



A rapid Transition from ice covered CO₂-rich Waters to a biologically mediated CO₂ Sink in the eastern Weddell Gyre

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Circumpolar Deep Water (CDW), locally called Warm Deep Water, (WDW), enters the Weddell Gyre in the southeast, roughly at 25-30°E. In December 2002-January 2003 we studied the effect of entrainment of WDW on the fugacity of carbon dioxide (fCO₂) and dissolved inorganic carbon (DIC) in Weddell Sea surface waters. Ultimately the fCO₂ difference across the sea surface drives CO₂ air-sea fluxes. Deep CTD sections and surface transects of fCO₂ were made along the Prime Meridian, a northwest-southeast section, and along 17-23°E during cruise ANT XX/2 on FS *Polarstern*. Upward movement and entrainment of WDW into the winter mixed layer had significantly increased DIC and fCO₂ below the sea ice along 0°W and 17 to 23°E, notably in the southern Weddell Gyre. Nonetheless, the ice cover largely prevented outgassing of CO₂ to the atmosphere. During and upon melting of the ice, biological activity rapidly reduced surface water fCO₂ by up to 100 μatm, thus creating a sink for atmospheric CO₂. Despite the tendency of the surfacing of WDW to cause CO₂ supersaturation, the Weddell Gyre may well be a CO₂ sink on an annual basis due to this effective mechanism involving ice cover and ensuing biological fCO₂ reduction. The CO₂ source tendency deriving from the upward movement of 'pre-industrial' CDW is declining, as atmospheric CO₂ levels continue to increase and thus the CO₂ sink of

the Weddell Gyre will continue to increase as well (provided the upward movement of WDW does not change much).