SCSDCT: a gap-filled chlorophyll-a reconstruction and its application

Wenfang Lu[1,*], Tianhao Wang[2], Hengye Ren[1], Young-Heon Jo[3]

[1]School of Marine Sciences, Sun Yat-Sen University, Zhuhai, China
[2]College of Ocean and Earth Sciences, Xiamen University, Xiamen, China
[3]Department of Oceanography and Marine Research Institute, Pusan National University, Busan, 46241, Republic of Korea

* e-mail:luwf6@sysu.edu.cn

In the South China Sea (SCS), the high missing rate is a major concern in ocean color products such as the chlorophyll-a (CHL). These constraints inhibit the understanding of CHL variabilities at short (<seasonal) scales. Here we introduce a new gap-filling method to reconstruct data gaps in a daily CHL remote sensing product. We applied discrete cosine transform with penalized least square approach, yielding a 15-year full-coverage daily 4-km CHL product named SCSDCT. Against the cross-validation set and an independent observational dataset collected from 34 cruises, evaluations suggest that product has outperformed the widely applied classical data-interpolating empirical orthogonal function (DINEOF) method. The complete CHL product was analyzed with a particular focus on the intraseasonal (~30-60 days) control by the Madden-Julian Oscillation (MJO). Using this dataset and numerical model, we further confirm the role of MJO on the pelagic ecosystem structure and biological pump, leading to profound impacts on the SCS ecosystem. Our results emphasize the important role of MJO in regulating the ecosystem at intraseasonal scale, thus improving our comprehension of the nonsteady dynamics of ecosystems in the SCS.
Keywords: ocean color; remote sensing reconstruction; chlorophyll-a; South China Sea

Evaluation of Uncertainties in Particle Absorption Coefficient Measurements Based on the Filter-Pad Technique and Approaches for Their Reduction

Riku Goto[1*], Hiroto Higa[1], Shintaro Takao[2], Amane Fujiwara[3], Tomonori Isada[4], Toru Hirawake[5]

[1]Institute of Urban Innovation, Yokohama National University, Yokohama, Japan
[2]Earth System Division, National Institute for Environmental Studies, Tsukuba, Japan
[3]Research Institute for Global Change, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Yokosuka, Japan
[4]Field Science Center for Northern Biosphere, Hokkaido University, Akkeshi, Japan
[5]National Institute of Polar Research, Tachikawa, Japan

* e-mail:goto-riku-ts@ynu.jp

In ocean color remote sensing, the importance of Inherent Optical Properties (IOPs) in understanding the marine light environment and in the development and validation of inversion models has been widely recognized (Lee et al., 2006). One of the main IOPs, the particle absorption coefficient, is measured using methods such as the Internally mounted sample in integrating sphere (IS-mode) or the Transmittance mode (T-mode), both based on the filter-pad technique (IOCCG Protocol Series (Roesler et al., 2018)). The IS-mode measures the absorbance of filtered samples placed inside an integrating sphere, detecting photons scattered from the sample. This reduces measurement uncertainty due to scattering loss and enables relatively accurate measurements. In contrast, many past in situ measurements of absorption coefficients have been obtained with the T-mode. The T-mode cannot detect light scattered on the filter, leading to scattered light being treated as absorption, which is known to result in overestimation of the measured values (Stramski et al., 2015). Therefore, clear methodologies and protocols are required to maximize the quality of T-mode data, to identify and quantify sources of uncertainty, and to apply corrections (IOCCG Protocol Series (Roesler et al., 2018)).

In this study, we compared measurements of a_p, a_{NAP}, and a_{ph} obtained with T-mode and IS-mode across four types of samples: Tokyo Bay, the Arctic Ocean, the Gulf of Thailand, and cultured phytoplankton. The results showed that although correlations were observed between values obtained from both modes, the slopes and intercepts differed among water bodies, suggesting that it is difficult to represent all regions with a single linear regression. On the other hand, in specific regions such as Tokyo Bay, the slopes of a_p, a_{NAP}, and a_{ph} tended to be expressed by nearly common proportional constants. Furthermore, by using a_{NAP}—which strongly reflects scattering—as an indicator, the potential was demonstrated to correct T-mode values of a_p.

Keywords: IOPs, light absorption coefficient, filter-pad technique, T-mode, IS-mode

Development of an IOP Ensemble Algorithm (IEA) for Estimating IOP Based on Water Mass Classification in Coastal Areas with High Turbidity

Sotaro Aburadani[1*], Hiroto Higa[2], Joji Ishizaka[3], Victor S. Kuwahara[4], Salem Ibrahim Salem[5]

[1]Former Department of Civil Engineering, Yokohama National University, Yokohama, Japan
[2]Institute of Urban Inovation, Yokohama National University, Yokohama, Japan
[3]Institute for Space-Earth Environment Research, Nagoya University, Nagoya, Japan
[4]Faculty of Education & Graduate School of Engineering, Soka University, Tokyo, Japan
[5]Faculty of Engineering, Kyoto University of Advanced Science, Kyoto, Japan

* e-mail:aburadni-sotaro-pz@outlook.jp

In ocean remote sensing, inherent optical properties (IOP) represent the light absorption and scattering characteristics of various marine substances such as phytoplankton and colored dissolved organic matter (CDOM). IOP is recognized as providing biogeochemically important information for estimating ocean primary production and carbon storage, as well as for detecting harmful algal blooms (Werdell et al., 2018).

IOP is estimated through inversion from Remote Sensing Reflectance (Rrs), and various algorithms for IOP estimation have been developed (Lee et al., 2002; Garver and Siegel., 1997; Hoge and Lyon., 1996., Smyth et al., 2006). However, IOP estimation is not a mathematically one-to-one relationship, and obtaining solutions via radiative transfer theory is difficult, resulting in known estimation uncertainties (Defoin-Plate et al., 2007). Particularly in optically complex coastal areas, it has been reported that the assumptions and approximations used in inversion limit applicability to specific concentration ranges, regions, and seasons, making transfer to different water bodies challenging (Najah et al. 2021). While globally acquired optical measurements have been used to validate conventional IOP estimation algorithms, challenges include insufficient dataset samples and limited water body coverage (IOCCG., 2006; Brewin et al., 2015). The applicability of algorithms capable of comprehensively covering water bodies with diverse optical characteristics, such as coastal areas with large dynamic ranges of water quality changes, remains largely unclear.

Therefore, this study targeted the global scale, including highly turbid coastal areas. It performed water mass classification based on IOP intensity using hierarchical clustering. Five semi-analytical algorithms were applied to each cluster to clarify the applicability of the algorithms to the optical characteristics of the water masses. Furthermore, by combining each algorithm using principal component regression with estimated values from each IOP estimation algorithm as explanatory variables and measured values as target variables, and optimizing using AIC (Akaike Information Criterion), we developed an IOP Ensemble Algorithm (IEA) that achieves greater versatility and accuracy than existing algorithms.

Keyword: Remote sensing,　IOP Estimation Algorithm，　Clustering

Spatial Analysis Based on Water Mass Classification Using GCOM-C/SGLI Inherent Optical Properties (IOPs) in Tokyo Bay and Sagami Bay, Japan

Kana Soematsu[1] , Natsuki Ichimura[2] , Hiroto Higa[3] , Salem Ibrahim Salem[4]

[1] Department of Civil Engineering, Yokohama National University, Yokohama, Japan
[2,3] Institute of Urban Inovation, Yokohama National University, Yokohama, Japan
[4] Earth Observation Science and Applications, Plymouth Marine Laboratory, Plymouth, UK

* e-mail:soematsu-kana-fw@ynu.jp

Coastal areas are sites of active primary production due to nutrient and organic matter influx via rivers, exerting a significant influence on the global carbon cycle. Sagami Bay is one of the major bays along the Pacific coast in southern Kanto, Japan. It is a water body where primary production undergoes complex changes due to the meandering Kuroshio Current, nutrient and organic matter inflow from rivers, and the advection of water masses containing highly concentrated phytoplankton originating from Tokyo Bay. Many aspects of the spatial behavior of primary production in Sagami Bay and the processes governing its fluctuations remain poorly understood. Analysis of the spatiotemporal behavior of primary production using satellite data is considered effective.

This study utilizes satellite data from the climate change observation satellite GCOM-C/SGLI (Global Change Observation Mission-Climate/Second-generation Global Imager) to separate optical water masses based on inherent optical properties (IOPs). This approach aims to clarify the complex water mass behavior in Sagami Bay and Tokyo Bay, and elucidate the spatial variation factors of primary production.

First, using SGLI data acquired from 2018 to 2024, we estimated phytoplankton (aph), non-biological particles (aNAP), the absorption coefficient of colored dissolved organic matter (aCDOM), and the backscattering coefficient of particles (bbp). The SGLI data used in this study were obtained as Level 2 products (Normalized Water-Leaving Radiance, NWLR) from JAXA's G-Portal. These were converted to remote sensing reflectance (Rrs) by dividing the extraterrestrial solar irradiance (Fo). For IOPs estimation, the Quasi-Analytical Algorithm (QAA) was employed, using the Rrs derived from SGLI data as input. Subsequently, based on the estimated IOPs, we analyzed the classification and spatiotemporal changes of water masses originating from land (due to river inflow), open ocean (due to Kuroshio meandering), and Tokyo Bay. We identified and examined their relationship with seasonal meteorological changes.

Keywords: Inherent Optical Properties（IOPs）, GCOM-C/SGLI, Primary Production, Coastal Areas, Sagami Bay, Tokyo Bay

Regionally Optimized Optical Water Type Classification for the Korean Seas Using Fuzzy C-Means Clustering

Jungho Im[1*], Sihun Jung[1], So-Hyun Kim[1]

[1]Department of Civil, Urban, Earth, and Environmental Engineering, Ulsan National Institute of Science and Technology (UNIST), Ulsan, South Korea

* e-mail: ersgis@unist.ac.kr

The optical properties of seawater are primarily controlled by the combined effects of phytoplankton, suspended particulate matter, and dissolved organic matter, which together provide a comprehensive indicator of water quality. Accurate classification of optical water types (OWTs) is therefore essential for characterizing regional environments and improving the reliability of ocean color products. The marine environment around the Korean Peninsula exhibits pronounced differences in water clarity, with the highly turbid Yellow Sea contrasting with the clear waters of the East Sea. Global OWT schemes and the Case-1/Case-2 classification are inadequate for such conditions, as they oversimplify optical complexity and show reduced robustness in coastal waters with high turbidity. The aim of this study was to develop a regionally optimized OWT framework for the Korean seas. We applied Fuzzy C-means clustering to six spectral bands (412, 443, 490, 510, 560, and 665 nm) of remote-sensing reflectance from the ESA Ocean Colour–Climate Change Initiative. This analysis yielded six distinct OWTs. The results demonstrated systematic increases in reflectance amplitude with rising turbidity, and a marked enhancement at 665 nm in the most turbid classes. Unlike global OWT systems that define 12–16 categories, the six-class framework derived here reflects the unique regional characteristics of the Korean seas while reducing redundancy. This region-specific classification provides a robust basis for enhancing the accuracy of chlorophyll-a and suspended matter retrievals in optically complex waters. The approach presented in this study can serve as a model for developing tailored OWT frameworks in other coastal regions where global classifications are insufficient.

Keywords: Ocean color, Coastal waters, Water quality, Turbidity

Simultaneous retrieval of water quality indicators using GCOM-C satellite and Machine learning models

Yuuto Sasaki[1*], Salem Ibrahim Salem[2], Muhammad Salah[1], Hiroto Higa[4], Joji Ishizaka[5]

[1] Graduate School of Engineering, Kyoto University of Advanced Science, Kyoto, Japan
[2] Plymouth Marine Laboratory, Plymouth UK
[4] Faculty of Urban Innovation, Yokohama National University, Yokohama, Japan
[5] Institute for Space-Earth Environmental Research (ISEE), Nagoya University, Japan
[*] e-mail: 2024mm10@kuas.ac.jp

In recent years, water quality deterioration caused by various factors—including pollution from domestic wastewater, rising water temperatures, and decreased oxygen concentrations due to eutrophication—has become a significant concern, severely impacting ecosystems and human livelihoods. Satellite observation provides a powerful tool for monitoring water quality indicators through consistent measurements and global coverage. Satellite remote sensing reflectance (Rrs) is governed by all components within a water body. Therefore, this study focuses on the simultaneous estimation of chlorophyll a (Chla), total suspended matter (TSM), and the absorption of colored dissolved organic matter at 440 nm (aCDOM440) as water quality indicators. Acquiring multiple water quality indicators simultaneously reduces interdependencies and noise between indicators, improving model accuracy. To our knowledge, this represents pioneering research on multi-parameter retrieval using the second-generation Earth observation instrument (SGLI) aboard the Global Change Observation Mission-Computer (GCOM-C) satellite. We developed machine learning models, including a one-dimensional convolutional neural network (1D-CNN) model that takes SGLI's visible Rrs product (6 spectral bands) as input and outputs the three water quality indicators (i.e., Chla, TSM, and aCDOM440), as well as Light Gradient Boosting Machine (LightGBM) model and Extreme Gradient Boosting (XGBoost) model. The model was trained using 7,974 *in situ* observations, integrating the GLORIA dataset with observational data from Japan, Thailand, and Vietnam, ensuring global coverage. The proposed machine learning models were also evaluated compared with empirical algorithms. The validation results indicate that the XGBoost model demonstrated superior performance across three water quality indicators. For example, regarding MAE, the XGBoost model achieved reductions of up to 2.2% for Chla, up to 22% for TSM, and up to 28% for aCDOM440 compared to other models. This presentation provides a detailed description of the dataset, comparisons with

other algorithms and machine learning models, validation results using actual SGLI data, and validation using time-series data.

