

Oceanic sources and sinks for atmospheric CO₂

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Our understanding of the oceanic sources and sinks for atmospheric CO₂, and in particular the oceanic uptake for anthropogenic CO₂ has made great advances over the last decade. This is in large part due to four converging factors. First, we are able now, with some confidence, to compute directly the air-sea flux of CO₂ across the air-sea interface on a global basis thanks to the compilation of a large data base of observations of the air-sea difference in the partial pressure of CO₂. Second, the completion of the JGOFS/WOCE global carbon survey produced for the first time a high-quality global-scale data set of inorganic carbon. Third, a method has been devised, by which the small anthropogenic CO₂ signal can be separated from the large natural carbon background, allowing us to directly determine the oceanic inventory of anthropogenic CO₂. The fourth and final factor is the development and application of inverse methods that take advantage of the first three developments in order to compute separately the air-sea flux of pre-industrial and anthropogenic CO₂. These observations and analyses indicate that the ocean is the most important sink for anthropogenic CO₂ after the atmosphere by taking up about a third of the anthropogenic CO₂ emissions, or about 2.2 +/- 0.25 Pg C yr⁻¹ for a nominal year of 1995 (see abstract by Mikaloff-Fletcher et al.). The inversely estimated natural air-sea fluxes reveal the expected pattern with CO₂ outgassing in the tropics and CO₂ uptake at mid to high latitudes. The subpolar regions of the Southern Hemisphere defy this trend, exhibiting strong outgassing of natural CO₂, associated with the upwelling of waters rich in atmospheric CO₂ from depth. The contemporary air-sea fluxes from the inversion agree reasonably well with flux estimates derived from DeltapCO₂ observations, with the exception of the subpolar regions in the Southern hemisphere where our flux estimates are three to five times smaller, and an equatorward shift of the main oceanic sink regions. When analyzed in the context of observed atmospheric CO₂ variations, our results support the existence of a substantial sink for anthropogenic CO₂ in the northern hemisphere terrestrial biosphere, and a stronger terrestrial carbon loss in the tropics (see abstract by Jacobson et al.).