Geophysical Research Abstracts, Vol. 7, 09646, 2005
SRef-ID: 1607-7962/gra/EGU05-A-09646

Adiabatic reduction of circulation–related CO_2 air–sea flux biases in North Atlantic carbon–cycle models

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Physical transport processes of carbon, alkalinity, heat, and nutrients to a large extent control the partial pressure of CO_2 at the sea surface and hence the oceanic carbon uptake. Using a state-of-the-art model of the North Atlantic at eddy–permitting resolution we show that biases in the simulated circulation generate errors in air-sea fluxes of CO_2 which are still larger than those associated with the considerable uncertainties in parameterizations of the air-sea gas exchange.

A semi-prognostic correction method that adiabatically corrects the momentum equations while conserving water mass properties and tracers is shown to yield a more realistic description of the carbon fluxes into the North Atlantic at little additional computational cost. Due to upper ocean flow patterns in better agreement with observations, simulated CO_2 uptake in the corrected regional model is larger by 25% compared to the uncorrected model.