Validation of Himawari-8/AHI by Ray-matching method

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Outline

- Validation method for AHI VIS/NIR bands
  - New monitoring page of ray-matching method
- Implementation of ray-matching method
- Ray-matching results with comparing RTM method
- Validation of AHI sensor degradation trends
- Seasonal variation in ray-matching
- Preliminary results of ray-matching with N20/VIIRS
- Summary and future work

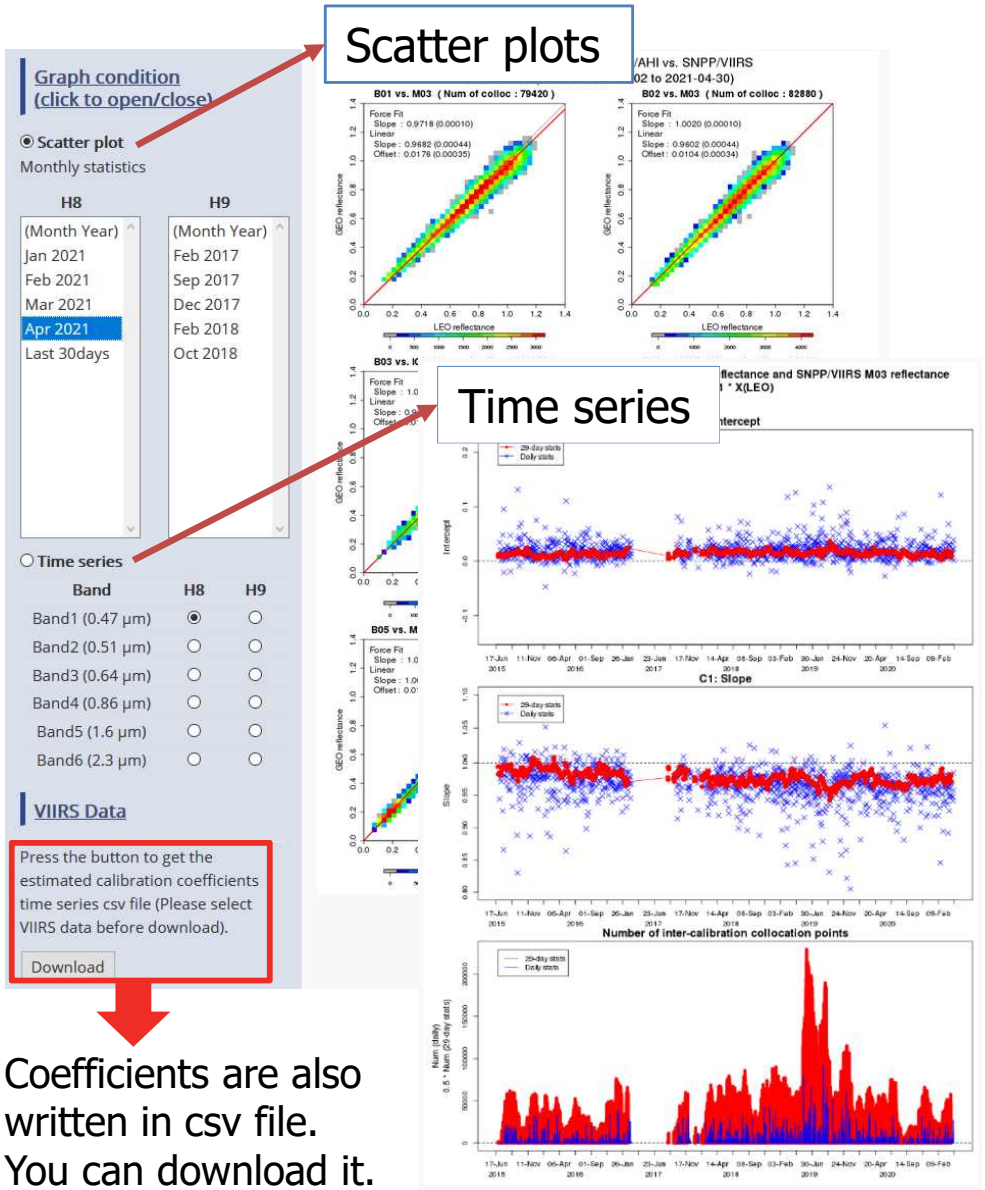
Validation methods for AHI VIS/NIR bands

- Comparison with using RSTAR radiative transfer model
  - with Terra and Aqua/MODIS
    - https://www.data.jma.go.jp/mscweb/data/monitoring/gsics/vis/monit_visvical.html
- Ray-matching method
  - with SNPP/VIIRS
    - Monitoring page new available from June 7,2021 https://www.data.jma.go.jp/mscweb/data/monitoring/gsics/vis/raymatch/monit_visraymatch.html

- DCC method
- Lunar Calibration

} Not available on our web page yet

Ray-matching method monitoring page

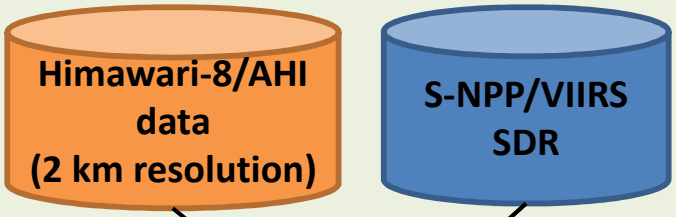


Coefficients are also written in csv file.
You can download it.

Ray-matching method in JMA

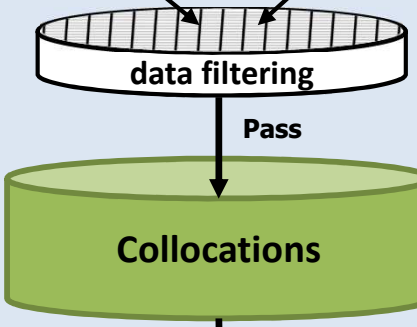
Input Data

- Himawari-8 data is not corrected by solar diffuser on real-time basis
- VIIRS data is downloaded from NOAA CLASS server



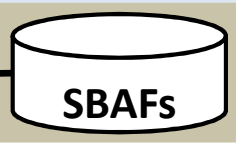
Himawari-8 /AHI	Band01 (0.47 µm)	Band02 (0.51 µm)	Band03 (0.64 µm)	Band04 (0.86 µm)	Band05 (1.6 µm)	Band06 (2.3 µm)
S-NPP /VIIRS	M03 (0.49 µm)	M03 (0.49 µm)	I01 (0.64 µm)	M07 (0.87 µm)	M10 (1.6 µm)	M11 (2.3 µm)

