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Dirty sea ice drives higher Mn concentrations in the Canada Basin

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The rapidly changing conditions of the Arctic sea ice system have cascading impacts on the biogeochemical cycles of the ocean. Sea ice transports sediments, nutrients, trace metals, pollutants, and gases from the extensive continental shelves into the more isolated central basins. However, it is difficult to assess the net contribution of this supply mechanism on nutrients in the surface ocean. In this study, we used Manganese (Mn), a micronutrient and tracer which can integrate source fluctuations in space and time, to understand the net impact of the long range transport of sea ice for Mn.

We developed a three-dimensional dissolved Mn model within a subdomain of the 1/12 degree Arctic and Northern Hemispheric Atlantic (ANHA12) configuration of NEMO centred on the Canadian Arctic Archipelago, and evaluated this model with in situ observations from the 2015 Canadian GEOTRACES cruises. The Mn model incorporates parameterizations for the contributions from river discharge, sediment resuspension, atmospheric deposition of aerosols directly to the ocean and via melt from sea ice, release of sediment from sea ice, and reversible scavenging, while the NEMO-TOP engine takes care of the advection and diffusion of the tracers.

Simulations with this model from 2002 to 2019 indicate that the majority of external Mn contributed annually to the Canada Basin surface is released by sediment from sea ice, much of which originates from the Siberian shelves. Reduced sea ice longevity in the Siberian shelf regions has been postulated to result in the disruption of the long range transport of sea ice by the transpolar drift. This reduced sea ice supply has the potential to decrease the Canada Basin Mn surface maximum and downstream Mn supply, with implications for other nutrients (such as Fe) contained in ice-rafted sediments as well. These results demonstrate some of the many changes to the biogeochemical supply mechanisms expected in the near-future in the Arctic Ocean and the subpolar seas.