Interactive comment on "Twelve thousand years of dust: the Holocene global dust cycle constrained by natural archives" by S. Albani et al.

This paper aims to provide a global synthesis of Holocene dust mass accumulation rates (DMAR) and particle size distributions (PSD) from various archives. Additionally the compiled data is compared to a global model of the dust cycle using the Community Earth System Model (CESM).

S. Albani et al. present a transparent process which they use to select DMAR time series from various archives ranging from marine over lacustrine and terrestial sediments to ice cores. Considering the great uncertainties associated with the individual archives and methods and the differences between the archives this compilation is an ambitious undertaking. It demands a careful review of each type of archive and each individual record which is the major part of the presented work.

The manuscript fits well into the focus of "Climate of the Past" and is in general suitable for publication. However some minor clarifications and changes are needed before final publication.

Difference to DIRTMAP The presented study is similar to the DIRTMAP effort initiated by Kohfeld and Harrison (2001). S. Albani et al. provide some comparison of their work to DIRTMAP, however, it would be very helpful for the reader if the differences where stated more clearly within the introduction.

Terminology The terminology used in this study to describe the different parts that make up an eolian dust archive are very much specific to sediment archives and is not applicable to ice cores even though the concepts might be the same.

It would be desirable to use archive agnostic terms (e.g. Matrix or Archive Accumulation Rate) such that it is immediately clear that the concepts are valid for all the records presented here. However, I am not sure about the exact terms to use. In any case, some additional sentences are needed within the introduction to clarify the transfer of the different terms to non sediment archives.

PSDs – Section 3.4 S. Albani et al. put great stress on the importance of the particulate size distributions for the usability of the archives. They use a simple rebinning approach to facilitate the intercomparison of the size distributions within in the database. The approach is well described in this section of the manuscript, however it remains unclear whether number or volume distributions where used and are published in the database. Both of these informations should be added.

Additionally one very important information gets lost through the rebinning: the upper and lower limit of the dataset. Due to analytical constraints only part of the complete size distribution is usually observed. The resulting truncation of small and large particles can have a big influence on the total DMAR depending on the truncation limits. In the compiled database, bins below and above the limit are given as containing zero (counts/volume), when they should be reported as missing values. There is a huge difference between not observing anything and observing nothing. For that reason, the detection limits should be stated alongside the size distributions.

S. Albani et al. also do not clearly state how they deal with the truncation in the derivation of the total DMAR and how this translates into the size bins used for the model exercise.

Fine dust fraction – Table 1 For some of the archives used by the authors no information about the particle sizes are available. For these, S. Albani et al. provide the fine fraction (<10 µm) seemingly arbitrary in Table 1 of the manuscript. It remains entirely unclear whether these fractions were given by the original authors of the studies associated with the records or if they where set by the authors of this study.

Given that these estimates of the fine fraction are an important part of the comparison between model and data the source and/or approach used should be stated very clearly in the text.

4287:17 The term of sediment accumulation rate is not applicable in the case of snow/ice being the archive matrix.

4302:17 None of the cited references provide any error estimate for the reconstructed accumulation rate of the records used in this study. It follows, that the authors used the dating uncertainties to infer the errors of the accumulation rate which will yield far to optimistic error estimates.

It is inherently difficult to assess the uncertainty associated with reconstructed accumulation rates, especially if they are calculated from the age model of the ice core (which is the case for records here). In general the uncertainty is a combination of the errors of the vertical velocity (given by the dating error) as well as the uncertainty coming from the flow model used to correct for the thinning of the annual layers with increasing depth. Given the fact that the dating has been proven to be very accurate (especially in the Holocene), the uncertainty of the reconstructed accumulation rate is dominated by far by the error of the thinning function. This is, for example, very well illustrated in Kindler et al. (2014) for the last glacial, where the accumulation rate is reconstructed through δ^{15}N measurements. Thus only estimating the uncertainty through the dating error will in general yield to low error estimates.

I would advice the authors to contact the original authors of the reconstructions to provide an estimate of the uncertainties of their thinning models. In any way, I would suspect the relative error of the accumulation rate to realistically be at least in the 10 % to 20 % range.

4314:22 The statement about changing deposition mechanisms as source of variability during the Holocene needs some further clarification. Unnerstad and Hansson (2001) have tackled this problem for the last glacial maximum, where due to the significant lower accumulation rate dry particle deposition has played a much larger role. However during the Holocene the accumulation rate is thought to be stable.

Data Accessibility Together with the manuscript the authors supply DMAR time series as well as the rebinned PSDs. Besides the missing information stated above it would be good if the quality labels that the authors assigned to the individual data sets would be provided in machine readable form as well.

Additionally the authors state the possible application of their modeled global dust fluxes as input for other model studies. To facilitate that it would be good if the global fields of DMAR for the different time slices could be made accessible as downloads.

Wrong Citations There are two wrong citations in the text one of Ruth et al., 2003 and of Reid et al., 2003. Here the bibliography information used to generate the references is not correct.

Lately the bibliography export of the Whiley Journals has been acting up so it is probably a good idea to recheck all the used references.

Figures In general the Figures provided with the manuscript are illustrative of S. Albani et al. 's argumentation, even though their layout is probably not final. In Figure 16 the labels of the individual datasets shown are often not visible because they overlap.

References

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Kohfeld, K. E. and Harrison, S. P. (2001). "DIRTMAP: the geological record of dust". In: *Earth-Science Reviews* 54.1-3, pp. 81–114. DOI: 10.1016/S0012-8252(01)00042-3.

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Unnerstad, L. and Hansson, M. E. (2001). "Simulated airborne particle size distributions over Greenland during Last Glacial Maximum". In: *Geophysical Research Letters* 28, pp. 287–290. DOI: 10.1029/2000GL012194.