JAXA Joint PI meeting, 19.1.2022 Online

Improvement, Validation and Application of the SGLI/GCOM-C ocean colour algorithms

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My menu in RA2 over the last 3 years

- In situ data acquisition (for cal/val)
  Basin scale
  Regional scale
  Local scale

- Algorithm refinement & validation

- Application studies

FY2019-2021

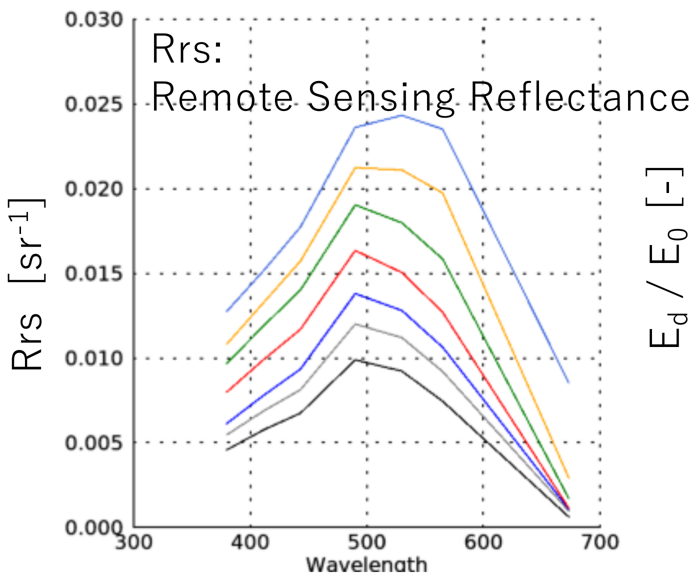
In situ observation overview

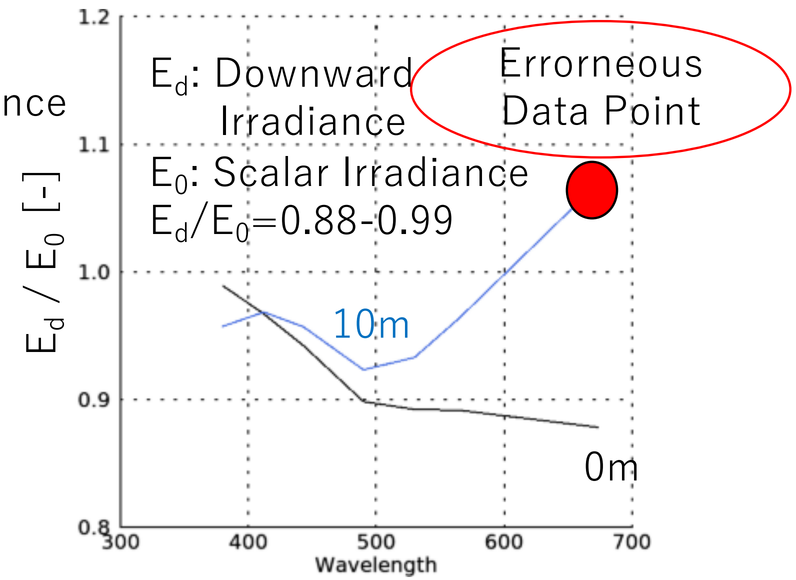
"(20xx)" indicates year of delivery, not year of data acquisition

	nLw or Rrs	a_CDOM	Chla	IOPs (absorption)
Basin Scale (The Atlantic)	✓ (2019)	✓ (2020) (2021)	✓ (2019)	✓ (2021)
(The SouthEast Pacific)		✓ (2021)		
Regional Scale (Philippines Sea)			✓ (2019)	
Local Scale (Suruga Bay)	✓ (2019)		✓ (2019) (2021)	
(Oshoro Bay)	✓ (2021)			

FY2021 In situ observation (Local Scale)

	Apr	May	Jun	July	Aug	Sep	Oct	Nov
2020	N/A	✓	✓	✓	✓	✓	✓	✓
2021	Cancelled	Cancelled	Cancelled	Cancelled	Cancelled	Cancelled	Cancelled	Cancelled





Message: As E_d can differ from E_0 by > 10% (depending on wavelengths), the underwater light intensity may carefully be examined for analysis of heat budget, primary production etc.)

