Geophysical Research Abstracts
Vol. 13, EGU2011-5278, 2011
EGU General Assembly 2011

Sensitivity of atmospheric CO2 to changes in ocean circulation: role of the surface chemistry

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The University of Victoria earth system climate model is used to investigate the changes in the ocean carbon budget for different classical circulation changes (e.g. due to a shutdown of the North Atlantic Deep Water production or a change in the Southern Hemisphere Westerlies). Particular emphasis is given to evaluating the respective contribution of changes in the oceanic carbon pumps storage capacity and to changes in the surface chemistry (alkalinity, temperature, salinity).

A definition of the global Revelle factor is developed which is directly related to the spatially variable Revelle factors of the ocean. As other global Revelle factor used previously, this definition is suitable for cases of addition of carbon from an external source or for changes in the non-buffered ocean carbon inventory (i.e. the oceanic carbon pumps storage capacity). But most importantly, this definition highlights that changes of surface alkalinity, temperature and salinity can be considered as a forcing to the distribution of carbon between the atmosphere and the ocean buffered carbon inventory.

For all the circulation changes considered here, the sign of the atmospheric CO2 change is found to be driven by the variations in the efficiency of the oceanic carbon pumps. However the concomitant changes of the surface chemistry can either greatly enhance or inhibit the atmospheric response.