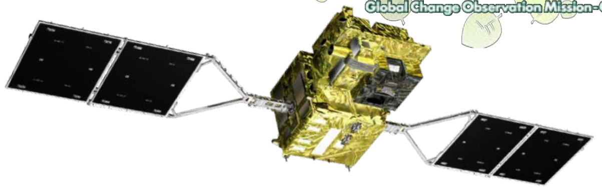

# JAXA GCOM-C research and applications


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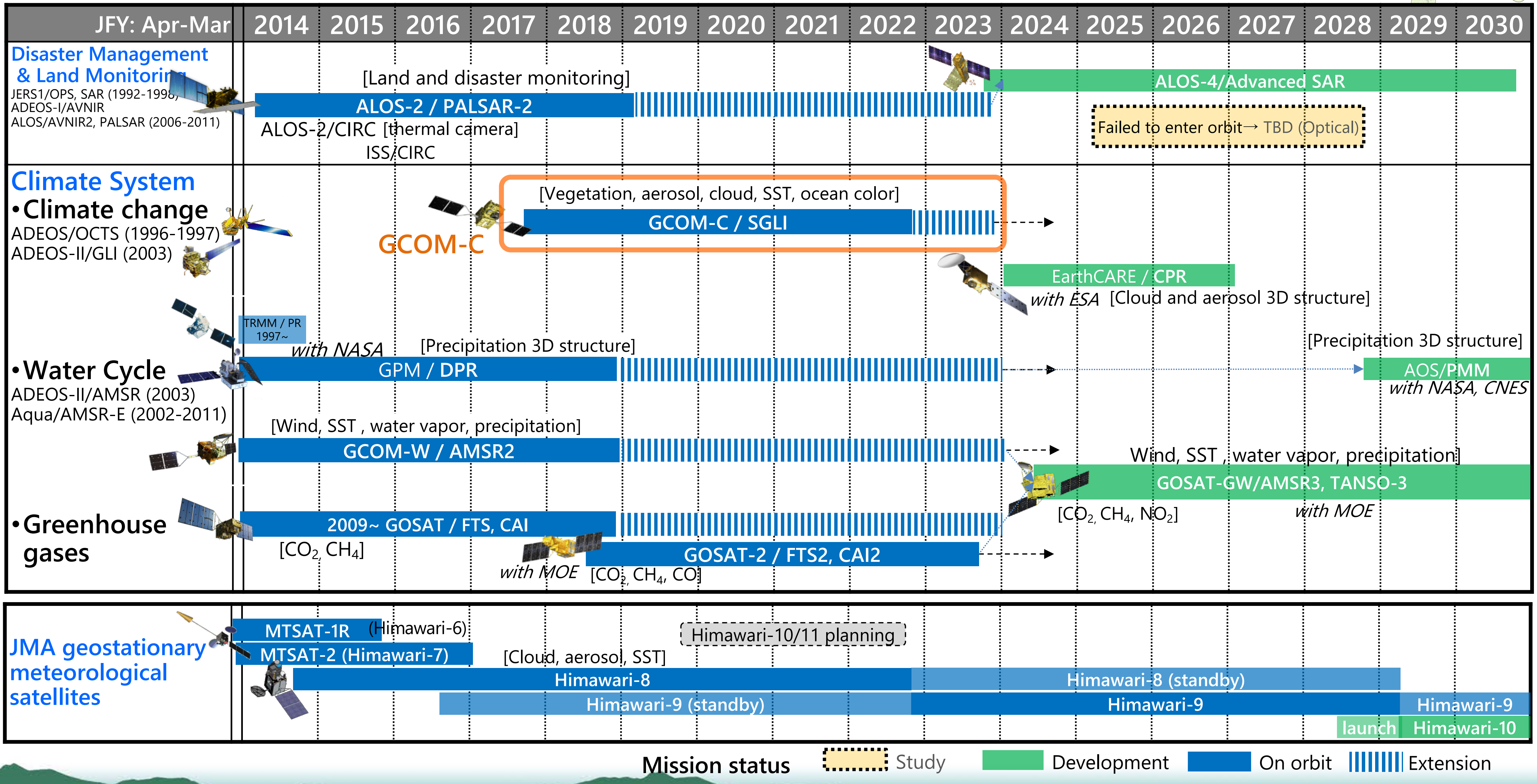
JAXA/EORC


the 5th International Ocean Colour Science (IOCS) Meeting

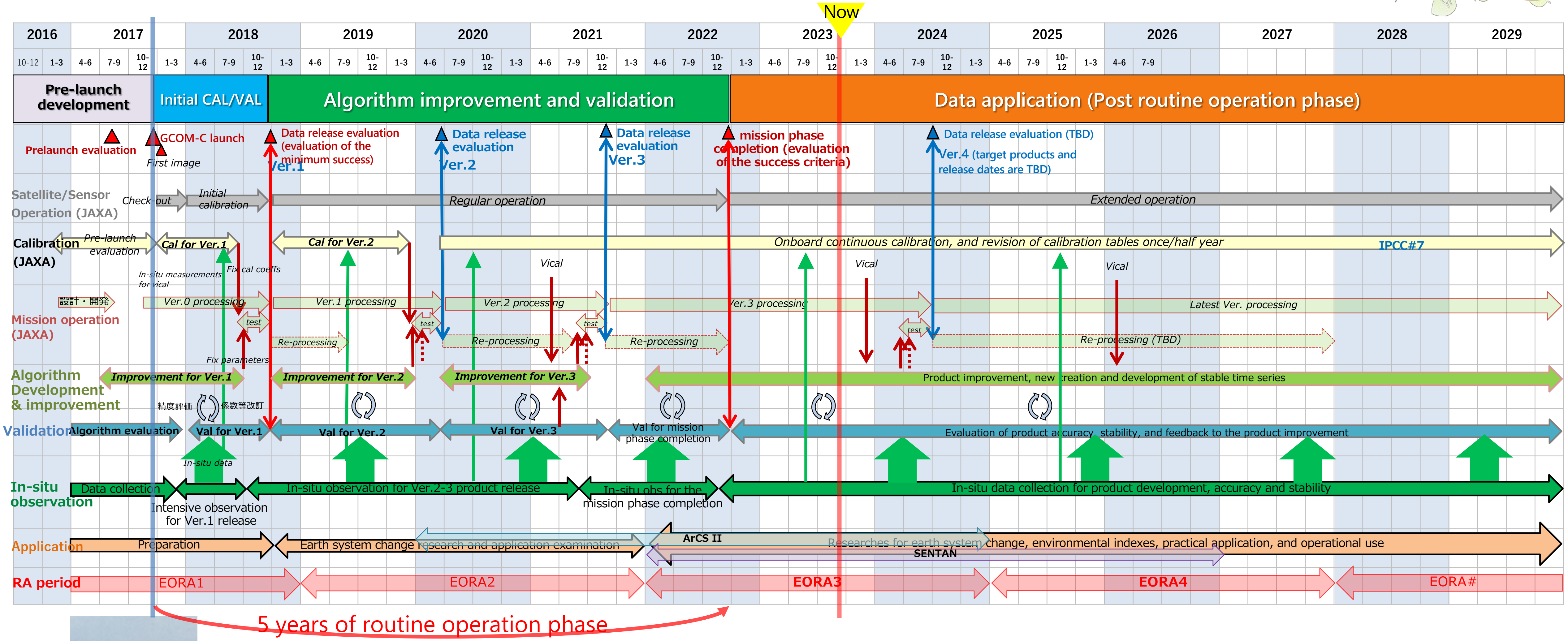
University of South Florida (USF), St. Petersburg Campus

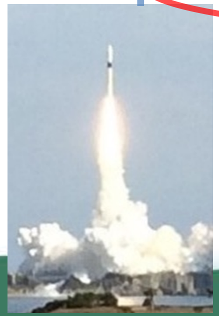
15 Nov. 2023

# 1. Introduction: JAXA Earth observation satellite missions



# 1. Introduction: GCOM-C science mission schedule

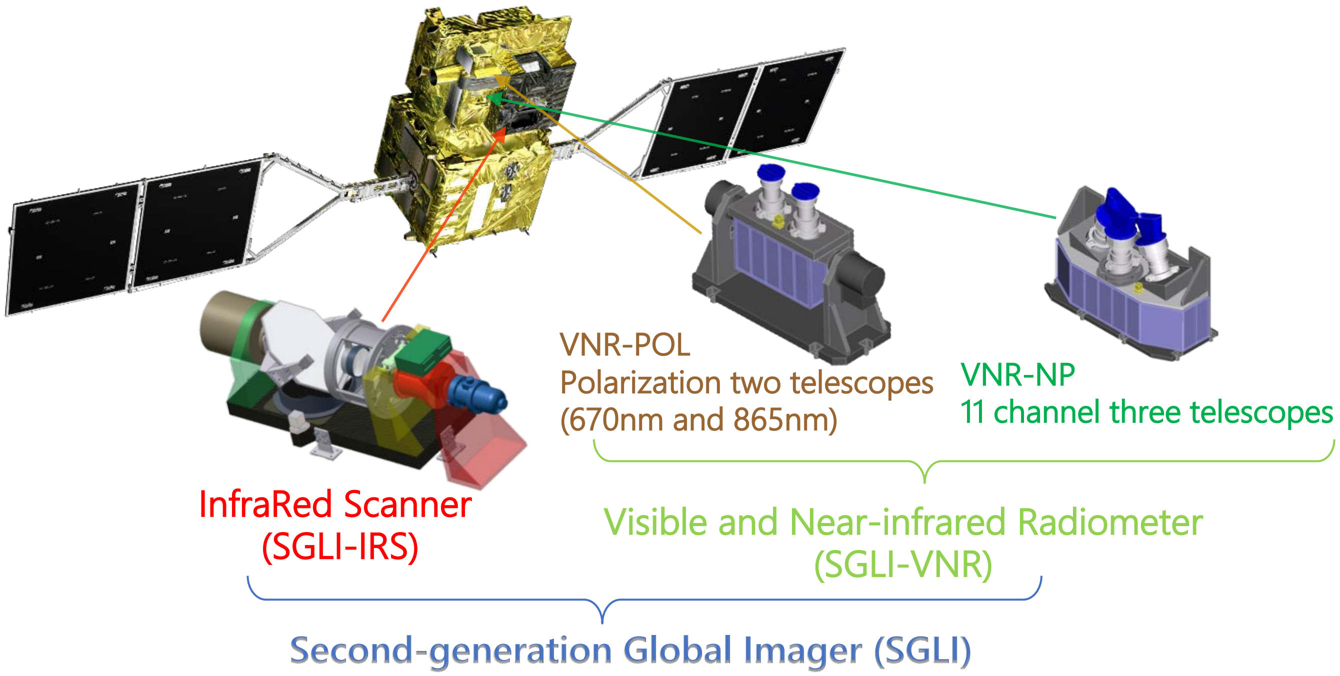


- ✓ In the extension phase, the application researches will be more focused (monitoring of the earth system change, practical application, and connection to the operational uses)
- ✓ Product development/evaluation supporting the applications will be continued