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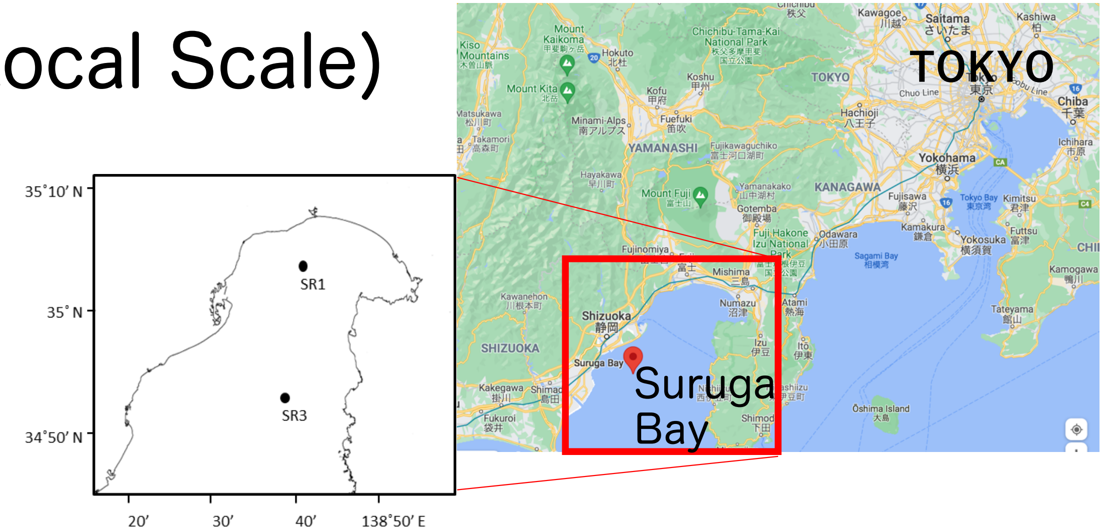
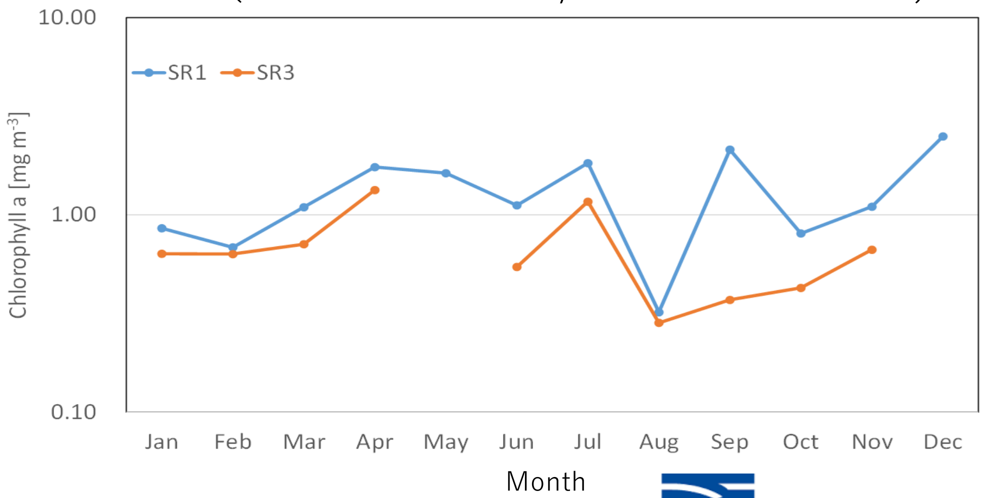
FY2021

In situ observation (Local Scale)

2021	SR1		SR3	
	date	**Chla [mg m^{-3}]**	date	**Chla [mg m^{-3}]**
Jan.	01/06	**0.86**	01/12	**0.64**
Feb.	02/09	**0.68**	02/10	**0.63**
Mar.	03/17	**1.09**	03/18	**0.71**
Apr.	04/16	**1.75**	04/23	**1.34**
May	05/23	**1.63**		
Jun.	06/05	**1.12**	06/07	**0.54**
Jul.	07/09	**1.83**	07/14	**1.17**
Aug.	08/03	**0.32**	08/04	**0.28**
Sep.	09/13	**2.14**	09/14	**0.37**
Oct.	10/14	**0.81**	10/16	**0.43**
Nov.	11/04	**1.10**	11/18	**0.67**
Dec.	12/02	**2.50**		



St. SR1 (35° 03′ 20″ N, 138° 41′ 00″ E z=1000 m)
St. SR3 (34° 53′ 00″ N, 138° 38′ 30″ E, z=1600 m)



TOKAI UNIVERSITY

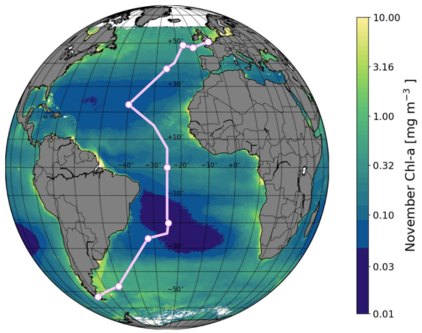
Message: Yearly Maximum in Chla was not found in Spring season in SR1

