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Climate of the Past Discussions

Interactive comment on "Global aridity synthesis for the last 60 000 years" *by* Florian Fuhrmann et al.

Anonymous Referee #1

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The manuscript describes an effort to generalize aridity patterns for the last 60 Kyears from a dataset comprising a selection of paleoclimate records, including pollen assemblages, speleothems, and a variety of dust proxies, organized in 10 regions. An aridity index is calculated for each region based on those paleorecords, and is used as a target for comparison with climate model simulations. The motivation of the work described here is relevant, the aim ambitious, and the devised general strategy very interesting. However, the presentation quality is not adequate; in particular the methodology is not described with sufficient detail, so that it is difficult to make an informed assessment on the robustness of the approach and the results. Therefore I recommend a substantial revision of the manuscript.

General comments

At this stage several passages in the text appear confusing, because of the use of the language, and sometimes contradictive. I provide some specific examples below, but I recommend carefully reviewing the entire manuscript in the spirit of addressing this comment.

The methods section is not satisfactory as it is now, since it resembles a short collection of sparse statements. It needs to be much more precise in detailing the different kinds of proxies used, and should be organized in a more organic way. It should also explain clearly what is the general strategy and what are the common rules used to (a) select and (b) treat the data and (c) the uncertainties. This is not discussed even in the supplement. Several datasets with potential relevance to this work are not even mentioned. The whole section should be substantially revised.

In addition, I think that the scope of the work should be clarified. When I read "synthesis" I would expect a complete data collection and selection by means of transparent filters, before aggregating the results. If on the other hand the strategy is to pick specific records, which are deemed representative of specific regions, then I think that (a) a discussion is needed on why these particular records were selected, and what is the inherent uncertainty in the choice, and (b) the main title and scope should reflect more faithfully this approach.

Concerning dust records, several proxies are used. While this may not pose a problem per se in the context of this study, a discussion is missing on other processes, in addition to "aridity", that could potentially affect the signal (changes in sedimentation rates controlled by productivity in the oceans and precipitation ice cores, etc.). What are the uncertainties related to the choice of specific proxies? In addition, any connection between sources of dust and specific paleodust records seems to have been disregarded, casting a doubt on the validity of certain regional interpretations (e.g. sources of dust to Greenland, EDML, Mediterranean Sea). These aspects should be thoroughly discussed.

Specific comments

1, 9 > “all regions show” it would be more appropriate to say “all the regions analyzed in this study show”

1, 10 > not always WITH the same timing

1, 11 > Perhaps what you mean is “Such discrepancies have been interpreted as regional effects, although stratigraphic uncertainties may affect some of the proposed interpretations”? Please clarify

1, 14 > “both lines of evidence show great agreement”: which lines of evidence? Agreement of what with what?

1, 16 > FOCI

1, 20-21 > This sentence is awkward, please rephrase, e.g. Geological archives have the potential to provide information on the past states of climate variables at the global and regional level, and their evolution in time.

1, 26-27 > what do you mean by “ice sheets . . . are apparently also teleconnected with global sea level”? Please rephrase

2, 1-4 > How did you screen ∼2000 papers? Did you use some search algorithm and keywords?

2, 5-6 > Have you considered paleolake levels as a potential proxy as well?

2, 7 > “Arid” rather than “desert”

3, 12 > “The synthesis” rather than “The comparison”?

3, 12 > In this section you should explain in a very transparent way which are the rules for selecting specific records. And why specific one(s) are used to calculate the aridity index, rather than others (within a given region, e.g. Bunker vs Spannagel Cave in Figure 2). In addition, what are the rules to determine the time step of the aridity index,

given that the 3 records typically have different time axes?

3, 14 > What do you mean by “we use the original stratigraphy”? Aren’t you saying that you port the chronologies to the GICC05 time scale? In addition, there is no mention as to how this operation was carried out: did you use some software?

3, 19-20 > What do you mean by “the errors . . . below 4% in total”?

3, 27-29 > Please rephrase this sentence

4, 1 > What is the global climate structure?

4, 4 > “For THE Northern Hemisphere . . .” and so forth, please review the use of the language throughout the manuscript

4, 8 > Larger than what?

4, 16 > Do you mean precipitation proxies?

4, 19 > “divided in three parts” is not clear at all. I guess what you are trying to say is that you assign each point in the pollen / dust time series to a category from 0 to 2, based on the current value of the rescaled record as a percentage with respect to the top value (which corresponds to 100%)? Is that correct? However, it is not clear what are those original values. One can only try to guess it is maybe the percentage of tree pollen is the whole pollen assemblage for a given point? What is it for dust? It could be many things since you indicated several different proxies for dust. In fact by looking at the supplement it seems it depends on each different proxy. Also, you do not spell out how you calculate the aridity index, one can grasp from the caption of table 1 that is the sum of the three “scores” for speleothem, tree pollen, and dust. Your procedure and the rationale behind it should be explained in detail and clearly in the methods section.

5, 2-9 > This section is also very confusing, it should be profoundly revised. First, you should probably mention that there are uncertainties on the age of the samples, and uncertainties on the specific values of the variables, in addition to their uncertainty as

proxies for a particular system. Second, you should clarify which are the cases where you have an uncertainty estimate from the original study and what it refers to. Then you can talk about the case where you have to assign the uncertainty arbitrarily to each sample in your time series, and you should specify on what grounds you assign a particular values (it could be the reference to a paper using the same kind of proxy, for instance). Fourth, as a key to read Table 2, you should describe explicitly if you have only one record for each kind of proxy for each region, or else how you dealt with multiple records. Finally, it may be more interesting to use other records than the "chosen" one, where available, to calculate the aridity index, as a metric for uncertainty / intra-regional variability.

