## Mitigating Phytoplankton Phenology Mismatches in the Arctic Ocean Biogeochemical Reanalysis

Data assimilation is a crucial tool for reconstructing the four-dimensional biogeochemical state in the polar ocean due to the sparseness of observations. However, biogeochemical data assimilation in the polar ocean faces unique challenges associated with the complex ocean-sea ice-biogeochemistry coupled system. In our recent efforts to produce biogeochemical reanalysis data for the Arctic Ocean using the Ensemble Kalman Smoother (EnKS) data assimilation system, we identified a critical issue: mismatched phytoplankton phenology between observations and models can significantly deteriorate the quality of biogeochemical state estimates. This deterioration is characterized by the accumulation of nitrate and the subsequent development of enhanced primary production. This issue is particularly pronounced when systematic model biases are present in the satellite-observable ocean surface variables, such as surface chlorophyll-a concentrations and sea surface temperatures. We explore the mechanistic background for th

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