The 13th Asia-Oceania Meteorological Satellite Users' Conference

Validation of AHI on Himawari-8/-9 in L1 Products and Preliminary Study Using PCA for Himawari-10

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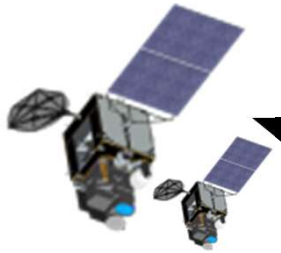

2014 Himawari-8
2016 Himawari-9

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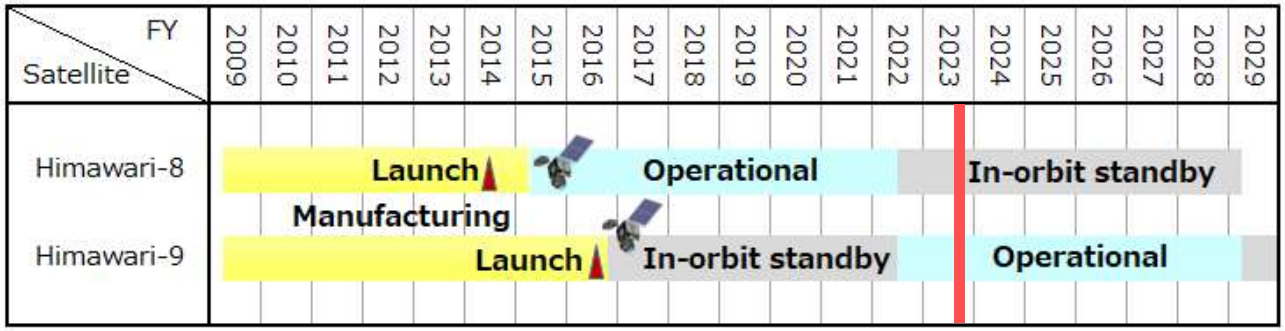
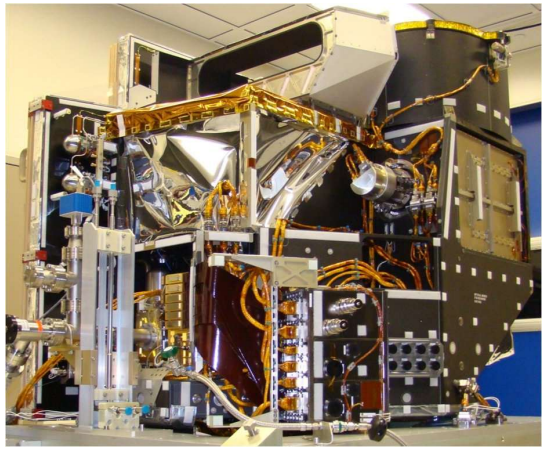
Mission Overview

- Himawari-8/-9 are the third generation geostationary meteorological satellites operated by Japan Meteorological Agency (JMA).
- Himawari-9
  - 2nd Nov 2016 Launch
  - 10th Mar 2017 In-orbit standby
  - 27th Sep 2022 Data dissemination in parallel with Himawari-8
  - 13th Dec 2022 Operational after switchover
- Himawari-8
  - 13th Dec 2022 In-orbit standby after switchover



AHI Specifications

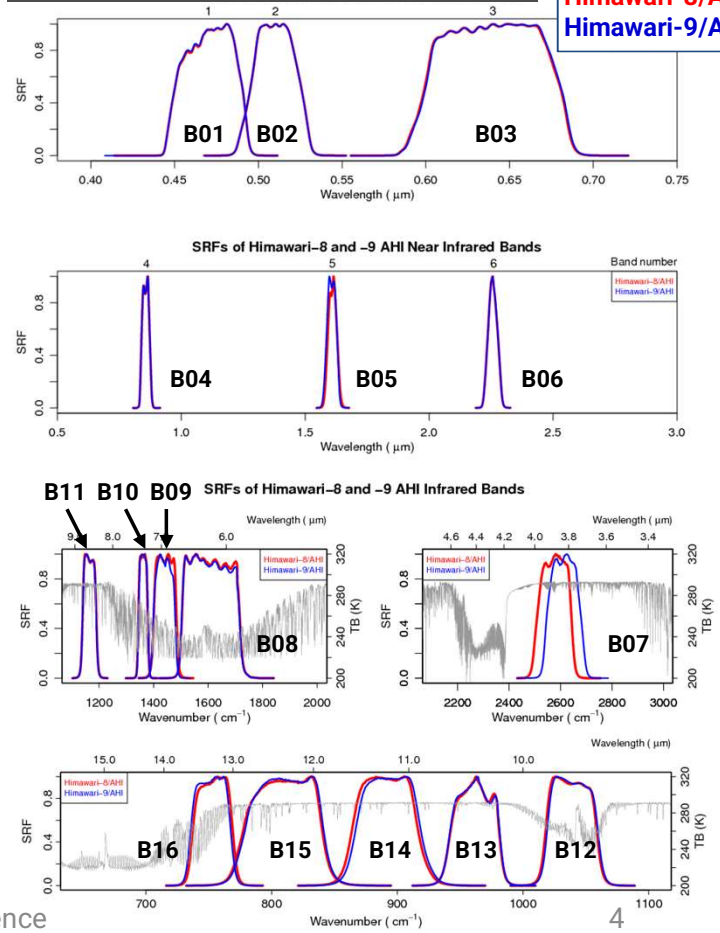
- Advanced Himawari Imager (AHI) onboard Himawari-8/-9 is the same series imager as ABI on GOES satellites and AMI on GK2A.