Collocating



Observation time difference	< 5 min.
Satellite zenith angle difference	< 10 deg.
Satellite azimuth angle difference	< 10 deg.
Sun glint angle (AHI only)	> 25 deg.
Brightness temperature @ 10.4 µm (AHI only)	< 273.15 K
STDV of reflectance/Mean of reflectance	< 5%

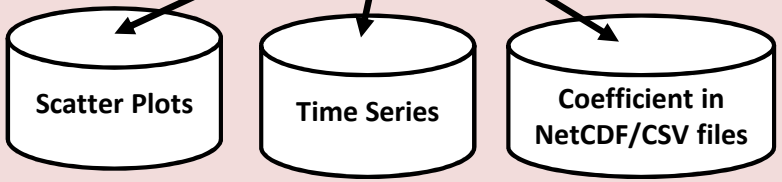
Apply SBAFs



Using NASA SBAF Tool (B01-05) and calculating radiative transfer model (B06)

Analysis

Outcomes



- based on Reflectance
- Regression type
  - Linear fit regression with/without offset

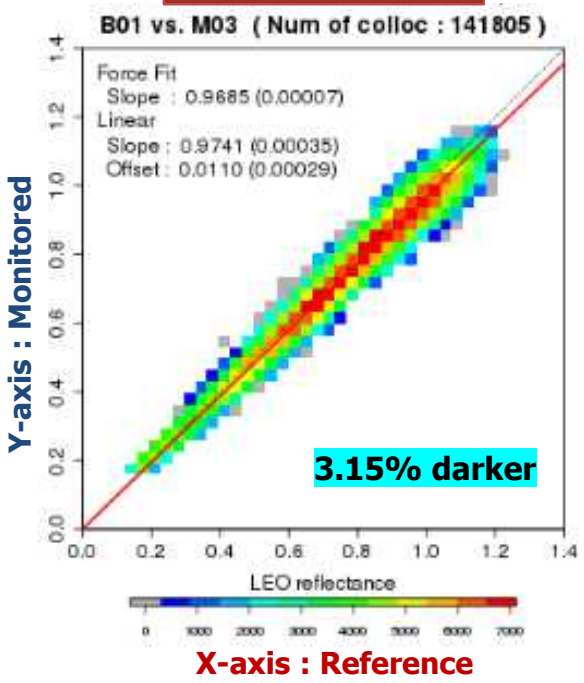
*** Coefficient in NetCDF files are Not Online**

Ray-matching vs. RTM method

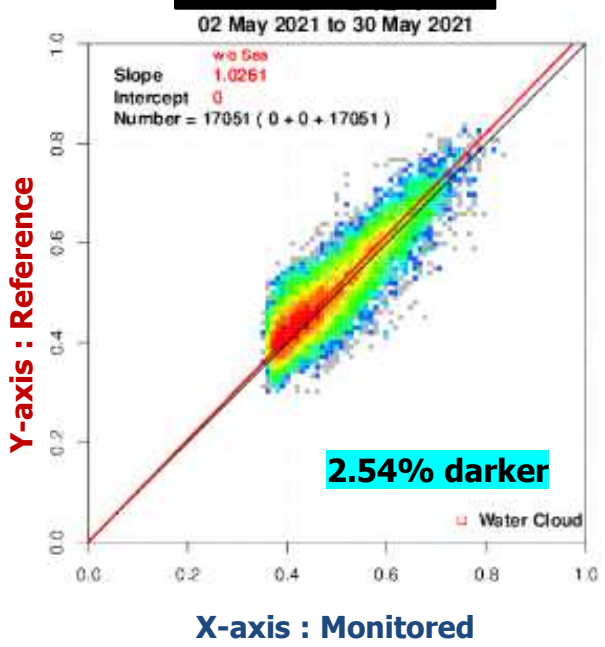
Scatter plot in May 2021

- Although Band 1, 3, 4 and 6 are good agreement (<2%), band 2 and 5 are a bit difference.
- Diff. of input data?
  - Ray-matching : SNPP/VIIRS
  - RTM: Aqua/MODIS(C6)
    - ➢ considering the comparison with same input data by implementation of RTM method with VIIRS
- Due to less stability of the slope value of ray-matching than RTM ?

Ray-matching



RTM



X and Y axes of Ray-matching are opposite to RTM method

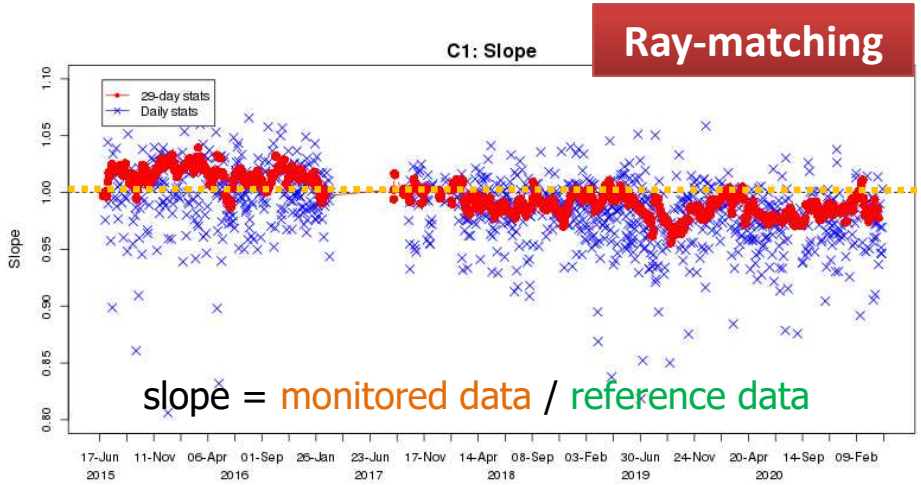
Himawari-8 bands are brighter (+) or darker (-) than reference in May 2021

