Ver.3 Ocean Products

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/m²/str/um (>600nm)	30% (<600nm) 0.25W/m²/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.

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

Major Updates of Algorithm:

- Added water leaving reflectance estimation model in the red(VN07) and near-infrared(VN10) bands using Linear combination index (LCI)
- Applied the vicarious calibration
- Improved sunglint correction method
- Added negative NWLR correction
- Revision of QA flags and Mask for statistics

Validation Method:

Validated the accuracies of predicted NWLR data from the SGLI algorithm comparing with in-situ data: ship observation, buoy(MOBY and BOUSSOLE) and AERONET-OC

Quality Control:

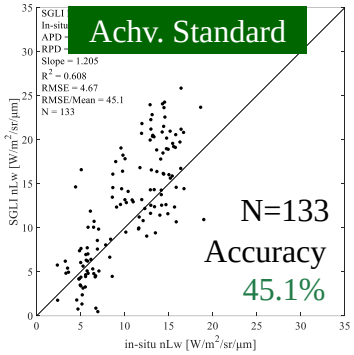
- *In-situ* data: time difference in ±3 hours to SGLI observation
- SGLI data: average of the data passed the following conditions within a 5 by 5 pixel centered the in-situ point (for details refer to Bailey *et al*, 2006)
    1. 13 or more pixels which satisfies the following conditions: aerosol optical thickness < 0.5, solar zenith angle < 70 degrees, NWLR of all channels > 0, CLDAFFCTD flag isn't set.
    2. Median CV (coefficient of variation) computed from NWLR_380-565nm and Taua_865nm less than 0.15

Period of Validation:

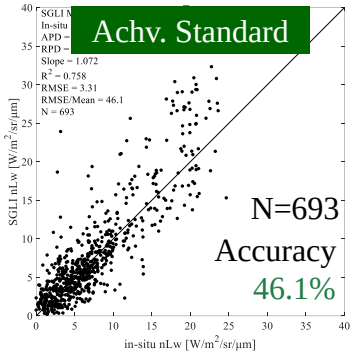
- January 1, 2018 - July 31, 2021

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

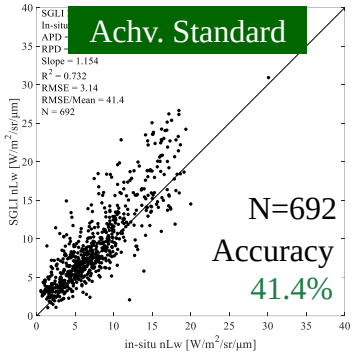
380nm



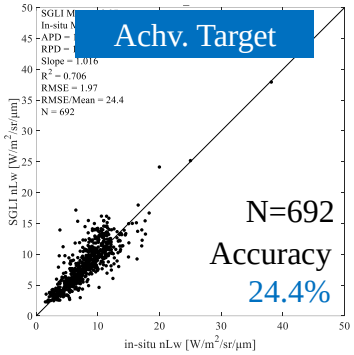
412nm



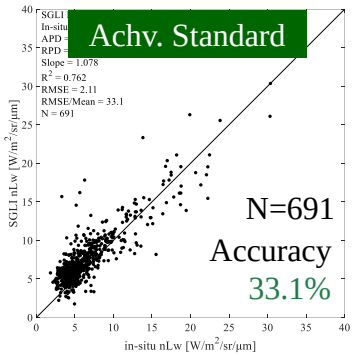
443nm



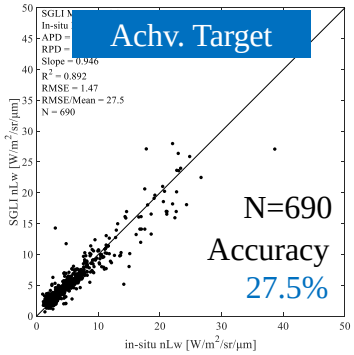
490nm



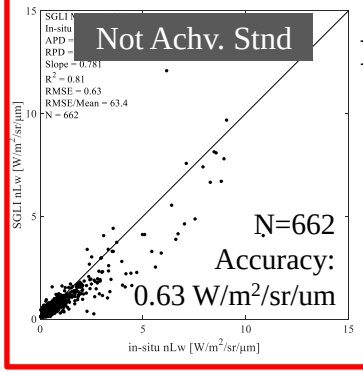
530nm



565nm

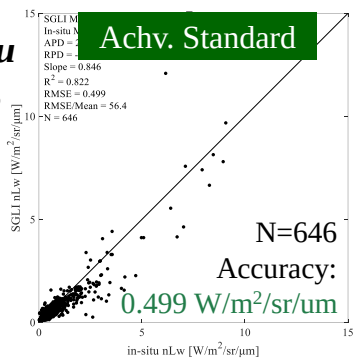


673.5nm



Remove *in-situ* data on lakes

673.5nm



- 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 NWLR Products: Normalized Water-Leaving Radiance - ACP

Major Updates of Algorithm:

- Added water leaving reflectance estimation model in the red(VN07) and near-infrared(VN10) bands using Linear combination index (LCI)
- Applied the vicarious calibration
- Improved sunglint correction method
- Added negative NWLR correction
- **Described correction formula for TAUA_670 and TAUA_865 in HDF attributes**