# 1. Introduction: GCOM-C/SGLI

## Global Change Observation Mission – Climate, "SHIKISAI"




| GCOM-C characteristics | |
|---|---|
| Launch Date | 23 Dec. 2017 (data available since 1 Jan 2018) |
| Orbit | Sun-synchronous (descending local time: 10:30am), Altitude: 798km, Inclination: 98.6deg |

| SGLI channel specification | | | | | | | |
|---|---|---|---|---|---|---|---|
| swath | CH | λ | Δλ | $L_{std}$ | $L_{max}$ | SNR@$L_{std}$ | IFOV |
| km | | nm | | W/m²/sr/μm K: Kelvin | | - K: NEΔT | m |
| 1150km (VNR: push-broom electric scan) | VN01 | 380.0 | 10.6 | 60 | 240-241 | 624-675 | 250 /1000 |
| | VN02 | 412.5 | 10.3 | 75 | 305-318 | 786-826 | 250 /1000 |
| | VN03 | 443.2 | 10.1 | 64 | 457-467 | 487-531 | 250 /1000 |
| | VN04 | 489.8 | 10.3 | 53 | 147-150 | 858-870 | 250 /1000 |
| | VN05 | 529.6 | 19.1 | 41 | 361-364 | 457-522 | 250 /1000 |
| | VN06 | 566.2 | 19.8 | 33 | 95-96 | 1027-1064 | 250 /1000 |
| | VN07 | 672.0 | 22.0 | 23 | 69-70 | 988-1088 | 250 /1000 |
| | VN08 | 672.1 | 21.9 | 25 | 213-217 | 537-564 | 250 /1000 |
| | VN09 | 763.1 | 11.4 | 40 | 351-359 | 1592-1746* | 250 /1000* |
| | VN10 | 866.8 | 20.9 | 8 | 37-38 | 470-510 | 250 /1000 |
| | VN11 | 867.1 | 20.8 | 30 | 305-306 | 471-511 | 250 /1000 |
| | PL01 | 671.9 | 20.6 | 25 | 293 | 609 | 1000@nadir |
| | PL02 | 866.2 | 20.3 | 30 | 396 | 646 | 1000@nadir |
| 1400km (IRS: whisk-broom) | SW01 | 1055 | 21.1 | 57 | 289.2 | 951.8 | 1000 |
| | SW02 | 1385 | 20.1 | 8 | 118.9 | 347.3 | 1000 |
| | SW03 | 1635 | 195.0 | 3 | 50.6 | 100.5 | 250 /1000 |
| | SW04 | 2209 | 50.4 | 1.9 | 21.7 | 378.7 | 1000 |
| | TI01 | 10793 | 756 | 300K | 340K | 0.08K | 250/500/1000 |
| | TI02 | 11956 | 759 | 300K | 340K | 0.13K | 250/500/1000 |

https://suzaku.eorc.jaxa.jp/GCOM_C/data/prelaunch/index.html

- ✓ **SGLI has 250-m spatial resolution with 1150-1400 km swath and 19 channels in 0.38-12 μm wavelengths including 2 polarization channels**

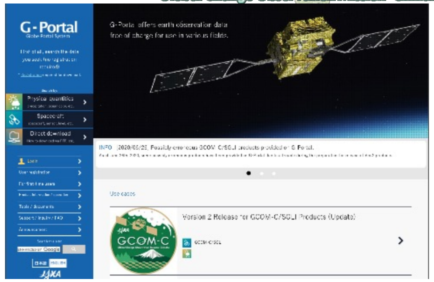
# 1. Introduction: GCOM-C Principal Investigators (EORA3: JFY2022-2024)

| | PI Name | Affiliation |
|---|---|---|
| Land | Yoshiaki HONDA | Chiba Univ. |
| | Kenlo Nasahara | Tsukuba Univ. |
| | Hideki KOBAYASHI | JAMSTEC |
| | Tatsuro Nakaji | Hokkaido Univ. |
| | Wei Yang | Chiba Univ. |
| | Masao MORIYAMA | Nagasaki Univ. |
| | Noriko SOYAMA | Tenri Univ. |
| | Masahiro Tasumi | Miyazaki Univ. |
| | Takayuki KANEKO | Tokyo Univ. ERI |
| | Masataka TAKAGI | Kochi Univ. of Technology |
| Atmosphere | Takashi Nakajima | Tokai Univ. |
| | Kentaroh Suzuki | Tokyo Univ. AORI |
| | Hironobu Iwabuchi | Tohoku Univ. |
| | Hiroshi Ishimoto | JMA MRI |
| | Sonoyo Mukai | The Kyoto College of Graduate Studies for Informatics |
| | Miho Sekiguchi | Tokyo Univ. of Marine Science and Technology |
| | Makoto KUJI | Nara Women's Univ. |
| | Hitoshi Irie | Chiba Univ. |
| | Akihiro Yamazaki | JMA MRI |
| | Kazuma Aoki | Toyama Univ. |
| | Pradeep Khatri | Tohoku Univ. |
| | Hiroshi Kobayashi | Yamanashi Univ. |
| | Jérôme RIEDI | Université de Lille |

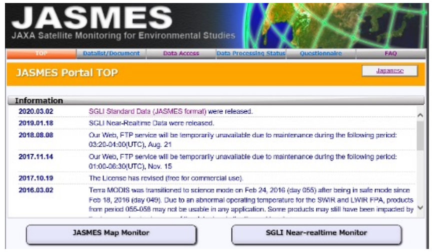
| | PI Name | Affiliation |
|---|---|---|
| Ocean | Toru Hirawake | NIPR |
| | Hiroto Higa | Yokohama National Univ. |
| | Takafumi Hirata | Hokkaido Univ. |
| | Joji Ishizaka | Nagoya Univ. |
| | Shintaro Takao | NIES |
| | Robert J. Frouin | Scripps Institution of Oceanography |
| | David Antoine | Curtin Univ. |
| | Victor S. Kuwahara | Soka Univ. |
| | Eko Siswanto | JAMSTEC |
| | Joaquim I. Goes | Columbia Univ. |
| | Fumihiro Takahashi | Green & Life Innovation, Inc |
| | Menghua Wang | NOAA/NESDIS/STAR |
| | Lachlan McKinna | Go2Q Pty Ltd |
| Cryosphere | Masahiro Hori | Toyama Univ. |
| | Teruo Aoki | NIPR |
| | Knut Stamnes | Stevens Institute of Technology |
| Multiple mission | Keiya Yumimoto | Kyusyu Univ. |
| | Daisuke Goto | NIES |
| | Sei-Ichi Saitoh | Digital Hokkaido |
| | Tomonori Isada | Hokkaido Univ. |
| | Atsushi Matsuoka | Univ. New Hampshire |
| | Takemasa Miyoshi | RIKEN |
| | Kaoru Tachiiri | JAMSTEC |
| | Naohiko Hirasawa | NIPR |

# 1. Introduction: GCOM-C Ver. 3 products

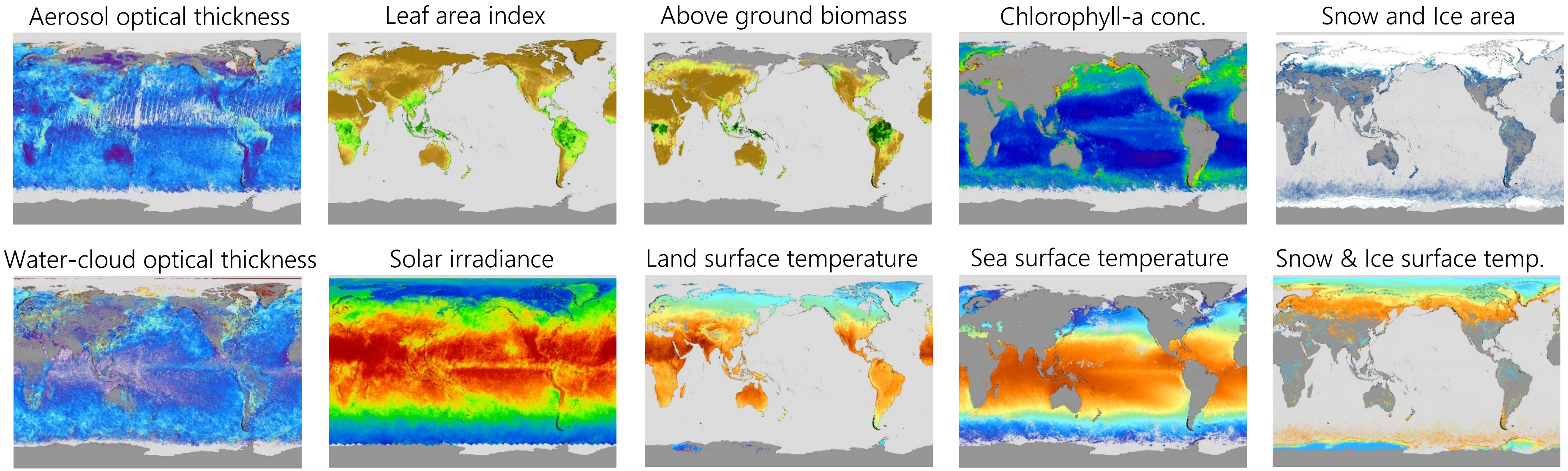
- ✓ Ver.3 standard products (Level-1, 2, and 3 HDF5 format) have been open to the public via JAXA data portal, **G-Portal** (search and direct SFTP)
- ✓ Reprocessing status: https://shikisai.jaxa.jp/status_v3_en.html
- ✓ Some products are available via JAXA multi-sensor data site, **JASMES** (binary or NetCDF)
- ✓ Validation by in-situ observations and other satellites https://suzaku.eorc.jaxa.jp/GCOM_C/data/validation.html




https://gportal.jaxa.jp/gpr/



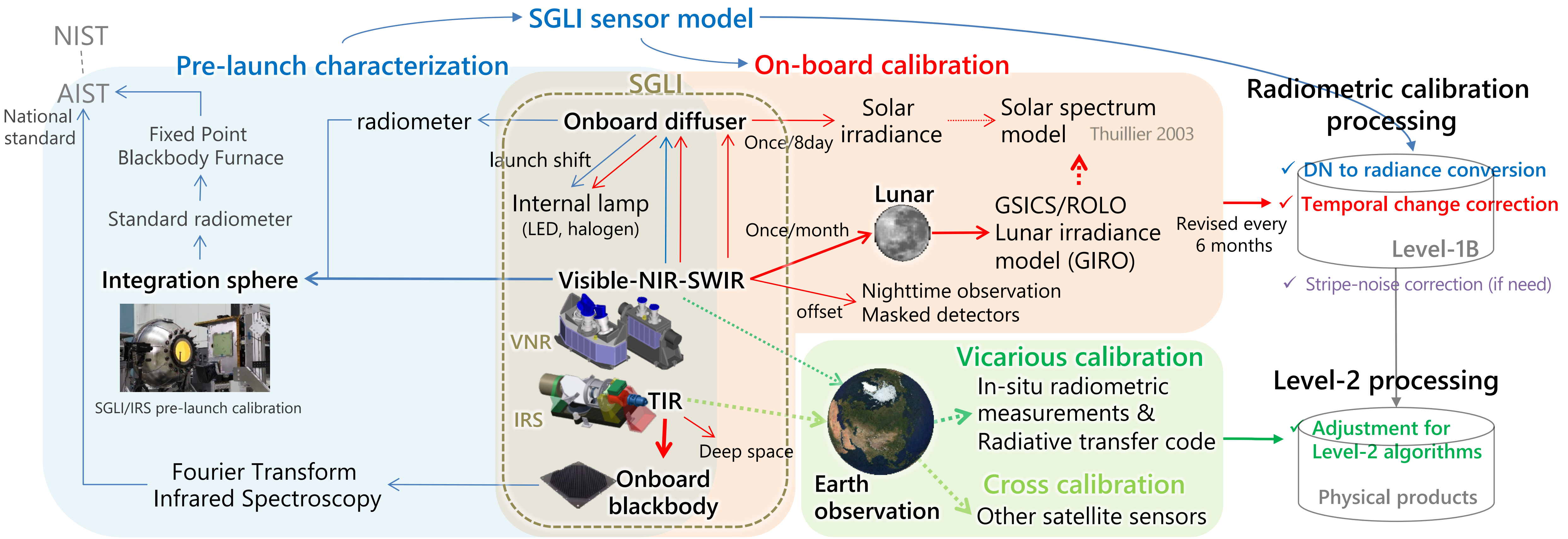

https://kuroshio.eorc.jaxa.jp/JASMES/index.html




Examples of GCOM-C global monthly map (Level-3) April 2022

# 2. Calibration: 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



# 2. Calibration: Key revisions of post-launch SGLI calibration

**Calibration tables** (revised every 6 months)

(a) Temporal change of Gain

(b) VNR DS pixel-selection tables

(c) VNR offset difference from DS offset

(d) TIR onboard TDI pixel selection

**Calibration coefficients from each observation**

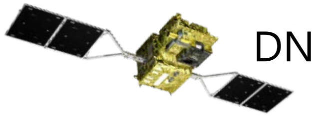
- VNR Offset from Dark Signal (DS) detectors
- Deep space (SW+TIR) and black body (TIR)

