Comparing parameterizations of gas transfer velocity and their effect on the global marine CO$_2$ budget

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One of the dominant sources of uncertainty in the calculation of air-sea flux of carbon dioxide originates from the various parameterizations of the gas transfer velocity $k$ that are in use. Whilst it is undisputed that most of these parameterizations have shortcomings, neglecting processes which influence air-sea gas exchange and do not scale with wind speed alone, there is no general agreement about which parameterizations are most accurate.

The existing parameterizations are based on various non-linear forms of wind speed or friction velocity, on sea surface roughness and, to a lesser extent, on temperature and salinity. Most of these parameters can be retrieved from remote sensing data providing global coverage on daily to monthly intervals. However, the global budgets of carbon dioxide that can be calculated with the help of these data differ substantially in value and meaning depending on the choice of data and equation for the gas transfer velocity. In this work we compare several $k$-parameterizations, employing different types of satellite data in order to obtain a measurement of uncertainty in gas exchange calculations evaluated at both regional and global scales.

We show results based on classic $k$-parameterizations by [Liss and Merlivat, 1986], [Wanninkhof, 1992] and [Wanninkhof and McGillis, 1999] which are all primarily based on wind speed. These are then compared with results based on two newer parameterizations. The first one by [Woolf, in press] relates the gas transfer velocity to friction velocity and significant wave height. The second parameterization by [Glover et al., 2002] uses sea surface roughness obtained by an altimeter operating at dual frequency to calculate the gas transfer velocity. Both of these approaches have an advantage over the classic wind-speed based parameterizations; they rely on parameters which should be more directly linked to gas exchange than wind speed, since they have the potential to incorporate effects of natural surface films, boundary layer instability and wave fetch on air-sea gas exchange.

REFERENCES


Woolf, D.K., in press. Parameterization of gas transfer velocities and sea-state-dependent wave breaking, Tellus B.