FY2021

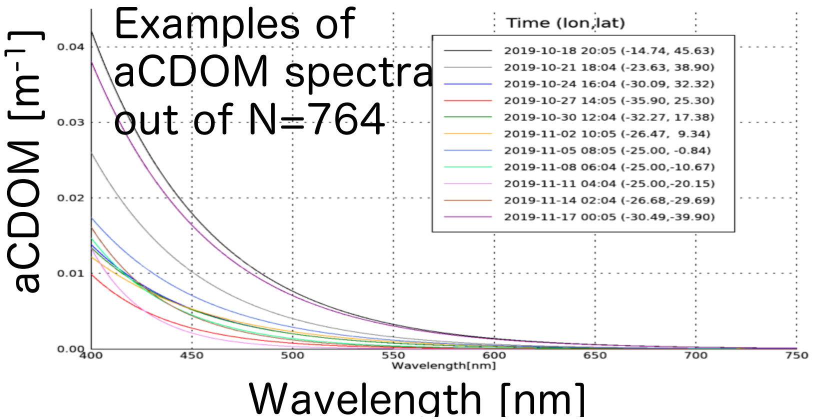
In situ observation (Basin Scale)

AMT-30 Cruise *was cancelled* due to COVID pandemic
(in stead, the previous AMT-29 data (IOPs) from 2019 is delivered)

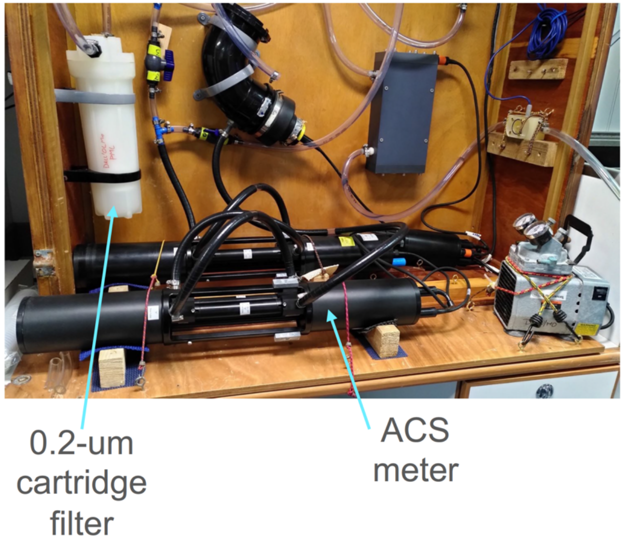
Atlantic Meridional Transect 29



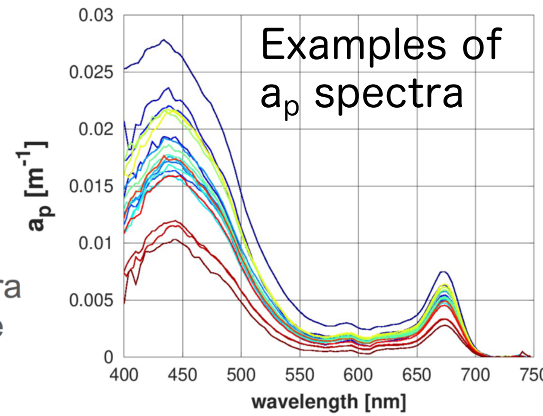
RRS Discovery: Oct 13 – Nov 25, 2019



Hyperspectral particulate absorption



I will deliver continuous surface measurements of hyperspectral a_p between 400 – 750 nm collected with a WETLabs ACS meter that sampled the ship's clean seawater supply. Highly accurate spectra were obtained by measuring for 10' every hour 0.2-um filtered seawater (Dall'Olmo et al. 2009, 2012).



Subset of preliminary a_p spectra collected during one day of the expedition.

