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UPPER OCEAN VARIABILITY IN CARBON DIOXIDE SOUTH OF AUSTRALIA.

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Surface carbon dioxide (CO_2) observations are integral to understanding the role of the Southern Ocean in the global carbon cycle, and to developing reliable predictions of biogeochemical responses to altered climatic conditions. Carbon dioxide (CO_2) observations made in surface waters of the Australian sector of the Southern Ocean between the years 1991 and 2002 were used to estimate the seasonal variability in the fugacity of CO_2 (fCO_2) and net air-sea carbon fluxes.

The results showed a net annual uptake of CO_2 by the surface ocean over the entire region. The greatest seasonal uptake and lowest fCO_2 values were observed in Spring/Summer in the sub-Antarctic zone (SAZ: 44°S-50°S) and in the Seasonal Sea-ice Zone (SIZ: south of 62°S). The seasonal maximum in uptake for these regions is consistent with increased phytoplankton biomass and shoaling mixed layers over the Spring/Summer period. The High Nutrient Low Chlorophyll waters between 50°S and 62°S, also had maximum uptake in summer, but less compared to the SAZ and SIZ regions. Winter surface waters were close to or slightly above equilibrium, with respect to atmospheric CO_2. The reduced uptake in winter appeared due to deeper mixing, lower biomass, and air-sea CO_2 exchange. The highest fCO_2 values in Winter were observed under or near the seasonal sea-ice where entrainment of deeper CO_2-rich waters and ice cover would maintain high surface fCO_2 values. The smallest seasonal amplitude in the surface fCO_2 and net air-sea fluxes was found from 51°S to 54°S, a region on the southern edge of the SAZ and between the North sub-Antarctic Front and North Polar Front.

The uptake estimates derived from the data were in good agreement with the CO_2 flux climatology of Takahashi (2002), except in the SAZ and SIZ where we observed greater and less uptake, respectively.