Introduction to GOCI-II Radiometric Calibration

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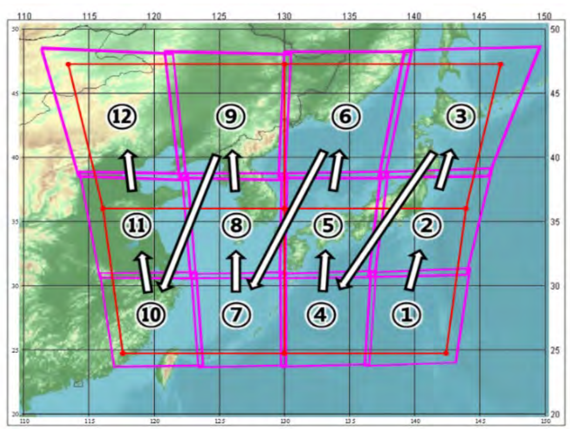
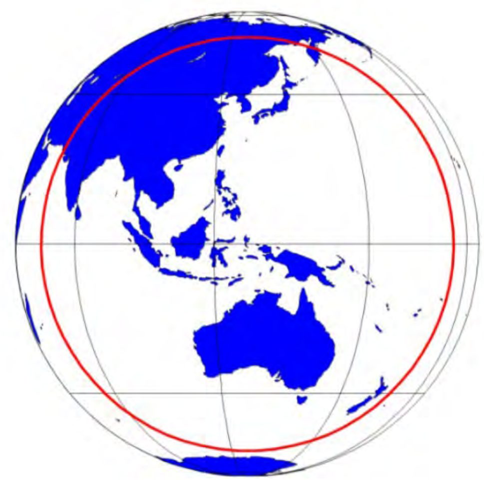
Contents

Overview of GOCI-II (1/3)

- Major missions of GOCI-II
  - ✓ To maintain ocean color mission continuity of COMS in ocean color observations
  - ✓ To improve monitoring capability of ocean biophysical phenomena and maritime disasters
  - ✓ To estimate ocean climate change with monitoring global marine ecosystem
  - ✓ Continuation and expansion of the GOCI mission
    - Local Area Imaging centered at 130°E, 36°N
    - Full Disk Imaging & Lunar Calibration
    - 12 spectral channels and one wideband channel for star imaging



Reference Local Area Imaging

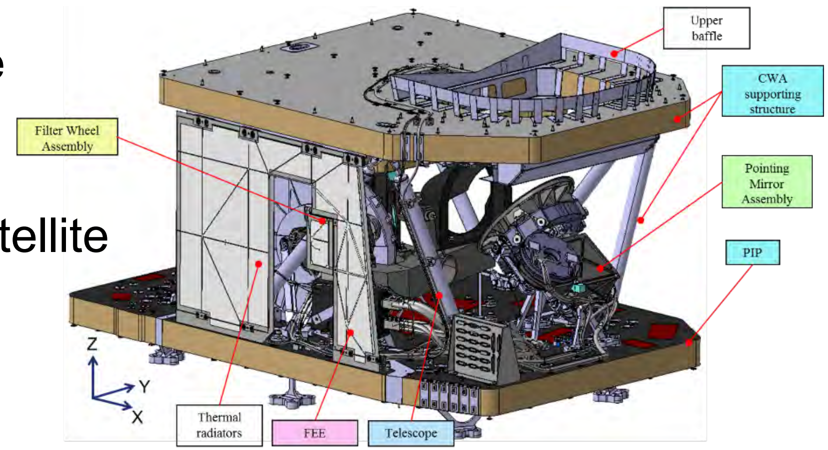


Full Disk Imaging

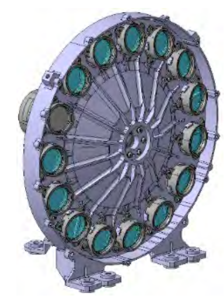
Overview of GOCI-II (2/3)

- Sensor Unit
  - ✓ Shutter wheel: Shutter & Solar diffuser
  - ✓ Pointing Mirror: 2-D scan mechanism
  - ✓ Telescope: Three Mirror Anastigmat (TMA)
  - ✓ Filter wheel: 14 spectral filters and dark plate
  - ✓ Detector: 2-D CMOS array
  - ✓ FEE: Front End Electronics
  - ✓ PIP: Thermal & mechanical isolation from satellite
- IEU (Instrument Electronics Unit)

