

Detailed Reports on the Validation of the SGLI Products

4. Ocean Products

4. Validation Results of Ocean Products

4.1 Evaluation Summary

Product	Release threshold	Standard accuracy	Target accuracy	Status ^{*1}	Evaluation Methods
Normalized water leaving radiance (incl. cloud detection)	60% (443~565nm)	50% (<600nm) 0.5W/m ² /str/um (>600nm)	30% (<600nm) 0.25W/m ² /str/um (>600nm)	◎	Comparison with in-situ observation data.
Atmospheric correction parameters	80% (AOT@865nm)	50% (AOT@865nm)	30% (AOT@865nm)	○	Comparison with in-situ observation data.
Photosynthetically available radiation	20% (10km/month)	15% (10km/month)	10% (10km/month)	◎	Comparison with in-situ observation data.
Chlorophyll-a concentration	-60~+150% (offshore)	-60~+150%	-35~+50% (offshore), -50~+100% (coast)	○	Comparison with in-situ observation data.
Total suspended matter concentration	-60~+150% (offshore)	-60~+150%	-50~+100%	○	Comparison with other satellite data (GOCI).
Colored dissolved organic matter	-60~+150% (offshore)	-60~+150%	-50~+100%	○	Comparison with in-situ observation and other satellite data (MODIS).
Sea surface temperature	0.8 K (daytime)	0.8 K (day & night time)	0.6 K (day & night time)	☆	Comparison with in-situ observation data.

*1 Symbols denote as follows; ○: the release threshold achieved, ◎: the standard accuracy achieved, ☆: the target accuracy achieved.

4. Validation Results of Ocean Products

4.2 (a) Normalized water leaving radiance (NWLR)

Validation Method:

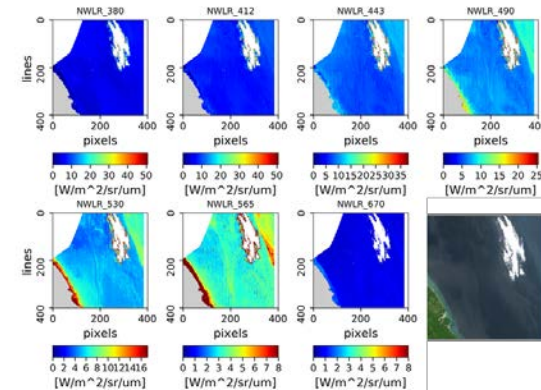
- RMS errors are evaluated comparing SGLI-derived NWLR with in-situ optical measurements conducted during simultaneous buoy (MOBY*1), tower (AERONET-OC: sky- and ocean-radiometer installed on oceanic towers) and the campaigns of ship observations and also comparing with other satellite products.

Validation data and condition etc.:

- In-situ data acquired within 3 hours from SGLI observations were used for comparison.
- SGLI data were extracted from 5 by 5 pixels near the in-situ observation sites to have one averaged value and then the data were selected by the following criteria (Bailey, 2006);
 1. Aerosol optical thickness (AOT) ≤ 0.3 , solar zenith angle ≤ 70 deg., the atmospheric correction scheme passed successfully, the target pixel is neither near the cloudy pixel nor within the region of the sun-glint correction, and the number of valid pixels ≥ 13 .
 2. A coefficient of variation (CV) is computed for pixels which passed the 1st test (1.) for bands between 412 and 565 nm and for the AOT 865 nm using the arithmetic mean and standard deviation of the 5x5 pixels, and the median CV is less than 0.15.

Validation period:

- Yoko-Maru: Feb. 2nd to Oct. 16th 2018
- Shinsei-Maru: May 21st to 28th 2018
- Nagasaki-Maru: Jul. 19th to 27th 2018
- MOBY*: Jan. 1st to Jul. 9th 2018
- AERONET-OC: Jan. 1st to Oct. 26th 2018