Validation Method:

Validated the accuracies of predicted aerosol optical thickness at 865nm(Taua_865) from the SGLI algorithm comparing with *in-situ* data of AERONET-OC and AERONET Maritime Aerosol Network (MAN)

Quality Control:

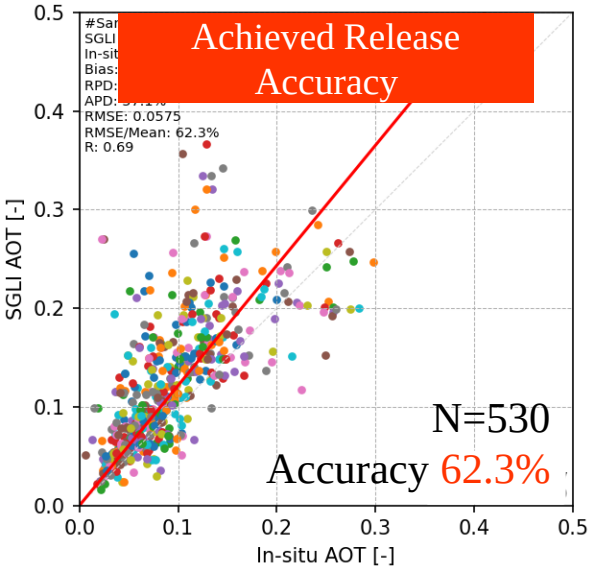
- *In-situ* data: time difference in ±3 hours to SGLI observation
- SGLI data: average of the data passed the following conditions within a 5 by 5 pixel centered the in-situ point (for details refer to Bailey *et al*, 2006)
  1. 13 or more pixels which satisfies the following conditions: aerosol optical thickness < 0.5, solar zenith angle < 70 degrees, NWLR of all channels > 0, CLDAFFCTD, GAMMMA-OUT and OVERITER flags aren't set.
  2. Coefficient of variation for TAUA_865 less than 0.05

Period of Validation:

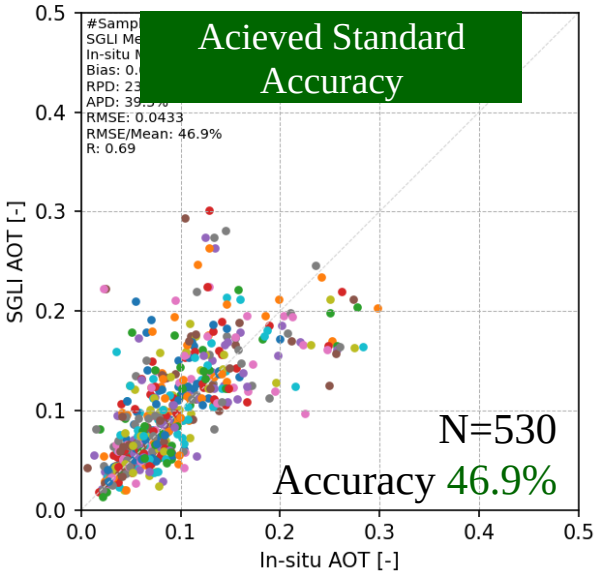
- January 1, 2018 - March 31, 2021

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

TAUA_865



TAUA_865_corrected



There is a positive bias because the aerosol model used in the atmospheric correction is optimized for NWLR not AOT estimation.

