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

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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
Large phytoplankton dominated and high PP food web

Small phytoplankton dominated and low PP food web

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: \( F_L = \left[ \text{Chl}_{>5\mu m} / \text{totalChl} \right] \times 100 \) [%]

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

Results & Discussion

Model validation

- MODIS L2-daily match-ups (1-km) at 30 stations
- Slightly over estimates in lower %\( \text{Chl}_{>5\mu m} \) and under estimates in high %\( \text{Chl}_{>5\mu m} \)
- It is sufficient to discuss %\( \text{Chl}_{>5\mu m} \) variability
Absorption based primary production model (ABPM)

\[ PP_{eu} = f[\alpha_{ph}(0-)] \times Z_{eu} \times \frac{0.66125 \times E_{0}}{E_{0} + 4.1} \times DL \]

Function of SST in VGPM

\[ \rho_{opt} \times Chl_{surf} \]

Chl \( \alpha \) and SST were not used.

Absorption coefficient at the sea surface

Hirawake et al. 2011 Polar Biology

ABPM validation

<table>
<thead>
<tr>
<th>Indices</th>
<th>In this study</th>
<th>Hill and Zimmerman (2010)</th>
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<tbody>
<tr>
<td>n</td>
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<tr>
<td>RMSE</td>
<td>0.555</td>
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<tr>
<td>Bias</td>
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<td>0.294</td>
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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

- 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 an 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.