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Is phytoplankton responsible for pumping CO_2 in the Weddell Sea?

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The Southern Ocean is thought to be a sink of atmospheric CO_2 although the uptake magnitude is still a matter of debate. We report the first estimates of ocean-atmosphere CO_2 fluxes from the Weddell Sea west of 30ºW based on observations collected in the austral summers between 2001 and 2005. . The data consists of high-resolution sea surface temperature, salinity, carbonate system (pCO_2, TCO_2, Alkalinity), dissolved O_2 and nutrients (nitrates, phosphates and silicates), phytoplankton taxonomy and biomass (total Chl-a for three size class, $< 0.5\mu$m, $>10\mu$m and 5μm$<$ Chl-a $<10\mu$m).

The estimated CO_2 sink and the phytoplankton Chl-a biomass are larger than reported in the eastern Weddell. About 88˚% of the explored area presents a mean sea-air CO_2 flux -7.8mmol m^{-2}.day^{-1}, one of the strongest CO_2sinks observed in the contemporary ocean. A small fraction of the western Weddell in the central cyclonic gyre is a small source of atmospheric CO_2. The region of net CO_2 emission is associated with upwelling of deep waters. The negative $\Delta pCO_2$and associated CO_2 fluxes are one order of magnitude and almost twice larger, than reported in north and east Weddell Sea, and other Southern Ocean areas. The mean Chl-a over the western Weddell Sea is 1.45 mg.$m^{-3,}$ and presents maxima of 18mg.m^{-3} south of Orkney Island, and 5mg.m^{-3} along the Antarctic shelf. These regions are characterized by abundance of large cells and diatoms (dominated by *Pseudo-nitzschia* species), which are presumably responsible for the strong CO_2 uptake. The diatom and biomass abundance may explain the high accumulation rate of opal and carbon observed in the Weddell Sea sediments. The observation of very low nutrient levels around the diatom bloom suggest that, during the Austral summer, phytoplankton growth is nutrient limited, in contrast with light or iron. Our results suggest that extrapolation of CO_2 fluxes and the biological carbon pump based on observations collected in other regions of the Weddell Sea may significantly underestimate the mean ocean CO_2 uptake.