Clim. Past Discuss., 10, C1587–C1589, 2014
www.clim-past-discuss.net/10/C1587/2014/

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 #1

Received and published: 29 September 2014

This paper attempts to simulate the dust cycle in Antarctica by using the global aerosol-climate model ECHAM5-HAM. I have several concerns about the approach adopted, in particular because the model aims to extrapolate the physics that hold for tropical regions to the Antarctic domain, without paying attention to the specificity of the dust cycle in Antarctica.

I will focus here on some major weak points. First, when dealing with dust reaching the remote, high-elevation Antarctic sites such as Dome C and Vostok cited in the text, one has to consider that the altitude of dust transport is well above the levels where most washing out occurs: decay of 222Rn of continental origin suggests a transport duration as long as 3 to 4 weeks. This should be comparable to the time of transport of dust to

inner sites, while the authors suggest a much shorter time of about 10 days. Such a short transport time is reasonable only for marine aerosol. Therefore, a first important critic is related to the duration of fine particles transport from the source areas to the interior of Antarctica.

A second issue concerns LGM climate: the "dust source productivity" increased during LGM with respect to Holocene of a factor 3 to 5, as documented by Martinez-Garcia et al., 2009, 2014, Lamy et al., 2014, Jaccard et al., 2013. These authors all provide evidence for an LGM/Holocene dust source change that is in this order of magnitude, and it is not clear how/if the authors have taken this literature into account.

When considering a change in snow accumulation rate in Antarctica of a factor 2 between LGM and Holocene, the remaining factor (about 5) that is missing to explain the 30-to-50 fold increase registered in Antarctic ice cores during LGM can be attributed to transport efficiency, and to a longer lifetime of dust in the atmosphere during the last glacial period (as suggested also by Petit Delmonte 2009). In this work it is not clear how/if the authors have considered an increase of dust residence time in the atmosphere related to the reduced atmospheric water vapor.

Other points that are equally important include the use of a mass mean radius of 1.75 micron, that is obviously too coarse with respect to dust in central Antarctica (mass mean radii around 1 micron), and another size bin that seems a bit small for mineral dust. Further, the authors seem to ignore literature on Antarctic dust between 2001 and 2014, and they use DIRTMAP as reference for "observations". Dust flux to plateau sites (Dome C area) in preindustrial times is around 0.2*10(-3) mg/m2 per year (Delmonte et al., 2013), that is much lower than the Holocene mean at Dome C and Vostok (0.4*10(-3) mg/m2 per year, Delmonte et al., 2005). Today, DIRTMAP values that are taken as "reference" for the observations are considered too high and cannot be used for comparison. A direct consequence of this is that the model overestimates observations of a factor that is much higher than the one stated in this paper.

Normalization to CTRL values is reasonable, but:

-The 3.8 increase in dust flux (wrt CTRL) at 6 kyrs BP seems very large for central Antarctica and there is no clear evidence for this in Holocene data from Vostok and Dome C (Delmonte et al., 2005) - or you have a reference for this? -LGM dust flux as clearly admitted, is underestimated. In EPICA Dome C the LGM/Holocene flux ratio is aroung 22-23 while the LGM/preindustrial flux ratio would be up to 45! Probably the lack of glaciogenic dust sources accounts for this discrepancy only in part, but a role is probably played by mineral aerosol residence time in the atmosphere.

As far as the simulation does not reproduce properly observations during LGM it seems not clear why the authors decided to extend the simulations to older, climate periods where the dust cycle in Antarctica is less well known.

On the whole, the simulation presented does not take into account some important constraints for the dust cycle in Antarctica it seems necessary to deeply revise this approach.

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