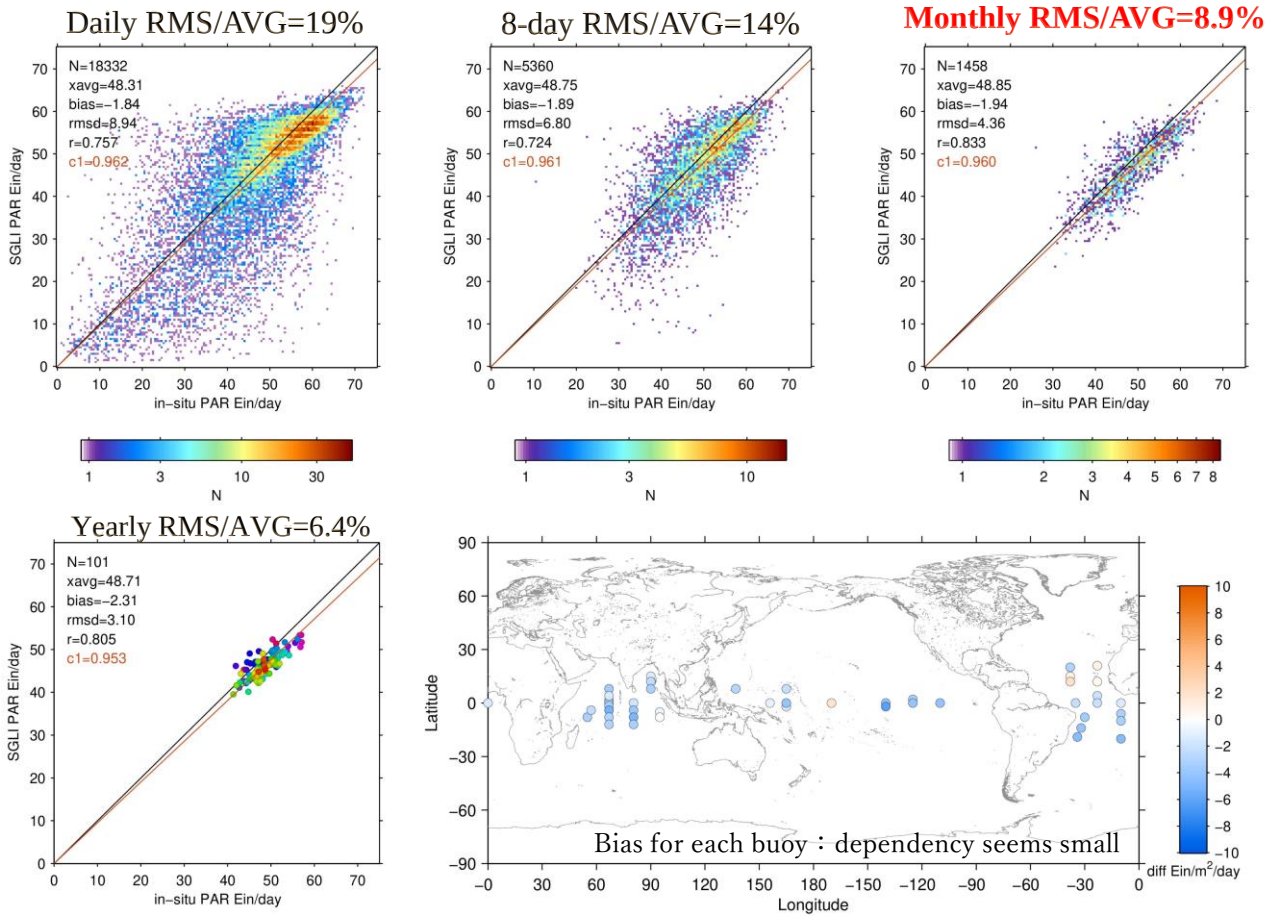
→ It is possible to obtain values closer to reality and achieve standard accuracy by applying the correction formula.

Correction formula：TAUA_865_corrected = 0.822 * TAUA_865 + 0.0

Validation Result	Release Accuracy	Standard Accuracy	Target Accuracy
[Ver. 2] 65%(not corrected) [Ver. 3] 46%(corrected)	80% (AOT@865)	50% (AOT@865)	30% (AOT@865)

Achieved Standard Accuracy

Photosynthetically available radiation



- Daily PAR is estimated by instantaneous transmittance from visible channels.
- Reference PAR is made from daily SWR observed by buoy, PAR/SWR ration estimated by Pstar-4 calculation and objective analysis water vapor data
- Achieved the target accuracy （No change from ver.2）

Validation result	Release accuracy	Standard accuracy	Target accuracy
[Ver.2] 9.5%→**[Ver.3] 8.9%**	20% (10km/month)	15% (10km/month)	10% (10km/month)

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

Major Updates of Algorithm:

- None of major updates

Validation Method:

Validated the accuracies of predicted CHLA data from the SGLI algorithm comparing with *in-situ* data(High Performance Liquid Chromatography: HPLC or fluorescence method) of ship observation.

Quality Control:

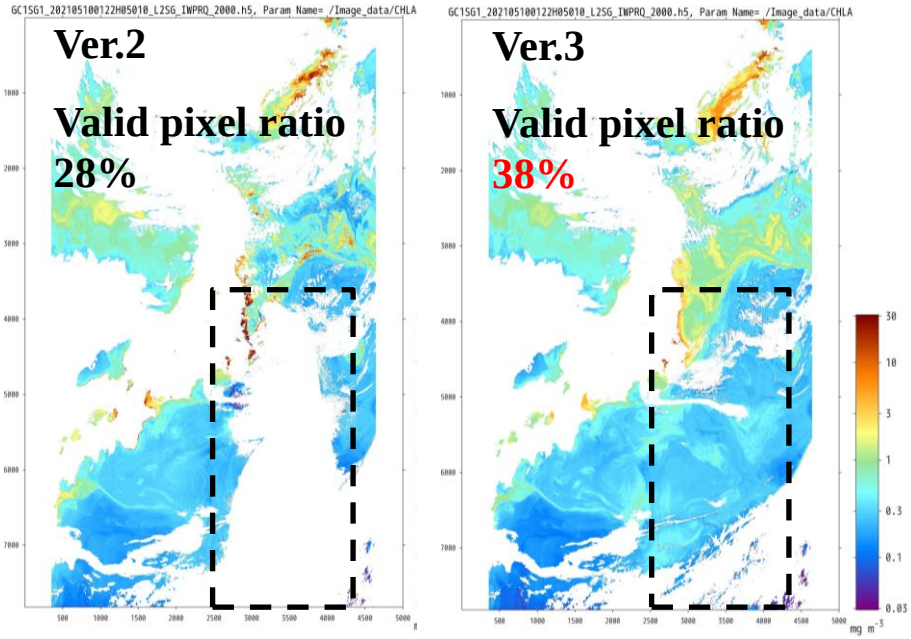
- ***In-situ* data:** time difference in ±3 hours to SGLI observation
- **SGLI data**: average of the data passed the following conditions within a 5 by 5 pixel centered the in-situ point
    1. 13 or more pixels which satisfies the following conditions: aerosol optical thickness < 0.5, solar zenith angle < 70 degrees, NWLR of all channels > 0, CLDAFFCTD flag isn't set.
    2. Median CV (coefficient of variation) computed from NWLR_380-565nm and Taua_865nm less than 0.15