Machine Learning-Based pCO_2 Estimation in the East China Sea for Spatiotemporal Patterns from 2003 to 2023: Optical Water Classification

DoHyeon Kwon[1,2], HuiTae Joo[2], YoungHeon Jo[1*], JiSuk Ahn[2], HwaEun Jung[2]
[1] Department of Oceanography, Pusan National University, Busan, Republic of Korea
[2] Climate Change Research Division, National Institute of Fisheries Science, Busan, Republic of Korea

* e-mail:joyoung@pusan.ac.kr

The East China Sea (ECS) is a critical region in the marine carbon cycle, but its complex physical and biogeochemical processes, combined with the coexistence of optically heterogeneous water masses, have limited the accurate estimation of sea surface partial pressure of carbon dioxide (pCO_2) from satellite data. This study presents an improved framework that first classifies the region into two distinct water masses Case I (clear waters), Case II (turbid waters), based on their inherent optical properties, specifically the normalized water-leaving radiance at 555nm (nL_w555). Using satellite and reanalysis data from 2003 to 2023, an optimized machine learning algorithm, Categorical Boosting (CatBoost), was developed and tailored to the unique characteristics of each water mass. The resulting model demonstrated high predictive accuracy, achieving an overall coefficient of determination (R^2) of 0.93 and a root mean square error (RMSE) of 12.59 μatm. This method substantially improved performance in the challenging Case II region (RMSE = 18.87 μatm), reducing estimation errors by over 60% compared to previous algorithms. Analysis of the ECS pCO_2 time series revealed that the two water masses function as distinct systems. Time-series decomposition showed that Case I and Case II exhibit fundamentally different relationships with seasonal drivers, such as Sea Surface Salinity (SSS), and long-term climate phenomena like the El Niño–Southern Oscillation (ENSO). While the ECS acts as a net annual CO_2 sink (−2.31 mmol $m^{-2}day^{-1}$), the mechanisms differ significantly between the two regions. Case I is predominantly controlled by thermodynamic effects, whereas Case II is governed by a complex interplay of physical mixing and riverine inputs. These findings demonstrate that classifying water masses based on optical properties provides an effective strategy for resolving carbon dynamics in the complex ECS.

Keywords: East China Sea, Remote sensing, Carbon Dioxide Partial Pressure, Optical Water Classification, Sea-Air CO_2 Flux

Local Tuning of Satellite Chlorophyll-a in Coastal Waters using Simple Statistical and Machine Learning Techniques

Joji Ishizaka[1] *, Hiroki Tsukamoto[2], Masataka Hayashi[2], Ryota Kikuchi[1]

[1]Institute for Space-Earth Environmental Research (ISEE), Nagoya University, Japan
[2]Science and Technology (SAT), Japan

* e-mail:joji.ishizaka@gmail.com

In coastal semi-enclosed waters, the accuracy of satellite-derived chlorophyll-a is often poor due to the errors in both atmospheric correction and in-water algorithms. In Japan, the use of satellite chlorophyll-a data is still limited, partly becuase some stakeholders have observed discrepancies between in-site and satellite-derived chlorophyll-a. While the development of more complex algorithms is ongoing, it will take time before they become practical. In the meantime, it is useful to improve existing satellite chlorophyll-a products using available in-situ observations of chlorophyll-a. In this study, we aim to improve satellite chlorophyll-a in the Ise Bay, Japan, using simple statistical and machine learning techniques.

Keywords: Satellite chlorophyll-a, local tuning, enclose sea, Ise Bay (up to 5 words)

Machine Learning boosts robust ocean color retrieval in complex atmosphere and ocean systems: taking coastal Forel-Ule Index mapping as an example

Ruofei Liu[1], Dingcheng Ye[1], Jinzhao Xiang[1], Binyu Wang[2], Shenglei Wang[3], Rongjie Liu[4], Yanlong Chen[5], Wee Cheah[6], Keunyong Kim[7], Tingwei Cui[1*]

[1]School of Atmospheric Sciences, School of Artificial Intelligence, Sun Yat-Sen University & Southern Marine Science and Engineering Guangdong Laboratory (Zhuhai) & Key Laboratory of Tropical Atmosphere-Ocean System, Ministry of Education, Zhuhai 519082, China
[2] College of Optoelectronic Information Engineering, Ocean University of China, Qingdao 266100, China
[3]International Research Center of Big Data for Sustainable Development Goals, Beijing 100094, China
[4]First Institute of Oceanography, Ministry of Natural Resources, Qingdao 266061, China (e-mail: liurj@fio.org.cn)
[5]National Marine Environmental Monitoring Center, Dalian 116000, China (e-mail: ylchen@nmemc.org.cn).
[6]Institute of Ocean and Earth Sciences (IOES), Universiti Malaya, 50603 Kuala Lumpur, Malaysia. (e-mail: wee.cheah@um.edu.my).
[7]Korea Ocean Satellite Center, Korea Institute of Ocean Science & Technology, Busan, 49111, Republic of Korea

* e-mail:cuitw@mail.sysu.edu.cn

Accurate satellite ocean color retrieval in complex atmosphere-ocean systems faces significant challenges. Traditional algorithms relying on remote sensing reflectance ($R_{rs}(\lambda)$) are hindered by considerable uncertainty or invalid values due to the imperfectness or failure of atmospheric correction. This study addresses these limitations by leveraging Machine Learning (ML) to explore Rayleigh-corrected reflectance ($R_{rc}(\lambda)$) data towards accurate Forel-Ule Index (FUI) retrieval in the complex atmosphere-ocean environment of the China adjacent seas. First, satellite-ground matchups were constructed with 1,005 in-situ FUI data and quasi-synchronized Moderate-resolution Imaging Spectroradiometer (MODIS) $R_{rc}(\lambda)$ images ($0 <$ Aerosol Optical Thickness < 0.39). Then, machine learning algorithms, including Random Forest (RF), Support Vector Regression (SVR), and Extreme Gradient Boosting (XGBoost), were compared to identify the optimal one (XGBoost) to construct the FUI retrieval model (XGB-Rrc), with median absolute percentage difference (APDm) and R^2 of 20.0% and 0.74. Independent validation demonstrates that the new model (APDm = 16.7%) outperforms the existing one (CIE-Rrs, APDm = 50.0%), especially over turbid waters (FUI ≥ 15). Further test over turbid estuaries and bays confirms the general global applicability. Finally, the daily and monthly FUI data products with 1 km spatial resolution for China adjacent seas from 2003 to 2023 were derived from 35,546 MODIS $R_{rc}(\lambda)$ images. The new product shows a 10% (7%) increase in percentage of valid data for daily (monthly) time series,

with notable improvements of 17% (24%) in coastal waters (within 20 km from coastline), when compared to $R_{rs}(\lambda)$-derived FUI products. Both the high accuracy and complete spatio-temporal coverage helps revealing short-term FUI variability after a heavy rainfall and long-term FUI changes missed by $R_{rs}(\lambda)$-derived products. The proposed approach may provide some insights for retrieving other ocean color parameters and contribute to high-accuracy remote sensing retrievals in complex atmosphere-ocean systems.

Keywords: Machine Learning, Complex atmosphere-ocean systems, Forel-Ule Index, Rayleigh-corrected reflectance.

Toward longterm observation by GCOM-C

Hiroshi Murakami[1]*, Taiga Nakayama[1]

[1] Earth Observation Research Center, Japan Aerospace Exploration Agency, Tsukuba Ibaraki, Japan

* e-mail: Murakami.hiroshi.eo@jaxa.jp

Global Change Observation Mission - Climate (GCOM-C), known as SHIKISAI, has successfully operated for over 7.5 years since its launch in December 2017, exceeding its originally planned mission lifetime of five years. The Second-generation Global Imager (SGLI) onboard GCOM-C has provided global observations with a spatial resolution of 250 meters over land and coastal areas, and one kilometer over offshore regions. The sensor covers a swath width of 1150 km for visible and near-infrared channels, and 1400 km for shortwave infrared and thermal infrared channels.

To ensure data quality, SGLI is equipped with onboard calibration capabilities, including a solar diffuser and internal lamps. Monthly pitch maneuvers have been conducted since launch to enable lunar calibration at a constant lunar phase angle about +7 degrees [1]. In addition to these onboard methods, vicarious calibration has been performed using moored optical buoys such as MOBY and BOUSSOLE [2]. To maintain the accuracy of data products, radiometric calibration tables are routinely updated every six months mainly usint the results from the Lunar calibration. Validation activities [3] are also continuously carried out through in-situ measurements in collaboration with research partners such as GCOM-C Principal Investigators, Fishery research institute and so on.

Currently, the mission focuses on contribution to long-term global environmental monitoring, particularly in the context of ongoing climate change. Achieving this goal requires the integration of GCOM-C data with datasets from other satellite sensors to extend the temporal coverage. Although the data integration is not perfect currently, the first version of a 25-year dataset combining ocean color and related observation variables has successfully revealed decadal-scale changes in both physical and biological environments at global and regional scales. Such integrated datasets are expected to play a significant role in monitoring climate-related changes in the coming decades, as well as in improving the prediction capabilities of Earth system models.

[1] Urabe et al., 2020, “Radiometric Model and Inter-Comparison Results ofthe SGLI-VNR On-Board Calibration”, remotesensing, 12, 69, doi:10.3390/rs12010069.

[2]Murakami et al., 2022, “System vicarious calibration of GCOM-C/SGLI visible and near-infrared channels”, Journal of Oceanography, 78, 245–261, Doi:10.1007/s10872-022-00632-x

[3]JAXA GCOM-C homepage: https://suzaku.eorc.jaxa.jp/GCOM_C/data/validation.html

Keywords: GCOM-C, SGLI, SHIKISAI, Calibration, Timeseries

Evaluation of near-blue UV remote sensing reflectance over the global ocean from SNPP VIIRS, PACE OCI, and GCOM-C SGLI

Lufei Zheng,[1] Zhongping Lee,[1,*] Yongchao Wang,[2] Xiaolong Yu,[1] Wendian Lai,[1] and Shaoling Shang [1]

[1] State Key Laboratory of Marine Environmental Science, College of Ocean and Earth Sciences, Xiamen University, Xiamen 361102, China.
[2] Tianjin Research Institute for Water Transport Engineering, National Engineering Research Center of Port Hydraulic Construction Technology, Tianjin 300456, China

* e-mail:zhongping.lee@umb.edu

Solar radiation in the ultraviolet (UV) bands plays an important role in marine biogeochemical processes, and at the same time, measurements of a satellite sensor in the UV help the data processing of ocean color satellites. However, historically, satellite ocean color missions lack UV measurements; only in recent years have there been satellite sensors, such as PACE OCI, to provide a direct measurement of radiance in the near-blue UV (nbUV) domain. To address the limitation of earlier measurements, a deep-learning-based system (termed $\mathrm{UVISR_{dl}}$) has been previously introduced to estimate remote-sensing reflectance (R_{rs}) of the nbUV bands at 360, 380, and 400 nm from R_{rs}(visible). In this study, as PACE OCI offers global-ocean hyperspectral R_{rs} products from UV to visible bands, we leveraged this opportunity to comprehensively evaluate the performance of this $\mathrm{UVISR_{dl}}$ system and compare the R_{rs}(nbUV) among VIIRS, OCI, and SGLI. It is found that the R_{rs}(nbUV) values from VIIRS and OCI exhibit high consistency, with mean absolute unbiased relative difference (MAURD) ranging from 0.23–0.30 at 360 nm, 0.21–0.22 at 380 nm, and 0.17–0.20 at 400 nm, while the SGLI shows lower consistency compared to the former two (MAURD = ~0.41–0.50 at 380 nm). More importantly, the consistency assessment metrics in R_{rs}(nbUV) between VIIRS and OCI are nearly the same, regardless of whether the OCI R_{rs}(nbUV) were derived from $\mathrm{UVISR_{dl}}$ or measured directly. These findings demonstrate $\mathrm{UVISR_{dl}}$'s potential for extending global-scale UV reflectance back into periods lacking direct UV observations, enabling the generation of long-term remote-sensing products, and deepening our understanding of the interactions between UV radiation and biogeochemical processes in the global ocean.

