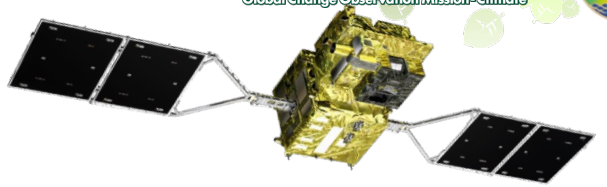

SGLI offset correction

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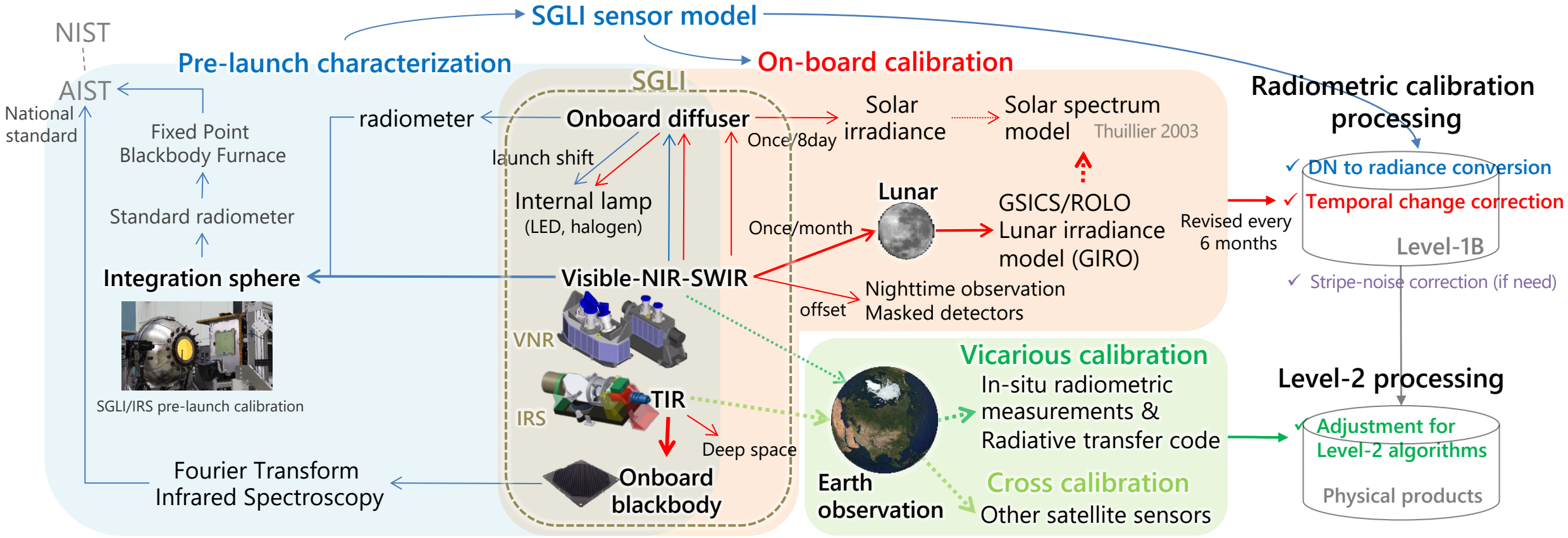
the 5th International Ocean Colour Science (IOCS) Meeting
University of South Florida (USF), St. Petersburg Campus
15 Nov. 2023

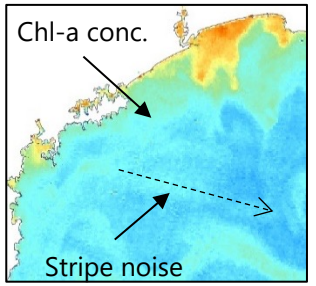
SGLI radiometric calibration system

- ✓ Level-1 radiometric calibration is based on the sensor model constructed by the pre-launch characterization
- ✓ Temporal change is corrected by the on-board calibration results updated every 6 months in the L1 processing
- ✓ Vicarious and cross calibration will be used for confirmation of the onboard calibration, and more accurate calibration (adjustment) required for the L2 algorithms



