Natural variability and anthropogenic trends in the ocean carbon sink

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Abstract: The ocean removes from the atmosphere approximately 25% of annual anthropogenic CO_2 emissions, and thus substantially slows climate change. Distinguishing natural variability in the ocean carbon sink from climate-driven feedbacks is critical for diagnosing the state of the global carbon cycle and for understanding the ability of the ocean carbon sink to persist into the future. Based on globally observed surface ocean partial pressure of CO_2 ($pCO_2^{s.ocean}$), trends in the ocean carbon sink are evaluated over 16 gyre-scale biomes. Trends spanning decadal to multidecadal timescales between 1981 and 2010 are considered. On decadal timescales, $pCO_2^{s.ocean}$ trends are found to be of variable magnitude and quite sensitive the period of analysis. On longer time frames, most biomes display $pCO_2^{s.ocean}$ trends parallel to or shallower than trends in atmospheric pCO_2. In North Atlantic, long-term warming has become a significant and persistent contributor to the observed increase in $pCO_2^{s.ocean}$ throughout the 2000s. This warming is partially anthropogenic; thus, these results are first evidence of a negative feedback from climate change on the ocean carbon sink. This data analysis is complemented by a eddy-permitting North Atlantic model for 1948-2005 that allows us to parse impacts on $pCO_2^{s.ocean}$ from anthropogenic warming, the Atlantic Meridional Oscillation and the North Atlantic Oscillation..