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Climate of the Past Discussions

Interactive comment on "The challenge of simulating warmth of the mid-Miocene Climate Optimum in CESM1" *by* A. Goldner et al.

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The objective of this paper is to use the Community Earth System Model (CESM1.0) to see if it can better reproduce the middle Miocene climate optimum (MMCO), the period between ∼17 and ∼14 Ma. There are three important problems associated with trying to reproduce the MMCO, and to a lesser extent, the entire Miocene. First, there is the warmth. Greenhouse gas levels in the middle Miocene do not seem to be particularly high, but average temperature seems to be significantly warmer than the Holocene (7.6° as estimated in this paper). The second problem is the precipitation pattern (Eronen et al, 2012, Geology) where the northern hemisphere desert belts were significantly wetter then, getting around 500 mm more precipitation annually at the MMCO and gradually drying out by the late Miocene. Finally, there is stability to the

warmth essentially for the entire Miocene, requiring some sort of important negative feedbacks perhaps from boundary conditions that we have yet to fully understand. Goldner et al focus on the temperature problem

The proxy temperature compilation done for the paper is important, and illustrates the lack of quantitative information about this important climate regime. Especially important is the lack of ocean temperature data. I like their emphasis on the pointwise comparisons as a way to compare models with proxy data, so that real mismatches are highlighted rather than obscured. From comparing the data in the figures, it is clear that the land records cause the most problems for the modelâĂŤthey should discuss this to some extent.

The CESM runs reported in this paper include a pre-industrial control, 400 ppm control, Miocene boundary conditions and CO2 at 400, 560 and 800 ppm (the MMCO range), changes in Antarctic Ice Sheet size, and by warming the eastern equatorial Pacific ("El Padre"). Adding El Padre did help significantly to warm the poles. By doing the different sensitivity tests they find that the continental configuration and vegetation makes about a 2.4° warming in the model vs a pre-industrial control with 400 ppm CO2 in the atmosphere. They could only match temperatures with 800 ppm CO2, probably too high when compared to proxy CO2 data.

I think the paper is basically ready, but could use some more background information about the problem of Miocene warmth and why it is important to study the Miocene in the introduction, as well as a more systematic description of what sensitivity tests were performed, e.g., a table listing the run names and what conditions were altered.

I also felt that the paper needed better description about what in CESM1.0 is new and improved over old models. As a non-modeler it is unclear why I should care about CESM vs CCSM. I do find it interesting later in the paper to find that the primary difference to CCSM3.0 is that it has a higher sensitivity. What causes that? They need to better explain how the slab ocean worksâĂŤdoes it have wind driven mixed layer? How does it parameterize interactions with a deep ocean? They also need to synopsize how the Miocene vegetation cover from Herold et al (2011) differs from modern, since vegetation has been argued to be a significant factor to maintain Miocene climates.

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