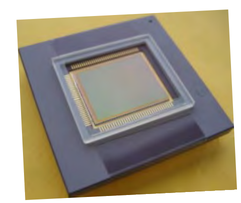
Sensor Unit



Pointing mirror mechanism



Filter wheel



2D CMOS detector

Overview of GOCI-II (3/3)

- On-board Calibration Devices for in-orbit solar calibration
  - Located in front of the pointing mirror to cover whole optical path
  - Two on-board calibration devices
    - SD(Solar diffuser): full aperture
    - DAMD (Diffuser Aging Monitoring Device): partial aperture

SD
(solar diffuser)

DAMD
(Diffuser Aging Monitoring Device)

GOCI-II Radiometric Model

➢ Radiometric model for GOCI-II

$$L(B,i,j)=\frac{G(B,i,j)}{T_{\text{int}}(B)}\times\left[\bar{Y}(B,i,j)+\alpha(B,i,j)\bar{Y}^2(B,i,j)+\beta(B,i,j)\bar{Y}^4(B,i,j)\right]$$

$$\bar{Y}(B,i,j)=Y(B,i,j)-O(i,j)T_{\text{int}}(B)-F(i,j)$$

Y(B,i,j): output digital count for each pixel for spectral channel B
G(B,i,j): linear radiometric gain of pixel (i, j) for spectral channel B
L(B,i,j): input radiance of pixel (i,j) for spectral band B
T_{int}(B): integration time for spectral band B
α(B,i,j) ,β(B,i,j): nonlinearities of pixel (i,j) for spectral channel B
O(i,j), F(i,j): offset parameters

Radiometric model has been validated through pre-launch radiometric characterization.

GOCI-II Radiometric Calibration Plan

On-ground calibration
- Absolute calibration
  - Gain parameter measurement
- Characterization of on-board calibration devices
  - SD (Solar Diffuser),
  - DAMD (Diffuser aging monitoring device)

✓ On-ground absolute gain has been used as initial value for early orbit operation.

In-orbit solar calibration (absolute calibration)
- Gain parameter measurement (sun imaging using the SD)
- Aging parameter measurement of SD (sun imaging using the DAMD & moon imaging)