	B01	B02	B03	B04	B05	B06
RM	-3.15%	-0.02%	-0.18%	-1.18%	+6.22%	-5.08%
RTM	-2.54%	-3.66%	-1.45%	-0.62%	+2.87%	-6.61%

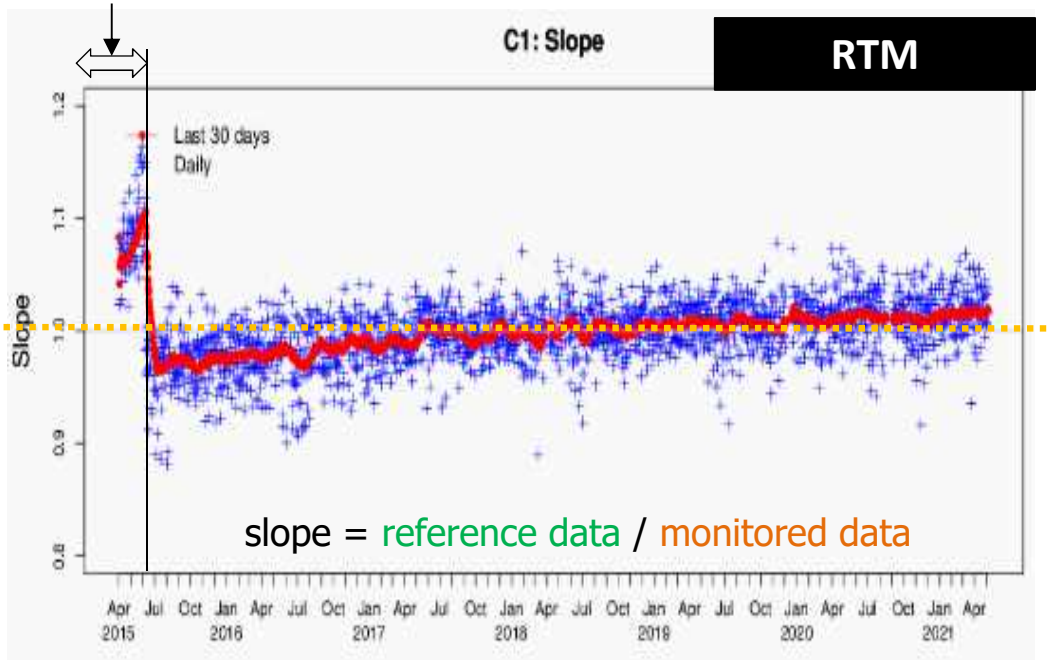
Ray-matching vs. RTM method

Time-series

- The slope value variations of ray-matching look larger than these of RTM.

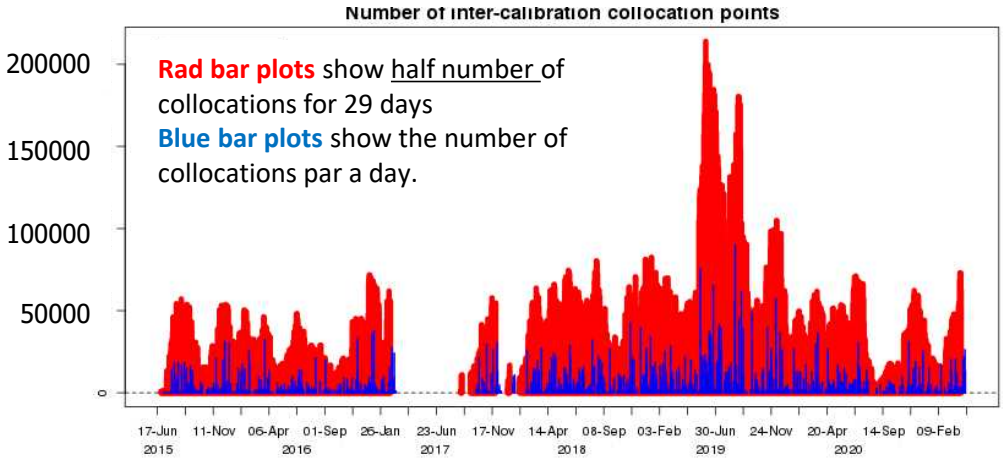


This period is not shown in Ray-matching left Fig.



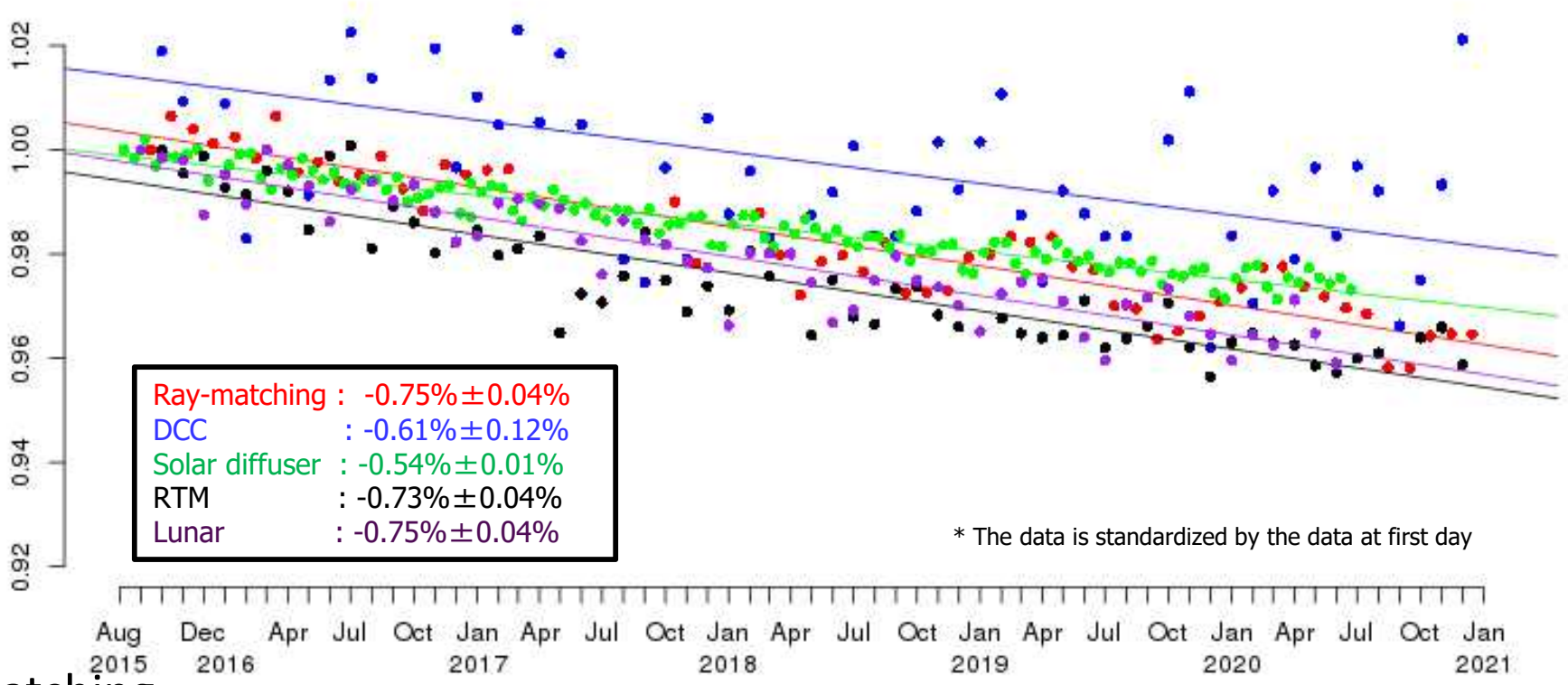
Bule and **Red** plots represent value **par a day** and **about a month.**

- In ray-matching, the stability of validation result depend on number of collocations
  - ➢ The slope varies easily as number of collocations par a day varies considerably.
  - ➢ Need to reconsider collocation conditions?



