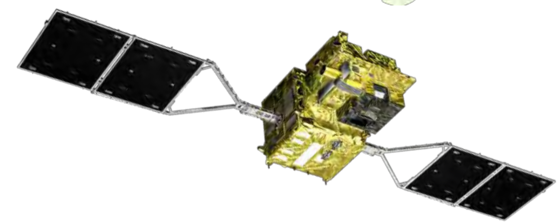

Updates on the calibration status of SGLI

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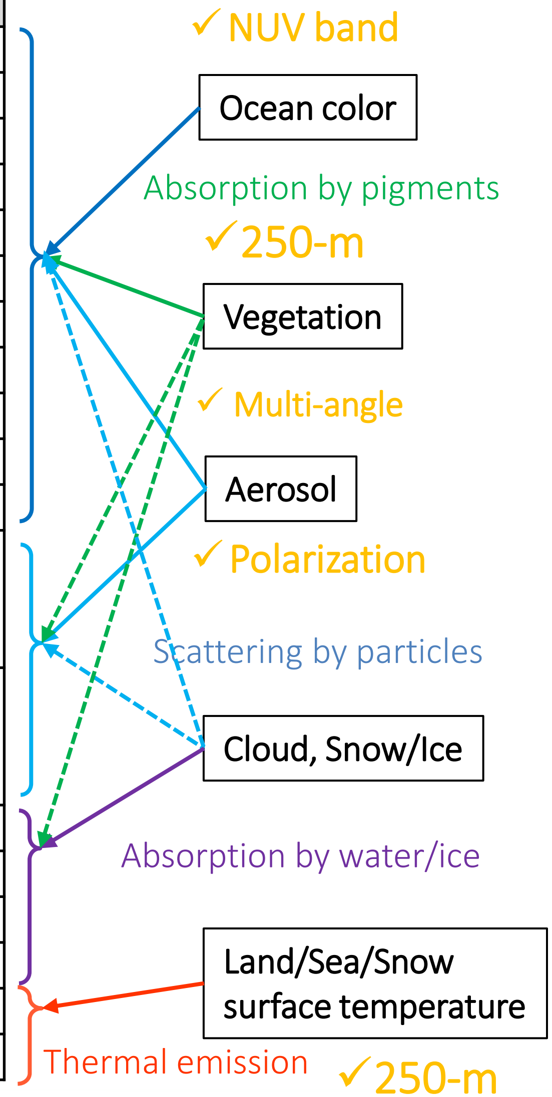
JAXA/EORC

