

Is there a useful indicator for thresholds in the AMOC?

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Paleodata has revealed many abrupt changes in climate and ocean circulation. Abrupt changes of the AMOC can be connected to the existence of multiple equilibria under similar boundary conditions. The textbook example for explaining multiple steady states of the AMOC has become the Stommel two-box model, although only afterwards its relevance to the global ocean circulation was recognized. In the nineties a series of extensions followed of the Stommel model. One of these was performed by Stefan Rahmstorf. He studied a simple box model in which stability of the AMOC turns out to be controlled by the atmospheric freshwater transport from the “Southern Ocean” into the “Atlantic”. Later on, this concept was extended to a realistic multi-basin configuration. It was recognized that it was not the atmospheric freshwater transport, but freshwater (or salt) transport by the overturning circulation, short named Mov (Fov), that was the crucial parameter in determining the amount of steady states for the AMOC. In the Rahmstorf box model these two were equivalent (each other opposite), but in a 3D ocean basin one has to make a distinction between overturning and gyre transport of freshwater. The net evaporation from the Atlantic to the Pacific has to be compensated by freshwater import by overturning and gyre circulation across the southern boundary of the Atlantic. Making the connecting of the Atlantic freshwater budget to Stommel’s advective salt feedback, implies that multiple equilibria of the overturning circulation can only exist when the overturning circulation exports freshwater from the Atlantic, that is, when the upper branch of the overturning is saltier than the North Atlantic Deep Water that leaves the Atlantic. It must be dominated by thermocline water from the Indian Ocean. Here, the role of Mov as an indicator for the multiple equilibria regime of the AMOC will be reviewed. Also, it will be discussed to what extent other (atmospheric) feedbacks might degrade the crucial role of Mov.