Validation of AHI sensor degradation

Degradation trends of AHI-8 B03(0.64um)

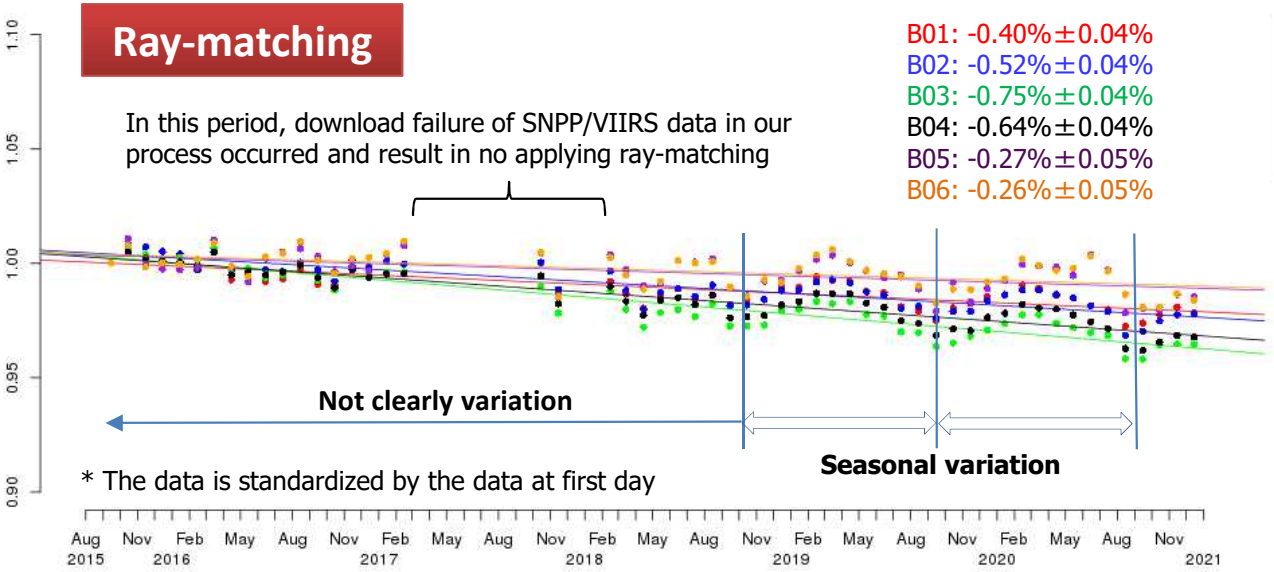


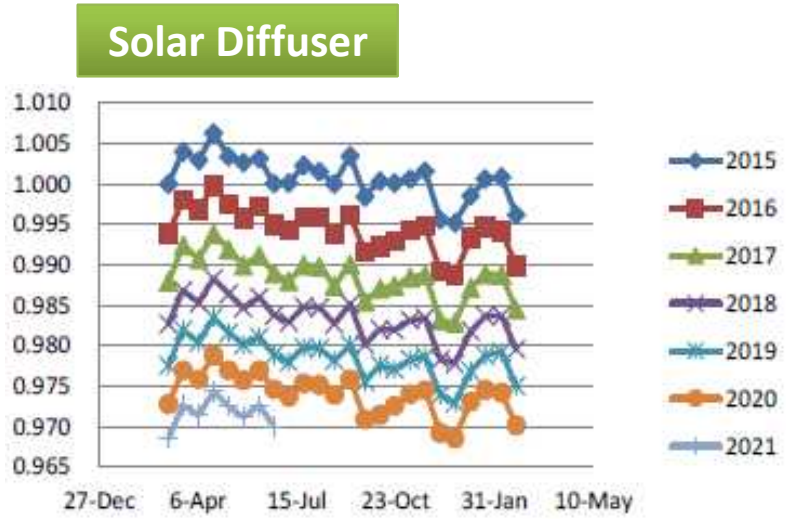
In ray-matching,

- good agreement with the validation by using **RTM method** and **lunar calibration**.
- differ from that by **solar diffuser**
- it seems that seasonal variation appear and magnitude of the variation is increasing.

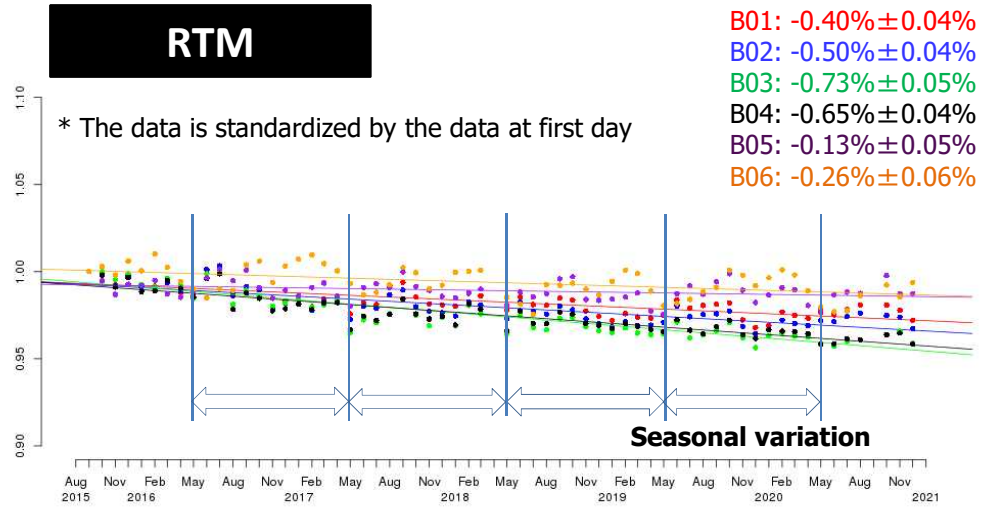
Seasonal variation in ray-matching

- Seasonal variation appears in all VNIR bands in ray-matching
- Although the trends by solar diffuser and RTM method also look to vary seasonally
  - In Ray-matching
    - Variation amplitude is larger
    - Variation cycle differ