IOCCG calibration task force workshop

4 Feb. 2022

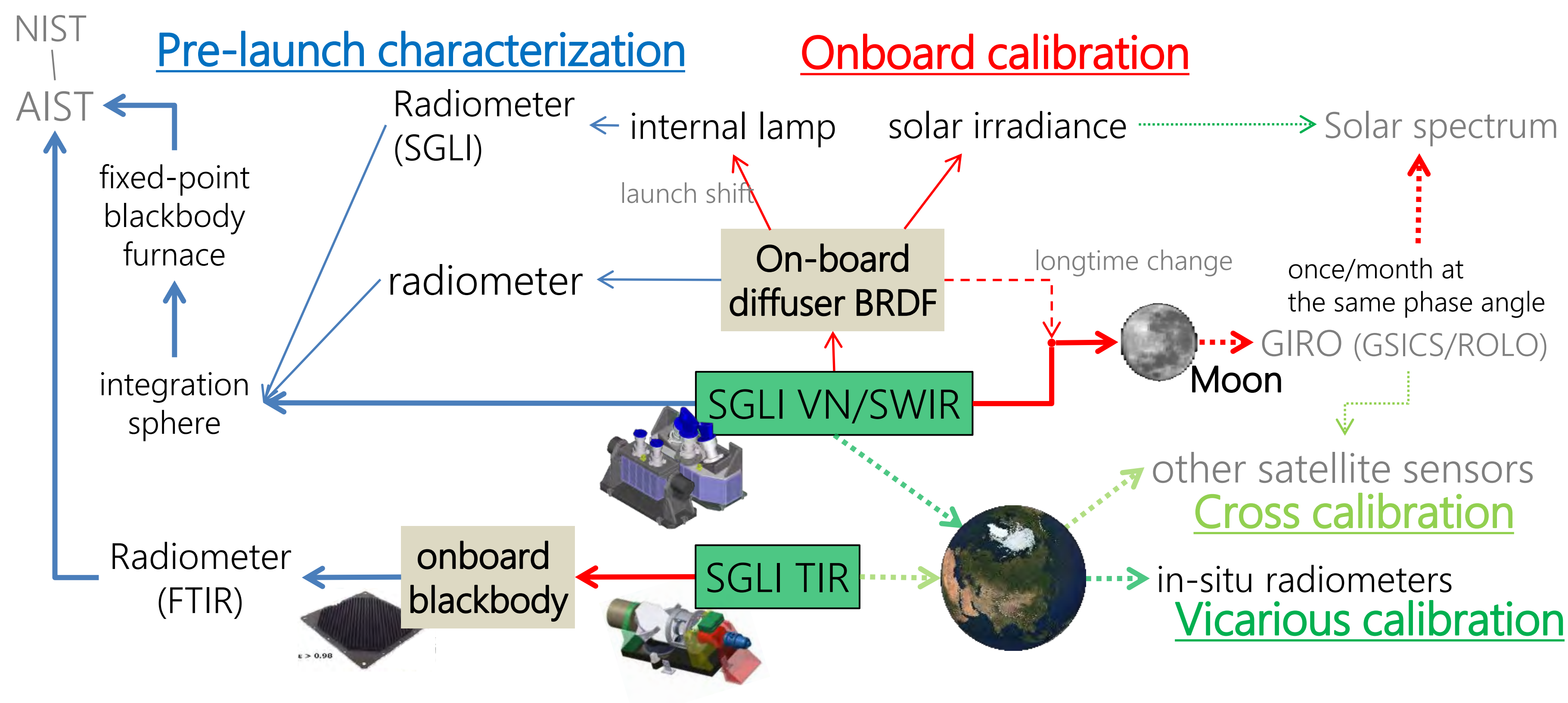
1. GCOM-C/SGLI: observation channels

Sub-system	channel	Center wavelength	width	Standard radiance	Saturation radiance	SNR	Pixel size
		nm		W/m^2/sr/μm or Kelvin		TI: NEΔT	m
Visible and Near Infrared Radiometer (VNR)	VN01	379.9	10.6	60	240-241	624-675	**250**/1000
	VN02	412.3	10.3	75	305-318	786-826	**250**/1000
	VN03	443.3	10.1	64	457-467	487-531	**250**/1000
	VN04	490.0	10.3	53	147-150	858-870	**250**/1000
	VN05	529.7	19.1	41	361-364	457-522	**250**/1000
	VN06	566.1	19.8	33	95-96	1027-1064	**250**/1000
	VN07	672.3	22.0	23	69-70	988-1088	**250**/1000
	VN08	672.4	21.9	25	213-217	537-564	**250**/1000
	VN09	763.1	11.4	40	351-359	1592-1746	250/**1000**
	VN10	867.1	20.9	8	37-38	470-510	**250**/1000
	VN11	867.4	20.8	30	305-306	471-511	**250**/1000
	PL01 +60	672 .2	20.6	25	295	609	**1000**
	PL01 +0				315	707	
	PL01 –60				293	614	
	PL02 +60	866.3	20.3	30	396	646	**1000**
	PL02 +0				424	763	
	PL02 –60				400	752	
Infrared Scanner (IRS)	SW01	1050	21.1	57	289.2	951.8	**1000**
	SW02	1390	20.1	8	118.9	347.3	**1000**
	SW03	1630	195.0	3	50.6	100.5	**250**/1000
	SW04	2210	50.4	1.9	21.7	378.7	**1000**
	TI01	10785	756	300K	340K	0.08K	**250**/500/1000
	TI02	11975	759	300K	340K	0.13K	**250**/500/1000



Cited from Okamura et al., 2018. SNR is defined at the standard radiance and IFOV shown by bold characters

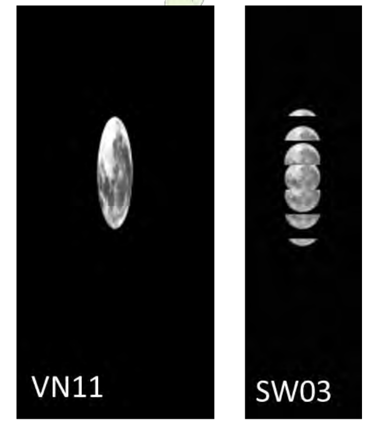
2. GCOM-C/SGLI radiometric calibration system



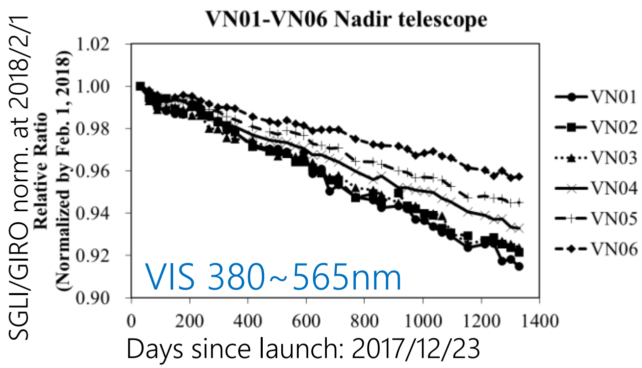
- ✓ Post-launch Level-1 calibration will be based on the onboard calibration with sensor model developed by the pre-launch characterization
- ✓ Vicarious and cross calibration will be used for confirmation of the onboard calibration, and more accurate calibration (adjustment) required for the L2 algorithms

