A spatially explicit uncertainty analysis of the air-sea CO_2 flux from observations

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The ocean is an essential part of global climate and the global carbon cycle, but in order to improve our understanding of its role as climate regulator, we need to precisely quantify the amount of carbon exchanged at the air-sea interface. With this in mind, we developed a two-step neural network machine learning approach (SOM-FFN) in order to reconstruct the partial pressure of carbon dioxide (pCO_2) at a 1°x1° resolution. This provides an important observational resource to compute the global air-sea CO_2 flux. However, uncertainties in neural network and other interpolation techniques can be large, especially in remote or seldom sampled ocean regions. These uncertainties, consisting of mapping or extrapolation uncertainties as well as those associated with the kinetic transfer of a gas across the air-sea interface, are seldom taken into consideration despite their significant effect on our ability to balance regional and global carbon budgets. Here, we report on the development of a two-dimensional (longitude and latitude) gridded uncertainty product, available publicly alongside our standard neural network air-sea CO_2 flux output. This product will provide tools necessary to improve computations of the air-sea CO_2 fluxes and uncertainties in support of regional carbon budgets. Analysis using this dataset allows for evaluation of high-uncertainty regions and identification of areas within flux calculation in the machine learning process that could be further constrained, and could contribute to a more accurately calculated global stocktake of ocean carbon.