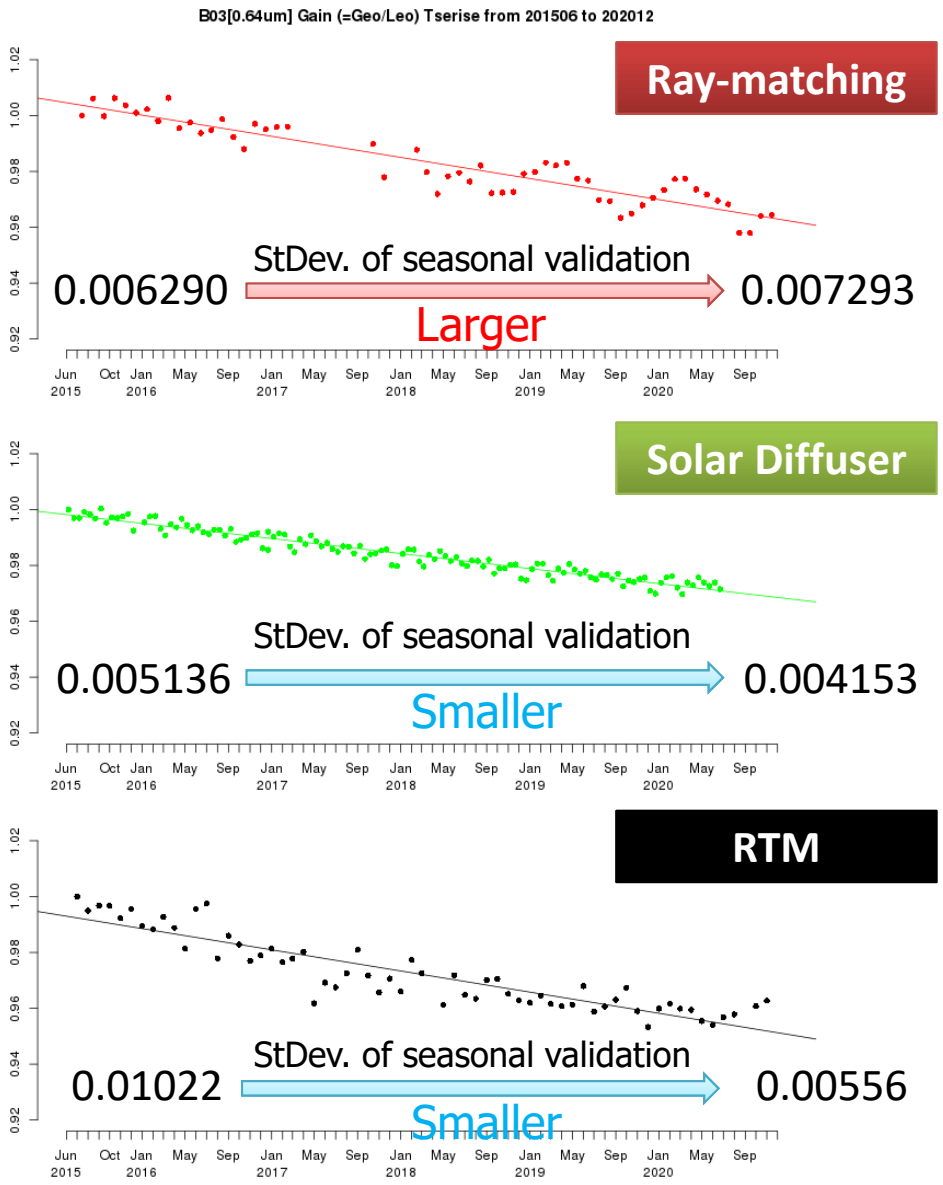
Solar Diffuser observation trends (B03 0.64um)



Seasonal variation in ray-matching

- In ray-matching, the magnitude of the seasonal variation looks increasing over time.
  - ➢ Calculating the standard deviation for two periods
    - Fist half period : 2015-2017
    - Second half period : 2018-2020
  - ➢ Increasing of standard deviation is only in ray-matching case.

- Our implementation of ray-matching has room of improvement

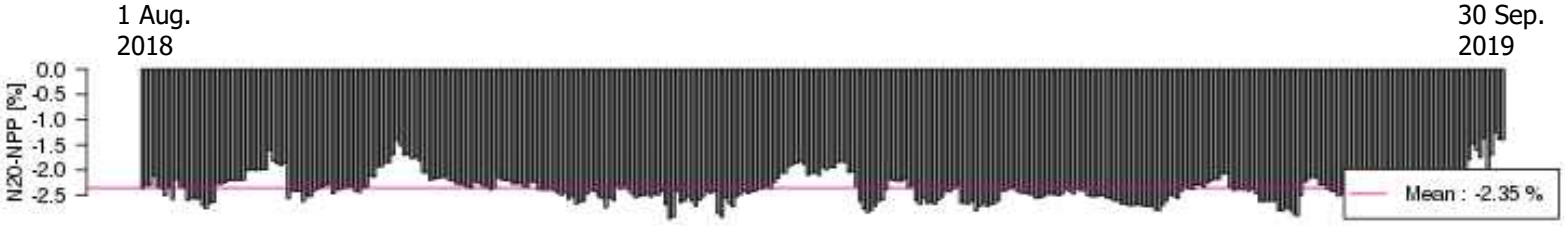


Preliminary Result comparing with NOAA20/VIIRS

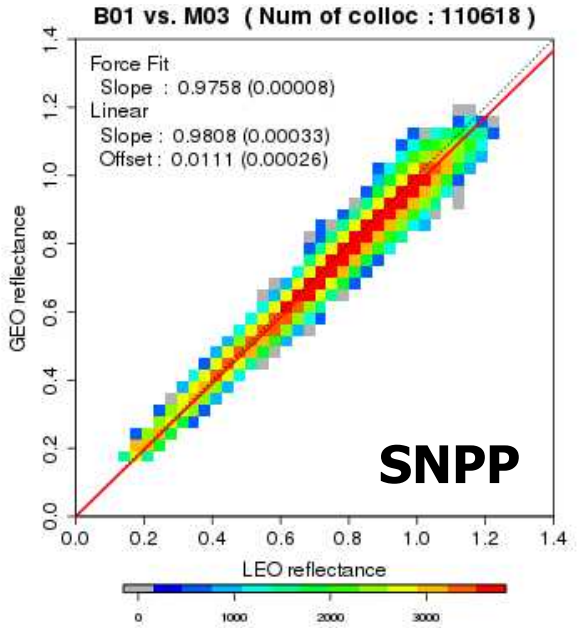
Ray-matching with NOAA20/VIIRS is now testing under development.

