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Climate of the Past Discussions

Interactive comment on "A mechanism for dust-induced destabilization of glacial climates" *by* B. F. Farrell and D. S. Abbot

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In this paper we propose a theory for abrupt climate change during glacials as recorded in the proxy climate record. The glacial climate, and in particular the stadial-interstadial transitions that occurred during glacials, have no analog in the Holocene. These were rare events separated by thousands of years, but when they occur the transition happens on a time scale of a few years. If one were to run a perfect climate model with all physics perfectly resolved, then starting in a stadial state one would need to run for about two thousand years before, over a year of two, an abrupt transition to the very distinct interstadial state occurred. So even with a perfect model the conclusion that the initial climate was stable would be verified for as long as one is likely to run the model. Therefore, examining model results, which are generally recognized not

to have complete physics, can not falsify the mechanism we propose. Consider, for example, the necessity to resolve clouds, which is required to properly model precipitation scavenging of aerosols. It is not that we "...don't like GCMs..." it is that we are trying to understand a phenomenon that the present generation of models is not capable of simulating. Presumably, when a future GCM is run with a fully resolved boundary layer and resolved surface saltation physics and resolved microscale frontal structures and resolved clouds and for a few thousand years then an abrupt transition will be observed to happen spontaneously. In the meantime, we can make progress by appealing to physical principles aided by simple models to explore directions in which the solution to the enigma of abrupt climate change may lie.

We address the reviewer's specific comments as follows:

"The authors say that they use 10x current values for dust for their calculations for the glacial climate: where and when are these values typical for?"

As stated in the paper the 10x dust is taken from ice core data.

"Of course if the whole planet had dust values 10x the values seen over the Sahara all the time it would probably have huge dust impacts: but the deposition would have to be much higher than observed..."

As explained in the paper, dust load is determined by both the dust source rate and the dust residence time. We propose a mechanism for greatly increasing the residence time of fine aerosols. That the dust source rate was higher during glacials is not disputed as it is clear from ice core data, loess deposits, and marine sediments, as discussed in the paper.

"Please justify how the mechanism you describe here could work in a 3d world...If you dont like GCMs, why would you use the most uncertain part of a GCM (the clouds, radiation, and subgrid mixing), and leave out the only part we know they do well (resolved flow)."

The concept we are advancing is that convection would be inhibited by the dust induced heating in the upper troposphere. To test this properly in 3D would require a global cloud resolving model. We look forward to using such a model in our future work.

Interactive comment on Clim. Past Discuss., 8, 1721, 2012.