PML Plymouth Marine Laboratory

FY2019-2021

Satellite Algorithm Development

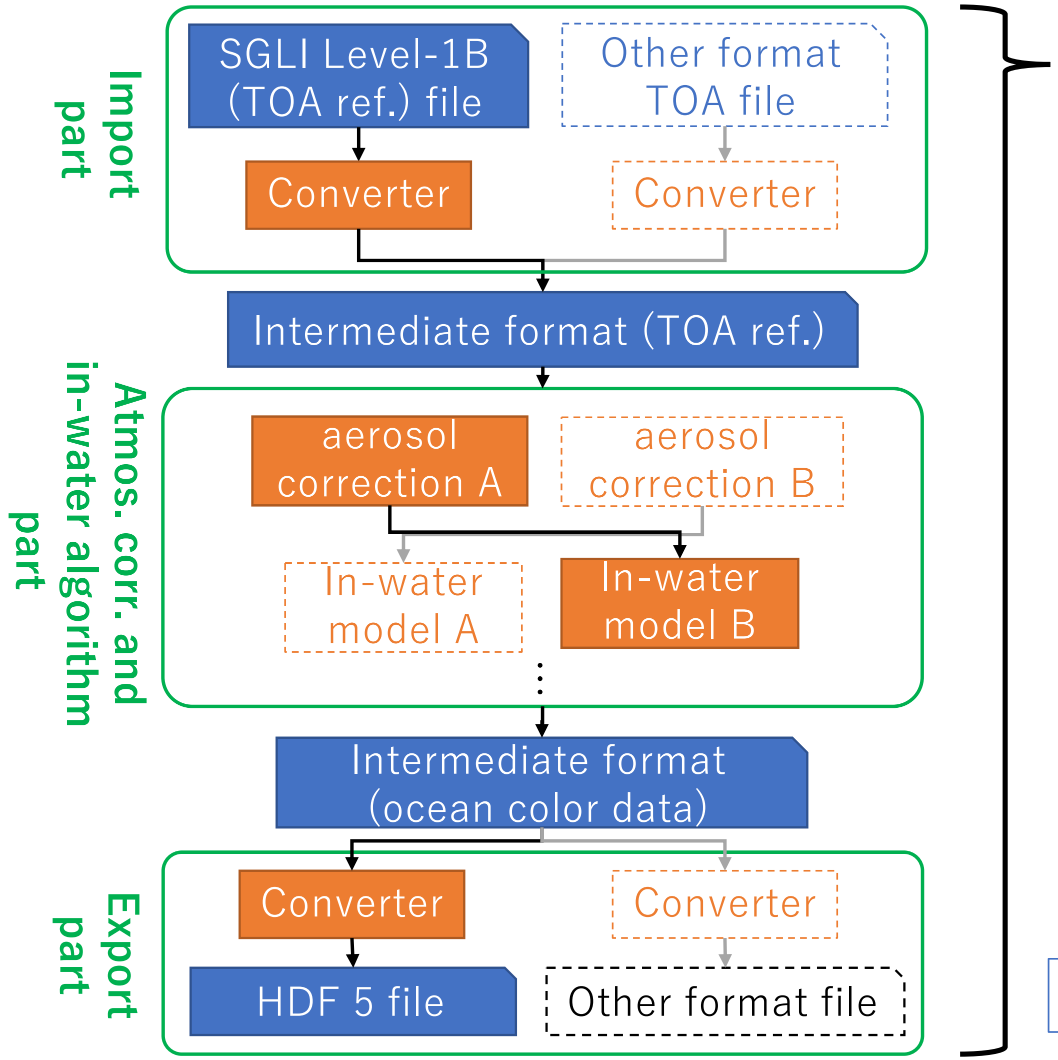
aCDOM: the absorption coefficient of chromophoic dissolved organic matter
IOPs: Inherent Optical Properties
PFTs: Phytoplankton Functional Types
Zeu: Euphotic Depth

"(20xx)" indicates year of delivery, not year of data acquisition

	aCDOM	IOPs	PFTs	Zeu
Revision	✓ (2019)	✓ (2019) (2020)	✓ (2020)	✓ (2020) (2021)
Validation	See Dr. Matsuoka's presentation (2021)	See Dr. Higa's presentation (2021)		✓ (2021)

FY2021

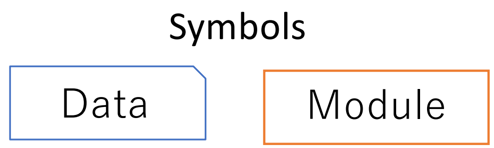
Development of SGLI community implementation code



Main features:

- **Implemented entirely in Python 3:**
  - To reduce environment dependency (operating system, library..)
  - To enable user to change the code relatively easily.
- **Modularized processing and scalability:**
  - Divide the main and the file format dependent processing parts by using intermediate format data
  - Can be added, deleted and customized the process without dependence on other processes by the modularization

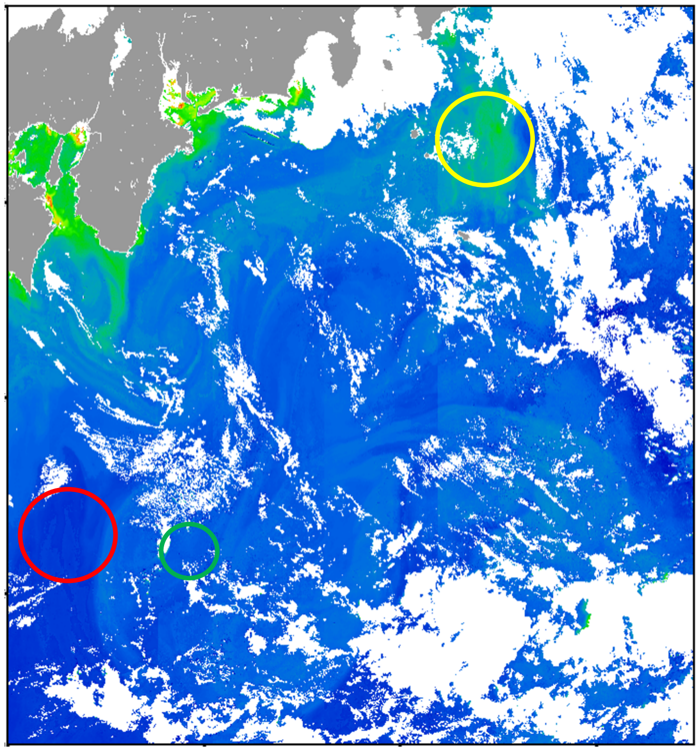
Note: This system consumes more memory and processing time than compiled languages (C, Fortran)