Band	Wavelength [μm]	Spatial Resolution at SSP [km]	
1	0.47	1	RGB band Composited
2	0.51	1	
3	0.64	0.5	
4	0.86	1	
5	1.6	2	
6	2.3	2	
7	3.9	2	
8	6.2	2	Water Vapor
9	7.0	2	
10	7.3	2	
11	8.6	2	SO_2
12	9.6	2	O_3
13	10.4	2	Atmospheric Window
14	11.2	2	
15	12.3	2	
16	13.3	2	CO_2

Spectral Response Functions

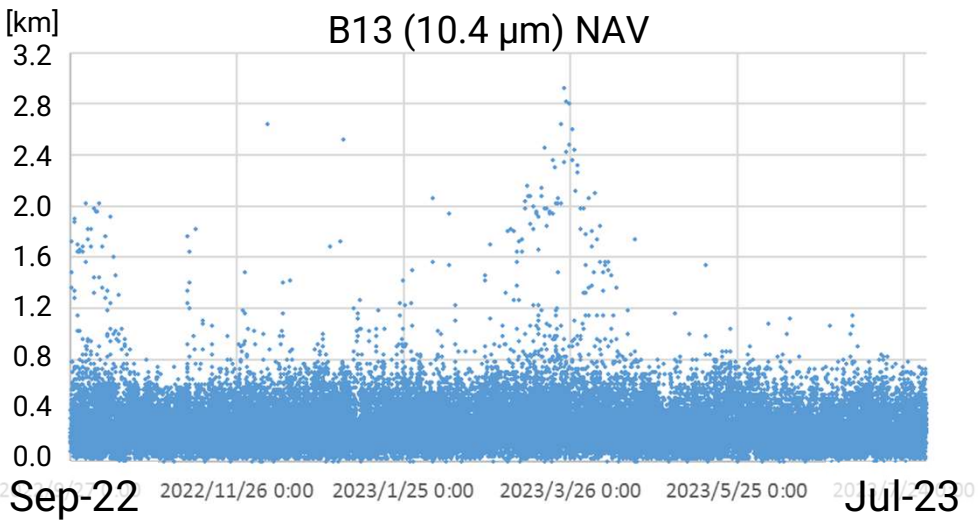
Himawari-8/AHI
Himawari-9/AHI

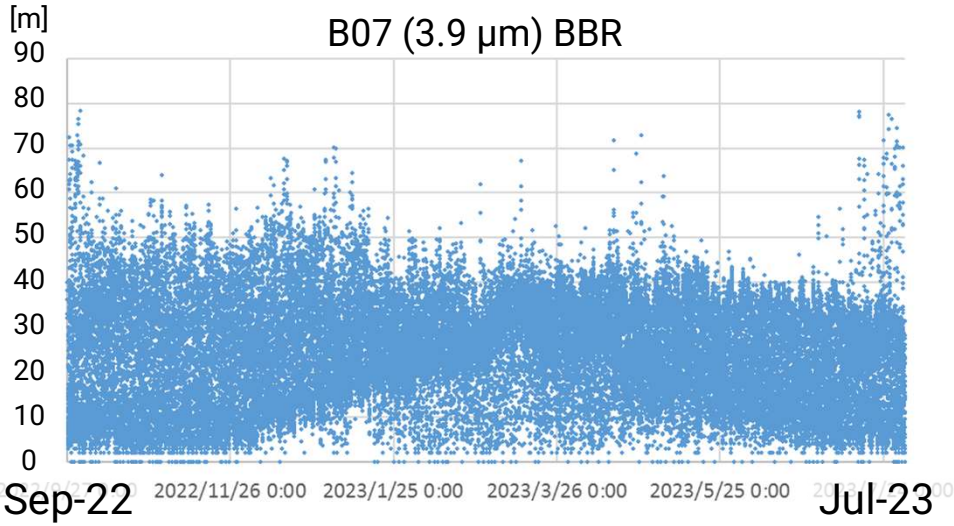


Himawari-9/AHI INR Performance

- Image navigation accuracy (absolute bias) using landmarks (NAV)
  - Mostly smaller than 0.4 km.
  - Errors over 1 km are mainly seen at midnight of eclipse seasons.
- Inter-band co-registration accuracy vs. B13 (10.4 μm) (BBR)
  - Band-dependent but mostly smaller than 40 m.