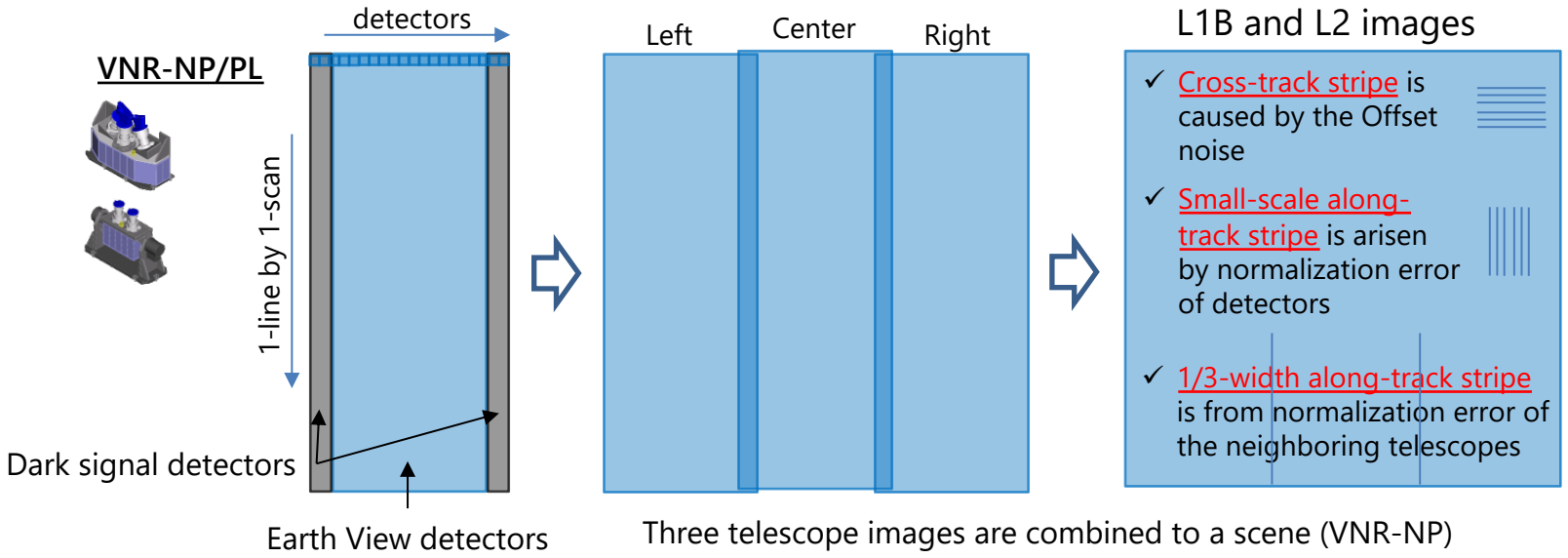
VNR stripe noise reduction

- The stripe noise should be reduced to avoid misrecognition the observation phenomena (front, plume..) and to utilize the sensor SNR performance as much as possible
- The SGLI-VNR consists of 1-D detectors, and tends to make along- and cross-track stripe noises
- Because the Offset can fluctuate and jump in the space environment, it is corrected by line-by-line offset estimation and update the LUT



(1) Dark Signal Non-Uniformity (DNSU) tables derived by evaluating the nighttime observation is updated every 6 months

(2) The selection table of sample pixels to estimate the dark current every scan is revised to avoid irregular jump due to the space environment every 6 months



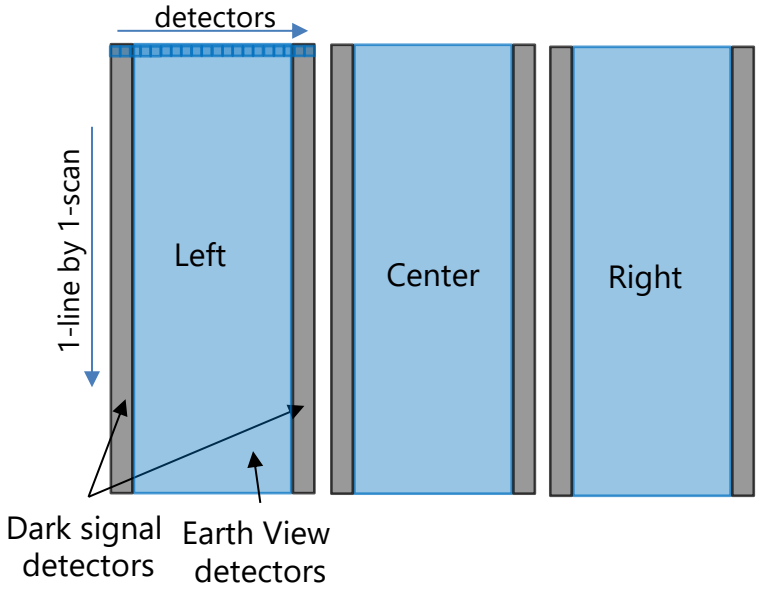
Three telescope images are combined to a scene (VNR-NP)

