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Towards a universal relationship between wind speed and gas exchange: Gas transfer velocities measured with 3He/SF6 during the Southern Ocean Gas Exchange Experiment

David Ho (1), Rik Wanninkhof (2), Peter Schlosser (3), David S. Ullman (4), and David Hebert (5)

(1) Department of Oceanography, University of Hawaii, Honolulu, United States (ho@hawaii.edu), (2) NOAA/AOML/OCD, Miami, United States, (3) Lamont Doherty Earth Observatory, Columbia University, Palisades, United States, (4) Graduate School of Oceanography, University of Rhode Island, Narragansett, United States, (5) Fisheries and Ocean Canada, Bedford Institute of Oceanography, Dartmouth, Canada

Two ^{3}He/SF$_6$ dual gas tracer injections were conducted during the Southern Ocean Gas Exchange Experiment (SO GasEx) to determine gas transfer velocities. During the experiment, wind speeds of up to 16.4 m s^{-1} were encountered. The gas transfer velocity$k$was calculated from the decrease in the observed ^{3}He/SF$_6$ ratio using three different mathematical approaches. Discrete points of wind speed and corresponding k were obtained from the change in ^{3}He/SF$_6$ ratio over 3 time intervals. The results were also evaluated using an analytical model and a 1-D numerical model. The results from the three approaches agreed to within the error of the estimates of about 13-15% for Patch 1, and 4% for Patch 2. Moreover, ^{3}He/SF$_6$ dual tracer results from SO GasEx are similar to those from other areas in both the coastal and open ocean, and in agreement with existing wind speed/gas exchange parameterizations. This suggests that wind forcing is the major driver of gas exchange for slightly soluble gases in the ocean and that other known impacts are either intrinsically related to wind or have a small effect ($<$20 % on average) on timescales of the order of days to weeks. The functionality of the wind speed dependence (quadratic, or cubic) cannot be unequivocally determined from SO GasEx results.