(e) Statistical normalization of inter-telescope diff. (VNR)

(f) Statistical normalization of TIR detector gains

**Post-launch calibration analysis**

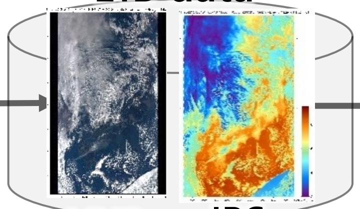
- Lunar calibration by ROLO (VNR, SW)
- DS detectors on the array edges
- VNR Offset calibration by nighttime observation
- TIR raw detector health check
- Internal lamp and solar calibration (VNR, SW)
- Evaluation of stray light (earth and lunar observations)
- Inter-channel comparison
- Polarization sensitivity
- Vicarious and cross calibration (VNR, SW, TIR)



DN → Level-1 processing → L1B data → L2 processing

(TOA radiance L = (DN – Offset) * Gain)

L1B data

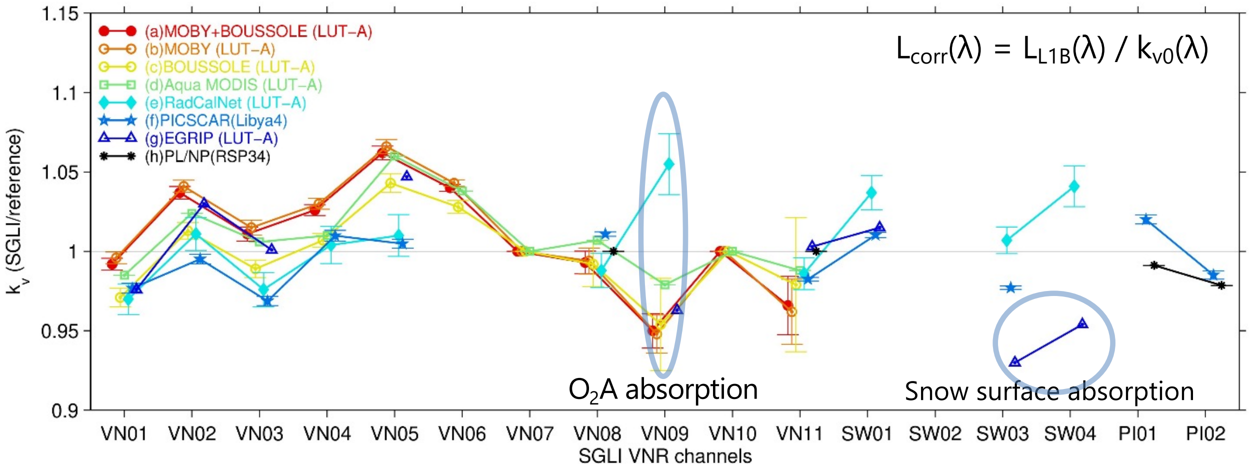


# 2. Calibration: Vicarious calibration

- SGLI vicarious calibration uses in-situ reflectance measurements over various surfaces, MOBY, BOUSSOLE, RadCalNet, Ice sheet, etc., (after the temporal change correction in L1B processing)
- The results are confirmed by cross calibration with MODIS $R_{rs}$ over the ocean, and PICSCAR over the desert

✓ Spectral shapes of the coefficients were roughly consistent among the results over the various surfaces (<5% except for absorption channels)

✓ Coefficients by MOBY+BOUSSOLE have applied to the ocean color processing




| λ(nm)(channel) | 380 (VN01) | 412 (VN02) | 443 (VN03) | 490 (VN04) | 530 (VN05) | 566 (VN06) | 672 (VN07) | 672 (VN08) | 763 (VN09) | 867 (VN10) | 867 (VN11) | 1055 (SW01) | 1385 (SW02) | 1635 (SW03) | 2209 (SW04) | 672 (PI01) | 866 (PI02) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| kv0(MOBY+BOUSSOLE N=83) | 0.992 | 1.037 | 1.011 | 1.026 | 1.062 | 1.040 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.991 *2 | 0.979 *2 |
| kv0(MOBY N=69) | 0.996 | 1.041 | 1.015 | 1.030 | 1.066 | 1.043 | 1.0 | 0.994 | 0.948 | 1.0 | 0.994 | | | | | | |
| kv0(BOUSSOLE N=14) | 0.971 | 1.013 | 0.989 | 1.007 | 1.043 | 1.028 | 1.0 | 0.992 | 0.954 | 1.0 | 0.979 | | | | | | |
| kv0(Aqua Rrs N=43621501) | 0.985 | 1.024 | 1.006 | 1.010 | 1.060 | 1.038 | 1.0 | 1.007 | 0.979 | 1.0 | 0.988 | | | | | | |
| kv0(RadCALNet N=226) | 0.967 | 1.009 | 0.979 | 0.994 | 1.015 | | | 0.994 | 1.054 | | 0.991 | 1.033 | | 1.005 | 1.037 | | |
| kv0(PICSCAR Libya4 N=443) | 0.977 | 0.995 | 0.969 | 1.010 | 1.005 | | | 1.011 | | | 0.983 | 1.010 | | 0.977 | | 1.0201 | 0.9851 |
| kv0(EGRIP N=3) | 0.976 | 1.030 | 1.001 | | 1.047 | | | | 0.963 | | 1.003 | 1.015 | | 0.930 | 0.954 | | |

*2 They are derived by comparison of TOA reflectance of the POL nadir path (RSP034) in 2020

https://suzaku.eorc.jaxa.jp/GCOM_C/data/prelaunch/index_cal.html

# 3. Validation: Ver.3 OC products


Validation

Validation activities aim to evaluate the accuracy of geophysical products by comparing in-situ measurements and/or other satellite products with SGLI estimates. These activities will be implemented by effectively using the operational in-situ observations in cooperation with the worldwide meteorological/oceanographical organizations, and by conducting dedicated field observations for particular geophysical variables like chlorophyll-a concentration.

The validation results for each product are the following.

Validation Results of SGLI Standard Products (Level-2)

Version 3.0

- SGLI L2 Product Summary (Eng., PDF 1.2MB)
- SGLI L2 Land Products (Eng., PDF 5.6MB)
- SGLI L2 Atmosphere Products (Eng., PDF 3.6MB)
- SGLI L2 Ocean Products (Eng., PDF 2.7MB)
- SGLI L2 Cryosphere Products (Eng., PDF 1.2MB)

All-in-one package file:

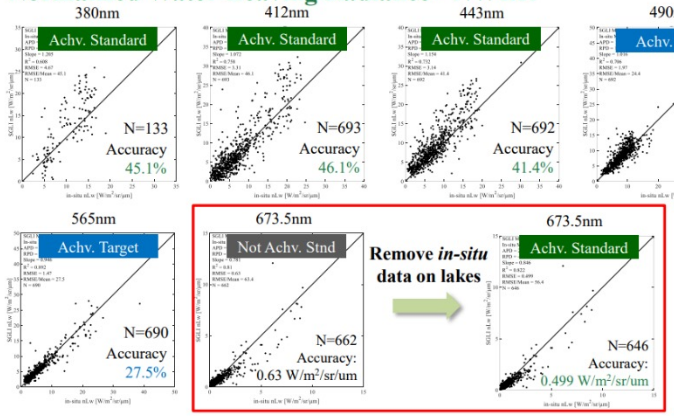
- SGLI L2 Summary and Results of All Products (Eng., PDF 12.6MB)

✓ The in-situ data has been provided by GCOM-C ocean group PIs and Japan Fisheries Research and Education Agency

✓ JAXA partially support the observations (e.g., instrument, consumables, travel, ..)

https://suzaku.eorc.jaxa.jp/GCOM_C/data/validation.html

## Validation Results of Ocean NWLR Products: Normalized Water-Leaving Radiance - NWLR

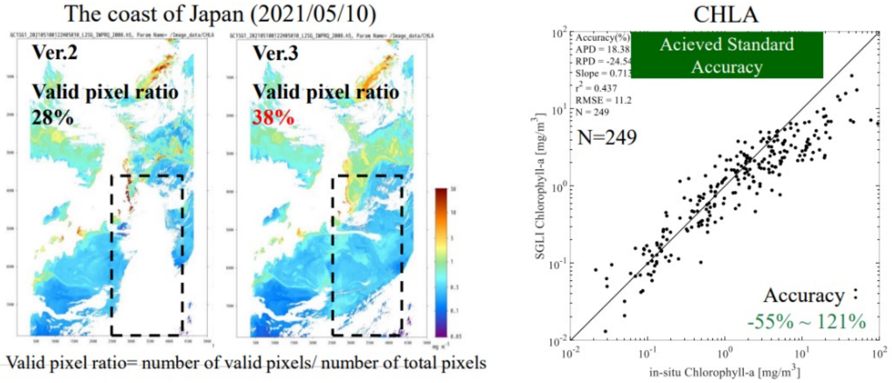



- NWLR(673.5nm) didn't achieved the standard accuracy on coastal regions.
  → Standard accuracy is achieved when in-situ data on lakes, which are not originally subject to validation, are excluded.

- NWLR(490nm, 565nm) achieved the target accuracies, NWLR(380-443nm, 530nm, 673.5nm) achieved the standard accuracies.
- Increased number of valid pixels [Version 2]: 117-616 points → [Version3]: 133-693 points

| Validation Result | Release Accuracy | Standard Accuracy | Target Accuracy |
|---|---|---|---|
| [Ver. 2] 21-42%→[Ver. 3] 23-46% | 60%(443-565 nm) | 50% (≦600 nm) | 30% (≦600 nm) |
| [Ver. 2]0.61 →[Ver. 3] 0.499W/m²/sr/um | N/A | 0.5W/m2/sr/um (>600 nm) | 0.25W/m2/sr/um (>600 nm) |

## Validation Results of Ocean IWPR Products: Chlorophyll-a Concentration - CHLA



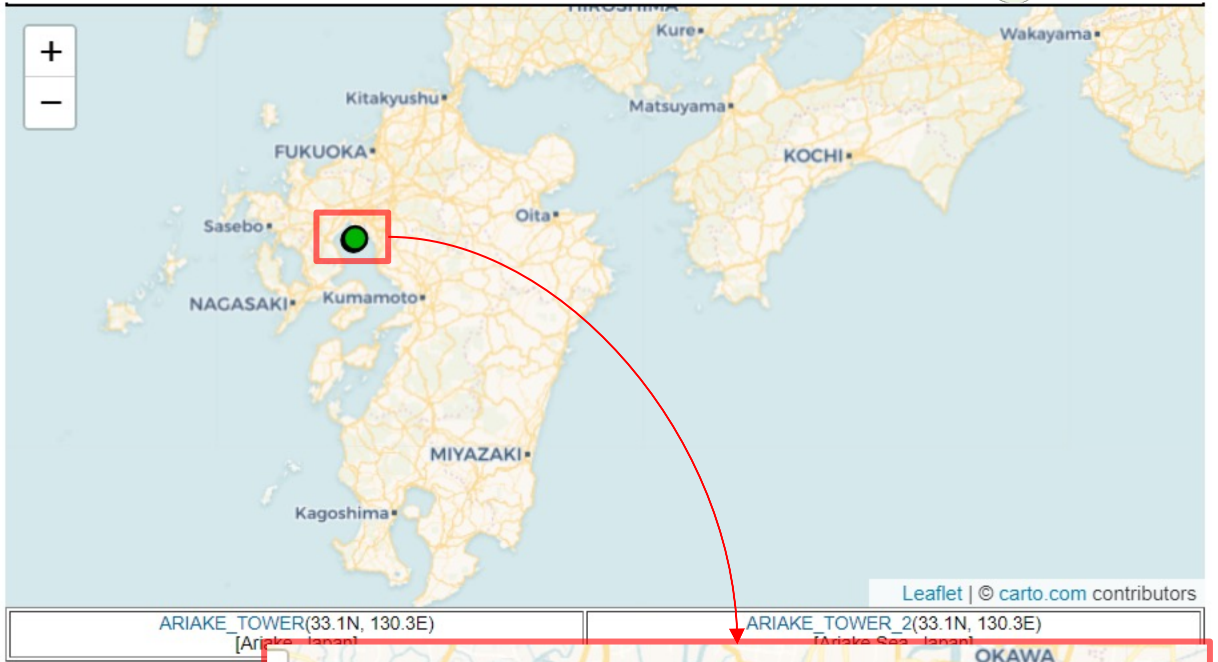

Valid pixel ratio= number of valid pixels/ number of total pixels

- Achieved Standard Accuracy
- Increased the number of validation points on coastal and sunglint areas because of the improvement of NWLR estimation.

