Geosci. Model Dev. Discuss., 3, C731–C734, 2011
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Geoscientific
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Interactive comment on "

A new coupled ice sheet-climate model: description and sensitivity to model physics under Eemian, Last Glacial Maximum, late Holocene and modern climate conditions" *by* J. G. Fyke et al.

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Received and published: 25 January 2011

[12pt]article geometry a4paper

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3, C731–C734, 2011

Interactive Comment

Response to Anonymous Referee 1 regarding: A new coupled ice sheet-climate model: description and sensitivity to model physics under Eemian, Last Glacial Maximum, late Holocene and modern climate conditions

Jeremy Fyke, on behalf of the authors

I thank Referee 1 for his/her valuable comments to the manuscript. Replies to these comments are below.

1. We appreciate the reviewer's notice that description of precipitation is not complete. This has been improved in the text by specifically noting the following points. In the simulations described here we compute relative humidity (RH) at each sub-gridded elevation level as a function of temperature (itself a function of elevation within a single climate model cell) and the specific humidity of the overlying climate model atmosphere grid. Sub-grid precipitation is then calculated based on the 'sub-gridded' RH values (with the snow-rain decision taken into account at each sub-gridded elevation bin).

2. We have now included a better description of the ocean circulation under the ice shelf. Briefly here: the default UVic ESCM global model ocean bathymetry was

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first improved by integrating bathymetry from the BEDMAP dataset to better represent under-shelf bathymetry, particularly around the interior of the Ross and Weddell Seas. The ocean therefore is free to circulate to the equivalent of the modern-day grounding line and underneath the dynamic ice shelf (derived by the ice sheet model). Where ice shelf coverage exists, the underlying ocean is partially/fully insulated from atmospheric heat and moisture fluxes, depending on the fractional ice shelf coverage of ocean in the ocean cell. Sea ice is not allowed to grow in grid cells that are fully ice covered, and in partially-covered grid cells, the energy fluxes into and out of the sea ice is scaled to reflect the ice shelf fractional coverage. Wind stress is not scaled, as unrealistic sea ice convergence occurred in these partially-covered grid cells when wind stress was reduced. Heat and moisture fluxes associated with the sub-ice-shelf/ocean interface are taken into account, and are applied at the ice shelf edge in the current model.

The ocean boundary does not yet migrate with a migrating grounding line, nor does it 'feel' ice shelf draft (we are very interested in overcoming this handicap in future iterations of the model, as this seems to be one requirement of a full prognostic coupling between marine ice sheets and ocean models).

3. The Pollard-DeConto (2009) melt scheme is fully described in the 'Methods' section of that paper. However, we have now included a fuller reference to the procedure in this manuscript, as well as a brief description in the text itself, to clarify use in the present model.

4. Ice sheet volumes and areas are simply calculated from all available ice-covered areas in the model; the model does not generate significant isolated ice caps in either the AIS or GIS for the simulations carried out for this manuscript. Thus, no mask was used to hide isolated glaciers, and the over-estimate of late Holocene ice volume can unfortunately not be attributed to isolated ice.

5. We agree. These plots have been regenerated as difference plots.

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6. Technical corrections: each of these helpful corrections has been integrated into the manuscript text.

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