GOCI-II, current status, validation and applications

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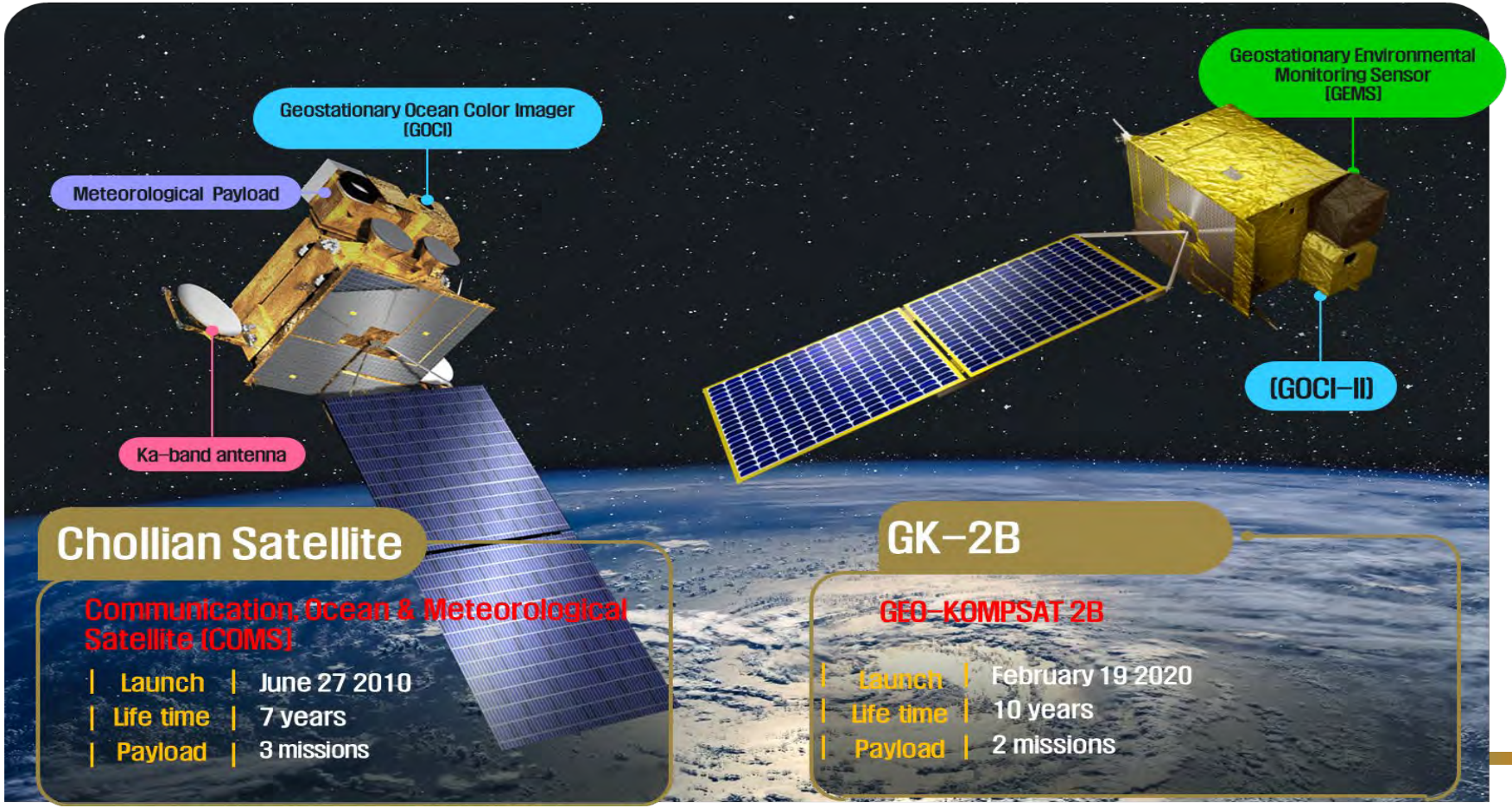
KOSC

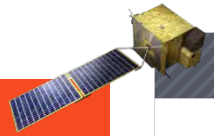
I. Overview

Overview of GOCI/GOCI-II



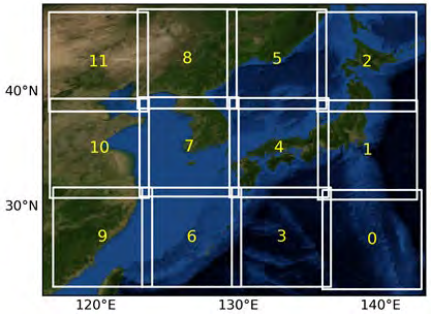
GOCI/GOCI-II Specifications

	GOCI	GOCI-II
Observation mode	Local (2,500 km × 2,500 km) -	Local (2,500 km × 2,500 km), Full Disk (12,800 km × 12,800 km)
No. of slot	16 slots / Local –	12 slots / Local, 235 slots / Full Disk
Spatial resolution	500 m	250 m
Temporal resolution	8 times / Local (00:15 UTC ~ 07:15 UTC) -	10 times / Local (23:15 UTC ~ 08:15 UTC) 1 time / Full Disk (20 UTC~ 10 UTC)
Spectral resolution	412 nm, 443 nm, 490 nm 555 nm, 660 nm 680 nm, 745 nm, 865 nm	380 nm, 412 nm, 443 nm, 490 nm 510 nm, 555 nm, 620 nm, 660 nm 680 nm, 790 nm, 745 nm, 865 nm Wide Band



Observation Mode

Local Area (LA)



Full Disk (FD)

GOCI-II 26 L2 products

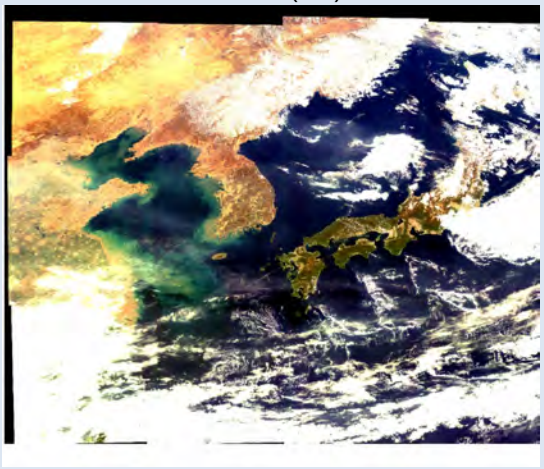
Category	Products	Abbreviation
AC	Rayleigh Corrected Reflectance	R_{hoC}
	Remote Sensing Reflectance	R_{rs}
	Absorption Coefficients	A
	Backscattering Coefficients	B_b
OC	Diffuse Attenuation Coefficient	K_d
	Secchi Disk Depth	Z_{sd}
	Chlorophyll-a Concentration	Chl
	Total Suspended Material Concentration	TSS
	Colored Dissolved Organic Matter	CDOM
OCEAN	Floating Algae	FA
	Marine Fog	MF
	Red Tide Index	RI
	Sea Ice	SI

Category	Products	Abbreviation
OCEAN	Primary Production	PP
	Chlorophyll-a Front	CF
	Sea Surface Current	SSC
	Low Sea Surface Salinity	LSSS
	Fishing Ground Information	FGI
AERO	Aerosol Optical Depth	AOD
	Aerosol Type, including DUST	AT
	Aerosol Type	
LAND	Land Surface Reflectance	LSR
	Land Surface Albedo	LSA
	Normalized Difference Vegetation Index	NDVI
	Enhanced Vegetation Index	EVI
	Land Cover	LC