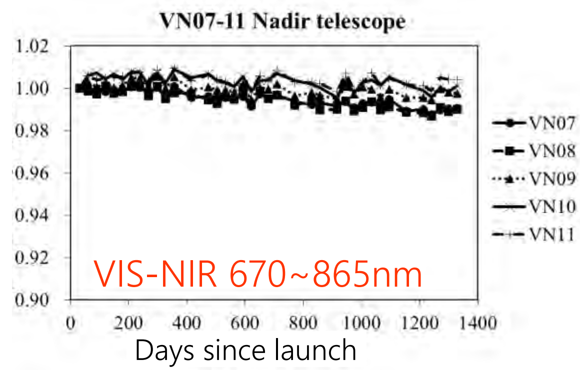
3. SGLI Lunar CAL by GIRO

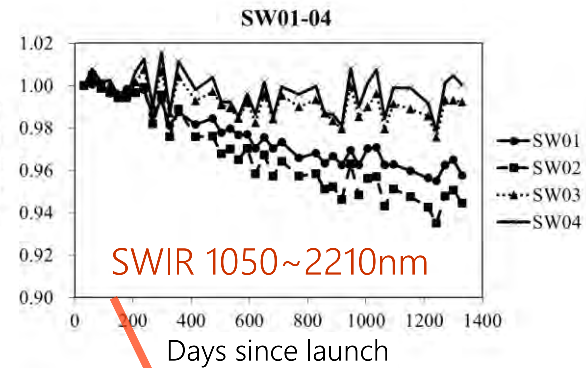
- ✓ GCOM-C SGLI lunar calibration is regularly updated by the monthly lunar observations (by the pitch maneuver; 58 times in 2018-2021) with GIRO
- ✓ The SGLI/GIRO trends are consistent with ones from the other onboard and vicarious calibrations
- ✓ Phase angle (+5~+10 degree) dependency is evaluated by AHI lunar observations at various phase angles



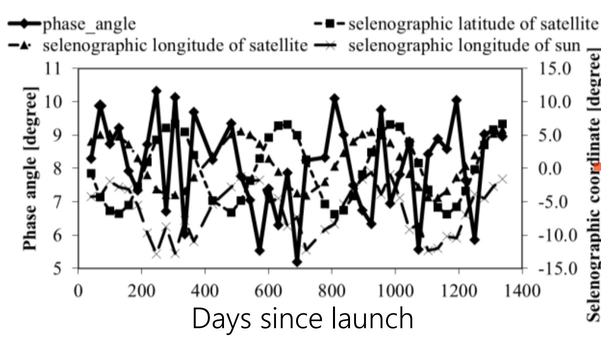
Time series of SGLI/GIRO trend (Normalized by 2018/2/1)



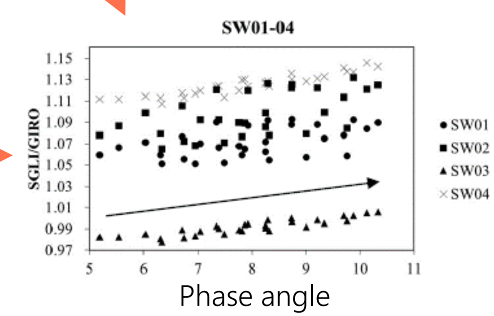




Phase angle of the moon observations



Phase angle dependency (SWIR)



- Urabe, T., Xiong, X., Hashiguchi, T., Ando, S., Okamura, Y., Tanaka, K. (2020) Radiometric Model and Inter-Comparison Results of the SGLI-VNR On-Board Calibration, Remote Sensing, 12(1), 69. DOI: [10.3390/rs12010069](10.3390/rs12010069)
- Urabe, T., Xiong, X., Hashiguchi, T., Ando, S., Okamura, Y., Tanaka, K., Mokuno M., (2019) Lunar Calibration Inter-Comparison of SGLI, MODIS and VIIRS, Proc. of IEEE/IGARSS, pp. 8481-8484 (28 July 2019) DOI: 10.1109/IGARSS.2019.8897892

