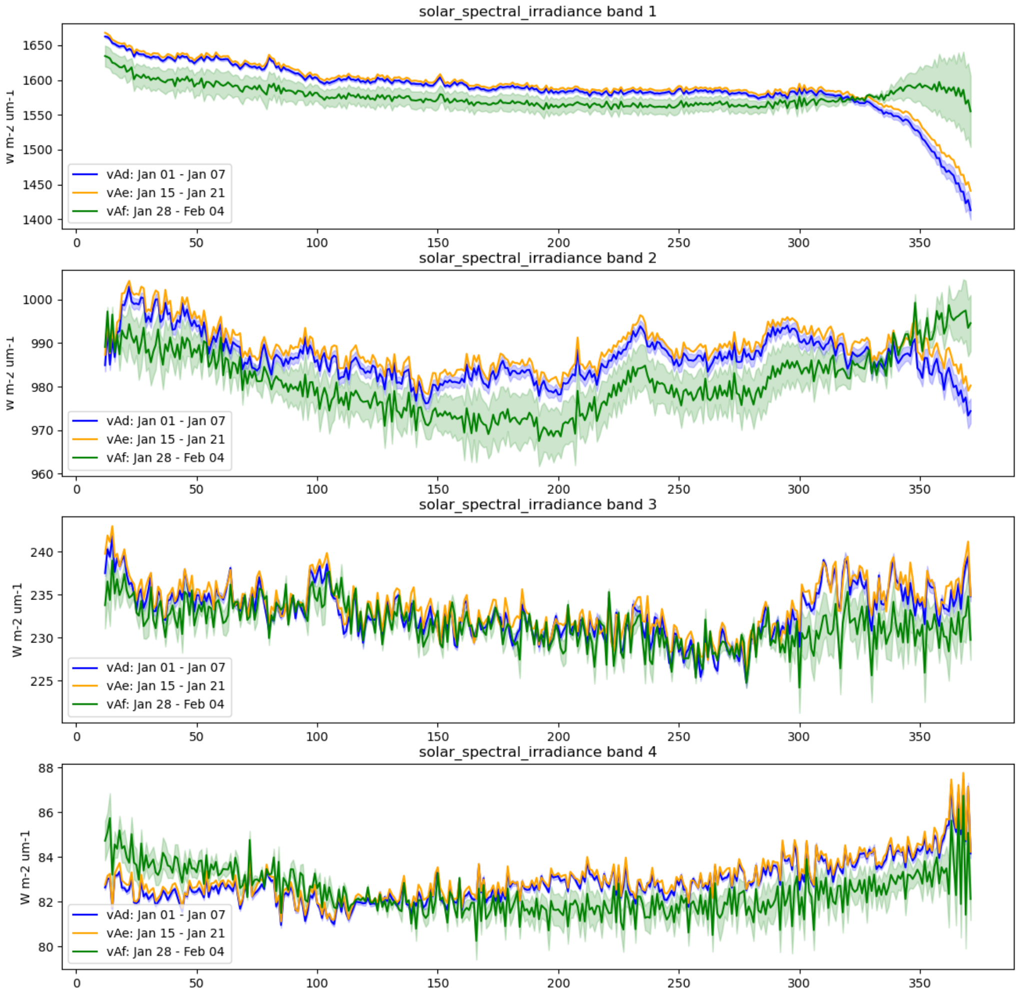
MSI vs Himawari-9/AHI

- Re-grid pixels to make matchup data
  - MSI: resolution reduced to 2km(L1) or 5km(L2)
  - AHI: search nearest neighbor pixels of MSI



