Influence of surface water stratification on phytoplankton blooms in the Arctic: a case study at Fram Strait

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Question of interest
Are more stratified waters associated with stronger and earlier phytoplankton blooms in the Fram Strait?

Region: Fram Strait
- Area of major transport of Atlantic water into the Arctic ocean
- Warm and saline West Spitsbergen Current (extension of Norwegian Atlantic Current) in the eastern part
- Cold and low salinity East Greenland current in the western part (which is ice-covered most time of the year)

Results of cross-correlation analysis
Time period: April-August 1998-2009
Location: 10 sites with 20km radius in the ice-free part of Fram Strait

Parameters modeled \cite{4,5} for cross-correlation analysis with chlorophyll-a:

Strongest correlation - between CHL and Mixed Layer Depth (MLD)

Data used

<table>
<thead>
<tr>
<th>Name</th>
<th>Time period</th>
<th>Temporal resolution</th>
<th>Spatial resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>GlobColour (merged MERIS-MODIS-SeaWiFS) CHL</td>
<td>1998-2009</td>
<td>daily, monthly</td>
<td>4.6 km</td>
</tr>
<tr>
<td>In-situ CHL (Turner Fluorometer)</td>
<td>2000-2009</td>
<td>- point measurement</td>
<td></td>
</tr>
<tr>
<td>High-resolution NAOSIM output</td>
<td>1998-2009</td>
<td>monthly</td>
<td>9 km</td>
</tr>
<tr>
<td>PHAROS group (University of Bremen) SIC (retrieved from AMSR-E)</td>
<td>1998-2009</td>
<td>daily</td>
<td>6.25 km</td>
</tr>
</tbody>
</table>

Validation of satellite data (chlorophyll-a)

![Graph showing validation of satellite data for chlorophyll-a](image)

No simple relationship between phytoplankton bloom and sea ice

![Graph showing no simple relationship between phytoplankton bloom and sea ice](image)

Conclusions
- We found no simple relationship between the phytoplankton bloom and the sea ice concentration.
- Results of correlating CHL time series with that of 6 physical parameters show the parameter mostly correlated with CHL is the Mixed Layer Depth. The use of two different MLD definitions did not significantly change the results.
- Mixed Layer Depth is negatively correlated with the chlorophyll-a in the open ocean part of region, i.e. shallow MLD corresponds to higher phytoplankton concentrations. We suggest the reason for this lies in the more stratified waters triggering the bloom start.
- In the coastal part we observed hardly any correlation, which can be explained either by different mechanisms guiding phytoplankton growth on the coast or by poor data quality in the coastal area.

Outlook
- Perform crosswavelet or EOF analysis to study periodicities of CHL and MLD
- Use in-situ data to adopt global primary production model by Antoine et Moréll (1996) to the Greenland Sea conditions \cite{9}. Retrieve primary production values.

References
2. Chlorophyll-a data from Dr. Eva-Maria Nöthig, AWI, Bremerhaven, 2000-2009 RV Polarstern and RV Maria S Merian cruises.
3. Sea ice concentration maps from PHAROS Group, Institute of Environmental Physics, University of Bremen. http://www.iup.uni-bremen.de:8084/amsr/amsre.html
4. Water temperature, salinity, density, change in salinity from ice melt and sea ice concentration modeled by Prof. Dr. R. Gerdes and C. Köberle, AWI, Bremerhaven.
10. Map of the North Atlantic Ocean. Credit: Jack Cook, Woods Hole Oceanographic Institution, USA

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