International Ocean Colour Science Meeting 2015 | Advancing Global Ocean Colour Observations

IOCS meeting 2015
Wed. 17 June, Break out session 5

Ocean colour algorithms and datasets developed within the framework of the GRENE (Green Network of Excellence) Program

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GRENE-Arctic HOKKAIDO UNIVERSITY GCOM-C Global Change Observation Mission-Climate

GRENE project

Green Network of Excellence Program
Arctic Climate Change Research Project (2011-2016)

"Rapid Change of the Arctic Climate System and its Global Influences"

by National Institute of Polar Research, Japan (NIPR) as the core institute
with more than 300 researchers from many institutes and universities in Japan

Strategic Research Targets

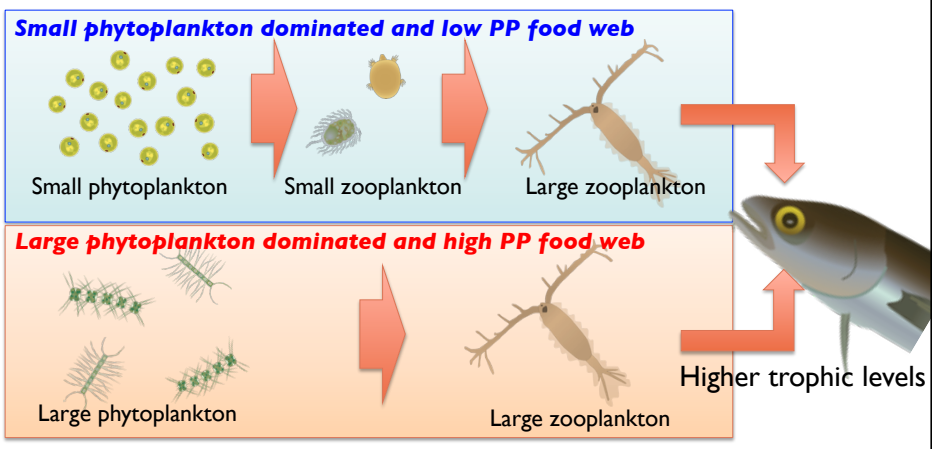
1. ***Understanding the mechanism of warming amplification in the Arctic***

2. ***Understanding the Arctic system for global climate and future change***

3. ***Evaluation of the effects of Arctic change on weather in Japan(3a), marine ecosystems and fisheries (3b)***

4. ***Prediction of sea Ice distribution and Arctic sea routes***

Ocean color studies in the GRENE



Short chained food web
= large change when small change occurred in lower trophic levels

Question: How are phytoplankton size and primary production changing with sea ice variation?

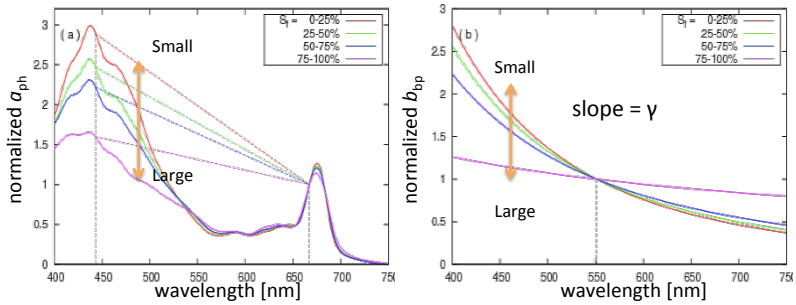
Algorithm development and validation in the GRENE

- Validation of phytoplankton size algorithm (Fujiwara et al., 2011)
- Development and validation of absorption-based primary production algorithm (Hirawake et al., 2012)
- Both algorithms are developed using a_{ph} due to reduce effect of CDOM.
- These algorithm are extended to global scale for the SGLI/GCOM-C satellite launched in 2017 by JAXA

Phytoplankton Size Discrimination Model

Size Index: **F_L = [Chl$a_{>5\mu m}$ / totalChl$a$] × 100 [%]**

spectral shape of absorption and backscattering coefficients



parameterized F_L with a light absorption ratio, $a_{ph}(443)/a_{ph}(667)$, and spectral slope of backscattering spectrum, γ:

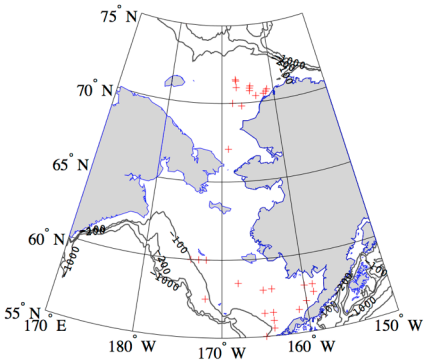
$$F_L = \frac{100}{1+\exp[-(p \times a_{ph}(443)/a_{ph}(667) + q \times \gamma + r)]} \ [\%]$$

