Ver2. 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:

- Improved aerosol estimation method, sunglint correction method, in-water model
- Applied the vicarious calibration of version 2.0

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_865 nm less than 0.15

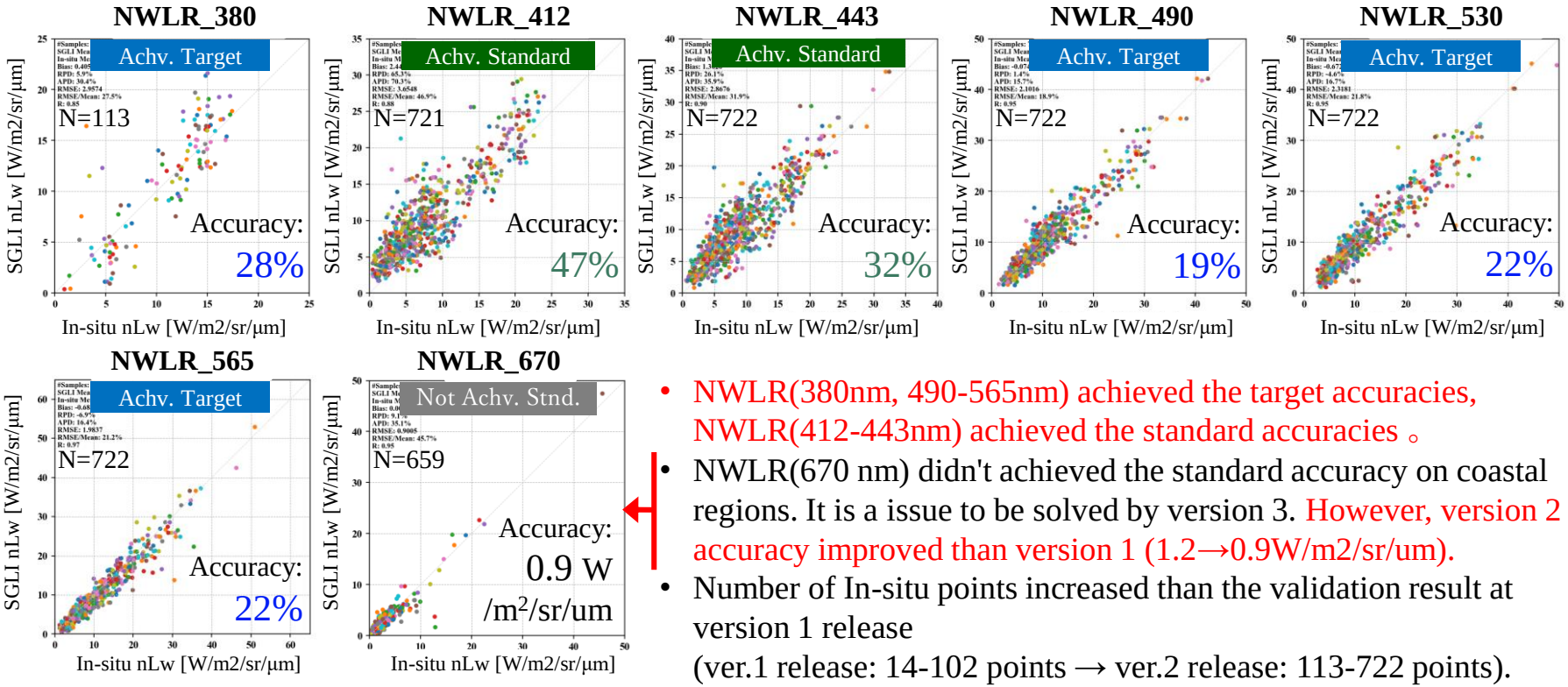
Period of Validation

- January 1, 2018-February 29, 2020

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.

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

- **Ver. 2: Validation Results**



- NWLR(380nm, 490-565nm) achieved the target accuracies, NWLR(412-443nm) achieved the standard accuracies 。
- NWLR(670 nm) didn't achieved the standard accuracy on coastal regions. It is a issue to be solved by version 3. However, version 2 accuracy improved than version 1 (1.2→0.9W/m2/sr/um).
- Number of In-situ points increased than the validation result at version 1 release
  (ver.1 release: 14-102 points → ver.2 release: 113-722 points).