MSI　　AHI　　Re-grided AHI

Solar_spectral_irradiance



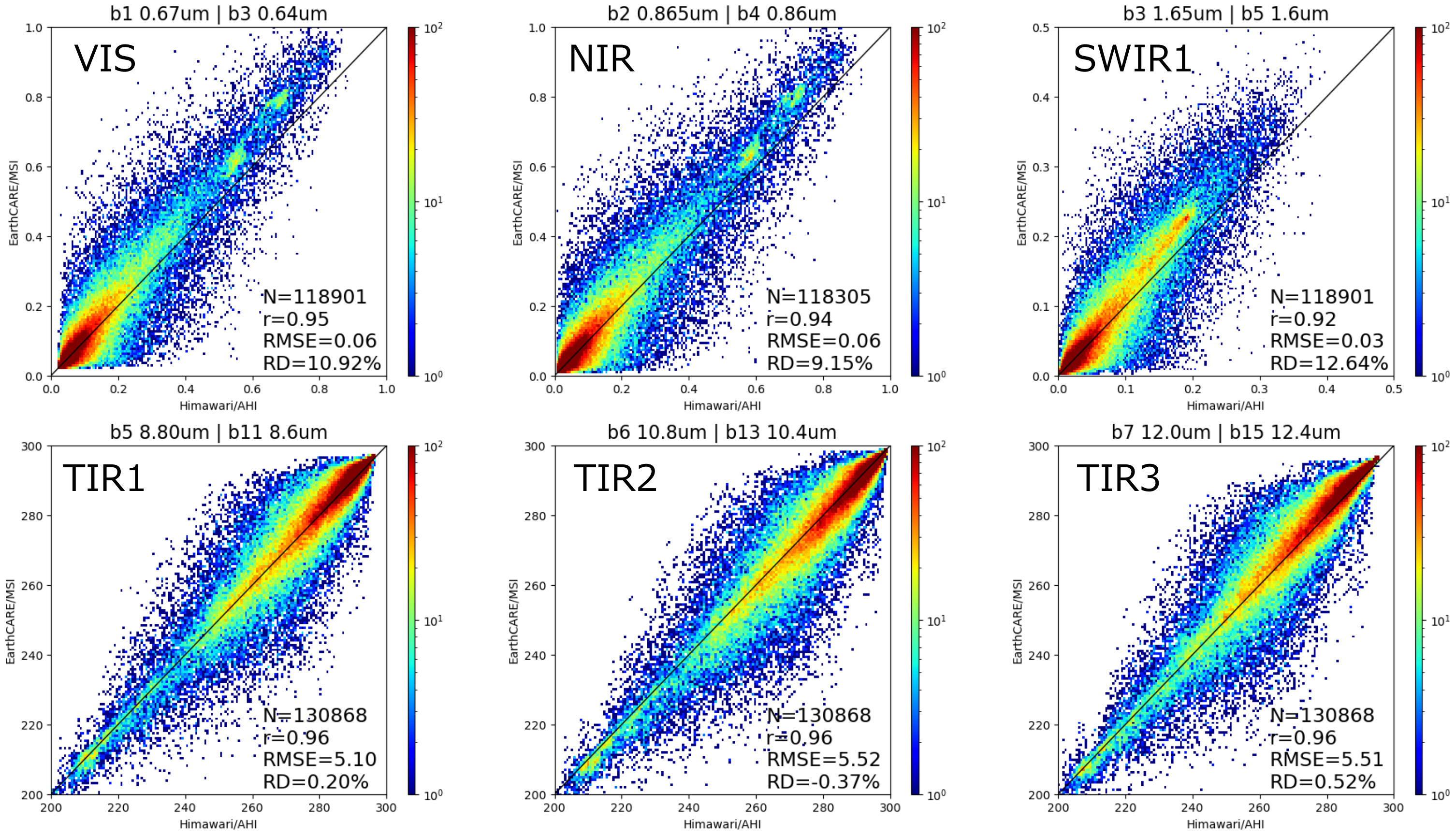
- Convert VNS radiance to albedo with solar spectral irradiance

$$R = \frac{\pi L_{(\lambda)}}{F_{0(\lambda)} \cos(SOZ)}$$

$$Albedo = R \times \cos(SOZ) = \frac{\pi L_{(\lambda)}}{F_{0(\lambda)}}$$

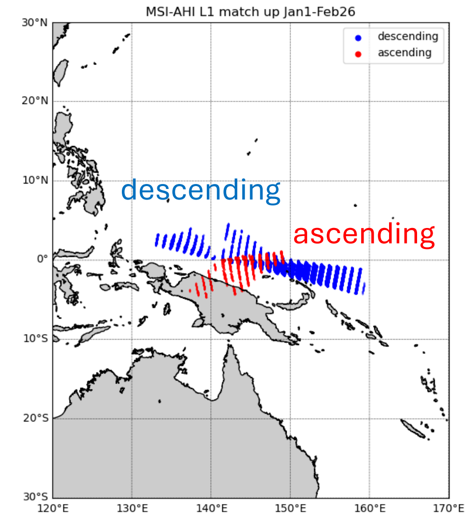
$L_{(\lambda)}$: pixel_value
$F_{0(\lambda)}$: solar_spectral_irradiance
SOZ: solar_zenith_angle