Current Status of GOCI/GOCI-II

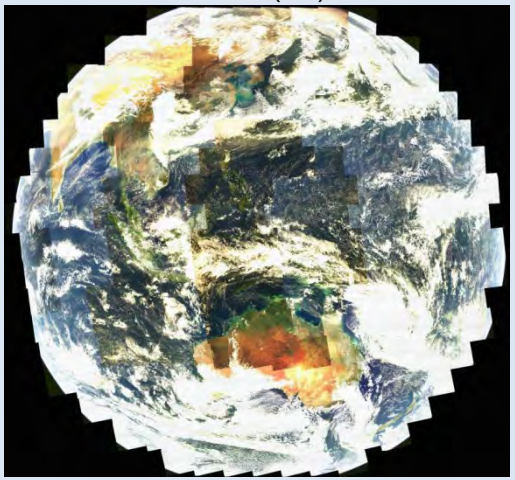
	~2019	2020	2021	2022~2030
GOCI	in operation		※ mission officially ended in March, 2021	
GOCI-II	prelaunch	launch → IOT	Public service for Level 1 data (Oct. 2020, KHOA)	
			Public service for 26 products (Jan. 2021, KHOA)	

GOCI-II(LA)



13:15, 23 March 2020, (KST)

GOCI-II(FD)



14 March 2020

* KHOA : Korea Hydrographic and Oceanographic Agency

Public Service for GOCI-II

GK-2B Satellite
35,786Km (128.2E)

Satellite operation
(KARI)

KOSC
(KIOST)

Generating L1, L2

NOSC
(KHOA)

GOCI-II Data Service

End User

WEB based service

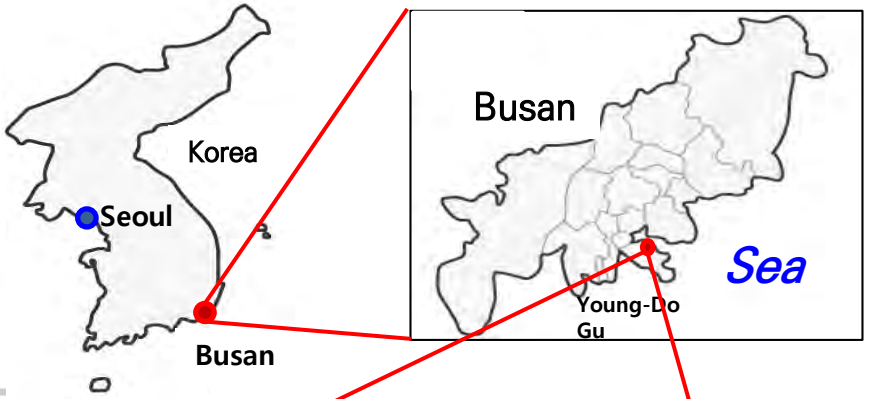
Supporting organization

** National Ocean Satellite Center (NOSC) in Korea Hydrographic and Oceanographic Agency (KHOA)*

National Ocean Satellite Center (NOSC)

NOSC was established within KHOA (Korea Hydrographic and Oceanographic Agency) in May, 2019

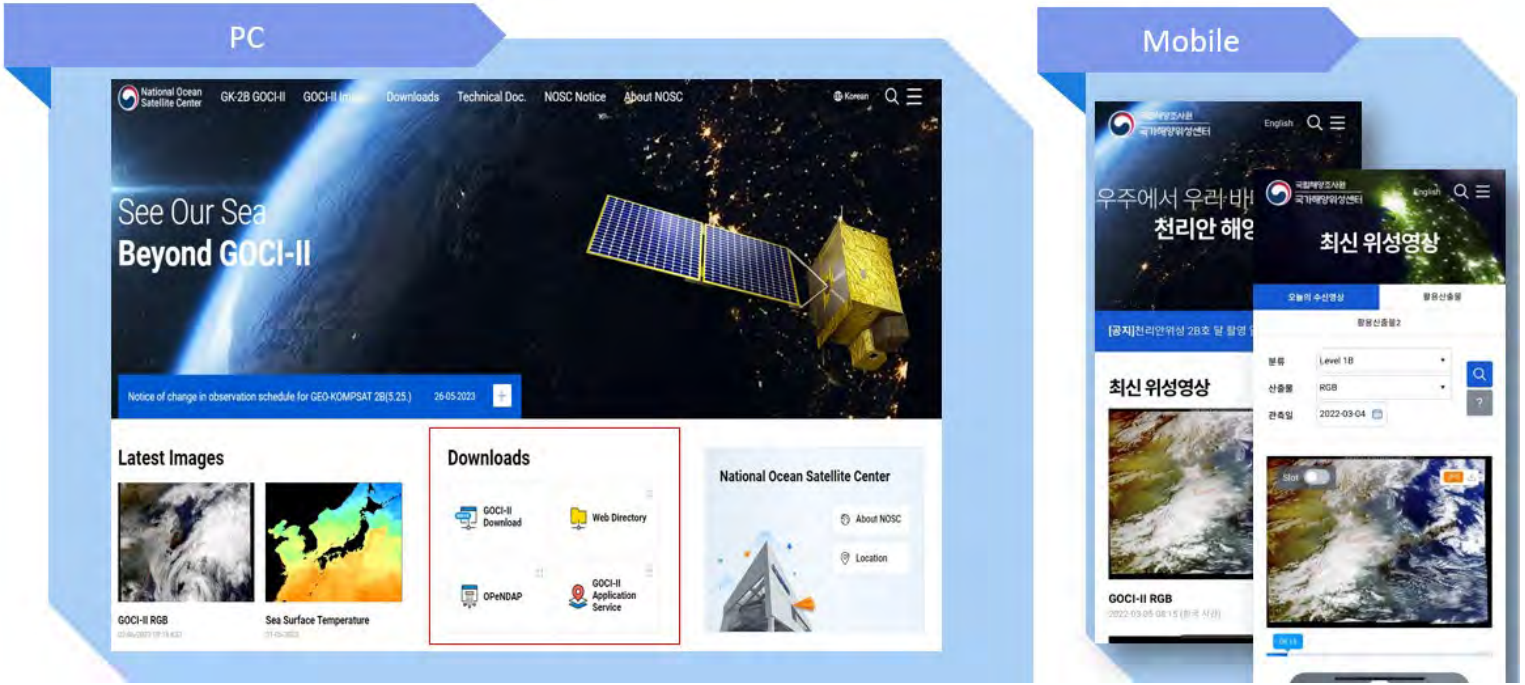
2019.5.	2020.2.	2020.10.
NOSC established	GK-2B launched	GK-2B service commenced



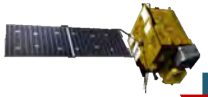
- Establishing efficient national satellite policy
- Developing new applications of the satellites
- Improving the satellite policy

Public Service for GOCI-II by NOSC

- Established new website *(www.nosc.go.kr)* and started public service from Jan. 2023



Project on GOCI-II accuracy enhancement



Rrs, CHL, TSM, CDOM (basic ocean color products) have been generated and publicly provided without securing accuracies