Validation Result	Release Accuracy	Standard Accuracy	Target Accuracy
[Ver. 1]30-40 → **[Ver. 2] 19-47% (≤600nm)**	60% (443-565 nm)	50% (≤600 nm),	30% (≤600 nm)
[Ver. 1] 1.2 → **[Ver. 2] 0.9W/m²/sr/um (>600nm)**	N/A	0.5W/m2/sr/um (>600nm)	0.25W/m²/sr/um (>600nm)

Achieved the standard accuracies (≤600 nm)

Validation Results of Ocean NWLR Products : Atmospheric Correction Parameters - ACP

Major Updates of Algorithm:

- Improved aerosol estimation method, sunglint correction method, in-water model
- Applied the vicarious calibration of version 2.0

Validation Method:

Validated the accuracy of predicted aerosol optical thickness at 865 nm (Taua_865) from the SGLI algorithm comparing with *in-situ* data of AERONET-OC

Quality Control:

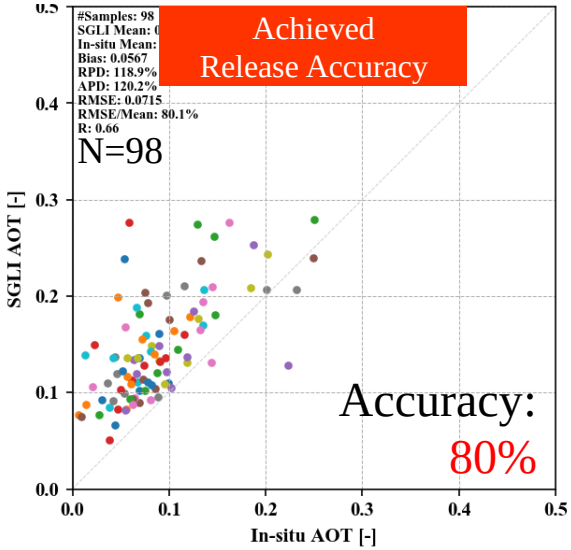
- ***In-situ* data**: time difference in ±3 hours to SGLI observation
- **SGLI data**: average of the data passed the following conditions within a 5 by 5 pixel centered the in-situ point (for details refer to Bailey *et al.*, 2006) :
  1. 13 or more pixels which satisfies the following conditions: aerosol optical thickness < 0.3, solar zenith angle < 70 degrees, NWLR of all channels > 0, CLDAFFCTD, GAMMA-OUT and OVERITER flags aren't set.
  2. Coefficient of variation for Taua_865 nm less than 0.05

Period of Validation

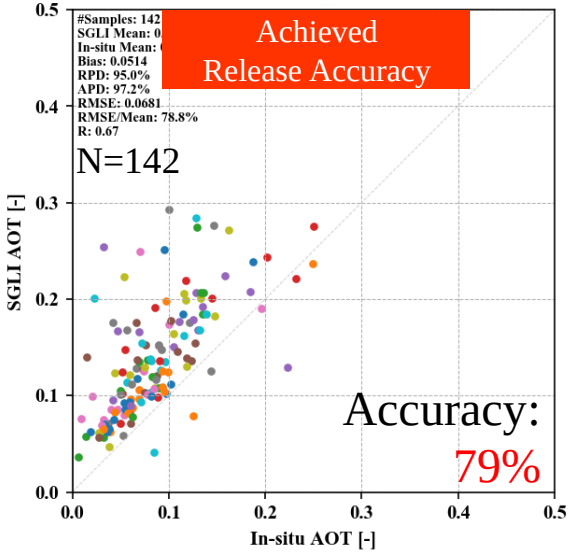
- January 1, 2018-February 29, 2020

Validation Results of Ocean Products:
- Atmospheric Correction Parameters: ACP

TAUA_865: Ver. 1 [for reference]