Time series of NAV and BBR performance from Sept. 2022 to Jul. 2023

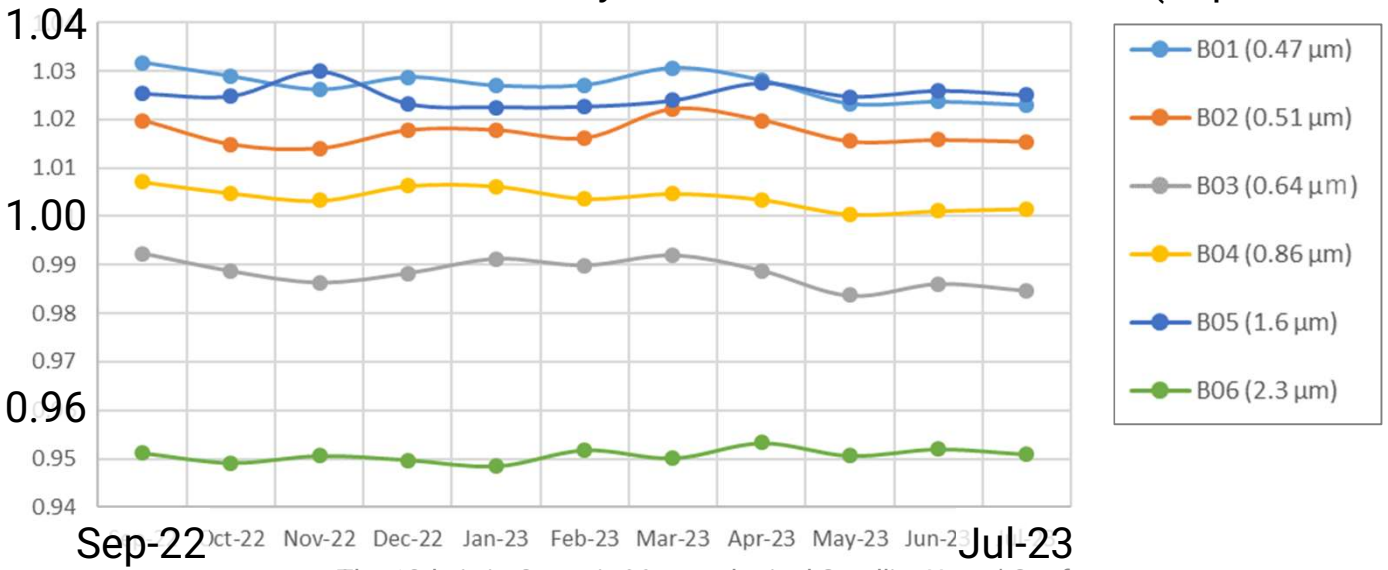




Himawari-9/AHI VNIR Calibration Performance

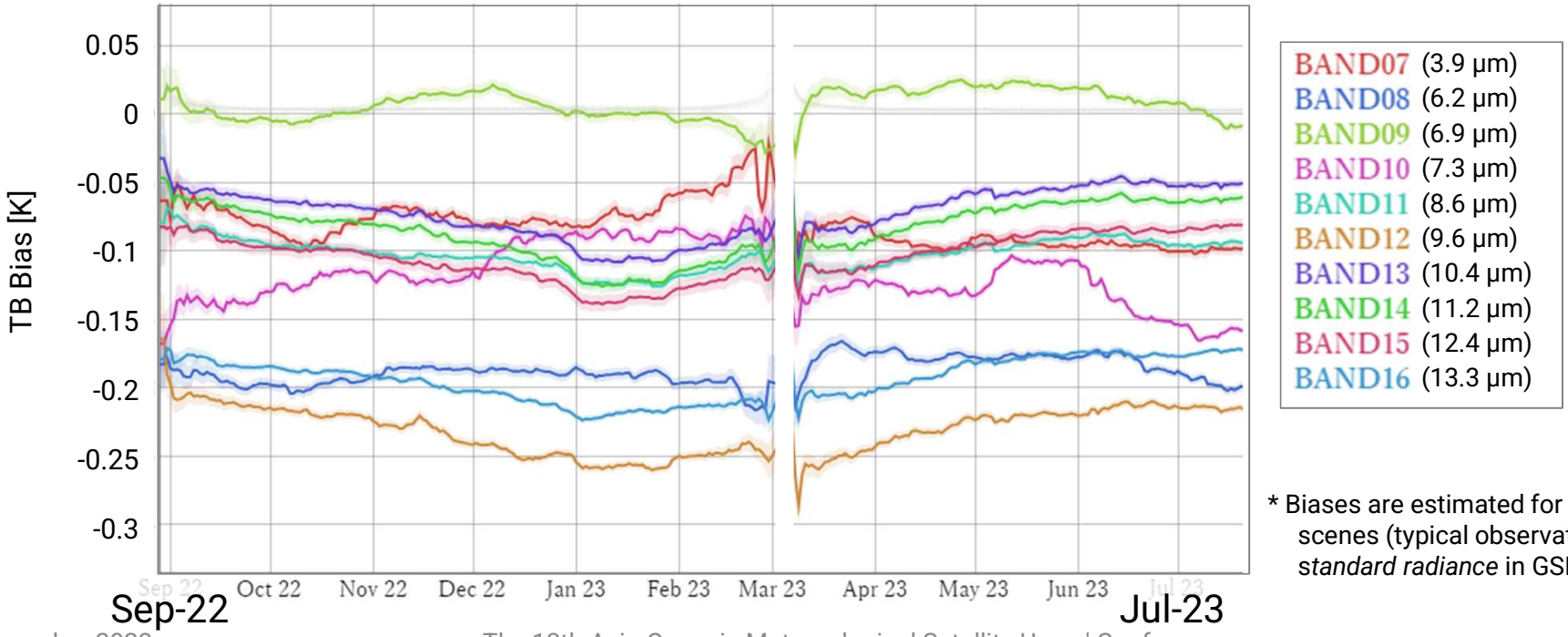
- Comparison of AHI and NOAA-20/VIIRS reflectance (i.e. “ray-matching” inter-calibration)
  - SRF differences between AHI and VIIRS are compensated by Spectral Band Adjustment Factor (SBAF) developed by NASA/LaRC. SBAF: https://satcorps.larc.nasa.gov/cgi-bin/site/showdoc?mnemonic=SBAF
- Biases against the reference are 1 – 5%
  - Small degradation trends (~0.5%/year) in B03 and B04 are seen in Himawari-8/AHI.