Keywords: ocean color remote sensing, nearblue UV, deep learning

Iterative Approach to the Geostationary Ocean Color Imager-II (GOCI-II) Radiometric Calibration

Minsang Kim[1,2] , Myung-Sook Park[1*], Jae-Hyun Ahn[1], Jong-Kuk Choi[1]

[1] Korea Institute of Ocean Science and Technology, Korea Ocean Satellite Center, Busan, South Korea
[2] University of Science and Technology, Daejeon, South Korea

* e-mail:mspark@kiost.ac.kr

Geostationary ocean color satellites such as Geostationary Ocean Color Imager (GOCI) and its successor GOCI-II enable high-frequency observations of diurnal ocean variability, complementing long-term climate records from polar-orbiting missions like MODerate resolution Imaging Spectroradiometer (MODIS) and Visible Infrared Imaging Radiometer Suite (VIIRS). Ensuring the stability of these data requires accurate radiometric calibration (RC), as uncertainties in sensor gain propagate directly into Level-2 products, including remote sensing reflectance and chlorophyll-a concentration.

In this study, we developed an iterative RC framework for GOCI-II using Solar Diffuser observations from 2020 to 2023. Seasonal variations related to solar observational geography were first corrected with an angle-dependent adjustment, followed by a temporal trend model to capture long-term degradation. Unlike single-step methods, the iterative approach alternately applies these two corrections, with each iteration reducing residual errors. The updated model revealed wavelength-dependent sensor degradation, with gain decreases of 1–7% over a three-year period. Reprocessed Top-of-Atmosphere (TOA) radiances showed consistent increases across all bands. Importantly, Level-2 products exhibited improved stability, with reduced seasonal fluctuations in remote sensing reflectance and more accurate chlorophyll-a retrievals. These results demonstrate that the iterative calibration approach ensures robust long-term stability of GOCI-II radiometric data, thereby providing consistent ocean color products and supporting sustained satellite-based monitoring of marine ecosystems.

Funding: This research was supported by Korea Institute of Marine Science & Technology Promotion(KIMST) funded by the Ministry of Oceans and Fisheries(RS-2022-KS221660).

Keywords: Geostationary Ocean Color Imager-II (GOCI-II), Ocean color remote sensing, Radiometric performance, Iterative approach

Multi-Sensor Approach to Improve GOCI-II Gas Absorption Correction Using AMI and GEMS data

Kyeong-Sang Lee[1], Myung-Sook Park[1], Jong-Kuk Choi[1], Sujung Bae[1], Eunkyung Lee[1], Jae-Hyun Ahn[1*]

[1]Korea Ocean Satellite Center, Korea Institute of Ocean Science and Technology

* e-mail:brtnt@kiost.ac.kr

Atmospheric correction constitutes one of the most fundamental steps in ocean color remote sensing, as it enables the retrieval of accurate sea surface reflectance by systematically removing the effects of atmospheric scattering and absorption. The reliability of all downstream ocean color products—such as chlorophyll-a concentration, total suspended matter, and colored dissolved organic matter—depends directly on the accuracy of this correction step. Even relatively small errors introduced during atmospheric correction can propagate and amplify through subsequent processing, resulting in significant uncertainties in scientific interpretation and practical applications. For this reason, the continuous refinement of atmospheric correction algorithms is essential to ensure the maximum scientific return and societal utility of satellite-based ocean color measurements.

With the deployment of new ocean-viewing satellite sensors, notable progress has been made in improving corrections for aerosols, cloud contamination, and optically complex waters (Ahn et al., 2020). However, as international standards for remote sensing reflectance (Rrs) accuracy have become more demanding, there is a growing need to improve every component of the atmospheric correction algorithm. Mélin et al. (2022) emphasized that uncertainties in auxiliary inputs, such as atmospheric gas concentrations, can significantly affect the stability and reliability of Rrs, highlighting the necessity of using high-quality ancillary datasets.

In this study, we present an approach to enhance GOCI-II Rrs retrievals by refining gas absorption correction through integration with AMI (GK-2A) and GEMS (GK-2B). These geostationary instruments, co-located with GOCI-II, provide near real-time atmospheric gas concentration data with higher spatial and temporal resolution than the widely used NCEP forecasts. By exploiting this multi-sensor synergy, the derived gas transmittance and Rrs values showed improved agreement with ECMWF reanalysis, along with reduced daily MAPD variability, thereby demonstrating the effectiveness of observation-based data integration for advancing atmospheric correction.

Keywords: Gas absorption correction, Remote sensing reflectance, radiative transfer simulation, Geostationry Ocean Color Imager-II, Fusion

Acknowledgments: This research was supported by Korea Institute of Marine Science & Technology Promotion(KIMST) funded by the Ministry of Oceans and Fisheries(RS-2022-KS221660).

Current Calibraiton and Validation status of the GOCI-II Atmospheric Correction

Jae-Hyun Ahn[1], Kyeong-Sang Lee[1], Jeong-Eon Moon[1], Tai-Hyun Han[1], Min-Sang Kim[1], Myung-Sook Park[1], Su-Jung Bae[1], Eun-Kyung Lee[1], Eunna Jang[1], Sun-Ju Lee[1], Jong-Kuk Choi[1*]

[1]Korea Ocean Satellite Center, Korea Institute of Ocean Science & Technology

* e-mail: jkchoi@kiost.ac.kr

The Geostationary Ocean Color Imager series (i.e., GOCI and GOCI-II) are an advanced ocean color remote sensing in terms of providing synoptic regional observations of coastal and open ocean phenomena in the Northeast Asian Seas. As the first spaceborne ocean color sensor capturing daytime imagery with unprecedented temporal resolution, it has been particularly valuable for studying short-term variability in biological and physical processes. Atmospheric correction is a critical step in retrieving accurate ocean color information, as it compensates for atmospheric scattering and absorption in top-of-atmosphere radiance. The GOCI-II atmospheric correction algorithm builds upon the previous GOCI method, with enhancements to improve accuracy, especially in turbid waters. This is achieved through the addition of two new spectral bands at 620 nm and 709 nm, which help to better characterize in water suspended sediment types in optically complex coastal and estuarine regions. System vicarious calibration (SVC) gains are derived following the SeaWiFS heritage approach, using VIIRS R_{rs} datasets processed by NASA/OBPG. The most recent atmospheric correction, after SVC application, has been rigorously validated with *in situ* radiometric data from both clear and turbid waters, the MarONet system deployed in support of PACE calibration, and the AERONET-OC site at Socheong-cho Station.

Keywords: GOCI-II, atmospheric correction, vicarious calibration, calibration and validation

Spatiotemporal Variability of Net Primary Production in the Northwestern Pacific Ocean within 1997 – 2023 period

Eko Siswanto, Yoshikazu Sasai, Kazuhiko Matsumoto, Chiho Sukigara, Makio C. Honda*

Research Institute for Global Change (RIGC), Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Japan

* e-mail: ekosiswanto@jamstec.go.jp

Satellite-derived net primary production (NPP) from four models (VGPM, CBPM, Eppley-VGPM, and CAFE) was analyzed to examine the NPP spatiotemporal variability in the northwestern Pacific Ocean (NWPO) from 1997 to 2023. Monthly NPP data at 9-km resolution were obtained from Ocean Productivity site (https://orca.science.oregonstate.edu/).

Model-based NPPs were first validated against in situ NPP measurements collected at several fixed stations (e.g., K2, S1) within the NWPO. All four models reproduced the observed seasonal cycle and showed strong correlations with in situ NPP ($r \geq 0.72$), supporting their use for subsequent spatiotemporal analyses. To focus on decadal variability and long-term trends, the seasonal signal was removed by subtracting the monthly climatological mean from the NPP time series.

Despite differences in the spatial extent of modeled NPP patterns, NPP in the sub-Arctic region generally increased—likely linked to rising sea-surface temperatures—while NPP in the subtropical region declined. Basin-wide NPPs were more strongly associated with the Pacific Decadal Oscillation than with El Niño–Southern Oscillation events. An Empirical Orthogonal Function analysis will further characterize these patterns and will be presented in detail during the conference.

Keywords: Remote sensing, primary production, long-term trend, decadal variation

Relationships between oceanic conditions and Common minke whale (Balaenoptera acutorostrata) distribution in spring observed along the eastern coast of Korea

Keiko Yamada[1*], In Woo Han[2], Joon-Taek Yoo[3]

[1]Deparment of Environmental Engineering, College of Engineering, Keimyung University, Daegu, 42601, Republic of Korea
[2]Cetacean Research Institute, National Institute of Fisheries Science, Ulsan, 44780, Republic of Korea
[3]Subtropical Fisheries Research Institute, National Institute of Fisheries Science, Jeju, 63068, Republic of Korea

* e-mail:keikoy@kmu.ac.kr

The National Institute of Fisheries Science (NIFS) in Korea has conducted a ship sighting survey of cetaceans living around the Korean peninsula since 2000. Common minke whale is one of the observed species, and it is said that they show the northward migration along the Korean peninsula in spring. The interannual variabilities of oceanic conditions in the study area, sea surface temperature (SST) and chlorophyll-a (Chl-a) concentration, were investigated using data from the Moderate Resolution Imaging Spectrometer (MODIS), and the relationship with the sighting survey location of Common minke whales in spring was examined.

The SST of the study area showed a large difference in the north-south direction (Apr: 10 – 18 °C, May: 11 – 20 °C), and it also showed an increasing trend of about 2 °C during these 20 years. During the spring observation (April and May), common minke whales were observed for 11 years (2003, 2005, 2006, 2007, 2009, 2010, 2012, 2015, 2016, 2020, and 2022). More than 80% of the minke whales observed in April and May appeared in the area where the SST was from 13 to 16 °C and 13 to 17 °C, respectively.

The relatively high Chl-a was observed widely in the study area due to the spring bloom in April, and the high Chl-a area was mainly formed along the coastal area in May. Although Chl-a did not show the remarkable feature like SST, about 50% of observed Minke whales were found in the high Chl-a area, higher than 1 $\mu g\ l^{-1}$.

Although Minke whales were mainly observed in the blooming area, which has high productivity, they did not appear if the area was higher than 17 °C. With the rising temperature in the study area, the Minke whales may change their migration route and timing in the future.

Keywords: Sea surface temperature, chlorophyll-a, East/Japan Sea, northward migration

Relationship between Sargassum biomass and marine heatwaves

Jisun Shin[1] , Young-Heon Jo[2*]

[1] Marine Research Institute, Pusan National University, Busan, South Korea
[2] Department of Oceanography, Pusan National University, Busan, South Korea

* e-mail: sjs1008@pusan.ac.kr/joyoung@pusan.ac.kr

Sargassum horneri has continuously drifted from the East China Sea to the coasts of Korea and Jeju Island since 2015, causing increasing damage to aquaculture and navigation. Effective management of these large-scale influxes requires understanding not only the spatial distribution and biomass but also the relationship with extreme oceanic conditions such as marine heatwaves. The objective of this study is to quantify the linkage between daily S. horneri biomass variability and marine heatwave (MHW) events. Daily biomass-density maps were generated from Geostationary Ocean Color Imager–II (GOCI-II) data using a machine-learning model trained with environmental variables. MHWs were identified from NASA Multi-scale Ultra-high Resolution Sea Surface Temperature (MUR SST) daily data (1 km spatial resolution). A marine heatwave was defined as a period when the daily mean sea surface temperature exceeded the long-term 90th percentile for at least five consecutive days. To evaluate the influence of MHWs, we compared the timing and spatial extent of heatwave events with the daily Sargassum biomass maps. For each MHW event, we analyzed biomass change rates, distribution-expansion speed, and the movement of high-density biomass centers using time-series and spatial statistical methods. A ±7-day window around each MHW event was used to calculate pixel-level mean biomass differences. The results provide new insight into how MHWs affect fluctuations in Sargassum biomass and elucidate underlying mechanisms. These findings offer essential baseline information for early-warning and management systems to mitigate large-scale Sargassum influxes along the Korean coast.

Keywords: Sargassum, marine heatwave, GOCI-II

Long-term variation in primary production enhancement due to typhoons in the subtropical region of the western north Pacific

Mitsuhiro Toratani[1] , Kenya Mori[2], Yoshikazu Sasai[3], Kazunori Ogata[3]

[1] Tokai Research and Information Center, Tokai University, Japan
[2] Graduate School of Engineering, Tokai University, Japan
[3] Japan Agency for Marine-Earth Science and Technology, Japan

* e-mail:tora@tokai.ac.jp

The subtropical area of the northwest Pacific are characterized by low chlorophyll a concentrations throughout the year. It is known that when typhoons pass through this region, nutrients are supplied from the deep layer, causing chlorophyll a concentrations to rise. This study used satellite data to investigate the increase in phytoplankton primary production caused by typhoons passing through the subtropical area of the northwest Pacific over a 27-year period. The results confirmed that increases are relatively low during summer and higher for typhoons passing in October; increases in primary production per typhoon range from zero to over 950 GgC; and the annual cumulative increase varies significantly from year to year. The reason for fewer increases in summer and more in October is thought to be influenced by the development of the mixed layer due to sea surface cooling. Factors causing large variations in the increase in primary production per typhoon include typhoon intensity and movement speed, but it was suggested that multiple factors are involved and cannot be explained by any single factor alone. Factors causing the year-to-year variation, such as El Niño and La Niña phenomena, were considered but not fully understood.

Going forward, we plan to advance our research while considering changes in ocean structure due to global warming and other factors, and investigate the impact of typhoons in the Northwest Pacific.