TAUA_865: Ver. 2



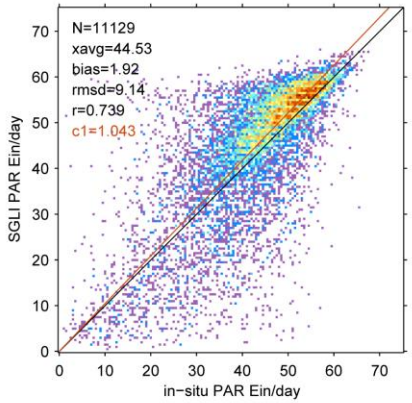
- ✓ Kept the release accuracy
- ✓ Increased the validation points than version 1

Validation Result	Release Accuracy	Standard Accuracy	Target Accuracy
[Ver. 1] 80% → **79% (AOT@865nm)**	80% (AOT@865nm)	50% (AOT@865nm)	30% (AOT@865nm)

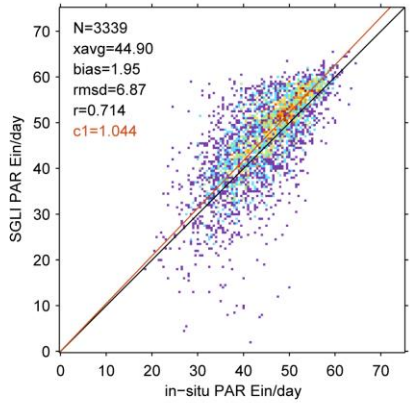
Achieved the release accuracy

Photosynthetically available radiation

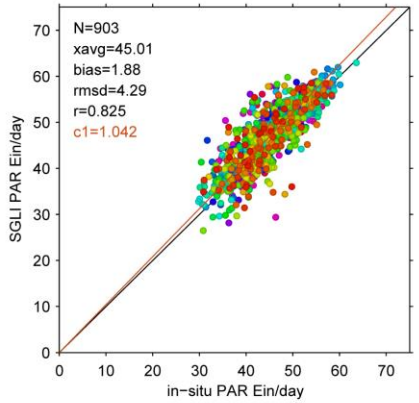
Daily RMS/AVG=21%

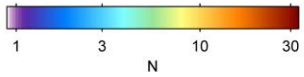


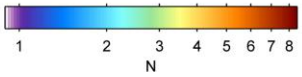
8-day RMS/AVG=15%



Monthly RMS/AVG=9.5%

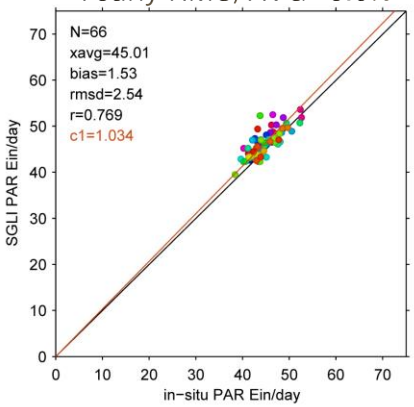


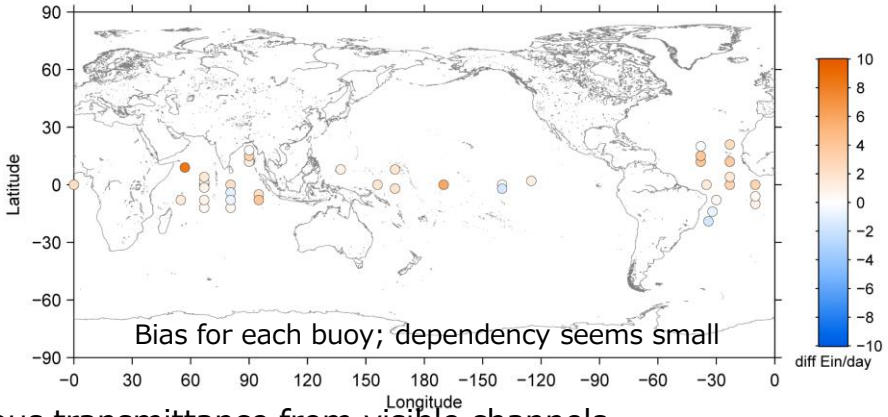




Colors indicate difference of the buoy

Yearly RMS/AVG=5.6%





Bias for each buoy; dependency seems small

- ✓ Daily PAR is estimated by instantaneous transmittance from visible channels.
- ✓ Reference PAR is made from daily SWR observed by buoy, PAR/SWR ratio estimated by Pstar-4 calculation and objective analysis water vapor data
- ✓ SGLI PAR will be able to achieve the target accuracy; improvement from Ver.1 is mainly from L1B improvement

Validation result	Release accuracy	Standard accuracy	Target accuracy