3. SGLI Lunar CAL by GIRO

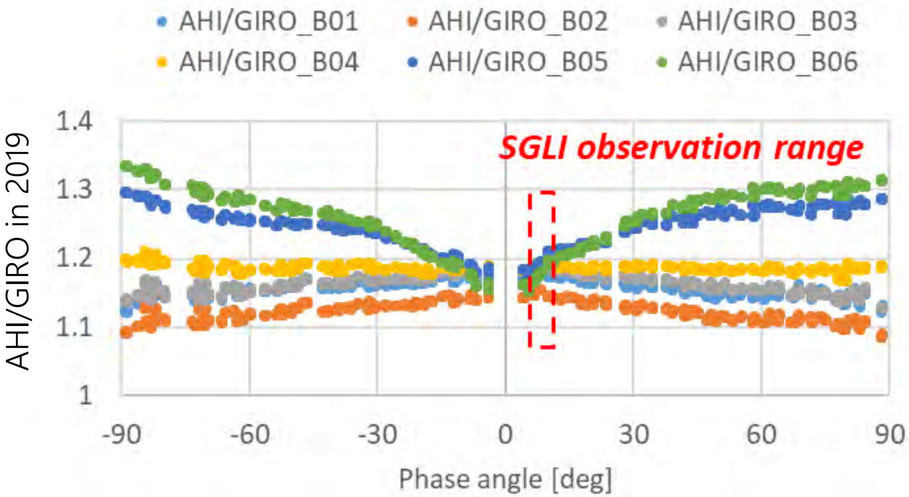
GCOM-C
Global Change Observation Mission-Climate

- ✓ The gain degradation could be separated from the phase angle dependency by the simple multi regression model:

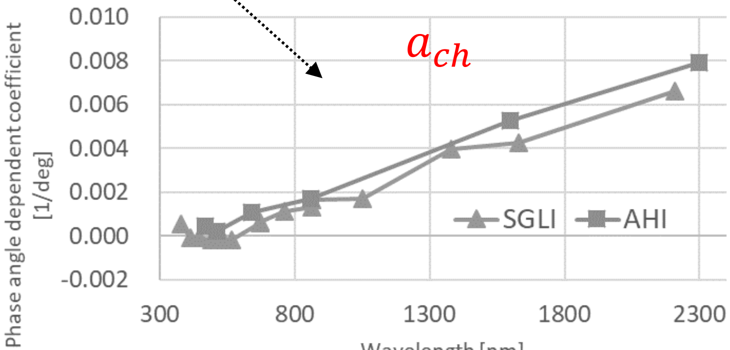
$$f_{ch,n} = a_{ch} \times g_n + b_{ch} \times d_n + c_{ch}$$

f : SGLI/GIRO trend
g : phase angle (deg)
d : days since launch
n : index of each lunar observation
a_{ch}: phase angle dependent coefficient
b_{ch}: sensor degradation coefficient
c_{ch}: constant

- ✓ The phase angle dependency of SGLI were confirmed by comparing with one of Himawari-8 AHI/GIRO



✓ Consistent between SGLI and AHI



AHI Lunar data are provided by JMA/MSC

- ✓ **The gain degradation, $b_{ch} \times d$, has been considered in Ver.2 SGLI Level-1B**

$$L_{L1B}(\lambda) = L_{orig}(\lambda) \,/\, (1.0 + b_{ch}(\lambda) \times d)$$

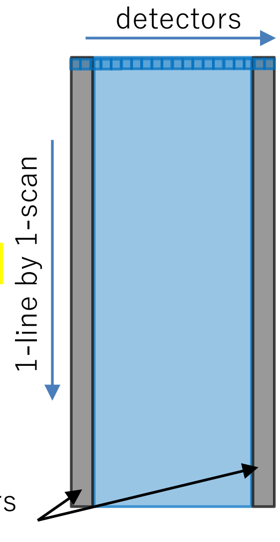
Hashiguchi et al., SGLI Lunar Calibration Evaluation, 3rd Lunar Calibration Workshop, November 17, 2020,
https://suzaku.eorc.jaxa.jp/GCOM_C/resources/files/17a_TaichiroHashiguchi_GCOM-C_SGLI_201117.pdf

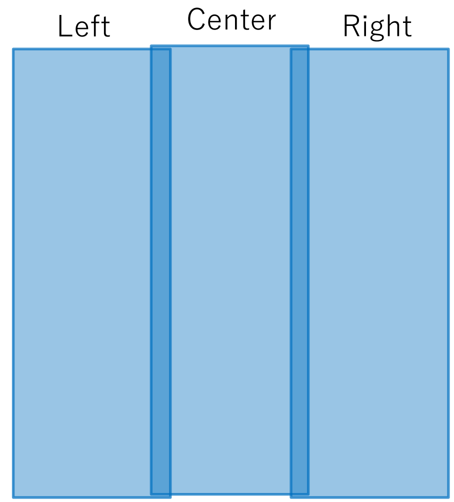
4. Image quality: possible noise pattern

VNR-NP/PL

- **Offset** is estimated from the mask detectors by each scan
- Difference between the mask detectors and observation detectors (DSNU) are updated by nighttime obs. /half year
- **Gain** is modeled by the pre-launch tests