GOCI-II Launch (2020.02)

GOCI-II mission life time ('20~'29, 10 years)

	'15	'16	'17	'18	'19	'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30
GOCI-II	algorithms for 26 GOCI-II products were developed using simulation data (initial algorithm not validated)							'Accuracy enhancement of GOCI-II'								

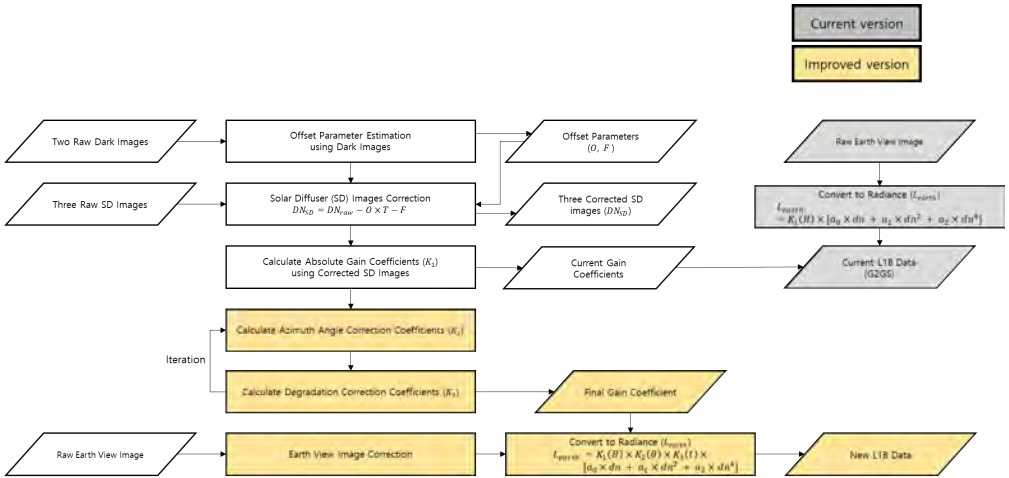
Establishing Cal/Val standardization and improving accuracy at international level

- Development of technology for cal/val of GOCI-II products
- Research on algorithm improvement for GOCI-II products
- Development of atmospheric correction technique based on the integration of GeoKompsat-2A/2B

II. Works we are doing

GOCI-II Radiative Calibration

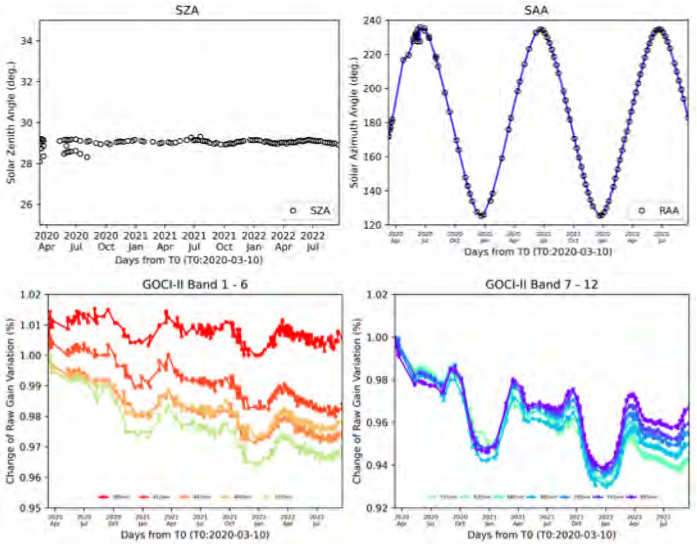
Flow chart of GOCI-II RC algorithm



$$L_{earth} = K_1(B) \times K_2(\theta) \times K_3(t) \times [a_0 \times dn + a_1 \times dn^2 + a_2 \times dn^4]$$

$K_1(B)$: absolute gain coefficient,
$K_2(\theta)$: azimuth angle correction (BTDF) coefficient,
$K_3(t)$: sensor degradation correction coefficient
dn: digital number after dark image correction
a_0, a_1, a_2: coefficient of GOCI-II RC algorithm

Time series of Solar Diffuser (SD) Observational Angle and Gain parameters



- Gain has seasonality
- Gain has variability depending on the band

Improvement of GOCI-II RC algorithm

BTDF: Bi-directional Transmittance Distribution Function

BTDF and Degradation Correction Algorithm

Step 1. BTDF correction

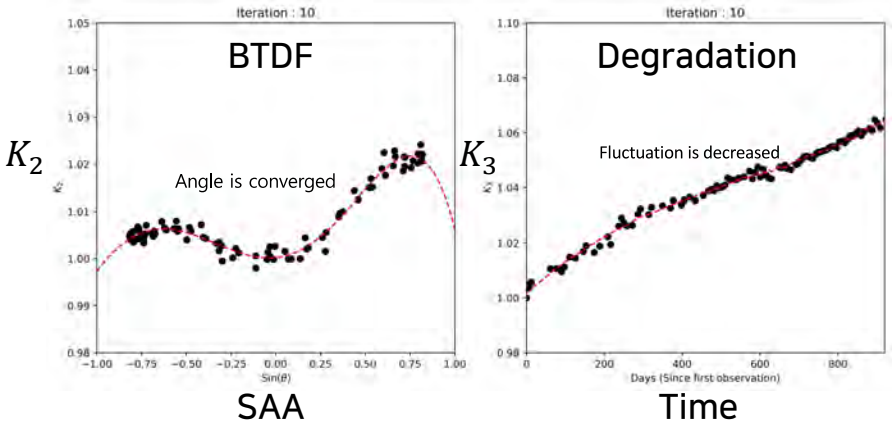
$$K_2(B,\theta_{SAA}) = b_0(B) + \sum_{i=1}^{5} b_i(\mathrm{B}) \times \sin(\theta_{SAA})^i$$

Step 2. Trend correction (degradation)

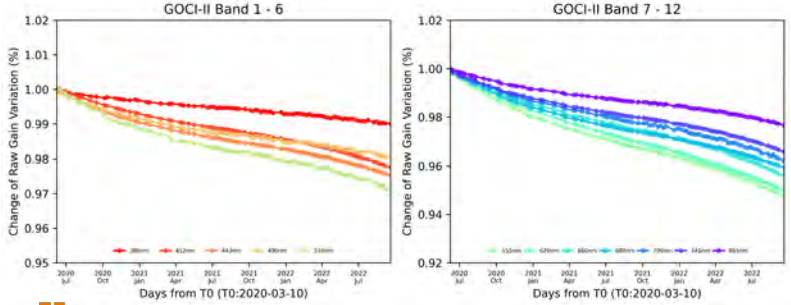
$$K_3(B,t) = c_0(B) + \sum_{i=1}^{5} c_i(\mathrm{B}) \times days(since\ first\ observation)^i$$