Keywords: Remote sensing, primary production, typhoon, Northwest pacific

Analysis on Subsurface Coastal Upwelling Processes based on Vertical Profiles of Temperature and Salinity derived from Machine Learning

Yoon-Seo Jeong[1], Hyun-Jin Yang[1], Dong-Young Kim, Young-Heon Jo[1, 2]*

[1] BK21 School of Earth and Environmental Systems, Pusan National University, Busan 46241, Republic of Korea
[2] Department of Oceanography and Marine Research Institute, Pusan National University, Busan 46241, South Korea

* e-mail: ys091901@gmail.com

Coastal upwelling is influenced by factors such as stratification, topography, and wind, which alter the depth at which upwelling occurs. It is known that the physical and biogeochemical characteristics, such as temperature, salinity, and nutrients, of upwelled water masses can vary substantially depending on the source depth. Therefore, to explain the environmental changes induced by upwelling, it is essential to analyze the upwelling life cycle, including source depth, development, and decay. However, studies analyzing upwelling life cycle using subsurface observations in the coastal waters of the East Sea remain limited due to a lack of timely available data. Thus, this study aims to analyze the life cycle of coastal upwelling in the East Sea by constructing three-dimensional temperature and salinity profiles using machine learning methods. We applied a Light Gradient Boosting Machine (LightGBM) regression model to estimate temperature and salinity profiles between depths of 10 m and 500 m. Then, we computed three-dimensional (3D) geostrophic currents using satellite altimetry and dynamic height derived from temperature and salinity profiles. The model was trained with sea surface temperature, sea surface salinity, sea surface height, depth, tidal data, wind, latitude, and longitude as inputs, and subsurface temperature and salinity from the Korean National Institute of Fisheries Science (NIFS) Serial Oceanographic Observation as targets. As a result, the model estimated a daily 3D temperature and salinity dataset with a resolution of 12.5 km. The model performance at 250 m is as follows: temperature $R^2 = 0.81$, NRMSE = 0.07 °C, and salinity $R^2 = 0.63$, NRMSE = 0.07 psu. By analyzing the 3D geostrophic current, we identified the occurrence of upwelling and examined the upwelling life cycle, including the source depth. This study enhances our understanding of the relationship between the life cycle of coastal upwelling and coastal environmental changes in the East Sea.

Keywords: Remote sensing, Machine learning, Coastal upwelling, Subsurface

Analysis on Three-Dimensional Multi-scale Ocean Fronts in the East Sea Using a Deep-Learning algorithm and the Empirical Mode Decomposition

Eunju Kim[1], Hyun-Jin Yang[1], Dong-Young Kim[1], Young-Heon Jo[1,2*]

[1]BK21 School of Earth and Environmental Systems, Pusan National University, Busan 46241, Republic of Korea
[2]Department of Oceanography and Marine Research Institute, Pusan National University, Busan 46241, South Korea

* e-mail: joyoung@pusan.ac.kr

In the East Sea, ocean fronts are formed on various spatiotemporal scales driven by ocean currents, eddies, and coastal upwelling. Because the scale of fronts affects marine ecosystem and regional climate, understanding the processes of multi-scale fronts and monitoring their locations and relative strengths is essential. However, satellite-based technical methods for detecting ocean fronts identify various sea surface temperature gradients, making it difficult to distinguish dominant fronts. Moreover, it remains challenging to determine the exact location and strength of ocean fronts, because the detected front at the sea surface does not coincide exactly with the subsurface front. Therefore, it is necessary to examine the spatiotemporal variability of the multi-scale ocean front, including the subsurface. This study aims to quantify multiscale ocean fronts by timescales and to analyze the trend of fronts and the spatiotemporal variability of dominant frontal structures. The Convolutional Kolmogorov-Arnolds Network (ConvKAN) algorithm was used to reconstruct subsurface temperature profiles for the upper 500 m depth from 1999 to 2023. While satellite-derived sea surface variables (temperature, salinity, sea level height, wind, and tides) were used as inputs, subsurface vertical temperature profiles from the World Ocean Database (WOD) were used as the ground-truth output. As a result, we estimated daily 3-D temperature at a resolution of 25 km, which showed an accuracy of $R^2 = 0.93$ (NRMSE = 0.08) at 10 m depth and $R^2 = 0.74$ (NRMSE = 0.11) at 200 m depth. Empirical Mode Decomposition (EMD) was used to extract dominant fronts based on instantaneous frequency. The results show that the structure and trends of multiscale ocean fronts differ by temporal scale. Therefore, this study can be used to quantify how climate change affects the fishing ground and regional climate change through spatiotemporal changes of the multi-scale front.

Keywords: Multi-scale, Ocean front, Deep ocean remote sensing, Deep learning (up to 5 words)

Study on the Mechanisms of Extreme Sea Surface Temperature Events along the Korean Peninsula Coast

Hyun-Jin Yang[1], Young-Heon Jo[1]*

[1] Center for Remote Sensing, BK21 School of Earth and Environmental Systems, Oceanography, Pusan National University, Busan, Republic of Korea

* e-mail: joyoung@pusan.ac.kr

The variation of sea surface temperature (SST) along the Korean Peninsula coast is influenced by the Kuroshio Current, its branches, and atmospheric phenomena. In summer, the Changjiang Diluted Water (CDW), characterized by elevated temperatures due to stratification, is advected into the southern coast of Korea, altering the local marine environment. Such abnormal warming often causes mass mortality in aquaculture farms, resulting in significant economic losses for the fisheries sector. Therefore, investigating the mechanisms of abnormal SST events is crucial to mitigating aquaculture damage. The impact of physical changes in the waters surrounding the Korean Peninsula (the East Sea, the Yellow Sea, and the East China Sea) on coastal water temperatures is generally discussed in terms of direct influences, such as the currents. However, it is also necessary to assess indirect influences. In this study, we analyzed the relationship between physical environmental variables of the surrounding seas during summer (2000–2024) and in-situ coastal temperature observations using deep learning methods. Low-resolution datasets (25 km) of sea surface temperature, salinity, wind, and sea level anomaly were used to estimate high-resolution in-situ tide station observations, in order to investigate the influence of physical factors in the study area. This approach allowed us to quantitatively assess the association between large-scale physical states of the sea surface and local coastal SST variations. Therefore, this study is expected to make a significant contribution to monitoring coastal SST changes by analyzing the teleconnection between environmental changes in the study area and coastal SST variability along the Korean Peninsula.

Keywords: Extreme sea surface temperature events, teleconnection, deep learning, Korean coast

A Numerical Model Study of Coastal Submesoscale Dynamics Observed with Unmanned Aerial Vehicle

Sin-Young Kim[1], Jang-Geun Choi[3], Gi-Seop Lee[4], Dawoon Jung[5], Young-Heon Jo[1, 2*]

[1]BK21 School of Earth and Environmental Systems, Oceanography Major, Pusan National University, Busan, Republic of Korea
[2]Department of Oceanography and Marine Research Institute, Pusan National University, Busan, Republic of Korea
[3]Center for Ocean Engineering, University of New Hampshire, Durham, New Hampshire, United States.
[4]Marine Big Data & A.I Center, Korea Institute of Ocean Science & Technology, Busan, Republic of Korea.
[5]Ocean Circulation & Climate Research Department, Korea Institute of Ocean Science & Technology, Busan, Republic of Korea.

* e-mail:tmzkt35@naver.com

The southern coast of Korea is characterized by a complex Rias coast, and a bartoropic flow regime dominated by strong tides. Under the influence of tidal forcing, complex current patterns develop regularly, leading to the generation of coastal eddies with spatial scales ranging from 0.1 to 10 km. These submesoscale eddies serve as an intermediary between mesoscale dynamics and small-scale turbulence, playing an important role in energy transfer. This study builds upon the cyclonic eddy observed during a field campaign near Nodae Island (Kim et al., 2024) and expands the analysis through high-resolution numerical modeling of the broader Yokji region. The Deflt3D model was validated using Acoustic Wave and Current profiler data, as well as unmanned aerial vehicle-based surface current estimation, and by comparing modeled surface flow patterns with Sentinel-2 true-color imagery. To characterize the eddy generation and interaction processes, we computed a series of diagnostic variables, mainly Rossby number and eddy kinetic energy, from the model results. To further investigate the underlying energy dynamics, we applied a coarse-graining method that decomposes the flow field into scale-dependent mean and fluctuation components. This enabled spatially resolved estimation of cross-scale kinetic energy flux and horizontal Reynolds stress. The analysis revealed that energy is transferred upscale (inverse cascading) into the adjacent, larger-scale background current during the eddy dissipation phase, and that barotropic shear instability occurring near the cape is a potential contributor to the observed eddy generation. As a future step, we aim to rigorously quantify the energy conversion between kinetic and potential energy by deriving energy budgets from the governing equations. This framework will enhance the understanding of local and nonlocal energy source-sink dynamics in shallow coastal waters and improve our insights for submesoscale interactions

Keywords: Submesoscale eddy, barotropic shear instability, Energy transfer, Generation mechanism

Red-Tide Quantification Using an Airborne Multispectral Camera

Seungil Baek[1], Sooyoon Koh[1], Moonho Son[2], Seunghoon Park[3], and Wonkook Kim[1]*

[1]Department of Civil and Environmental Engineering, Pusan National University
[2]Southeast Marine Fisheries Research Institute, National Institute of Fisheries Science
[3]Korea Coast Guard Region-West

* e-mail:Wonkook@Pusan.ac.kr

Red tides pose significant biological and economic risks to marine ecosystems, coastal communities, and aquaculture, necessitating rapid and reliable monitoring. Satellite ocean-color observations offer synoptic coverage but are often hampered at mid-latitudes by persistent summer cloud cover and by the coarse spatial resolution of ocean-color sensors (typically ~250 m), which is inadequate for small, near-shore events. Airborne platforms equipped with multispectral or hyperspectral sensors complement satellites by flying below cloud decks (~1 km) and flexibly surveying complex coastlines. Yet quantitative retrievals from airborne multispectral data remain challenging for three reasons: (i) most prior work targets freshwater cyanobacteria rather than coastal red-tide taxa; (ii) many approaches are non-quantitative, relying on digital numbers without atmospheric correction; and (iii) aircraft operations demand stricter calibration and preprocessing than typical drone deployments.

In this study, we develop a radiance-based red-tide quantification algorithm and an preprocessing workflow for a multispectral camera (RedEdge-MX) mounted on a CN-235 aircraft operated by the Korea Coast Guard. The algorithm targets *Margalefidinium polykrikoides* and is developed from shipborne observations, specifically hyperspectral radiance measurements (TriOS RAMSES) and water samples (chlorophyll-a), and is subsequently adapted for application to the airborne multispectral sensor. Validation results show a relative uncertainty of 30–45% and a relative bias of less than 5% in the estimated red-tide concentration.

The operational workflow includes sensor calibration and radiometric normalization, empirical atmospheric correction tailored to ~1 km flight altitudes (with sunglint mitigation), and geometric and band-to-band co-registration. Applied to airborne imagery, these steps produce quantitative maps of red-tide concentration and distribution. The approach mitigates cloud interference and enables early-stage detection along hundreds of kilometers of coastline, providing actionable lead time for local authorities and aquaculture operators.

Keywords: Remote sensing, Airborne, Multispectral, Red tide

Improving Marine Fog Detection using Spatio-Temporal Features from Geostationary Ocean Color Imager (GOCI- II)

Jinwan Joo[1] , Myung-sook Park[1], Minsang Kim[1]

[1]Korea Ocean Satellite Center (KOSC), .Korea Insitute of Ocean Science and Technology (KIOST), 385, Haeyang-ro, Yeongdo-gu, Busan 49111, Korea

* e-mail: jwjoo@kiost.ac.kr

Accurate detection of marine fog, a major meteorological phenomenon that poses a direct threat to maritime safety, is crucial. The distinction between marine fog and low-level stratus clouds in satellite imagery is often challenging, as they frequently share similar spectral and textural characteristics. Therefore, this study shifts focus from these static properties to the distinct dynamic characteristics of fog and clouds. To analyze these kinematic differences, we performed a time-series correlation analysis on satellite images with a one-hour time lag. The analysis revealed that this approach provides useful information for distinguishing between the two, reflecting the physical differences between homogeneous, slow-moving marine fog and complex, faster-moving clouds. These new variables can be utilized as auxiliary indices and are expected to contribute to improving the performance of machine learning-based detection models.

Keywords: Marine Fog, GOCI-II, Time-Series Analysis, Feature Engineering (up to 5 words)

AI-Based Classification of Jellyfish and Quantifying their Size and Distribution in the East China Sea

Yoo-Min Kim[1], Sin-Young Kim[1], Seok-Hyun Youn[2], Kyoung-Yeon Kim[2], Young-Heon Jo[1]*

[1] Department of Oceanography, BK21 Earth Environment Systems Education–Research Group, Pusan National University, Busan

[2] Department of Ocan Climate and Environment Research, National Institute of Fisheries Science, Busan

Corresponding author: joyoung@pusan.ac.kr

Jellyfish have emerged as a major ecological and socio-economic concern, significantly impacting fisheries, marine ecosystems, and coastal operations. With global warming, species that previously did not form large blooms are now appearing more frequently, raising interest in their life cycles and potential impacts. However, traditional field surveys and citizen reports mainly provide occurrence records and often lack quantitative information on abundance, spatial extent, and biomass. In addition, Visual observations and citizen science data are limited in rigor and, constrained by variable shooting conditions, inconsistent measurement scales, and the absence of standardized tools for area estimation.