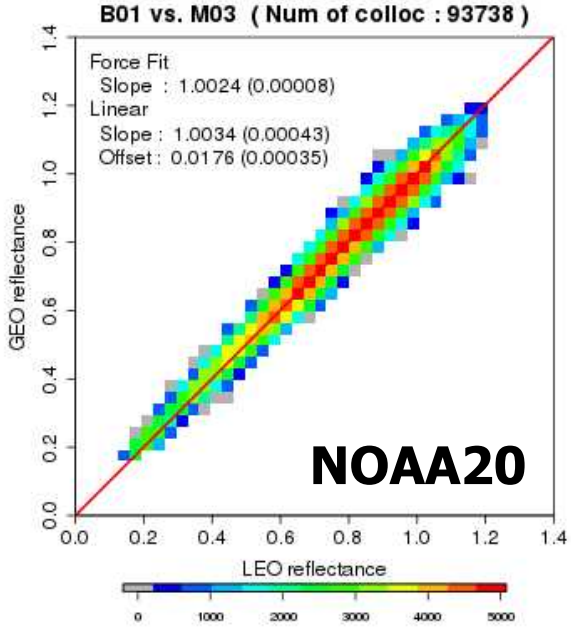
- In May 2019
  - coefficient of AHI-VIIRS ray-matching (B01)
    with SNPP : 0.9758
    with NOAA20 : 1.0024
    - ➢ Diff. of ray-matching result with NOAA20 against SNPP is 2.72%

- In average from Aug.2018 to Sep.2019
  Difference by AHI-VIIRS ray-matching is -2.35%.
  - ➢ Good agreement with NOAA20 bias against SNPP (-2.4%) reported on GSICS quarterly news (Vol. 14 No 4, 2021).



Difference of B01 RAC Coefficient (Leo/Geo) of ray-matching between SNPP and NOAA20 from August 2018 to September 2019





Summary and plan

Summary

- In JMA, the ray-matching implementation to Himawari-8/-9 has done.
- Monitoring page was opened from June 7,2021
  - Ray-matching results are good agreement with previous RTM method. But ray-matching has larger variability than RTM method.
- AHI sensor degradation trend by ray-matching aligns with the trend by RTM and Lunar, but looks different by solar diffuser for some bands.
- Ray-matching has the seasonal variations in all VNIR bands and the variations tend to increase. Other methods also have seasonal variations, but variation magnitude and cycle differ to these of ray-matching.
  - These results may indicate room of improvement in our implementation
- Working on ray-matching with N20/VIIRS
  - Currently good agreement with SNPP/VIIRS

Future work

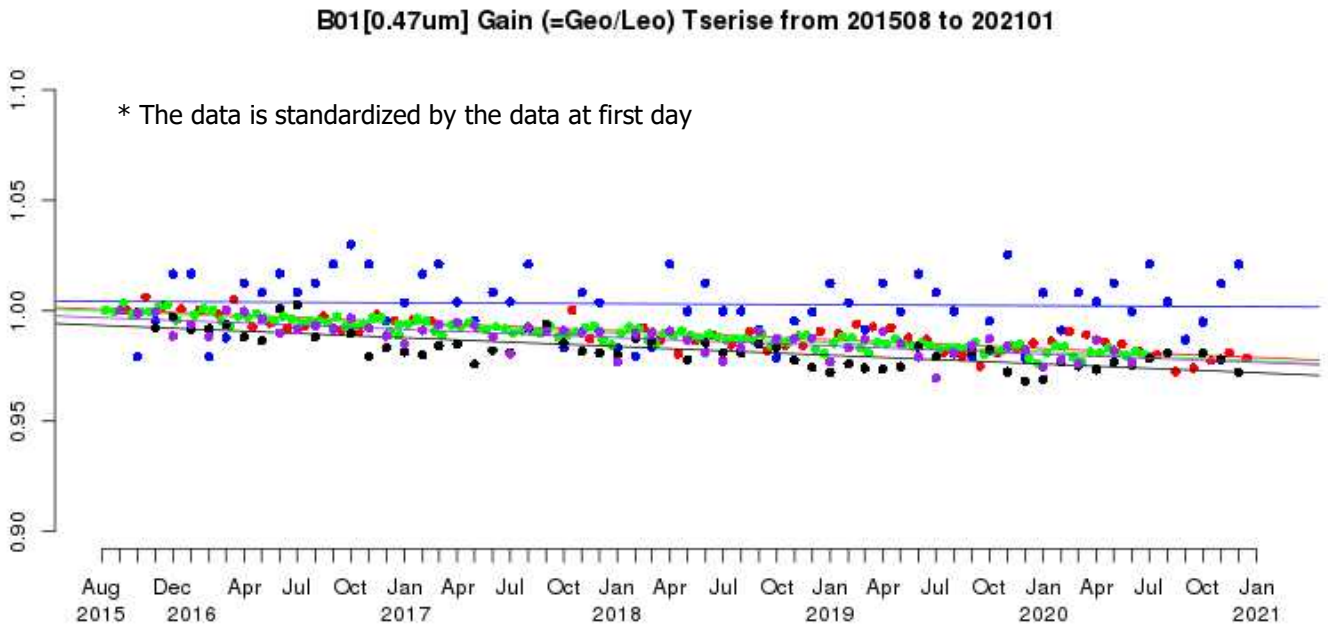
- Investigation to thresholds and new conditions (Dave 2016)
- registering ray-matching GSICS correction products on the Demonstration phase.

- Thank you

AHI-8 sensor's degradation trends validations

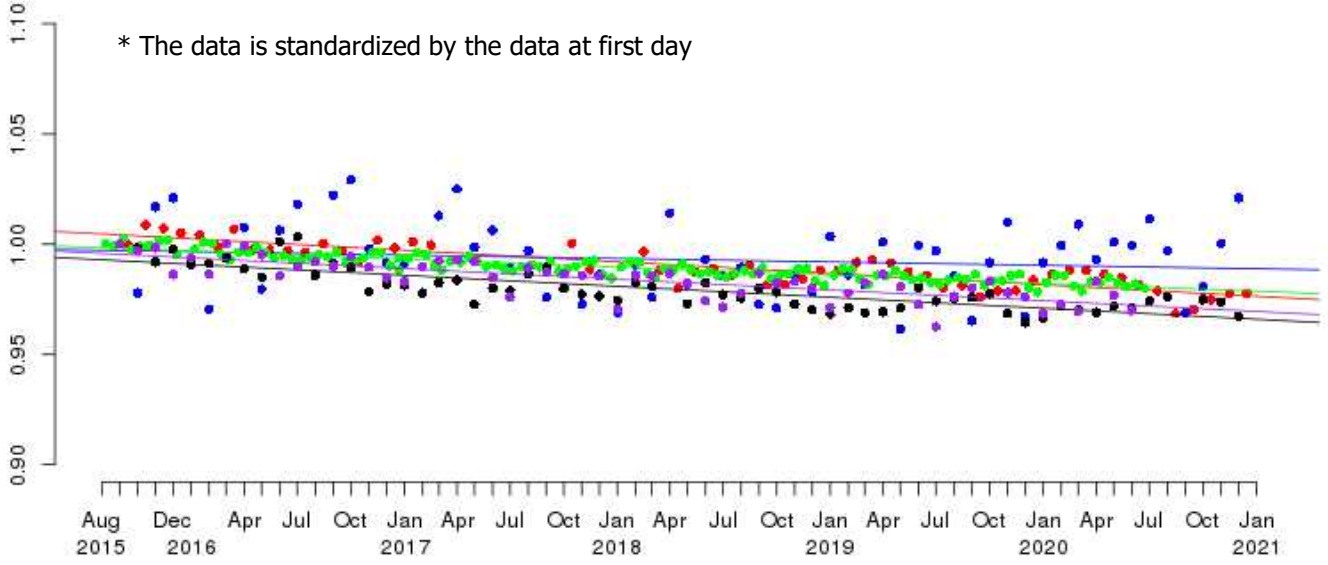
B01(0.47um)