L1 Comparison - MSI vs AHI



Version: vAf
Frame: E, A
Period:
Jan 1 – Feb 27
SAA and SAZ diff. within 5 degrees

Matchup site



- 3 TIR channel values match well
- VNS was overestimated due to imperfect calibration

L2 Cloud Mask

- MSI_CLP has Clear Confidence Level (CCL)
- Clear/Cloudy criteria set as follows
  - MSI CCL: 0-3 → cloudy | MSI CCL: 4-7 → clear
  - AHI CM : 2-3 → cloudy | AHI CM : 0-1 → clear

Ocean surface

Ocean Total: 4923767		AHI cloudy	AHI clear
MSI	cloudy	1957298	460516
		39.8%	9.35%
	clear	189028	2316925
		3.84%	47.1%

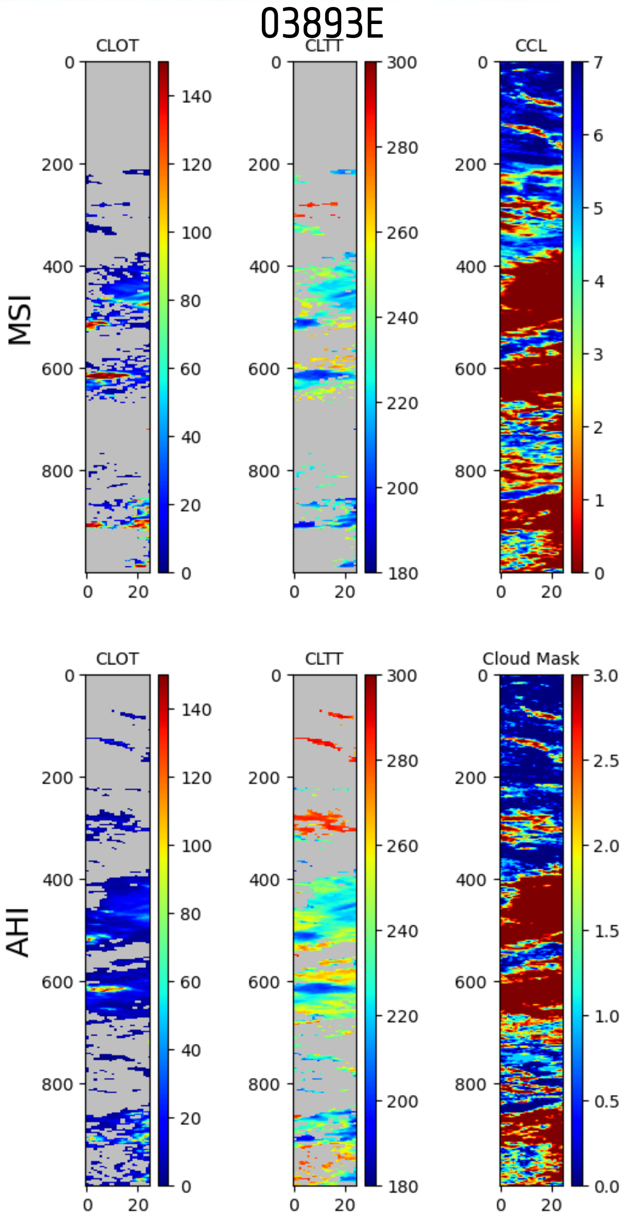
match : 86.8%, mismatch : 13.2%

Land surface

Land Total: 673464		AHI cloudy	AHI clear
MSI	cloudy	251872	53171
		37.4%	7.90%
	clear	15983	352438
		2.37%	52.3%