Period of Validation:

- January 1, 2018 - December 31, 2020

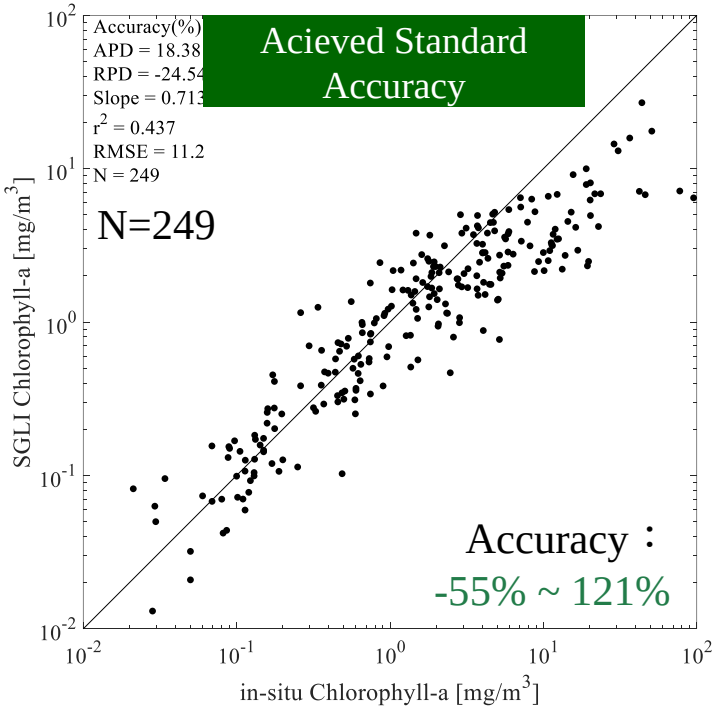
Validation Results of Ocean IWPR Products: Chlorophyll-a Concentration - CHLA

The coast of Japan (2021/05/10)



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

CHLA



- 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% →[Ver. 2] -58~137%	-60%~+150%(offshore)	-60%~+150%	-35%~+50%(offshore) -50%~+100%(coastal)

Validation Results of Ocean IWPR Products: Colored Dissolved Organic Matter - CDOM

Major Updates of Algorithm:

- None of major updates

Validation Method:

Validated the accuracies of predicted CDOM data from the SGLI algorithm comparing with *in-situ* data of ship observation.

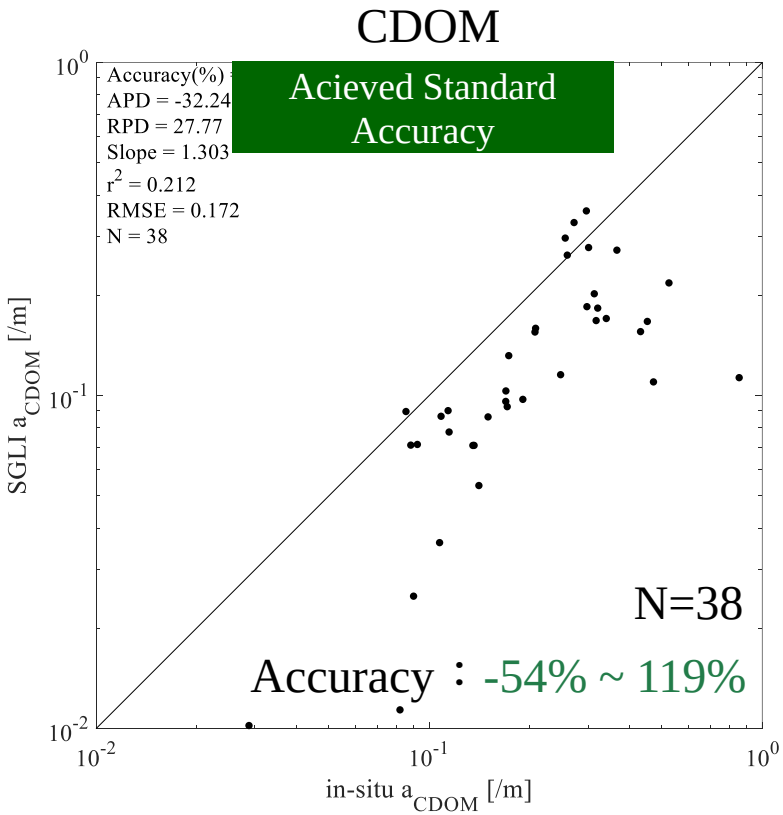
Quality Control:

- *In-situ* data: time difference in ±3 hours to SGLI observation
- SGLI data: average of the data passed the following conditions within a 5 by 5 pixel centered the in-situ point
  1. 13 or more pixels which satisfies the following conditions: aerosol optical thickness < 0.5, solar zenith angle < 70 degrees, NWLR of all channels > 0, CLDAFFCTD flag isn't set.
  2. Median CV (coefficient of variation) computed from NWLR_380-565nm and Taua_865nm less than 0.05

Period of Validation:

- January 1, 2018 - December 31, 2020

Validation Results of Ocean IWPR Products: Colored Dissolved Organic Matter - CDOM



- 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. 1] -52~107% →[Ver. 2] -55~121%	-60%~+150%(offshore)	-60%~+150%	-50%~+100%

Validation Results of Ocean IWPR Products: Total Suspended Matter - TSM

Major Updates of Algorithm:

- None of major updates

Validation Method:

Validated the accuracies of predicted TSM data from the SGLI algorithm comparing with *in-situ* data of ship observation.

