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Atmospheric Chemistry and Physics Discussions

Interactive comment on "History of desert dust deposition recorded in the Elbrus ice core" *by* S. Kutuzov et al.

Anonymous Referee #1

Received and published: 5 June 2019

The manuscript by Kutuzov et al. presents a calcium-dust proxy record from an ice core drilled on Mt. Elbrus, Caucasus, spanning the time period 1774-2013 CE. The discussion on the dust proxy include separating the background signal and the main dust events, evaluating the frequency and amplitude of dust events, establishing a relation with the potential dust sources by means of analysis of atmospheric circulation patterns and climate indices. I found the dataset very interesting per se, which warrants publication in ACP. The discussion and interpretation of the record is quite detailed and includes very interesting findings, following an approach established by the same group of authors. However, I also found that one relevant issue, related to the almost 10-fold increase in snow accumulation with potential implications on the interpretation of the proxy record, is not discussed. Therefore I recommend a major review of the

manuscript.

General comments

After reading the manuscript, I am not sure whether the trends mostly reflect changes in deposition/accumulation processes rather than changes in dust emissions. This aspect is not discussed in the manuscript, while I believe it is central for the interpretation of the record. I elaborate on this consideration in the lines below.

In Figure 1a one can be appreciate how the summer half-year thickness, expressed in meters of water equivalent, increases significantly since the beginning of the record. This implies increased snow accumulation, in addition to the expected ice compaction with depth. In fact the "companion" discussion paper by Preunkert et al., reports a "decrease of the net annual snow accumulation from 1.5 mwe (0.8 mwe in summer and 0.7 mwe in winter) near the surface to 0.18 mwe (0.15 mwe in summer and 0.03 mwe in winter) at 157 m depth". Therefore we see an almost 10-fold increase in snow accumulation rates along the core. The authors discussed the related potential issues in determining the the ability to detect the frequency of dust events; in order to overcome this issue, they adopted a strategy with finer sampling in the bottom sections of the core. While this precaution is an effective measure to that aim, it does not respond to the issue of whether the increased accumulation rates reflect increased precipitation and wet scavenging, in other words a larger or more frequent sampling of the atmospheric dust loading during precipitation events. As a result, it cannot be safely concluded which effect primarily (or maybe both) determines the observed trends in the dust proxy. This kind of reasoning is partly grounded in the long-standing debate on whether for instance dust concentrations or deposition fluxes are a better proxy for atmospheric dust / dust variations (e.g. Fischer et al., 2007; Mahowald et al., 2011).

I recommend that these issues are throughly discussed in the manuscript, and the interpretations and conclusions weighted accordingly.

Specific comments

p. 2 / lines 3-4: Please explain how

2/4-5: please provide some references

2/8: it would seem more precise to say that many of the archives reported in the cited manuscript show a doubling of the respective dust signals

2/9-13: Given the level of detail reported here with reference to the cited paper, it may be worth reporting other studies as well (e.g. Ginoux et al., 2012; older papers assessing the issue at the global level)

2/25: Two references are listed as Kutuzov et al. 2015 a,b. Please delete the non-relevant one. In addition, remove from the reference list the discussion paper (Kutuzov et al., 2013).

3/9: Make sure that the special character is properly displayed. In addition, in the legends of Figures 1 and 2, a resolution of 0.5 x 0.5 degree is reported. Which one is correct?

3/12: Rather than aerosols, the HYSPLIT analysis reported here shows that "Elbrus glaciers receive AIR MASSES from sources . . ."

3/14-21: Please clarify whether the density plots in Figure 2 are based solely on the the back-trajectories passing close to the ground (and what about Figure 1?). In addition, please explain how did you define the well-mixed boundary layer.

3/25: Please report the geographical coordinates

3/26: ranged from . . . AT 10 m depth . . .

3/30: Could you report in a few words the main aspects of that methodology?

3/30-31: Please specify whether the sampling is continuous along the core

4/8-9: Define what is meant by decontamination blank

4/18-19: Please rephrase

5/7-8: Please report briefly the methodology of the cited paper, i.e. how one can identify dust events on the basis of Ca2+ and acidity records.

5/20-22: It would be interesting to estimate/report the uncertainty arising from this assumption, and propagate it to the dust proxy.

5/22-25: Can you provide an estimate of how much this uncertainty could amount to?

5/31 - 6/3: It is not clear what you mean by "disturb" in both sentences. Please rephrase.

6/8: What do yo mean by "warm periods"? Warm years/decades? Warm seasons?

References

Fischer, H., Siggaard-Andersen, M. L., Ruth, U., Rothlisberger, R., and Wolff, E. W.: Glacial/Interglacial changes in mineral dust and sea-salt records in polar ice cores: sources, transport, and deposition, Rev. Geophys., 45, RG1002, doi:10.1029/2005RG000192, 2007.

Ginoux, P., Prospero, J., Gill, T., Hsu, N., and Zhao, M.: Global-scale attribution of anthropogenic and natural dust sources and their emission rates based on MODIS deep blue aerosol products, Rev. Geophys., 50, RG3005, doi:10.1029/2012RG000388, 2012.

Mahowald, N., Albani, S., Engelstaedter, S., Winckler, G., and Goman, M.: Model insight into glacial-interglacial paleodust records, Quat. Sci. Rev., 30, 832–854, 2011.

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