Calibrated radiance L ~ (DN – **Offset**)*__Gain__

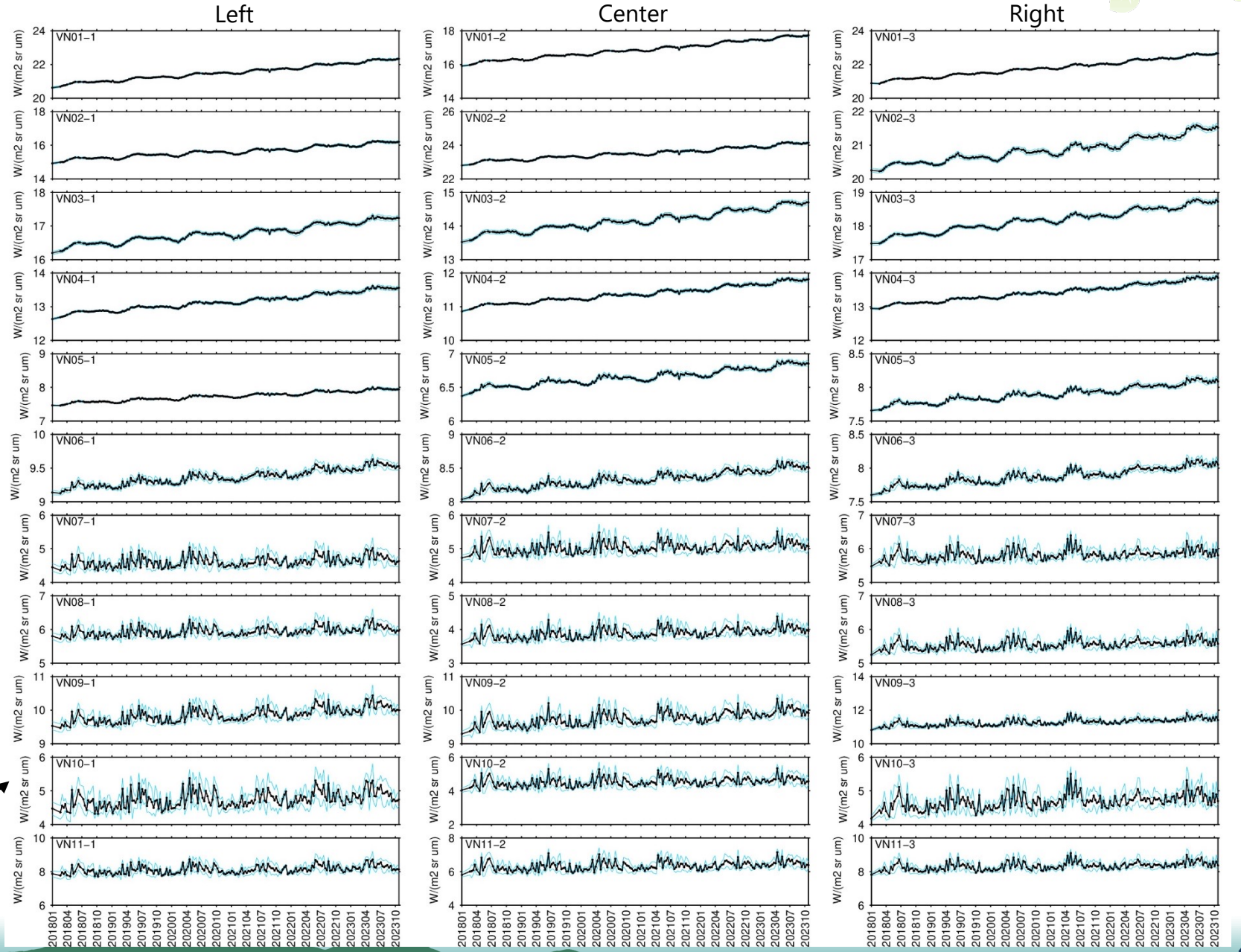
- **Offset** is estimated by selected average of the dark-signal (DS) detectors and difference between the DS average and the Earth View detectors (DSNU)
- **Gain** is modeled by the pre-launch laboratory tests, and the temporal change is estimated by the lunar calibration

VNR stripe noise reduction (dark signal pixels)

- Average of dark signals (DS) are used to estimate the Offset
- After L1 processing on 29 June 2020 (Ver.2), the detector selection table was revised to avoid large variation detectors every six months

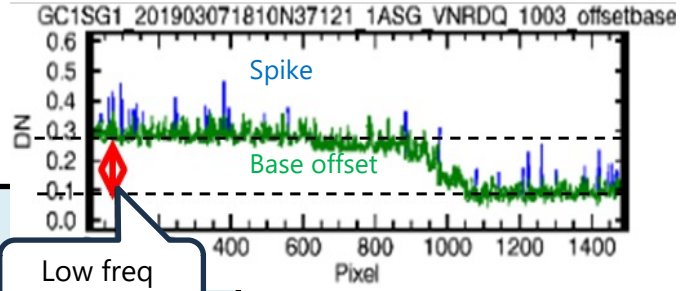


Long term change of DS average (black lines) and RMS in ~7500 lines (light blue lines) (the selection table is not applied)



VNR stripe noise reduction

Flow of detector selection and DSNU table revision for SGLI-VNR Offset estimation



(1) Small-scale along track stripe

【VNR-NP, PL】
Nighttime observation
Deep space in the pitch maneuver

→ Spike-noise removal

removal of outsiders in the dark signal detectors

→ DSNU evaluation

Difference between the dark signal and earth view detectors

Low freq characteristics

Along-track (line) average

Irregular deviation

【VNR-NP, PL】
Nighttime observation

→ **Temporal spike noise**
- Monitoring of frequency and intensity of the spike

→ **DNSU**
- Shape of DSNU
- Temporal change (from a scene to long-term scales) of the Offset level

→ *Revised by every 6 months* → DSNU table

(2) Cross track stripe

【VNR-NP, PL】
Calibration archive data

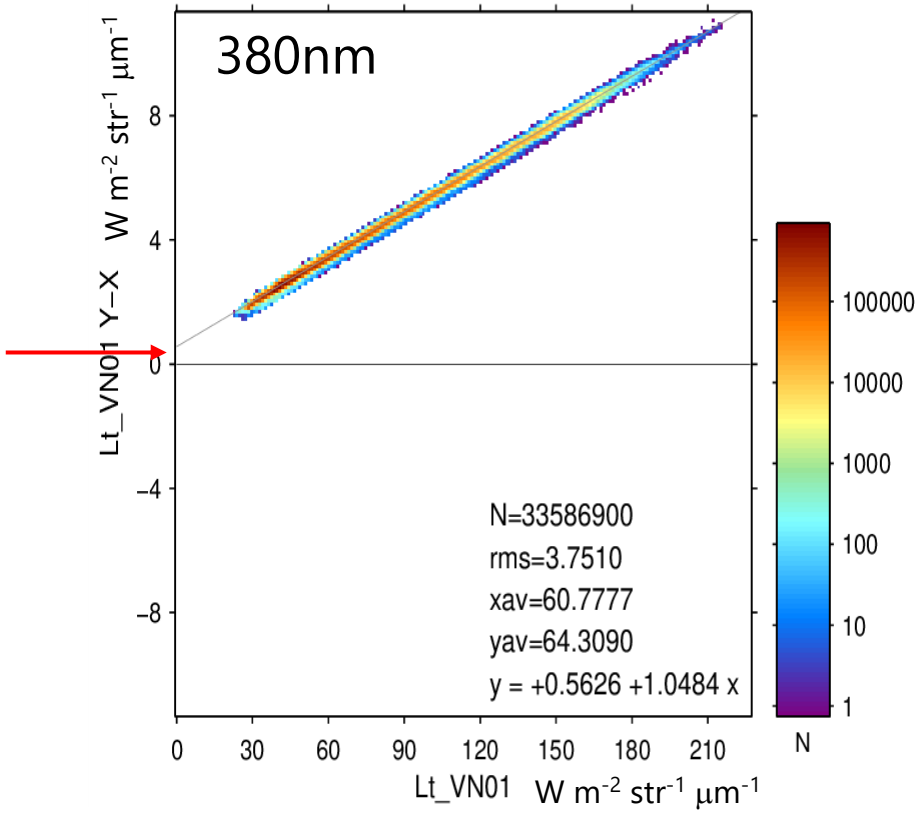
→ South Atlantic Anomaly (SAA) evaluation

