Variability in the biophysical environment of the Pacific Arctic

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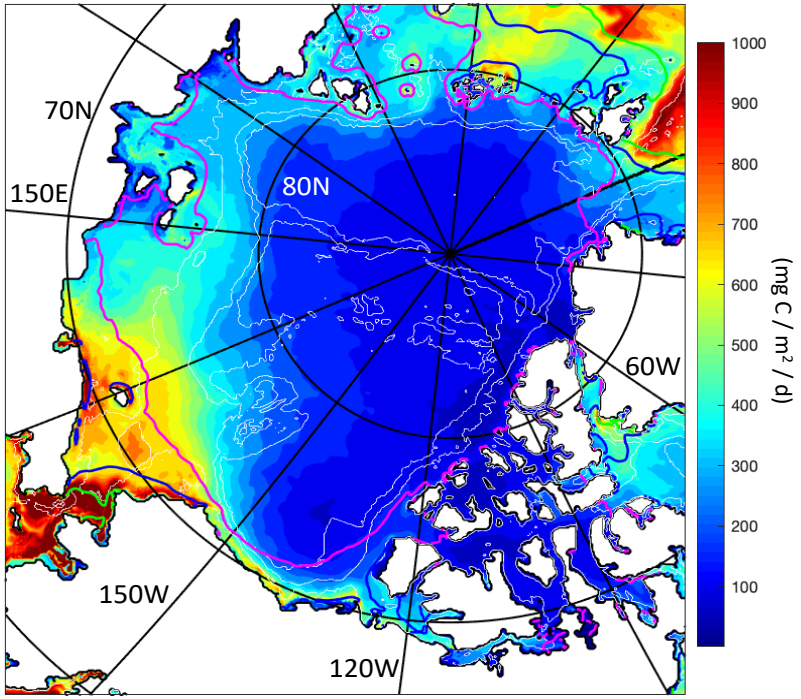
Science Summary

Hidden production: On the importance of pelagic phytoplankton blooms beneath Arctic sea ice

Objective

We quantify the pelagic primary production beneath Arctic sea ice, which is not available from observations, using RASM.



Mean primary production (mg C / m² / d) during June averaged over 1980-2018. White contour lines represent bathymetry (50, 500, and 2,000 m); green, blue and magenta contour lines represent ice concentration (15, 50, and 85%, respectively).

Research

- Literature is reviewed on the limited observations of under-sea ice phytoplankton blooms. Under-sea ice phytoplankton production is not available from satellite observations.
- According to model results, most primary production in the Arctic Ocean occurs under sea ice that is at least 50% in concentration.
- Annual cycles of primary production show there is a peak in June and time series over the last 4 decades show an increasing trend.

Impact

- Current observational estimates of the primary production in the Arctic Ocean may be significantly underestimated, due to the importance of under-sea ice production.
- Increased light transmission, due to the removal of sea ice, more extensive melt ponds, and thinner sea ice, is implicated as the main cause of increasing trends in primary production.

- Clement Kinney et al. 2020: Hidden production: On the importance of pelagic phytoplankton blooms beneath Arctic sea ice. Journal of Geophysical Research - Oceans, 125, 9, https://doi.org/10.1029/2020JC016211
- AGU Eos Research Spotlight: https://eos.org/research-spotlights/most-of-the-arctics-microscopic-algae-are-chilling-under-ice
- Frants et al. 2020: Evaluation of Under Sea-ice Phytoplankton Blooms in the Fully-Coupled, High-Resolution Regional Arctic System Model, Journal of Geophysical Research - Oceans, in review

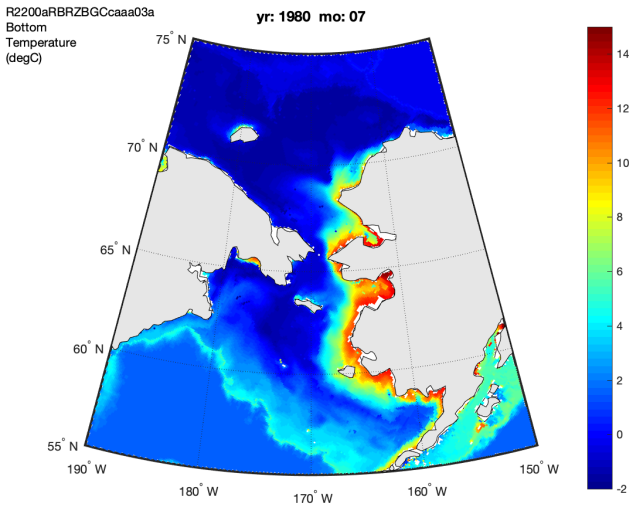
Future Research

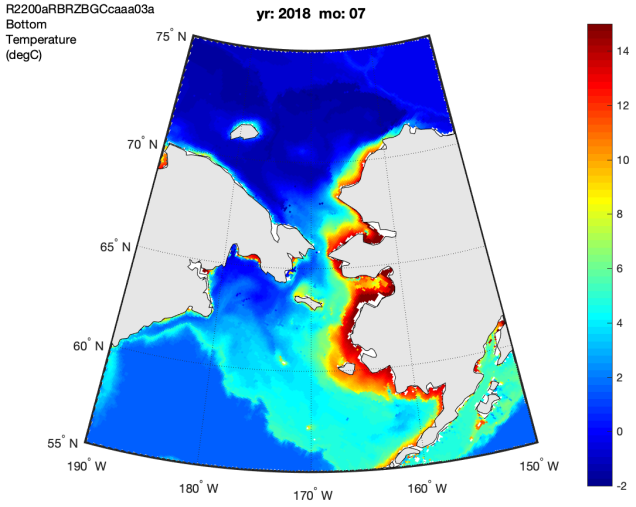
- **Bering Sea Cold Pool (bottom water < 2°C)**
  - Reduced winter sea ice in the Bering Sea in recent years is linked to a reduced distribution of the Cold Pool
  - Effects on circulation and biogeochemistry

- **Effects of riverine inputs on sea ice, light availability, and BGC processes**
  - HiLAT-RASM; E3SM; InteRFACE

- **Quantify the importance of melt ponds on under-ice light availability**
  - E3SM; HiLAT-RASM

- **Dimethyl sulfide (DMS)**
  - E3SM; atmospheric chemistry group at PNNL





Relationship to White Paper

- **Bering Sea Cold Pool (bottom water < 2°C)**
  - The absence of winter sea ice in the Bering Sea is an example of a ”climate extreme” that can be investigated for its affect on the physical environment and ecosystem

- **Effects of riverine inputs on sea ice, light availability, and BGC processes**
  - Looking at the linkage between the terrestrial and marine components

- **Importance of melt ponds on under-ice light availability**
  - Effects on the marine heat budget and ecosystem processes

- **Dimethyl sulfide (DMS)**
  - An investigation of the effects of marine DMSP/DMS on atmospheric cloud formation
  - Subsequent effects on the radiative budget