| Validation Result | Release Accuracy | Standard Accuracy | Target Accuracy |
|---|---|---|---|
| [Ver. 2] -55~121%<br>→[Ver. 2] -58~137% | -60%~+150%(offshore) | -60%~+150% | -35%~+50%(offshore)<br>-50%~+100%(coastal) |

# 3. Validation: Aeronet-OC/Ariake-Tower replacement

Considering the operation termination of the Saga Univ. Ariake observation tower mounting the Aeronet-OC system, we have moved the sensor to the Ariake Hayatsue-gawa tower of Saga Prefectural Ariake Fisheries Research and Development Center

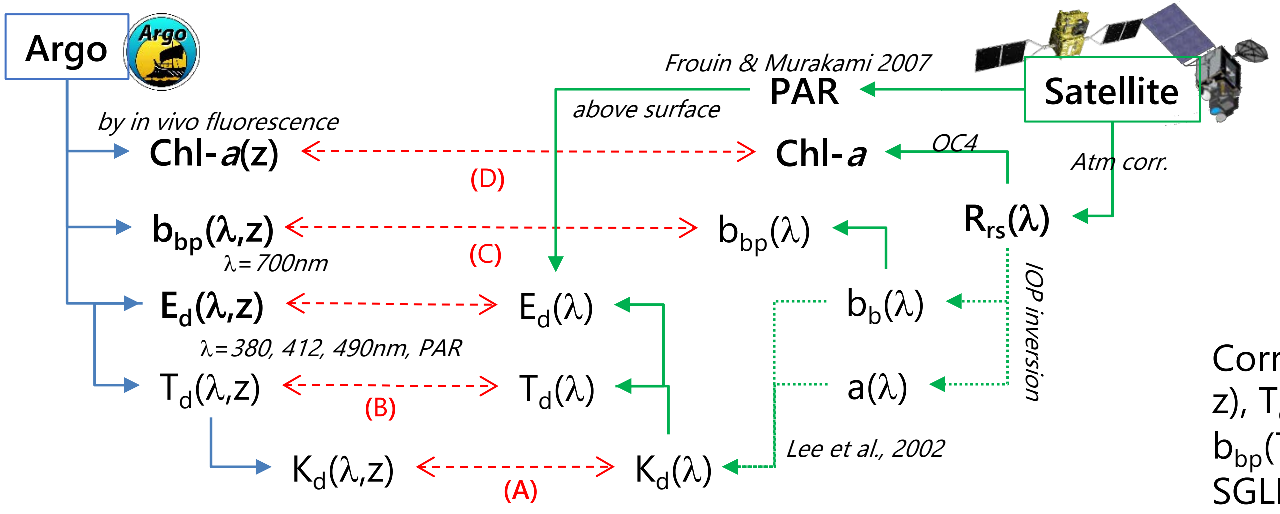



**ARIAKE_TOWER** (33.104N, 130.272E; **Feb 2018-Mar 2023**) operated by Saga University. It is about 5 km from the coast of Saga city in Ariake Sea

↓

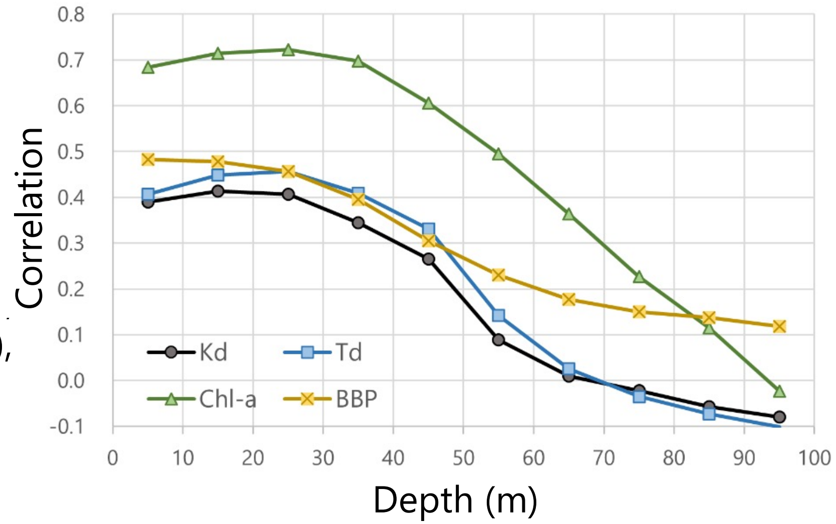
**ARIAKE_TOWER_2** (33.114N, 130.298E; **23 Sep. 2023-**) operated by JAXA on Ariake Hayatsue-gawa tower of Saga Prefectural Ariake Fisheries Research and Development Center in Ariake Sea, Japan. It is about 3.6 km south from the coast of Saga city in Ariake Sea.

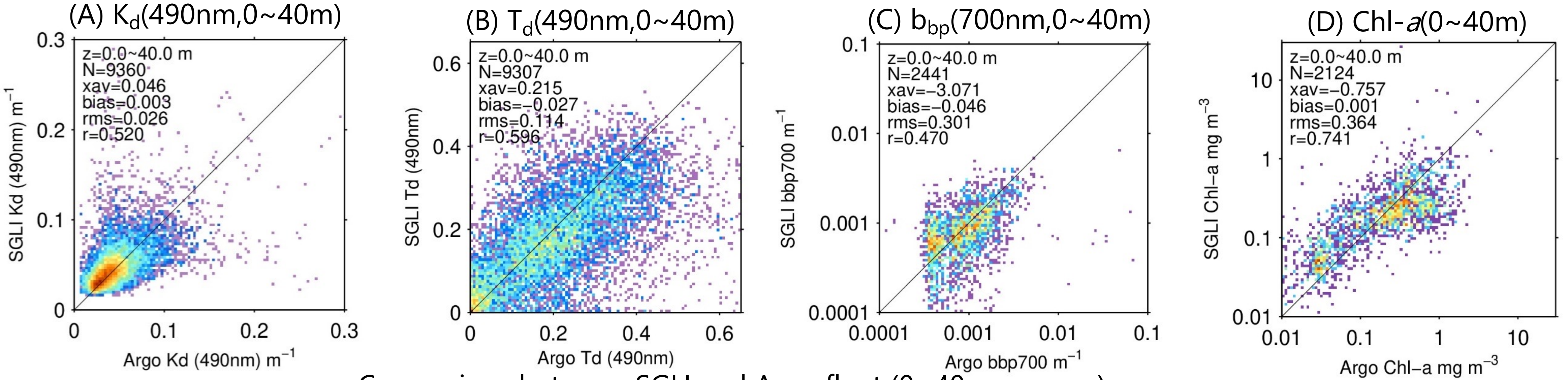

# 3. Validation: Comparison to BioGeoChemical (BGC) Argo




Flowchart of BGC Argo and satellite comparison

Correlation of $K_d$(490nm, z), $T_d$(490nm, z), Chl-$a$(z), $b_{bp}$(700nm, z) between SGLI estimates (8-day average) and BGC Argo




Comparison between SGLI and Argo float (0~40m average)

Stat of $b_{bp}$ and Chl-$a$ are on $\log_{10}$

# 4. SGLI observation: Five years SGLI observation of Earth environment

(1) Floating algae has captured by 250-m OC in the East China Sea every year

(2) Large suspended sediment (SS) plumes and land flooding areas could be seen by 250-m resolution after the heavy rain every year

(3) Heavy aerosol events from wildfires were captured by SGLI polarimetry (POL) and SGLI near-ultraviolet (NUV) channel in every year

(4) Continuous Kuroshio large meander since the GCOM-C launch; the ocean surface current from short time change between SGLI and OLCI

(5) Year to year difference of the vegetation phenology in the northeast Asia

(6) coccolithophore bloom in the Sagami Bay in May 2020

(7) Anomalous ocean color around Nishinoshima volcano in July 2020

(8) Significant decrease of shortwave radiation by the long-continued rain band over the East Asia in July 2020

(9) Upwelling of SS by typhoons in the East China Sea in summer 2020

(10) Kosa events captured by SGLI NUV channel in March-May 2021 and 2023

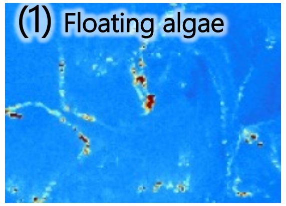
(11) Unusual high sea-surface temperature in the Japan Sea in summer 2021

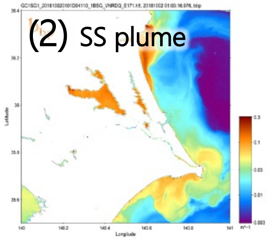
(12) Large scale red tide in the east coast of Hokkaido, Sep.-Nov. 2021

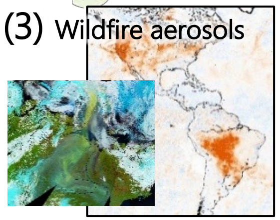
(13) Pumice rafts from Fukutoku-Oka-no-Ba after 14 Aug. 2021

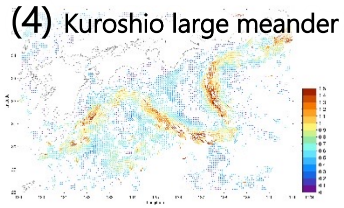
(14) Aerosol from Tonga volcano in Jan. 2022