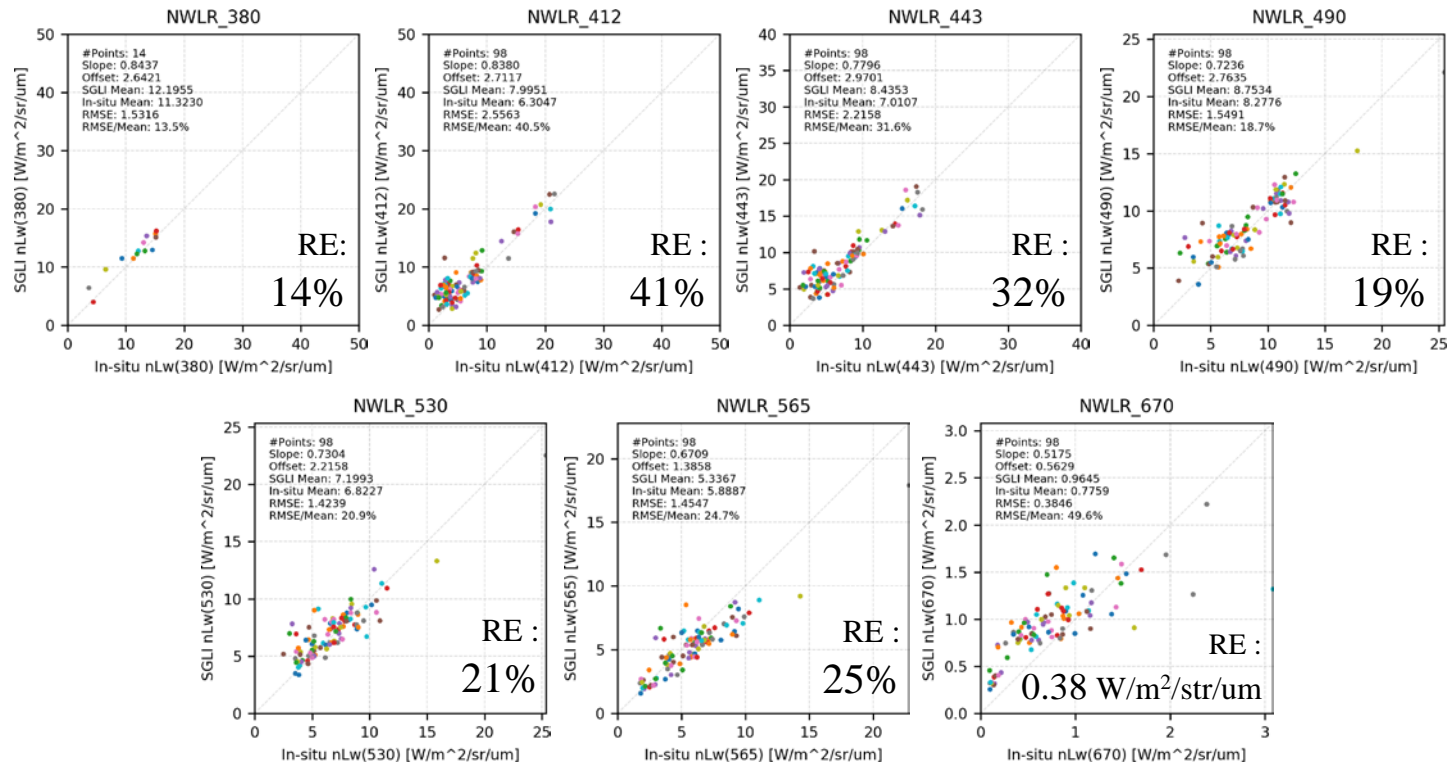
*1: MOBY data are provided from NOAA through the agreement (a memorandum of understanding (MoU)) between JAXA and NOAA.

Reference: Bailey, S.W., and Werdell, P.J. (2006). A multi-sensor approach for the on-orbit validation of ocean color satellite data products. Rem. Sens. Environ. 102, 12-23.

4. Validation Results of Ocean Products

4.2 (a) Normalized water leaving radiance (NWLR)

Validation Results:



Estimated errors	Release threshold	Standard accuracy	Target accuracy
14 ~ 41% (<=600nm) 0.38W/m ² /str/um (>600nm)	60% (443 ~ 565 nm)	50% (<600 nm), 0.5W/m ² /str/um (>600nm)	30% (<600 nm), 0.25W/m ² /str/um (>600nm)

Release threshold and Standard accuracy are achieved

4. Validation Results of Ocean Products

4.2 (b) Atmospheric correction parameters (ACP)

Validation Method:

- RMS errors are evaluated comparing SGLI-derived aerosol optical thickness (AOT) with in-situ measurements of AOT at the wavelength of 865 nm conducted during simultaneous tower (AERONET-OC: sky- and ocean-radiometer installed on oceanic towers).

Validation data and condition etc.:

- In-situ data acquired within 3 hours from SGLI observations were used for comparison.
- SGLI data were extracted from 5 by 5 pixels near the in-situ observation sites to have one averaged value and then the data were selected by the following criteria (Bailey, 2006);
 1. Aerosol optical thickness (AOT) ≤ 0.4 , solar zenith angle ≤ 70 deg., the atmospheric correction scheme passed successfully, the target pixel is neither near the cloudy pixel nor within the region of the sun-glint correction, and the number of valid pixels ≥ 13 .
 2. A coefficient of variation (CV) is computed for pixels which passed the 1st test (1.) for bands between 412 and 565 nm and for the AOT 865 nm using the arithmetic mean and standard deviation of the 5x5 pixels, and the median CV is less than 0.15.

Validation period:

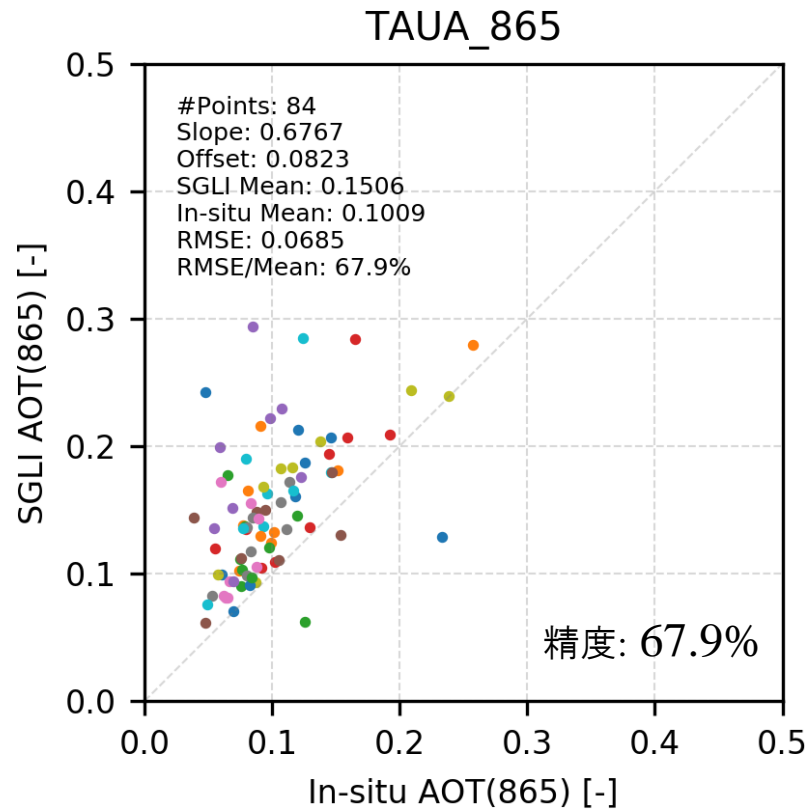
- AERONET-OC: Jan. 1st to Oct. 26th 2018

Reference: Bailey, S.W., and Werdell, P.J. (2006). A multi-sensor approach for the on-orbit validation of ocean color satellite data products. Rem. Sens. Environ. 102, 12-23.

4. Validation Results of Ocean Products

4.2 (b) Atmospheric correction parameters (ACP)

Validation Results:



Estimated errors	Release threshold	Standard accuracy	Target accuracy
68% (AOT@865nm)	80% (AOT@865nm)	50% (AOT@865nm)	30% (AOT@865nm)

Release threshold is achieved

4. Validation Results of Ocean Products

4.2 (c) Photosynthetically available radiation (PAR)

Validation Method:

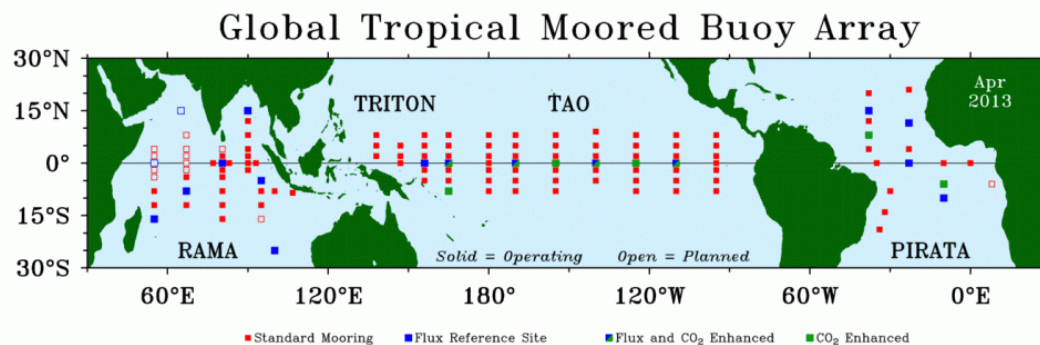
- RMS errors are evaluated comparing SGLI-derived monthly averaged PAR with those derived from mooring buoys such as TAO/TRITON, PIRATA, RAMA.

Validation data and condition etc.:

- In-situ data acquired within 3 hours from SGLI observations were converted to daily PARs and then averaged to monthly PARs for comparison with SGLI- PARs.
- Daily SGLI-PARs within 10 km box at the center of in-situ observation sites were extracted and then averaged to monthly PARs.

Validation period:

- TAO/TRITON、PIRATA、RAMA : Jan. 1st to Oct. 31th 2018

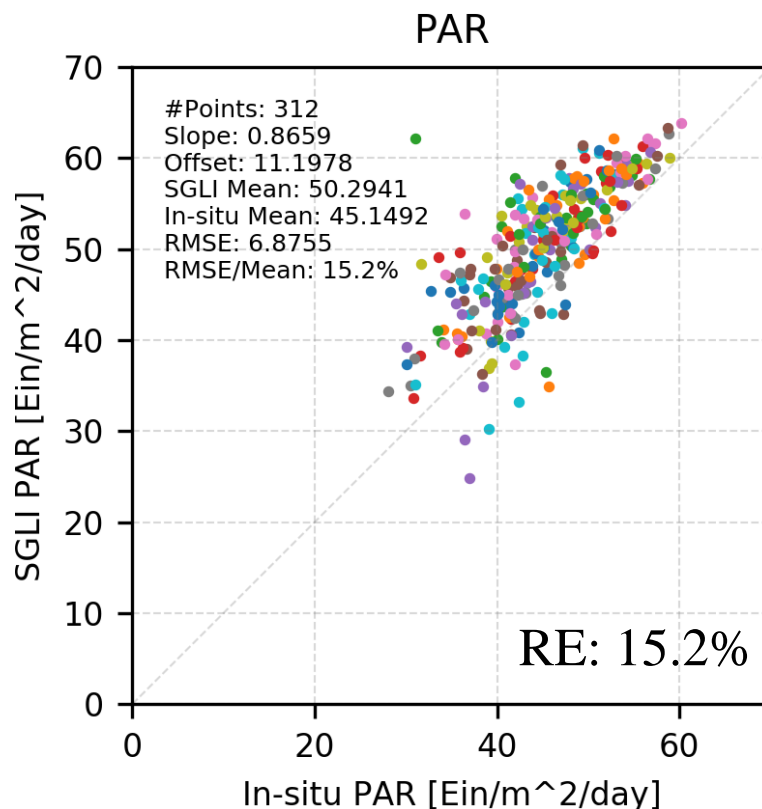


Reference: National Center for Atmospheric Research Staff (Eds). Last modified 01 Nov 2013. "The Climate Data Guide: Tropical Moored Buoy System: TAO, TRITON, PIRATA, RAMA (TOGA)." Retrieved from <https://climatedataguide.ucar.edu/climate-data/tropical-moored-buoy-system-tao-triton-pirata-rama-toga>.