To overcome these limitations, this study employed deep learning–based object detection to quantify the species composition and individual size of jellyfish originating in the East China Sea. Field surveys were conducted in May and July 2025 along presumed jellyfish migration routes and outbreak areas, where in situ videos were collected using drones, smartphones, and GoPro cameras. Among these, GoPro footage was analyzed with the YOLO algorithm to detect *Aurelia aurita* and *Nemopilema nomurai*, and bounding box information was used to estimate species identity and individual size. The model achieved a mean Average Precision of 0.863 and a maximum F1-score of 0.85.

Therefore, this study represents an AI-based approach to jellyfish monitoring, integrating field surveys with automated detection. Furthermore, this study is expected to contribute to broader applications to other marine organisms and floating objects for which accurate size and area estimation are essential.

Keywords: Remote sensing, object detection, jellyfish, marine organism monitoring

Development of a GOCI-II Algorithm for Red-Tide Detection and Concentration Estimation Using Physics-Based Machine Learning

Jong Hyuk Lee[1], Seungil Baek[1], Sooyoon Koh[1], Jae-Hyun Ahn[2], and Wonkook Kim[1]*

[1]Department of Civil and Environmental Engineering, Pusan National University, Republic of Korea
[2]Korea Ocean Satellite Center, Korea Institute of Ocean Science and Technology, Republic of Korea

* e-mail:ljh38633863@pusan.ac.kr

Red tide is a discoloration of seawater caused by a rapid increase in phytoplankton; when it occurs on a large scale, the resulting depletion of dissolved oxygen and toxin production can inflict severe damage on fish and shellfish. For an effective response, it is necessary not only to rapidly determine whether a red tide is present, but also to quantitatively estimate its concentration to gauge mortality risk and to decide the timing, spatial extent, and prioritization of measures such as suspending feed supply and restricting shipment. Geostationary satellites can continuously observe wide ocean areas at high frequency, enabling near-real-time tracking of red-tide occurrence, spread, and movement; owing to these advantages, the GOCI-II sensor aboard Geo-KOMPSAT-2B has become a primary platform for monitoring red tides along the Korean coast.

In satellite remote sensing, red-tide detection has used optical index–based methods and deep-learning models (e.g., U-Net segmentation, 1D-CNNs using remote sensing reflectance (R_{rs})). However, conventional ocean-color atmospheric-correction algorithms rely on the assumption that R_{rs} is zero in the near-infrared; this assumption breaks down in red-tide waters, biasing aerosol retrieval and increasing atmospheric-correction uncertainty, which in turn degrades the accuracy of index-based detection. Moreover, deep-learning-based detection algorithms require large training datasets spanning diverse conditions, but because red tides are infrequent and observations are constrained, the number of samples is often insufficient relative to model complexity, making overfitting likely.

To simultaneously mitigate atmospheric-correction uncertainty and the scarcity of training data, this study proposes a physics-based machine-learning algorithm for GOCI-II red-tide detection and concentration estimation that uses Rayleigh-corrected reflectance (RhoC) generated by a physical model as training data. We coupled a bio-optical model for red-tide waters with the 6SV radiative transfer model and, under conditions reflecting physically plausible ranges of red-tide concentration and atmospheric states (water vapor, aerosol optical depth [AOD], etc.) typical of the Korean coast, simulated band-specific RhoC for GOCI-II. Using the simulated RhoC as training data, we developed an XGBoost-based algorithm for red-tide detection and concentration estimation.

Keywords: Harmful algal blooms, GOCI-II, 6SV, Radiative transfer, Machine learning

Evaluation of Ocean Color Data Assimilation Configurations for Improving Phytoplankton Reproducibility in Tokyo Bay, Japan

Hiroto Imazu[1*] , Hiroto Higa[2] , Yuta Shinohara[3]

[1] Department of Civil Engineering, Yokohama National University, Yokohama, Japan
[2] Institute of Urban Innovation, Yokohama National University, Yokohama, Japan
[3] A Marine Environmental Information Group, Port and Airport Research Institute, Japan.

* e-mail:imazu-hiroto-xm@ynu.jp

Data assimilation integrating satellite ocean color observations with coupled physical–biogeochemical models is expected to improve the representation and predictive accuracy of physical and biogeochemical processes. Previous studies focusing on satellite-derived phytoplankton products have primarily targeted global and open-ocean regions, demonstrating the effectiveness of such approaches (e.g., Song et al., 2016; Pradhan et al., 2019). Skákala et al. (2018) and Fowler et al. (2023) assimilated satellite-derived chlorophyll-a (Chl-a) and phytoplankton functional groups over the northwestern European continental shelf, showing the potential of using functional group classifications as assimilation variables. However, in optically complex coastal waters, satellite-based phytoplankton estimates often exhibit substantial uncertainty, and assimilating such variables may instead degrade model performance rather than improve it.

This study aims to identify appropriate assimilation variables and control parameters for improving the representation of phytoplankton variability in coastal ecosystem models. Tokyo Bay, characterized by optically complex waters and large uncertainties in satellite observations, was selected as the target area. The four-dimensional ensemble variational (4D-EnVar) data assimilation method, which conserves mass and biogeochemical tracers, was applied to assimilate GCOM-C/SGLI ocean color data. Two types of satellite-derived variables—Chl-a and the light absorption coefficient of phytoplankton (a_{ph})—were tested. Sensitivity experiments were conducted by varying assimilation sites, assimilation periods, and control parameters. Model performance was quantitatively evaluated by comparing simulated phytoplankton dynamics with in situ Chl-a observations.

The results showed that the reproducibility of phytoplankton dynamics in the bay varied depending on the choice of assimilation variables and control parameters, underscoring the importance of selecting appropriate assimilation configurations.

Keywords: Data assimilation, Four-dimensional ensemble variational, Light absorption coefficient of phytoplankton, Chlorophyll-a, Ecosystem model

Vertical Distribution of Phytoplankton Signatures in the Temperate Coastal Waters of Sagami Bay

Mia L. Castillo[1]*, Brittany A. Chang[1], Robel M. Ashenafi[1], Koichi Yano[1], Kaito Kubozono[2], Victor S. Kuwahara[1]

[1]Graduate School of Science and Engineering, Soka University, 1-236 Tangi-machi, Hachioji, Tokyo 192-8577, Japan
[2]Fisheries Resource Institute, Japan Fisheries Research and Education Agency, 2-12-4 Fukuura, Kanazawa, Yokohama, 236-8648, Japan

* e-mail: Mia L. Castillo / e25m5818@soka-u.jp

Remote sensing has enhanced surface observations through improved temporal and spatial coverage, giving insight into surface Chlorophyll-*a* (Chl-*a*), Sea Surface Temperature (SST), and other parameters. However, satellite-derived Chl-*a* reflects concentrations from the first optical depth ($\zeta = 1/K_d$), approximately one-fifth of total Chl-*a* within the euphotic zone ($Z_{eu} = 4.6/K_d$), missing vertical variability. In temperate coastal waters, seasonal and episodic events cause rapid shifts in the vertical distribution of Chl-*a* and phytoplankton composition. Due to the complexity of coastal water systems, integrating *in situ* and remote sensing measurements is important to assess vertical structure and phytoplankton functional group dynamics. The goal of this study is to evaluate temporal and vertical distribution patterns of phytoplankton biomass and composition in Sagami Bay. The specific objectives are to: (1) Integrate Chl-*a* concentrations to relevant optical depths to improve the assessment of vertical biomass distribution; (2) Evaluate the extent to which satellite remote sensing underestimates subsurface Chl-*a*; (3) Characterize seasonal shifts in phytoplankton groups. This study compares satellite-derived surface Chl-*a* from GCOM-C/SGLI with *in situ* profiles of Chl-*a* fluorescence from CTD casts between 2018 and 2025 at Station M (35˚09' 45" N, 139˚10' 00" E). It analyzes nine matchups from August 2023 to May 2024, including validated Multi-Exciter fluorometric profiles. Preliminary results suggest that surface Chl-*a* values alone do not fully capture subsurface biomass, especially during seasonal transition or blooming periods. Depth integration of Chl-*a* to the ζ and Z_{eu} is being developed. Matching integrated Chl-*a* values to light-levels with multi-excitation fluorescence profiles will strengthen the link between bio-optical signals and phytoplankton composition. This approach will also improve our understanding of vertical and seasonal variability in temperate coastal waters.

Keywords: Phytoplankton biomass, light penetration, remote sensing, vertical variability

메모 포함[桑V1]: Do you need this sentence?

Controlled Sediment Retention for Flood Mitigation and Morphological Restoration in the Ma'an River

Dr. Forrest Wu[1], Happy Mareta[1 *], James K C Tseng[1], Julio Eko Prasetio Santoso[1]

[1] Lijou Engineering Consulting Co., Ltd, Hsinchu County, 30744, (ROC) Taiwan

* e-mail:happymareta2403@gmail.com

Soil erosion in upland catchments delivers substantial sediment to rivers, raising channel beds, reducing water conveyance capacity, and increasing flood hazards for downstream communities. In the Ma'an River, excessive sedimentation has accelerated flood risks and degraded river morphology, emphasizing the need for effective soil and water conservation measures.

The objective of this study is to evaluate the performance of multiple sediment control dams with regulated outlets in managing sediment inflow, preventing continuous bed aggradation, and supporting river self-restoration. Hydrologic and hydraulic modeling tools, specifically HEC-RAS, are employed to simulate watershed runoff, sediment yield, and channel response under different management scenarios. These models provide quantitative insight into the relationship between rainfall events, sediment transport, dam retention efficiency, and downstream hydraulic behavior.

Results indicate that a network of sediment control dams can retain a significant portion of the sediment load while releasing controlled amounts through outflow structures. This balance reduces the risk of excessive deposition, preserves downstream sediment continuity, and allows natural flushing processes to gradually restore channel depth. Simulation outputs also suggest a feasible recovery timeline for the Ma'an River to achieve stable morphology once inflows are regulated.

The broader implication of this work is that properly designed sediment control systems can mitigate flood risk, promote channel resilience, and provide a replicable approach for soil and water conservation in sediment-prone catchments.

Keywords: catchment management, hydrologic simulation, hydraulic modeling, sediment regulation, flood resilience, river restoration

On the Challenges of Retrieving Phytoplankton Properties from Remote-Sensing Observations

J. Xavier Prochaska[1,2,3*] , Robert J. Frouin[3*]

[1]Affiliate of the Ocean Sciences Department, University of California, Santa Cruz
[2]Kavli Institute for the Physics and Mathematics of the Universe, Tokyo, Japan
[3]Scripps Institution of Oceanography, University of California, San Diego

* e-mail:jxp@ucsc.edu

Remote-sensing satellites provide the only means to observe the entire ocean at high-temporal resolution. Optical-sensors assess ocean color through estimates of remote-sensing reflectance ($R_{rs}(\lambda)$). We emphasize a physical degeneracy in the radiative transfer equation that relates $R_{rs}(\lambda)$ to absorption and backscattering coefficients ($a(\lambda)$,$b_b(\lambda)$) known as inherent optical properties (IOPs). This degeneracy stems from $R_{rs}(\lambda)$ depending on the ratio $b_b(\lambda)/a(\lambda)$, preventing the independent retrieval of non-water IOPs without prior knowledge. We demonstrate that multi-spectral satellite observations lack the statistical power to recover more than three parameters describing non-water absorption and backscattering. Due to exponential-like absorption by colored dissolved organic matter and detritus at shorter wavelengths, multi-spectral Rrs(λ) data cannot detect phytoplankton absorption without strict priors, leading to biased and uncertain estimates. These results challenge decades of IOP retrieval literature, including assessments of phytoplankton growth and biomass. While hyperspectral observations hold promise to recover additional parameters, significant hurdles remain in accurately quantifying IOPs and phytoplankton biomass at a global scale.

Keywords: hyperspectral, IOP retrievals

Coastal benthic coverage mapping using UAV mounted hyperspectral sensors

Phillip Kim[1], Seungil Baek[1], Yujin Jeong[1], Kyoungseok Kwak[1], Aran Lee[1], Hyunggu Park[2], Ikjae Kim[3], and Wonkook Kim[1]*

[1] Department of Social and Environmental Systems Engineering, Pusan National University, Republic of Korea
[2] Korea Land and Geospatial Informatix Corporation (LX), Republic of Korea
[3] Geolabs, Republic of Korea

* e-mail:wonkook@pusan.ac.kr

Macroalgae and seagrasses in the coastal subtidal zone are responsible for primary production through photosynthesis, provide habitat for fish and invertebrates, and contribute to carbon and nutrient cycling as well as shoreline stabilization. Benthic cover by subtidal macroalgae is a key indicator for the conservation and management of coastal ecosystems, and UAV-based observations are effective for accurately identifying it while reducing constraints arising from weather conditions or site accessibility.

