Geophysical Research Abstracts,
Vol. 11, EGU2009-2475-1, 2009
EGU General Assembly 2009

Robustness of multiple equilibria in the global ocean circulation

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In a three-dimensional primitive equation ocean model with an idealized Atlantic-Pacific geometry we study the steady state solutions of the meridional overturning circulation versus freshwater input in the northern North Atlantic. We find that four different states, the Conveyor (C), the Southern Sinking (SS), the Northern Sinking (NS) and the Inverse Conveyor (IC), appear as two disconnected branches of steady solutions, where the C-state is connected with the SS-state and the NS-state with the IC-state. We argue that the latter has the intriguing consequence that the parameter volume for which multiple steady states exist is greatly increased and that possibilities for rapid changes in the meridional overturning circulation are not limited to the well-known C-SS transition.