

Various Sources of Dissolved Copper and Copper-Binding Ligands in the Chukchi Sea (western Arctic Ocean)

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The Arctic Ocean is experiencing increased riverine discharge and sea ice meltwater input due to accelerated global warming, which could result in elevated concentrations of organic matter and dissolved trace metals. Among these trace metals, dissolved copper (Cu) acts as an essential micronutrient for phytoplankton, but when the concentration of free Cu ions (Cu^{2+}) exceeds 10 pM, it can become toxic. Therefore, understanding the behavior of dissolved Cu might be important in the Arctic Ocean. In this study, we investigated the distribution and speciation of dissolved Cu in the Chukchi Sea (located in the western Arctic Ocean).

The concentrations of total dissolved Cu ranged from 1.5 to 4.9 nM (average: 3.4 ± 1.1 nM). Total dissolved Cu concentrations showed a negative relationship with salinity ($R^2 = 0.47$, $p < 0.001$) and a positive relationship with river water fraction ($R^2 = 0.72$, $p < 0.001$), suggesting that riverine input is a major driver of dissolved Cu distribution in the Chukchi Sea. Cu speciation was determined using Competitive Ligand Exchange / Adsorptive Cathodic Stripping Voltammetry (CLE-AdCSV) with a 5 μM SA detection window. The average concentration of strong Cu-binding organic ligands (L_1) was 4.6 ± 1.5 nM, with an average conditional stability constant ($\log K_1$) of 14.6 ± 0.5 , while weaker ligands (L_2) averaged 12.8 ± 4.6 nM, with a $\log K_2$ of 12.8 ± 0.4 . The concentration of free Cu^{2+} , a key factor in bioavailability, ranged from 3.6 to 67 fM. These levels could be non-toxic to phytoplankton in this study region, but some water samples may limit the growth of diatoms.

Our results show various sources of dissolved Cu and Cu-binding ligands in the Chukchi Sea and provide the first dataset on Cu speciation in the western Arctic Ocean.