Climate of the Past Discussions

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Comment on cp-2021-94

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Author comment on "A theory of glacial cycles: resolving Pleistocene puzzles" by Hsien-Wang Ou, Clim. Past Discuss., https://doi.org/10.5194/cp-2021-94-AC8, 2021

I want to applaud the editor for finding two highly qualitative reviewers, who have read the paper carefully and made constructive comments. They have raised a key issue about the role of the ocean, and I like to take this opportunity of my final response to further clarify my view.

- Both reviewers have invoked the well-established link of the glacial cycles to the summer insolation in questioning the ocean role. As stated in the first paragraph of my paper, I am fully subscribed to such link in late Pleistocene, which is simply an observational fact; my difference is that this link cannot be through the direct radiative forcing but through the ocean. That the ocean plays a central role in the glacial cycles is not "new", but has been strongly argued by Broecker and Denton more than thirty years ago, but unfortunately it remains overlooked.

- It is true that the direct forcing is implicated in Milankovitch theory and widely assumed to this date, but it runs into incontrovertible obstacle from observations. The direct forcing of the ablation is primarily through summer SAT, but the latter basically tracks the SST for the glacial cycles with similar amplitude (of order 10 C). Not only is it greater than that can be induced by direct forcing, but if it were, then SAT would be driving SST --- against the second law.

- Given the above observation, the question becomes why the direct forcing is still widely ascribed. One possible explanation is that an interactive MOC of a turbulent ocean, which regulates the SST, remains out of reach of numerical calculations since they need to resolve eddies while carrying out integration over orbital periods. This does not immunize them against replicating the observed SST and SAT --- even though the direct linkage can be boosted by tuning to produce realistic simulations.

- While it is beyond the reach of numerical calculations, a turbulent ocean can be incorporated in a theory via MEP. Despite its initial guesswork, MEP has entered the mainstream in recent years given the books, special volumes and symposia dedicated to the subject and it has been successfully applied in climate theories. Just because

the present paper may represent the first foray of MEP into paleoclimate arena does not make it "speculative", and it certainly is well justified as a working hypothesis. On the other hand, the demonstrated potency of MEP in resolving diverse glacial puzzles suggests its possible utility, which may lead to its further exploration by paleoclimate researchers. Indeed, in my current research on abrupt climate changes, I found that MEP may explain their salient features as well, further strengthening its relevance.

- Above arguments only crystallize while I was contemplating the reviewers' comments, for which I am thankful, and they point to the need for a thorough overhaul of the paper, which I will undertake regardless of your decision. Logistically, I do not know if the referees have the opportunity to provide additional input after digesting my original response, which would further aid my revision effort.