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Pack ice: a significant source of Fe to Antarctic surface waters?

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Known as an essential nutrient for phytoplankton growth, and hence involved in marine primary productivity and carbon export, iron (Fe) is a key element in the study of ocean-atmosphere interactions. This micro-nutrient has been shown to be limiting in "High-Nutrient, Low-Chlorophyll (HNLC)" areas such as the Southern Ocean where its inputs are low.

In the framework of the Belgian multidisciplinary project SIBClim (Sea Ice Biogeochemistry in a Climate change perspective), we have investigated spatial and temporal distribution of Fe in Antarctic pack ice. Samples of sea ice and its associated snow, brine and underlying seawater were collected and processed under trace metal clean conditions during the "ARISE in the east" (September-October 2003, 64-65˚S/112-119˚E, *RV Aurora Australis*) and the ISPOL (ANT XXII-2, November 2004-January 2005, 67-68˚S/54-55˚W, *RV Polarstern*) Antarctic cruises. Total dissolvable (unfiltered, pH 1.8) and dissolved (filtered$<0.2\mu$m, pH 1.8) Fe concentrations were measured by Flow Injection Analysis (FIA). Particulate Fe (PFe) and particulate Al (PAl) were analysed by GFAAS after digestion in strong acids of suspended matter collected on filters.

The most striking feature is certainly that Fe concentrations in sea ice can be up to two orders of magnitude higher than those measured in the underlying seawater. Iron is more concentrated in "winter" cold type stations than in "spring" warm type ones. This results from the enhanced ice permeability as spring settles in, which allows brine drainage within the ice cover and renders exchanges with the water column possible. The other main characteristic is the overall decrease with time of the DFe concentration at all depths (i.e. from 36.0 nM DFe on 29 November 2004 to 0.8 nM DFe on 30 December 2004, ISPOL campaign). Both ice melting and biological uptake could be responsible for DFe depletion in sea ice as the season progressed. Correlations between Fe pools and ice structures, together with other relevant parameters (temperature, salinity, nutrients, Chlorophyll a), shed some light on possible Fe sources and pathways to pack ice. Based on an averaged winter stock in Antarctic pack ice, Fe inputs from sea ice to surface waters are estimated. Flux calculations show that sea ice could represent a significant source of bioavailable Fe for Fe-deficient Antarctic surface waters and could thus induce algal blooms.