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Open ocean gas exchange parameterization uncertainties

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During the SOLAS Air-Sea Gas Exchange Experiment (SAGE), a dual tracer experiment was carried out in the Southern Ocean. The experiment aimed in particular to determine the gas exchange parameterization at high wind speeds, where the greatest uncertainty lies in the nonlinear parameterization of transfer velocity against wind speed. Here we examine the sources of uncertainty in this parameterization.

The experiment established that a quadratic parameterization provided a better statistically significant fit to the data than the cubic parameterization proposed by Wanninkhof and McGillis (1999). This is very significant for estimates of ocean uptake of carbon dioxide. The statistics do not preclude other forms. While gas transfer velocity is most commonly parameterized against wind speed due to the simplicity of this parameter, significant uncertainties in the wind measurement exist. Flow distortion around the measurement platform was corrected using the Gerris computational fluid dynamics model, and spatio-temporal differences between ship based winds and satellite scatterometer data were evaluated. Mixed layer dynamics during SAGE were complex, with water mass intrusion and small scale stratification. These contributions to the exchange uncertainty are shown in relation to the mixing of the $SF_6/^3He$ tracers with depth.