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Climate of the Past Discussions

Interactive comment on "Pliocene Model Intercomparison (PlioMIP) Phase 2: scientific objectives and experimental design" *by* A. M. Haywood et al.

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I feel this manuscript provides strong rationale and very helpful description of the PlioMIP2 experiment. I recommend that it is published subject to some revisions. I look forward to the actual experiment and hope that some interesting science will emerge from it. Below I'm suggesting some big revisions to the ensemble of simulations requested. I'm happy with the authors directly about whether these revisions truly represent better value for resources.

The vast majority of the simulations are required solely for the forcing factorisation. You might want to consider just important you feel this component of the research is. I

worry that the amount of simulations required really justify the extra effort. They need 6x as much computation as just doing the PlioMIP2 entry card, but surely gain nothing like as much as six times the information (considering the fact all CMIP6 models must do the DECK, I'm not counting the preindustrial run). You may want to think of the factorisation as a sub-experiment, otherwise PlioMIP2 appears really daunting.

1 Topography

I did have one question about the scope of the manuscript. It wasn't clear to whether it aims to serve to just as an experimental description, or will also act as the full description of the boundary condition datasets. I know that the previous experimental design (Haywood et al., 2011 was complemented by a data description paper (Dowsett et al., 2010). Whilst I think that most of datasets are adequately discussed in this manuscript (or prior publications), the topography feels under described. I hope that a separate manuscript is planned to describe all the underlying assumptions for this dataset and highlight the important changes. I would certainly like to see more discussion of the uncertainty inherent in the topography reconstruction. For example, a major change from PRISM3 is the closing of the Bering Strait. I remember seeing a poster at AGU 2014 by Dick Peltier presenting an alternate topography with it closed - this also included the novel scientific components described here. Whilst I'm happy with the reconstruction you present here, I don't feel there is any acknowledgment that it may have uncertainties.

It isn't clear to me how the ice sheets and topography are actually separated in the factorisation approach. I think you need to provide guidance in the manuscript. Does imposing ice-sheets also contain the topographic element associated with the ice-sheet or does that count in the topography? At its simplistic this could be ice-sheets could be thought of as white mountains, so the 'i' component only relates to the land surface

specification. That doesn't make much sense intuitively. The problem is however much more complicated than that, as you've taken account of the glacial isostatic adjustment in the your topographic reconstruction. At this point, I'm not sure it's that important (it would need to be discussed seriously in the factorisation results). Here you do need to provide instructions to allow the runs to be performed.

I was also confused by the discussion of the standard experiment. Surely altering the Bering Strait is a change in the Land-Sea mask. If modelling groups have the ability to do this change (and in my experience making new land is more awkward than new ocean), then shouldn't they be doing the other experiment. Incidentally, I would anticipate that this change is important for the AMOC, so well worth including if possible.

2 Simulations

My other major worry relates to the quantity of simulations requested by the full experimental design. Whilst, I understand the justification of most of them from a rigorous scientific standpoint, I wonder if they will be tackled by sufficient groups to allow a model intercomparison. I also feel that most of the justification is for the Pliocene factoralisation experiments, and insufficient discussion is made of the CMIP DECK.

It is never mentioned that E^{280} (the preindustrial control run) must be performed as part of the DECK for CMIP6. As an outsider, I may read this paper and be really afraid of joining PlioMIP2 because of the quantity of simulations required. I suggest it is worth emphasizing that you can join (and be an important member of PlioMIP2) just be performing a single run (Eoi^{400}). I don't know how many groups have signed up, but I'd expect most of them to only tackle that core simulation.

I was rather confused by the quantity of simulations requested for the Pliocene for Future side of Figure 2. There doesn't seem to be much joined up thinking between

this element and the wider picture of CMIP6. The purpose of the Tier 2 experiments E^{560} and Eoi^{560} appears to be to allow the Charney climate sensitivity to be calculated (Section 3.1.1). The DECK already involves a simulation specifically to calculate this metric - an abrupt quadrupling of CO_2 - using a technique devised by Gregory et al. (2004). This approach only needs 150 years of computation rather than the minimum of 500 years proposed here. The DECK also involves standard transient forcing simulation where CO_2 concentrations increase by 1% per year. Current approaches infer knowledge from past climates to constrain future projections involve either subsetting (i.e. discounting bad models) or using emergent constraints. Both of these approaches work based on just the CORE simulation and the simulations performed in the DECK. I therefore question whether any of the Pliocene for Future runs can be justified from that perspective.