Himawari-9/AHI reflectance divided by NOAA-20/VIIRS reflectance (Sept. 2022 - Jul. 2023)



Himawari-9/AHI IR Calibration Performance

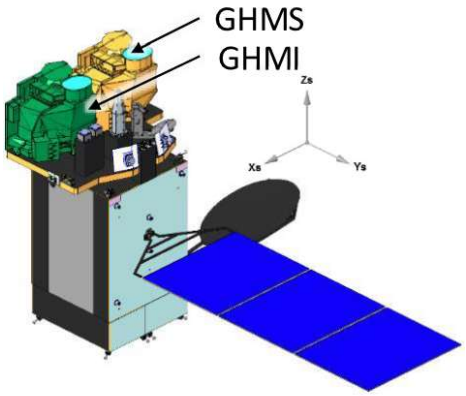
- TB biases vs. Metop-B/IASI at standard scenes*
  - Stable and small biases (< 0.3 K).
  - Variations in March 2023 are due to a lack of IASI data (No issues in Himawari-9/AHI observation performance).

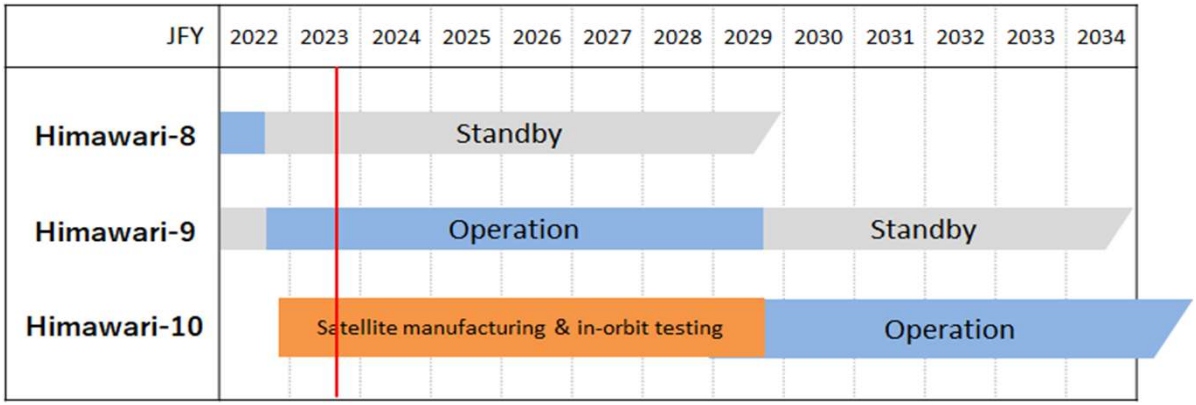


* Biases are estimated for clear sky ocean scenes (typical observation scene called *standard radiance* in GSICS).

