

Interactive comment on “Hydroclimate of the Last Glacial Maximum and deglaciation in southern Australia’s arid margin interpreted from speleothem records (23–15 ka)” by Pauline C. Treble et al.

Anonymous Referee #1

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General Comments High resolution and precisely-dated records of hydroclimate variability spanning the LGM to present across the southern and central portions of Australia are important but rare. This stalagmite record helps fill that spatial and temporal gap. The study rests on a foundation of data (the stable isotopes and trace element analyses are robust) and the dates are as good as can be expected given the constraints of the stalagmites (low ^{238}U and moderate to high ^{232}Th). The study is limited by a lack of observational data for the cave environment, dripwater, and precipitation. The claim that tropical moisture can regularly supply moisture as far south as this cave site is, to me, quite a remarkable claim and is an interesting argument that should be

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tested, perhaps by a modeling study.

In terms of presentation, the writing is somewhat formulaic and the figures – particularly the two composite data plots (Fig 3 and 6) – fail to paint a clear picture or advance an argument. These should be reworked to more clearly articulate the idea they are designed to promote. Figure 1 should be expanded to include some of the geographical landmarks mentioned in the text.

Specific Comments 31 – “prevented” might be too strong a word to use here. Marine sediments record continentally-sourced eolian debris that track atmospheric circulation quite well.

37 – Interpreting flood layering as a signal of enhanced recharge is not necessarily straightforward. The hydrological response of catchments and streams to extreme rainfall events during overall dry intervals, for example, can be quite distinct and more severe than during overall humid intervals thanks to a number of complex geomorphic feedbacks and/or changes in the seasonality of these rainfall events. It seems conceivable, at least, that increased flood events could represent extreme events during periods of enhanced aridity rather than enhanced rainfall.

39 – perhaps write “18O and 13C enrichment” rather than “isotopic enrichment”

41 – The nature of the changes in isotopes that accompany enhanced precipitation were described. I suggest also adding a phrase discussing what the nature of the calcite fabric changes are (e.g., faster-growing, less dense, and less optically translucent calcite during periods of enhanced rainfall).

55 – That tropical rainfall could influence Lake Eyre is reasonable given the size and location of its catchment. Rain can fall hundreds of km north of the lake. And clearly the ITCZ was pushed south during periods such as HS1. But is there any independent support (a modeling study, for example) for tropical moisture actually falling so far south? This seems remarkable and difficult to imagine.

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93 – This kind of discussion is somewhat problematic as it seems to suggest that the Westerlies exist in one of two different “mean states” when in reality, couldn’t they plausibly contain the same average position with some time periods being characterized by considerably greater spatiotemporal variability.

115 – At least at present. There were long stretches of time when Lake Eyre was massive and presumably the shape and location of the boundary between the dry interior and the wetter continental margin was profoundly different.

136 – It is awkward to use the phrase “relatively small catchment” to describe the few tens of square meters of landsurface that represents the catchment for a speleothem after discussing the hundreds of thousands of square kilometers of the Lake Frome catchment. These scales exist in different universes. By this standard, speleothems have pin-point, microscopic catchments.

197 – higher ET and not simply higher precip?

213 – Each cave has its own distinct hydrological characteristics, and at finer scales, hydrology can vary within a cave. At this point, I am somewhat skeptical of the utility of a distal (1000 km away) cave as a proxy for Mairs Cave.

245 – the reader would benefit from a more detailed explanation of the IOD, ENSO, and the interaction between the two and its impact on regional climatology

249 – what is the importance of the rainfall coming first from the Indian and then the Pacific ocean? This section seems to end abruptly.

442 – doesn’t fluid thickness reflect the geometry of the stalagmite growth surface as much as it reflects drip rate?

452 – is this 0.3‰ offset a function of the discrepancies between the two stable isotope labs?

466 – This is a pretty big offset. Could it be due to the different stable isotope labs?

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What about effects of growth rate on d18O as have recently been discussed?

475 – The figure does not really show such a correlations between the two stals. I would remove this line.

514 – Is there no way whatsoever to calculate expected calcite d18O values based on measured cave temp and regional precip d18O values? This is a much more reliable method than any sort of Hendy approach, in my opinion.

644 – Presumably these waters would need keep the stalagmites submerged for considerable lengths of time to produce noticeable corrosion.

689 – I don't understand this line of reasoning? Rain that is 5‰ (!) lighter than normal is quite a marker.

906 – I need to see some additional evidence for such a dramatically southward displacement of the monsoon during HS1. If this were the case, there should be a good deal of geomorphic evidence from across the Australian center. What about a modeling study?

Figure 3 and 6 – It is difficult to understand what big picture argument is being made by these figures. They seem more like collections of data that do not necessary have much or anything to do with one another other. Additional information is required in the figure and/or the figure caption to tie things together. For example, the green rectangle is supposed to denote a wet period, but looking at the assembled data, I see no clear evidence to support this argument.

Figure 5 – The spectral work seems to be thrown in almost as an afterthought. What is the relevance of these periodicities? The centennial variability is interesting but the spectral analysis doesn't really inform this part of the work.

Technical Corrections 34 – reword as “providing for the first time a detailed. . .”

36 – delete “for the first time”

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44 – I assume this means “16.0 ka”?

78 – delete the semicolon

82 – delete the comma

83 - delete the comma

84 – ITCZ already defined in Abstract

86 – delete the comma

125 – replace the semicolon with a comma

126 – “contribute”

133 – This discussion should be accompanied by a map, perhaps as an inset in Figure 1.

137 – While “relative” refers, I assume, to stream sedimentary sequences discussed above, use of this term here seems a bit awkward.

141 – delete everything on this line “iv”

145 – Reword as “revealing the timing and structure of ice age terminations”

155 – The use of commas in this line makes it difficult to follow

163 – I believe Rasmussen did some work in Carlsbad Caverns, as well.

166 – “, and hence”

202 – remove second comma

204 – same comment as for line 197

236 – missing a period after “years”

237 – “Eastern” should be “eastern”

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243 – “AD 1974”

243 – “Lake Frome and Lake Callbonna”

246 – again, the reader needs a better map

247 – do you mean rainfall “records” were broken?

259 – delete “formations” and pluralize “speleothem”

265 – “AD 1998”

268 – what is a “pool-formed decoration?” Please explain. A photo would also be helpful. End sentence after “decoration”

268 – delete “as well as reports from cavers”

268 – reword as “In addition, cavers report 3 m of water in the entrance shaft in 1974. . .”

284 – delete “of unknown duration and frequency”

287 – repair the comma splice

300 – this is an incomplete phrase that doesn’t match with (i)

346 – no need to include Australian National University again on this line

347 – “by a slit”

350 – “laser was”

354 – delete “using”

354 – are these ppm?

405 – delete comma

406 – within error of each other?

407 – quantify “significant”.

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414 – repetition of “growth” in this line is awkward

422 – instead use “composed”?

424 – do mean “flank” as in the vertical sides of the stalagmite or flank of the top growth surface?

425 – what is geometric selection?

525 – replace “s” with “s.d.”

618 – “parent dripwaters, perhaps by incomplete equilibration or . . .”

621 – delete comma

621 – “supports the argument that considerable”

669 – delete comma

673 – what does “natural” refer to here?

761 – why include “hydrologically”?

769 – delete open paren

784 – delete the comma

861 – “support the argument that”

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