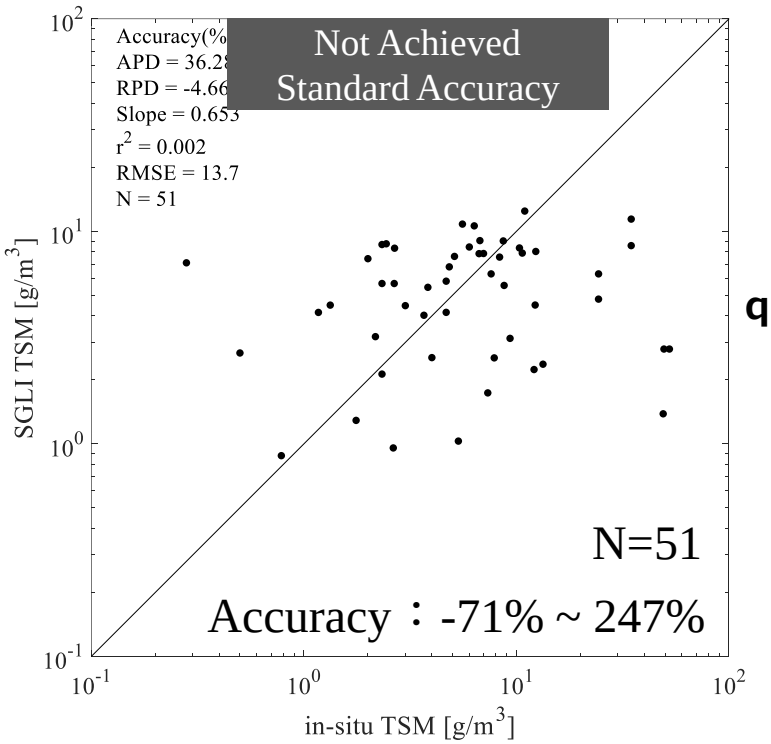
Quality Control:

- *In-situ* data: time difference in ±3 hours to SGLI observation
- SGLI data: average of the data passed the following conditions within a 5 by 5 pixel centered the in-situ point
  1. 13 or more pixels which satisfies the following conditions: aerosol optical thickness < 0.5, solar zenith angle < 70 degrees, NWLR of all channels > 0, CLDAFFCTD flag isn't set.
  2. Median CV (coefficient of variation) computed from NWLR_380-565nm and Taua_865nm less than 0.15

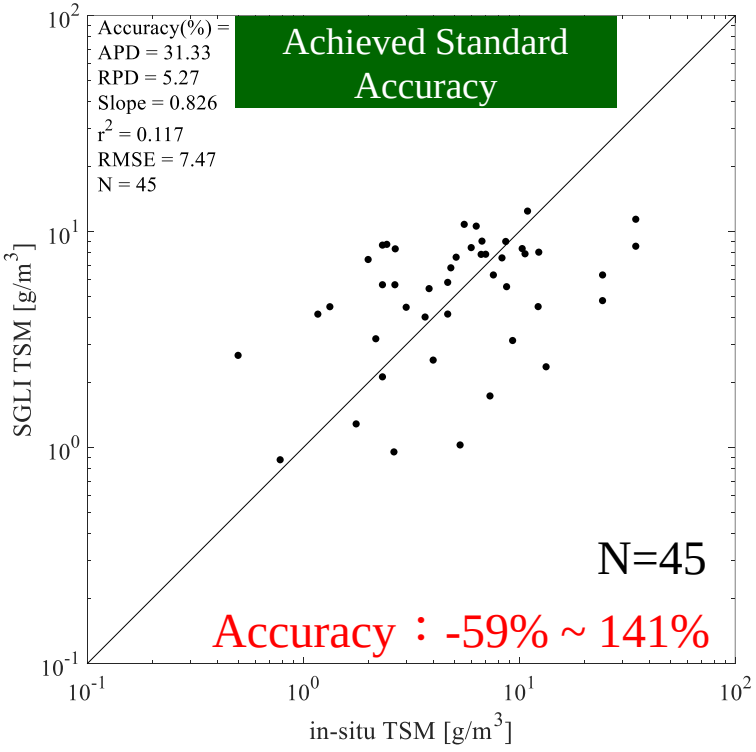
Period of Validation:

- January 1, 2018 - December 31, 2020

Validation Results of Ocean IWPR Products: Total Suspended Matter - TSM



***in-situ* data quality control**



Standard accuracy is achieved except when there are errors in in-situ data or when the TSM concentration is particularly high, as on the English Channel.
(See appendix for details on quality control.)