match : 89.7%, mismatch : 10.3%

→ Cloud mask matches well



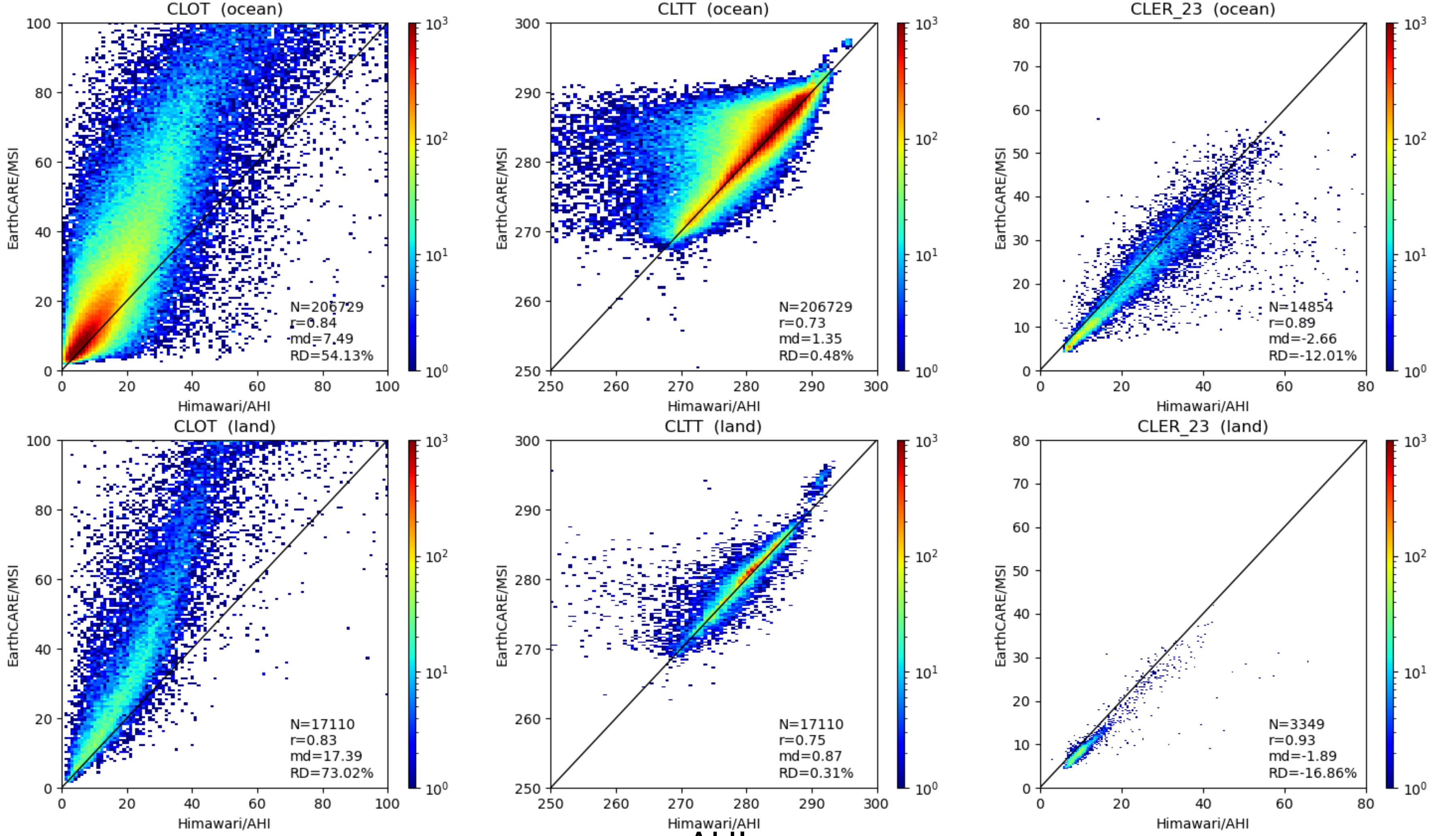
L2 Liquid Water Cloud

Cloud Optical Thickness | Cloud Top Temperature | Cloud Effective Radius (2.2um)