In response to this need, coastal monitoring studies using drones have been conducted; however, most have relied on multispectral or RGB sensors. These approaches can be used for simple cover classification, but the limited number of bands makes it difficult to finely discriminate macroalgal taxonomic groups (e.g., brown vs. green macroalgae), and retrievals are sensitive to variations in water depth and turbidity.

This study presents a coastal subtidal monitoring methodology that combines UAV hyperspectral imagery with a physics-based model to overcome these limitations. The study area was around Uga Port, Ulsan, Republic of Korea, where hyperspectral images were acquired using a Corning microHSI SHARK sensor. The acquired imagery underwent radiometric calibration by deriving new DN-to-radiance conversion coefficients from simultaneous TriOS RAMSES spectroradiometer measurements, followed by atmospheric correction using reference tarps with 3%, 36%, and 56% reflectance. The corrected imagery was then applied to the SAMBUCA (Semi-Analytical Model for Bathymetry, Unmixing and Concentration Assessment) model to estimate macroalgal cover.

The reliability of preprocessing was verified by comparing the measured reflectance of cyan, magenta, and green reference tarps with the reflectance from the corrected imagery. The resulting benthic cover maps showed high agreement when compared with low-altitude UAV RGB imagery. This study demonstrates that combining UAV hyperspectral imagery with a physics-based model is an effective method for accurately estimating subtidal macroalgal cover in coastal waters and can compensate for the limitations of existing monitoring approaches.

Keywords: Remote sensing, hyperspectral, macroalgae, UAV, SAMBUCA

A Deep Learning-Based Environmental Stress Index for Monitoring Coral Reefs in Indonesia

Ni Putu Praja Chintya[1] , Wonkook Kim[1]*

[1]Department of Civil and Environmental Engineering, Pusan National University, South Korea

* e-mail:wonkook@pusan.ac.kr

Indonesia contains about 18% of the world's coral reefs and hosts roughly 76% of known coral species. These reefs support biodiversity and provide benefits for fisheries, tourism, and coastal protection. They are currently facing increasing threats from climate change and human activities. During the recent 2024-2025 global bleaching event, bleaching in Indonesia ranged from 10-15% in Jakarta Bay to up to 90% in some cultivated coral sites in Bali. These widespread impacts highlight the need for large-scale stress monitoring to evaluate bleaching risk and support management. Large-scale systems such as NOAA's Coral Reef Watch provide global coverage using thermal stress indicators from satellite data. These approaches, however, are limited because they focus mainly on temperature, while other factors including turbidity, light availability, and nutrient-related changes also affect bleaching. To address this, stress monitoring requires an approach that integrates multiple environmental drivers.

In this study, we propose a new AI-based stress estimator, the Coral Reef Environmental Stress Index (CRESI), which integrates multi-source spatial information including satellite observations, GIS data, and reanalysis data. CRESI is a deep learning–based index that combines seven variables: bathymetry, turbidity (Kd), chlorophyll-a (Chl-a), photosynthetically active radiation (PAR), sea surface temperature (SST), SST anomaly (SSTA), and degree heating weeks (DHW). Environmental data from 2019–2024 were collected from VIIRS and NOAA reanalysis products, and bleaching/non-bleaching labels were derived from Allen Coral Atlas and Coral Watch records. The model was built on an LSTM-based architecture with four components: (i) an LSTM backbone for long-term temporal patterns, (ii) convolutional layers to capture short-term anomalies such as heat spikes, (iii) regional embeddings from clustering to represent geographic context, and (iv) an attention mechanism to emphasize key time steps within the six-month biweekly series.

Model performance was evaluated using two spatial accuracy metrics: HS-over-BO, which measures the percentage of bleaching events correctly predicted as high stress, and BX-over-LS, which measures the percentage of low-stress predictions that correspond to non-bleaching cases. Using 12 monthly test datasets across Indonesia, HS-over-BO accuracy ranged from 54.7% to 97.7%, with values above 90% in February, March, April, and December, and the lowest values in September and October (54.7%). BX-over-LS accuracy ranged from 84.8% to 100% and remained above 90% in most months.

Keywords: coral reefs, Indonesia, environmental stress, coral bleaching, LSTM, machine learning

Monitoring Summer Eelgrass Die-offs in Nanao Bay Using a Compact Sonar Mounted on a Stand-up Paddle Surfboard

Genki Terauchi[1*], Takashi Oba[1], Koji Furukawa[2]

[1]Northwest Pacific Region Environmental Cooperation Center, Japan
[2]SeaTruth, LLC, Japan

* e-mail:terauchi@npec.or.jp

Large-scale die-offs of eelgrass (*Zostera marina*) in Nanao Bay have been reported during the summer (August-September), associated with rising sea temperatures in recent years. Conventional survey methods are time-consuming and costly, creating a need for a simpler, more mobile monitoring technique. This study investigates a method for efficiently capturing seasonal changes in eelgrass beds using the compact acoustic device "Deeper" and verifies its effectiveness.

The survey was conducted in a persistent eelgrass habitat near the mouth of the Funao River in western Nanao Bay on June 12 and August 27, 2025. A Deeper sonar, fixed to the bottom of a stand-up paddle surfboard, was used to collect sonar reflection intensity data. A comparison of the data from the two dates against underwater images strongly indicated that a large-scale die-off occurred during the summer; the dense eelgrass detected in June had largely disappeared by August. These results demonstrate that this method is effective for monitoring eelgrass decline. Furthermore, the data collected by the Deeper sonar shows potential for use as ground-truth data in Seagrass Mapper, a cloud-based tool for mapping eelgrass habitat, to improve the accuracy of satellite image analysis for mapping seagrass beds.

Keywords: optical remote sensing, seagrass detection, sonar, stand up paddle surfboard, Seagarass Mapper (up to 5 words)

How extreme weather events reshape biological carbon pump in tropical/subtropical western North Pacific

Yung-Yen Shih[1,*]; Chin-Chang Hung[2]; Pei-Yu Fu[1]; Zong-Ru Cheng[1]

[1]Department of Applied Science, ROC Naval Academy, Kaohsiung, Taiwan, ROC.
[2]Department of Oceanography, National Sun Yat-Sen University, Kaohsiung, Taiwan, ROC.

* e-mail: syy660627syy@gmail.com

The negative phase of the Arctic Oscillation (AO) weakens Arctic westerlies, allowing cold air to penetrate southward and trigger extreme winter events in mid-to-low latitudes. This study examines the influence of such events on marine biogeochemical processes in low-latitude seas using satellite and in situ data from October 2012 to April 2024. Results show that pronounced negative AO phases enhance phytoplankton biomass, accelerate carbon fixation, and significantly increase particulate organic carbon (POC) export fluxes. Cold air outbreaks intensify ocean mixing, facilitating more efficient carbon transport from surface to deep waters and strengthening the oceanic carbon sink. When accounting for extreme weather—identified by POC flux differences of −25% to −84% between modeled and trap-collected data, and by sea surface temperatures below climatological averages—the annual carbon sink increases to 134.4 ± 26.4 Mt CO_2 yr^{-1}, compared to 96.8 ± 17.4 Mt CO_2 yr^{-1} during non-extreme periods (Hung et al., 2024). These findings underscore the critical, yet underrecognized, role of episodic winter storms in amplifying carbon sequestration in low-latitude marine systems.

Keywords: Arctic Oscillation (AO); marine blue carbon; extreme weather events; particulate organic carbon (POC)

Comparison assessment of *in situ* and satellite-based methods for estimating marine carbon sinks in the seas around Taiwan

Zi-Xin Liao[1], Yung-Yen Shih[1], Chin-Chang Hung[2]

[1]Department of Applied Science, ROC Naval Academy, Kaohsiung, Taiwan ROC
[2]Department of Oceanography, National Sun Yat-sen University, Kaohsiung, Taiwan, ROC

* e-mail: kimmy950131@gmail.com

This study evaluates the estimation of marine carbon sinks within Taiwan's Provisional Enforcement Line (PEL) using three approaches. The first method employed direct measurements of particulate organic carbon (POC) flux from sediment traps, scaled to the PEL area. The second method estimated carbon sinks by multiplying satellite-derived primary production (PP) with regional export efficiencies, yielding an average POC flux for the entire PEL. The third method used satellite-derived PP at the grid-cell level, applying export efficiencies individually to each grid and summing the results to obtain total carbon sink estimates. Results showed that sediment trap–based estimates 20 million ton-C y^{-1} (MT-C y^{-1}) provided the baseline for comparison. The satellite-based average method (Method 2) yielded 19 MT-C y^{-1}, differing by 7% from the trap-derived estimate, while the grid-based method (Method 3) differed by 22%. These findings highlight that satellite remote sensing, when combined with export algorithms, can provide reasonable estimates of regional carbon sinks. However, systematic calibration against in situ sediment trap data remains essential to reduce uncertainties and improve reliability. Expanding trap-based observations will be critical for refining satellite-derived models and enhancing carbon sink assessments in Taiwan's waters.

Keywords: marine carbon sink, provisional enforcement line, particulate organic carbon, primary productivity

An Analysis on Water Types Classification in the Western Arctic Ocean in Summer

Kwang-Mo Kim[1], Hyun-Jin Yang[1], and Young-Heon Jo[1,2]*

[1]BK21 School of Earth and Environmental Systems, Pusan National University, Busan 46241, Republic of Korea

[2]Department of Oceanography, Pusan National University, Busan, 46241, Republic of Korea

* e-mail: joyoung@pusan.ac.kr.

Accelerated global warming has led to summer reductions in sea ice extent across the Western Arctic Ocean. This reduction in sea ice area releases meltwater (MW) and riverine water (RW), triggering marine heatwaves (MHW). Following previous studies, we categorized satellite observations into three water types (seawater (SW), MW, and RW). We also analyzed the physical drivers of MHW for May to September of each year from 2012 through 2019. To overcome the frequent gaps in satellite data caused by low solar elevation and cloud cover, we reconstructed suspended particulate matter (SPM) and sea surface salinity (SSS) using the Data-Interpolating Empirical Orthogonal Functions (DINEOF) method. The validation showed $R^2 = 0.96$ and RMSE = 0.81 g m^{-3} for SPM, and $R^2 = 0.66$ and RMSE = 1.68 psu for SSS. For each water-mass class, we trained a Random Forest (RF) model using sea surface temperature (SST), SSS, SPM, and surface winds as predictors, and then quantified variable contributions using SHapley Additive exPlanations (SHAP). Across the SW, MW, and RW classes, model performance was represented by R^2 values of 0.50, 0.62, and 0.62 and RMSE values of 1.30 °C, 1.40 °C, and 0.96 °C, respectively. SHAP results indicate that MHW in the SW class is negatively associated with salinity, whereas the MW and RW water classes show the opposite relationship. Moreover, when water-mass mixing intensifies, MHW within the SW class tends to be more pronounced under low-salinity conditions. These findings underscore the value of explicit water-mass classification and the quantitative characterization for understanding Arctic MHW. This study will also help future studies on water-mass classification and mixing in the Arctic Ocean. (words :269)

Keywords: Remote Sensing, Physical Oceanography, Global Warming, Surface Stratification, Polar Ocean

Reducing Uncertainty in a Marine Biological Carbon Pump Model for the Northern South China Sea by Incorporating Satellite-Derived Parameters

Zong-Ru Cheng[1], Yung-Yen Shih[1], Chin-Chang Hung[2]

[1] Department of Applied Science, ROC Naval Academy, Kaohsiung, Taiwan, ROC.
[2] Department of Oceanography, National Sun Yat-Sen University, Kaohsiung, Taiwan, ROC.

* e-mail:
Zong-Ru Cheng: james940217@gmail.com
Yung-Yen Shih: syy660627syy@gmail.com
Chin-Chang Hung: cchung@mail.nsysu.edu.tw

The marine biological carbon pump is crucial for regulating atmospheric CO_2, and the particulate organic carbon (POC) flux is a key indicator of its efficiency. While global satellite-based POC flux models offer effective monitoring solutions, their direct application to regional seas often results in significant biases. This study aims to demonstrate this issue and develop a more reliable estimate for the Northern South China Sea (NSCS) through local parameter optimization. First, we evaluate the baseline performance of five global POC flux models in the NSCS: Laws (2000), Dunne (2005), Henson (2011), Laws (2011a), and Laws (2011b). Subsequently, we employ the Levenberg-Marquardt (LM) algorithm for local parameter optimization, fitting each model to satellite remote sensing and *in-situ* data from the NSCS. The results reveal that the direct application of the original models leads to substantial errors; their predicted averages deviate significantly from the measured average (62.0 ± 21.2 mg-C m^{-2} d^{-1}) and exhibit high variability. However, after regional parameter optimization, the accuracy and stability of all models were substantially improved, highlighting the necessity of local calibration. Among the optimized models, the modified Laws (2011b) model demonstrated the best performance. Its average predicted value (61.9 ± 16.7 mg-C m^{-2} d^{-1}) was nearly identical to the measured value, and its root mean square error (RMSE) was significantly reduced from 33.6 to 13.3. This value was the lowest among all models, indicating the least bias and highest stability.