Himawari-10 Overview

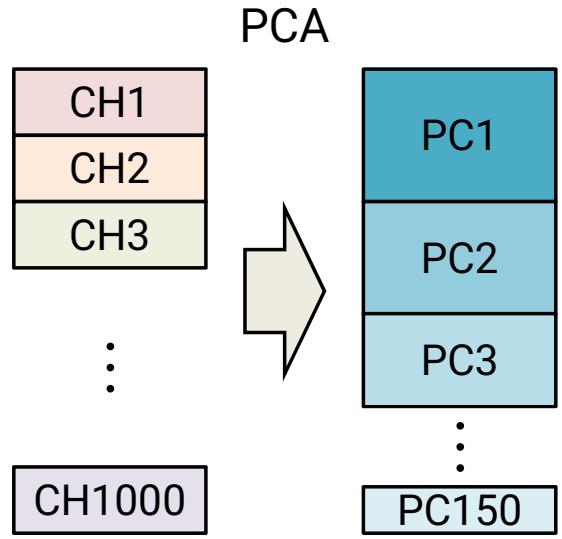
- JMA contracted manufacturing of the follow-on satellite Himawari-10 in March 2023, with initiation of operation scheduled for FY 2029.
- Onboard sensors for meteorological/non-meteorological purposes
  - Geostationary HiMawari Imager (GHMI)
    - Successor to AHI, improvement from Himawari-8/9 (e.g. 18 bands)
  - Geostationary HiMawari Sounder (GHMS)
    - Hyperspectral IR sounder (HSS) captures 3-D atmospheric state for improving JMA services in extreme weather monitoring, nowcasting and numerical weather predictions (NWP).





Preliminary Study Using PCA for Himawari-10

- HSS measurements
  - Represented as radiances of more than 1000 wavenumbers, which are spectrally highly correlated
- Using Principal Component Analysis (PCA)
  - Remove noise while preserving the signal
  - Compress data size by reducing dimensionality

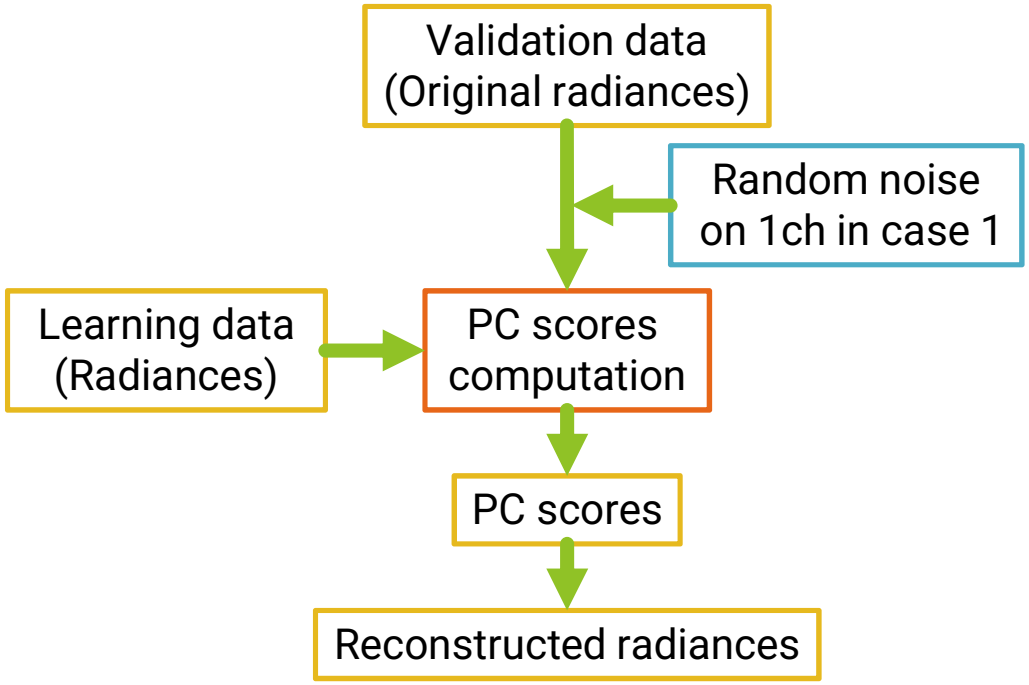


Investigate the applicability of reconstructed radiances from PC scores to L1 data monitoring and other applications (e.g., NWP)