Ocean

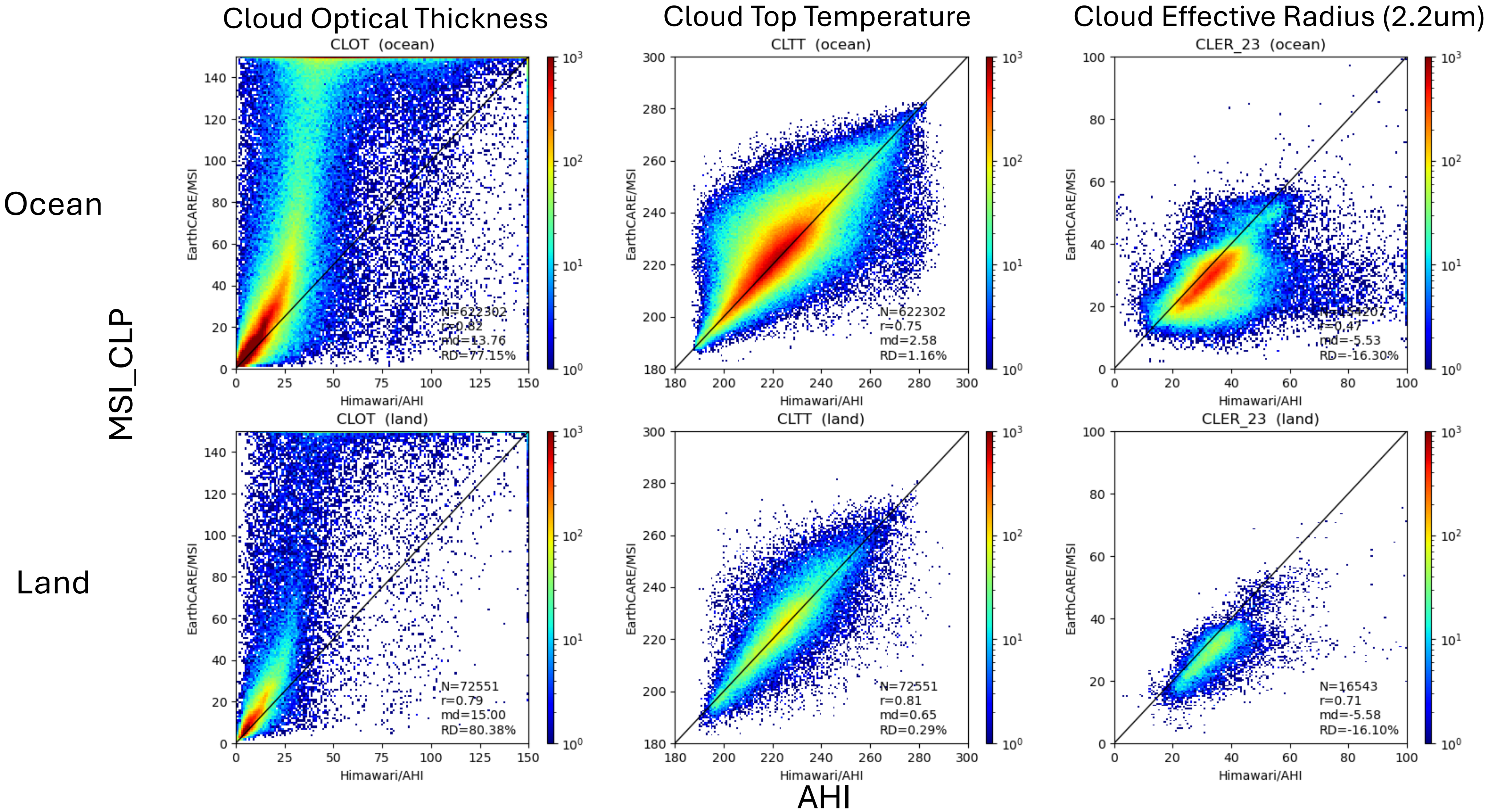
Land

MSI_CLP



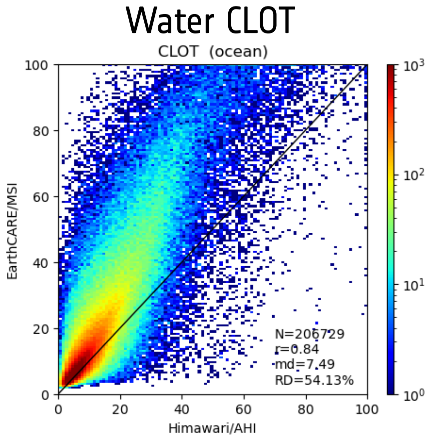
AHI

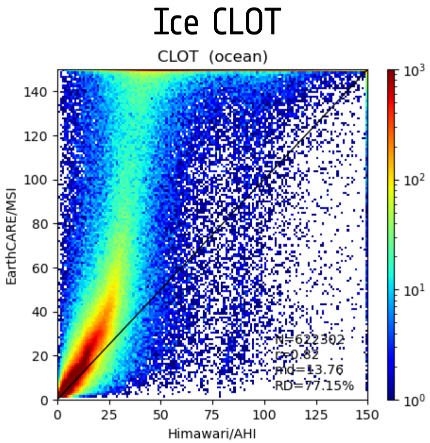
L2 Ice Cloud



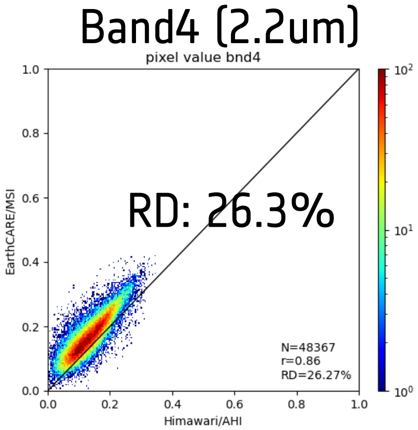
Cloud Optical Thickness
Cloud Top Temperature
Cloud Effective Radius (2.2um)
Ocean
Land
MSI_CLP
AHI
CLOT (ocean)
N=622302
r=0.62
md=13.76
RD=77.15%
CLTT (ocean)
N=622302
r=0.75