Ray-matching : -0.40%±0.04%
DCC : -0.04%±0.11%
Solar diffuser : -0.42%±0.01%
RTM : -0.40%±0.04%
Lunar : -0.37%±0.04%



B02(0.51um)

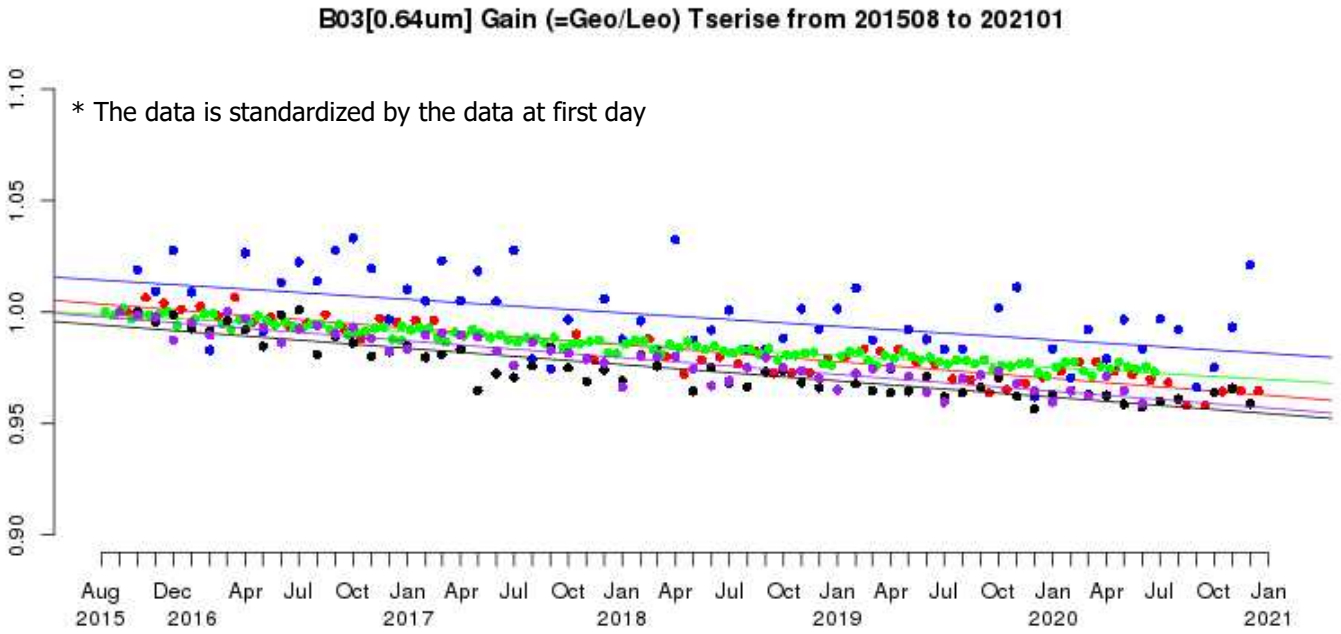
Ray-matching : -0.52%±0.04%
DCC : -0.15%±0.13%
Solar diffuser : -0.36%±0.02%
RTM : -0.50%±0.04%
Lunar : -0.49%±0.05%



AHI-8 sensor's degradation trends validations

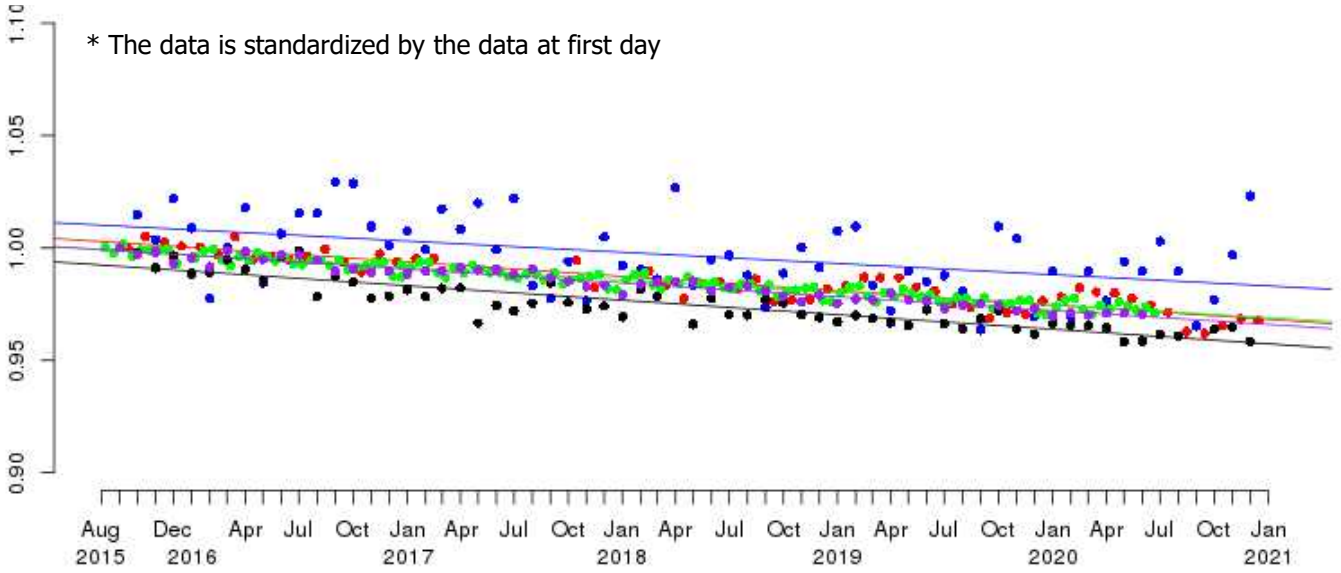
B03(0.64um)