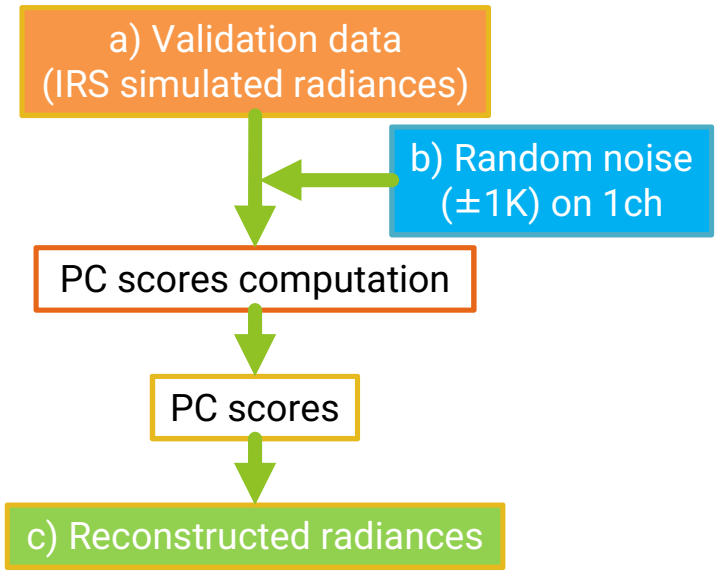
HSS Data Used for Validation and Method

- HSS data
  - Case 1) MTG/IRS simulated radiances
    - NWP SAF Radiance Simulator + ERA-5
    - LW: 881ch, MW: 1079ch
  - Case 2) NOAA-20/CrIS observed radiances
    - LW: 717ch, MW: 869ch, SW: 637ch
- Method
  - Compute PC scores from noise-added radiances (case 1) or original radiances (case 2)
    - 150 scores for each band
  - Reconstruct radiances from all PC scores
  - Compare reconstructed radiances with noise-added radiances or original radiances

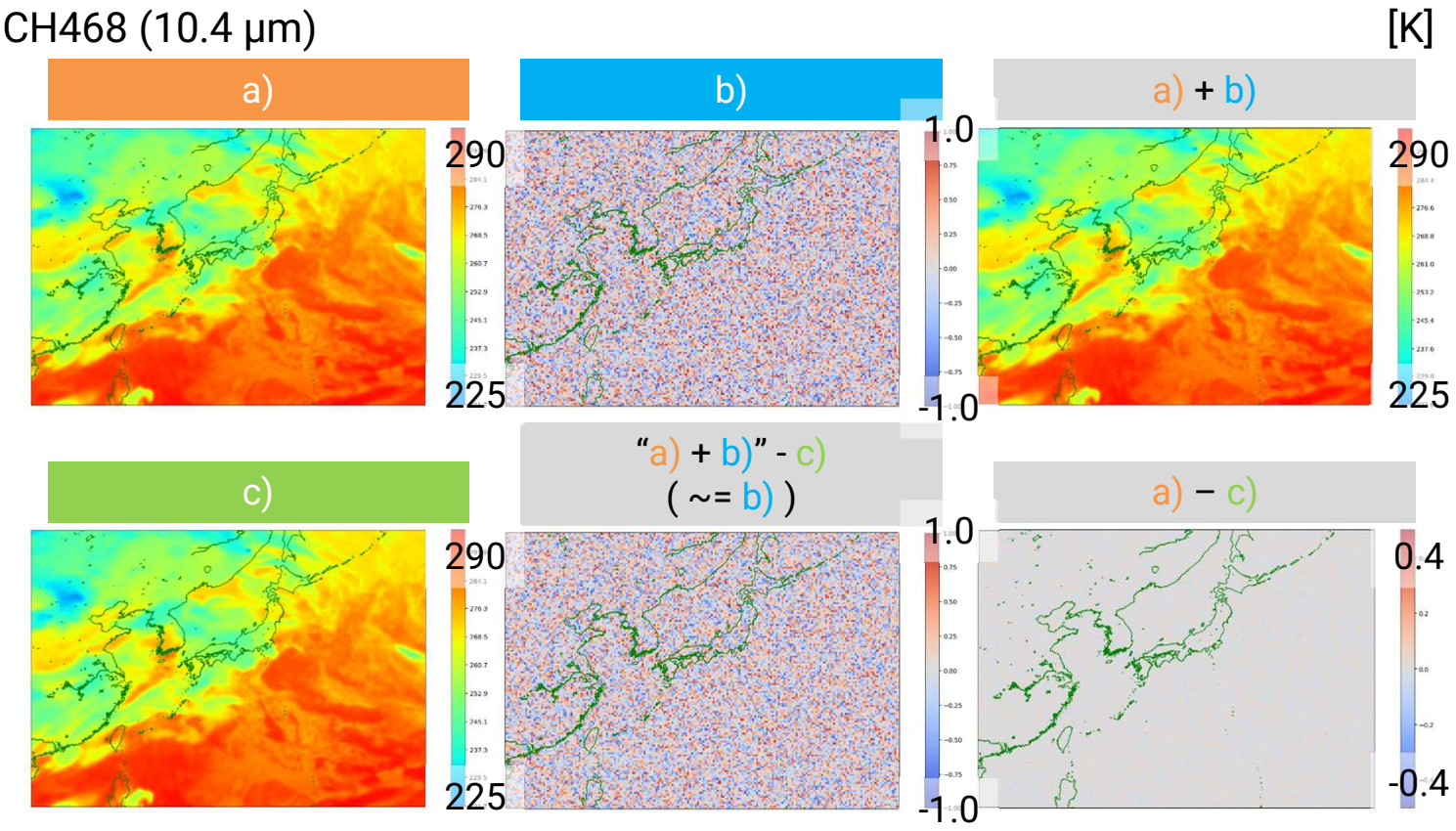
Flow from PC scores computation to reconstruction



Case 1) MTG/IRS Simulated Radiances



- Reconstructed radiances contain very few “added-noise”



