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Climate of the Past Discussions

Interactive comment on "Using results from the PlioMIP ensemble to investigate the Greenland Ice Sheet during the warm Pliocene" *by* A. M. Dolan et al.

Anonymous Referee #2

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General comments

The manuscript of Dolan et al. investigates the sensitivity of the Greenland Ice Sheet (GrIS) to atmospheric forcing fields during the warm Pliocene. The document is nicely written and presents some really interesting analysis. This paper is a certainly a valuable contribution, and in particular it represents a needed step towards the next phase of PlioMIP. However, the manuscript could be improved in some places.

The ISM description is generally too weak. I can understand that the ISM physical description is not necessarily needed for this paper, but I would have appreciated more description of the SMB computation. In particular, the chosen SMB model is very

simple and a justification for this choice is needed. For example, some possible improvements of the original PDD scheme are not even considered nor listed, such as melt factors depending on temperature (Tarasov and Peltier, 2002) or water retention (Janssens and Huybrechts, 2000). Also, from the text, I assume you used mean annual and July temperature in order to evaluate the PDD, via a sinus function. This seems again a strong simplification and, therefore, a justification for not using directly the monthly fields from the climate models would be appreciated. Also, there is no information about an eventual partitioning between snow and rain from the total precipitation.

In addition, the authors discard the precipitation correction for elevation changes. I acknowledge the fact that a simple parametrisation is far from obvious, as precipitation is a complex process that cannot be represented by a function of altitude only. However, neglecting this effect strikes me as a strong assumption. This could be justify for small changes in the ice sheet topography (such as for the initial downscaling for example). However, for large changes happening during the Pliocene (from present day ice sheet to almost ice free), this assumption may be inappropriate. Considering their initial SMB (Fig. 8), I believe that COSMOS, MIROC or MRI (AGCM) would have presented much reduced GrIS with a precipitation correction factor, as we cannot really expect that with a 3km gain on the west flank on the ice sheet (and thus a cooling of $\sim$18°C) the precipitation would stay the same. Neglecting the precipitation correction would probably tend to exacerbate model differences and it does not seem justified. At least a discussion would be greatly appreciated.

Specific comments

3483 Title Maybe switch from Pliocene to mid-Pliocene warm period?

3485-3488 Introduction It would be great to have a little bit more of a discussion about the data here. Some references you cited later (e.g. Bierman et al. (2014) about summit being ice free or de Vernal suggesting a forested South Greenland) do not appear

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in this section. Also, how well the models capture the Arctic warming as reconstructed from proxy?

3488 It would have made more sense to me to see the inter-model differences (currently in 3.1.) in here, instead of in the results section.

3490 l. 18-19 Again, it seems that you don't use the monthly fields from the climate models. What about the seasonality of climate fields in the PlioMIP ensemble? Could this seasonality have an impact on the computed PDD?

3490 l. 18-19 Is July temperature meant to represent mean summer temperature?

3490 l.26 is this lapse rate used to correct the temperature as the elevation change during the simulation?

3491 l.26-3492 l.10 Following my main comment, Charbit et al. (2013) suggest that PDD scheme flavours strongly impact the model results for glacial inception, not only the ablation parameter values. Also, you may want to add a bit of discussion regarding the results of Rogozhina and Rau (2014) on the importance of the temperature standard deviation?

3492 l.4 I think you meant "2008a".

3492 l.21-22 And for the Pliocene run?

3494 l.3-14 I might be wrong but I think the low sensitivity of the pre-industrial ice sheet to ablation rates comes from the fact that you have very little ablation over the GrIS under pre-industrial climate. Especially if as you have a bias towards a higher ice sheet, the lapse rate would tend to limit further the melt. A time series of melt for the pre-industrial simulation might help you to diagnose this? Again, maybe part of this low sensitivity is related to the fact that you discard the precipitation correction?

3494 l.25-28 True, and the horizontal model resolution is also crucial.

3495 l.3-6 If you start your simulation with a present-day geometry, you will eventually

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end up with an inner sea. You need to describe your initial ice configuration (bedrock, ice thickness, ice temperature) for the Pliocene experiments.

3498 l.9 Annual / summer mean?

3498 l.10 “A strong warming” compared to what? When?

3498 l.24-25 I suggest you get rid of “amin” notation.

3500 I think it could be useful to have a summarizing table with some averaged numbers for each ensemble member (GrIS volume difference during the mPWP, temperature, precipitation, SST, ice fraction).

3504 l.13-18 The findings of Bierman et al. (2014) are that soils have been subaerially exposed for more than 1 million years. Is it not jumping onto conclusion to claim that it was ice free during the warm Pliocene?

3518 Table 1 What is preferred or alternate LSM?

3519 Table 2 I suggest you add in a separate table, the values corresponding to the red-blue-yellow filled dot?

3520 Table 3 What is the “Greenland region”? Formatting: COSMOS-AOGCM row.

3523 Figure 1 Is there any isostatic model embedded in BASISM? Also, where the bedrock data comes from, surely there is some kind of isostatic adjustment in Figure 1. Stone et al. (2010) suggested that the bedrock was a major source of model sensitivity and you may want to comment a little bit about that? Again, you should specify somewhere the initial ice configuration for the Pliocene simulations.

3524 Figure 2 The differences are on the same heigh level? If this is surface level, I don’t understand why we cannot see the impact of the topography difference on some of the models.

3526 Figure 4 Same as before.

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3532-3 Figure 10-11 Annual mean?

References

Bierman, P.R., Corbett, L.B., Graly, J.A., Neumann, T.A., Lini, A., Crosby, B.T., Rood, D.H., 2014. Preservation of a Preglacial Landscape Under the Center of the Greenland Ice Sheet. Science 344, 402–405. doi:10.1126/science.1249047 Charbit, S., Dumas, C., Kageyama, M., Roche, D.M., Ritz, C., 2013. Influence of ablation-related processes in the build-up of simulated Northern Hemisphere ice sheets during the last glacial cycle. The Cryosphere 7, 681–698. doi:10.5194/tc-7-681-2013 Janssens, I., Huybrechts, P., 2000. The treatment of meltwater retardation in mass-balance parameterizations of the Greenland ice sheet. Ann. Glaciol. 31, 133–140. Rogozhina, I., Rau, D., 2014. Vital role of daily temperature variability in surface mass balance parameterizations of the Greenland Ice Sheet. The Cryosphere 8, 575–585. doi:10.5194/tc-8-575-2014 Stone, E.J., Lunt, D.J., Rutt, I.C., Hanna, E., 2010. Investigating the sensitivity of numerical model simulations of the modern state of the Greenland ice-sheet and its future response to climate change. The Cryosphere 4, 397–417. doi:10.5194/tc-4-397-2010 Tarasov, L., Richard Peltier, W., 2002. Greenland glacial history and local geodynamic consequences. Geophys. J. Int. 150, 198–229. doi:10.1046/j.1365-246X.2002.01702.x

Interactive comment on Clim. Past Discuss., 10, 3483, 2014.