md=2.58
RD=1.16%
CLER_23 (ocean)
N=154207
r=0.47
md=-5.53
RD=-16.30%
CLOT (land)
N=72551
r=0.79
md=15.00
RD=80.38%
CLTT (land)
N=72551
r=0.81
md=0.65
RD=0.29%
CLER_23 (land)
N=16543
r=0.71
md=-5.58
RD=-16.10%
EarthCARE/MSI
Himawari/AHI

VNS bias affects CLOT retrieval

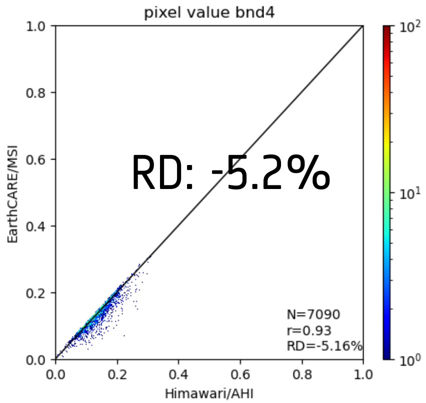




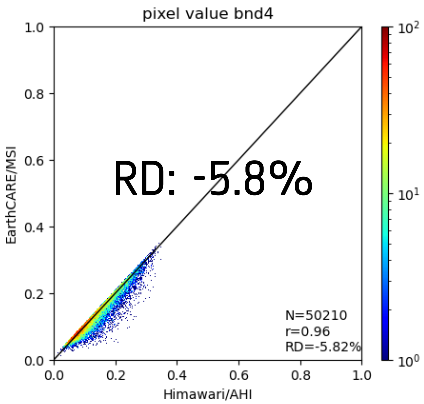
What if L1 VNS bias was corrected?

