



The Weddell Sea atmospheric CO₂ uptake: An overview of its seasonal cycle and relationship to sea ice

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The Weddell Sea has previously been estimated to be a net atmospheric CO₂ sink, transporting anthropogenic CO₂ to deeper parts of the ocean. However, a paucity of spatial and temporal observational data coverage hinders a complete understanding of its (seasonal and interannual) variability, how it is affected by seasonal sea ice cover, and how it may change with rapidly changing Antarctic sea ice regimes. We provide a status overview of all available partial pressure CO₂ (pCO₂) observations and estimates in the Weddell Sea, including SOCAT, GLODAP, and SOCCOM float datasets. We identify a particular lack of data on the continental shelves. Floats fill the wintertime-gap by obtaining year-round data, but are restricted to the open ocean and water depths of at least 2000 m. The collated dataset illustrates a seasonal cycle for the Weddell Sea, in which the summertime CO₂ uptake can be strong with a mean of $-1.2 \text{ mol m}^{-2} \text{ yr}^{-1}$, but extremely variable ($\pm 2.2 \text{ mol m}^{-2} \text{ yr}^{-1}$). Some of the summertime CO₂ uptake is compensated by wintertime CO₂ outgassing, particularly in the northern Weddell Sea where sea ice cover is lowest and wind speeds are high. We use additional reanalysis and observational data-based products to perform a further analysis of differences between subregions within the Weddell Sea. Results show that most regions have a strong seasonal cycle in the sea-air CO₂ gradient, with mean amplitudes ranging between 27 μatm (Northern Weddell Sea) and 100 μatm (eastern Peninsula shelf regions). However, wintertime outgassing is largely restricted by sea ice cover in all regions. The central Weddell Sea seems to be a particularly important region for net CO₂ uptake, which is partly explained by the timing of wintertime sea ice advance before the surface pCO₂ oversaturates with respect to atmospheric CO₂. These results imply that the timing of sea ice advance or retreat can have high impact on the net CO₂ uptake of the Weddell Sea.