5, 14 > I am not sure what you mean by "one of the large feedback regions": please rephrase

5, 19-20 > VARVE not warve

6, 4-5 > What does the dust concentration in the NGRIP ice core have to do with aridity in central Europe? I don't think it is appropriate to make such a statement without further discussion. As you know, there are several hypotheses concerning the interpretation of the Greenland dust records (e.g.(Mayewski et al., 2014; Steffensen et al., 2008)), and the major source of dust to the Greenland ice sheets are not uniquely attributed to Europe, to say the least (e.g.(Bory et al., 2003; Rousseau et al., 2014; Svensson et al., 2000; Újvári et al., 2015)). In view of these aspects, please state explicitly what is the link in your line of reasoning (e.g. generalized aridity in the northern hemisphere, in Eurasia, ...), and what are the assumptions you make (e.g. Europe is major dust source to Greenland?), justifying them with adequate references to the literature.

6, 22 > Tree pollen?

6, 23 > "precipitation was at the lowest values of the whole record": which record are you referring to? To speleothem records? The aridity index?

6, 29 > Which speleothem?

S1-S9 > In these sections of the supplement I would expect to find more specific considerations on the selections of records (e.g. why data from (Pourmand et al., 2004) are not included in S1? Or (Skonieczny et al., 2019) in S2? Or the loess records in the discussion about central Europe? What's the link between EDML dust and Oceania? Etc. ...), before discussing those that are selected. Also, I did not find the details of how data are aggregated into the aridity index (e.g. why sometimes 4 records are considered, sometimes 2?). As mentioned already, the general rules for data selection should be spelled out clearly in the methods sections, and specific choices of notable datasets not included should be discussed in the supplement.

8, 6 > RELATED information

8, 11 > The proxies show an opposing signal ?

8, 13 > It is not clear how Figure 4 was produced. What is the role of the "additional information"? Are those the thin overlapping bars?

9, 11-12 > Please rephrase

9, 15 > "impair"?

9, 21 > How do you define a climate improvement? Please avoid terms like improvement and amelioration, impair?; expressions describing the changing state of the discussed variable should be preferred, such as drier, wetter, colder, etc.

10, 8 > representative of the Cariaco Basin

11, 4 > WHEN both hemispheres

14, 6-9 > Not clear, please rephrase

14, 24 > SPATIAL trends 16, 12 > All regions analyzed here

References

Bory, A. J.-M., Biscaye, P. E. and Grousset, F. E.: Two distinct seasonal Asian source regions for mineral dust deposited in Greenland (NorthGRIP), Geophys. Res. Lett., 30(4), doi:10.1029/2002GL016446, 2003.

Mayewski, P. A., Sneed, S. B., Birkel, S. D., Kurbatov, A. V. and Maasch, K. A.: Holocene warming marked by abrupt onset of longer summers and reduced storm frequency around Greenland, J. Quat. Sci., 29(1), 99–104, doi:10.1002/jqs.2684, 2014.

Pourmand, A., Marcantonio, F. and Schulz, H.: Variations in productivity and eolian fluxes in the northeastern Arabian Sea during the past 110 ka, Earth Planet. Sci. Lett., 221(1–4), 39–54, doi:10.1016/S0012-821X(04)00109-8, 2004.

Rousseau, D.-D., Chauvel, C., Sima, A., Hatté, C., Lagroix, F., Antoine, P., Balkanski, Y., Fuchs, M., Mellett, C., Kageyama, M., Ramstein, G. and Lang, A.: European glacial dust deposits: Geochemical constraints on atmospheric dust cycle modeling: European Glacial Dust Deposits, Geophys. Res. Lett., 41(21), 7666–7674, doi:10.1002/2014GL061382, 2014.

Skonieczny, C., McGee, D., Winckler, G., Bory, A., Bradtmiller, L. I., Kinsley, C. W., Polissar, P. J., De Pol-Holz, R., Rossignol, L. and Malaizé, B.: Monsoon-driven Saharan dust variability over the past 240,000 years, Sci. Adv., 5(1), eaav1887, doi:10.1126/sciadv.aav1887, 2019.

Steffensen, J. P., Andersen, K. K., Bigler, M., Clausen, H. B., Dahl-Jensen, D., Fischer, H., Goto-Azuma, K., Hansson, M., Johnsen, S. J., Jouzel, J., Masson-Delmotte, V., Popp, T., Rasmussen, S. O., Rothlisberger, R., Ruth, U., Stauffer, B., Siggaard-Andersen, M.-L., Sveinbjornsdottir, A. E., Svensson, A. and White, J. W. C.: High-Resolution Greenland Ice Core Data Show Abrupt Climate Change Happens in Few Years, Science, 321(5889), 680–684, doi:10.1126/science.1157707, 2008.

Svensson, A., Biscaye, P. E. and Grousset, F. E.: Characterization of late glacial continental dust in the Greenland Ice Core Project ice core, J. Geophys. Res. Atmospheres,

105(D4), 4637–4656, doi:10.1029/1999JD901093, 2000.

Újvári, G., Stevens, T., Svensson, A., Klötzli, U. S., Manning, C., Németh, T., Kovács, J., Sweeney, M. R., Gocke, M., Wiesenberg, G. L. B., Markovic, S. B. and Zech, M.: Two possible source regions for central Greenland last glacial dust, Geophys. Res. Lett., 42(23), 10,399-10,408, doi:10.1002/2015GL066153, 2015.

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