[Ver. 1] 15% (10km/month) →**[Ver.2] 9.5% (10km/month)**	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 accuracy 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:

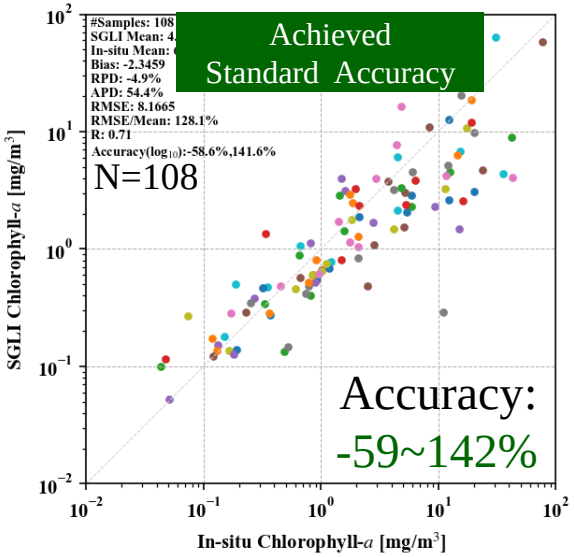
- ***In-situ* data**: time difference in ±3 hours to SGLI observation
- **SGLI data**: average of the data passed the following conditions within a 5 by 5 pixels centered the in-situ point :
  1. 13 or more pixels which satisfies the following conditions: aerosol optical thickness < 0.5, solar zenith angle < 70 degrees, NWLR of all channels > 0, CLDAFFCTD flag isn't set.

Period of Validation

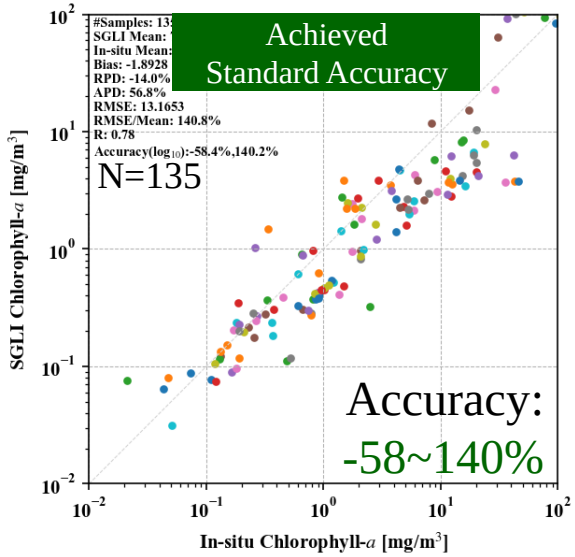
- January 1, 2018-February 29, 2020

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

CHLA: Ver. 1 [for reference]



CHLA: Ver. 2



- ✓ Increased the validation points
  (at time of Ver. 1 release: 9 points → 135 points)
- ✓ **Achieved the standard accuracy (include the coastal area)**

Validation Result	Release Accuracy	Standard Accuracy	Target Accuracy
[Ver. 1] -59~142% **→[Ver. 2] -58~140%**	-60~+150% (offshore)	-60~+150%	-35~+50% (offshore) -50~+100% (coastal)

Achieved the standard accuracy

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

Major Updates of Algorithm:

- Improved the empirical formula

Validation Method:

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

Quality Control:

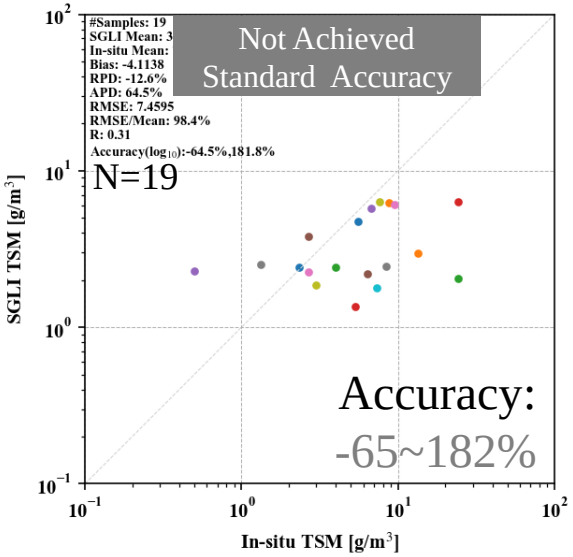
- ***In-situ* data**: time difference in ±3 hours to SGLI observation
- **SGLI data**: average of the data passed the following conditions within a 5 by 5 pixels centered the in-situ point:
  1. 13 or more pixels which satisfies the following conditions: aerosol optical thickness < 0.5, solar zenith angle < 70 degrees, NWLR of all channels > 0, CLDAFFCTD flag isn't set.

Period of Validation

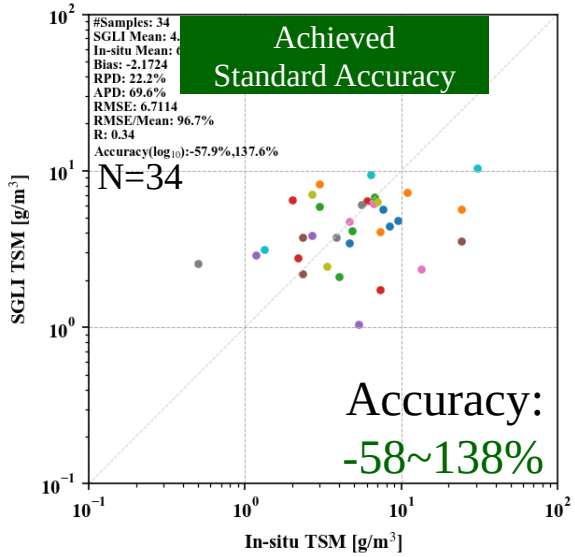
- January 1, 2018-February 29, 2020

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

TSM: Ver. 1 [for reference]



TSM: Ver. 2



- ✓ Validated for *in-situ* data (at time of version 1 release, *in-situ* data comparison was not possible)
- ✓ **Achieved the standard accuracy** (issue: continue to validate with wider range data)

Validation Result	Release Accuracy	Standard Accuracy	Target Accuracy
[Ver. 1] -65~182% →**[Ver.2] -58~138%**	-60~+150% (offshore)	-60~+150%	-50~+100%

Achieved the standard accuracy

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

Major Updates of Algorithm:

- Improved the empirical formula

Validation Method:

Validated the accuracy 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 (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_865 nm less than 0.05.