The question of state dependence of climate sensitivity is an rather interesting one. The most efficient way to tackle it would be perform the Abrupt 4xCO2 experiment feature in the DECK, but using a Pliocene base state (perhaps denoted as $Eio^{400}_{4xCO_2}$). This would effectively replace Eio^{560}, whilst E^{560} gains little over and above the $E^{280}_{4xCO_2}$ simulation already in the DECK.

I don't know whether there is any benefit to replicating the 1% simulation from a Pliocene base state, as I'm not sure people have previously investigated whether the ocean heat uptake efficiency is state dependent. It's an interesting experiment to consider for some explorative science, but you'd probably need to do it in one model first to justify its inclusion.

There is an alternative potential justification for both E^{400} and E^{560}, which is that they version of a stabilisation scenario. I didn't immediately spot any runs in ScenarioMIP looking at determining what our target CO_2 should be on the longer term. Nonetheless, I'd hestitate to include them in PlioMIP2 with that solely justification and feel they would sit better elsewhere. It would appear that you need E^{400} for the factorisation however. If you include that run, please talk to some folks involved in ScenarioMIP and try to get

Expt Name	Status
E^{280}	*CMIP6 DECK*
$E^{280}_{4xCO_2}$	*CMIP6 DECK*
Eoi^{400}	CORE
Eoi^{350}	Tier 1
Eoi^{450}	Tier 1
$\mathrm{Eoi}^{400}_{4xCO_2}$	Future
E^{400}	Linear Fact.
Eo^{400}	Linear Fact.
Eo^{280}	Non-linear Fact.
Eoi^{280}	Non-linear Fact.
Ei^{400}	Non-linear Fact.
Ei^{280}	Non-linear Fact.
Eio^{280}	Non-linear Fact.

Table 1. An alternate set of experiments that I feel would get the same amount of information, but for fewer resources.

it used from both perspectives.

Despite all these negative comments about the scenario choices, you're surely along the correct lines. You may want to instead have Eoi^{350} and Eoi^{450} as a Tier 1, that spans both the past and future elements, as I feel the CO_2 uncertainty is pretty important to examine for both. This would mean that the Pliocene for Future section consists solely of $\mathrm{Eio}^{400}_{4xCO_2}$. My recommended groupings would look like those in the table.

3 Line-by-Line comments

P4005, L5-8 This paragraph-long sentence could be split into more-easily digestible chunks.

P4005, L19 At some point mPWP stood for mid-Piacenzian (Dowsett et al., 2011). I'm happy with you adopting the language of the IPCC here, but did you want to mention this alternative at some point?

P4006, L4 I wonder if there should be a citation here for the scientific objectives - e.g. Haywood et al (2011). Incidentally, I wonder if the scientific objectives here are really listed in the correct order. Instead they read a little like the order of the first few publications, which may lead people to think that the objectives were determined retrospectively.

P4006, L5 I think you need to differentiate between the actaul and simulated mPWP climate.

P4006, L10 Monsoons doesn't deserve a capital.

P4006, L11 Should this objective not be higher up the list?

P4006, L18 Is 'require' the correct word. Perhaps 'enforce' would be more appropriate? The PMIP2 LGM subset of simulations with interactive vegetation surely required vegetation to change.

P4006, L22 Is is possible for GMD to link to the whole special issue at this point?

P4006, L25 I don't know if this potential to identify arteacts was ever actually used. If there is an example in one of the papers, it might be nice to give it here.

P4007, L1-8 Would this paragraph about PLISMIP sit better underneath the list of results?

P4007, L9 Word choice of 'outputs'. This makes it sounds a bit too REF orientated.

P4007, L10-36 This lits of output reads a little strangely. I suggest either properly aligning them to the objectives above, or making them more directly linked to the papers.

P4007, L14 Is 1.84 presented at an excessive level of accuracy?

P4007, L19 Should this be Zhang et al., 2013b? There are two papers but different lead authors called Zhang in 2013 mentioned. I'm not what the best practice is for differentiating them, but at present they are ambiguous citations.

P4008, L16 I've just realised that this diagram implies that compensating errors do not exist. There's no need to alter the diagram, but perhaps you need to acknowledge that you may get the right answer for the wrong reasons.

