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Uncertainty of the global oceanic CO_2 exchange at the air-water interface induced by the choice of the gas exchange velocity formulation and the wind product: quantification and spatial analysis

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In lakes, rivers, estuaries and the ocean, the quantification of air-water CO_2 exchange (FCO_2) is still characterized by large uncertainties partly due to the lack of agreement over the parameterization of the gas exchange velocity (k). Although the ocean is generally regarded as the best constrained system because k is only controlled by the wind speed, numerous formulations are still currently used, leading to potentially large differences in FCO_2. Here, a quantitative global spatial analysis of FCO_2 is presented using several k-wind speed formulations in order to compare the effect of the choice of parameterization of k on FCO_2. This analysis is performed at a 1 degree resolution using a sea surface pCO_2 product generated using a two-step artificial neuronal network by Landschützer et al. (2015) over the 1991-2011 period. Four different global wind speed datasets (CCMP, ERA, NCEP 1 and NCEP 2) are also used to assess the effect of the choice of one wind speed product over the other when calculating the global and regional oceanic FCO_2. Results indicate that this choice of wind speed product only leads to small discrepancies globally (6 %) except with NCEP 2 which produces a more intense global FCO_2 compared to the other wind products. Regionally, theses differences are even more pronounced. For a given wind speed product, the choice of parametrization of k yields global FCO_2 differences ranging from 7 % to 16 % depending on the wind product used. We also provide latitudinal profiles of FCO_2 and its uncertainty calculated combining all combinations between the different k-relationships and the four wind speed products. Wind speeds >14 m s-1, which only account for 7 % of all observations, contributes disproportionately to the global oceanic FCO_2 and, for this range of wind speeds, the uncertainty induced by the choice of formulation for k is maximum (∼50 %).