

Review of “Uncertainties in the modelled CO<sub>2</sub> threshold for Antarctic glaciation” by Gasson et al.

The authors presented the synthesis of offline simulations of Antarctic glaciation using Glimmer Ice Sheet Model forced by the climate conditions from global climate models. This synthesis is important for the development and understanding of the coupled ice-sheet/climate model. The authors did a great job in graphic presentation of their results. I recommend the paper be published after the following comments are addressed.

General comments:

The authors have shown clearly the CO<sub>2</sub> threshold for Antarctic glaciation depends on 1) lapse rate, 2) Antarctic bedrock topographies, 3) climate model.

But the authors concluded in the last sentence of the abstract that 560-920 ppmv is the threshold for Antarctic glaciation. I assume this threshold is derived from the summary figure, Fig. 4, which is only based on single lapse rate of 7 K/km (Fig. 5) and single topography (TOPO1, Fig. 7).

I suggest the authors recalculate the CO<sub>2</sub> threshold for Antarctic glaciation with all three uncertainties (lapse rate, Antarctic bedrock topographies, climate model).

Minor comments:

5702. 19-20: growth of an intermediate sized ice sheet (> 25 m sea level equivalent) ~~occurs with for~~ atmospheric CO<sub>2</sub> concentrations in the range of 560–920 ppmv, which is consistent with previous studies.

5703. 13. earlier than ~~the~~ this event, during the Eocene (Miller et al., 2008).

5703. 19. to investigate the model dependence of the ~~Antarctic~~ atmospheric CO<sub>2</sub> threshold for Antarctic glaciation.

5704. 10. We use the Glimmer ISM in this paper, and the mechanics of this model are documented in Rutt et al. (2009).

5705. 1. The ISM has a spatial resolution of 20 km x 20 km, and all simulations are initiated from ice-free conditions.

5705. 10-13. Previous modelling studies suggest that Antarctic glaciation generates a number of feedbacks on the climate system, such as changes in surface albedo, sea- ice and cloud cover (e.g. DeConto et al., 2007; Goldner et al., 2013). Wwe

acknowledge the limitations of our methodology in representing these feedbacks.

5705. 18-19. The mass balance scheme adopted is the widely used positive-degree day (PDD) method (Reeh, 1991). Is the PDD method the state-of-art mass balance scheme, or there is more advanced mass balance schemes? Please discuss the potential uncertainty associated with different mass balance schemes.

| 5710. 21-22. ~~to~~The model checks for potential negative values for precipitation resulting from this scaling and resets these to zero.

5720. 12-18. ... This suggests that the strong HadCM3L seasonality is caused by the change to early Eocene boundary conditions, although it is interesting that a similar change does not affect the other GCMs.

I don't agree. Clearly HadCM3L has the strongest seasonality in modern control simulations among all GCMs in Fig. 10.

5721. 14-15. The offline simulations undertaken in this paper suggest that the modelled ~~glacial~~CO<sub>2</sub> threshold for Antarctic glaciation is highly climate--model dependent.

| 5726. 1. ~~than that~~ some other mechanism prevented glaciation.