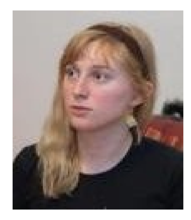

Chlorophyll-a data as the main input parameter to primary production models: case study for the Greenland Sea

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Why chlorophyll-a?

Our long-term goal is to estimate the primary production in the Greenland Sea. Chlorophyll-a (the proxy of phytoplankton biomass) is the basis for the majority of Primary Production (PP) models. Studies that compare different PP models show that primary production estimated from only CHLorophyll-a (CHL) produces time averages not that different from those of other models (which account for additional parameters) [2]. Therefore we need a closer look to the chlorophyll-a data available. We are interested in 1)in-situ data as the information on the phytoplankton vertical profile and 2)satellite data as the input to the PP models.

We wonder

1.1. What is the seasonal change in the CHL vertical profile?
1.2. How is the Greenland Sea relationship between the “surface” value and the profile different from the global relationship?
2.1. What is the availability of the satellite CHL data in the region of study?
2.2. How well do the satellite data correspond to the in-situ data?

Region and data

Region. Greenland Sea sector of Arctic: north to the Arctic circle (66°33'39''), 45°W-15°E

1. In-situ data

- Years 1957-2009
- April-September
- Depths till 150m
- 1680 data points

Source: Unpublished data from RV 'Polarstern' and “Maria S. Merian” cruises + ARCSS-PP database [5]

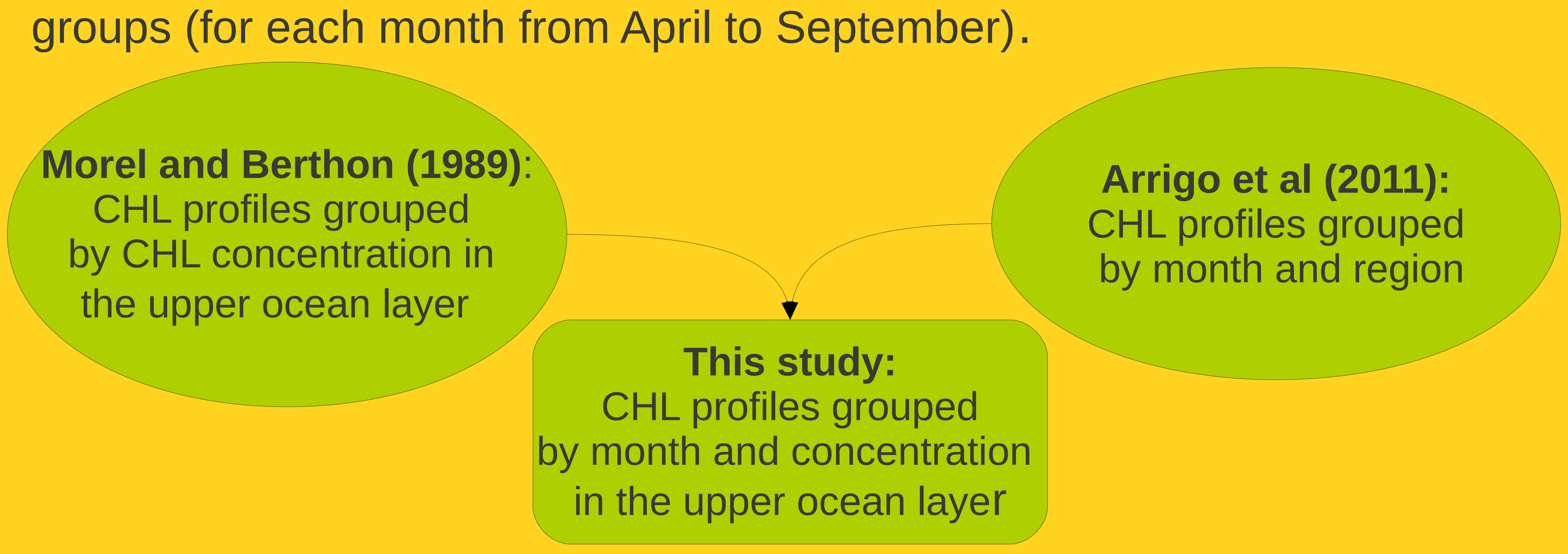
2. Satellite data

- Years 1998-2009
- April-August
- Depths till 20m in 95% cases
- 4.5 km spatial resolution
- 1-day temporal resolution

Source: GlobColour 3-sensor merged CHL product for Case1 waters [3]

Method

1. CHL profiles. We considered only profiles with 3 depths and more. The calculation procedure: 1)extrapolate profiles to zero depth; 2)calculate Zeu [6]; 3)from Zeu[1] calculate Zpd[2] by dividing Zeu by 4.6 [6]; 4)calculate mean CHL concentration for Zpd (called Cpd[3]); 5)divide all CHL profiles into 7 groups according to Cpd value; 6)subdivided these 7 groups into monthly groups (for each month from April to September).



