Geophysical Research Abstracts
Vol. 12, EGU2010-6903, 2010
EGU General Assembly 2010

Predictability of the Thermohaline Circulation collapse in a chaotic idealized model

Florian Sévellec and Alexey V. Fedorov
Yale University, Department of Gelogy and Geophysics, New Haven, United States (florian.sevellec@yale.edu)

Howard-Malkus's loop model is modified to represent the switch between the thermal and the haline stable steady-states of the Stommel's box model of thermohaline circulation. This 3 degrees-of-freedom model reveals a bifurcation between a thermal stable steady-state and three steady-states (one unstable, and two stables), occurring through an imperfect pitchfork bifurcation when the freshwater flux is increased. The "imperfection" of this latter is controlled by the intensity of the North-South thermal gradient. For higher value of the freshwater flux an infinite-period bifurcation occurs when the three steady-states becomes unstable. Then, the time integrations of the model exhibits a chaotic behavior. Hence, a weak difference in the initial condition can lead to a strong discrepancy in the final state. The trajectories correspond to switches between a thermal-phase (close to the thermal steady-state) and a haline-phase (close to the haline steady-state). The spectral analysis reveals both several peaks in the centennial timescales and a strong signature in the millennial timescales.

To characterized the predictability of this chaotic idealized model, a Generalized Stability Analysis is made along the trajectories of the model. This analysis shows the regular structure of the error growth in the strange attractor: away from the unstable thermal steady-state the trajectories are particularly unstable and close from it they are stable. This shows that some regions of the phase space are more crucial, in term of predictability, than other. In our case, the study highlights the importance of the stratification as an accurate index to predict: (i) the time left in the thermal-phase and (ii) the time that we are going to spend in the in-coming haline-phase.