4. Validation Results of Ocean Products

4.2 (c) Photosynthetically available radiation (PAR)

Validation Results:



Estimated errors	Release threshold	Standard accuracy	Target accuracy
15% (10km/monthly ave.)	20% (10km/monthly ave.)	15% (10km/monthly ave.)	10% (10km/monthly ave.)

Release threshold and Standard accuracy are achieved

4. Validation Results of Ocean Products

4.2 (d) Chlorophyll-a concentration (CHLA)

Validation Method:

- RMS errors are evaluated comparing SGLI derived CHLA with those derived from in-situ sampled sea water by fluorescence method or HPLC analysis and also with other satellite products.

Validation data and condition etc.:

- In-situ data acquired within 3 hours from SGLI observations were used for comparison.
- SGLI data were extracted from 5 by 5 pixels near the in-situ observation sites to have one averaged value and then the SGLI data were selected by the following criteria (Bailey, 2006);
 1. Aerosol optical thickness (AOT) ≤ 0.3 , solar zenith angle ≤ 70 deg., the atmospheric correction scheme passed successfully, the target pixel is neither near the cloudy pixel nor within the region of the sun-glint correction, and the number of valid pixels ≥ 13 .
 2. A coefficient of variation (CV) is computed for pixels which passed the 1st test (1.) for bands between 412 and 565 nm and for the AOT 865 nm using the arithmetic mean and standard deviation of the 5x5 pixels, and the median CV is less than 0.15.
- Comparisons between SGLI and other satellite CHLA products were conducted for monthly averaged global data projected on grids with 1/24 deg. Interval.

Validation period:

- Yoko-Maru: Feb. 2nd to Oct. 16th 2018
- Shinsei-Maru: May 21st to 28th 2018
- Nagasaki-Maru: Jul. 19th to 27th 2018
- Hokko-Maru: Jun. 1st to 8th 2018
- Aqua/MODIS: Oct. 1st to 31st 2018

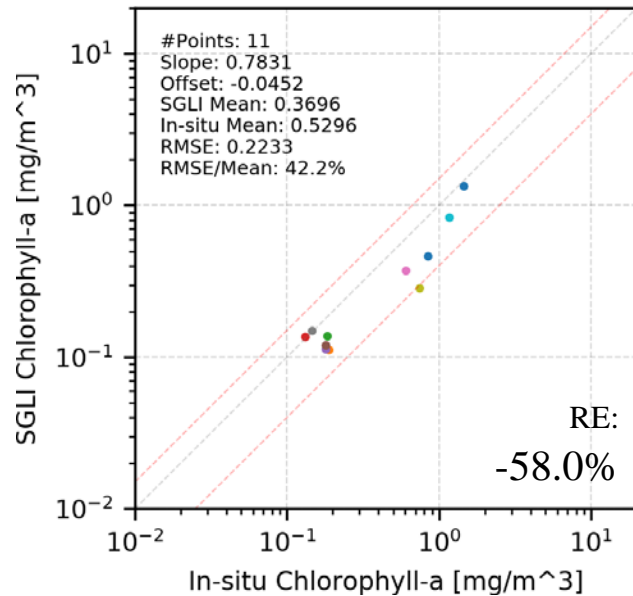
Reference: Bailey, S.W., and Werdell, P.J. (2006). A multi-sensor approach for the on-orbit validation of ocean color satellite data products. Rem. Sens. Environ. 102, 12-23.

4. Validation Results of Ocean Products

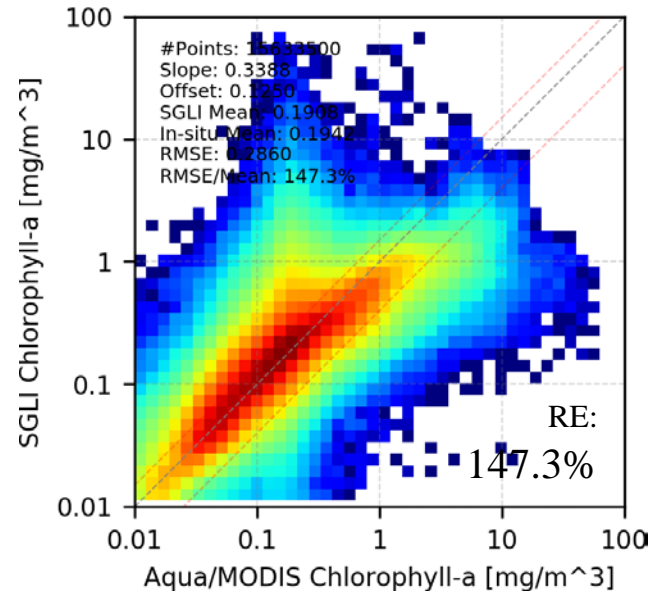
4.2 (d) Chlorophyll-a concentration (CHLA)

