Clim. Past Discuss., 9, C2200–C2202, 2013
www.clim-past-discuss.net/9/C2200/2013/

Climate of the Past Discussions

Interactive comment on "The initiation of Neoproterozoic "snowball" climates in CCSM3: the influence of paleo-continental configuration" *by* Y. Liu et al.

Anonymous Referee #2

Received and published: 1 October 2013

The puzzle represented by the Neoproterozoic global glaciations continues to capture the interest of researchers a decade and a half after the term "snowball Earth" was popularized by Hoffman et al. (1998), and rightly so. The descent into extreme cold climate, followed by recovery to more clement conditions via unknown processes, stretches our understanding of how Earth's climate system ought to operate, at a time that is also tantalizingly close to the first appearance of advanced multicellular life, leading to speculation on the role of climate driving evolution. However, quite a few snowball modeling efforts over the years have focused more on trying to model the idea of what Hoffman et al. envisioned, i.e. the total glaciation of the "hard snowball" scenario, rather than trying to capture reality to the best of our ability to reproduce. The

result has been some provocative theoretical work which is interesting, but doesn't advance well the geology or paleobiology communities' understanding of what may have actually occurred.

This reviewer was therefore pleased to see Liu et al. explore the parameter space of continental configuration and associated 3D ocean circulation patterns from a more realistic perspective. The choices made regarding land surface characteristics, etc. are reasonable, the rationale is clearly laid out, and the consequences of those choices and the subsequent results are discussed in a thorough manner.

My main criticism of the paper centers on the glossing over of the choice of continental configurations, specifically the 570 Ma configuration for the Gaskiers glaciation, because in doing so I think the authors are missing an opportunity to highlight still more strangeness regarding Neoproterzoic climates. I understand that by going with the 720 Ma (Sturtian) and 570 Ma (Gaskiers) reconstructions, the authors gain some variety in land distribution that using a 635 Ma (Marinoan) reconstruction wouldn't provide. But the Gaskiers glaciation is emphatically not a Marinoan event, falling as it does in the Ediacaran period (635-542 Ma), and moreover, it was not a snowball glaciation. Thus the exercise of trying to identify a snowball bifurcation point for the 570 Ma time period doesn't really make sense in terms of the goal of increased modeling realism, even though the continental reconstruction might make for an easier comparison to earlier work by the authors.

That the CCSM3 as configured actually generates a colder world for the 570 Ma non-snowball glacial event vs. the 720 Ma snowball event is a really interesting outcome, however, and deserves a rather more extensive discussion as to why the model results don't appear to be lining up with the geologic record. It may be the result of the experiment configuration, or perhaps something in the way the model is parameterized; maybe the authors themselves are uncertain as to the source of the discrepancy. But in this reviewer's opinion, it would be more useful to the paleoclimate community at large to discuss the model/data split, and provide some informed speculation and spe-

cific suggestions for further exploration, than it would be to simply report another set of bifurcation points. In this way, the authors would be helping to foster more conversation between the data world and the modeling world.

A couple of minor points:

Fig. 4 is referenced re the continental configurations used once before Fig. 1, and twice before Figs. 2 and 3; perhaps these can be re-ordered, or a new Fig. 1 created indicating just the continental/bathymetric features used.

Run 11 as shown in Fig 2 does not appear to have achieved equilibrium at the end of 2000 years. – do the authors know how much more run time is required for that run to come into equilibrium?

Interactive comment on Clim. Past Discuss., 9, 3615, 2013.