Validation Result	Release Accuracy	Standard Accuracy	Target Accuracy
[Ver. 2] -70~232% →[Ver. 3] -63~171%	-60%~+150%(offshore)	-60%~+150%	-50%~+100%

Validation Results of Ocean SST Products: Sea Surface Temperature - SST

Major Updates of Algorithm:

- Introduction of atmospheric optical thickness climatology to improve atmospheric correction.
- Cloud mask method:
  1. Improvements by introduction of 1.6 micron data and so on (Daytime) and
  2. Readjustment of thresholds for each quality level (Nighttime).
- Introduction of a preprocessing to reduce stripes and random noise in L1B data.

Validation Method:

SGLI SST Version 3 was validated by comparing SGLI SSTs with in-situ SSTs.

Quality Control:

- *In-situ* data: Moored and drifting buoys data provided by NOAA/iQuam (version 2.1). The data were screened based on the QC result of the iQuam. High qualified data (iquam flag = 0 and quality level = 5) were used for the validation.

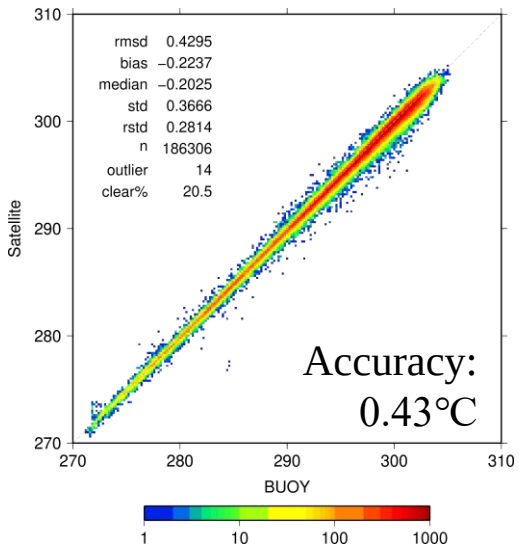
- SGLI data: SGLI SST V3 of the 1-km spatial resolution with the quality assured as good or acceptable: which are used to calculate L3 statistics. An SGLI SST nearest to the center was chosen for each 1hr x 3km collocation window centered on each buoy data and compared with the centered buoy data.

Period of Validation:

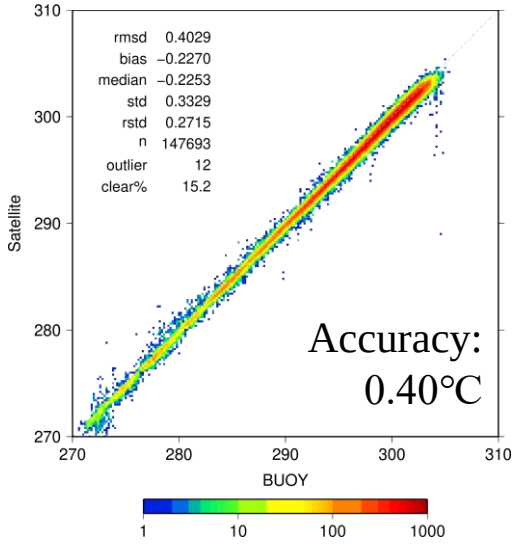
- January 1, 2018 - December 31, 2019

Validation Results of Ocean SST Products: Sea Surface Temperature - SST

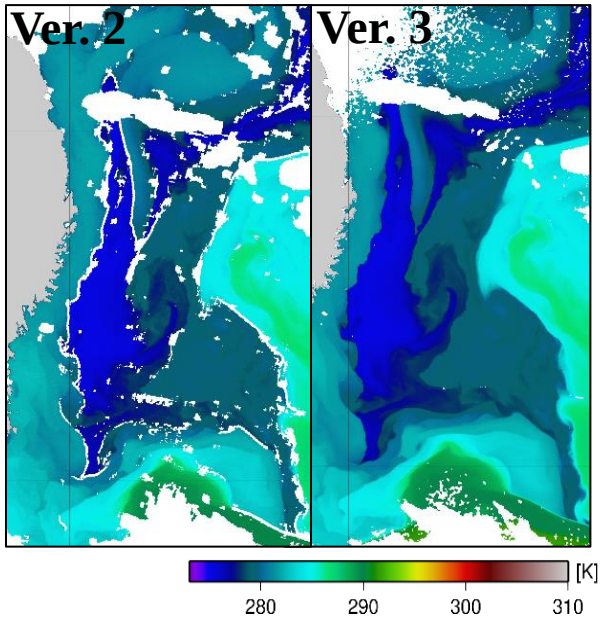
SST (Daytime)



SST (Nighttime)



Improved cloud mask



- The increased total number of valid pixels is due to the improved cloud masking.
- Cloud contaminations have been improved at night due to adjusted thresholds.