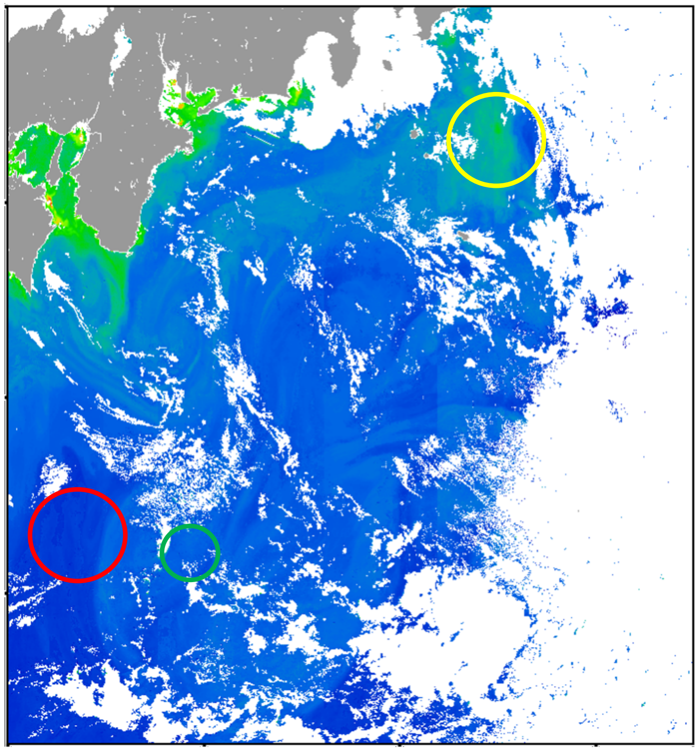
FY2021

Uncertainty analysis: Effects of atmospheric correction

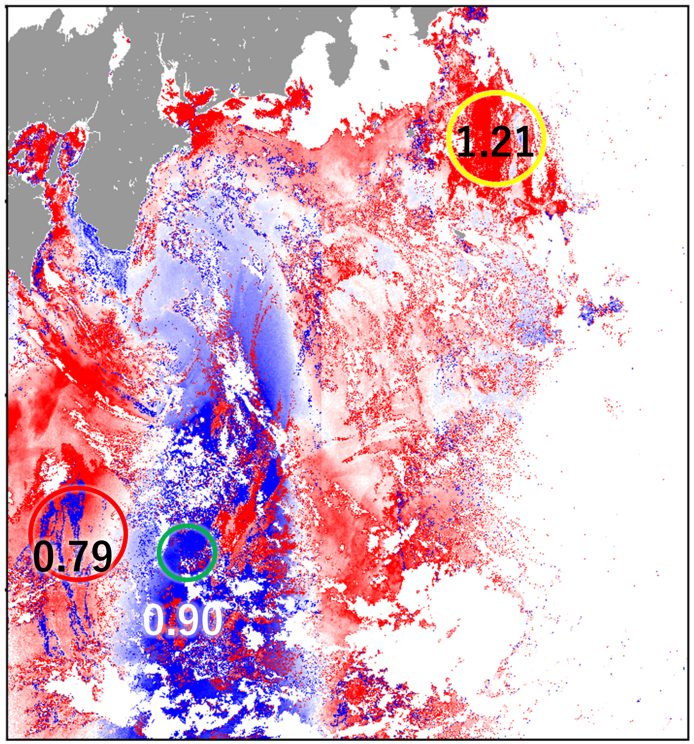
Previous report (FY2019) showed an average error of +69% in a_CDOM validation



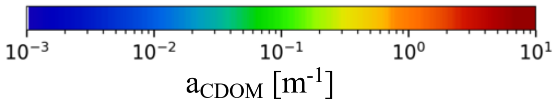
(a) Equivalent to SGLI version 3

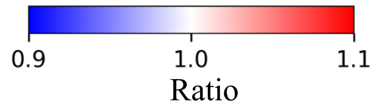


(b) Different aerosol model and no negative nL_w correction



(c)Ratio of (a) to (b)





Message: Choice of atmospheric correction alone can introduce > 20% difference in aCDOM product

FY2021 Validation of Euphotic Depth (Zeu)

(Irradiance Data(spectral, vertical profile) provided by Dr. Kuwahara & Mr. Kaji)

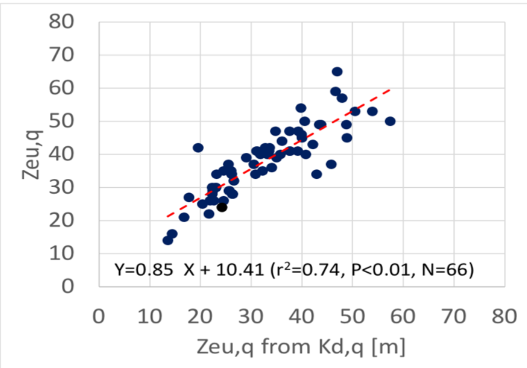
The algorithm for Euphotic Depth (Zeu) has the following points to investigate:

① How is the estimation of Zeu from the diffuse attenuation coefficient (K_{PAR}) is robust?

