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Irreversible Transition to a State with Higher Entropy Production in Oceanic General Circulation

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The mechanism of transitions among multiple steady states of thermohaline circulation is investigated from a thermodynamic viewpoint. A new quantitative method is developed to express the rate of entropy production for a large-scale open system and its surroundings by the transports of heat and matter. An oceanic general circulation model is used to obtain multiple steady states under the same set of a wind forcing and mixed boundary conditions, and the rate of entropy production is calculated during the transition among the multiple steady states by this new method. The results always show a tendency to move to a state with higher entropy production, except when the perturbation destroyed the system's initial state altogether. It is suggested that the rate of entropy production represents relative stability of multiple steady states in nonlinear fluid systems in general, including our climate system.

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