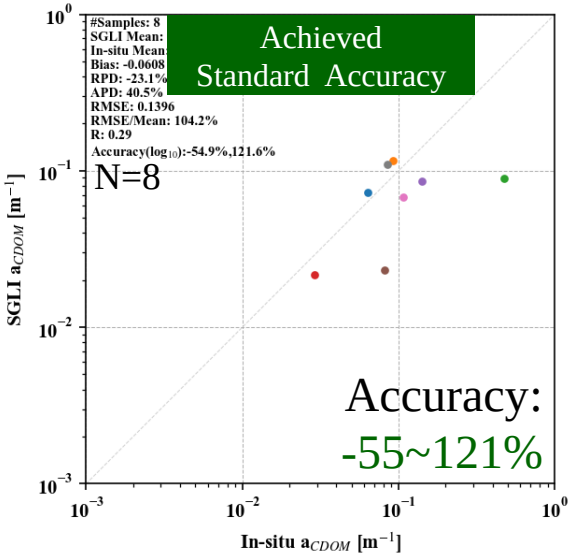
Period of Validation

- January 1, 2018-February 29, 2020

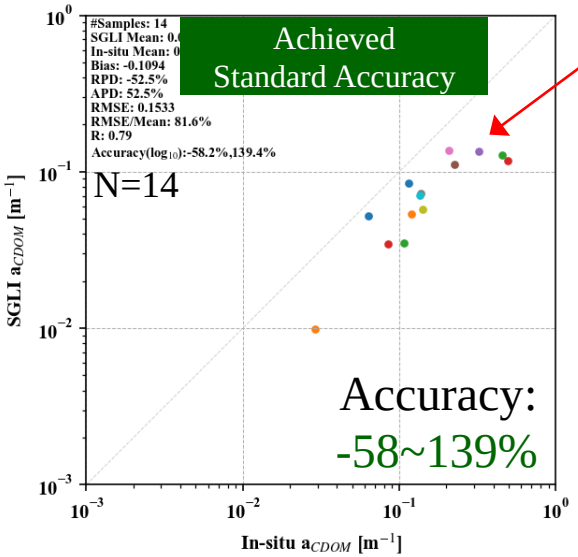
Reference: Bailey, S.W., and Werdell, P.J. (2006). A multi-sensor approach for the on-orbit validation of ocean color satellite data products. Rem. Sens. Environ. 102, 12-23.

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

CDOM: Ver. 1 [for reference]

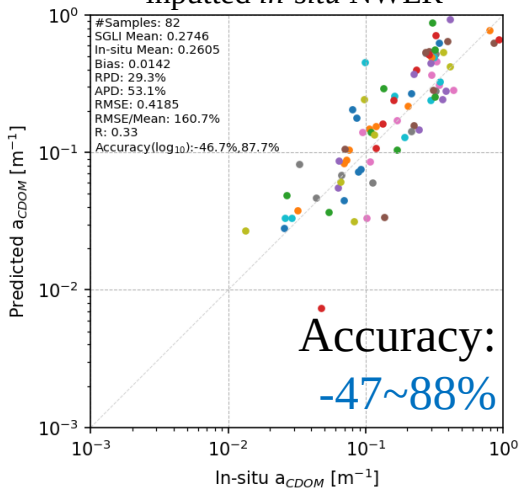


CDOM: Ver. 2



The underestimation bias is cased by the accuracies of the input NWLR. The bias doesn't occur when the in-situ NWLR is inputted, as shown below.

Ver. 2 CDOM
inputted *in-situ* NWLR



- ✓ Increased the validation points
  (at time of Ver. 1 release: 5points →14 points)
- ✓ **Achieved the standard accuracy (include the coastal area)**

Validation Result	Release Accuracy	Standard Accuracy	Target Accuracy
[Ver. 1] -55~121% **→[Ver.2] -58~139%**	-60~+150% (offshore)	-60~+150%	-50~+100%

Achieved the standard accuracy

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

Major Updates of Algorithm:

- Improved the cloud mask algorithm (modified cloud mask on coast and inland waters）
- Modified the probability density function of cloud mask

Validation Method:

Validated the accuracy of predicted SST data from the SGLI algorithm comparing with *in-situ* data of iQuam (Ship and buoy observations)