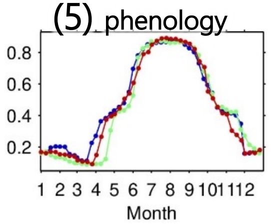
(15) Heatwave in 2022 and 2023

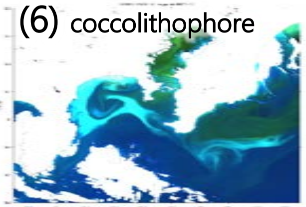


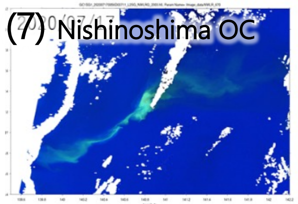



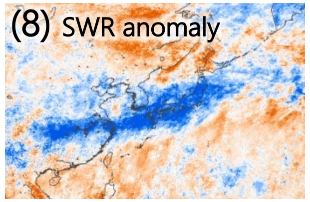



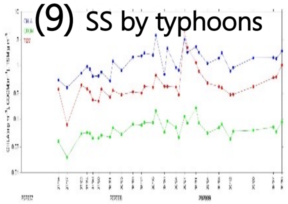



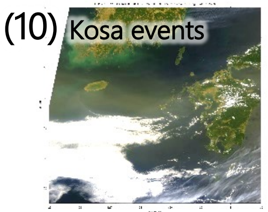



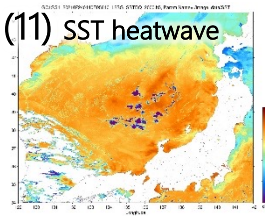



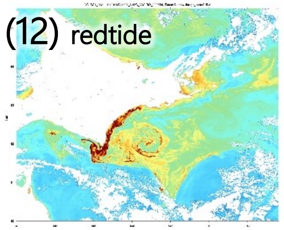



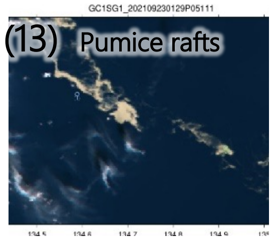



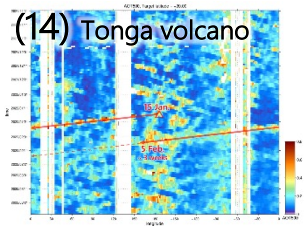



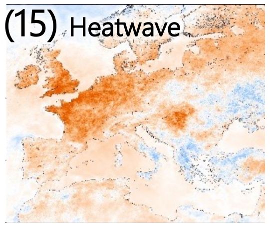



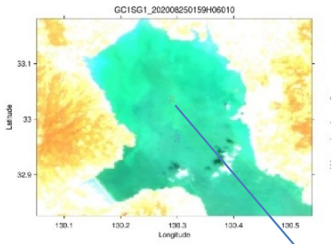



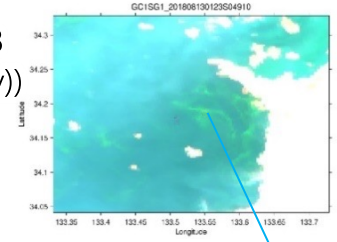



# 4. SGLI observation: Various red tide spectra around Japan by SGLI 250m

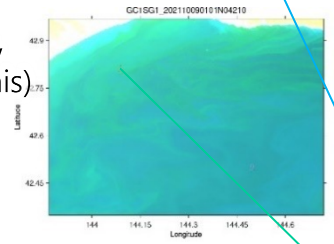
Ariake Bay, 25 Aug. 2020
(Diatom)



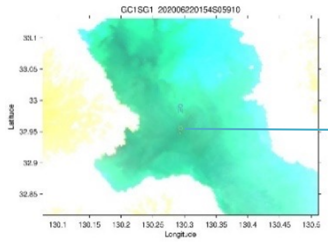

Seto inland sea, 13 Aug. 2018
(Karenia mikimotoi (probably))

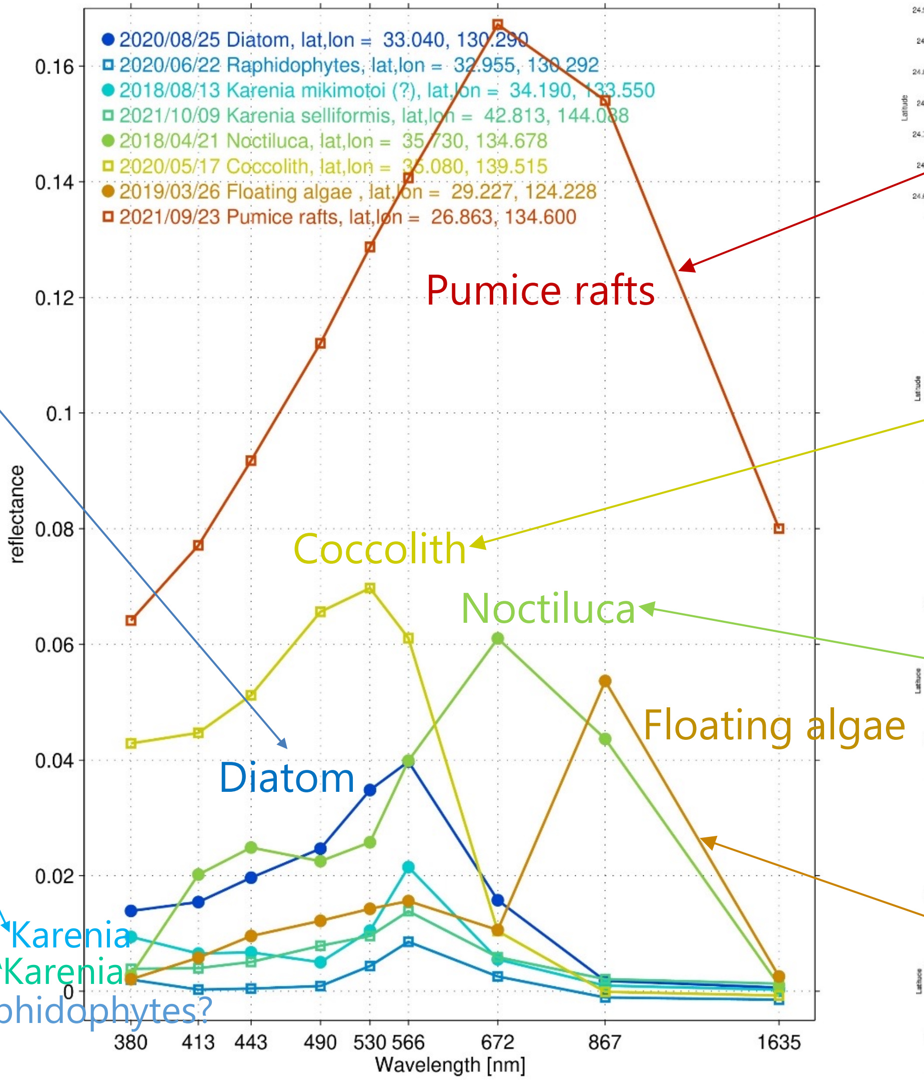



Southeast coast of Hokkaido,
9 Oct. 2021 (Karenia selliformis)

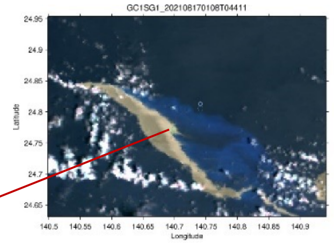



Ariake Bay, 22 Jun. 2020
(Raphidophytes)

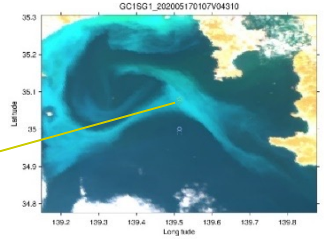




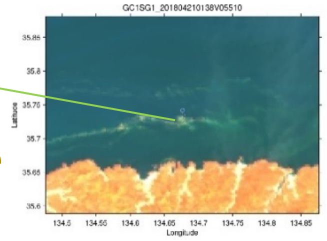

South of Japan, 17 Aug. 2021
(Pumice rafts)



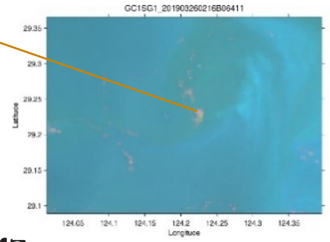
Sagami Bay, 17 May 2020
(Coccolith)



Northern Coast of Hyogo,
21 Apr. 2018 (Noctiluca)



East China Sea, 26 Mar. 2019
(Floating algae)

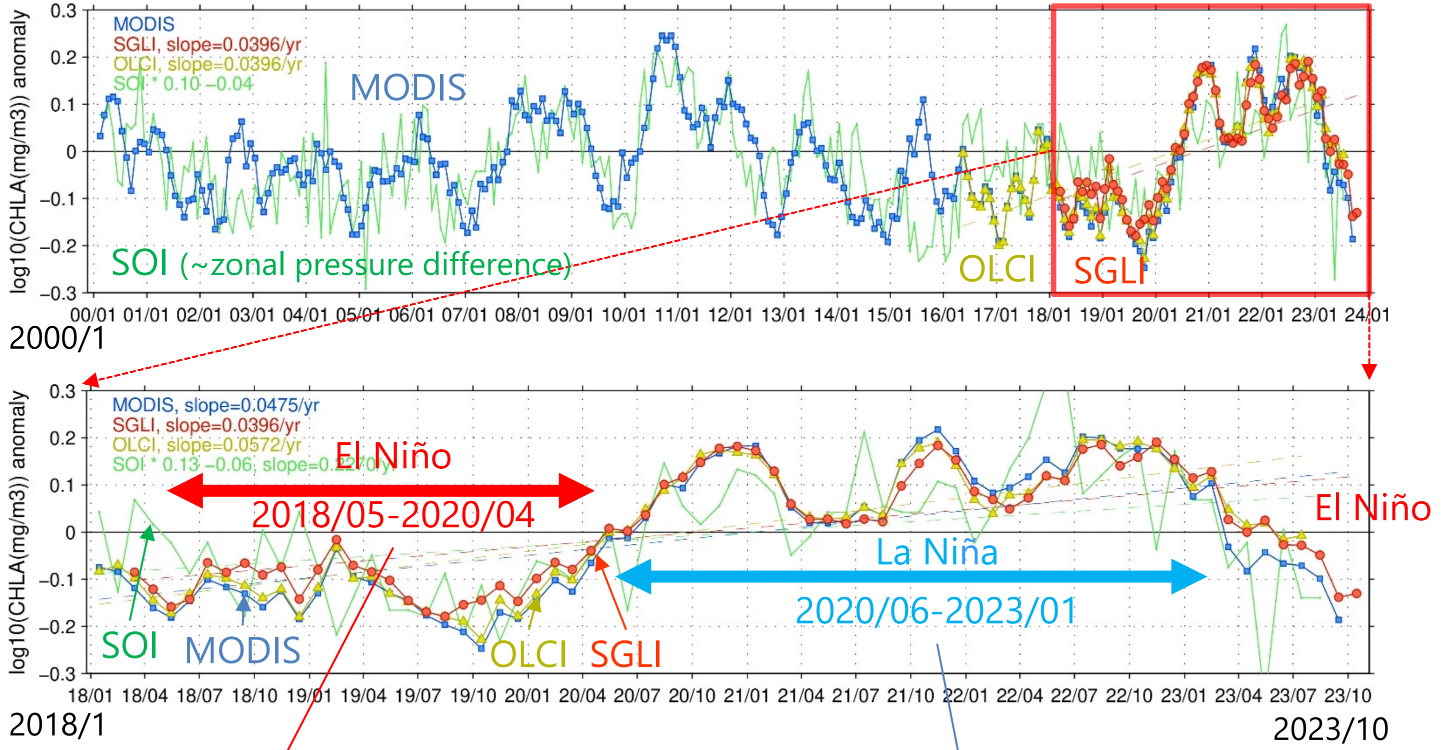


**Examples of SGLI water-leaving reflectance spectra**

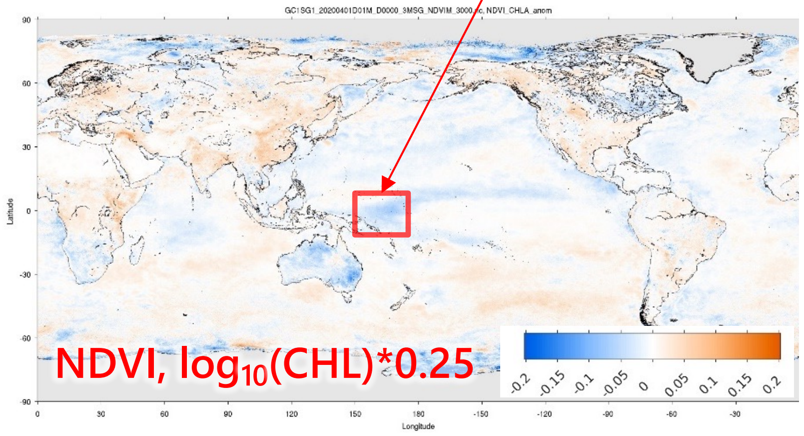
Note: they are not the spectra of the target materials but the ones of the SGLI pixels including the target materials