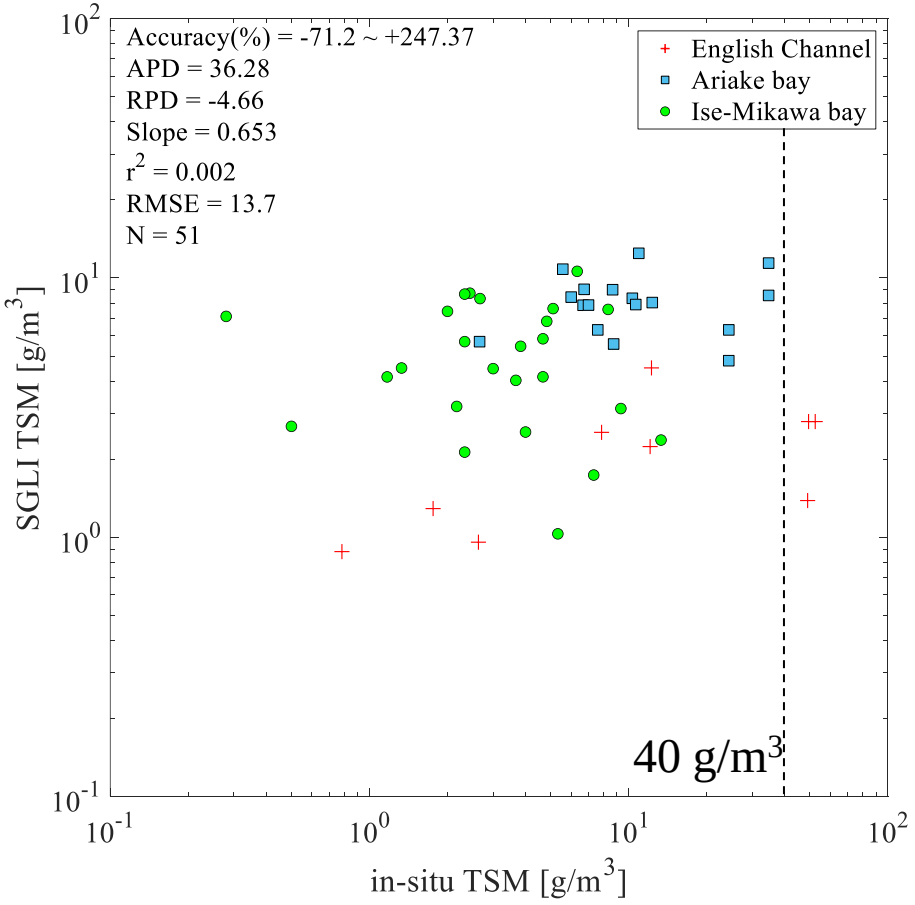
Modified cloud masking has also improved cloud masks at and around SST fronts during the daytime.

Validation Result	Release Accuracy	Standard Accuracy	Target Accuracy
0.4(V2) → 0.4℃ (daytime) 0.7(V2) → 0.4℃ (nighttime)	0.8℃ (日中)	0.8℃	0.6℃

Achieved Target Accuracy

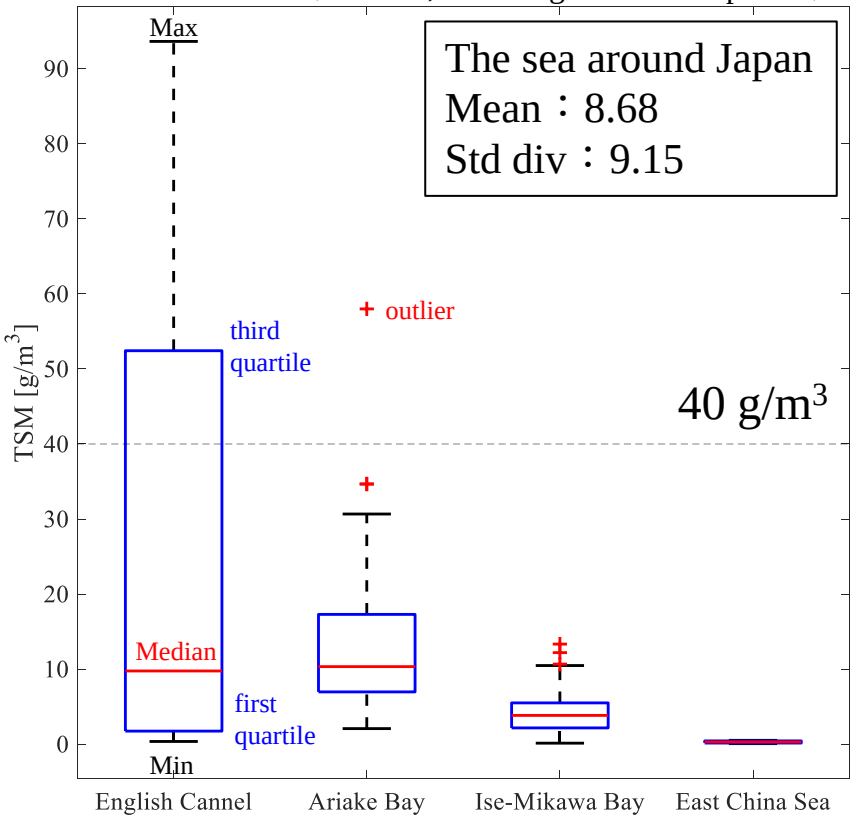
(Appendix) Validation Results of Ocean IWPR Products: Total Suspended Matter - TSM

TSM validation results color-coded by sea area.