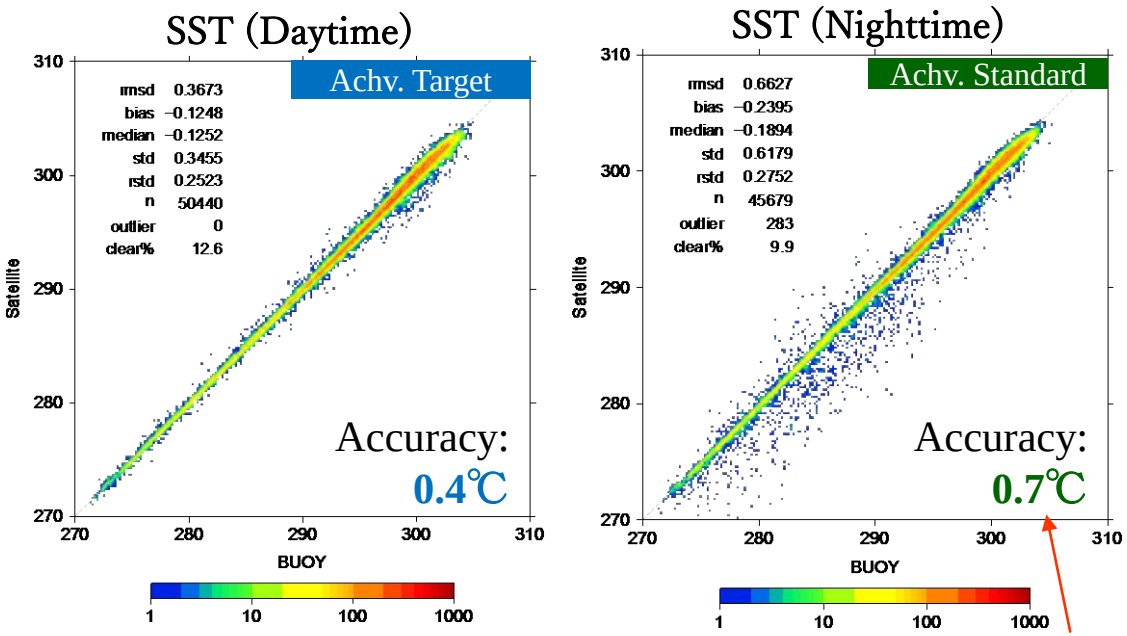
Quality Control:

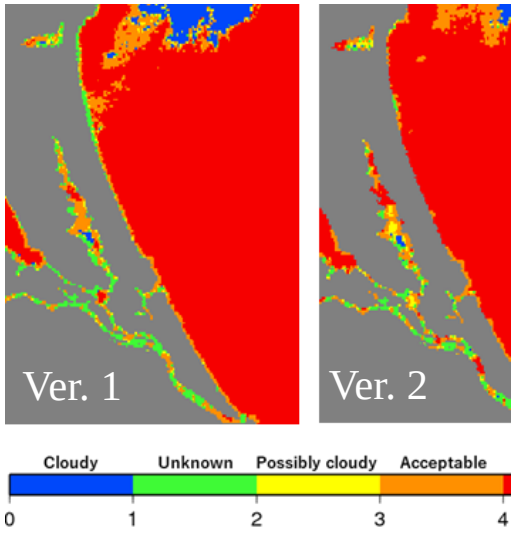
- ***In-situ* data**: bouy data from NOAA/ iQuam passed the following conditions:
  1. quality control level on iQuam: iquam_flag=0, quality_level=5
  2. time difference in ±30 minutes to SGLI observation
- **SGLI data**: average of the 1km data passed the following conditions within a 5 by 5 pixels (3 km) centered the in-situ point:
  1. Standard deviation of the 5 by 5 pixels < 1.0 degrees C
  2. Minimum and maximum temperature differences of the 5 by 5 pixels < 3.0 degrees C
  3. Temperature difference between SGLI and iQuam < 5.0 degrees C
  4. Flag of quality assurance: Good or Acceptable

Period of Validation

- January 1, 2018-Decenber 31, 2019

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





*) In the night time, more pixels on coastal areas became available by modified cloud detection algorithm, whereas the accuracy deteriorated by the slight increase of cloud affected pixels.

On coastal area, pixels masked on version 1 as shown green of the left figure became available as shown red of the right figure.

Validation Result	Release Accuracy	Standard Accuracy	Target Accuracy
[Ver.1] 0.4 → **[Ver.2] 0.4 ℃ (D)** [Ver.1] 0.5 → **[Ver.2] 0.7 ℃ (N)***	0.8℃ (Daytime)	0.8℃	0.6℃

Achieved the target accuracy in the daytime and the standard accuracy in the nighttime