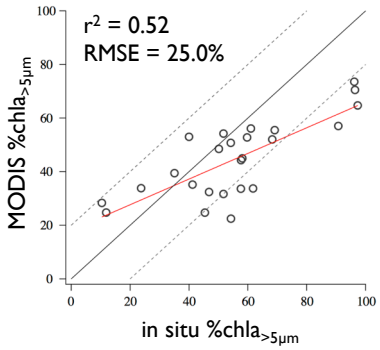
Rrs → Optical model → a_{ph}, b_{bp}

Size Discrimination Model (SDM)
Fujiwara et al. 2011, BG

Results & Discussion

Model validation



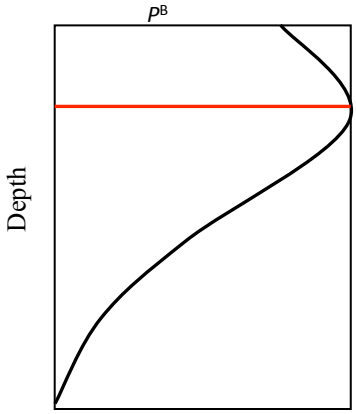


- MODIS L2-daily match-ups (1-km) at 30 stations
- Slightly over estimates in lower %chla$_{>5\mu m}$ and under estimates in high %chla$_{>5\mu m}$
- It is sufficient to discuss %chla$_{>5\mu m}$ variability

Absorption based primary production model (ABPM)

$$PP_{eu} = f[\tilde{a}_{ph}(0\text{-})] \times Z_{eu} \times \frac{0.66125 \times E_0}{E_0 + 4.1} \times DL$$

VGPM (Behrenfeld & Falkowski, 1997)



Function of SST in VGPM

$P^B_{opt} \times Chl_{surf}$

$\tilde{a}_{ph}(0\text{-})$

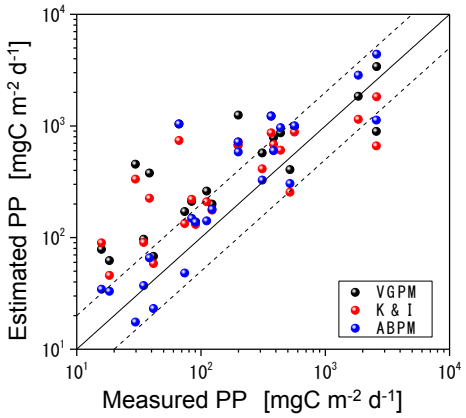
Absorption coefficient at the sea surface

Chl *a* and SST were not used.

Hirawake et al. 2011 Polar Biology
Hirawake et al. 2012 ICES J. Mar. Sci.

7

ABPM validation



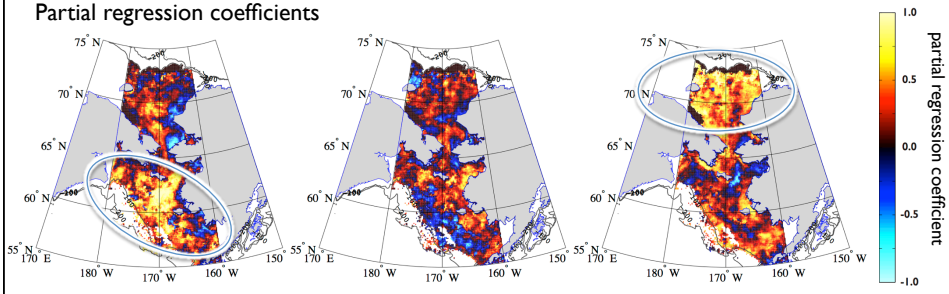
Indices	In this study			Hill and Zimmerman (2010)	
	VGPM	K&I	ABPM	VGPM	CBPM_Arc
n	23	23	23	-	-
RMSE	0.555	0.487	0.375	0.470	0.620
Bias	0.405	0.294	0.186	-0.100	0.380

Futsuki, Hirawake et al. (to be published)

Contribution of phytoplankton size, sea surface temperature and ice free period on annual primary production

Standardized multiple regression analysis (APP = %Chla$_{>5\mu m}$ + SST + IFD)

Partial regression coefficients



(%Chla$_{>5\mu m}$) (SST) (length of ice-free period)

- Open-water period controls APP especially in the northern part of the shelf (e.g., Arrigo et al. 2008, 2011, Pabi et al. 2008)
- Phytoplankton size is a important factor to control APP in the Bering Sea

Fujiwara et al. (2015), BGD soon

Datasets

- Spectral radiation, HPLC, Fluorometry chl.a, bb (Hydroscat-6), aph, CDOM, primary production
- Data are partly available from JAMSTEC or GRENE (NIPR) database.

Issues in optics/ocean colour in the Arctic

- Data are concentrated in Pacific and Atlantic side and there are few data from Russian area.
- Negative a_{ph} values have been frequently detected.
- We can not get ocean colour data of fall bloom in October because the data in the Arctic Ocean is masked due to the high solar zenith angle.