Validation Results:

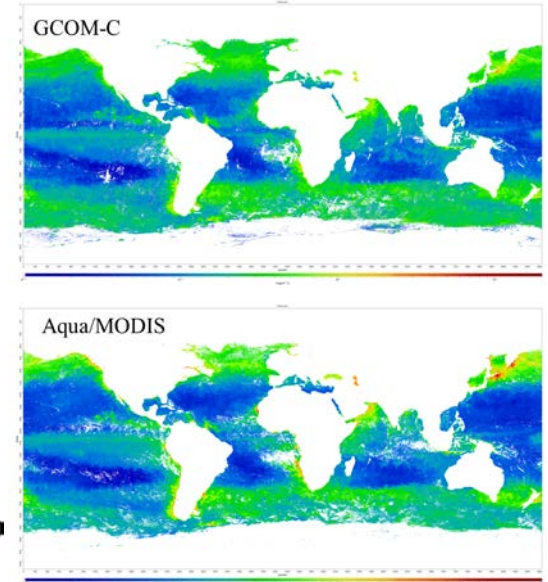
VS. In-situ data (open sea)



VS. Aqua/MODIS (open sea)



Monthly (Oct.) ave. Chl-a



Estimated errors	Release threshold	Standard accuracy	Target accuracy
-58% (in-situ, open sea) 147% (Aqua/MODIS, open sea)	-60~+150% (open sea)	-60~+150%	-35~+50% (open sea), -50~+100% (coastal)

Release threshold is achieved

4. Validation Results of Ocean Products

4.2 (e) Total suspended matter concentration (TSM)

Validation Method:

- RMS errors are evaluated comparing SGLI derived TSM with those derived from in-situ sampled sea water by filtration method (weighting the dried filters before and after the filtration to estimate the mass of suspended matter) and also with other satellite products.

Validation data and condition etc.:

- Comparisons only with other satellite products were conducted because there are no in-situ data available at the moment of evaluation 1-year after the GCOM-C launch.
- Korean's geostationary satellite "GOCI"-derived TSM was used for the comparison with SGLI for the TSM range of 0.1 to 65 g/m³ (*1). The comparison was made on the spatial grids of 1 km.

Validation period:

- GOCI: Oct. 31, 2018.

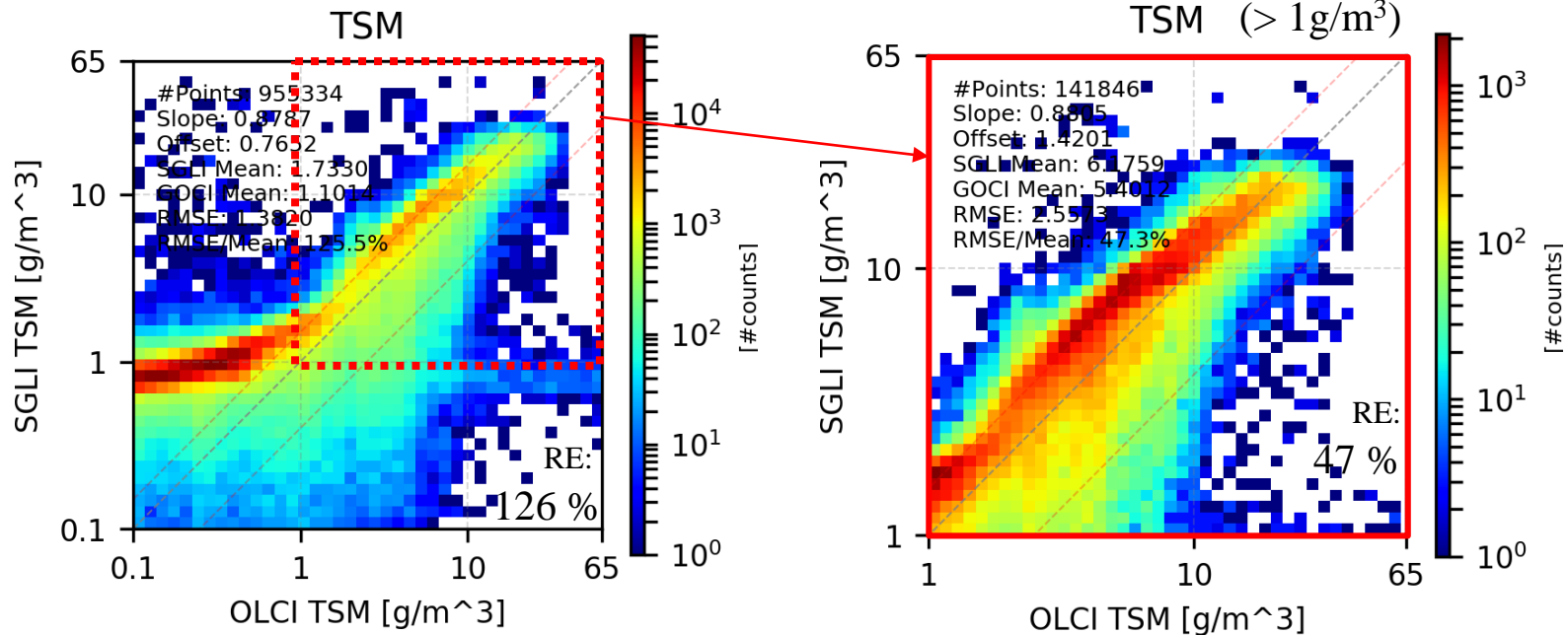
*1: The definition of GOCI's TSM is different from that of SGLI. That is, GOCI's TSM is the amount of floating inorganic matter in seawater, whereas SGLI's TSM is the sum of floating inorganic and organic matter in seawater. Thus, SGLI's TSM is considered to be larger than that of GOCI.

