Improving existing satellite ocean color observations of the Chukchi and Beaufort Seas for biogeochemical modeling

Atmospheric correction of ocean-color imagery in the Arctic brings some specific challenges that the standard atmospheric correction algorithm does not address, namely low solar elevation, high cloud frequency, multi-layered polar clouds, presence of ice in the field-of-view, and adjacency effects from highly reflecting surfaces covered by snow and ice and from clouds. In this region, the complex interactions between the scattering by molecules, aerosols, clouds, and the surface reflection are not described accurately by the standard algorithm, which has the only flexibility to tune its aerosol model to fit the measurements. Large uncertainties are therefore associated with the standard ocean-color products, whose spatial and temporal coverage is considerably reduced by cloudiness. Even weekly composites show no information in many areas. This limits the utility of the standards products, making their assimilation in biogeochemical models difficult and preventing their use in quantitative applications. To face the challenges, we propose to use a more flexible atmospheric correction algorithm referred to as POLYMER, originally developed to process MERIS data in glitter-affected areas. This algorithm does not use a specific aerosol model but fits the atmospheric reflectance by a polynomial with (1) a non spectral term that accounts for any non spectral scattering (clouds, coarse aerosol mode) or reflection (glitter, whitecaps, small ice surfaces), (2) a spectral term with a power law in wavelength to the power -1 (fine aerosol mode), and (3) a spectral term with a power law in wavelength to the power -4 (molecular scattering, adjacency effects from clouds and white surfaces). The algorithm will be adapted to SeaWiFS and MODIS data and used to generate, for the Chukchi and Beaufort seas, a time series of marine reflectance and chlorophyll concentration from MERIS, MODIS-Aqua and -Terra, and SeaWiFS at a daily temporal scale and a 4.63 km spatial resolution. The time series will cover at least the years 2009, 2010, and 2011, eventually more years as resources permit. The data from individual sensors will first be binned and merged, by performing an average. The missing values will then be reconstructed by fitting the data with a model describing the dynamics of marine reflectance and chlorophyll concentration. An estimation procedure will be developed, that takes into account exogenous variables that influence the stochastic process, i.e., sea surface temperature and photo-synthetically available radiation, retrieved on the entire space-time domain. Accuracy of the derived marine reflectance and chlorophyll concentration will be quantified in comparison with available data from bio-optical archives and measurements performed during the MALINA 2009 and the ICESCAPE 2010 and 2011 expeditions. The investigation will provide improved ocean-color observations to determine the space and time characteristics of Arctic phytoplankton blooms, which develop over relatively short time scales, and to estimate phytoplankton primary production and assess its annual to inter-annual variability.