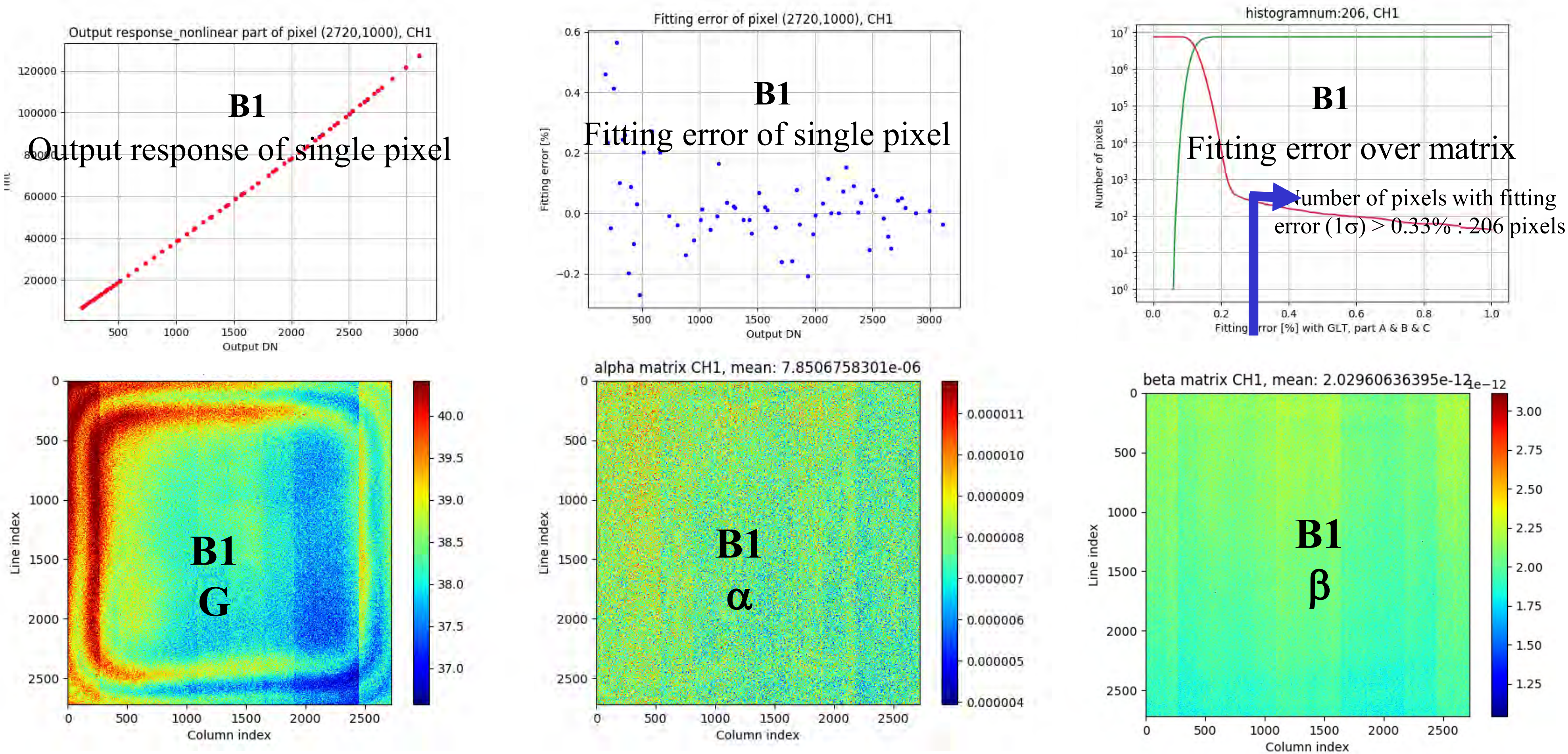
✓ In-orbit absolute gain has been calculated through solar calibration by using the diffusion characteristics of on-board calibration devices.

In-orbit stability monitoring
- Relative gain variation monitoring
  - Sun imaging (using DAMD)
  - Moon imaging

✓ Monitoring of radiometric gain stability

Pre-launch On-ground Calibration (1/3)

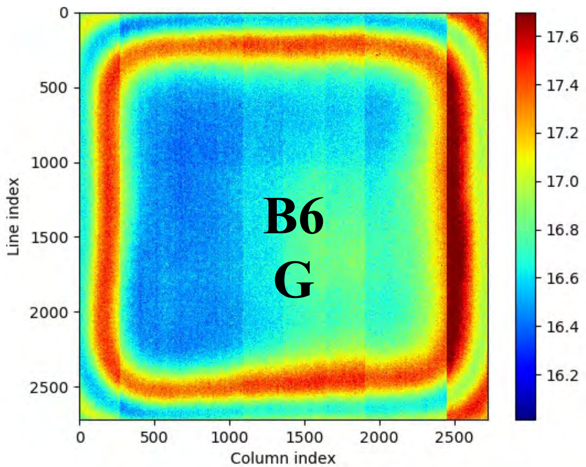
- **Radiometric model validation through on-ground characterization**