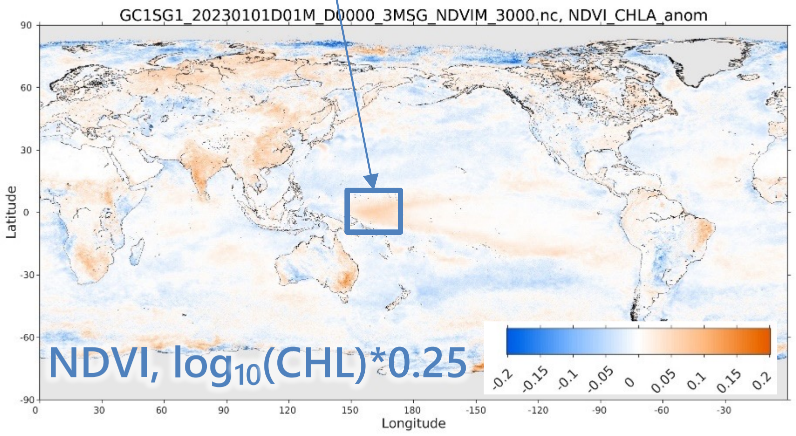
# 4. SGLI observation: SGLI Resent 5-year monthly anomaly

- As a first step, we made SGLI climatology data by the simple way using 2000-2019 average of MODIS product (2002-2019 for CHLA) and SGLI-MODIS difference in the overlap period, 2018-2022
- Anomaly images and monthly climatology files are available: https://www.eorc.jaxa.jp/JASMES/SGLI_STD/




- ✓ The first half (~2020/04) tended to El Niño and positive PDO
- ✓ The latter part tended to La Niña (2020/06-2021/04 and 2021/09-2023/1) and negative PDO



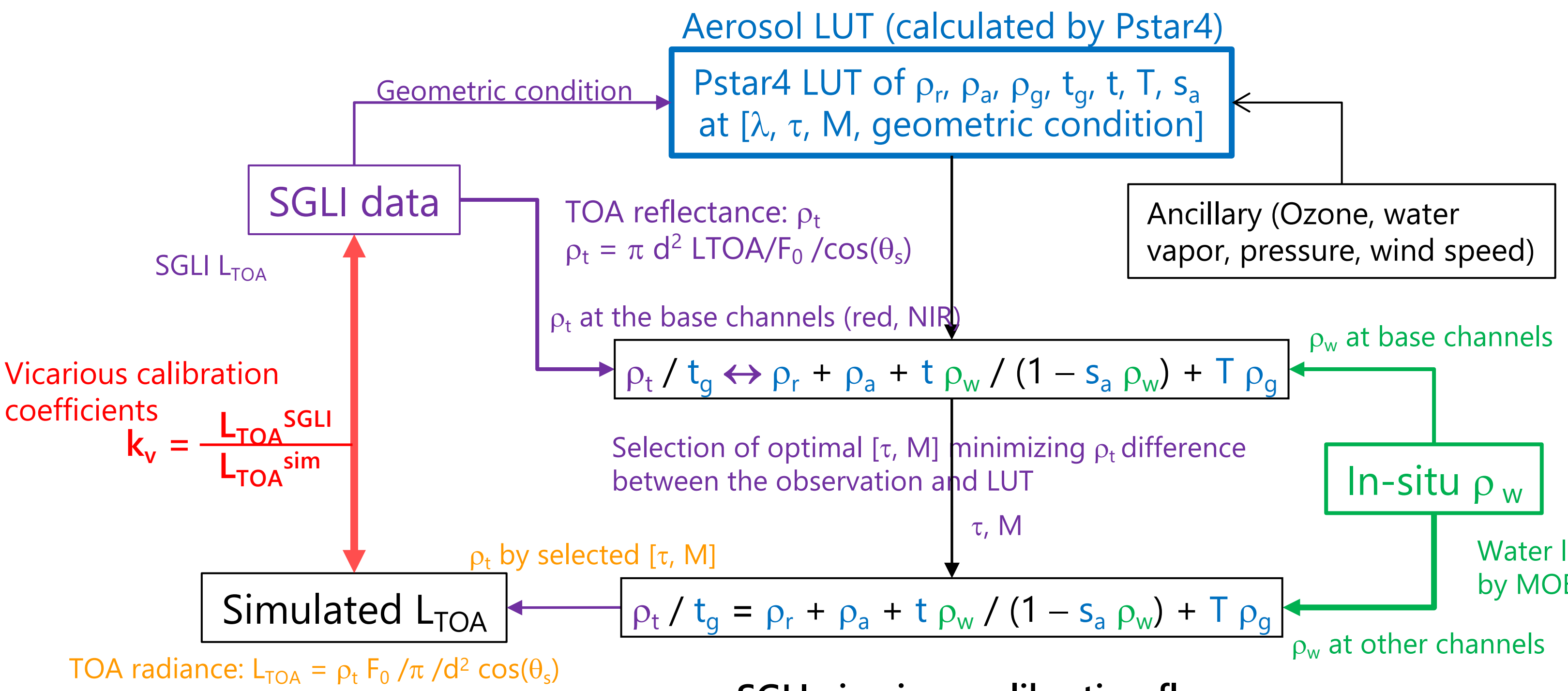
# 5. Summary

- ✓ GCOM-C/SGLI has been operated continuously and accumulated global data for about 6 years since Jan 2018; the operation phase has been transitioned to the extension phase since 2023
- ✓ Temporal change of radiometric calibration has been corrected in L1B processing based on the lunar calibration by GIRO
- ✓ VNR dark signal (offset) is monitored and reflected to the calibration tables every 6 months
- ✓ Vicarious calibration by using MOBY and BOUSSOLE has been reflected to the OC processing
- ✓ SGLI OC products have been validated by in-situ measurements provided by PIs and collaborative institutes
- ✓ SGLI has observed various environmental events in the five years including red tide, pumice rafts, floating algae, coastal sediment by the multi channels with 250-m resolution
- ✓ We have started timeseries analysis of SST, Chl-*a*, SWR, NDVI, LST, AOT.. by combined use of multiple sensors, however, more precise consistency of the datasets, algorithms and calibration is essential for reliable time series analysis for the climate researches
- ✓ In the extension phase, we will more focus on application researches (monitoring/prediction of the earth system change (SENTAN, ArCS II) and bridging to the operational uses) in addition to the product development/evaluation required by the applications

Back up slides

# 2. Calibration: Vicarious calibration

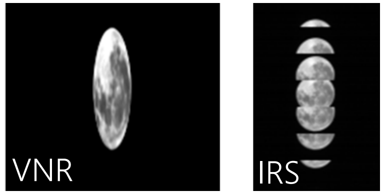
- SGLI vicarious calibration is based on in-situ water-leaving radiance ($L_{wn}$) observation of MOBY (Clark et al., 2003) and BOUSSOLE (Antoine et al., 2006) with BRDF correction by Morel and Maritorena 2001
- For each in-situ observation (clear sky and out of the sun-glint area), the aerosol reflectance and transmittance are estimated by SGLI observations at VN07 and VN10 as same as the ocean-color atmospheric correction except for using in-situ $L_{wn}$ at VN07 band




**SGLI vicarious calibration flow**

$\rho_w$: water-leaving reflectance,
$\rho_r$: molecule reflectance,
$\rho_a$: aerosol reflectance,
t: global transmittance,
T: direct transmittance,
$s_a$: spherical albedo,
$\rho_g$: sunglint reflectance,
$t_g$: transmittance by $O_3$, $H_2O$ and $O_2$,
$\lambda$: SGLI channel,
$\tau$: aerosol optical thickness,
M: aerosol-type model

# 2. Calibration: SGLI Lunar CAL by GIRO



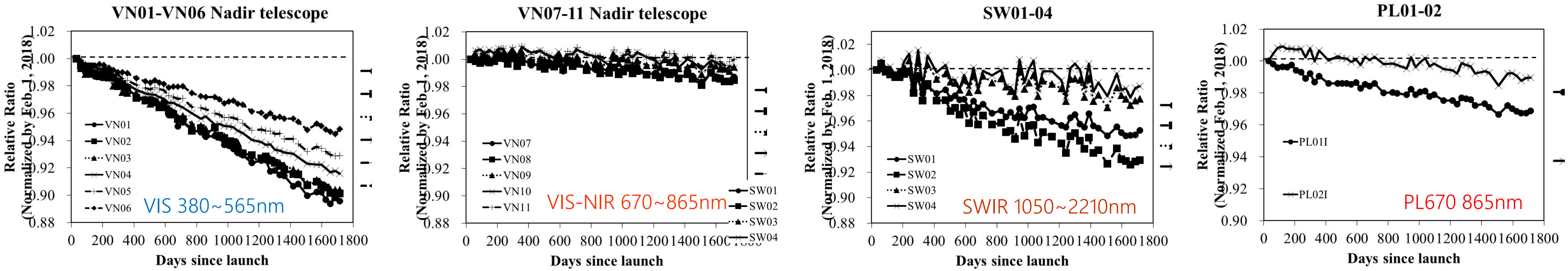

- GCOM-C SGLI lunar calibration is regularly updated by the monthly (phase angle ~7°) lunar observation operations (by the pitch maneuver; 69 times in 2018-2023) with GIRO
- All SGLI lunar observation data (GIRO input/output files) have been submitted to GLOD

✓The temporal change, $b_{ch}$, is estimated by the multiple regression with the lunar phase angle, $g_n$

$$f_{ch,n} = a_{ch} \times g_n + b_{ch} \times d_n + c_{ch}$$ (d: days from launch, ch: SGLI channels)

✓ $b_{ch}$ is updated half-yearly, and $L_{ch}^{orig}$ is corrected to $L_{ch}^{L1B}$ in the Level-1B processing

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

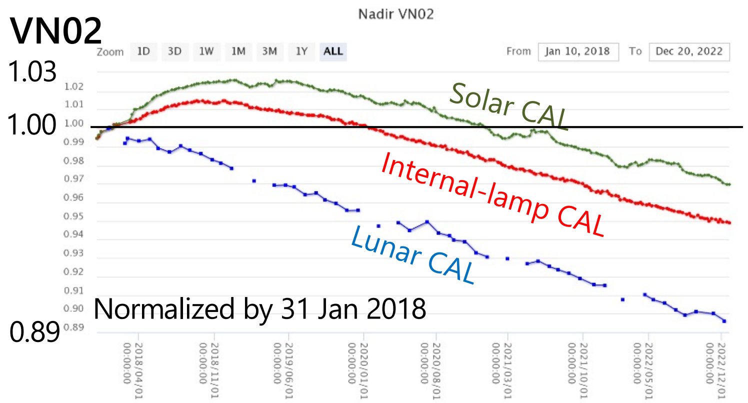


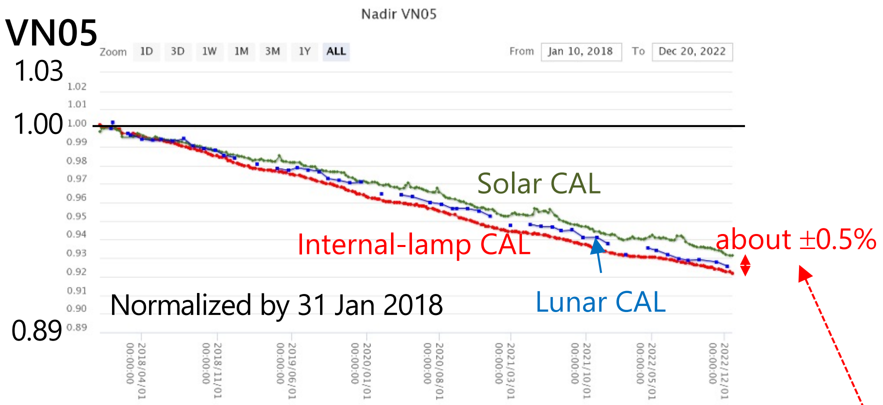

Time series of SGLI/GIRO trend (Normalized by 2018/2/1)

