Gas transfer velocities measured at low wind speed over a lake

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ABSTRACT: The relationship between gas transfer velocity and wind speed was evaluated at low wind speeds by quantifying the rate of evasion of the deliberate tracer, SF_6, from a small oligotrophic lake. Several possible relationships between gas transfer velocity and low wind speed were evaluated by using 1-min-averaged wind speeds as a measure of the instantaneous wind speed values. Gas transfer velocities in this data set can be estimated virtually equally well by assuming any of three widely used relationships between k_{600} and winds referenced to 10-m height, U_{10}: (1) a bilinear dependence with a break in the slope at ~3.7 m s^{-1}, which resulted in the best fit; (2) a power dependence; and (3) a constant transfer velocity for U_{10} < ~3.7 m s^{-1}, with a linear dependence on wind speed at higher wind speeds. The lack of a unique relationship between transfer velocity and wind speed at low wind speeds suggests that other processes, such as convective cooling, contribute significantly to gas exchange when the wind speeds are low. All three proposed relationships clearly show a strong dependence on wind for winds > 3.7 m s^{-1} which, coupled with the typical variability in instantaneous wind speeds observed in the field, leads to average transfer velocity estimates that are higher than those predicted for steady wind trends. The transfer velocities predicted by the bilinear steady wind relationship for U_{10} < ~3.7 m s^{-1} are virtually identical to the theoretical predictions for transfer across a smooth surface.