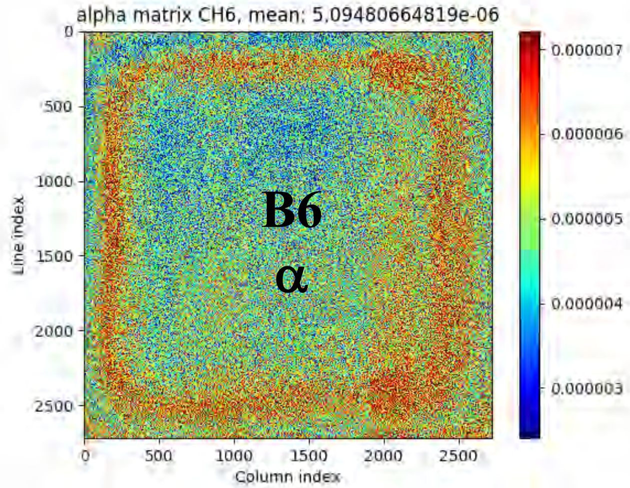


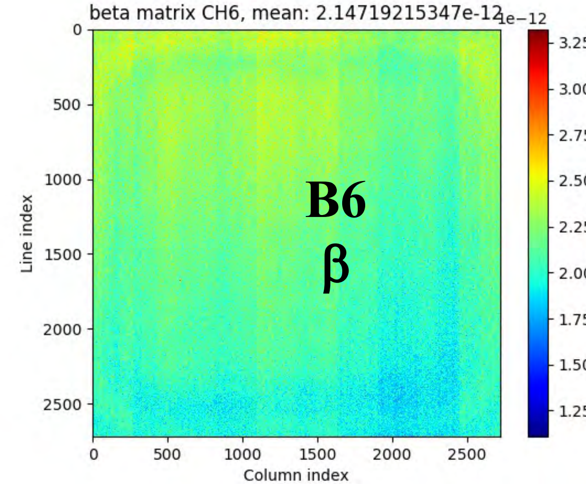
→Radiometric model is validated over full dynamic range.
→Defective pixel list has been identified. (around 200 pixels for all spectral channels)

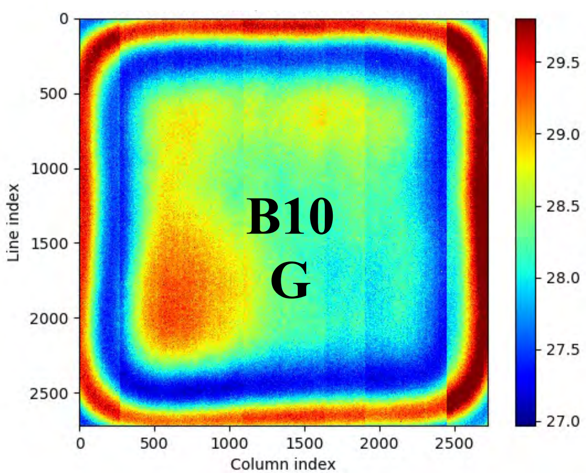
Pre-launch On-ground Calibration (2/3)

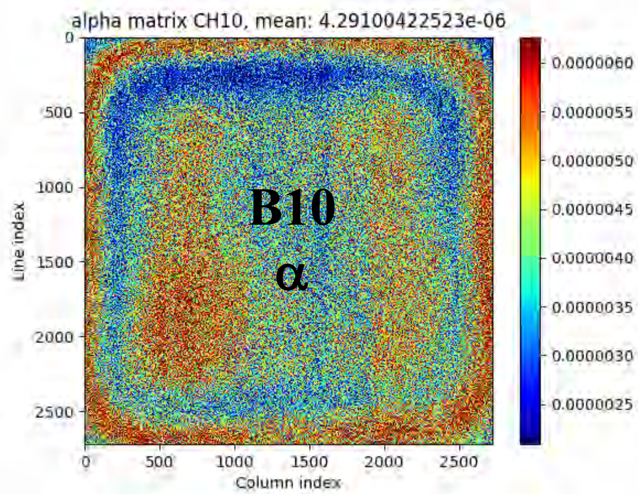
- Radiometric model shows similar performance (fitting error) for all spectral channels.
- PRNU pattern is different from spectral channel to channel.

