Development of Water Environment Monitoring System for Coastal Areas and Lakes Using GCOM-C/SGLI (FY 2021)

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Objectives in FY 2019 - 2021

- ✓ To collect optical and water quality data in coastal areas and lakes where red tide, algal bloom, and blue tide occurs.
- ✓ To develop estimation methods of red tide, algal bloom and blue tide for SGLI based on observed data and radiative transfer simulation.
- ✓ To develop a water environment monitoring system by combining numerical simulation of hydrodynamic and ecosystem and SGLI data.

in situ data collection

CIMEL sun-photometer has been installed at Kemigawa offshore of Tokyo Bay. Using the nLw, AOD and SSA measured by AERONET-OC, we analyzed the condition which atmospheric correction results which become negative.

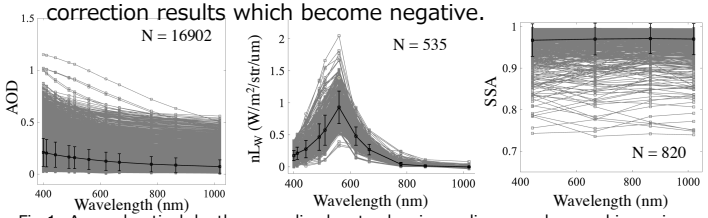

Fig.1: Aerosol optical depth, normalized water-leaving radiance and several inversion products measured from Sep. 2019 to present at Tokyo Bay

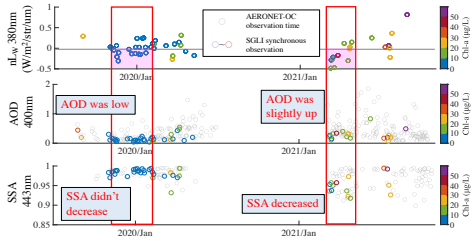

Fig.2: Time series of nLw, AOD, and SSA in Kemigawa, Tokyo Bay. It was confirmed that there were situations when the atmospheric correction error occurred when SSA was low, but there were also the situation when the atmospheric correction error occurred when chlorophyll-a was low and SSA was close to 1.

Radiative transfer simulation

Radiative transfer simulations using measured water quality and IOPs were carried out in three high turbid waters, such as Tokyo Bay, Kasumigaura, and the Gulf of Thailand.

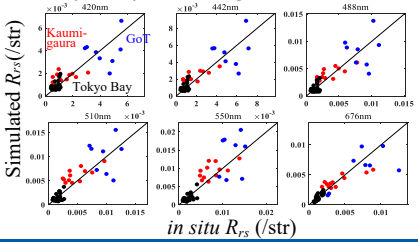

Fig 3: Comparison of simulated Rrs with measured values. In Tokyo Bay, where organic matter is dominant, Rrs can be calculated with relatively high accuracy. In Kasumigaura and the GoT, where scattering is high, the input of the backscattering probability (B) is important, and the accuracy of the calculation is improved by using literature values of B obtained in waters with similar optical properties.

Synthetic simulated data set

Based on in situ IOPs and AOPs, a synthetic dataset for optically complex turbid waters was developed by radiative transfer simulation.

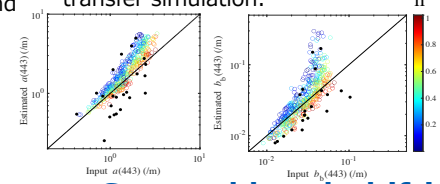

Fig.4: Estimation of a and bb by GIOP using synthetic data. The color bar represents n in the bio-optical model of bb. The results show that the accuracy of IOPs estimation changes with the change in n.

Spectral band-shifting method

Using unique Rrs dataset based on HICO satellite data. A Spectral Matching Technique based on HICO unique Rrs dataset (SMTH) was developed and evaluated the SMTH in comparison with other techniques using global dataset.

