Earth System Dynamics Discussions

Earth Syst. Dynam. Discuss., referee comment RC2
https://doi.org/10.5194/esd-2021-7-RC2, 2021
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Comment on esd-2021-7

Anonymous Referee #2

Referee comment on "Abrupt climate change as a rate-dependent cascading tipping point" by Johannes Lohmann et al., Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2021-7-RC2, 2021

This paper presents and analyzes a dynamical system where the Stommel model is coupled to a zero-dimensional sea-ice model. The sea-ice model exhibits a fold bifurcation. Since there is a separation of time scales between the ice dynamics and the ocean dynamics, as the ice model's tipping point is crossed, there is an almost instantaneous "parameter change" in the Stommel model. The change in ocean dynamics may hence be described as a rate-induced tipping point.

The paper is well written, but I still find it difficult to read. I encourage the authors to present a clearer "take-home-message."

I have a few suggestions and questions that the authors may use in their revision:

- Why not present and analyze the coupled model (Eq. 6) before discussing rate-induced tipping in the Stommel model? I feel that a "standard analysis" of the model in Eq. 6 is missing? You have a relatively simple dynamical system and one control parameter (R). Don't you have a simple saddle-node bifurcation in the three-dimensional system?
- As you go into more detail, is it possible to be more precise? I feel that it becomes very descriptive.
- How important is it that the Stommel model has a bistable regime? What would happen if you just coupled the sea-ice model to a simpler model with a smooth transition between "modes".
- I would like to see a discussion of how your proposed EW indicator would work in a "real-data setting".

There are a few typos in the manuscript. You'll find them when you read through it carefully. I am looking forward to reading a revised version.