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TITLE: Sources and fluxes of dissolved iron in the Bellingshausen Sea (West Antarctica): The importance of sea ice, icebergs and the continental margin

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ABSTRACT:

This study was conducted to estimate the potential for natural iron fertilization in the Bellingshausen Sea, a remote region in the Pacific sector of the Southern Ocean. Seawater samples were collected during early austral spring 2007 near the continental margin, in the wake of an iceberg and near Peter I Island in order to identify and quantify Fe sources to the upper ocean. We concomitantly collected sea ice cores for Fe analysis during a time series sampling program on an ice floe. Looking at the upper 200 m, our seawater data together with other published data suggest a large-scale exponential meridional decrease of DFe concentrations with increasing distance from the coastline noticeable up to 1400 km to the north into the ACC. From this DFe gradient we estimated DFe fluxes into the upper mixed layer of the Bellingshausen Sea using a simple one-dimensional horizontal and vertical diffusion/advection model. We also estimated the melting input from sea ice and icebergs. DFe fluxes were compared for three biogeochemical provinces: ice covered continental shelf, marginal ice zone near the continental margin, and the open ocean. Fe in sea ice decreased with time enabling us to estimate a melt flux of 0.3 ?mol/m2/d DFe. We found that going from the continental shelf to the open ocean the dominant Fe fluxes gradually change from horizontal advection on the continental shelf (54% of a total DFe flux of 7.6 ± 5.0 ?mol/m2/d) via sea ice melt in the pack ice near the continental margin (56% of a total DFe flux of 0.55 ± 0.18 ?mol/m2/d) to vertical advection (58% of a total DFe flux of 0.038 ± 0.027 ?mol/m2/d) in the ice free open ocean. A significant DFe flux of 0.6 ?mol/m2/d was estimated for iceberg melting, but this flux took place below the upper mixed layer and was not taken into further account. Fueling the high horizontal flux on the continental shelf is likely benthic diffusion and sediment resuspension. This is indicated by enhanced total dissolvable Fe (TD-Fe) and dissolved Fe (DFe) in the upper 200 m close to Peter I Island, and near the seafloor at the other stations. Also mid-depth TD-Fe increases near the continental margin were observed. Comparison of estimates of biogenic Fe fixation (based on estimates for Southern Ocean carbon fixation) with the fluxes computed here, indicates an excess of new DFe input on the continental shelf and increasing Fe limitation going from the continental margin towards the open ocean.

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