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Earth System Dynamics
Discussions

Interactive comment on "ESD Ideas: The Peclet number is a centerstone of the orbital and millennial Pleistocene variability" *by* Mikhail Y. Verbitsky and Michel Crucifix

Anonymous Referee #2

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This manuscript presents a further development of the Verbitsky et al. papers (2018 ; 2019) that try to capture Quaternary climate variability. Following many previous suggestions that the millenial scale climate variability and the Milankovitch one are strongly connected, the authors attempt to provide a common simple framework for these two different modes of climate changes using a conceptual model. This model is more complex than its predecessor, with 5 dynamical variables (instead of 3) and about 16 parameters (instead of about 11) if I am correct. The output of the model is not actually compared to observation, but only shows "more variability" in both the 100-kyr band and the millennial band. In other words, I find that the complexity of the model does not scale reasonably well with its results. But more importantly, I do

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Discussion paper

not agree with some basic assumptions made by the authors, as explained below: standard knowledge shows that the Peclet number should increase when the ice sheet size decrease, not the opposite. I therefore cannot recommend publication of this manuscript.

Main comments:

1 - The key element of this paper is the Peclet number defined as “a H/k”, with “a” the mass balance, “H” the ice thickness and “k” the temperature diffusivity. The authors assume that this number is an increasing function of ice-sheet size. But standard knowledge of ice-sheets suggests that this is very likely to be just the opposite. Indeed, today we have a rather good knowledge of two ice-sheets (Greenland and Antarctica). The size of Greenland is smaller than the size of Antarctica and its height H is roughly 70% or 80% of the one of Antarctica. But the advection parameter “a” (ice accumulation minus ablation) is certainly much higher in Greenland (about 5 to 10 times higher). This is partly due to atmospheric circulation and continental set-up, but mostly due to ice sheet height: the larger the ice sheet, the higher its surface, the drier the climate. I therefore do not think reasonable to assume that the Peclet number defined above would increase with ice sheet size. On the contrary, I expect it to decrease strongly. Overall, diffusion should dominate the dynamics of large ice sheets, since they have very little precipitations. This is likely the case for the Laurentide ice sheet in the past, as it is for Antarctica today. I therefore strongly disagree with the main message of this manuscript.

2 - I also find it difficult to appreciate the relevance of such a model without any result in the time domain. If I understand well the wavelet diagram, the model exhibits a very strong 400-ky oscillation that is certainly not observed (the famous 400-kyr problem. . .). I therefore doubt that this (rather complex) model can bring any insight in the problem of Quaternary climate variability.

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