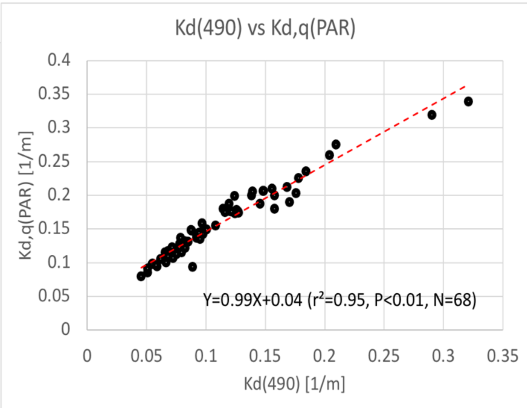
② How can K_{PAR} be derived from a limited number of bands of SGLI ?

<u>The algorithm was theoretically developed using only numerical simulations</u> by considering these questions. The verification of the algorithm assumptions and the algorithm validation were missing using in situ data.

① Zeu,q vs. Zeu,q from Kd_{PARq}

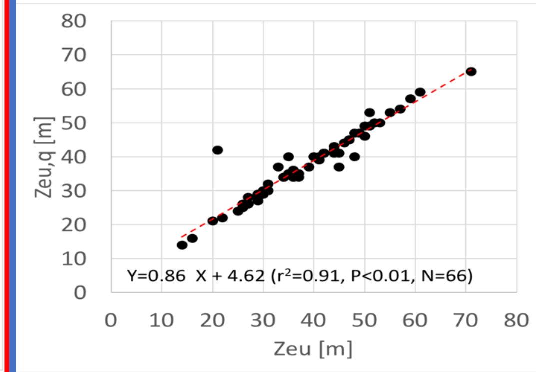


② $Kd_{PAR,q}$ vs. Kd(490)



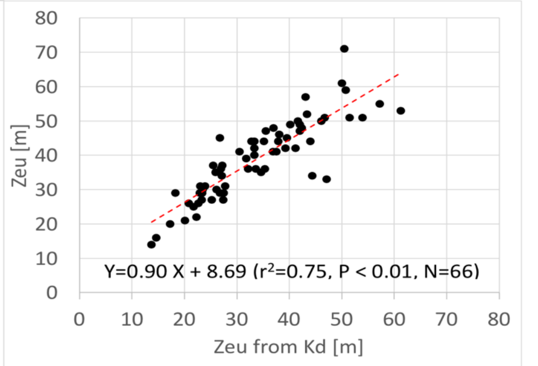
Zeu,q vs. Zeu

Zeu (quantum) vs Zeu(irrad)



Zeu vs Zeu from Kd_{PAR}

Zeu(irrad.) vs Kd_{PAR}(irradi.)



Messages: I. Principle of theoretical algorithm was verified, and found to work well, by actual in situ data.

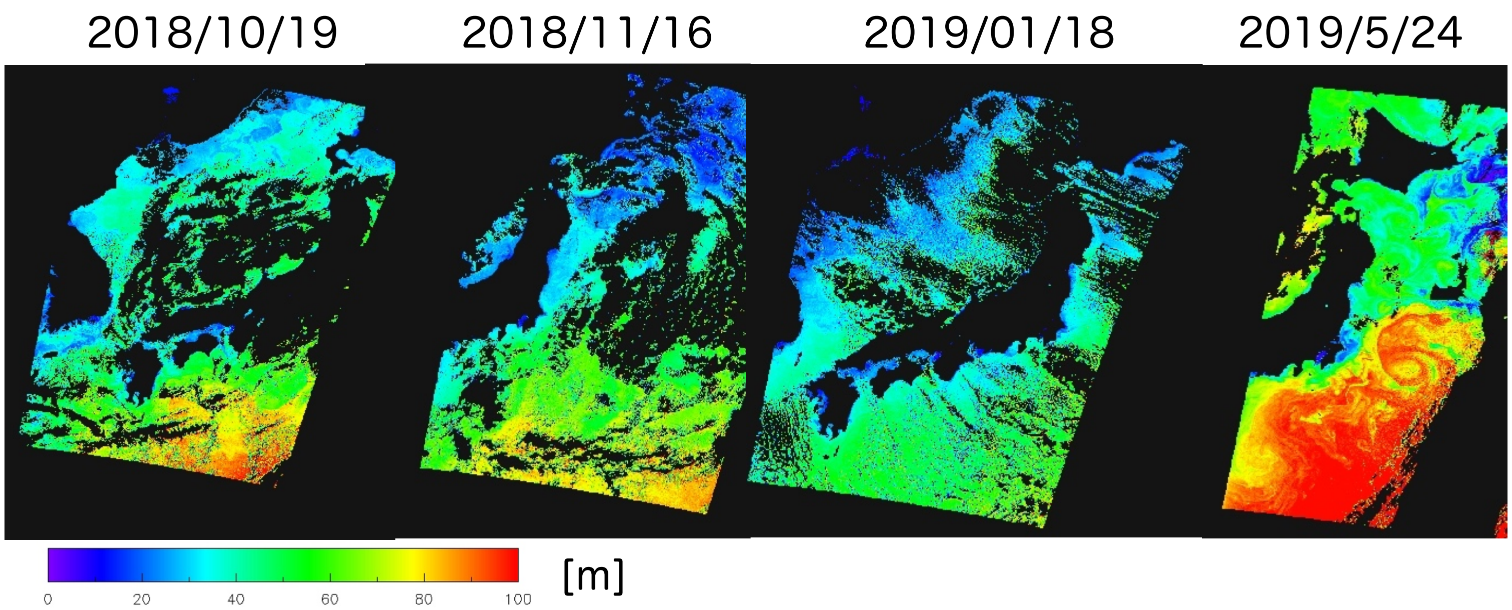
II. Uncertainty needs to be considered when Zeu **is derived** from Kd_{PAR} or Kd (even for in situ data).

