Bioactive trace elements (Cu, Zn, Cd and Co) in the Southern Ocean

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Meridional transact between Cape Town and Antarctica provides a unique opportunity to study trace metal distribution and cycling as it crosses through major fronts delineating distinct water masses controlled by deep water circulation pattern. Measurements show majority fraction of trace metals occur in the dissolved phase. Surface depletion of the dissolved component of all four elements indicates bio-utilization. Copper, Cd and Zn show a typical nutrient like profile and correlate well with PO_4 whereas Co shows a hybrid profile with a sub-surface maxima followed by evidence of scavenging at deeper depths. The AAIW/UCDW boundary controls the scavenging onset depth and may be a prominent control in the meridional depletion of surface dissolved Co. Furthermore, Co concentrations decrease heading south through ACC towards the Weddell Gyre – the only element to exhibit this behavior. Although Cd displays nutrient like profiles, highest utilization in surface water was observed within the sub-tropical zone (~17 pmol/kg) with little uptake in regions close to Antarctica (~744 pmol/kg). Dissolved copper in mixed layer depth varies between 0.75 nmol/kg near the Sub-tropical Front to 1 nmol/kg near the Antarctic Polar Front. There exists a strong correlation (R^2 = 0.73 to 0.99) between Cu and Si and the Cu:Si ratio shows minor increase southward from STZ (0.013 nM/μM) to Weddell Gyre (0.015 nM/μM). However, the correlation of Cu:Si weakens with the water column depth. Of the four elements considered, Zn concentrations were the highest (e.g., 9 nmol/kg) in surface waters of STZ with concentrations decreasing southward until close to Antarctic continental margin where concentration increase (4.6 nmol/kg) once again. Similar to Cu, Zn also showed a strong correlation with Si along the transact as well as down the water column and Zn:Si ratio did not vary significantly (0.04 nM/μM – 0.07 nM/μM) across the transact. Variations in the surface-water trace metal distribution could also be attributed to phytoplankton community structure change, for example, from diatom dominated system (Zn:Co = 0.30) to haptophyte (Type 6) dominated waters (Zn:Co = 0.15).