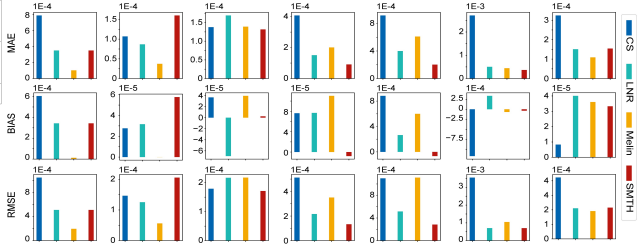

Fig.5: Overall Performance. The SMTH technique outperform other technique in green-red region of spectrum.

Validation of IOPs algorithms

Optical measurements (Rrs, IOPs) in a coastal area with high turbidity were used to validate various IOPs algorithms.

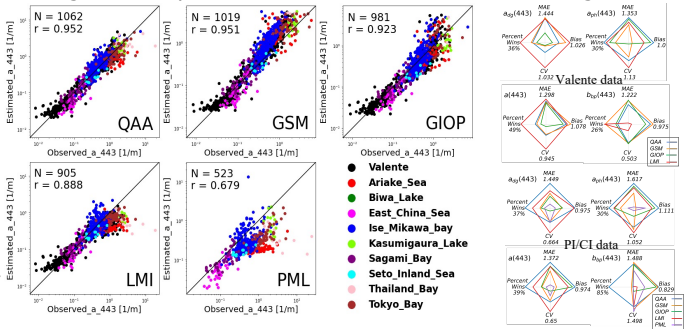

Fig.6: Relationship between estimated and measured IOPs by each algorithm and results of the algorithm evaluation index (Rader Chart) by Seegers et al., 2018. The validation was carried out using the Valente data set and the PI/CI coastal data set.

AC model for high turbid areas

A new atmospheric correction (AC) model based on IOPs model was developed. The accuracy of the calculation was high when Chl-a was low, but insufficient when Chl-a was high.

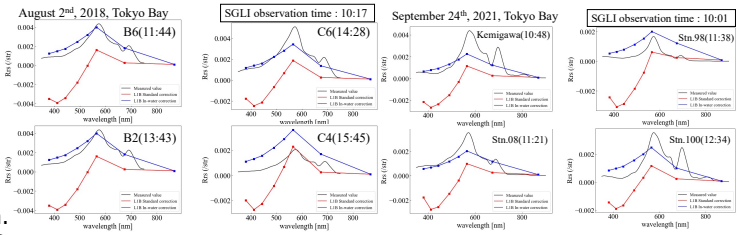

Fig.7: Comparison of measured and calculated Rrs on 2 August 2018 (low Chl-a) and 24 September 2021 (high Chla). The red line shows the standard atmospheric correction v1 and the blue line shows the suggested method.

Numerical simulation of blue tides

We developed a three-dimensional hydrodynamics and ecosystem model that can reproduce the leaching of hydrogen sulfide and the formation and disappearance of sulfur (blue tide).

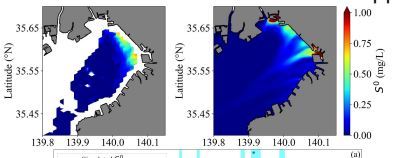

Fig.8: The figure is a comparison between the estimated sulfur (So) from satellite data (left figure) and the calculated So (right). The spatial extent of So in the surface layer can now be reproduced.

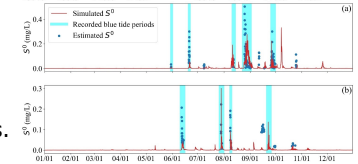

Fig. 9: Time series of simulated and estimated So in Kemigawa tower. The figure shows the comparison between the estimated sulfur from the turbidity sensor and the calculated sulfur. The timing of sulfur occurrences can be well simulated.

Summary

- ✓ Synchronized optical data with SGLI were collected by ship observation and AERONET-OC in coastal areas.
- ✓ Radiative transfer calculations in high turbid waters were carried out and B in high scattering waters were discussed.
- ✓ The applicability of the IOPs algorithm is investigated by generating optically complex synthetic data.
- ✓ A new spectral band-shifting method is proposed based on HICO-based LUT.
- ✓ The Valente data and the PI/CI coastal data were used to verify various IOPs algorithms.
- ✓ Developed an AC model suitable for high turbid waters.
- ✓ A numerical model can simulate blue tides was developed and compared with estimated So from satellite data.

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