

Bering Sea PROJECT

UNDERSTANDING ECOSYSTEM PROCESSES IN THE BERING SEA 2007-2013

# The Contribution of Dissolved Iron from Melting Ice in the Bering Sea

SEA ICE AND IRON - ESSENTIAL SPRINGTIME ROLES

BEST-BSIERP

Like humans, algae require the trace metal iron for healthy growth. We tested the hypothesis that although the initial algal growth in spring depletes available iron (Fe) in the winter-mixed surface water of the Bering Sea shelf, resulting in limited algal growth, the input of Fe from melting ice relieves this limitation.

Sea ice can be an important source of available Fe to the surface ocean (Figure 1). Fe-rich particles derived from eolian deposition, fresh water runoff, and sediment suspension can be incorporated into sea ice during its formation. When ice melts in the spring, these Fe-rich mineral particles are released into the water column, and a portion of the particulate Fe becomes dissolved, contributing to the available Fe flux to the stratified surface water. This additional Fe source is especially important to the spring bloom, as vertical mixing of iron-rich subsurface waters is inhibited by the strong water column stratification brought about by the creation of a surface low-density layer of water when the ice melts.

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Pathways of iron supply from melting sea ice to the water column.



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## The Big Picture

We explored the role of sea ice in delivering dissolved iron (DFe), essential to the health of phytoplankton, and found that areas of the Bering Sea outer shelf not influenced by ice contain insufficient DFe for the complete assimilation of available nitrate by algae. In contrast, outer shelf areas influenced by melting sea ice contained sufficient DFe concentrations to support complete biological utilization of nitrate. In addition to providing water column stability, melting sea ice provides a source of DFe to the outer shelf that is important in maintaining ice-edge algal blooms. In the absence of this input, diatom productivity over the outer shelf and shelf break may become limited by iron during spring. Variability in sea ice extent is likely to translate into a varying supply of DFe to the Bering Sea outer shelf and shelf break in early spring, and thereby contribute to changes in the timing and community composition of the spring phytoplankton bloom.

THE ROLE OF ICE MELTING IN PROVIDING AVAILABLE IRON TO THE SURFACE WATER OF THE EASTERN BERING SEA SHELF A component of the BEST-BSIERP Bering Sea Project, funded by the National Science Foundation and the North Pacific Research Board with in-kind support from participants.

#### How We Did It

Our dissolved iron (DFe) measurements from both water column samples and ice cores collected during the 2007- Bering Sea Project cruise indicate that the melting ice provided substantial DFe to the water column. This additional DFe input, while highly variable (Figure 2), was particularly important to shelf break surface waters. In the absence of this Fe source, the concentration of DFe in the surface water would not be sufficient to allow algae to utilize fully the high nutrient concentrations observed in the outer shelf, and the productivity of this area would be limited below its full potential. The particulate Fe in the ice cores was 1 - 2 orders of

magnitude higher than the DFe in the ice core. If only a portion of this is bioavailable, it represents a further substantial source of Fe from the melting ice.

### Why We Did It

The Bering Sea is one of the most productive regions in the world. It exhibits a band of exceptionally high productivity along the shelf break during spring and summer. Previous observational and modeling studies indicate that changes in the seasonal ice cover influence open-water productivity (the timing of the spring bloom and the composition of the phytoplankton community) over the Bering Sea shelf and shelf break.



*Dissolved iron concentrations from replicate samples in the sea ice of the Eastern Bering Sea shelf in April/May 2007, with data from the Arctic and Antarctic Oceans for comparison.* 



The timing of the spring bloom also affects the transfer of energy to upper trophic levels. Because the outer shelf contains much higher concentrations of macronutrients, particularly nitrogen, than the middle and inner shelf, an ice edge that reaches the outer shelf in spring has the potential to support a larger ice edge phytoplankton bloom as ice begins to melt. However, high macronutrient concentrations in the outer shelf can only be fully assimilated when enough iron is available. We determined the acutely important influence of ice melt on the distribution of DFe, compared to available macronutrients in this area, and its possible implications for the spring phytoplankton bloom.

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The Bering Sea Project is a partnership between the North Pacific Research Board's Bering Sea Integrated Ecosystem Research Program and the National Science Foundation's Bering Ecosystem Study. www.nprb.org/beringseaproject