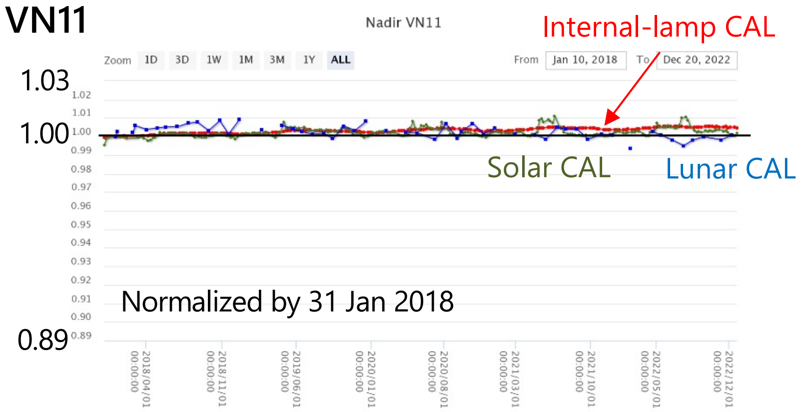
- Urabe et al. (2020). DOI: 10.3390/rs12010069;
- Urabe et al. (2019) DOI: 10.1109/IGARSS.2019.8897892

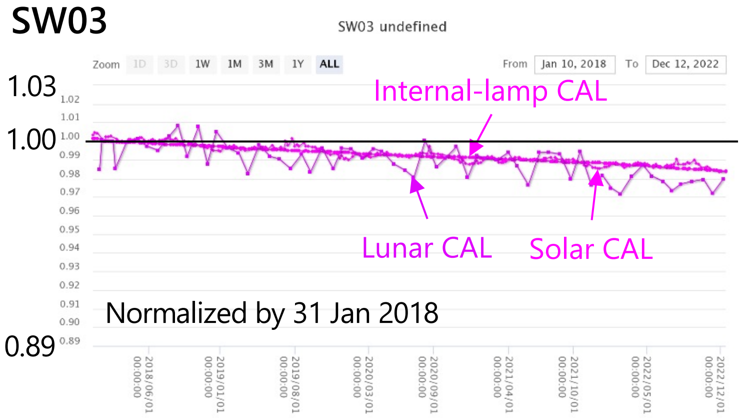
# 2. Calibration: Comparison among on-board calibrations

- ✓ The lunar CAL is operated by each lunar period (29 days), the solar CAL and internal-lamp CAL by every 8 days
- ✓ The lunar model is used to evaluate the temporal change because it can include bias error
- ✓ The solar calibration can include estimation error from temporal change of the diffuser reflectance; the internal lamp calibration can include errors from temporal changes of internal-lamp illuminance and the diffuser reflectance



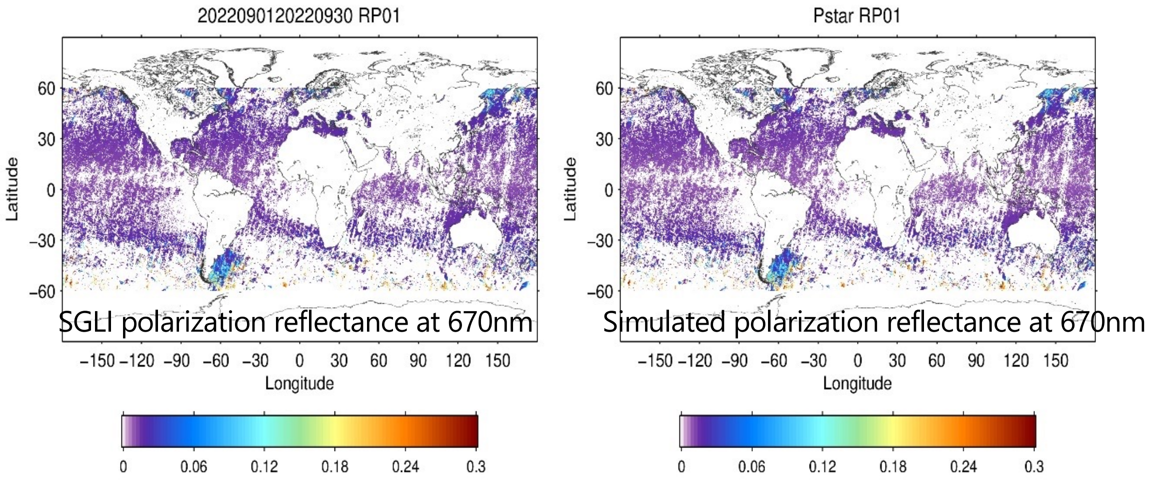

- ✓ Because of the diffuser reflectance change especially in shorter wavelengths the difference among the results becomes large (e.g., VN02), however, the it is small (less than about ±0.5%) in other wavelengths

Temporal change of the lunar, solar, and internal lamp calibrations from 2018 to 2022 (results of VN0, VN0, VN11 and SW03 are shown）

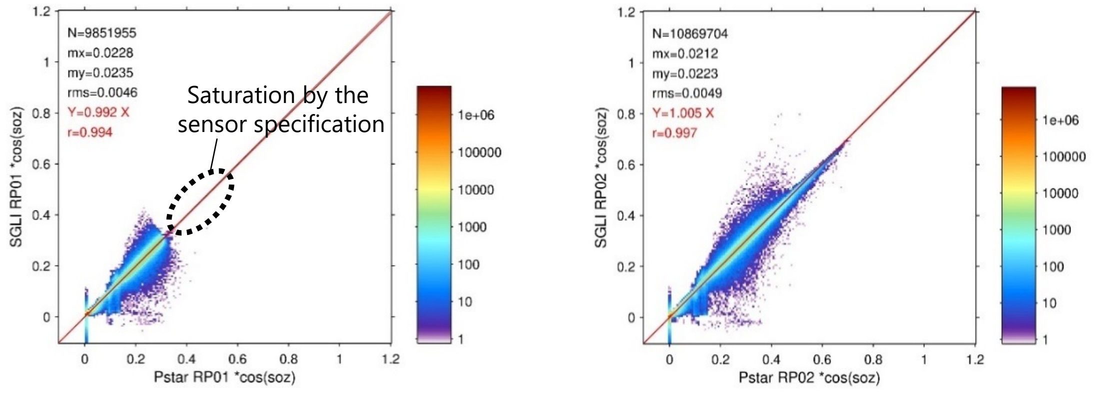
# 2. Calibration: Vicarious calibration of SGLI Polarimetry

- SGLI polarimetry (two wavelengths, 670nm and 865nm with 45-deg slant-view telescopes) is evaluated by the polarization reflectance simulated by the radiative transfer code (Pstar4*) using SGLI non-polarization observation (nadir-view telescopes)
- Method:
  1. Aerosol properties (AOT and aerosol-type models) are estimated by the non-polarization nadir-view channels (VN08, VN11)
  2. Sunglint reflectance of polarization slant-view channels are estimated by the observed I component and the estimated aerosol properties
  3. TOA polarization reflectance at 670nm and 865nm (RP01 and RP02 respectively) are simulated by Pstar4 using the sunglint reflectance and the aerosol properties in the clear sky areas of AOT<0.1

✓ **RP01/Pstar4=1.01 (RMSD=0.007), RP02/Pstar4=1.02 (RMSD=0.007) as the average of 2018-2022**




Examples of SGLI observed and Pstar4 simulated polarization reflectance in Sep. 2022




RP01(670nm) by Pstar4 RP01(865nm) by Pstar4

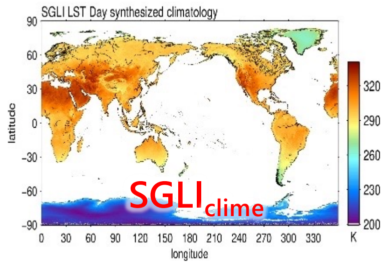
Examples of comparison between SGLI and Pstar4 simulated RP in Sep. 2022

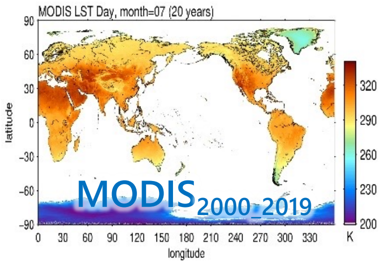
* Ota Y, Higurashi A, Nakajima T, Yokota T (2010) Matrix formulations of radiative transfer including the polarization effect in a coupled atmosphere-ocean system. J Quant Spectrosc Radiat Transfer 111:878–894. https://doi.org/10.1016/j.jqsrt.2009.11.021.

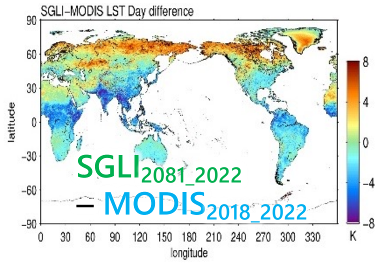
# 4. SGLI observation: Time series analysis

- ✓ As a first step, the SGLI climatology data were simply made by using 2000-2019 average of MODIS product (2002-2019 for CHLA) and SGLI-MODIS difference in the overlap period, 2018-2022

$$SGLI_{clime} = MODIS_{2000\_2019} + (SGLI_{2018\_2022} - MODIS_{2018\_2022})$$




Datasets in the climatology file (netCDF):

*tag*_climatology: synthesized climatology for SGLI (offset corrected)

*tag*_MODIS_average: MODIS average (can be used for MODIS)

*tag*_SGLI_STD: Standard deviation of SGLI in the overlap period

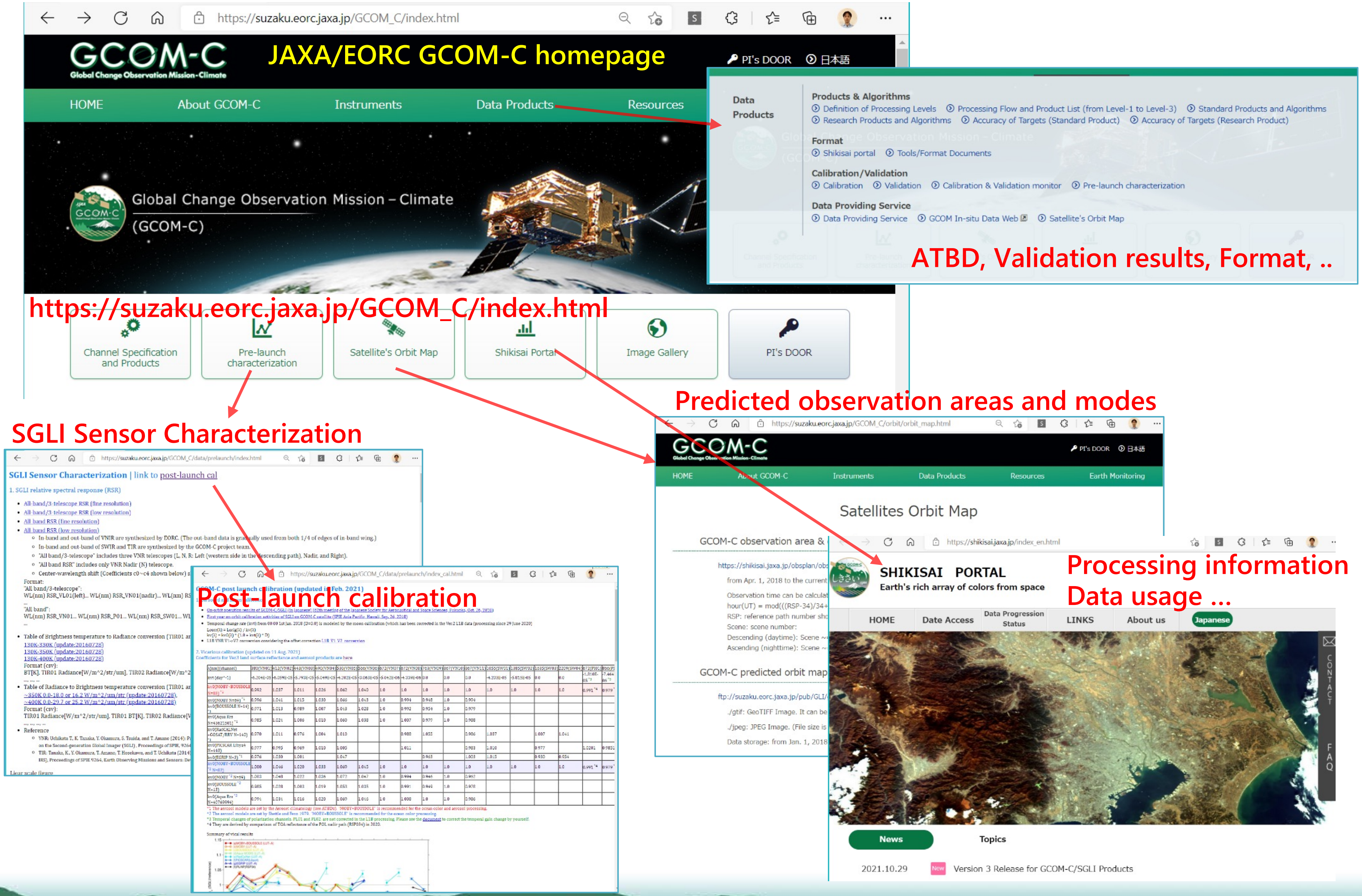
*tag*_MODIS_STD: Standard deviation of MODIS in the overlap period