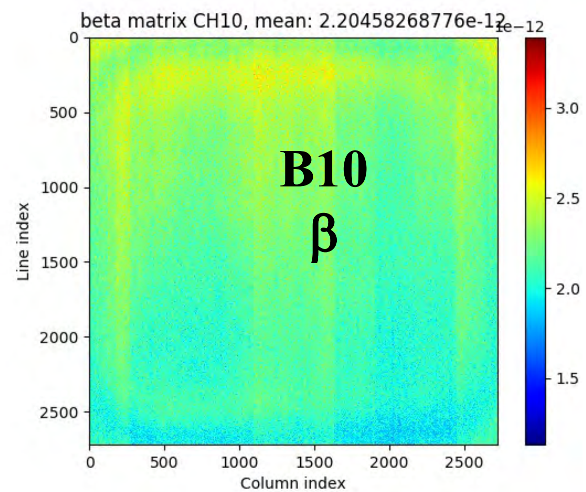










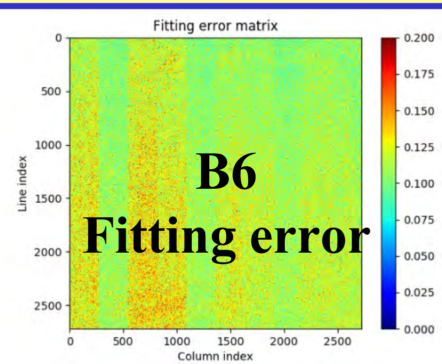


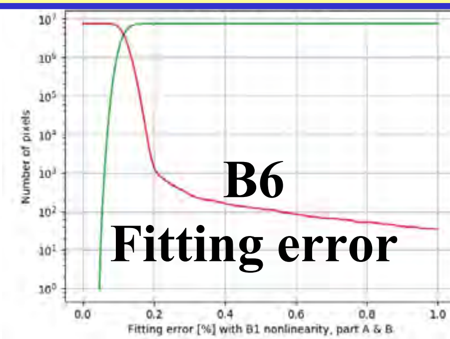
Pre-launch On-ground Calibration (3/3)

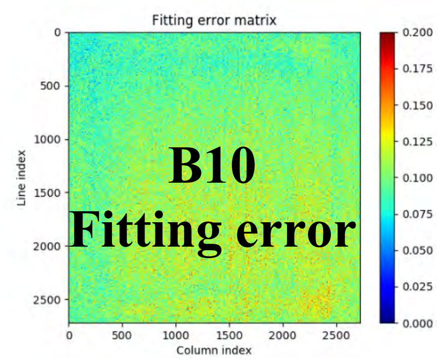
- **Non-linearity pattern due to PRNU**

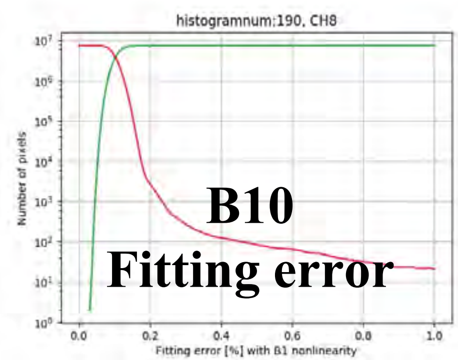
✓Nonlinearity is expected to be the same for all spectral channels.
✓Characterization results shows similar level of nonlinearity over for spectral channels.
✓But, there is a pattern in nonlinearity over matrix due to PRNU. → Channel to channel deviation
✓**This deviation will not degrade the fitting performance. However, nonlinearity has been characterized for each spectral channels.**

When linear gain parameter is estimated with known nonlinear parameters (B1), fitting results shows similar performance.