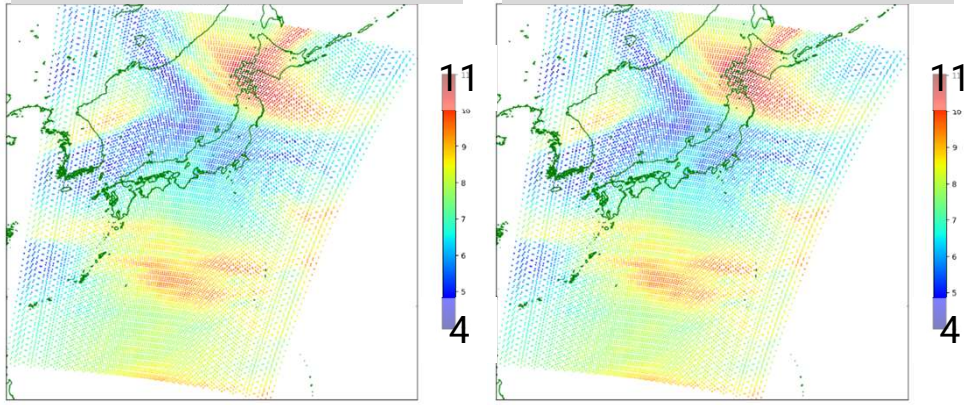
Max difference: ~0.1 K

Case 2) NOAA-20/CrIS Observed Radiances

MW CH300

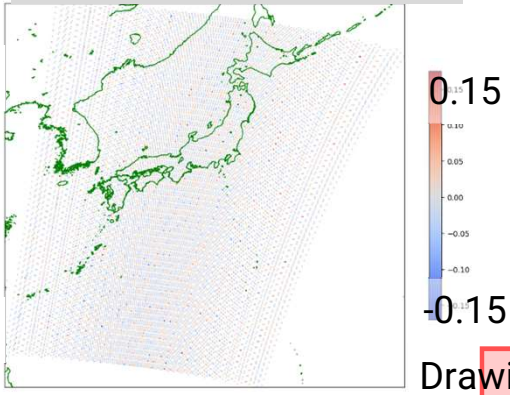
[mW/m²・sr・cm⁻¹]