L ~ (DN – Offset)*Gain



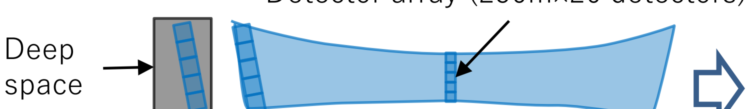


Connect the 3-telescopes at the center of overlaps

L1B scene

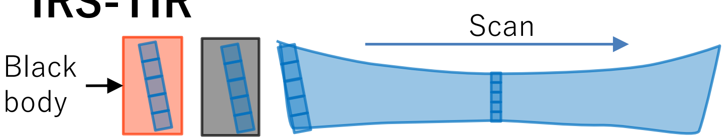
- ✓ Line stripes can be caused from the offset noise
- ✓ Column stripes can be from the static noise of gain and offset (DSNU)
- ✓ 1/3 gap can be from the 3-telescope difference (gain, spectral response..)

IRS-SWIR

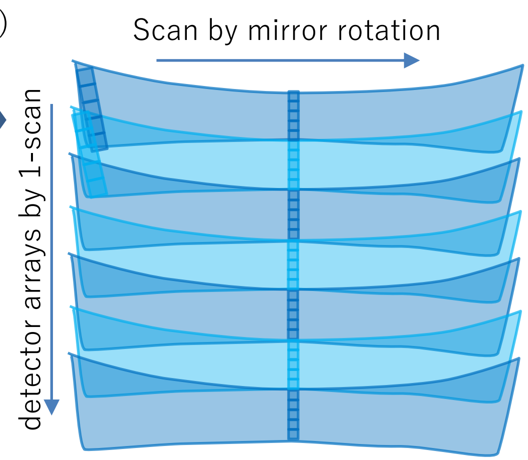


- **Offset** from the deep space by each scan
- **Gain** by the pre-launch tests

IRS-TIR



- **Offset** and **gain** are estimated from the deep space and black body data by each scan



Resampling to the L1B coordinate
(one detector is selected from the overlaps)

L1B scene

- ✓ Line and array stripes can be cause from the offset and gain noise
- ✓ The stripes change along the pixel due to shift of the pixel selection

✓ The noise can be enhanced in the Level-2 processing when the pixel locations are different (<subpixel) among the channels

Horizontal stripe noise: selection of mask detectors

Observation data

CH_telescope PreSCAN PreOPB PostOPB PostSCAN

	Pre-Scan																		Pre-OPB								Dummy		Post-OPB								Post-Scan																	
	1~20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73~92
VN01_L	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN02_L	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	0	N/A	N/A	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN03_L	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN04_L	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN05_L	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN06_L	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN07_L	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	N/A	N/A	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN08_L	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN09_L	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN10_L	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN11_L	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN01_N	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	0	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN02_N	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN03_N	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN04_N	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN05_N	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN06_N	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	0	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN07_N	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN08_N	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN09_N	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN10_N	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN11_N	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN01_R	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN02_R	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN03_R	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	0	0	N/A	N/A	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN04_R	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN05_R	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN06_R	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN07_R	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN08_R	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	0	N/A	N/A	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN09_R	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN10_R	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A
VN11_R	N/A	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	N/A	N/A	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A

Used detectors Used detectors Used detectors

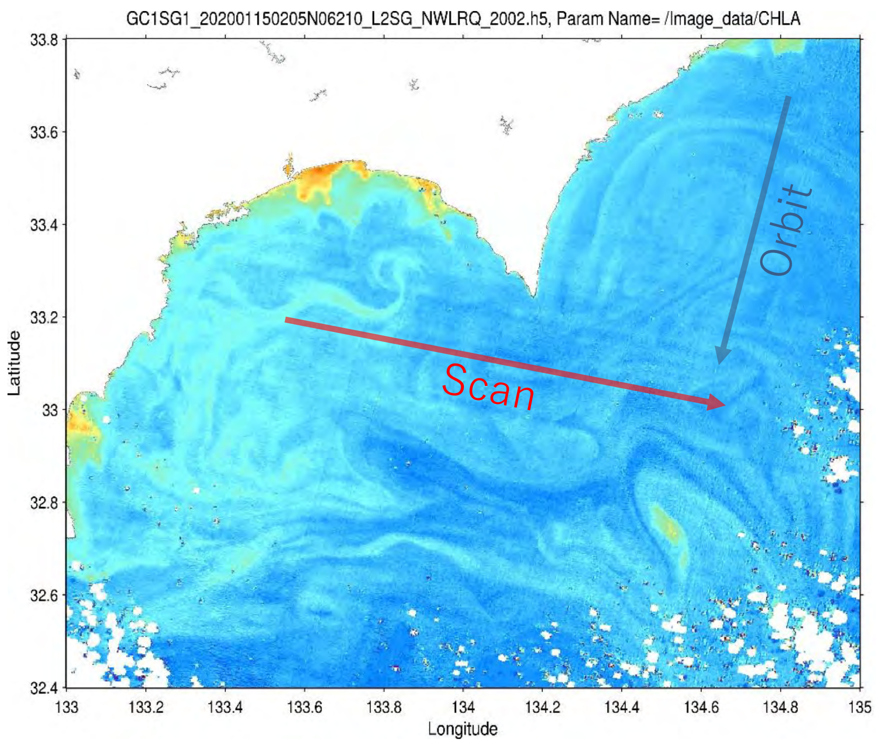
Detectors of red rectangles are used detectors in the old processing (Ver.1)