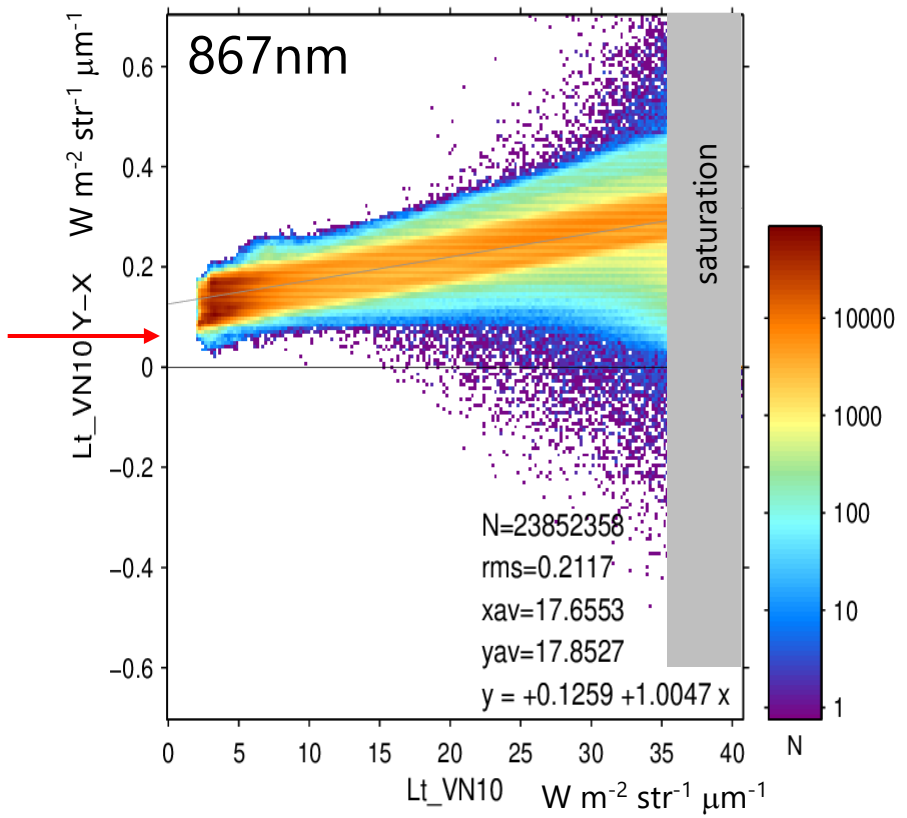
- Removal of outsiders in Optical Black/Pre/post scan
- Monitoring SAA influence

