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Seasonal cycling of dissolved Fe in the South Atlantic marginal ice zone of the Southern Ocean

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Using oceanographic expeditions (Southern Ocean Seasonal Experiment, 2019) conducted along the Bonus Goodhope Line, this study aims to understand seasonal dissolved Fe (dFe) dynamics in and around the marginal ice zone(MIZ) at 59.47-51.35 and its link to phytoplankton blooms.

dFe shows a typical nutrient distribution at 15 of the 19 stations in this seasonal comparison, with the remainder showing relatively constant concentrations with depth. Remineralisation depth ranges were identified from below the Mixed Layer Depths(MLD) to approximately 200m below ice and 500m in the open ocean. Seasonally, the MLD varied significantly, ranging between 26m and 151m with spring (86.74m±38.05,n=17) showing a shallower MLD average compared to winter (115.26±18.1,n=7). Ice melt resulted in the shoaling of the MLD due to increased freshwater input within surface layers, evident when comparing the MLD under the pack ice with that further north, where melting occurs.

Shallowing of MLD resulted in higher dFe concentrations in upper waters (surface to MLD; 0.08-0.82 nmol/L, n=53) in spring compared to winter (0.05-0.56 nmol/L, n=26).Winter dFe concentrations in open oceans were slightly lower than those in the MIZ, while spring measurements showed no significant difference. Close to the ice edge, two distinct phytoplankton blooms (19-22th October and 6-9th November) were observed in spring. Chlorophyl-a (Chl-a) was measured up to 2.67 mg/m^3(n=101), notably higher than the winter maximum of 0.28158mg/m^3(n=18). High dFe concentrations were evident along the edge of the ice, however, the Apparent Oxygen Utilisation was low, which indicates significant Fe being supplied by mechanisms different than remineralization. The decrease seen in surface water salinity along the zero meridian between 54-56°S suggests that the lateral flowing ice melt may be acting as an Fe source. The supply of deep-water Fe through nutrient-rich Upper Circumpolar Deep Waters (UCDW) upwelling in this region cannot be discounted though. We conclude that ice melt, upwelling processes and internal cycling are driving Fe dynamics and controlling primary productivity.