Ray-matching : -0.75%±0.04%
DCC : -0.61%±0.11%
Solar diffuser : -0.54%±0.01%
RTM : -0.73%±0.05%
Lunar : -0.75%±0.04%



B04(0.86um)

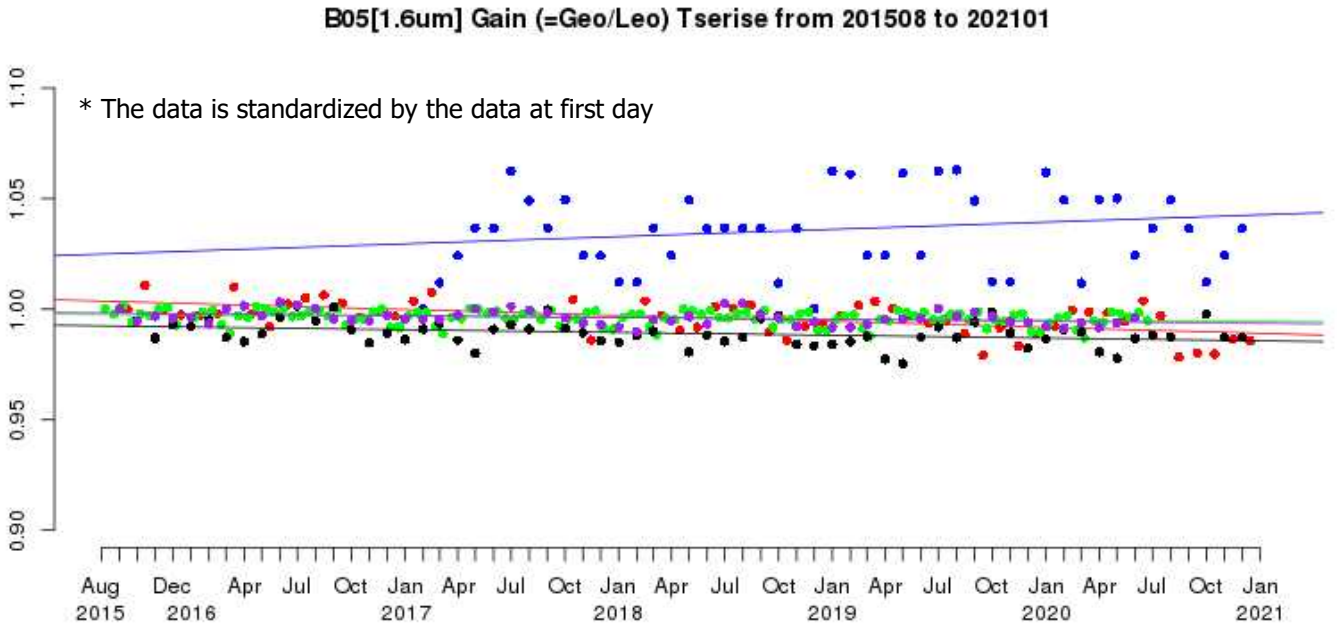
Ray-matching : -0.64%±0.04%
DCC : -0.50%±0.12%
Solar diffuser : -0.56%±0.01%
RTM : -0.65%±0.04%
Lunar : -0.61%±0.02%



AHI-8 sensor's degradation trends validations

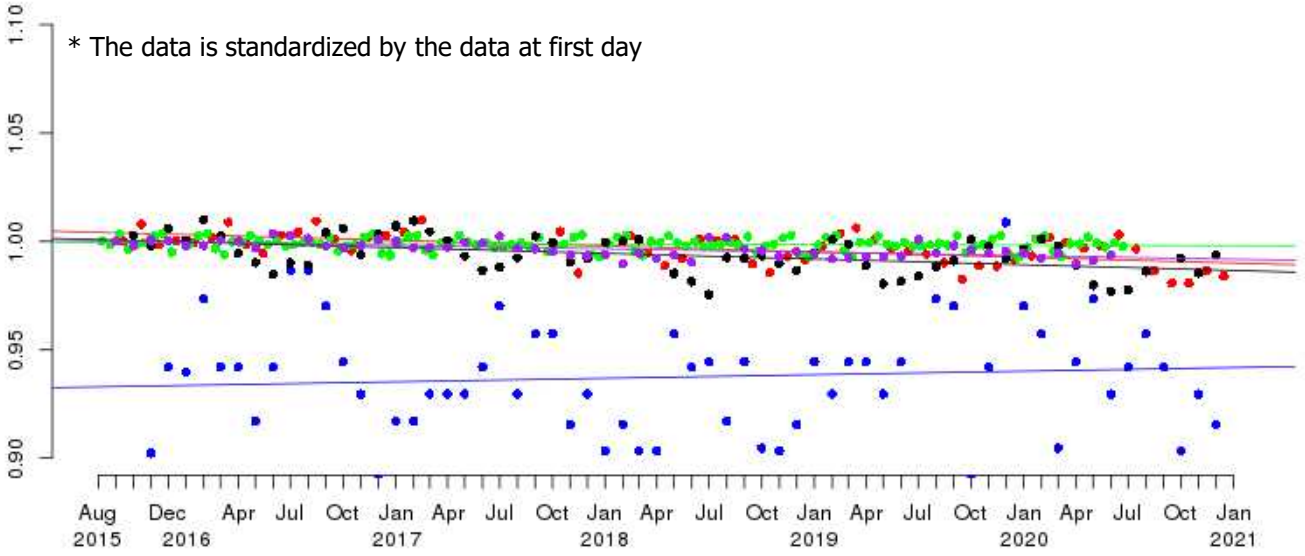
B05（1.6um）

Ray-matching : -0.27%±0.05%
DCC : +0.33%±0.27%
Solar diffuser : -0.06%±0.02%
RTM : -0.13%±0.05%
Lunar : -0.09%±0.03%



B06（2.3um）

Ray-matching : -0.26%±0.05%
DCC : +0.16%±0.27%
Solar diffuser : -0.03%±0.02%
RTM : -0.26%±0.06%
Lunar : -0.16%±0.03%



Standard Deviation in validation method

RayMatch	B01	B02	B03	B04	B05	B06
2015-2017	0.004916	0.004718	0.006237	0.005035	0.005527	0.005898
2018-2020	0.005726	0.006298	0.007353	0.007378	0.007039	0.007255

RTM	B01	B02	B03	B04	B05	B06
2015-2017	0.007296	0.008337	0.010220	0.008992	0.005019	0.007590
2018-2020	0.005023	0.004817	0.005597	0.005783	0.005287	0.008135

SD	B01	B02	B03	B04	B05	B06
2015-2017	0.004092	0.004186	0.004918	0.004761	0.003131	0.002871
2018-2020	0.003759	0.003214	0.004153	0.004823	0.003198	0.002809