Gray and Orange detectors are excluded

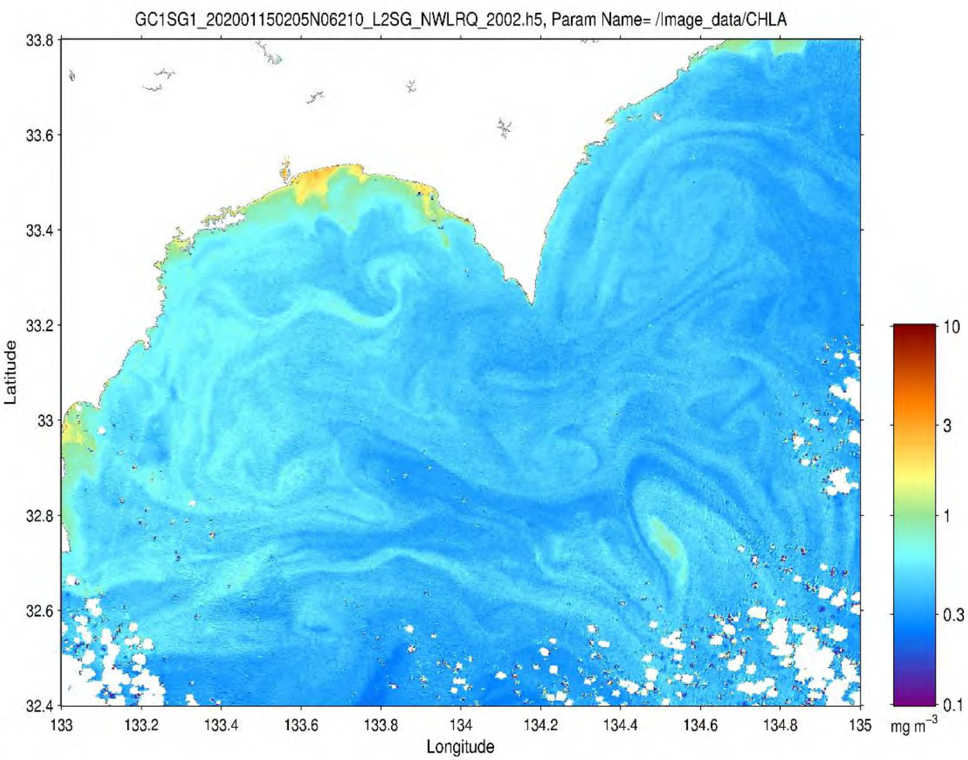
- ✓ Some detectors (especially in Post OPB) used for the offset correction showed <u>variance uncorrelated with the observation detectors</u>; they cause horizontal stripe on the L1B image
- ✓ By excluding the irregular pixels, the horizontal stripe has been improved