4. Validation Results of Ocean Products

4.2 (e) Total suspended matter concentration (TSM)

Validation Results:

Comparison with GOCI



※The definition of GOCI's TSM: "The amount of floating inorganic matte in seawater"*¹⁾

*1) http://kosc.kiost.ac.kr/eng/p30/kosc_p33.html

Estimated errors	Release threshold	Standard accuracy	Target accuracy
126% (vs. GOCI) -53% (vs. GOCI, > 1g/m ³)	-60~+150% (open sea)	-60~+150%	-50~+100%

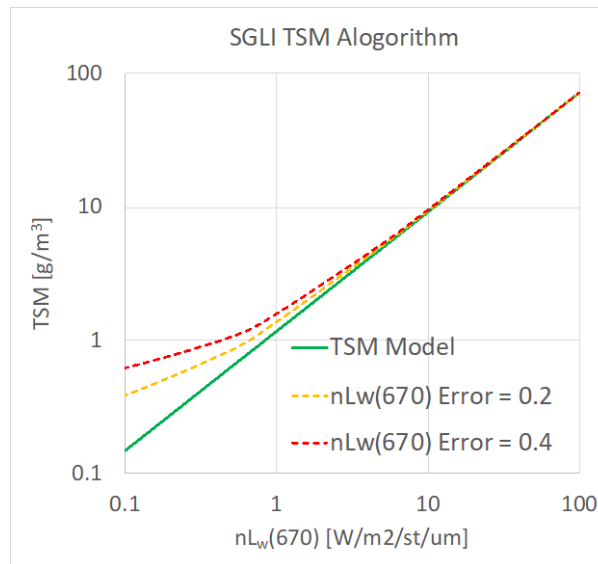
Release threshold is achieved

4. Validation Results of Ocean Products

4.2 (e) Total suspended matter concentration (TSM)

Validation Results (Cont.):

- SGLI-derived TSMs tend to be higher than those of GOCI for the TSM range higher than 1 g/m^3 which is considered due to the difference of the TSM definition between SGLI and GOCI as described before.
- In addition, SGLI-derived TSMs become significantly higher than those of GOCI at the lower TSM range less than 1 g/m^3 which can be considered due to an overestimation of NWLR at 670 nm as shown in the figure below. The overestimation of TSM could be reduced after the improvement of the SGLI NWLR product by next update.



- NWLR(670) error of $0.4 \text{ W/m}^2/\text{sr}/\mu\text{m}$ is the estimated accuracy in this evaluation (within the standard accuracy).
- nLw(670) error of $0.2 \text{ W/m}^2/\text{sr}/\mu\text{m}$ is the estimate using in-situ data from MOBY*¹ (within the target accuracy).

*1: MOBY data are provided from NOAA through the agreement (a memorandum of understanding (MoU)) between JAXA and NOAA.

The effects of NWLR (670) errors on TSM

4. Validation Results of Ocean Products

4.2 (f) Colored dissolved organic matter (CDOM)

Validation Method:

- RMS error is evaluated comparing SGLI derived CDOM with those derived from in-situ sampled sea water by optical measurements and also with other satellite products.

Validation data and condition etc.:

- In-situ data acquired within 3 hours from SGLI observations were used for comparison.
- SGLI data were extracted from 5 by 5 pixels near the in-situ observation sites to have one averaged value and then the SGLI data were selected by the following criteria (Bailey, 2006);
 1. Aerosol optical thickness (AOT) ≤ 0.3 , solar zenith angle ≤ 70 deg., the atmospheric correction scheme passed successfully, the target pixel is neither near the cloudy pixel nor within the region of the sun-glint correction, and the number of valid pixels ≥ 13 .
 2. A coefficient of variation (CV) is computed for pixels which passed the 1st test (1.) for bands between 412 and 565 nm and for the AOT 865 nm using the arithmetic mean and standard deviation of the 5x5 pixels, and the median CV is less than 0.15.
- Comparisons between SGLI and other satellite CDOM products were conducted for monthly averaged global data projected on grids with 1/24 deg. Interval.

