A role of sea ice melt water on iron supply to surface water in the polar and the sub-polar Ocean

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Massive utilization of nitrate in the surface layer in summer in the polar ocean in the Northern Hemisphere indicates sufficient supply of bioavailable iron into surface water. To reveal iron supply processes in the Arctic ocean and the sub-polar marginal sea, the Okhotsk Sea, in the early stage of biological increase, we investigated a roles of sea ice melt water on iron supply to surface phytoplankton community. First, we conducted surface towed fish clean sampling from the Bering sea shelf area, thorugh the Bering strait, and around sea ice edge in the Chukchi Sea. Alkalinity was measured as tracer which can be used for classify the sources of fresh water, river discharge or sea ice melting. Judging from the potential alkalinity, sea ice melt water was clearly distributed around edge of the sea ice. Dissolved iron and total dissolvable iron concentration well correlated with a fraction of sea ice melt water, and iron concentration increased with increasing of the fraction. On the other hand, area of Alaskan coastal current (ACC), west coast of Alaska, both of river water and sea ice melt water existed and iron concentrations correlated with fraction of sum of river water and sea ice melt waters. Our estimate from the slope of the correlation indicate that the sea ice melt water have comparable impact on iron supply as river discarge. Second, we also conducted winter observation in the sea ice area of the southern Okhotsk Sea. Hydrographic observations were carried out at a station in deep basin (>900 m) of the southern Okhotsk Sea in late-November 2013 (absence of sea ice) and in mid-February 2014 (presence of sea ice). We observed a striking temporal change in surface mixed-layer Fe concentrations, from ~6.5 nM for total dissolvable iron and ~0.96 nM for dissolved iron in November, to ~62.5 nM for total dissolvable iron and ~3.37 nM for dissolved iron in February. The increases of the mixed-layer Fe concentrations in February coincided with a decrease in seawater salinity. A three-component mixing scheme of seawater, sea ice melt water, and Amur River water using relationship between alkalinity and salinity revealed that the low seawater salinity observed in the mixed-layer was affected by the sea ice melt water, not the Amur River water. The inventory which is released Fe to the mixed-layer from sea ice is estimated using the Fe profiles in November and February as the inventory of 7407 μmol m^{-2} for total dissolvable iron and 375 μmol m^{-2} for dissolved iron, quantitatively. These observational studies clearly indicate that sea ice melting is one of significant process for deliver micro-nutrient, iron, to the surface water in the seasonal ice zone.