Example of SGLI stripe noise

Chl-a test by Ver.1 L1B



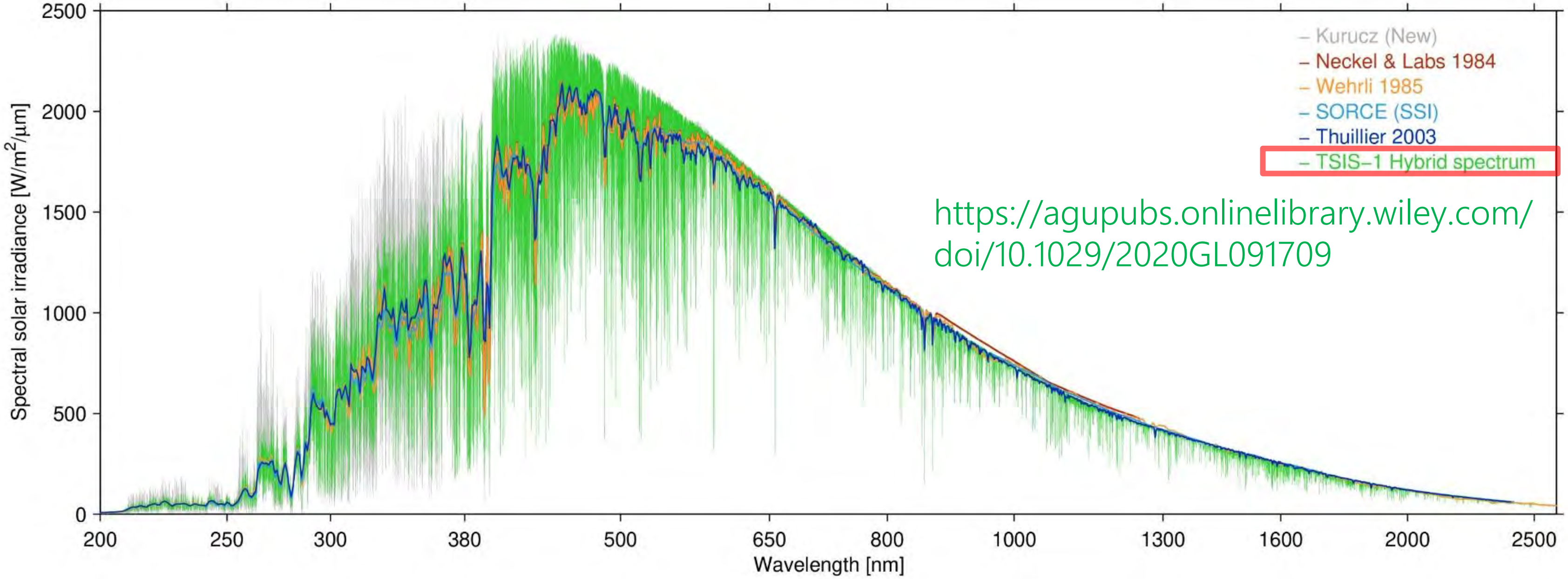
Chl-a test by Ver.2 L1B



Chl-a image off the Shikoku island, Japan on 15 Jan 2020

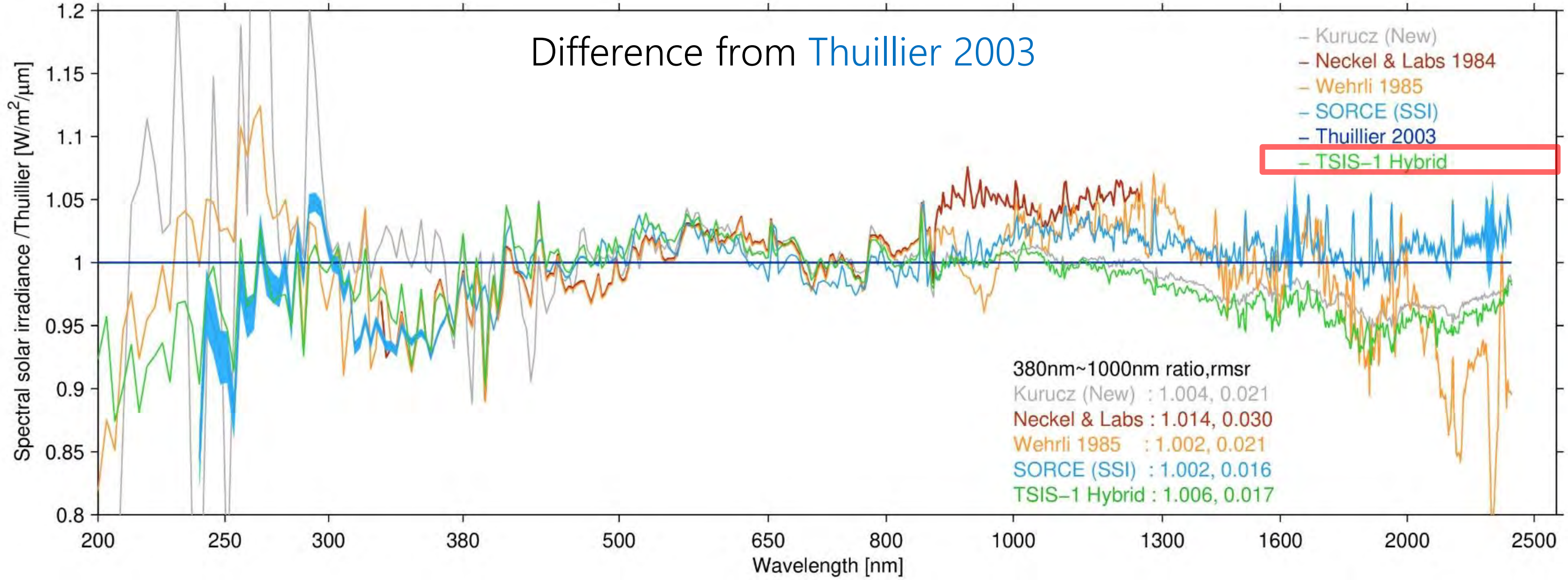
✓ Along track and cross track stripes are improved by the revision of the offset correction (Ver.2)