Distribution of in-situ TSM by sea area

（All data, including non-matchup data）

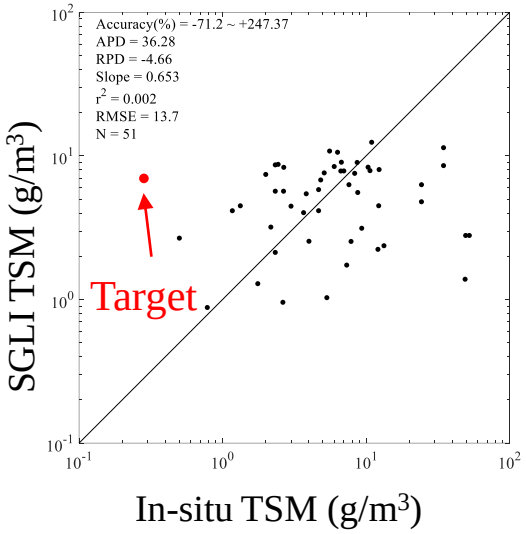


※The outlier is the value that is more than 1.5 times the quartile range away from the first and third quartiles.

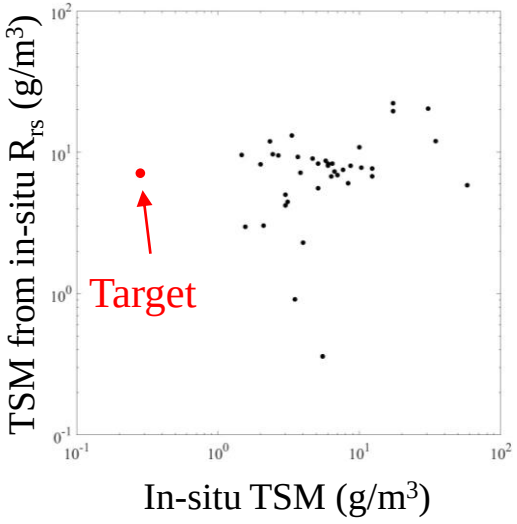
- TSM on the English Channel in spring are extremely high and rarely exceed 40 g/m3 on the sea around Japan.
- In this validation, *in-situ* data of TSM > 40g/m^3 is removed.

(Appendix) Validation Results of Ocean IWPR Products: Total Suspended Matter - TSM

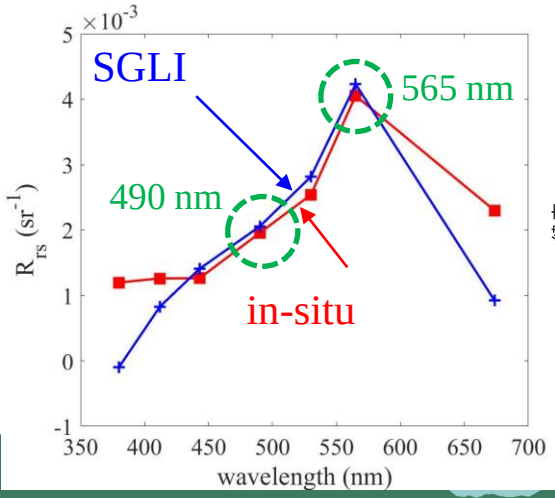
(A) *in-situ* TSM vs. SGLI TSM



(B) *in-situ* TSM vs. TSM estimated from *in-situ* R_{rs}



(C) Rrs comparison of the target point



(D) Water sampling points on the same day

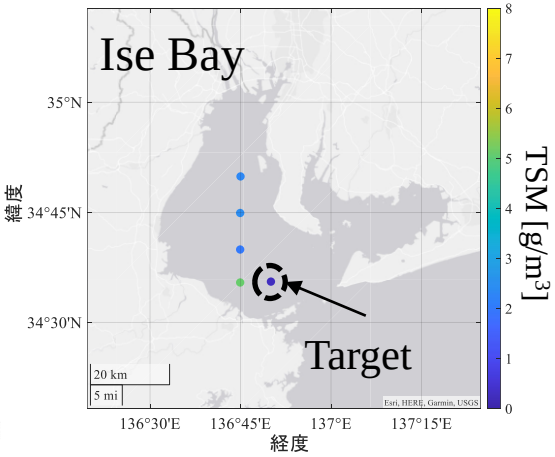


Table 1: Comparison of estimated and in-situ values for TSM and Chl-a

	TSM (g/m^3)	Chl-*a* (mg/m^3)
in-situ	0.28	36.55
SGLI	7.11	15.85

- Estimation error of R_{rs} (NWLR) is unlikely to be the cause of outlier of TSM estimate at the target point :
  - TSM estimation from in-situ Rrs at the TSM sampling point is far off (Figure B).
  - R_{rs} at 490 nm and 565 nm, which are necessary for TSM estimation, are close to in-situ R_{rs} (Figure C).
- High possibility of measurement error in in-situ TSM :
  - TSM at the near stations on the same day (Figure D) varied from 2 to 5 g/m3 , but Chl-a was similar at 21 to 44 mg/m3.
  - TSM value is too small for Chl-a (Table 1)

Removed as an outlier in this validation