→ *Every 6 months* → Detector selection table

data　evaluation

Influence of the offset change in L1B





Difference between before (Ver. 1) and after (Ver. 2) the offset revision

X: before revision (including error from offset change),

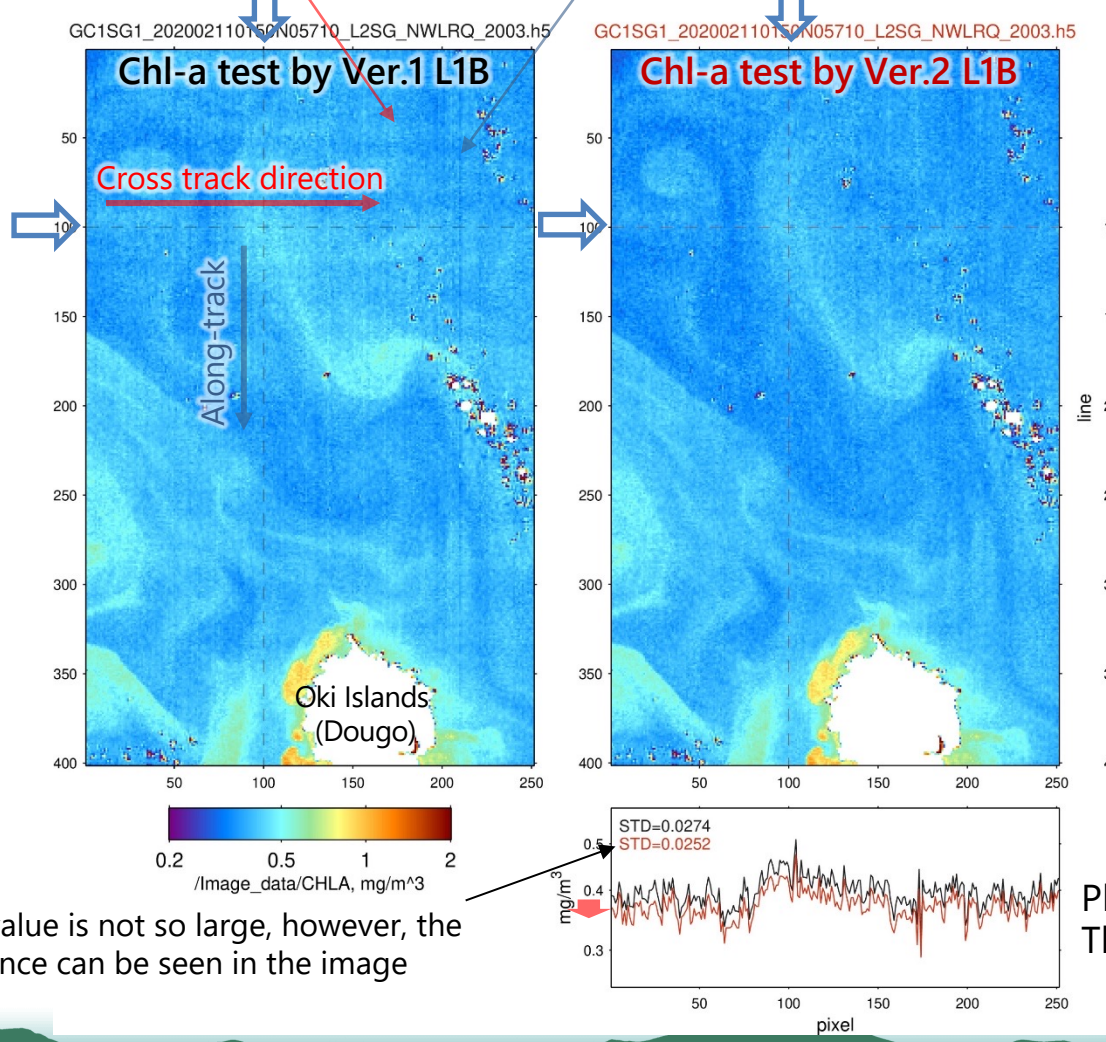
Y: after revision (including offset table revision and gain correction by Lunar calibration)

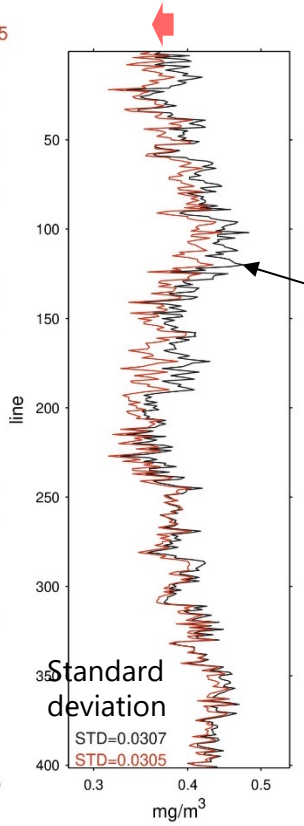
VNR stripe noise reduction (on a Chl-a image)

An example of Chl-a concentration image on 11 Feb. 2020 north of Oki Island Japan

Cross-track stripe noise (10-100 lines scale)

Small scale along-track stripe





Plot on the along-track broken lines

The black line shows Ver.1, and the red line Ver.2 (after reduction)

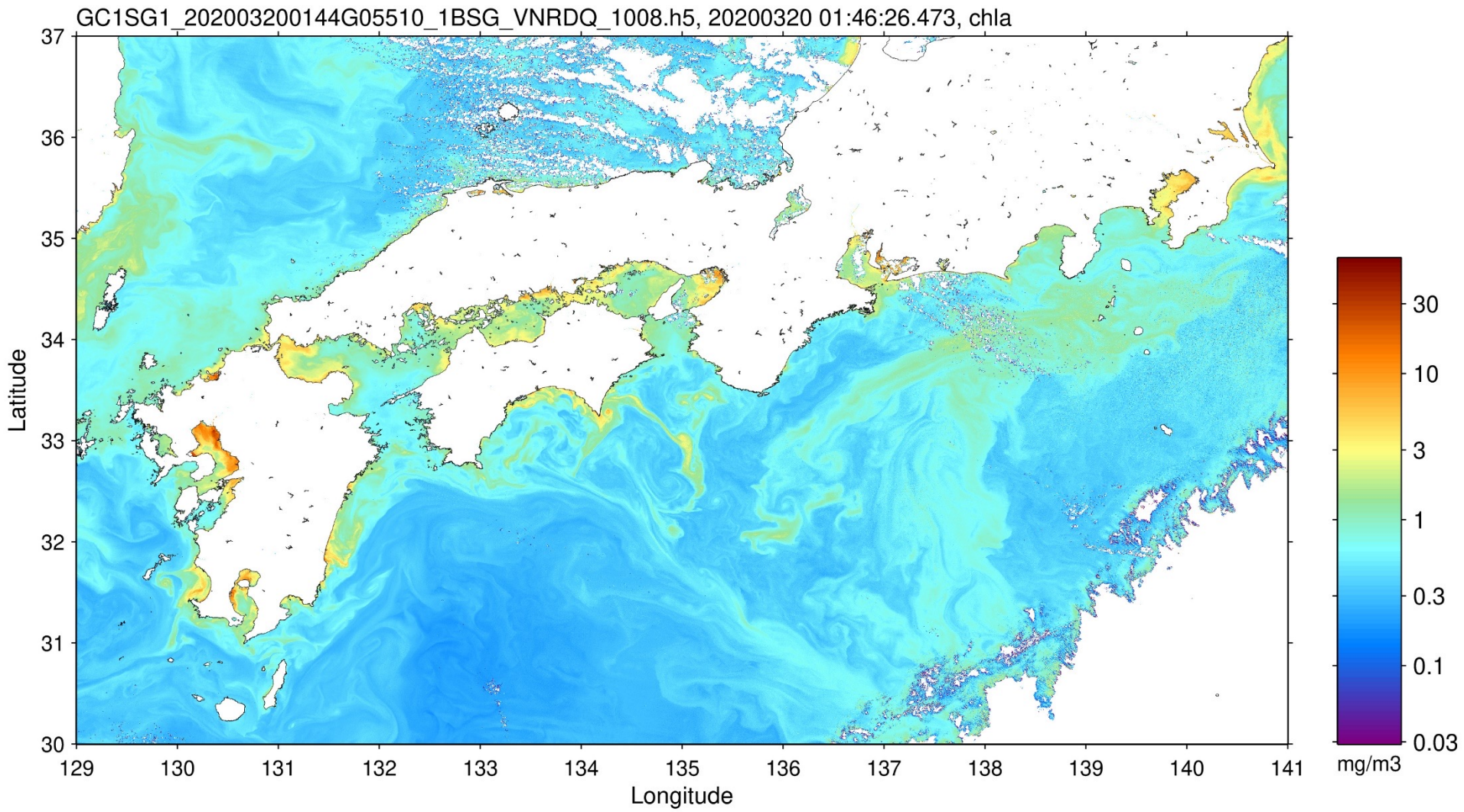
✓ The offset revision improved the stripe noise by10% in maximum