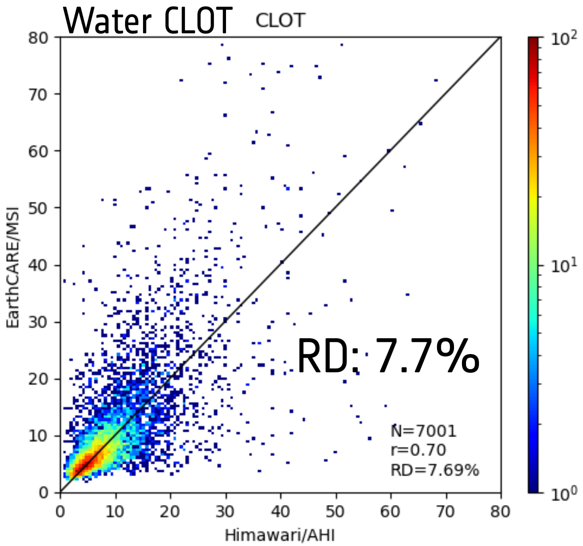


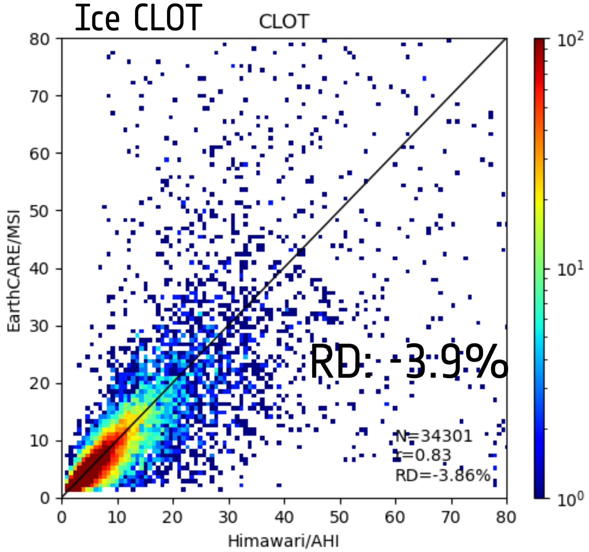
QC



QC







Simple Quality Control

(QC1): band4

MSI_band4 – AHI_band4 <0.02

(QC2): band1

MSI_band1- AHI_band1 < 0.01

Summary

According to the result of intercomparison between MSI and AHI,

- 3 TIR channels are well calibrated.
- Version vAf of VNS is still excessive and remains calibration issues.

- Cloud optical thickness tends to be overestimate.
- Cloud top temperature and effective radius are estimated relatively well.

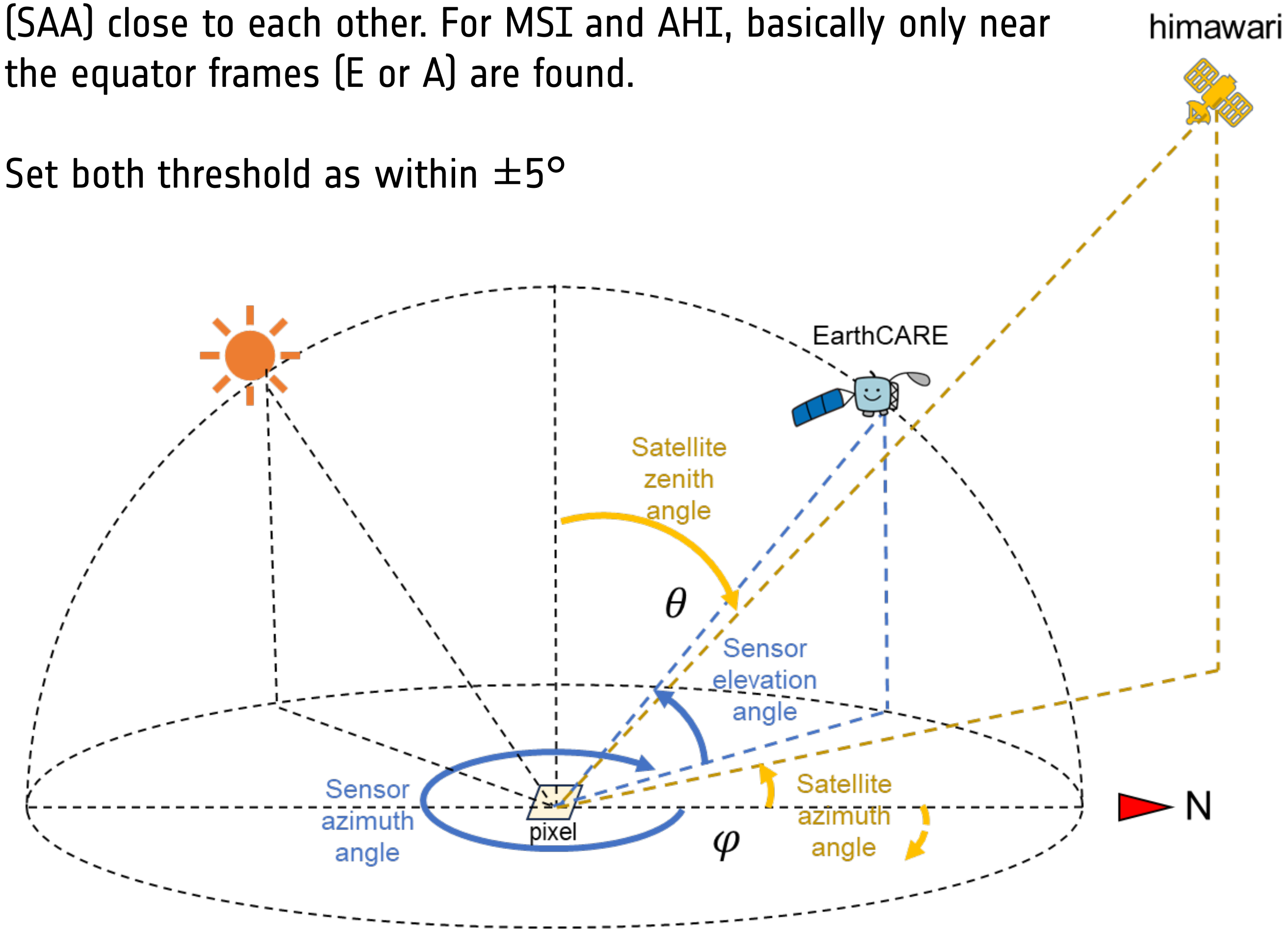
- Implemented a (very) simple quality control to reduce the L1 VNS bias, over-trend of cloud optical thickness was mitigated and matched with good accuracy.