Step 3. BTDF iteration apply

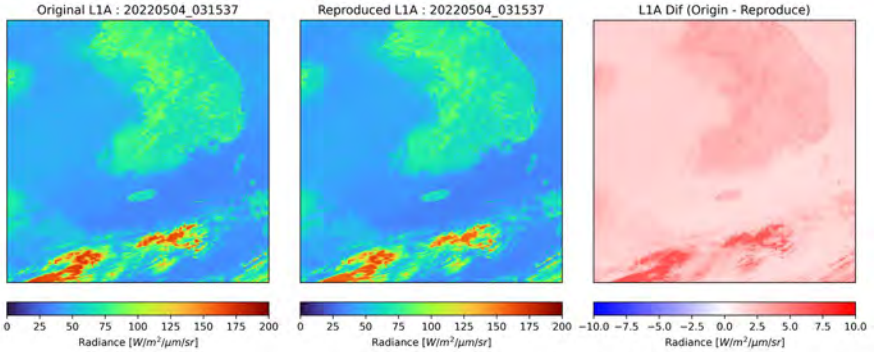
$$K_{2,3}(B,\theta_{SAA},t) = K_2 \times K_3(iteration, optimization)$$



Timeseries of Updated GOCI-II RC Gain



Effect of RC: TOA radiance



Improvement of GOCI-II RC algorithm

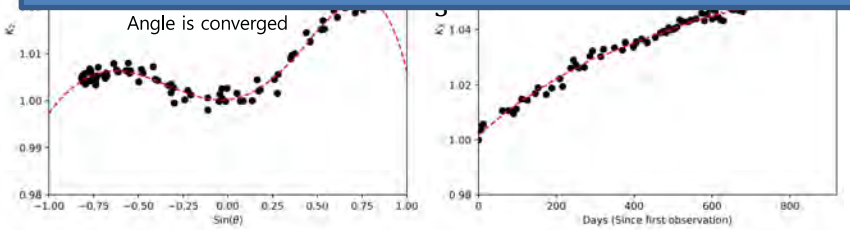
BTDF: Bi-directional Transmittance Distribution Function

BTDF and Degradation Correction Algorithm

Timeseries of Updated GOCI-II RC Gain

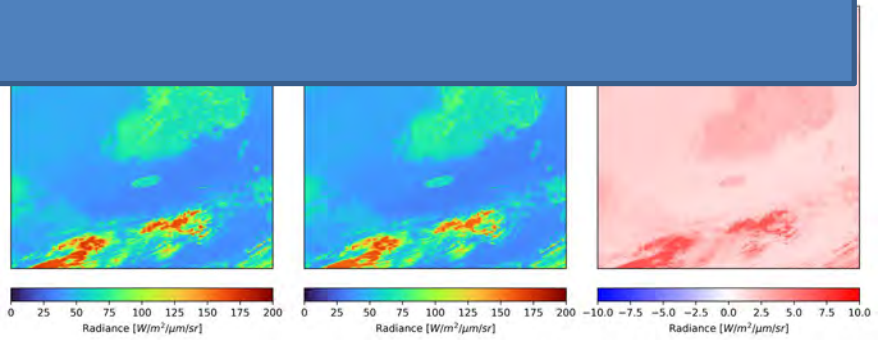
Poster #: 138
Date: Friday
Session #: 6
Title: On-orbit Radiometric Calibration of GOCI-II Solar Diffuser with Improved Bidirectional Transmittance Distribution Function

K_2



SAA

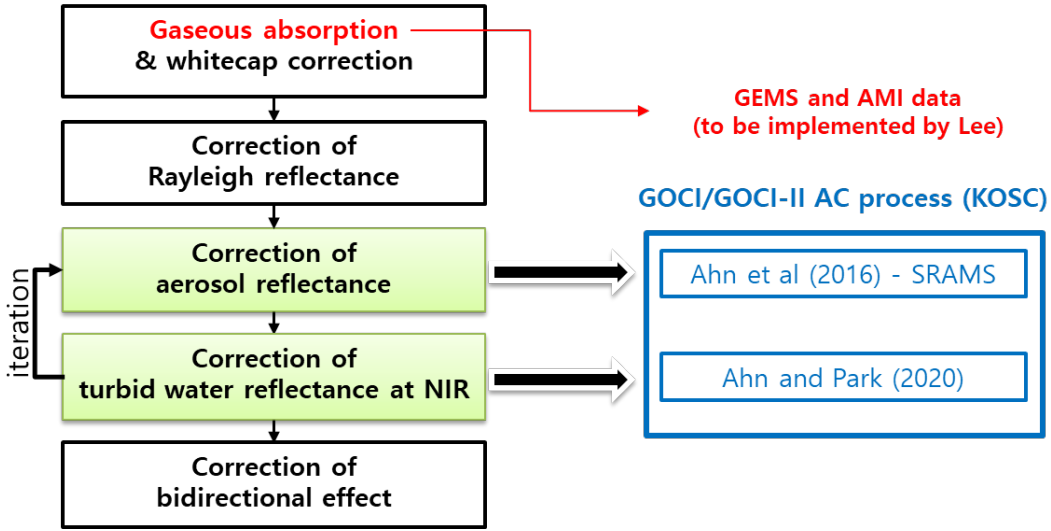
Time



Atmospheric correction and it's Cal/Val

GOCI-II AC and VC methods are theoretically based on the SeaWiFS algorithm

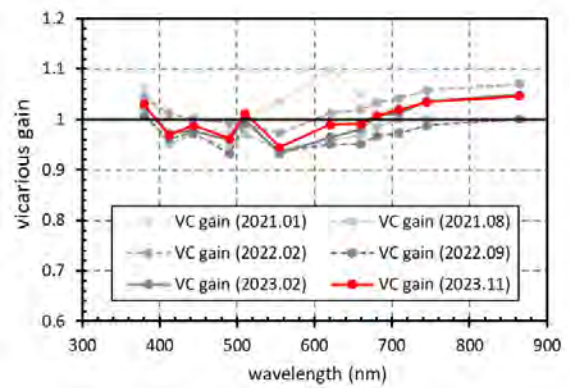
[Atmospheric Correction Process]



Overall flowchart of GOCI-II AC

[Vicarious Calibration Process]

- Current GOCI-II's vicarious calibration relies on the R_{rs} data derived from VIIRS in case-I waters
- Machine learning with simulation dataset for case-I water is used for spectral conversion of VIIRS R_{rs} into GOCI-II's R_{rs}

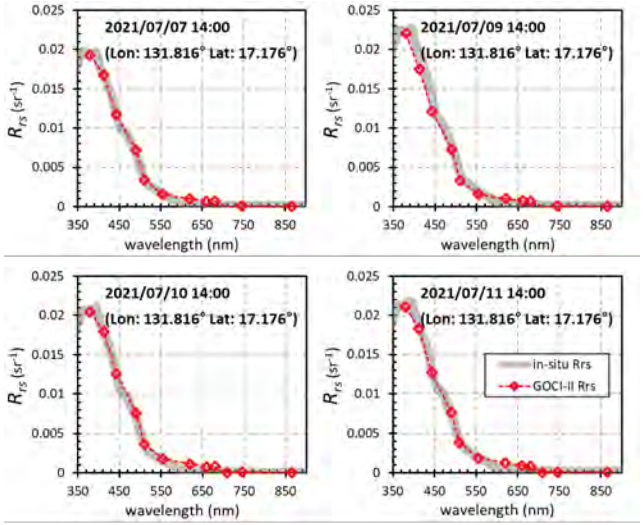


GOCI-II VC gain update history

Initial validation for atmospheric correction

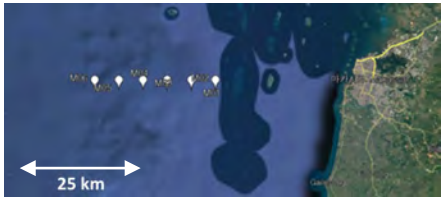
Current match-up results from case-1 waters in FD area