STD value is not so large, however, the influence can be seen in the image

Plot on the cross-track (along-scan) broken lines
The black line shows Ver.1, and the red line Ver.2 (after reduction)

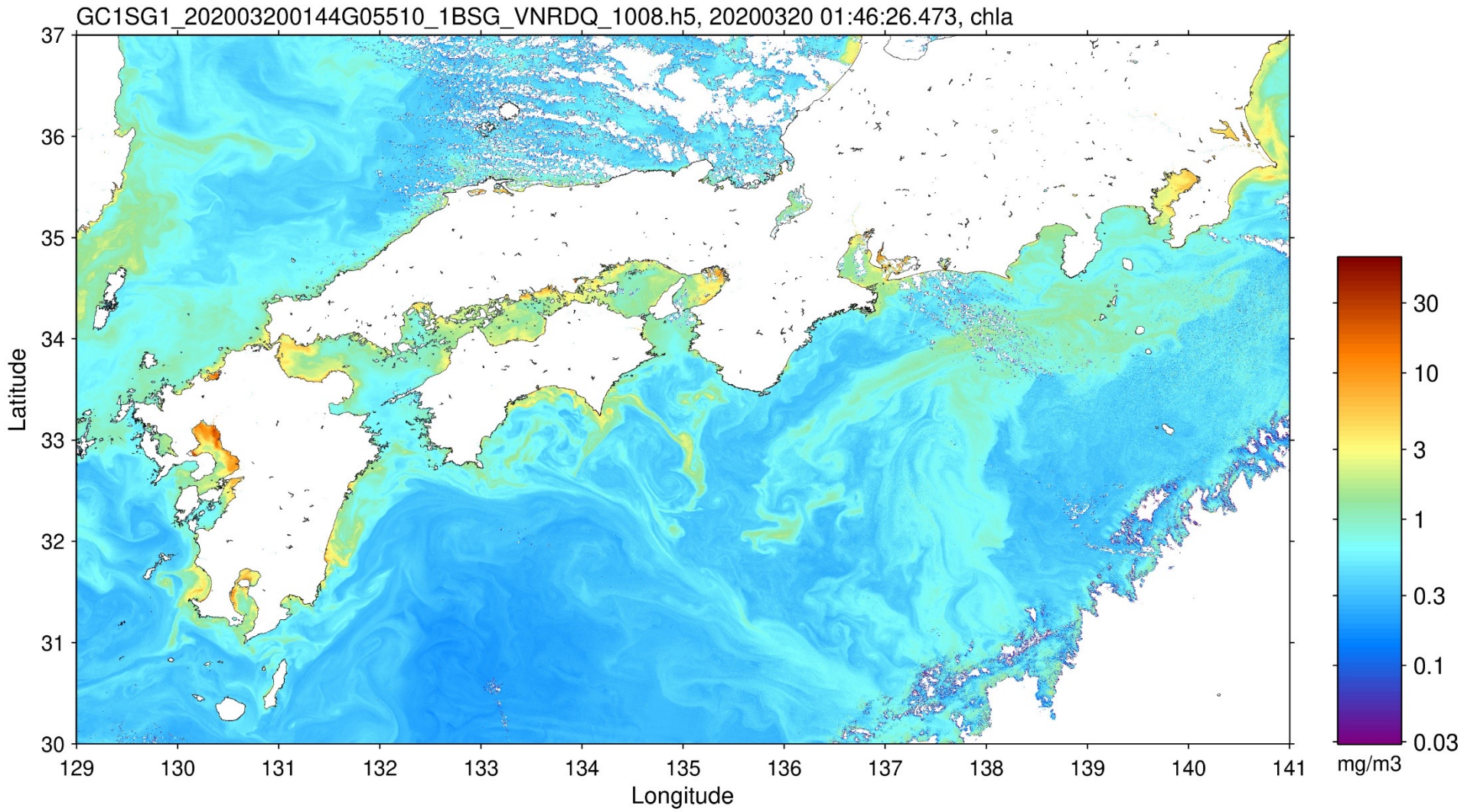
Influence of offset correction on Chl-a image