Keywords: POC flux, parameter optimization, Levenberg-Marquardt algorithm, model bias, regional calibration,

Comparative Analysis of Total Column Ozone from GK-2A/AMI and GK-2B/GEMS for Improving Atmospheric Correction of GOCI-II

Eunkyung Lee[1], Jaehyun Ahn[1], Kyeongsang Lee[1*]

[1]Korea Ocean Satellite Center, Korea Institute of Ocean Science and Technology, South Korea

* e-mail: kyeongsang@kiost.ac.kr

Accurate atmospheric correction is essential for producing reliable ocean color products from the Geostationary Ocean Color Imager-II (GOCI-II). A key step in this process is gaseous absorption correction, where total column ozone (TCO) serves as a critical input variable, particularly affecting transmittance in the UV and blue spectral bands. Since GOCI-II does not provide its own ozone retrievals, external datasets from co-orbiting geostationary satellites must be used.

This study evaluates TCO products from the Advanced Meteorological Imager (AMI) onboard GK-2A and the Geostationary Environment Monitoring Spectrometer (GEMS) onboard GK-2B. Both datasets were spatially collocated to the GOCI-II Local Area (LA) grid using bilinear interpolation, and their accuracy was assessed against ECMWF ERA5 reanalysis data. Statistical metrics, including correlation, root mean square error, and bias, were calculated to quantify their performance.

Results indicate that both AMI and GEMS TCO products show high correlations with ERA5. However, AMI exhibits lower errors and smaller bias, while GEMS shows larger errors and a tendency toward negative bias, especially during summer months. Spatial analysis further reveals that AMI provides more stable performance across the study region, whereas GEMS is more affected by seasonal variability.

These findings suggest that AMI can be employed as the primary TCO source for GOCI-II atmospheric correction, with GEMS serving as a complementary dataset to mitigate gaps caused by cloud contamination. Future work will include applying these TCO datasets to GOCI-II gaseous absorption correction and comparing the resulting remote sensing reflectance (Rrs) to further assess their impact on ocean color retrievals.

Keywords: GOCI-II, AMI, GEMS, TCO

Estimation of High-Resolution Ocean Acidification Indices Using a Clustering-Regression Ensemble

Chae-Reum Kang[1] , Young-Heon JO[1]
[1]Depart of Oceanography, Pusan National University, Busan

* e-mail:joyoung@pusan.ac.kr

Since industrialization, the dissolution of CO_2 and changes in the carbonate system have led to a global decline in ocean pH, resulting in ocean acidification. Global ocean acidification has substantial impacts on marine ecosystems, and the waters surrounding the Korean Peninsula are experiencing a pH decline 1.5–2 times faster than the global average, highlighting the need for long-term monitoring. However, monitoring pH in coastal regions remains challenging due to the low spatiotemporal resolution of available data (monthly, 25 km). Therefore, this study aimed to estimate high-resolution ocean acidification data by developing a clustering–regression ensemble-based machine learning model. Specifically, we constructed a machine learning model that reconstructs pH using the combination of pCO_2 and total alkalinity (TA). The input data for the model included sea surface temperature, salinity, mixed layer depth, chlorophyll, and nutrient variables from CMEMS. pCO_2 and total alkalinity (TA) were obtained from the Surface Ocean CO_2 Atlas (SOCAT) and the Global Ocean Data Analysis Project (GLODAP), respectively. Using these datasets, we applied a clustering–regression ensemble approach: MiniBatch K-means was used to partition the data into six clusters, and nonlinear regression models were used within each cluster. Specifically, pCO_2 and TA were estimated through an ensemble of LightGBM and a multilayer perceptron (MLP) model and a Support Vector Regression (SVR) model, respectively. The pH was calculated using the PyCO2SYS package, based on pCO_2 and TA. The model was trained on data from 2010 to 2018 and validated against in-situ data from 2019 to 2022. The results showed validation accuracy of pCO_2 ($R^2 = 0.936$), TA ($R^2 = 0.789$), and pH ($R^2 = 0.897$), indicating high accuracy. The findings are expected to make a significant contribution to ocean acidification monitoring and research, particularly in the seas surrounding the Korean Peninsula.

Keywords: Remote sensing, Ocean acidification, Clustering–regression ensemble, Machine learning, High-resolution pH reconstruction

Seasonal and Long-Term Variability in GOCI-II Level-3 Chlorophyll-*a* Concentration

Ji-Yeon Baek[1*], Sujung Bae[1], Minsang Kim[1], Jae-Hyun Ahn[1], Jong-Kuk Choi[1], Myung-Sook Park[1]

[1]Korea Ocean Satellite Center, Korea Insitute of Ocean Science and Technology

* e-mail:jy_baek@kiost.ac.kr

The Geostationary Ocean Color Imager-2 (GOCI-II) provides 250 m ocean-color observations over ~10 daytime hours, offering unique sub-daily sampling yet complicating the creation of long-term, globally comparable chlorophyll-*a* (Chl-*a*) records. To address this, we generate Level-3 (L3) Chl-*a* concentrations that are suitable for analyzing seasonal and long-term variability, and are comparable to established global products. Level-2 Chl-*a* is converted to L3 monthly composites on an international standard grid (4 km) via an L3 binning procedure: (i) remapping to the standard 4 km grid, (ii) applying QA/flag screening to suppress cloud-influenced pixels, and (iii) aggregating by sum/count with a final mean. The resulting GOCI-II L3 Chl-*a* concentrations were compared with monthly records from the Moderate Resolution Imaging Spectroradiometer (MODIS) and the Visible Infrared Imaging Radiometer Suite (VIIRS), all on the same grid. A time-series analysis of the monthly record was employed to detect seasonal and long-term variability. The GOCI-II L3 Chl-*a* data were generally consistent with MODIS/VIIRS, exhibiting regional and seasonal variations. Accordingly, it provides a reliable long-term record for global comparison, operational monitoring, and time-series analysis.

Keywords: GOCI-II; Long-Term trends; Seasonal variability; L3 binning

Improving GOCI-II IOP Retrieval with Hybrid Machine Learning Approaches

Eunna Jang[1] , Jae-Hyun Ahn[1*]

[1]Korea Ocean Satellite Center, Korea Institute of Ocean Science & Technology, Busan, Korea

* e-mail:brtnt@kiost.ac.kr

Accurate retrieval of Inherent Optical Properties (IOPs) is essential for characterizing light absorption and scattering in marine environments. Reliable IOP estimates are vital for tracking ecological processes, detecting biogeochemical variations, and managing coastal to open-ocean ecosystems. Satellite ocean-color missions, such as GOCI-II, provide broad spatial and temporal coverage for IOP monitoring, complementing limited in-situ sampling efforts. Quasi-analytical algorithms (QAA) have been widely applied to convert remote-sensing reflectance (R_{rs}) into IOPs; however, their reliance on empirical parameterizations often restricts accuracy, particularly in optically complex waters.

In this work, we introduce a hybrid framework that incorporates machine learning (ML) into QAA-based schemes by replacing empirical terms with data-driven functions. Using simulated R_{rs} datasets from the HydroLight radiative transfer model, our approach enables robust estimation of total absorption (a_total) and total backscattering (bb_total) across all GOCI-II bands. Validation results highlight that this hybrid model enhances retrieval accuracy for both absorption and scattering coefficients when compared to conventional formulations. These results demonstrate the effectiveness of merging traditional optical models with ML-based methods for improved IOP retrieval from GOCI-II observations. The proposed framework provides a promising direction for advancing regional ocean-color applications and supporting marine environmental monitoring.

Keywords: GOCI-II, IOP, Machine learning, QAA

The difference between *in situ* and satellite-based dissolved organic carbon in South China Sea

Sheng-Lun Chen[1], Yung-Yen Shih[1], Chin-Chang Hung[2]

[1]Department of Applied Science, ROC Naval Academy, Kaohsiung, Taiwan ROC
[2]Department of Oceanography, National Sun Yat-sen University, Kaohsiung, Taiwan, ROC

* e-mail:anderson20051206@gmail.com

Dissolved Organic Carbon (DOC) is a crucial component of the oceanic carbon cycle. According to the previous study, the global DOC reservoir is estimated at ~700 gigatons (GT), vastly exceeding the 3 GT of particulate organic carbon. However, direct sampling of DOC is logistically demanding, requiring ship-based expeditions to specific locations at specific times—an approach that is both time-consuming and resource-intensive, with no guarantee of successful sampling. To address this challenge, this study explores the use of satellite remote sensing for large-scale DOC estimate. Focusing on the northern South China Sea, we applied a quasi-analytical algorithm to satellite reflectance data at 443 nm to infer DOC concentrations. The satellite-based estimates were compared with *in situ* measurements to evaluate accuracy. The results show a mean error of −21% in offshore waters and −20% in nearshore regions, with an overall average error of −21%. These findings suggest that while satellite-based DOC estimation is feasible, further refinement and regional calibration are necessary to improve predictive accuracy.

Keywords: Dissolved Organic Carbon, Remote sensing, northern South China Sea, quasi-analytical algorithm

Simultaneous Assimilation of HF Radar and Ocean Color Satellite Data to Improve a Transport Model for a Semi-Enclosed Bay

Kotaro Yamashita[1]*, Hiroto Higa[1], Yuta Shinohara[2]

[1]Department of Civil Engineering, Yokohama National University, Japan
[2] A Marine Environmental Information Group, Port and Airport Research Institute, Japan.

* e-mail:yamashita-kotaro-bd@ynu.jp

Data assimilation between satellite observations and hydrodynamic–ecosystem numerical models has been demonstrated to be effective mainly in global or open-ocean regions. However, its application to enclosed coastal waters, where physical environments and water quality fluctuate substantially over short time scales, remains challenging. One major difficulty arises from the estimation of suspended matter in water, which is generally based on empirical algorithms and thus often entails high uncertainty in optically complex enclosed bays. Moreover, the spatial distribution of suspended matter is strongly governed by advective and diffusive transport. Therefore, while accurate flow simulation is a prerequisite for satellite data assimilation, in coastal areas with complex topography the flow itself becomes complicated, further increasing computational uncertainty.

To simultaneously address these issues, this study develops a method for assimilating both surface current direction and velocity observed by High-frequency (HF) radar and ocean color satellite data into a coupled hydrodynamic–ecosystem model. In particular, for the assimilation of ocean color data, uncertainty was reduced by targeting Inherent Optical Properties (IOPs) derived semi-analytically based on optical theory.

Tokyo Bay, an optically complex water body where satellite observation uncertainties are high, was selected as the study area. The assimilation scheme employed a four-dimensional ensemble variational (4D-EnVar) method, which preserves material conservation laws, to simultaneously assimilate GCOM-C/SGLI ocean color satellite data and HF radar data deployed within the bay. The assimilation variables included east–west and north–south surface velocities from HF radar observations and the particle backscattering coefficient (b_{bp}), an IOP derived from satellite observations.

Comparison of the model results after assimilation with independent observations confirmed a reduction in errors in both the hydrodynamic and ecosystem models. These findings suggest that simultaneous assimilation of HF radar and ocean color satellite data can effectively enhance the reproducibility of numerical models in enclosed bays.

Keywords: Remote sensing, hyperspectral, radiative transfer simulation

Phenological Characteristics of Phytoplankton Bloom in the South China Sea

Mohd Ikmal Shafiq Rosli[1], Wee Cheah*[1], Fadzil Md. Firdzaus[1] , Wan-Ling Tseng[2] , Chun Hoe Chow[3] and Azizan Abu Samah[1]

[1]Institute of Ocean and Earth Sciences, Universiti Malaya, Kuala Lumpur, Malaysia
[2]International Degree Program in Climate Change and Sustainable Development, National Taiwan University, Taipei, Taiwan.
[3] Department of Marine Environmental Informatics, National Taiwan Ocean University, Keelung, Taiwan

* e-mail: wee.cheah@um.edu.my

The South China Sea (SCS) is a vital marine ecosystem, contributing ~10% of the global fish catch and providing employment for millions of fishermen/women. However, increasing anthropogenic pressures—such as overfishing, pollution, and climate change—threaten its sustainability. Phytoplankton blooms, as key indicators of marine productivity, play a crucial role in the food web and are sensitive to environmental changes. In this study, we will analyse the phenological characteristics of phytoplankton blooms in the SCS. Using satellite-derived chlorophyll-*a* concentration we will assess the timing, intensity, and duration of blooms, focusing their variability across coastal and open sea regions. Preliminary results revealed significant spatial and temporal differences perhaps associated with physical processes. Furthermore, we will examine the interannual variability of this the bloom events, in addition to the long-term changes in the phenological characteristics of phytoplankton bloom. Understanding these patterns is essential for sustainable fisheries management and marine conservation in the SCS. Our findings provide insights to inform policies aimed at preserving the region's biodiversity and food security.