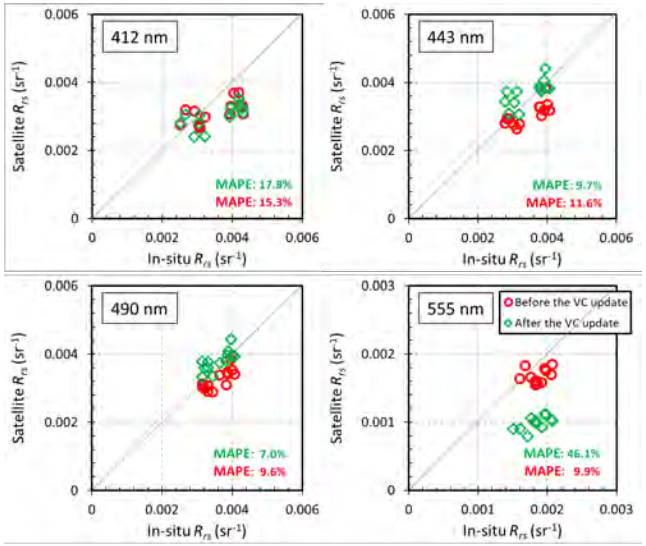
[Match-ups in Philippine sea]



wavelength	MAPE (%)	RMSE (sr^{-1})	wavelength	MAPE (%)	RMSE (sr^{-1})
380 nm	7.9	0.00183	555 nm	8.9	0.00022
412 nm	3.5	0.00104	620 nm	150.5	0.00066
443 nm	3.9	0.00081	660 nm	167.8	0.00049
490 nm	5.7	0.00047	680 nm	183.1	0.00048
510 nm	7.7	0.00044			

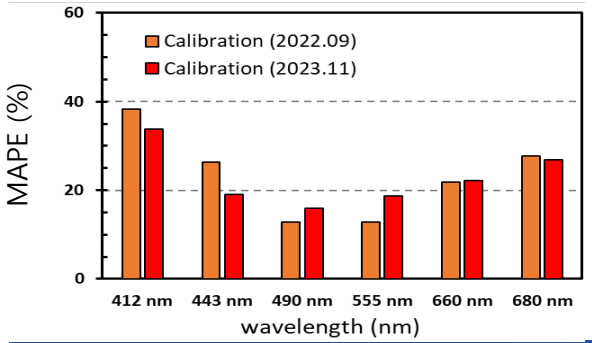
[Match-ups in Makassar / Indonesia]

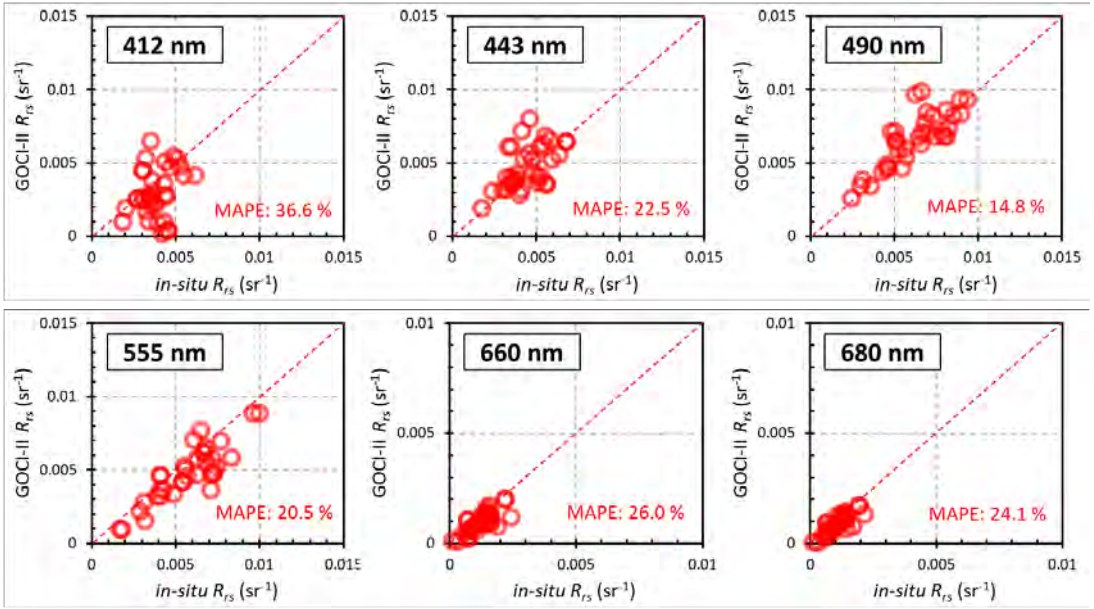




Initial validation for atmospheric correction

Some match-ups from Socheong Station (AERONET-OC)

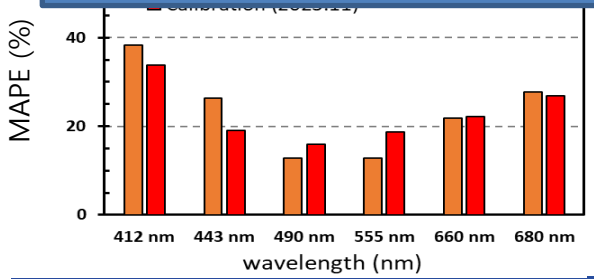


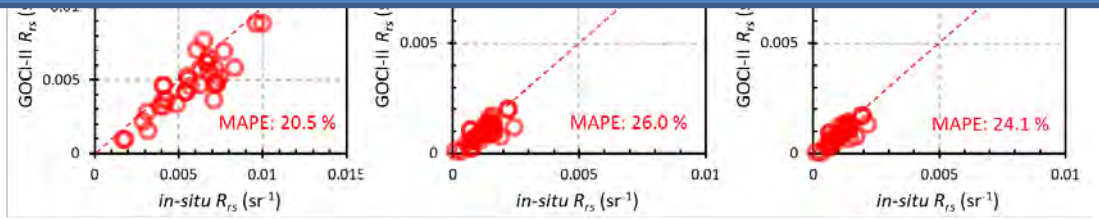


Initial validation for atmospheric correction

Some match-ups from Socheong Station (AERONET-OC)

Poster #: 126
Date: Tuesday
Session #: 1
Title: Latest atmospheric correction algorithm updates for the operational GOCI-II data processing system





GK-2A/B Fusion for GOCI-II gas absorption correction

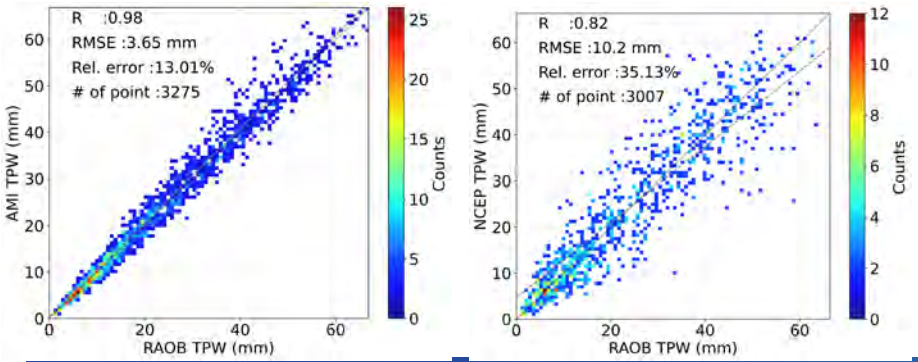
World's first operating system of GK-2A/B satellites