Input: VNRDQ_1008, corr: old



Influence of offset correction on Chl-a image

Input: VNRDQ_1008, corr: new (bias correction)

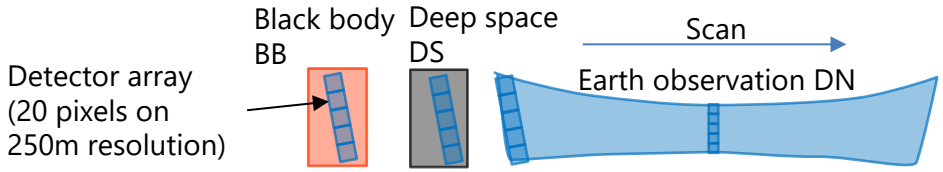


SGLI-IRS/TIR cross track stripe noise reduction

SGLI-TIR image tend to have cross-track stripe due to the cross-track direction scan by array of 20 (250m) or 5 (1km) detectors and remaining detector normalization error (Offset and Gain) after the and black body - deep space calibration

1. A reference smooth image is prepared by running mean of 20×20 pixels in the ocean area excluding large scattered values
2. Correction coefficients are calculated for seven line-blocks in a scene having overlaps of +1 and -1 blocks
    1. Correction ratio of c_1 is calculated by comparing target detectors and the reference image at the same location

       $L_{corr}(pixel, line) = c_1(detector(line)) * L_{org}(pixel, line)$
    2. Normalizing c_1 for the detector average to be 1.0
3. Applying c_1 by interpolating from the center lines of neighboring blocks to the target lines (applied when the target pixels their radiance level are within the level of c_1 calculation samples)



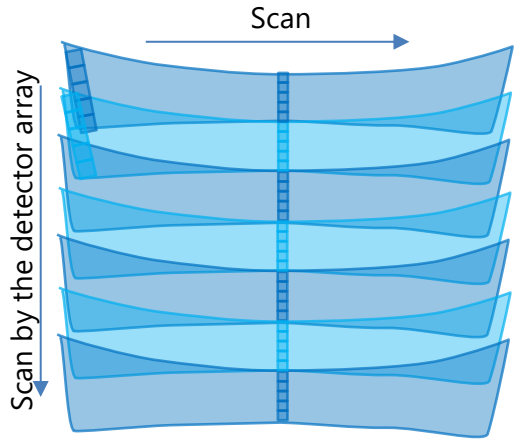
- TOA radiance (L) is calculated by Offset and Gain estimated by two points: deep space (DS) and black body (BB) radiance (BR) calculated from BB temperature Bb_{temp} each scan
- **L = (DN' – DS') * Gain**