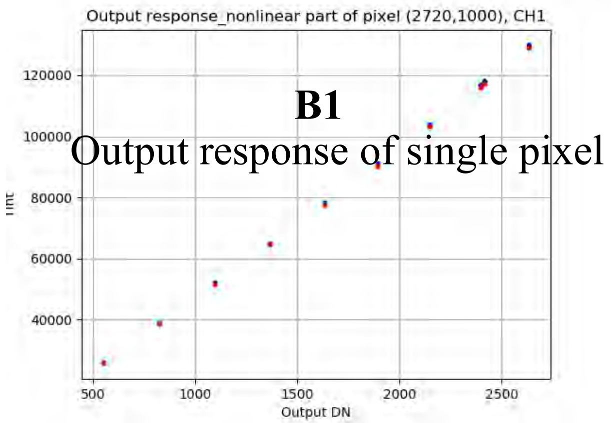


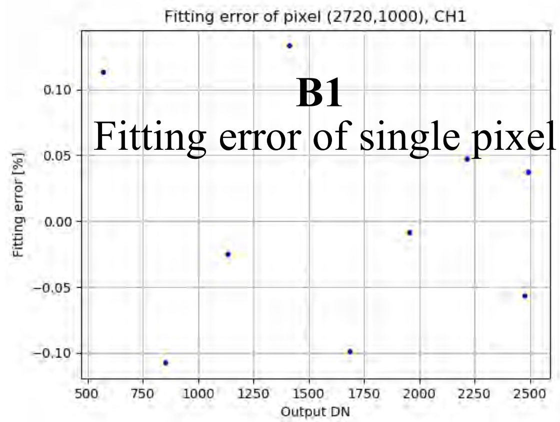


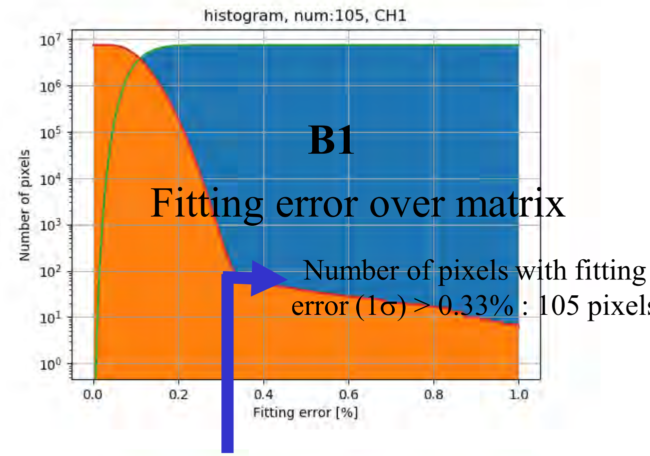


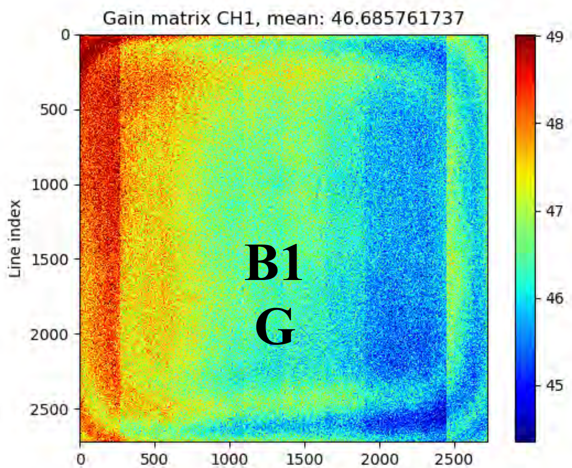
In-Orbit Solar Calibration (1/2)

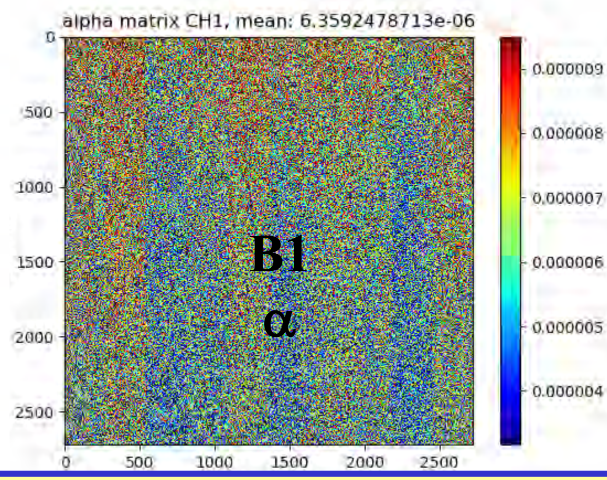
- **Radiometric model validation through In-orbit solar calibration: B1**