Simultaneously operates ocean color (GOCI-II), environment (GEMS) and meteorological (AMI) imagers on the same geostationary orbit

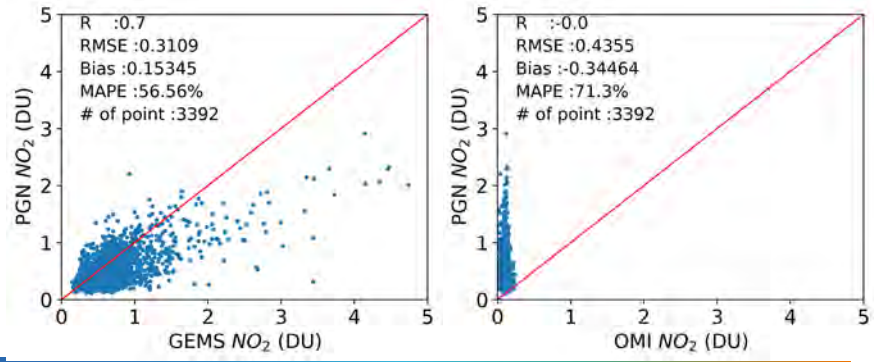
Satellite/Sensor	Temporal resolution	Spatial resolution	Number of channel	Spectral range
GK-2B/GOCI-II	1-hour (LA mode)	0.5~2 km	13	375~900 nm
GK-2B/GEMS	1-hour	7×8 km	1000	300~500 nm
GK-2A/AMI	10-min (FD)	0.25 km	16	470~13,310 nm

GEMS & AMI Gas data: higher spatiotemporal resolution and accuracy compared to OMI and NCEP forecast data.

AMI&NCEP TPW vs. Radiosonde measurements



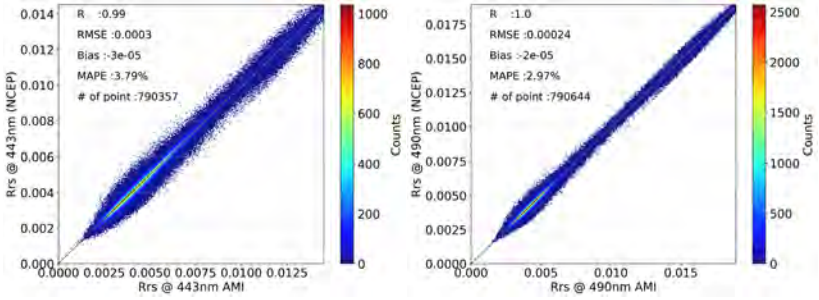
GEMS&OMI NO_2 amount vs. pandora measurements

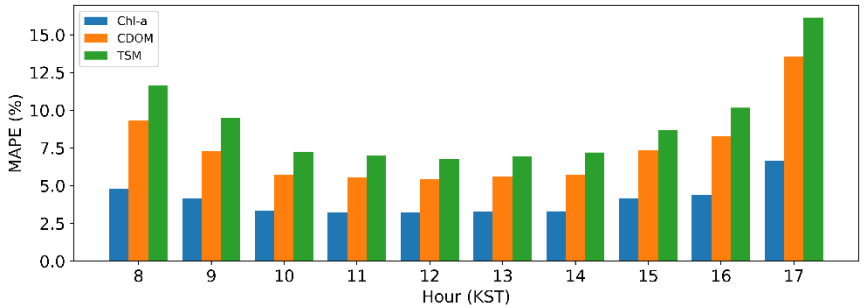


GK-2A/B Fusion for GOCI-II gas absorption correction

Improvements of gas absorption correction through fusion with AMI TPW and GEMS NO_2 data

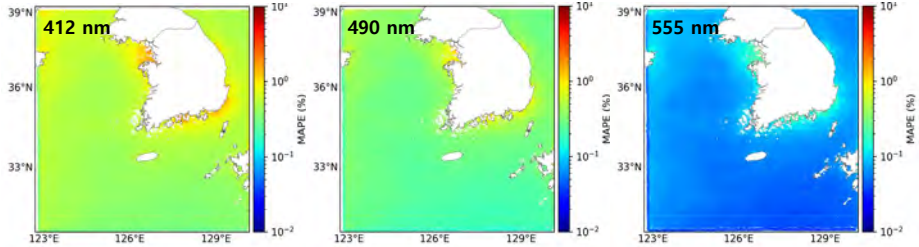
Differences in OC products based on TPW data



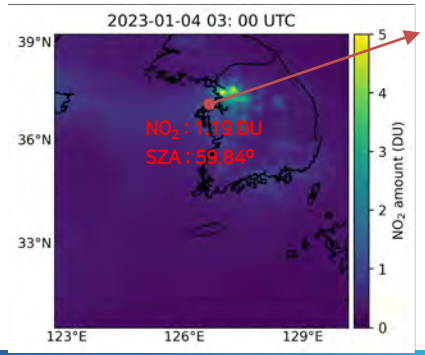


Lee et al. 2021 (Remote Sensing)

MAPD of TOA radiance before and after NO_2 absorption correction
(1/1 2023 ~ 8/20 2023, 03:15 UTC)



Impact of NO_2 absorption correction on OC data

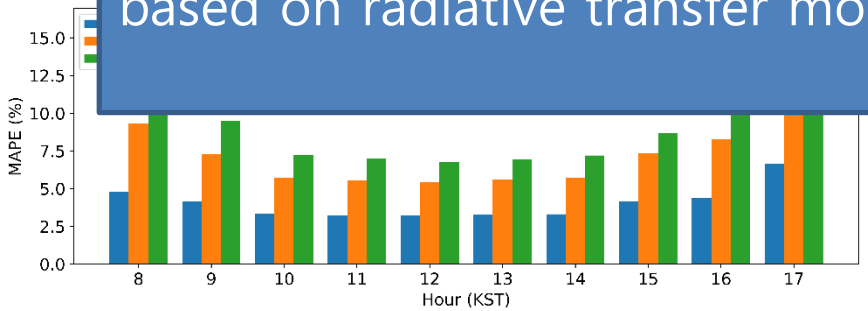


	Before correction	After correction	APD (%)
Rrs_{412}	0.00948 sr^{-1}	0.01635 sr^{-1}	72.53
Rrs_{443}	0.00983 sr^{-1}	0.01423 sr^{-1}	44.67
Rrs_{490}	0.01691 sr^{-1}	0.01916 sr^{-1}	13.34
Rrs_{510}	0.01483 sr^{-1}	0.01610 sr^{-1}	8.62
Rrs_{555}	0.01783 sr^{-1}	0.01819 sr^{-1}	2.05
Rrs_{620}	0.00951 sr^{-1}	0.00960 sr^{-1}	1.00
CHL	2.49 mg/m^3	1.83 mg/m^3	36.97
$a_{dom}440$	0.114 m^{-1}	0.088 m^{-1}	28.43

