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# Modelling iron - light colimitation in the Amundsen Sea, West Antarctica

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Primary production in the Southern Ocean plays a large role in sequestering atmospheric $CO_2$, an important process for future climate projections. Results from oceanographic cruises and remote sensing (Arrigo et al. 2015) show a correlation between ice shelf melt rate and annual net primary productivity (NPP) in coastal waters around Antarctica. It has been suggested that the high NPP observed close to Dotson Ice Shelf in West Antarctica is permitted by strong meltwater plumes carrying iron from glaciers into the iron-limited waters of the Amundsen Sea Polynya (ASP). However the concentration of iron in glacial meltwater is poorly constrained, and there are competing sources which may dominate the pool of iron available for phytoplankton growth (St-Laurent et al. 2017). These sources include the Circumpolar Deep Water (CDW) which itself drives basal melting, as well as benthic sediments. Furthermore it has been argued that in the Amundsen Sea phytoplankton growth rates are limited not by iron but by light, and thus that surface irradiance is the dominant control on the size of plankton blooms (Park et al. 2017). In this study the MIT general circulation model (MITgcm) with a static ice shelf is used in conjunction with a biogeochemical model (BLING) (Galbraith et al. 2010) to simulate annual cycles of sea ice extent, mixed layer depth and NPP. An idealised domain covering Dotson Ice Shelf and the ASP is used to compare the pathways and biological uptake of different iron sources, and the relative importance of changes to the availability of light and of iron in the water column. Model outputs suggest a low sensitivity of NPP to the quantity of iron present in meltwater, but a complex dependence on melt rate and surface forcings, due to impacts on stratification and circulation. Iron inputs from glacial meltwater and from intrusions of circumpolar deep water (CDW) are seen to occupy different regions of the meltwater plume and thus to follow different isopycnals from the shelf cavity into the ocean. Furthermore meltwater transported from nearby ice shelves via coastal currents can have a more significant impact on productivity than that from Dotson Ice Shelf itself. These results from an idealized modelling study demonstrate that both the basal melting of ice shelves and local atmospheric forcings can play a role in determining NPP in West Antarctica, and thus changes in both must be considered in order to quantify the potential of the Southern Ocean carbon sink as a feedback in global climate change.