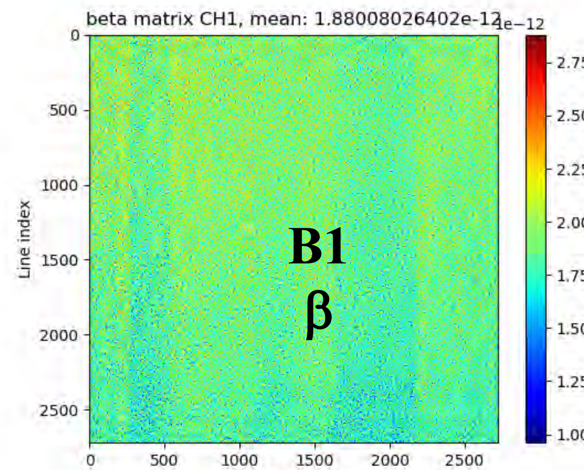








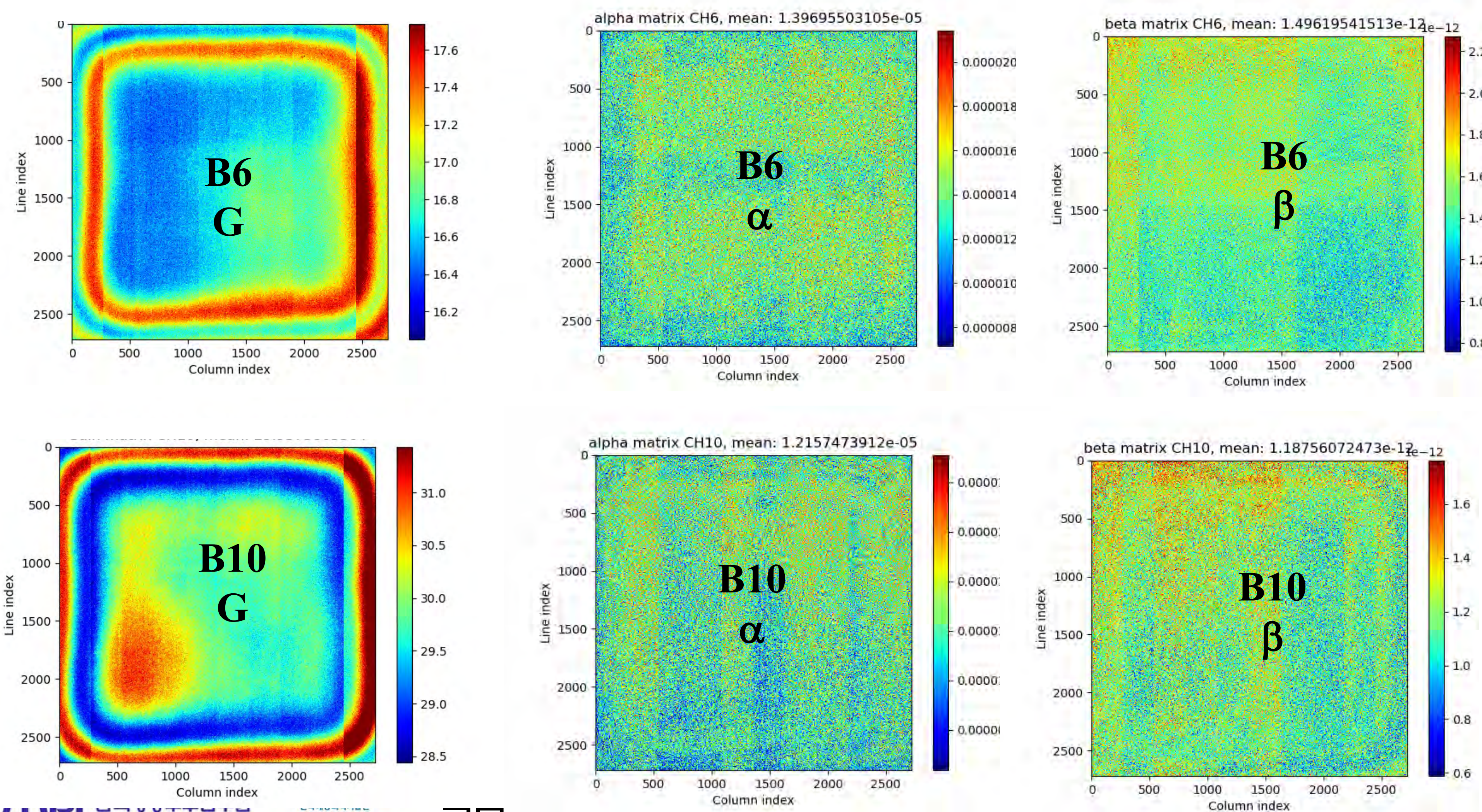




→ Radiometric model is validated through in-orbit solar calibration.
→ On-ground defective pixel list has been confirmed.
→ PRNU pattern deviation from on-ground result has been observed.