P4009, L3 tense of 'will be'

P4009, L12 I know all citations definitely state that temporal uncertainty as important, but do they actually address the issue fully. I remember seeing simulations for different orbital conditions at meetings to elaborate this issue, but are they in the cited references?

P4009, L17 This statement seems rather strongly worded as written, especially as it comes without references or examples. You may be able to find some corroboration for it from the PIGS/QUIGS work.

P4009, L29 You may want to rephrase this sentence. I understand that you've saying the date of 3.205Ma may be revised. But would the orbital configuration associated with KM5c alter. If so, then is the justification for the time-slice invalid? Was this not addressed elsewhere (Haywood et al., 2013)?

P4010, L12 I think this needs either further explanation or a reference.

P4010, L15 Capitalisation of Future

P4010, L16 I agree with you about the importance of understanding future, but this wasn't mentioned as an objective for PlioMIP1 in the list earlier.

P4010, L16 The "Pliocene for Future" and "Pliocene for Pliocene" terms are dropped in here without much explanation.

P4010, L24 I think should have a reference for this example. Perhaps **?**?

P4011, Sect 2. Don't feel afraid to refer to later sections of the manuscript where relevant.

P4011, L8 half's -> halves

P4011, L9 should -> would (?)

P4011, L13 I think it would help if you explicitly described the Eoi^{400} simulation as the core experiment before descending into the Tier 1 and Tier 2 ones.

P4012, L4 You may want to state that the Eoi^{450} runs fits in the P4P section too.

P4012, L4 Perhaps you could explicitly state the concept of CO_2 equivalency here.

P4013 Is there a reason to shift from 'preferred' and 'alternate' names used in PlioMIP1?

P4013, L4 The discussion of the standard LSM seems contrary to the discussion in sect 2.3.2

P4013, L20 Add 'equilibrated' or some such word before 'coupled'. Clearly the RCP and Historical runs are not 500 years long in CMIP. Also drop 'see' before Taylor reference.

P4014, L9 I find it surprising that there isn't any mention of the fact that PlioMIP1 used 405 ppm. Is there a particular reason for the change?

P4014, L20 Note that Fran Bragg's PhD thesis suggested that the 405 ppm was too much Methane/NO_2 equivalency for the 380$\pm$25 ppm.

P4014, L29 I suggest putting the KM5c subclause in brackets with a reference to maintain the flow of the sentence. item[P4015, L9] Please refer to figure 3 somewhere. This seems the most appropriate place.

P4015, L15 Please my comment on the topography above. This sentence is insufficient to justify the new boundary conditions by itself.

P4015, L17 Clarify whether Bering Strait needs to be changed or not here.

P4017, L23 Explain how the ice-sheet and topography are to be decomposed for the factorisation simulations.

P4018, L3 Is 'predict' the best choice of word here?

P4019, L18 I was unsure why you have selected this river routing approach? In CESM this specification may require much more effort than formally deriving the new river routes from the Pliocene topography. Perhaps you could provide some justification for this choice.

P4020-1 See comment on simulations above

P4021, L20 the brackets around LR04 should be combined with the reference, which confusingly is actually 2005.

P4022, L3 The 'et al' is missing after Fedorov.

P4022, L8 You may want to mention that several of the regions of discord already have existing high resolution datasets appropriate for this work.

P4022, L10 Is it necessary to state that this community effort will run alongside the modelling effort. This would make it clear that there aren't any citations ready yet, but this manuscript won't the main paper describing them.

P4022, L16 tense of 'require'

P4022, L20 perhaps you could add 'although CMOR compliant data is preferred' at the end of the sentence: at least from a user's perspective.

P4022, L25 Is it wise to give some contact details for access to the data repository explicitly.

Table 3 Can you make the CORE experiments stand out a bit better. Either with textbf or by putting them to the top. The captions states this has already happened, but I can't see it.

Figure 2 I found it hard to read the text on this image. Please increase the resolution. You may also want to get it to conform with the experiment terminology used in the paper.

Figure 3 It is hard to see the regions highlighted. Perhaps lay out as top/bottom instead of left/right to increase the image size.

Figure 5 Perhaps increase the caption of this figure. It's hard to compare to modern at the moment. You could be more explicit about seeing the modern distribution and anomalies in Pound et al. (2014).

Figure 7 This images feels like it is missing a lot of context. Perhaps expand the caption and include some citations to papers with more information.

Interactive comment on Clim. Past Discuss., 11, 4003, 2015.