Validation period:

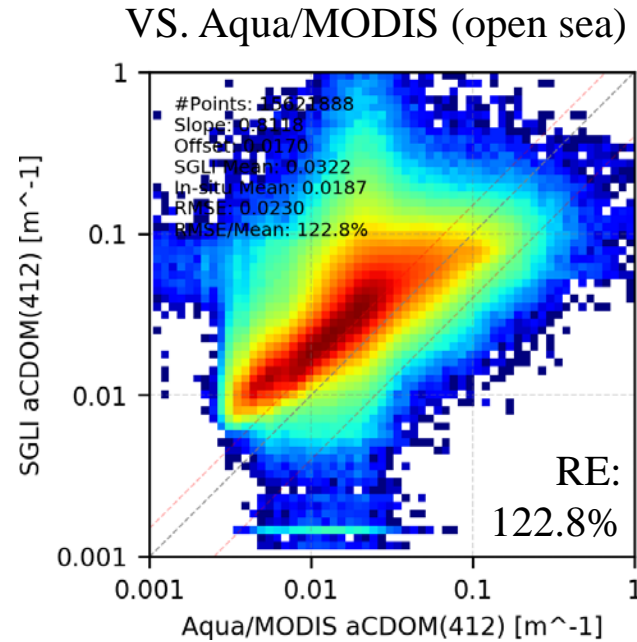
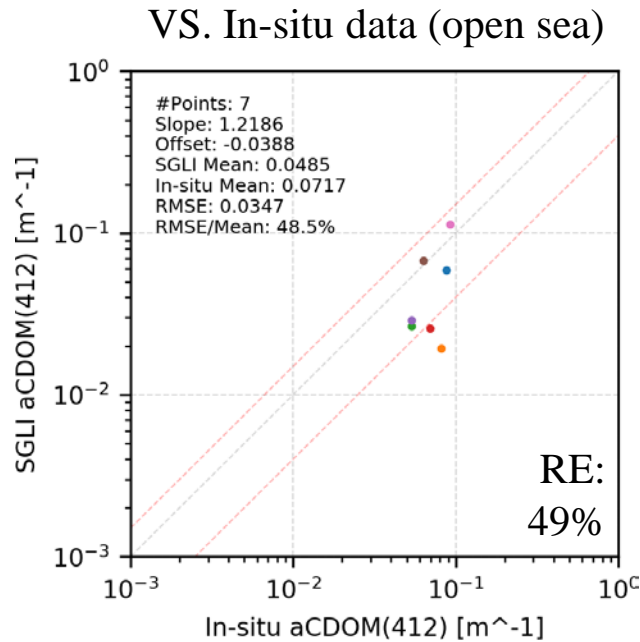
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- Shinsei-Maru: May 21st to 28th 2018
- Nagasaki-Maru: Jul. 19th to 27th 2018
- Hokko-Maru: Jun. 1st to 8th 2018
- Aqua/MODIS: Oct. 1st to 31st 2018

Reference: Bailey, S.W., and Werdell, P.J. (2006). A multi-sensor approach for the on-orbit validation of ocean color satellite data products. Rem. Sens. Environ. 102, 12-23.

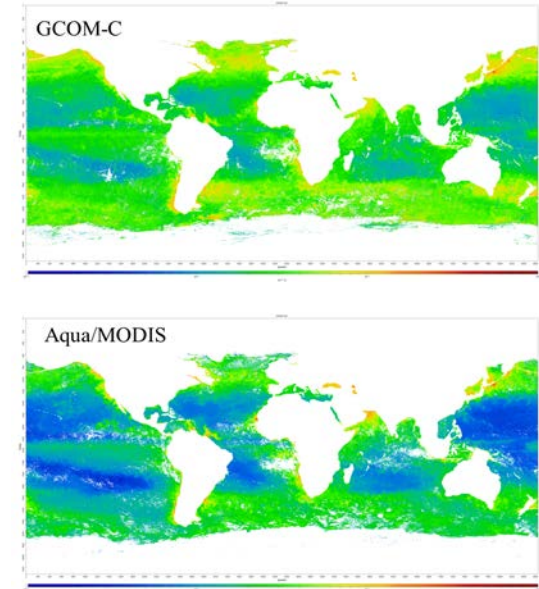
4. Validation Results of Ocean Products

4.2 (f) Colored dissolved organic matter (CDOM)

Validation Results:



Monthly (Oct.) ave. CDOM



Estimated errors	Release threshold	Standard accuracy	Target accuracy
-51% (in-situ, open sea) 123% (Aqua/MODIS, open sea)	-60~+150% (open sea)	-60~+150%	-50~+100%

Release threshold is achieved

4. Validation Results of Ocean Products

4.2 (g) Sea surface temperature (SST)

Validation Method:

- Overall RMS errors are evaluated comparing SGLI derived SST with those derived from buoy measurements obtained from iQuam.

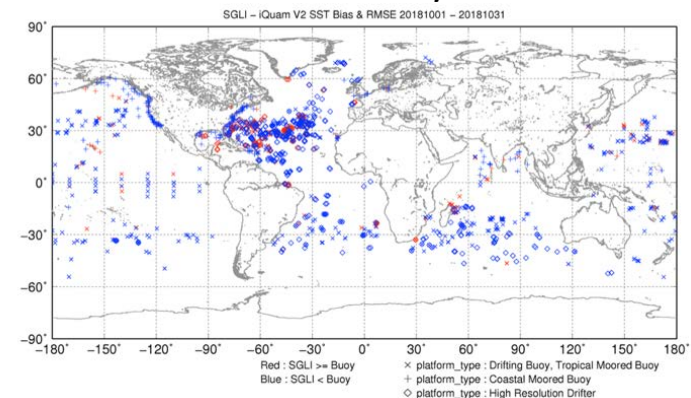
Validation data and condition etc.:

