

Interactive comment on “ESD Ideas: Why are glacial inceptions slower than terminations?” by Christine Ramadhin et al.

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Received and published: 19 March 2019

Ocean negative feedback may shorten glacial cycles instead of lengthening them

The authors suggest that ocean negative feedback may be responsible for a slow ice growth during typical ice-age cycle because “it seems intuitive that negative feedbacks would play critical roles in slowing the pace of a transition between equilibrium states”.

Unfortunately, this idea is questionable. In fact, an analysis of non-linear dynamical system model of ice ages can provide a quite nuanced picture, with episodes of stability alternating with episodes of acceleration. Hence, if the mechanism suggested by the authors is real (quantitative arguments have not been provided), one could counter-argue that the cause of the asymmetry is to be found in “positive feedbacks” acting

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during the deglaciation - this might actually be the most frequent explanation. The structure of ice ages cycle emerges from this interplay between negative and positive feedbacks all along the ice age cycle, so it is unclear why the asymmetry (well discussed) would necessarily point to a mechanism that has not been discussed in, to use the authors’ words, the “plethora” of other models.

Contrary to author’s assumption, the ice-age dynamics may be very counterintuitive. For example, it has been shown (Verbitsky et al., 2018), that regardless of the physical interpretation of the positive or negative ocean feedback, the period of glacial rhythmicity is defined by the ratio of intensities of ocean resultant (more positive or less positive) feedback to ice-sheet own negative feedback. When this ratio is high enough, the model exhibits late-Pleistocene type of rhythmicity with a period of about 100 ky. When the ratio is small (this is the case advocated by the authors, i.e., negative ocean feedback is strong enough to compensate for ocean positive feedback) the model exhibits early-Pleistocene type of fluctuations with a period of 40 ky.

Thus intensive ocean negative feedback may shorten glacial cycles instead of lengthening them.

References:

Verbitsky, M. Y., Crucifix, M., and Volobuev, D. M.: A theory of Pleistocene glacial rhythmicity, *Earth Syst. Dynam.*, 9, 1025-1043, <https://doi.org/10.5194/esd-9-1025-2018>, 2018

Interactive comment on *Earth Syst. Dynam. Discuss.*, <https://doi.org/10.5194/esd-2019-10>, 2019.

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