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Intercomparison of the Southern Ocean sea water pCO2 in IPCC AR5 coupled carbon/climate models

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Southern Ocean uptake of anthropogenic CO2 from the atmosphere is currently estimated to be responsible for about 40% of the global oceanic CO2 uptake. Fluxes of CO2 into the ocean are determined by the differences in the partial pressure of CO2 (pCO2) between the surface ocean and the overlying atmosphere. Recent measurements of Southern Ocean pCO2 have found that pCO2 in the surface waters of the Southern Ocean has increased at a rate that is similar to or slightly faster than the mean atmospheric rate of increase. The increased pCO2 values in the surface waters will decrease the Southern Ocean uptake of anthropogenic CO2. Warming of the upper 1000 m of the Antarctic Circumpolar Current (ACC) system might play a role in the increased Southern Ocean pCO2 values. Increased upwelling south of the ACC fronts driven by the strong, poleward shift of the westerly winds further brings rich Dissolved Inorganic Carbon from the deep ocean to the surface, but this may be offset by the reduced area (poleward shift of ACC fronts) over which upwelling occurs. The cross-frontal pCO2 transport plays a key role in the redistribution of the pCO2 in the surface Southern Ocean. We will examine the interplay of these physical processes in the spatio-temporal variations in Southern Ocean pCO2 in IPCC AR5 coupled carbon/climate Earth System Models (ESMs) models, by comparing the time-trends of sea water pCO2 north and south of the fronts. The intercomparisons of the Southern Ocean pCO2 time-trends will provide a useful assessment of the skill of the IPCC AR5 ESMs in predicting future atmospheric CO2 concentrations. The underway decade-long (2002-2012) pCO2 measurements in the Drake Passage will serve as an important benchmark for evaluating sea water pCO2 in IPCC ESMs during the 2002-2012 time period.