In-orbit Solar Calibration (2/2)

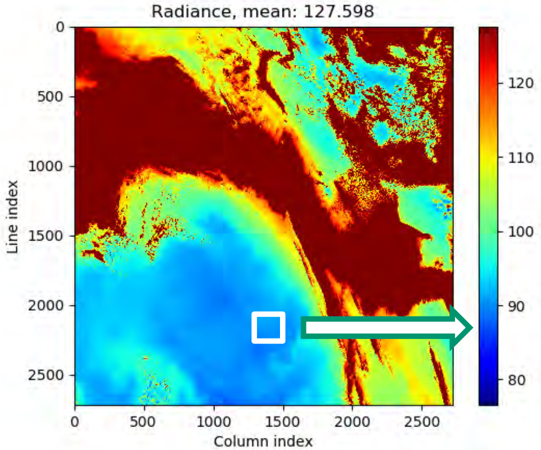
- Radiometric model shows similar performance (fitting error) for all spectral channels.
- Nonlinear parameters have been estimated for each spectral channel.



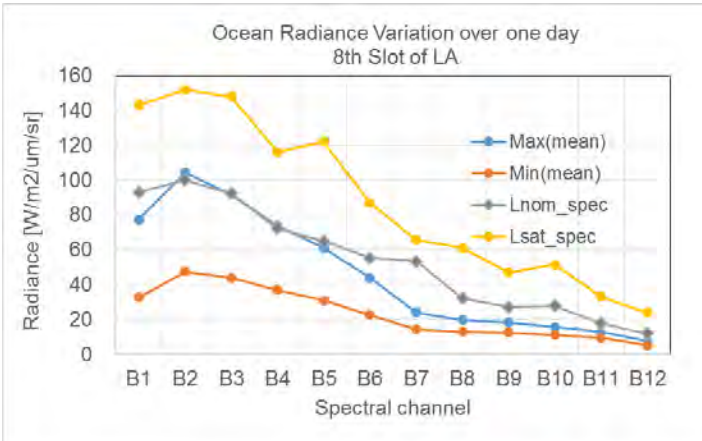
GK2
GEO-KOMPSAT-2A&2B

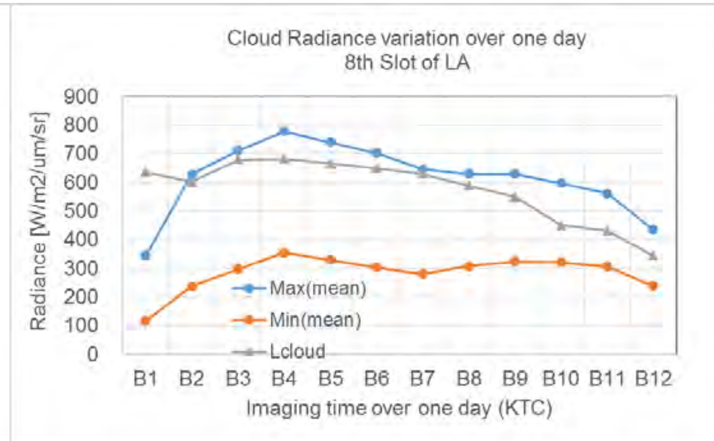
Imaging Parameter Adjustment for Daily Radiance Variation

➢ Daily radiance variation
(sample analysis using measurements acquired on 2020/03/19)



Spot for ocean radiance monitoring: 200pixels x 200pixels, 8th slot





- ✓ The daily radiance variation (mainly solar incident angle variation) is checked even though there are some error due to scene change.
- ✓ Daily maximum ocean radiance (at around noon in KTC) shows smaller value than the specification except B2/B3/B4.
- ✓ Cloud radiance measurements (max. measured at around noon in KTC) shows bigger value than the specification except B1.
- ✓ Three sets of video parameters for a day are applied to keep SNR performance. (monthly)

Discussions & Future Work

- **GOCI-II radiometric model has been validated through on-ground and in-orbit solar calibration.**
- **Radiometric gain parameters for GOCI-II in-orbit operation have been determined based on;**
  - On-ground calibration results
  - In-orbit solar calibration results
  - Comparison with GOCI-I radiance data
- **Radiometric gain monitoring shows some degradation depending on spectral channels. The radiometric gain parameters will be updated to reflect these variation.**
- **Regarding spectral channel B1, the Earth calibration will be performed to acquire the PRNU corresponding to radiance from the Earth.**