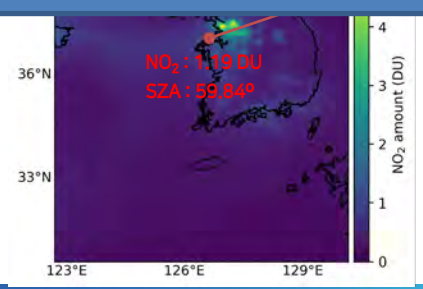
GK-2A/B Fusion for GOCI-II gas absorption correction

- Improvements of gas absorption correction through fusion with AMI TPW and GEMS NO_2 data

Poster #: 143
Date: Friday
Session #: 6
Title: Development of NO2 absorption correction model for GOCI-II based on radiative transfer model



Lee et al. 2021 (Remote Sensing)



Rrs_{443}	0.00983 sr^{-1}	0.01423 sr^{-1}	44.67
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Rrs_{620}	0.00951 sr^{-1}	0.00960 sr^{-1}	1.00
CHL	2.49 mg/m^3	1.83 mg/m^3	36.97
$a_{dom}440$	0.114 m^{-1}	0.088 m^{-1}	28.43

Improvement of GOCI-II IOP

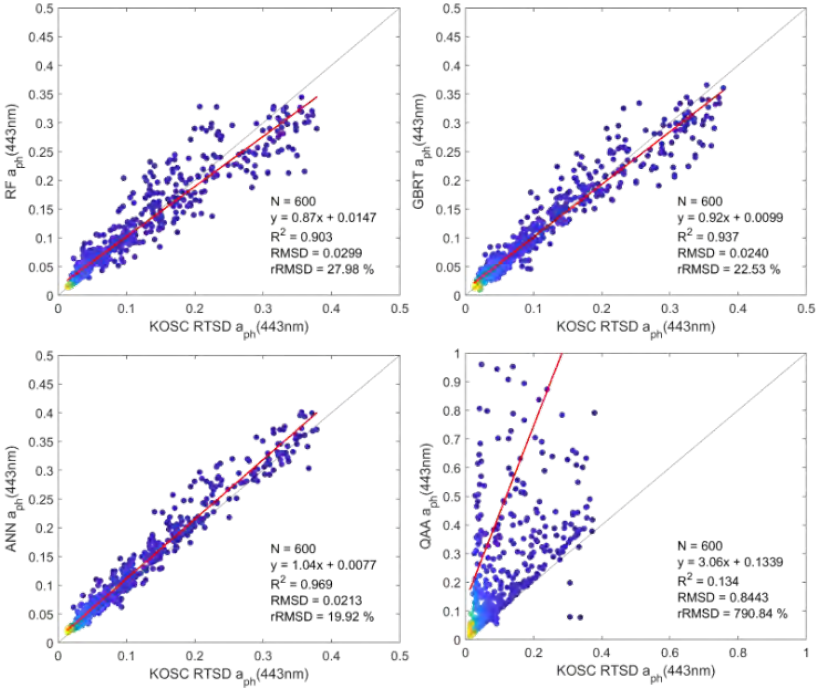
Machine learning-based IOP estimation using the R_{rs}

Please refer to Poster No.29 for more details!

Estimated IOP (a_{ph} (443nm), a_{dg} (443nm), b_{bp} (555nm)) using a radiative transfer simulation dataset (Hydrolight) based on machine learning

Type	Brown Earth, Red Clay, Yellow Clay	
CDOM	Chl-a	TSM
0.01 - 1.6654 m^{-1}	0.1 - 17.7438 mg/m^3	0.1 - 100 g/m^3

Input (11)	• Simulated R_{rs} of GOCI-II 7 bands (412, 443, 490, 510, 555, 620, and 660 nm) • Bands ratio
Target (3)	• Absorption coefficient of phytoplankton **(a_{ph}) (443 nm)** • Absorption coefficient of the combination of detritus and gelbstoff **(a_{dg}) (443 nm)** • Backscatter coefficient of particles **(b_{bp}) (555 nm)**
Machine learning models	• Random Forest (RF) • Gradient Boosted Regression Trees (GBRT) • Artificial Neural Network (ANN)



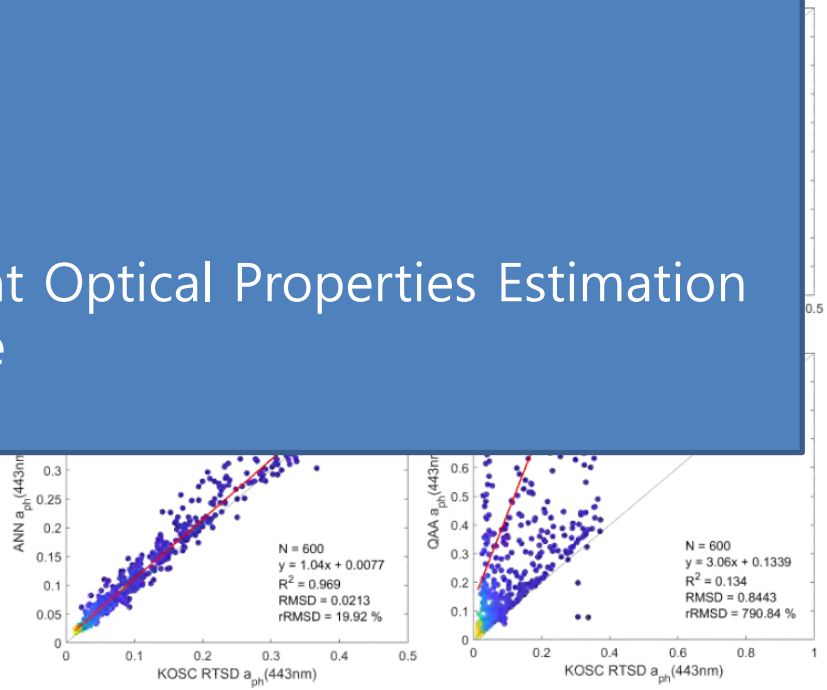
Improvement of GOCI-II IOP

Machine learning-based IOP estimation using the R_{rs}

Please refer to **Poster No.29** for more details!

Poster #: 29
Date: Wednesday
Session #: 2
Title: Machine Learning-based Inherent Optical Properties Estimation using the Remote Sensing Reflectance

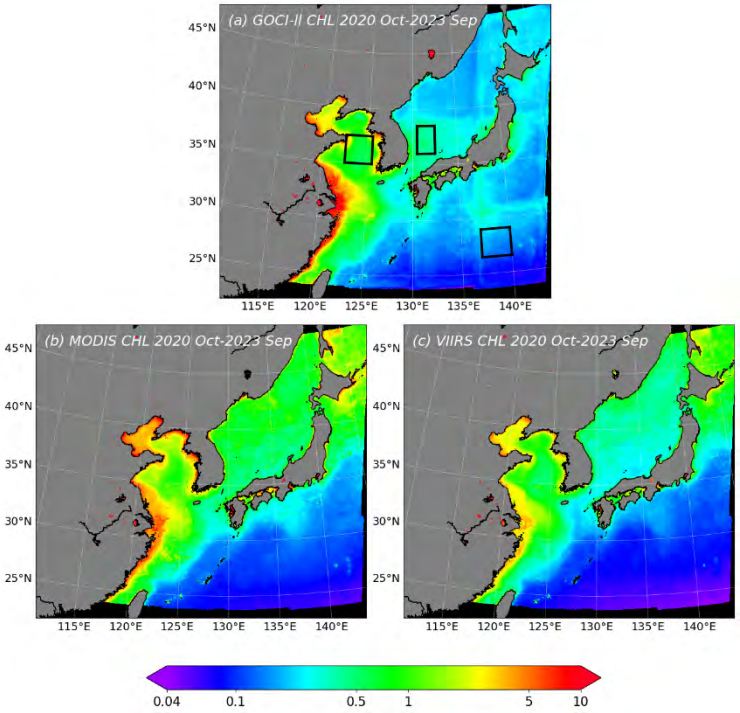
Target (3)	• Absorption coefficient of the combination of detritus and gelbstoff (a_{dg}) (443 nm) • Backscatter coefficient of particles (b_{bp}) (555 nm)
Machine learning models	• Random Forest (RF) • Gradient Boosted Regression Trees (GBRT) • Artificial Neural Network (ANN)



