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Paper needs to discuss data on provenance of Antarctic dust in LGM

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Community 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-CC1>, 2021

The paper by Krätschmer et al is a very welcome addition to the literature on dust modelling, particularly for the LGM. This adds to a number of studies such as those of Mahowald et al and it's excellent to have a new study using a more modern modelling set-up and with some novel diagnostics. It's an important topic because of its relevance to issues such as iron fertilisation, and its use in the interpretation of ice cores.

I do not intend to do a full review of the modelling aspects of the paper (best left to those with a modelling background), but rather to comment on particular issues related to what is seen in Antarctic ice cores. I enjoyed the description of what the model found and the comparison with previous modelling efforts. However I was rather astonished that the paper completely ignored recent discussions about the causes of increased dust in Antarctica during the LGM, and the extensive data papers that indicate a dominant South American source of dust across much of Antarctica in the LGM.

The latter issue (provenance) is the most glaring deficit in the paper. The authors conclude that Australia is the main source of dust to Antarctica in the LGM, with >70% contribution (Fig 4) over most of the continent. The authors then use this to discuss why other modelling studies might have got it wrong. In a very brief mention (line 401) it appears as if the authors are aware of the data (principally using Sr and Nd isotopes) showing a dominance of South American sources for the LGM (with a possibility of some Australian input in the Holocene, in contrast to their modelling results). This is not just a single result from one site, but is something documented at Vostok, Dome C, Talos Dome, and Taylor Glacier (e.g. Aarons et al 2017, Basile et al 1997, Delmonte et al 2008, Delmonte et al 2010). Given this obvious discrepancy between the modelling and the data it would surely be appropriate to either acknowledge that this is a discrepancy that implies an issue with the modelling, or offer reasons to suggest that the papers I mention have misinterpreted the geochemical data. It is certainly not OK to just ignore it, leaving the less informed reader with the misconception that it is likely that Australian sources dominate the Antarctic LGM dust budget.

Less serious is that the paper ignores a quite strong debate in the ice core community about the relative importance of changes in source strength and lifetime in determining the LGM increase in dust concentration. Papers addressing this (sometimes discussing

calcium as a dust proxy rather than dust per se) include (Wolff et al 2010, Fischer et al 2007, Petit et al 2009, Markle et al 2018). While the authors don't need to get into this debate in detail they could really offer some insight and it's a shame not to do so. The basic argument is that conceptual models suggest a big change in lifetime, while GCMs until now have not, having to rely on very big source changes to get the LGM dust increase. A question has been why the GCMs don't appear to document the change in dust lifetime one might expect due to the change in precipitation. The present paper is well-equipped to discuss this, mentioning that much of the transport is taking place above the level where precipitation occurs. However Fig 6 in the current paper suggests a new factor – that the transport level in the LGM is at lower altitude which does open the possibility of a second-order reason for a change in lifetime resulting from that (dust spending more time at altitudes where there is precipitation). Whether that change is really enough to explain the LGM increase (especially when in the current model the South American source sees a local precipitation increase) is not clear, but it would be valuable to see the discussion framed in this context.

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