*tag*_NUM: Match- up sample number in the overlap period

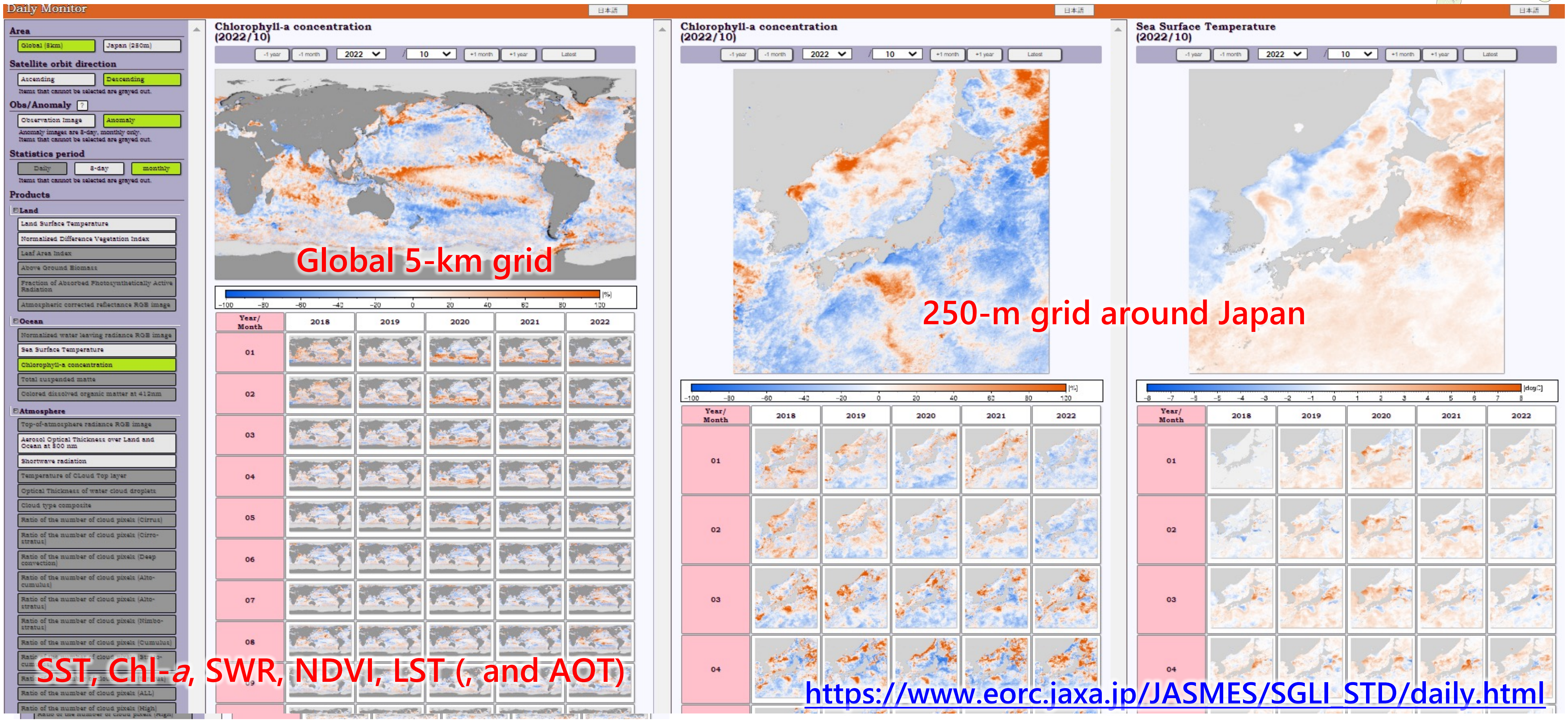
| Target variables | *tag* | SGLI (2018-) | MODIS (2000-) |
|---|---|---|---|
| Land surface temperature | LST | SGLI v3 | NASA MOD21C3, day/night-time separately |
| Normalized Difference Vegetation Index | NDVI | SGLI v3 | NASA MOD13C2, MOD13Q1 (around Japan) |
| Sea surface temperature | SST | SGLI v3 | Terra NASA OBPG MODIS, day/night-time |
| Chlorophyll-a concentration | CHLA | SGLI v3 + QC | NASA OBPG Aqua MODIS (chlor_a) |
| Daily mean of shortwave radiation | SWR | SGLI v3 | JASMES Terra+Aqua MODIS |
| Aerosol Optical thickness | AROT | SGLI v3 + QC | NRL C3 and NASA MCDAODHD AOD |

- ✓ Anomaly images and monthly climatology files are available: https://www.eorc.jaxa.jp/JASMES/SGLI_STD/

# information about GCOM-C/SGLI



# 3. GCOM-C timeseries analysis: JASMES homepage

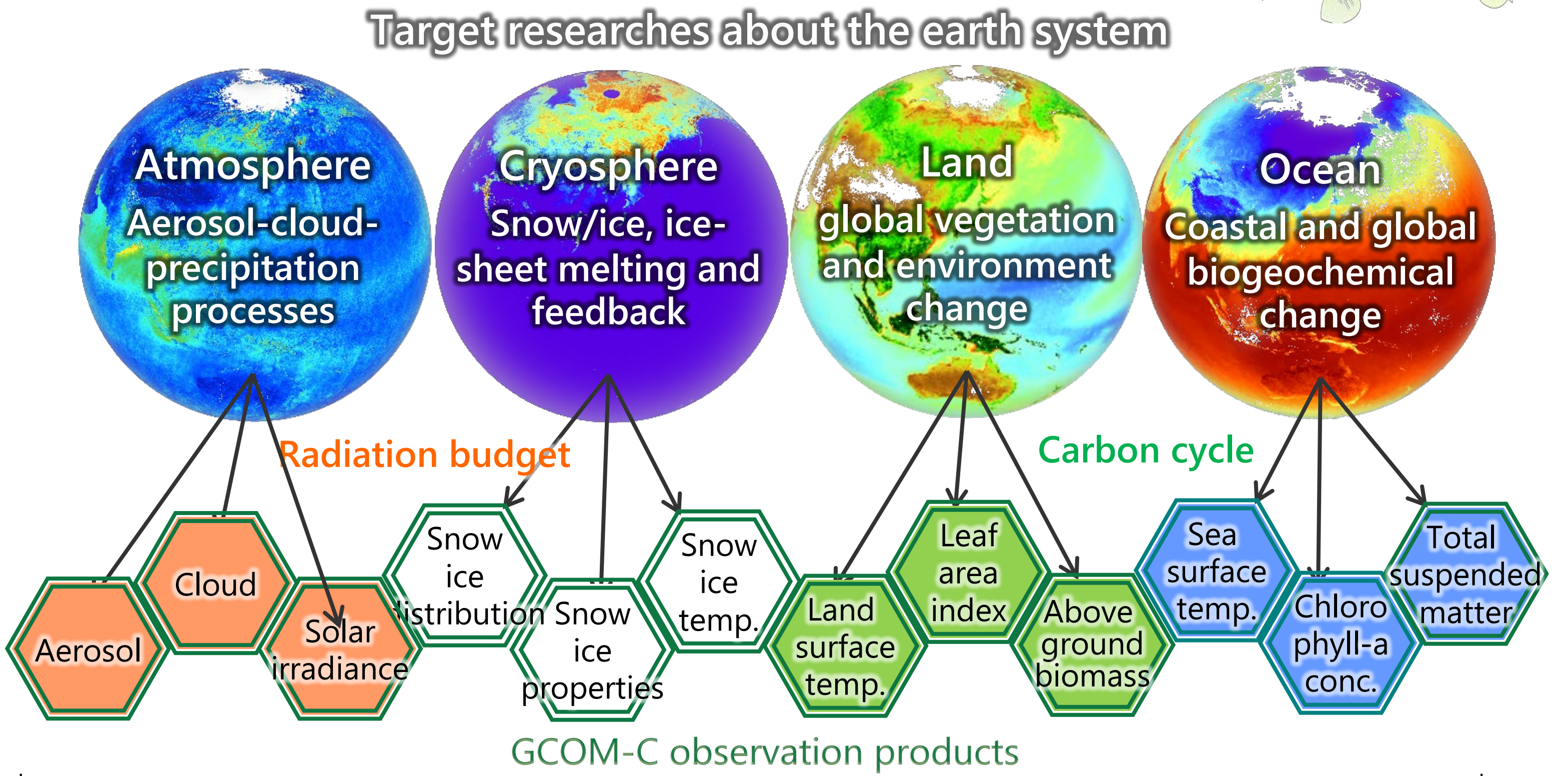



✓ The anomaly images (and the climatology data for SGLI monthly data) will be open from JAXA/EORC homepage (JASMES)

# GCOM-C research targets

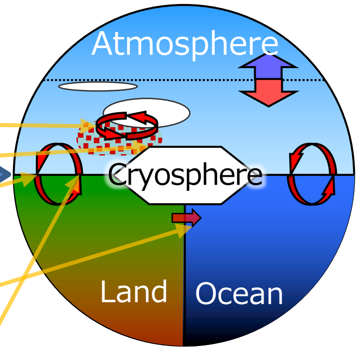
## Extension phase

- ✓ Application researches about monitoring & prediction of the earth system change (SENTAN, ArCS II), and bridging to the operational uses will be more focused
- ✓ Product development/evaluation supporting the applications will be continued
- ✓ Focus on timeseries
  - timeseries and anomaly map by synthesizing with other satellite data (currently SST, LST, SWR, albedo, NDVI, LAI, CHLA, NUV, POL,..)
  - We will make longer own timeseries with effective use of the SGLI characteristics including polarimetry, near-UV, and 250-m resolution




**Examples of the current research focus:**

- ✓ aerosol-cloud-precipitation processes
- ✓ arctic change including Greenland ice sheet
- ✓ seasonal and year-to-year change of the vegetation
- ✓ ocean ecosystem and carbon cycle including land-ocean I/F
- ✓ wildfire processes including land surface change and emission



**Earth system model**