5. New CEOS recommended Solar Spectral Irradiance Spectrum

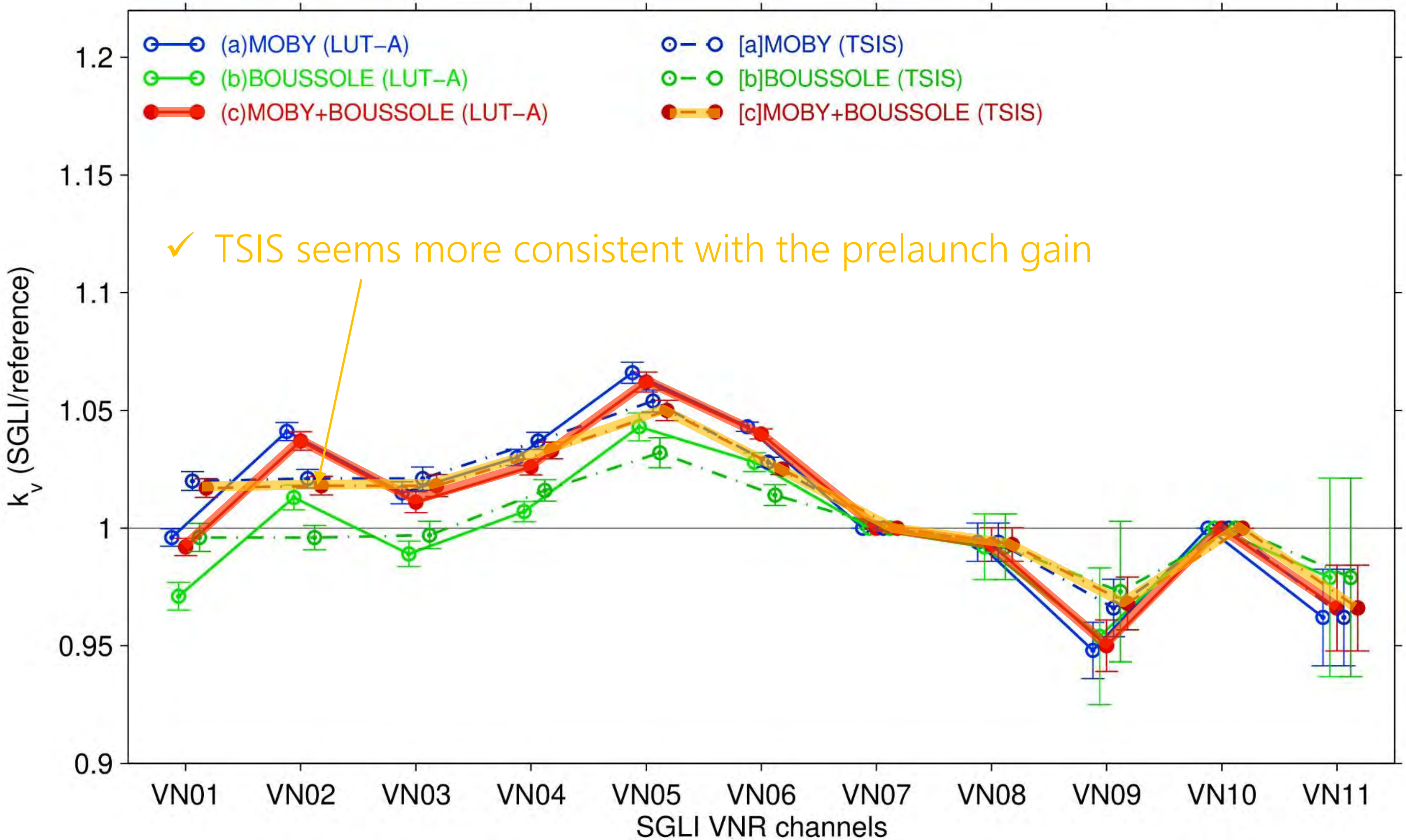


https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2020GL091709

Difference from Thuillier 2003



5. New CEOS recommended Solar Spectral Irradiance Spectrum



- ✓ No influence on the Lunar cal. because we use the temporal change
- ✓ L1B reflectance and vicarious calibration is influenced by the F_0

6. Summary

- ✓ Monthly lunar calibration works well by using GIRO
- ✓ The phase angle dependency has been corrected by lunar observations by the geostationary satellite imager, AHI
- ✓ The temporal change has been corrected in the L1B processing
- ✓ Revision of the offset correction has improved the along track and cross track stripe noise on L1B and OC images
- ✓ The new solar irradiance spectra make smooth spectra of the vicarious calibration: indicating consistency with the pre-launch calibration