Geophysical Research Abstracts, Vol. 7, 05561, 2005
SRef-ID: 1607-7962/gra/EGU05-A-05561

Unpredictable fate of the thermohaline circulation under future CO_2 scenarios

T. Lenton (1), A. Price (2), D. Cameron (3), J. Hargreaves (4), J. Annan (4), and the GENIE team (5)

(1) School of Environmental Sciences, University of East Anglia, Norwich, UK, (2) School of Engineering Sciences, Southampton University, UK, (3) Centre for Ecology and Hydrology, Edinburgh, UK, (4) Frontier Research Centre for Global Change, Yokohama, Japan, (5) http://www.genie.ac.uk/people/ (t.lenton@uea.ac.uk)

We examine the bi-stability of the thermohaline circulation and its vulnerability to future CO_2 forcing scenarios using the C-GOLDSTEIN Earth system model of intermediate complexity (EMIC), which includes a 3D frictional geostrophic ocean model. An Ensemble Kalman Filter (EnKF) approach is used to tune the parameters of the model by assimilating ocean (temperature, salinity and circulation strength) and atmospheric (surface air temperature and humidity) data. The resulting ensemble of 54 versions of the model (each with different parameter settings) represents a sample of the posterior probability distribution defined by prior beliefs and climate observations. It encapsulates uncertainty in the initial conditions, including the strength of the thermohaline circulation.

Initial work has shown that the model thermohaline circulation is close to a non-linear threshold, which may be crossed if the sensitivity of the hydrological cycle to global warming is high. As CO_2 is increased, there is a robust decline in overturning strength across all ensemble members, consistent with the century timescale response of full complexity models. However, once CO_2 is stabilised, the ensemble diverges with the THC collapsing completely in some members and stabilising at various strengths in others. This uncertainty in outcome is related to the uncertainty in initial conditions, and suggests that the fate of the thermohaline circulation may be inherently unpredictable. We will present the results of forcing all members of an improved ensemble with 21 different CO_2 concentration scenarios requested for the IPCC Fourth Assessment Report.