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Climate of the Past Discussions

Interactive comment on "Dust deposition in Antarctica in glacial and interglacial climate conditions: a modelling study" *by* N. Sudarchikova et al.

Anonymous Referee #2

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Sudarchikova et al present a model study on dust deposition in Antarctica based on a global aerosol-climate model ECHAM5-HAM. It is a first attempt to simulate past interglacial dust cycles by investigating different interglacial (pre-industrial, 6, 115, and 126 kyr BP) and glacial (21 kyr BP) climate conditions. The main goals are to estimate the quantitative contribution of different processes such as dust emission, atmospheric transport and precipitation as well as deposition changes in Antarcitca. The subject of the paper is within the scope of Climate of the Past. However, before this manuscript can be published major revisions to the manuscript should be performed by the authors according to the comments listed below.

The title of the paper suggests that the results of the model study are limited to dust

depostition in Antarctica. However, a substantial part of the results and discussion (and figures) include global results (e.g. p 3722 lines 8-20, p 3724 lines 9-20, p 3726 lines 1-11). I suggest to either restrict the results and discussion to Antarctica, or change the title and main focus of the paper. Since Antarctica is a particular location in terms of atmospheric circulation, and dust sources for Antarctica are southern South America, South Africa and Australia, and, thus, independent from other source regions than those mentioned here, this can be done easily.

P3718, L1: "Paleodust records provide mostly local information". I strongly disagree. This would be the case if there were only local, i.e. Antarctic sources active for the dust records in Antarctic ice cores. However, there is a set of (East) Antarctic ice cores (EDML, EDC, Vostok, TALDICE,...) with which the entire region >50°S can be investigated in terms of source regions/strength, transport effects etc. Thus, the entire dynamics of the high southern latitudes can be investigated, providing climate information far beyond a local scale.

P3718, line18. "no broad data sets of dust deposition exist". Please clarify that this refers to model simulation data sets. There are quite a few observational data sets from Antarctica available (see comment further down).

The model overestimates dust deposition flux in Antarctica by a factor of 2-3, according to the authors due to an overestimation of accumulation in Antarctica and thus wet deposition. The authors even say that a result of the pre-industrial simulation the dominant sink process of mineral dust in Antarctica is wet deposition (p 3723, line 26). Please clarify that this is a result of the model study and not an observation. The way this sentence is written this is not entirely clear. On p 3726, lines 15-18 this is written satisfactorily. However, it's not clarified here that again, this is based on an overestimated accumulation (especially for the LGM period we know that dry deposition is by far the most important deposition process). Please quantify this model bias (as has been done for the pre-industrial period) such that it can be compared to the pre-industrial results.

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Sect 4.4.1: It is mentioned that the model is in good agreement with west Antarctic observations but underestimates dust deposition on the East Antarctic plateau. However in fig 5 there is only one observation shown from west Antarctica and only two observations for East Antarctica. In order to have a more robust comparison between model and observations I suggest to increase the number of observations, i.e. add as many ice core records as possible (again, the paper is focused on Antarctica. With only three observations a reasonable model evaluation cannot be performed.) Why is EDML not included in this section (whereas it is included in sect 4.4.2)? Or is it just not indicated in Fig.5?. Additional literature which could be used as references for glacial/interglacial dust deposition changes are Fischer et al, 2007, Rev. Geophys, Fischer et al. 2007 Earth Planet. Sci. Lett., and Schüpbach et al. 2013, Clim. Past. There, also dust (nssCa, resp.) data from Talos Dome can be found which could be included in the comparison, especially also for sect. 4.4.2 where the authors mention the scarce availability of dust records. There is also the Dome Fuji ice core covering all investigated periods (Watanabe et al 1999, Annals of Glaciology, or maybe even more recent publications). For West Antarctica, there also might be more data available (WAIS Divide, Byrd,...). Even the authors acknowledge that more observational records are needed for a complete comparison (conclusions p3733, line16)

Sect. 4.4.2: Here the authors suddenly switch from dust deposition flux (as used previously) to dust mass concentration (also in Fig. 6). I suggest to use flux consistently throughout the entire manuscript, since this is a better measure of atmospheric dust in Antarctica than the concentration of dust in the ice. Are the model results shown in Fig 6 dust deposition fluxes or modelled dust concentration in the ice? Be careful not to mix the two parameters.

P 3728, lines12-14 The authors claim that very strong Australian emissions in the 6kyr and 126 kyr simulations cause an overestimation of the dust deposition at EDC. However, when looking at Fig. 8 I cannot see a single trajectory coming from Australia reach EDC. The only trajectories shown in Fig.8 reaching EDC are originating from

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South America. I acknowledge that the trajectories are based on modern meteorological data and, thus, it cannot be ruled out that the picture might be different for trajectories 6 kyr ago. Nevertheless, I would not expect such trajectories to be completely different from the modern ones. So, how can a change in Australian source strength have an effect on EDC, if the Australian" air parcels never reach EDC? Might there be an additional effect being responsible for the overestimation of dust deposition at EDC for the mentioned two time slices?

The authors have done reasonable air mass trajectory calculations to analyse the atmospheric transport and to calculate the potential dust transport. This is a nice piece of work. However, the presentation of the results of these air mass trajectories in Fig. 8 are very sketchy. Maybe the figure could be improved by plotting the "mean trajectory" from each starting point, instead of the arbitrarily chosen every 10th trajectory. This might reduce the number of individual lines of the plot and simultaneously strengthen the message of the figure.

Figure 4: The ratio of dust deposition at EDC and Vostok between the 6kyr time slice to CTRL is higher than between 21kyr and CTRL. Thus, from this figure I learn that dust deposition at these two locations was higher 6 kyr ago than 21 kyr ago, which is completely against any knowledge we have about dust in Antarctica. Something went wrong with the model here. Please clarify why this is the case or correct if it is wrong.

Interactive comment on Clim. Past Discuss., 10, 3715, 2014.