FY2021

7 satellite match-ups obtained for 66 in situ coastal data taken in Sagami Bay (previous side)

Match-up using 250m full-resolution SGLI data (median of 3x3 pixels, +/- 3 hours)

[m]	2018/3/15	2018/3/29	2018/10/19	2018/11/16	2019/1/18	2019/4/19	2019/5/24	Average
In Situ	27	26	36	41	49	29	35	35
Satellite	42	38	41	33	38	14	49	36
Diff.	15	12	5	-8	-11	-15	14	11
Diff. [%]	55%	46%	14%	-19%	-22%	-51%	40%	31%



JAXA Target = 30%

Message:
While (i) Zeu,q were obtained from Ed and should be updated using E_0 & (ii) there are some uncertainty in field data, the above validation result shows that the algorithm for Zeu (Research Product) is expected to achieve the JAXA target soon.

FY2021

PFTs: phytoplankton pigment inversion

Currently, PFT estimation purely relies on an empirical/statistical approach.

PFTs=f(Chla): it generally works on a basin scale but not necessarily on a smaller scale.

We attempted a new approach to break through the situation (i.e. inversion) by using Inherent Optical Property (IOP) of phytoplankton (=the absorption coefficient)

Phytoplankton groups	Diatoms	Prymnesiophytes	Chlorophytes
Marker Pigments	Fucoxanthin	19'-Hex 19'-But	Chl-b

$$C_{pig}=A_{pig}^{*-1}\,a_{ph}$$

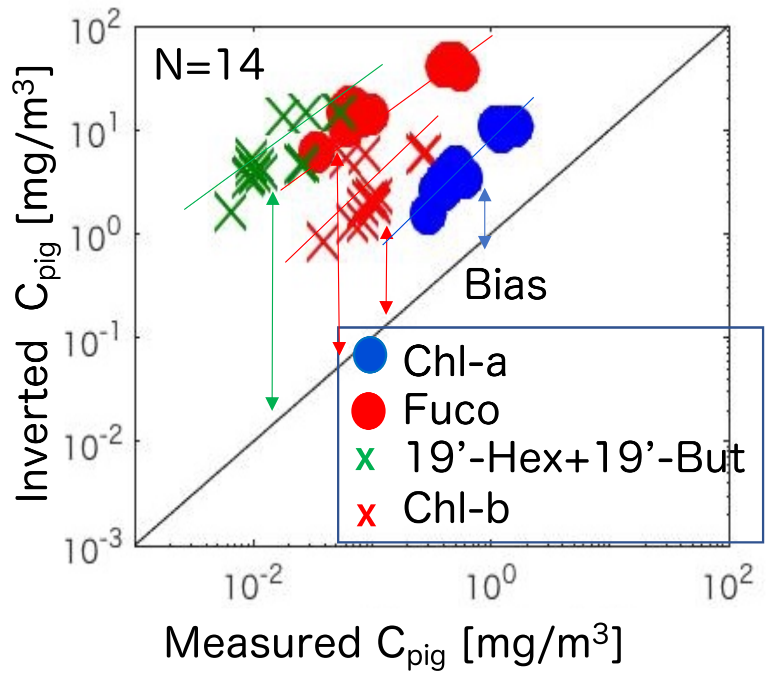
$$A^*_{pig}=\begin{pmatrix} a^*_{chla}(\lambda_1) & \cdots & a^*_{zea}(\lambda_1) \\ \vdots & \ddots & \vdots \\ a^*_{chla}(\lambda_n) & \cdots & a^*_{zea}(\lambda_n) \end{pmatrix}$$

$$a_{ph}=(a_{ph}(\lambda_1), a_{ph}(\lambda_2), \cdots a_{ph}(\lambda_n))^T$$

$$C_{pig}=(C_{Chla}, C_{Chlb}, C_{Fuco}, C_{Hex+But})^T$$

SoyoMaru 1304 cruise 2013
HPLC C_{pig} from Dr. Suzuki
$a_{ph}(\lambda)$ from Dr. Hirata
λ = 412,443,490,535 nm

