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Suppression of air-sea CO₂ transfer by surfactants – direct evidence from the Southern Ocean

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Uncertainty in the CO₂ gas transfer velocity (K_{660}) severely limits the accuracy of air-sea CO₂ flux calculations and hence hinders our ability to produce realistic climate projections. Recent field observations have suggested substantial variability in K_{660} , especially at low and high wind speeds. Laboratory experiments have shown that naturally occurring surface active organic materials, or surfactants, can suppress gas transfer. Here we provide direct open ocean evidence of gas transfer suppression due to surfactants from a ~11,000 km long research expedition by making measurements of the gas transfer efficiency (GTE) along with direct observation of K_{660} . GTE varied by 20% during the Southern Ocean transect and was distinct in different watermasses. Furthermore GTE correlated with and can explain about 9% of the scatter in K_{660} , suggesting that surfactants exert a measurable influence on air-sea CO₂ flux. Relative gas transfer suppression due to surfactants was ~30% at a global mean wind speed of 7 m s⁻¹ and was more important at lower wind speeds. Neglecting surfactant suppression may result in substantial spatial and temporal biases in the computed air-sea CO₂ fluxes.