  $DN' = \Sigma_{k=0,4}(G_0(k)*DN^k)$: non-linearity correction

  $DS' = \Sigma_{k=0,4}(G_0(k)*DS^k)$

  $BB' = \Sigma_{k=0,4}(G_0(k)*BB^k)$

  $Gain = BR(BB_{temp})/(BB' - DS')$



TIR Calibration

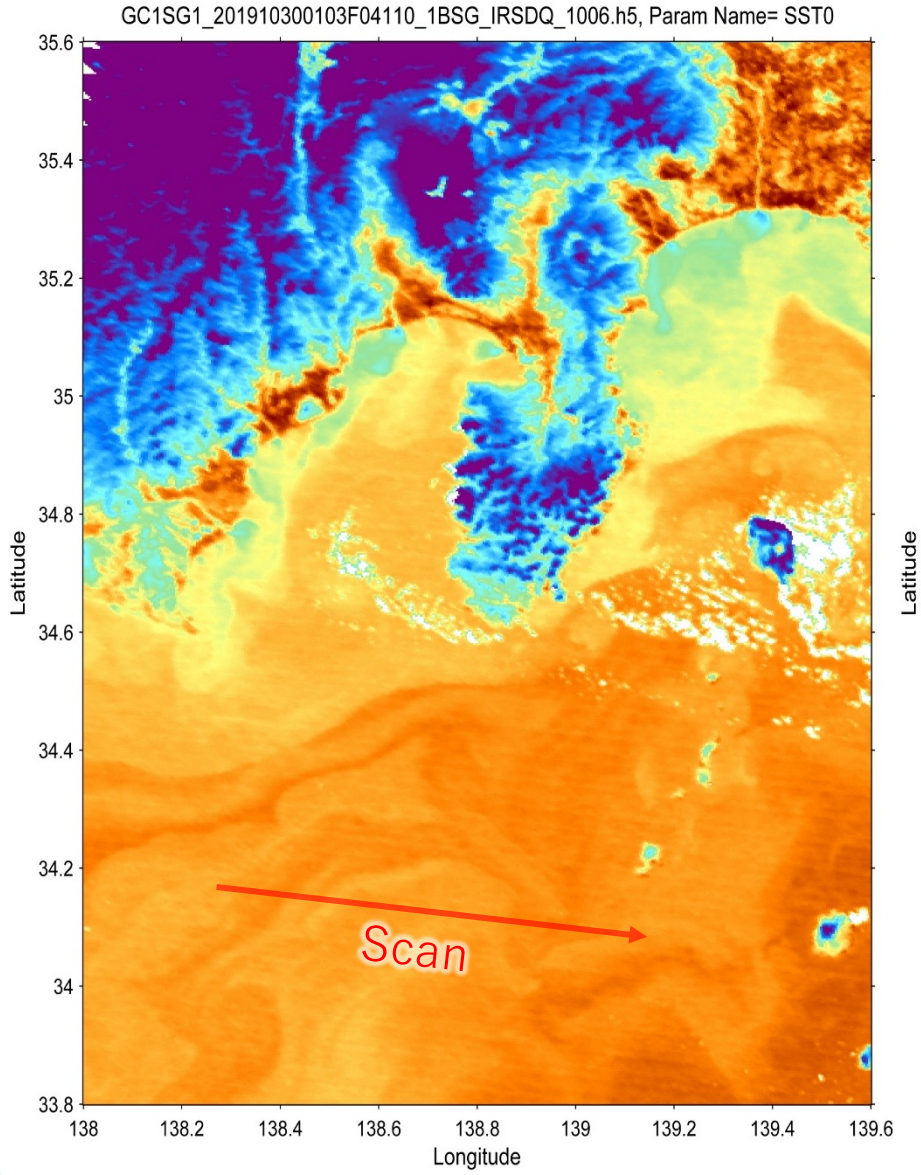
L1B scene

- ✓ Cross-track stripe noise can be caused by errors of Offset or detector Gain each scan
- ✓ The stripe noise can be modulated by L1B resampling

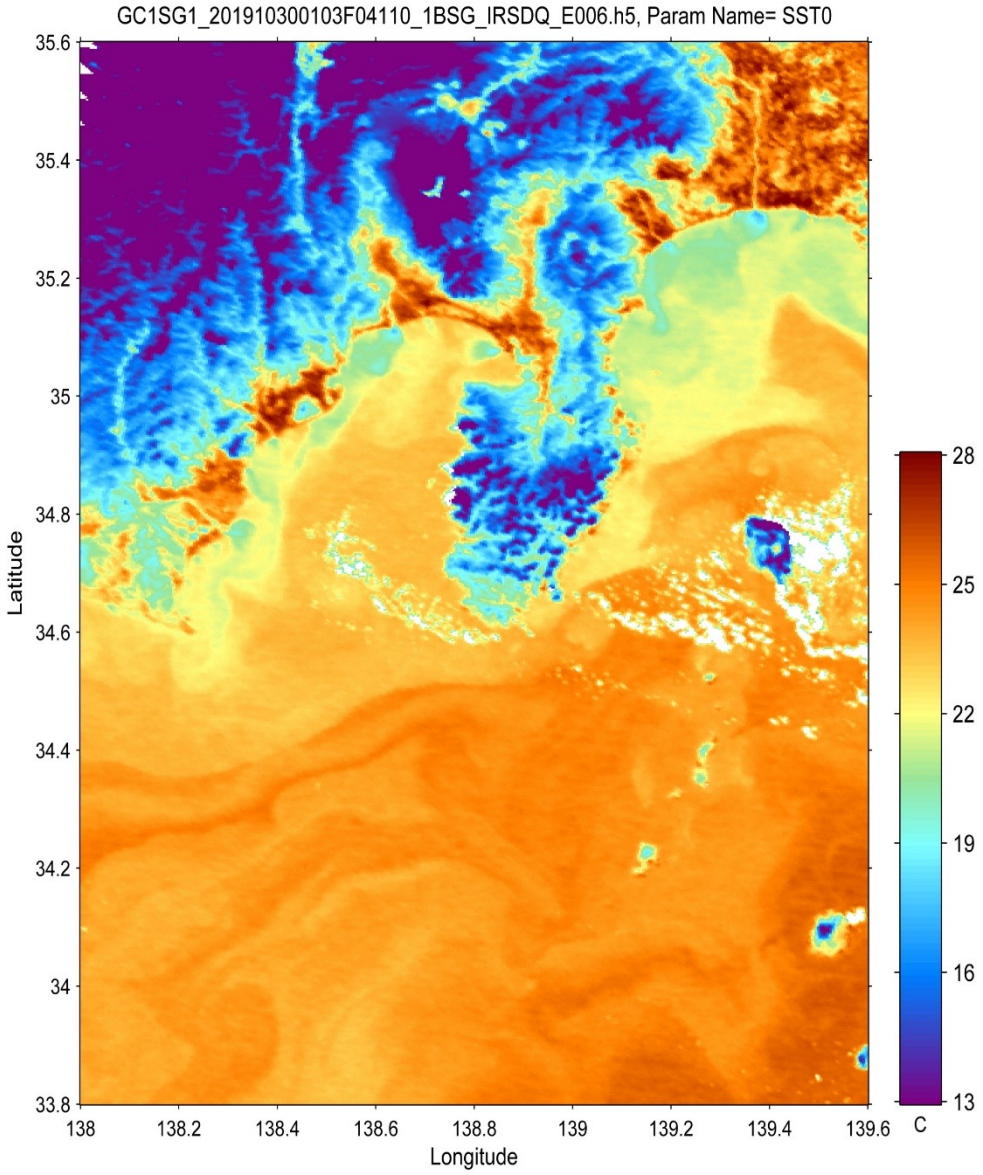
Mapping to L1B standard grid
(select a pixel if overlapped)

An example of the TIR detector normalization

SST (2019/10/30) before correction



SST (2019/10/30) after correction



Summary

- ✓ The offset changes can cause stripe noise (detector normalization error) and calibration bias (generally small but significant for the long-term timeseries analysis)
- ✓ Dark Signal (DS) can be changed due to the space ray (short term) and temporal changes of the detectors (long term)
- ✓ Continuous effort of offset calibration is important especially for the line sensor because the Earth View (EV) detectors cannot frequent see the deep space: selection of DS detector, and the table of difference between DS and EV detectors