Message: The method got regression slopes but w/ biases



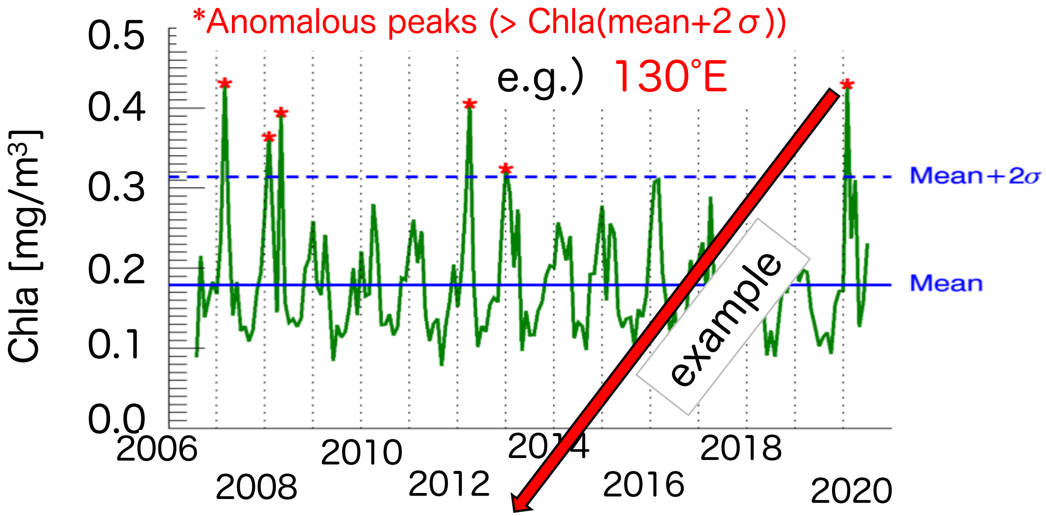
FY2019-2021

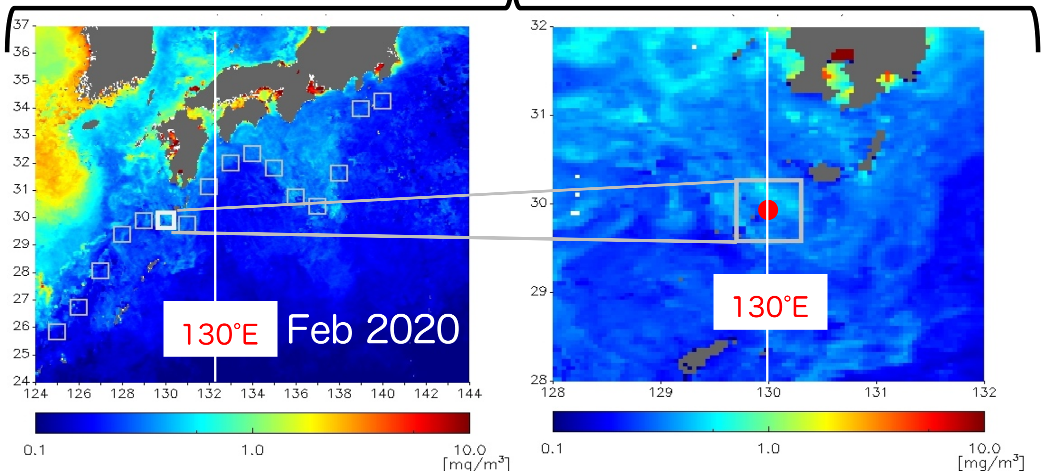
Application studies

	FY2019	FY2020	FY2021
Merging SGLI Chla with Himawari-8 Chla	△ Linear Minimum Mean Square Estimate	△ Linear Minimum Mean Square Estimate	
Chla analysis on the Kuroshio current			✓

FY2021

L3 Monthly Chla time series analysis for the Kuroshio using MODIS/AQUA





○ : anomalous peak(s) found

Longitude [deg.E]

year \ lon	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	Frequency of >2σ peak
2006																	0
2007					○	○						○	○				4
2008	○	○	○			○							○	○	○		7
2009			○	○	○							○		○	○	○	7
2010	○	○	○	○	○				○	○	○	○	○	○	○		12
2011	○	○	○	○	○					○				○			7
2012	○			○	○	○	○	○	○	○						○	9
2013		○				○	○				○		○		○	○	7
2014		○					○										2
2015					○					○				○		○	4
2016		○													○		3
2017																○	1
2018			○	○									○				3
2019				○	○							○	○	○			5
2020				○		○											2
回数	4	6	5	7	7	5	3	1	2	4	2	4	6	6	5	5	

Year

Frequency of >2σ peak

Messages:

Anomalous peaks occurs intermittently and are not rare

Anomalous peaks are frequently found between 2008-2013

Less anomalous peaks between 132-135°E (except 134°E)