Keywords: phenological changes, trend, climate change, phytoplankton, South China Sea

Applicability Assessment of an Optical Satellite–Based Turbidity Model in the Densu Delta, Ghana

Yo Matsumoto [1]* , Hiroto Higa [2], Salem Ibrahim Salem [3]

[1] Department of Civil Engineering, Yokohama, National University, Japan
[2] Institute of Urban Inovation, Yokohama National University, Yokohama, Japan
[3] Earth Observation Science and Applications, Plymouth Marine Laboratory, Plymouth, UK

* e-mail:matsumoto-yo-mn@ynu.jp

The Republic of Ghana, located in West Africa, is experiencing severe coastal erosion, which has become one of the main causes of frequent coastal flooding. In the Densu Delta near Accra, artificial sandbars have been excavated around the lagoon to mitigate flood damage. However, these activities have led to water quality deterioration, habitat degradation, and a decline in mangrove forests, all of which have significantly affected ecosystem processes. Consequently, coastal topographical changes are closely linked to the surrounding environment including water quality and ecosystems as well as to disaster prevention and mitigation. Continuous monitoring of these interactions is therefore essential.

Optical satellite observations enable low-cost, low-effort environmental monitoring without the need for continuous on-site measurements. Such techniques are particularly valuable in developing countries where sustained field observations are difficult. In the Densu Delta, the main environmental issues include identifying the sediment transport processes and sources responsible for sandbar formation, as well as the pollution sources originating from surrounding settlements. Spatial analysis of turbidity can provide valuable insights into these mechanisms and help elucidate the spatial formation processes and seasonal variation patterns of highly turbid waters within the lagoon.

In this study, field observations were conducted in the Densu Delta to analyze the relationships between measured turbidity and reflectance, thereby clarifying the characteristics of water quality and the optical environment in the lagoon. Based on these field results, a turbidity estimation model for optical satellite data was developed. Furthermore, to evaluate the applicability of satellite observations in a complex and narrow coastal area such as the Densu Delta, the effectiveness of turbidity mapping using multiple optical satellites with different spatial resolutions was examined. The outcomes of this study will be presented at this workshop.

Keywords: Remote sensing, Turbidity presumption, Coastal erosion, Environmental Monitoring

Application of Ocean Color Remote Sensing Data for Coastal Infrastructure Assessment Considering Ecosystem Services and Human Well-being

Kohtaroh Kobayashi[1]*, Hiroto Higa[1], Martin Mäll[1], Genki Terauchi[2] and Takayuki Suzuki[1]

[1] Institute of Urban Inovation, Yokohama National University, Yokohama, Japan

[2] Department of Research and Study, Northwest Pacific Region Environmental Cooperation Center, Toyama, Japan

* e-mail: kobayashi-kohtaroh-bj@ynu.jp

Until recently, coastal disaster prevention infrastructure has been dominated by Grey Infrastructure (GyI), such as concrete structures. However, growing attention has been directed toward Green Infrastructure (GI), which makes use of natural environments and ecosystems. While GI is expected to reduce maintenance costs and conserve natural environments, in practice it also provides numerous benefits to humans in the form of ecosystem services. Among all ecosystems on Earth, coastal ecosystem services are considered to have particularly high economic value. These benefits are noted to influence human well-being, and thus, in developing infrastructure, it is necessary to consider not only the functional aspects of the infrastructure but also the human well-being of local residents (Kobayashi et al., 2024).

GIS data, which spatially visualizes various survey results, is useful for quantifying ecosystem services in coastal areas. However, challenges include insufficient spatiotemporal resolution of data and disparities in data volume and quality across countries and regions. Utilizing satellite data, which excels in horizontal spatial observation, can be an effective means to address these issues. In particular, ocean color satellite data are effective for quantifying water quality, which is closely related to coastal ecosystems, and hold potential to play a significant role in evaluating coastal ecosystem services.

This study focuses on Coastal Eutrophication Potential derived from ocean color satellite data (Maúre at al., 2021) to assess their effectiveness for quantitative evaluation of ecosystem services in coastal areas. Furthermore, it attempts to analyze the contribution of ecosystem services to human well-being. For this evaluation, we developed an assessment framework for coastal infrastructure based on the ecosystem service cascade model, and examined how Coastal Eutrophication Potential obtained from ocean color satellite data influence ecosystem service assessment. This presentation will introduce the results of this study.

Keywords: Coastal Eutrophication Potential ,Well-being, Grey Infrastructure, Green Infrastructure, Ecosystem Services

Satellite-based assessment of marine blue carbon sinks in Taiwan and the northern South China Sea: validation against *in situ* observations

Yung-Yen Shih[1,2], Zong-Ru Cheng[2], Sheng-Lun Chen[2], Zi-Xin Liao[2], Chin-Chang Hung[1, *]

1. Department of Oceanography, National Sun Yat-Sen University, Kaohsiung, Taiwan, ROC.
2. Department of Applied Science, ROC Naval Academy, Kaohsiung, Taiwan, ROC.

* e-mail: cchung@mail.nsysu.edu.tw

Satellite remote sensing provides a powerful tool for large-scale and continuous monitoring of marine ecosystems, offering significant potential for quantifying blue carbon sinks. However, uncertainties remain regarding its accuracy relative to *in situ* observations. This study evaluates the performance of satellite-based models in estimating marine carbon sinks, focusing on Taiwan's Provisional Enforcement Line (PEL) and the northern South China Sea. Three comparative analyses were conducted: (1) between satellite-modeled and sediment trap–derived particulate organic carbon (POC) fluxes, (2) between POC sink estimates in the PEL from remote sensing and in situ approaches, and (3) between modeled and observed values under varying environmental conditions, including extreme weather events. Results show that satellite-based models underestimated POC fluxes by 35–85% compared with sediment trap measurements. In contrast, satellite-derived estimates of total carbon sinks within the PEL differed from in situ estimates by 7–22%, highlighting discrepancies at regional scales. During extreme events such as typhoons and winter storms, modeled POC fluxes deviated sharply from trap data, with differences ranging from −25% to −84%. Furthermore, satellite-derived dissolved organic carbon (DOC) estimates were consistently lower than in situ values by ~20–21%. These findings underscore both the potential and limitations of satellite-based approaches for quantifying marine blue carbon sinks. While remote sensing provides valuable large-scale insights, systematic calibration and validation with *in situ* data—especially under dynamic or extreme conditions—are essential to improve model reliability and ensure robust carbon budget assessment.

Keywords: blue carbon, satellite remote sensing, particulate organic carbon (POC), dissolved organic carbon (DOC), carbon sink

Distinction of Seasonal Internal Solitary Waves in the Lombok Strait using GCOM-C/SGLI Data

Chonnaniyah[1*] , Eko Siswanto[2], Takahiro Osawa[3]

[1]Environmental Engineering Program, Institute of Sciences and Technology Nahdlatul Ulama Bali (ISTNUBA), Denpasar, Bali, Indonesia
[2]Earth Surface System Research Center, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Yokohama, Kanagawa, Japan
[3]Center for Research and Application of Satellite Remote Sensing (YUCARS), Yamaguchi University, Tokiwadai, Ube, Yamaguchi, Japan

* e-mail:chonnaniyah@unud.ac.id

Internal Solitary Waves (ISWs) are energetic oceanic phenomena that play a crucial role in vertical mixing, sediment resuspension, and biological productivity, especially in narrow straits and shelf regions. This study investigates the seasonal variability and characteristics of ISWs in the Lombok Strait, Indonesia, using multi-satellite observations from GCOM-C/SGLI, Sentinel-1 SAR, and Terra/MODIS sensors. The Lombok Strait, located between Bali and Lombok Islands, is a key pathway for the Indonesian Throughflow and exhibits strong stratification influenced by monsoonal forcing. Multi-sensor satellite data from 2018 and 2019 were analyzed to extract ISW parameters such as soliton number, crest length, wavelength, and phase speed using a combination of pattern recognition and nonlinear wave modeling. The Korteweg–de Vries (KdV) equation was employed to estimate phase speeds from observed surface wave signatures. Seasonal comparisons revealed distinct ISW dynamics between the southeast monsoon (SEM) and northwest monsoon (NWM) periods.

Sentinel-1 SAR detected a higher number of solitons during the NWM, while optical sensors (SGLI and MODIS) showed wider wavelength structures during the SEM. Phase speed estimates derived from the KdV equation indicated faster propagation during the NWM season, suggesting stronger stratification and sharper thermocline gradients. Ocean color analysis from SGLI (chlorophyll-a, SST, and AOT) further revealed spatial patterns potentially linked to subsurface internal wave activity, particularly during the NWM. This study demonstrates the usefulness of multi-satellite synergy in observing and distinguishing seasonal ISW characteristics in the tropics. The integration of radar and optical observations provides complementary insights into surface manifestations and internal dynamics, supporting future modeling and field campaigns to better understand ocean processes in the Indonesian seas.

Keywords: Internal Solitary Waves (ISWs); Lombok Strait; GCOM-C/SGLI; Multi-satellite observation; ocean color

Analysis of the Nutrient Transport Process in the Southern Java Sea and their Interplay with Oceanic Eddy Occurrences

Takahiro Osawa[1], I Made Wira kumara Kamasan[1], Eko Siswanto[2], Imaoka Keiji[1]

[1]Research Center for Advanced Science and Innovation, Yamaguchi University, Japan
[2]Research Institute for Global Change, Japan Agency for Marine-Earth Science and Technology, Japan

* e-mail:osawaunu@yamaguchi-u.ac.jp

The Indonesian seas form a uniquely complex and dynamic region, serving as a crucial oceanic gateway between the Pacific and Indian Oceans. This inter-oceanic connection drives a wide range of circulation systems, including the Indonesian Throughflow (ITF) and regional currents such as the Southern Java Current (SJC). These currents play a significant role in modulating biophysical processes such as upwelling, nutrient transport, and phytoplankton productivity, which directly support Indonesia's rich fisheries resources.
This study aims to investigate and quantify the interactions among oceanic eddies, upwelling, Ekman transport, and nutrient dynamics in the southern Java Sea during the period 2010–2022. Multi-sensor satellite datasets were utilized, including: (1) sea surface height and geostrophic current data from Copernicus Marine Services for eddy detection and eddy kinetic energy calculation, (2) sea surface temperature (SST) data from OSTIA for upwelling and ENSO/IOD influences, (3) chlorophyll-a concentration from Global Colour for biological responses, and (4) ERA5 reanalysis winds for estimating Ekman mass transport and Ekman pumping velocity.

To identify dominant spatial-temporal patterns of variability, Empirical Orthogonal Function (EOF) analysis was applied to the combined datasets. The results show that in the inshore region, the first EOF mode explains over 70% of the total variance, indicating that wind-driven upwelling is the dominant mechanism controlling nutrient enhancement. In contrast, the offshore region exhibits over 50% variance in the first mode, mainly driven by horizontal wind-induced transport, with secondary contributions from mesoscale eddies. The correlations between eddy activity and nutrient concentration were found to be weak in both regions, suggesting limited biological influence of oceanic eddies compared to wind-driven processes.

In conclusion, this study highlights the dominant role of wind-driven upwelling and Ekman transport in modulating nutrient variability in the southern Java Sea. The contribution of oceanic eddies is relatively minor but may become significant under specific monsoon or interannual conditions. Further work integrating in-situ nutrient and biological data with satellite observations is recommended to improve the understanding of physical–biogeochemical coupling in this region.

Keywords: ocean color, remote sensing reconstruction, chlorophyll-a, South Jawa

Long-term Water Quality Properties measured from Satellite Ocean Color sensors using Improved Algorithms in the Chesapeake Bay

SeungHyun Son

ESSIC/CISESS, University of Maryland, College Park, MD, USA

ABSTRACT

Satellite remote sensing is a valuable tool for monitoring water quality properties, such as chlorophyll-a and water clarity, in the coastal waters with high spatial and temporal resolutions. In turbid coastal waters such as the Chesapeake Bay, the largest estuary in the U.S., water quality is strongly influenced by a complex mixture of chlorophyll concentration, colored dissolved organic matter (CDOM), and total suspended sediments (TSS). Accurate measurement of water quality parameters in turbid coastal waters is essential for understanding coastal ecosystem health and its interaction with extreme events, such as hurricanes and flooding. User needs helped prioritize this work for the Committee on Earth Observation Satellites Coastal Observations, Applications, Services, and Tools Virtual Constellation (CEOS COAST-VC).

This study utilizes two satellite ocean color datasets from the Moderate Resolution Imaging Spectroradiometer (MODIS) aboard Aqua (2002-2022) and the Visible Infrared Imaging Radiometer Suite (VIIRS) aboard the Suomi National Polar-orbiting Partnership (SNPP) (2012-2023). In support of CEOS COAST-VC users, it was undertaken to derive two water quality products for the Chesapeake Bay pilot region: chlorophyll-a using an Extra-Trees machine learning model and water clarity (Secchi Disk Depth) using a semi-analytical model. The satellite-derived water quality products are analyzed to assess seasonal and interannual variability in water quality and to investigate water quality responses to significant river discharges of dissolved and particulate materials as well as extreme hurricane events that induce strong vertical mixing and storm surges. Improved coastal satellite-derived data products, co-designed with COAST-VC pilot region stakeholders, are available on the CEOS COAST-VC's Application Knowledge Hub (https://www.star.nesdis.noaa.gov/socd/coast/).

Keywords: Ocean Remote Sensing, Water Quality, Chlorophyll-a, Water Clarity, Chesapeake Bay