Increasing anthropogenic CO2 inventories in the ocean

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A significant impetus for recent ocean biogeochemical research has been to better understand the ocean's role as a sink for anthropogenic CO2. In the 1990s carbon samples were collected and analyzed from approximately 95 research cruises run as part of the international World Ocean Circulation Experiment (WOCE) and the Joint Global Ocean Flux Study (JGOFS). Based on these data, Sabine et al. (2004) estimated that the total inventory of anthropogenic CO2 in the ocean (Cant) in the year 1994 was 118 ± 19 Pg C, accounting for 48% of the CO2 released from fossil fuel burning between 1800 and 1994. Since then two approaches that heavily rely on chlorofluorocarbon data have published global inventory estimates for the reference year 1994: 94-121 Pg C based on the TTD method (Waugh et al., 2006) and 114 ± 22 Pg C using a Green function approach (Khatiwala et al., 2009). In the early 2000s the physical and biogeochemical communities organized themselves to initiate an effort to collect full water column boundary to boundary hydrographic and geochemical data along a subset of the cruises that were initially run as part of the WOCE/JGOFS global survey in the 1990s. At least seven countries agreed to coordinate these repeat hydrographic survey cruises to monitor decadal-scale changes in the ocean. Preliminary results from these repeat cruises clearly demonstrate that detecting decadal changes in carbon inventory is a feasible undertaking, and that these data are good indicators of integrated changes in Cant storage. It is also clear that there are large spatial differences in the storage rates. There are several indications that, in some parts of the ocean, the storage rate is changing on decadal time scales, although it is unclear if this is a trend or variability. Another recent advancement in our understanding of the increases in Cant storage has been an appreciation for the role of marginal seas. A recent synthesis of Cant storage estimates for the major marginal seas suggests that as of 2008 up to 8.2 Pg C may be stored in these regions, i.e. approximately 6% of the global ocean Cant storage (Lee et al., 2011). A compilation of these recent marginal sea estimates together with the 2008 open ocean Cant distributions estimated using the approach of Khatiwala et al. (2009) gives a total ocean Cant inventory estimate of 148 ± 27 Pg C for 2008. References: Khatiwala, S., F. Primeau, and T. Hall, 2009: Reconstruction of the history of anthropogenic CO2 concentrations in the ocean. Nature, 462, doi:10.1038/nature08526, 346-350. Lee, K., C.L. Sabine, T. Tanhua, T.-W. Kim, R.A. Feely, and H.-C. Kim (2011): Roles of marginal seas in absorbing and storing fossil fuel CO2. Energy Environ. Sci., 4, doi: 10.1039/C0EE00663G, 1133-1146. Sabine, C. L., and Coauthors, 2004: The oceanic sink for anthropogenic CO2. Science, 305, 367-371. Waugh D.W., T. M. Hall, B. I. McNeil, R. Key, and R. J. Matear, 2006: Anthropogenic CO2 in the Oceans estimated using transit-time distributions. Tellus, 58B, 376-89.