Organic ligands control the concentrations of dissolved iron in Antarctic sea ice

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The organic complexation of iron (Fe) was assessed in 5 snow, 34 sea ice, 12 brine and 24 under-ice seawater samples collected during a time series in the East Antarctic sector in austral summer 2009. Similar to seawater, over 99% of Fe was bound to organic ligands in snow, sea ice and brines throughout the study. Dissolved organic ligand and Fe concentrations were higher in the brines and sea ice than in snow and seawater samples. In sea ice, [DFe] ranged from 2.1 to 81.0 nM and organic Fe complexing ligands ([Lt]) ranged from 4.5 to 72.1 nM, with complex stability $\log K_{FeL}$ = 21.0-23.0. Estimated concentrations of inorganic Fe ([Fe']) in sea ice ranged from 0.1 to 98.2 pM. In brines, [DFe] ranged from 0.3 to 34.6 nM and [Lt] ranged from 5.9 to 41.4 nM, with complex stability $\log K_{FeL}$=21.0-22.0. Estimated concentrations of inorganic Fe (Fe') in brines ranged from 0.7 to 7.2 pM. Organic ligands were nearly saturated with Fe in both sea ice and brines, with positive linear relationships observed between [DFe] and [Lt]: [Lt] = 0.90 [DFe] + 4.24 (R^2 = 0.93, n = 34) in sea ice and [Lt] = 1.08[DFe] + 4.86 (R^2 = 0.98, n = 12) in brines. Our results therefore suggest that the organic ligands produced by sea ice algae and bacteria keep Fe in the dissolved phase therefore enhancing its availability for the sea ice algal community. When DFe concentrations become higher than the ligand concentrations, non-organically bound Fe is transferred into the particulate phase by scavenging, biological uptake or precipitation processes. As sea ice starts to melt, DFe will be released into seawater together with organic ligands, potentially increasing the residence time of Fe in Antarctic surface waters and its bio-availability for the phytoplankton community.