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AN OBSERVATIONAL STRATEGY FOR ESTIMATING THE SOUTHERN OCEAN UPTAKE OF CO_2

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A sampling strategy to estimate the annual mean CO_2 uptake by the Southern Ocean was developed by applying 2D Fourier transforms and signal-to-noise ratios to the simulated air-sea CO_2 fluxes and ΔpCO_2 from an ocean biogeochemical model driven with NCEP-R1. Observations of pCO_2 were used to validate the statistical properties of the model and to estimate the mesoscale variability not captured by the model resolution. Sampling regularly every 3-months, at every 30˚ in longitude and 3˚ in latitude is sufficient to determine the net Southern Ocean CO_2 uptake. We applied this sampling strategy to the simulated air-sea fluxes to estimate a net annual mean CO_2 uptake of 0.6 ±0.1 PgC/yr (1990-1999). This uncertainty in the estimate was dominated by the simulated interannual variability, and not by errors in the sampling or unresolved mesoscale variability. Therefore, sampling at higher resolutions in space and time would not reduce the uncertainty in the Southern Ocean annual mean uptake any further. These results show that a doubling of the current Southern Ocean sampling (in longitude) would be required to constrain the net annual mean air-sea CO_2 fluxes to within the natural variability of the system.