[1]**Zeu** – euphotic depth (the depth where the downwelling photosynthetically available irradiance is reduced to 1% of its value at the surface[6])
[2]**Zpd** – penetration depth (the upper ocean layer from which 90% of optical remote sensing information originates[4])
[3]**Cpd** – mean CHL for the Zpd

2. Satellite CHL. For the satellite data validation in-situ data had to be sampled from depths less than 10m and with CHL maximum shallower than 20m. Satellite data were averaged for the 3x3 pixel box centered in the location of the in-situ data**.**

Results 1. CHL profiles

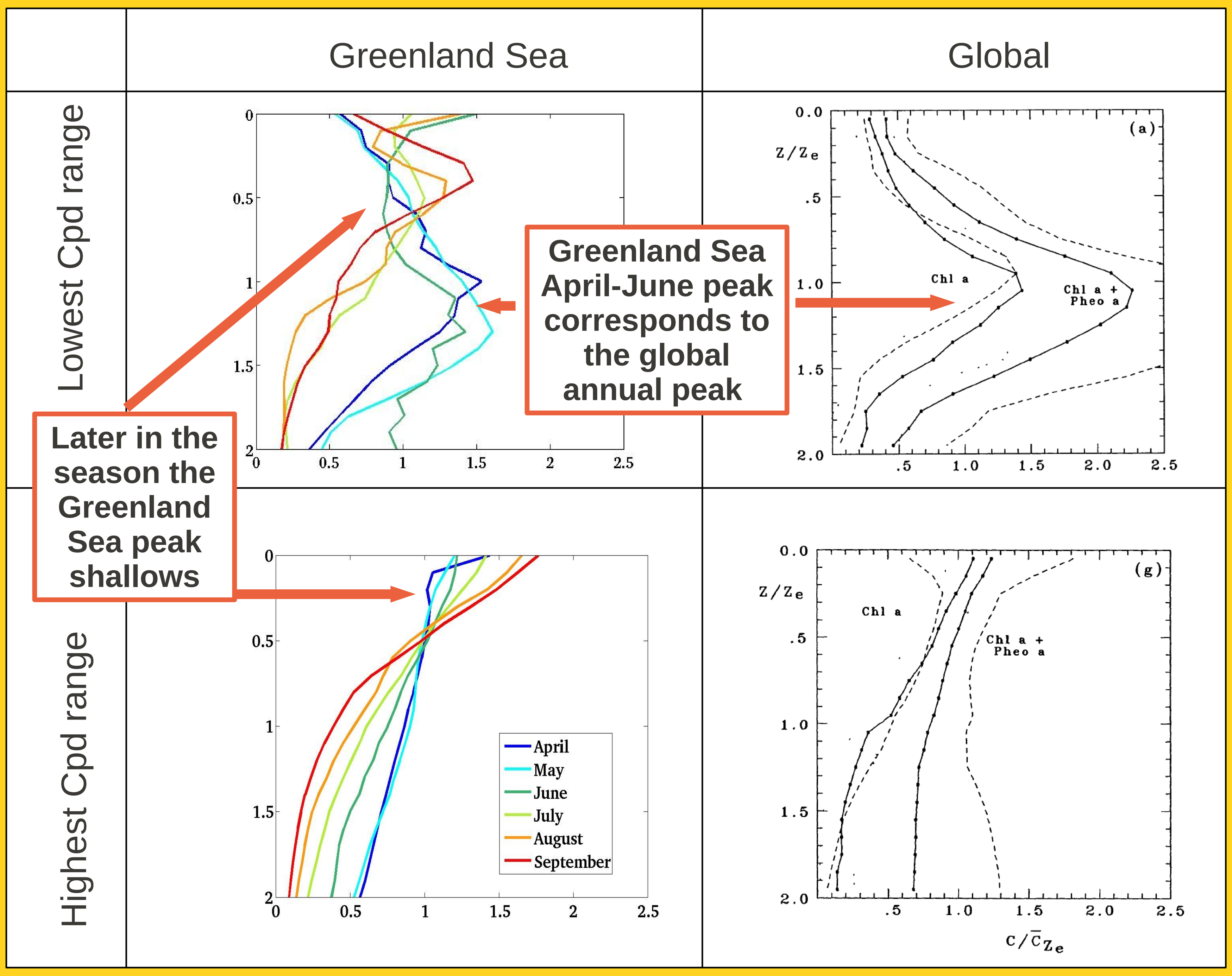
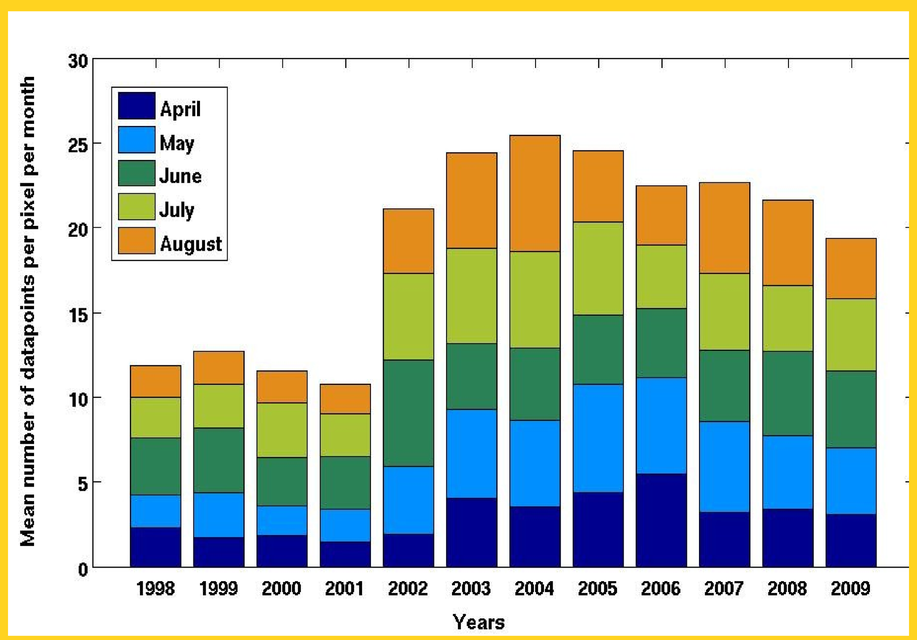


