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Earth System Dynamics
Discussions

Interactive comment on "ESD Ideas: Propagation of high-frequency forcing to ice age dynamics" *by* Mikhail Y. Verbitsky et al.

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Summary: In a sense, this manuscript is an extension or sequel to an ESD paper by the same authors from 2018. The main conclusion, derived from additional simulations with the model introduced in that paper, is that millennial and / or centennial scale processes can have a strong effect on ice age dynamics. It is submitted as an ESD ideas paper, and is consequently quite brief on some aspects. At several points, I would actually say that more detailed explanations would be helpful, depending on the space requirements for ideas, maybe even turning this into a 'normal' submission? Please see the following

Questions and Comments:

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Discussion paper

p1 l43: mid-June insolation at which latitude?

p2 l5: I think it is not explained why, in your model, the strong millennial-scale forcing leads to this specific change in the fixed point (in particular, warmer and less ice). Could you elaborate on the underlying mechanism? l11ff: I'm not sure if I understand what you write under part D: First, do you mean that the original frequencies of low-amplitude sinosoids are preserved by the model? Second, I thought that this case would refer to only periodic (and no astronomical) forcing, how can precession and obliquity be overlapped? See also the corresponding figure panel D.

l18ff: Could you elaborate how you use the Buckingham theorem to obtain this specific scaling relation? In particular, why does the amplitude have units km/kyr? You say previously that the amplitude of the periodic forcing is of similar amplitude as the insolation. Also, it would be good to carry out at a level of detail that allows everyone to understand why the exponents are fixed to -2, because this is crucial later on. Ideally, there would be a plot showing (from simulation data) that \Delta S is a quadratic function of (epsilon T).

l29: I'm not sure the 'brown' (red?) amplitude spectrum really has slope -2. Have you tried to make a linear fit for comparison?

l30: I don't understand where the different exponents come from; in particular, how does the "-5 to -1" range exactly relate to to exponents given in the lines above?

l34: I would suggest to make the frequency dependency of epsilon explicit

l35: Can you explain your interpretation of Eq (2), please? In principle, high frequencies are damped by the f^-2 term. Your main conclusion, that ice age dynamics can be affected by centennial time scales (in your model), is evident from Fig.1A, but I find it hard to infer this from Eq. (2) alone. It clear that there is interaction between the slow and the fast scales, but it's not clear how strong, because here it really depends on epsilon.

Figure: - Would it be possible to provide them in higher resolution? - I would suggest to interchange panels B and C - remove the word "Section" from the caption - i think it would be better to use the same axes for panels A and C

Technical corrections:

p1 l33: ... state of rest of the climate,...? l37: ... of the positive climate feedback to the negative glaciation feedback l40: ... to an - even modest - increase ... l42: ..., following standard practise, ...? l44: ...with sinosoids of 5-ky periodicity and variable amplitude. -> Could you be more specific regarding the ' variable' amplitude? l45: ... 5yr-periodic sinosoids of amplitude about ... p2 l17: ... given a periodic forcing ... l21: according to the π-theorem l44 ... forcing is large enough ...

Very best,

Niklas

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