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Influence of the physical environment on phytoplankton blooms in the Fram Strait

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The Fram Strait is the main gateway for water, heat and sea-ice exchanges between the Arctic Ocean and the North Atlantic. This complex physical environment results in highly variable primary production in space and time. In this study, in situ field data, remote sensing and modelling techniques were combined to investigate in detail the influence of melting sea-ice and ocean properties on the development of phytoplankton blooms in the Fram Strait region for the years 1998–2009. After validating the satellite-retrieved chlorophyll-a concentrations (chl-a) from temporarily ice-free zones of this region with in-situ data, these satellite data were averaged monthly into 20 $\times$ 20 km grid boxes, resulting in 10 fields. The influence of the following factors on the spatial and temporal variation of (satellite) chl-a was tested via cross correlation analysis: sea-ice concentration from satellite and sea-ice thickness, ocean stratification, water temperature and salinity time-series simulated by the ice-ocean model NAOSIM. The time series analysis showed a regional separation according to different physical processes affecting phytoplankton distribution. At the marginal ice zone the melting sea-ice was promoting phytoplankton growth by stratifying the water column and potentially seeding phytoplankton communities. Here, the highest mean chl-a averaged for the productive season (April–August) of 0.8 mg/m$\hat{}$3 was observed. In the open ocean, the phytoplankton variability was correlated highest to stratification formed by solar heating of the upper ocean layers. The coastal zone around Svalbard showed that processes associated with the presence of coastal ice were rather suppressing than promoting the phytoplankton growth. During the twelve years of observations, chlorophyll concentrations significantly increased in the southern part of the Fram Strait which was associated with an increase in sea surface temperature and a decrease in the Svalbard coastal ice.