Figure 1. Dimensionless CHL profiles grouped according to their Cpd value.
We show only two Cpd ranges (lowest with Cpd<0.3 on top and highest with Cpd>1 on bottom) out of 7 computed. Vertical axis shows depth divided by Zeu. Horizontal axis shows CHL divided by the mean CHL for Zeu.
Left: our results, different colours show different months.
Right: global relationship [6], we are interested in solid line marked CHLa (mean CHL profile).

Results 2. Satellite data availability and validation



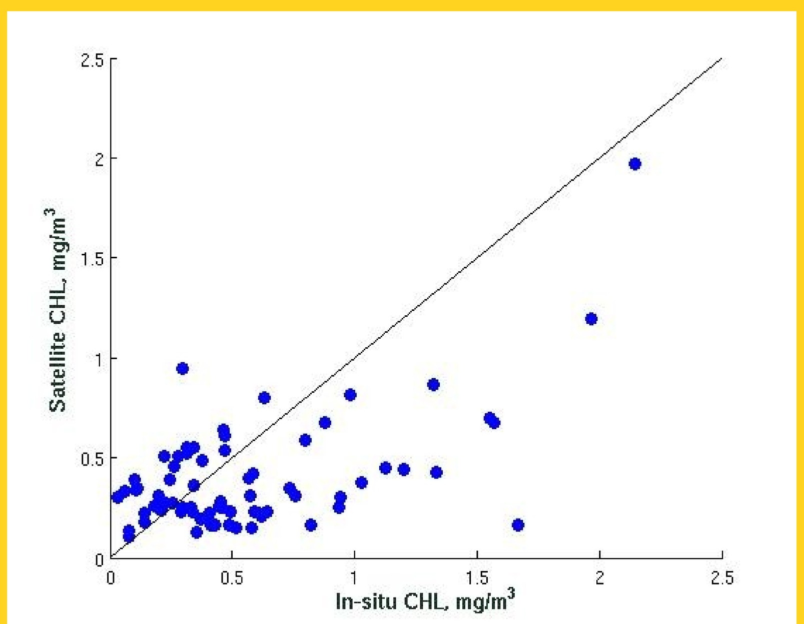


Figure 2. Left: mean number of valid satellite CHL [3] data points per pixel per month. Colours show different months. Right: Validation of the satellite CHL [3] against in-situ data of RV 'Polarstern', RV 'Maria S. Merian' cruises and ARCSS-PP database [5]. Black line is one-to-one line. Correlation statistics: N=74, R=0.68, RMS=0.54, OFFSET=0.2, SLOPE=0.33.

Conclusions

1.1 In the Greenland Sea phytoplankton maximum shallows towards the end of the bloom season. In case of low phytoplankton concentrations in the upper layer, the early season and late season peaks have the same magnitude. In case of high concentrations the peak is more pronounced in July-September than in April-June.
1.2. Global “upper layer CHL-CHL profile” relationship reflects only the April-June Greenland Sea phytoplankton peaks correctly. Both locations and magnitudes of July-September peaks are not reflected.
2.1. Depending on the year, from 11 to 27 valid satellite data points per pixel per year are on average available. With the launch of MODIS and MERIS (2002) number of valid pixels doubled. May and June are usually the months with most of the data.
2.2. After taking out the profiles with deep CHL maximum, with 74 collocations out of 526 (14%) and coefficient of correlation 0,68 (significant correlation, p<0.001) satellite and in-situ data are quite well correlated for the near-polar latitudes.
In future, to improve the estimates of PP for the Greenland Sea, both seasonal CHL variability and change of CHL profile according to the upper layer concentration should be taken into account.

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