Original radiances

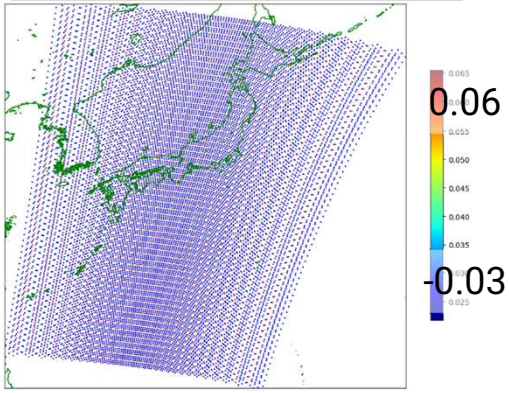


Reconstructed radiances

Difference

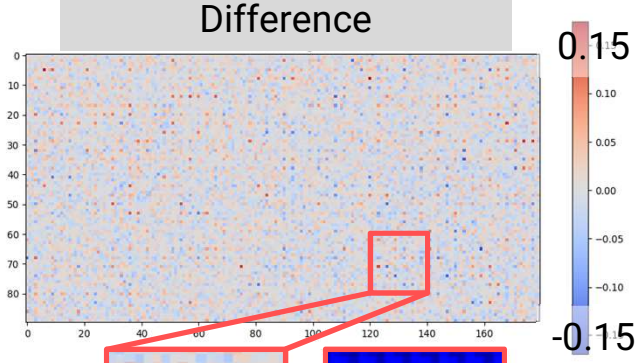


NEdR



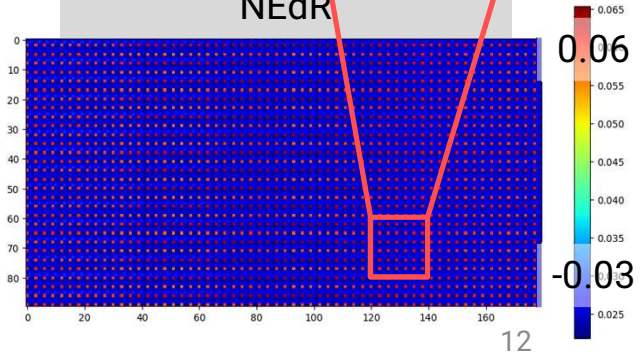
Drawing with non-projection

Difference



FOV 9

NEdR

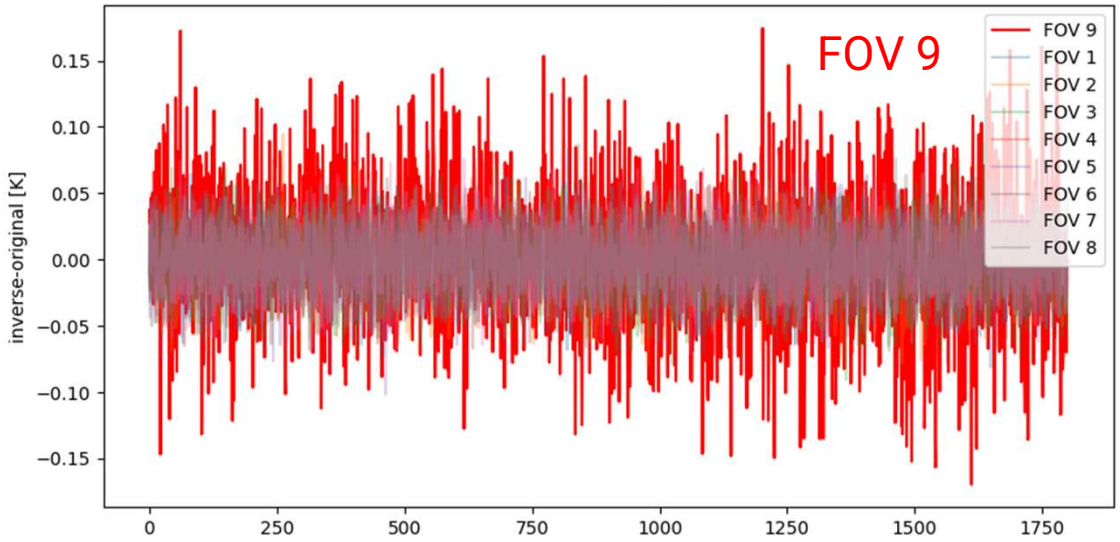


- Comparison of difference between original and reconstructed radiances with NEdR.
- Noise in the observed data has been reduced.

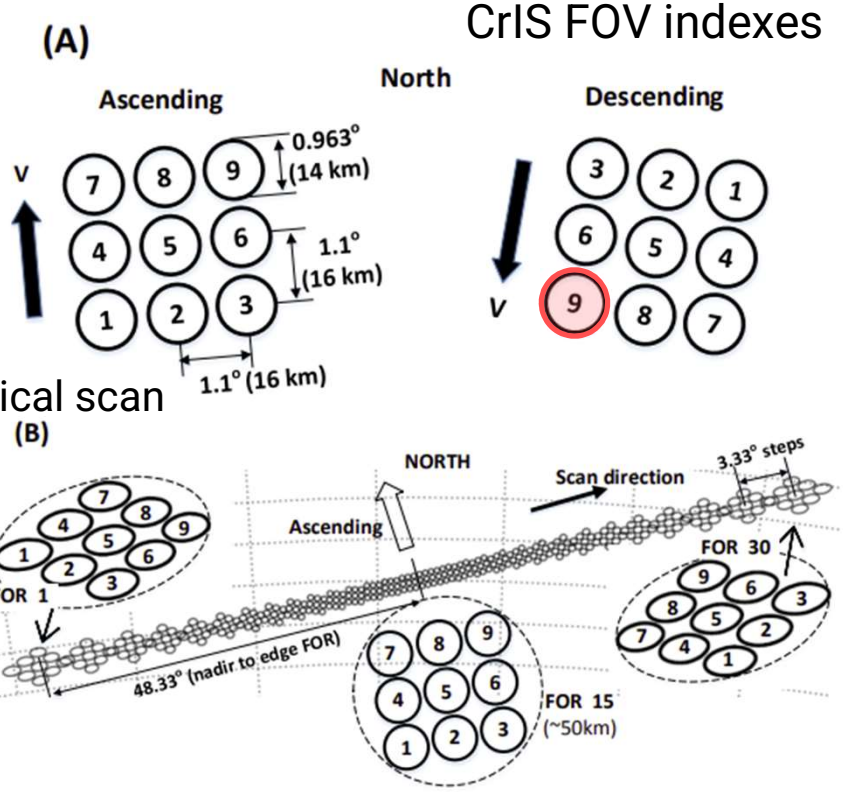
Case 2) NOAA-20/CrIS Observed Radiances

- CrIS NEdR is large at FOV 9 of descending orbit used in this study.
- Difference is large at FOV 9.

Difference between original and reconstructed radiances for each FOV



CrIS FOV indexes



a typical scan

(CrIS SDR User's Guide Version 1.1)

Summary

- Validation of Himawari-9/AHI Data Quality
  - INR accuracy is ~0.4 km (for reference mapping) and 40 m (between bands).
  - Radiometric calibration biases for VNIR bands are 1-5%, and those for IR bands are less than 0.3 K.
  - These have been as small as those of Himawari-8/AHI.
- Preliminary Study Using PCA for Himawari-10 HSS (GHMS)
  - To investigate the applicability of reconstructed radiances from PC scores to L1 data monitoring, we validated how much noise we can reduce by PCA.
  - Radiances reconstructed from PC scores using IRS simulated data and CrIS observed data significantly reduced the noise compared to the noise-added radiances or original radiances.
  - Future plans
    - How many PC scores to compute, How much data can be compressed
    - Use of computed PC scores for L1 data quality control and products