Climate of the Past Discussions

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Comment on cp-2021-73

Anonymous Referee #2

Referee comment on "Simulating glacial dust changes in the Southern Hemisphere using ECHAM6.3-HAM2.3" by Stephan Krätschmer et al., Clim. Past Discuss., https://doi.org/10.5194/cp-2021-73-RC2, 2021

Review of Simulating glacial dust changes in the Southern Hemisphere using ECHAM6.3-HAM2.3 by Krätschmer, et al. for Climate of the Past.

The authors of this study use the ECHAM climate model to investigate the global variability of mineral dust emission, transport, and deposition across three different mean climates. (modern, pre-industrial, and LGM), with a particular focus on the Southern Hemisphere. The land model component includes dynamic vegetation that determines dust source locations, thereby permitting prognostic determination of changing dust source strength and location through time, and their LGM simulation includes enlarged coastlines to include exposed continental shelf among the potential dust sources. For each of their simulations the authors compare their results to observations and other model results, sometimes finding agreement and sometimes not. Their simulation of the LGM, and investigation of how it differs from the PI, is noteworthy as there are limited model studies of this time period that include dynamic dust sources. Of particular note are a series of results regarding the spatial variability of the provenance of dust deposited on Antarctica and the Southern Ocean. These results are a valuable contribution to the ongoing discussion regarding the relative contributions of South American and Australian sources through time, and thus the appropriate interpretation of archives of paleodust from the region. As this is a topic with some disagreement, the addition of results from a new model is welcome.

Overall I found the paper very well written and organized, and enjoyable to read. I do have some unanswered questions as well as some minor suggestions for the authors, so my recommendation is acceptance upon minor revisions.

Primary comments

- The paper would benefit from more time in the introduction and conclusion spent reviewing what is known and the disagreements regarding dust provenance to Antarctic and the Southern Ocean. I was pleased when the authors brought up many of the studies when discussing their results, but I felt the bigger picture was somewhat overlooked. Specifically, there are conflicting studies regarding whether South America or Australia is the primary source of dust (and for that matter how much is contributed by Antarctic sources), and the relative role of dust source strength and transport efficiency. I think the authors have room here to set up and then answer some questions about how these discrepancies can be resolved by considering the time-varying relative strength of sources, the transport efficiency, and the spatial distribution of their influence. I think much of this information is already contained in the paper, but an explicit consideration of the debate would be valuable. One additional source to consider is Markle, et al. (2018).
- What about New Zealand? I was surprised that the LGM simulations don't seem to include an expanded dust source from the exposed continental shelf around New Zealand, nor any discussion of it as a dust source during that period. Neff, et al. (2015) and Koffman, et al. (2021) would be relevant to this discussion.
- The authors cover many of the modeling studies of dust transport to the Antarctic in their discussion of provenance, but there are also studies that take an isotopic approach that should be discussed as well. Wengler et al. (2019), McGee et al. (2016).

Minor comments

- How is land tiling / vegetation coverage determined for the newly exposed continental shelf? Essentially, is the newly exposed land always a dust source, or can it become vegetated?
- Since additional land area during the LGM is credited as one of the causes of increased dust emission, I would like some information, similar to the reported wind and precip changes, that tells me how much additional land there is in each region (and possibly some discussion of how much of the dust is being created from this new land).
- In Figure 3, why are the simulated dust deposition values so stratified? The observations appear continuous across a couple orders of magnitude, while the simulated deposition values appear to form horizontal lines.
- Continuous colorbars on log plots are difficult to accurately interpret. The maps in Figures 3 and 1 would be much easier to read if the colorbars had discreet steps (while keeping the log scale). In Figure 1 it didn't bother me to much because I was more interested in the qualitative pattern than the quantitative values, but Fig. 3e I wanted o know where the one contour was, which is quite difficult to tell. I would suggest colorbars similar to those in Figs 2 and 5.

References

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Wengler, et al. (2019) A geochemical approach to reconstruct modern dust fluxes and sources to the South Pacific, Geochimica et Cosmochimica Acta