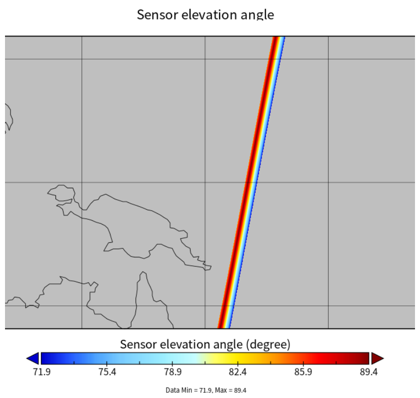
- **L1 VNS calibration is a key to improve L2 products!**

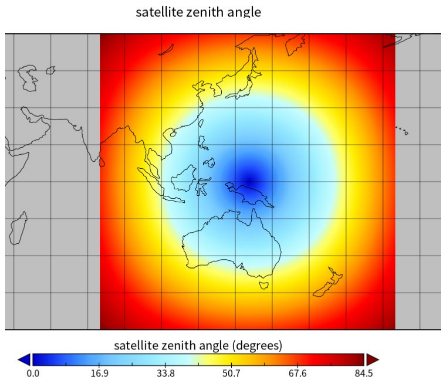
(Appendix) Geometrical Correction for L1 comparison

- Search satellite zenith angle (SAZ) and satellite azimuth angle (SAA) close to each other. For MSI and AHI, basically only near the equator frames (E or A) are found.

- Set both threshold as within ±5°

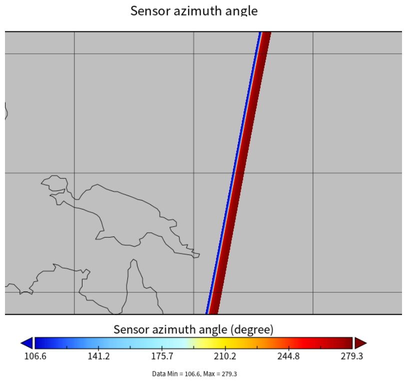


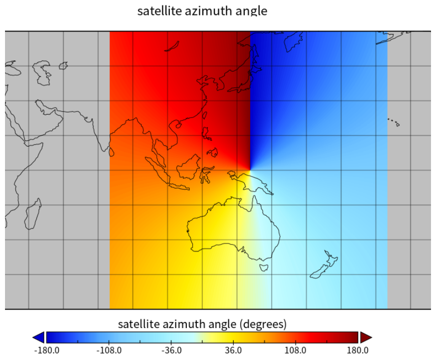




- AHI : zenith angle
- MSI : viewing angle

→ Convert MSI viewing angle to zenith angle





- AHI azimuth angle : -180 ～ 180
- MSI azimuth angle : 0 ～ 360

→ Fit azimuth angle range of MSI to that of AHI