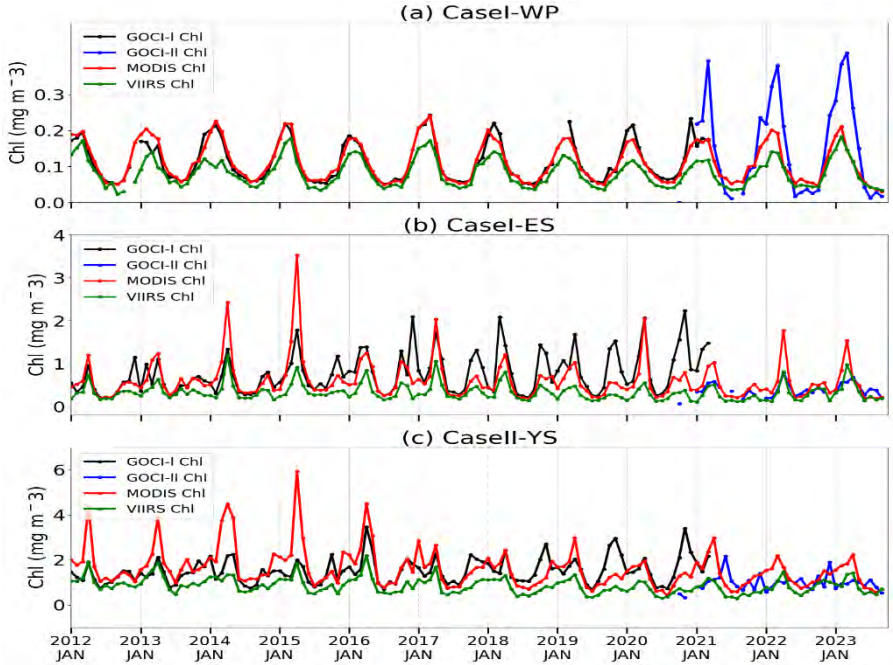
GOCI-II Early data L3 (updates planned)

Radiative Correction v. 1

Chl-a Climatology (October 2020-September 2023)



GOCI to GOCI-II Time series



Planned improvement of L3 time series

RC version 1 vs. version 2

Raw data (digital counts, Dn)

Radiative Correction v1 | Radiative Correction v2

L1b (TOA radiance, Lt)

Atmospheric correction /Vicarious calibration

Level 2 (R_{rs})

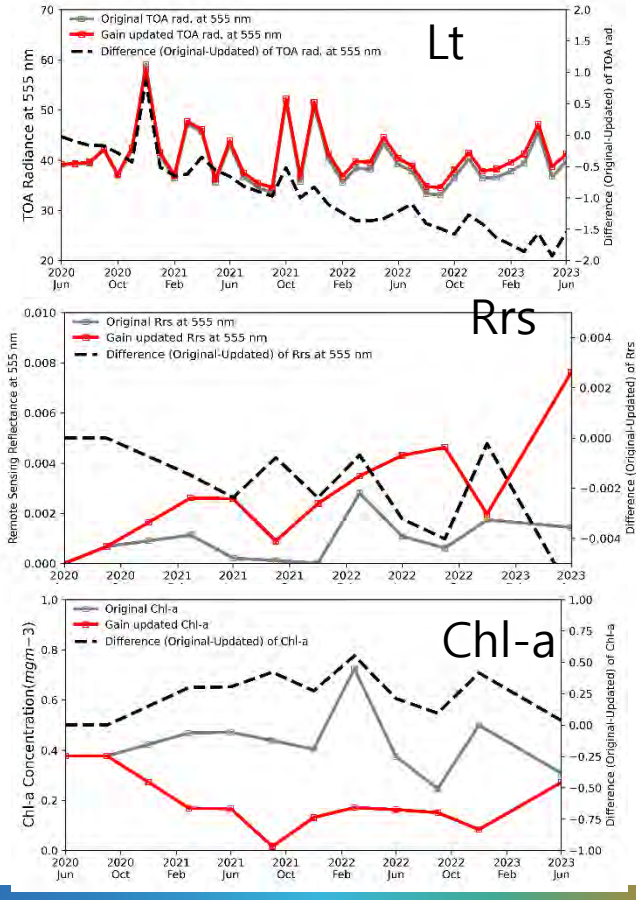
Level 2 Chl-a algorithm

Level 2 (Chl-a)

Spatial Binning

Level 3(Long-term data stability)

Impact of sensor degradation/calibration



Planned improvement of L3 time series

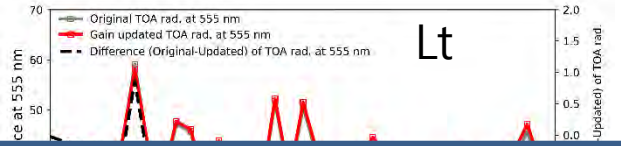
RC version 1 vs. version 2

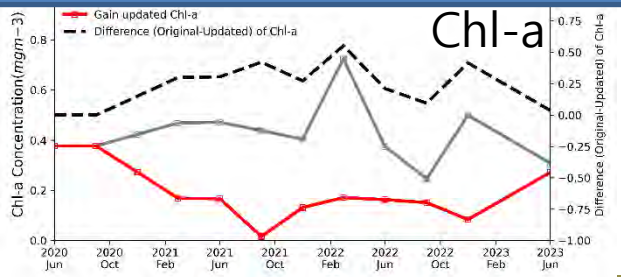
Raw data (digital counts, Dn)

Level 2 (Chl-a)

Spatial Binning

Level 3(Long-term data stability)





Poster #: 50
Date: Wednesday
Session #: 3
Title: Impacts of GOCI-II On-orbit Calibration on Ocean Color Data Record

Breakout WS 6: Ocean Colour Satellite Sensor Calibration

Summary

- Mission of GOCI has officially ended at the end of March 2021, and GOCI-II data has been in public service since October 2020
- A project on Cal/Val and algorithm improvement for GOCI-II started last year, thus we couldn't get plenty of in-situ measurement for Cal/Val yet
- Atmospheric correction algorithm of GOCI-II showed a good performance in Case-I waters in terms of the comparison with matchups in the open sea
- In the process of atmospheric correction, we are developing an algorithm to extract gas absorptions from satellite sensors in simultaneous operation
- We are developing Level-3 algorithms for GOCI-I/GOCI-II to provide long-term time-series data


Thank you !!!