- In-situ buoy data acquired within the spatial difference of 10 km and time difference of 2 hours from SGLI observations were used for comparison. In addition, before the comparison, the SGLI SSTs that meet the following conditions were selected;
 1. Standard deviation of SGLI SST within 5 x 5 pixels around the buoy location is less than 1.0 °C.
 2. The difference between maximum and minimum of SGLI SSTs within the 5x5 pixel box is less than 3.0 °C.
 3. The difference between SGLI SST and iQuam SST is less than 5 °C.
- SGLI SSTs at the spatial resolution of 1 km with the quality flag of “good” or “acceptable” were used for comparison (same as the input for Level-3 processing).
- The buoy data with the quality assurance flag of iquam_flag=0 and quality_level=5 were obtained from NOAA iQuam site and used for the comparison.

Validation period:

- Oct. 1st to 31st 2018.

Location of buoy data

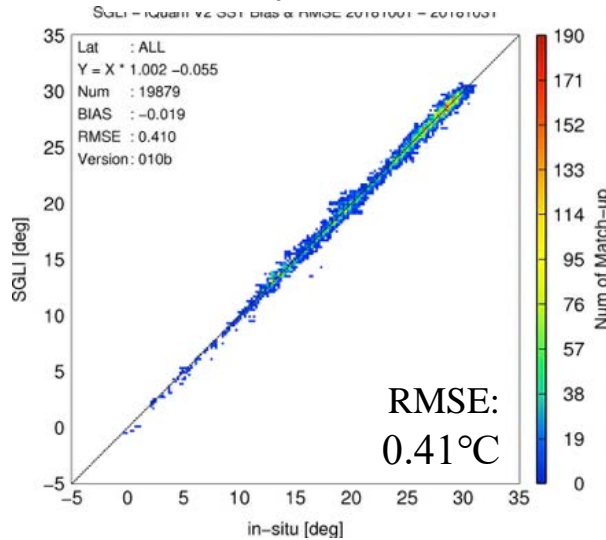


4. Validation Results of Ocean Products

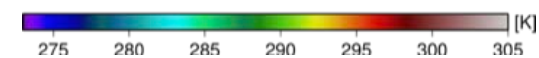
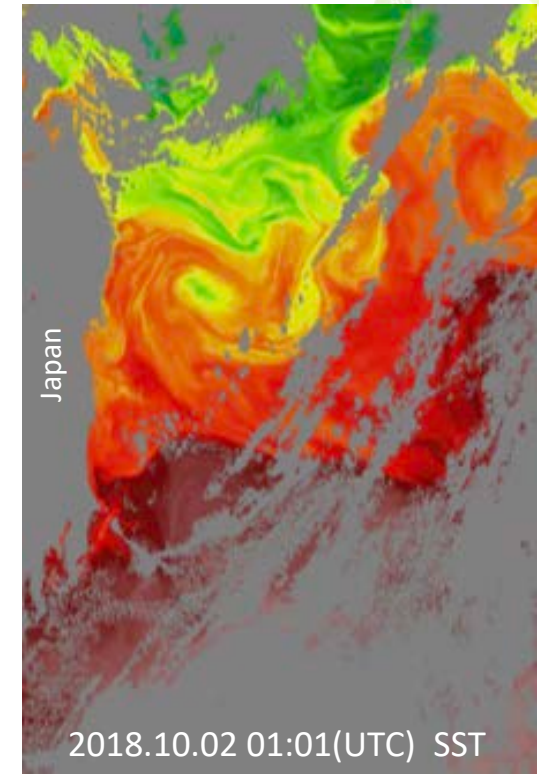
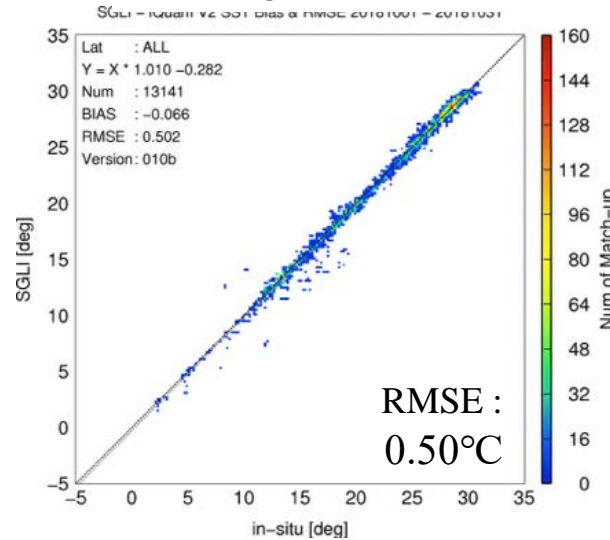
4.2 (g) Sea surface temperature (SST)

Validation Results:

Daytime



Nighttime



Spatial distribution of SGLI SST (the western North Pacific Ocean off Japan)

Estimated errors	Release threshold	Standard accuracy	Target accuracy
0.4°C (day) 0.5°C (night)	0.8°C (day)	0.8°C	0.6°C

Release threshold, Standard and Target accuracies are achieved