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Climate of the Past Discussions



# *Interactive comment on* "Interhemispheric coupling and warm Antarctic interglacials" *by* P. B. Holden et al.

**Anonymous Referee #2**

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In this paper, the authors explore periods of warmer-than-present east Antarctic temperatures at the beginning of the previous three interglacials. They propose a mechanism tied to the bipolar seesaw and meltwater-forced slowdown of the AMOC and the possible retreat of the WAIS. This mechanism is tested with a series of simulations: transient simulations with the GENIE-1 EMIC and snapshots with the HadCM3 AOGCM. The results are interesting and add to our understanding of the temperatures recorded in the Antarctic ice cores during previous interglacials. I would recommend publication in Climate of the Past after the authors address the concerns below.

Revisions needed:

Fig. 1a: Shaded bars, similar to what Cheng et al, 2009 did in their Science paper, would help the reader more clearly identify the relationship proposed in the text. Are



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there any IRD records that could also be added to this figure that supports the meltwater forcing (possibly, McManus et al., Science, 1999)?

Page 2558, line 12: Paleoclimatologists use “modern” in an ambiguous way which is confusing to those modeling and analyzing present-day and future climate change. “Modern” should be replaced here (and throughout paper) with more exactly what is meant: “Preindustrial”?

Section 2.1.1.: This section needs to be expanded by a paragraph or two and a few additional figures included to indicate the strengths, weaknesses, and caveats of GENIE-1 for this study. The reader should not have to search out the referenced papers (“elsewhere”) to determine the capability of this model for these transient simulations. Show the Atlantic MOC in the “traceable” preindustrial configuration and assess it for these applications. Is the Fa adjustment applied in this study’s GENIE simulations and , if so, how does it affect the model’s response to the meltwater forcing? Also show the annual mean air temperature anomalies in the model as compared to observed. Lenton et al indicate large errors in the simulation over eastern Antarctica. Expand on why the reader can still trust the sensitivity of the model here.

Page 2561, lines 24-26: Define the region where the meltwater pulse is added in the EFW simulations.

Page 2561, line 28: Replacing the WAIS with land at sea level (GENIE run) and 200m (HadCM3) could lead to much different responses than replacing with ocean. Please give the rationale for this and a reference. Also please indicate whether the WAIS as land includes any glacial ice covering it or is now specified as bare soil.

Page 2562, line 5: Overpeck et al., Science, 2006, also suggest a WAIS contribution to sea-level rise at MIS 5e.

Page 2563, last paragraph, Figure 1c: The authors need to address the spikiness of the GENIE responses of Antarctic SAT and SST anomalies, and, in particular, almost



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equal warmings occurring several times in short succession in Terminations II and IV, and then ending with a short, sharp cooling.

Page 2565, lines 17-18: Why would one expect cooling in the Southern Hemisphere (Fig 2b) with somewhat higher CO2? Can one really invoke the presence of the inferred remnant of the Laurentide ice sheet to explain the cooling in the Southern Hemisphere?

Page 2566, line 4: typo, “McManus”

Figures 2e and 2f, and associated text: It is not appropriate to show an average Antarctic SAT for the WAIS case in comparison to the Dome C record in Figure 2e, and in comparison to the NFW and FW cases in Figure 2f. The average warming in the WAIS case is significantly biased by the removal of the WAIS and replacement by land. Simulated warming for the WAIS experiment is much less in East Antarctica (Figure 2d). The brown curves in Figures 2e and 2f need to be replaced with the SAT anomalies calculated for only East Antarctic.

Page 2567, HadCM3 simulations: Please clarify the length of the hosing here. If the hosing is only for 200 years, then the full Southern Hemisphere warming may not be realized as compared to the much longer meltwater forcing as deduced from proxy record and used in GENIE simulations. This has been suggested in “thermal bipolar seesaw” conceptual model of Stocker and Johnsen (2003) which shows that although signals in the South Atlantic should be in antiphase with the North Atlantic, the heat reservoir of the Southern ocean should lengthen its response, as well as AOGCM simulations which indicate that the warming in the Southern Ocean and Antarctica shows the strongest relationship with the duration of the forcing rather than either the rate or total volume of water added to the North Atlantic (Otto-Bliesner and Brady, QSR, 2010).

Page 2567, lines 12-16, Figure 3d: Replacing the WAIS with glacial-free land at 200m (HadCM3) could lead to much different responses than replacing with ocean. Some sea ice might still remain over the summer months in the WAIS region, muting the



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warming found in Figure 3d. Unless there is a rationale for replacing the WAIS with land, this caveat needs to be acknowledged.

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