

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

### **Anonymous Referee #2**

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Review of "Global aridity synthesis for the last 60 000 years" by Fuhrmann et al.

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This study is an attempt to provide a global synthesis of aridity over the last 60 ka using a number of selected terrestrial (speleothem, lake, loess) and marine records of 10 regions on the globe. While the major outcomes (including the aridity index) of the manuscript results from an immense effort of synthesising various records having different chronologies, resolutions, proxies and associated uncertainties, it is particularly hard to judge what has been really done in terms methodology and if this is sound or not. In agreement with the opinion of referee #1, the methods section (+Supplementum) should be much more transparent to the reader, and the sometimes sloppy text and superficial statements, inappropriate usage of specific terms must be carefully re-

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vised. This also applies to some of the argumentations (e.g. Europe-Greenland aridity relations).

In general, it is suggested that the authors should 1) clearly present the core concept of proxy record selection for this synthesis, and 2) exclusively include records having independent absolute chronologies (i.e. NGRIP/MIS tuned chronologies should be avoided). In my view, the concept of excluding proxy records, which are otherwise well-dated, but do not extend back to 60 ka, should be revised or at least some justifications for this decision are required. Just to mention one excellent example: the Nussloch loess record in Germany (Central Europe), which has a quite well-defined, robust and precise  $^{14}\text{C}$ -chronology (extending back to 55 ka), has been omitted. Moreover, further details on the aridity index and age uncertainty calculations of proxy records must be provided. In my view, any proper assessment of the scientific content of this work can only be provided after a thorough revision of the methodological part.

Specific comments

#Manuscript

Page 1, lines 25-26, "MIS2 (Last Glacial Maximum (LGM) 24 000-14 700 yr b2k)": This is misleading, as the LGM was a globally recognizable, peak glacial period between 26-19 ka (broadly speaking), while the ages given are the widely accepted boundaries of MIS 2.

Page 2, lines 7-12: I would say dust is dominantly from deserts, but other dryland ecosystems (shrublands, grasslands and even forests with 300-500 mm annual rainfall; Breshears et al. 2003) can also produce fair amount of dust.

Page 3, lines 3-8: This is corroborated by other studies of loess records,  $^{14}\text{C}$ -dated in high (Nussloch, Germany; Moine et al., 2017) and extremely high (Dunaszekcso, Hungary; Ujvari et al., 2017) resolution. Why not using at least the Nussloch record for Central Europe, beyond the ELSA stack?

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Page 3, line 15: Provide more details on GICC05 (b2k) timescale conversion. Does this simply mean a 50 yr addition to the calibrated radiocarbon chronologies? How this approach was applied to the luminescence chronologies?

Page 4, lines 8-9: What does this sentence mean?

Page 4, lines 9-10: Does “eolian content” mean eolian fraction of sediments?

Page 4, lines 12-14: Fuzzy text (K/C ratio and related interpretations) must be revised.

Page 4, line 25, Table 1: It is still not entirely clear how these aridity values are calculated from dust. Dust MARs or grain size or what has been used and in which way? What does the internal normalization mean?

Page 5, section 2.2: I suppose this section describes age uncertainties. State this clearly. Have you considered proxy uncertainties?

Page 5, line 7: Does the “error of our aridity index” mean uncertainties related to dating/chronological uncertainties?

Page 5, line 10, Table 2 (header): Clarify that the “tree pollen/eolian dust uncertainties” are dating/chronology uncertainties. Provide more details on the method used for uncertainty estimations. Has this been done by Monte Carlo simulations?

Page 5, line 14: In what sense is Central Europe a “feedback region”? Clarify.

Page 6, lines 4-5: Provide numbers for “low dust concentration”. Do you refer to Greenland or dust source regions (or Central Europe) when talking about “intermediate to low aridity” in this sentence?

Page 6, line 6, “49.000 yr b2k”: Provide uncertainty for this date.

Page 6, line 25: Provide numbers of “extreme cold temperature” for the NGRIP site based on reconstructions of Kindler et al. (2014) and state clearly that these temperature estimates are not only from  $\delta^{18}\text{O}_{\text{ice}}$ , but a combination of  $\delta^{18}\text{O}_{\text{ice}}$  and  $\delta^{15}\text{N}$

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measurements (+ $\Delta$ age).

Page 6, lines 24-25: In this sentence you suppose a direct link between Central Europe and Greenland in terms of dust transport. On what basis? To my knowledge, the possibility of European dust sources for central Greenland (over the LGM) has been proposed in Ujvari et al. (2015), specifically based on Sr-Nd isotopic compositions. I would rather emphasize that the ELSA record reflect regional conditions and these could have differed from those in Greenland.

Page 7, lines 10-11: This is a bit strange suggestion or at least not explained properly. Central Europe cannot be taken as a reference, as no other regions. All regions have their own climatic history. The Greenland ice core records are usually taken as stratigraphic correlation targets as they have an unprecedented resolution, layer-counting chronology and reliable proxies.

Page 9, lines 11-12: I'm wondering why so many recent papers include one completely off-topic sentence about the migration of anatomically modern humans into Europe? Just one sentence pops up without any further discussion in most of these papers, including this one. This is pure hypothesis without any further evidence, therefore I strongly suggest deleting this sentence.

Page 12, lines 17-19: Talking about Heinrich-events, these should be indicated in Figure 6. Also, from where do you know if these are H-events or not in the studied dust records? Timing?

Page 13, line 4, "turning point": Do you refer to tipping points here?

Page 13, line 19: I suggest deleting the Gobi after "China" (in parenthesis), as there many other deserts in China, including the Taklimakan, Tengger, Hobq, Mu Us etc. deserts.

Page 14, lines 13-17 and Page 16, lines 2-6: These text parts should go somewhere in the Methodology section, in my opinion.

Page 14, line 28: Which simulation do you refer to? Barron and Pollard's?

#Supplementum

Page 21, line 21: Records with tuned chronologies should be excluded, in my view.

Page 22, lines 2-3: This is exactly the reason, which precludes unambiguous GI identifications in OSL-dated records, including Jingyuan in China. Such an “exercise” is difficult even using <sup>14</sup>C-chronologies, having an order of magnitude lower uncertainties.

Technical corrections

Page 3, line 23: write “pollens”

Page 3, line 30: dropstones? I would use “lithic clasts” or “detritus” or something like that

Page 5, line 19: write “varved” (same later)

Page 5, line 22: specify this abbreviation: Greenland Insterstadial (GI)

Page 6, line 2: write “caves”

Page 6, line 3: replace “strong precipitation amount” by “wet climate” or a similar expression

Page 6, line 5: write “beginning” (same below)

Page 6, line 10: write “hiatus”

Page 6, line 14: replace “on” by “to” after “apparently” and use “underlying” instead of “overlying”

Page 9, line 18: I can't find these red bars. Or do you refer to figure 4?

Page 9, line 23: delete “bevor” and write “before”

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Page 10, line 3, Figure 4 caption (second row), “red bars indicate high humidity”: this should be aridity, I guess

Page 14, line 3: delete “at” and use “in” before “Central Chinese”

Page 14, lines 7-9: first half of sentence makes no sense, rewrite please

Page 16, line 12: “large humidity” is bad phrasing, write “increased humidity” or simply “wet phase”

Page 16, line 13: write “considerably”

#### References

Breshears, D.D. et al., 2003. Wind and water erosion and transport in semi-arid shrubland, grassland, and forest ecosystems: quantifying dominance of horizontal wind-driven transport. *Earth Surf. Process. Landf.* 28, 1189–1209.

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