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Climate of the Past Discussions

Interactive comment on "Evaluating model outputs using integrated global speleothem records of climate change since the last glacial" *by* Laia Comas-Bru et al.

Anonymous Referee #1

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The paper compares isotopic simulations with ECHAM5-wiso for present day, last glacial maximum (LGM) and mid-holocene (MH) to speleothem records archived in the new SISAL database. They propose recommendations for an optimal model-data comparison, which can be useful for future such comparisons.

The paper is well-written, although it could sometimes be made more concise. The figures are of good quality.

Besides minor comments listed below, I have one major comment: the authors argue that it is useful for model evaluation to look at spatial patterns of absolute $\delta^{18}O$ for past climates (LGM, MH) rather than just looking at anomaly maps, in contrast with many

previous studies. However, the argument is not convincing and the examples given argue rather for the contrary. I would suggest to remove this sub-section and remove this recommendation.

1 Major comment: what is the added value of looking at spatial patterns for past climates compared to looking at them for present-day?

The authors argue that it is useful for model evaluation to look at spatial patterns of absolute $\delta^{18}O$ for past climates (LGM, MH) rather than just looking at anomaly maps, in contrast with many previous studies. This allows to have more sites for model-data comparison. However, what is the added value of looking at spatial patterns for past climates compared to looking at them for present-day? For present-day, spatial patterns would be the same to first order. At present, there are so many more sites available directly samplig precipitation (GNIP), so why bother with speleothem records for past climates?

- Figures 7 and 8 show the spatial patterns of observed and simulated $\delta^{18}O$ for LGM and MH. The sub-figure a representing North and South America are common to both figures, and they actually show very similar patterns. The same figure for present day would also show very similar patterns. This is because $\delta^{18}O$, temperature or precipitation changes between LGM, MH and present-day are much smaller than the magnitude of spatial variations along a transect covering such a wide range of latitudes. So these figures support my skepticism about the relevance of spatial patterns in absolute values for past climates.
  Figures 7b,c and 8b,c do not represent the same regions. But I'm sure that the maps for present-day would look very similar.
- The corresponding text bears several slips of the pen and/or interpretation errors, that probably reflect that writing this sub-section was not confortable:

- l 408: "$\delta^{18}O$ changes" should be replaced by "$\delta^{18}O$ patterns": the authors write "changes" because this is really what is interesting to look at, but actually the figures do not show it.
- l 412: "underestimates changes in precipitation": again, we cannot see changes from present-day to MH on this figure.

What you want to plot depends on the science question. If the science question is what controls spatial patterns in absolute values, then it's better to focus on present-day values; past climates do not provide much added value. But if the science question is what controls the changes at paleo-climatic time scales, then it is necessary to look at anomalies between 2 climatic states.

-> So I recommend to remove section 3.4, or replace it by an analysis of spatial patterns of anomalies, and to modify accordingly the abstract, protocol and conclusions.

2 Detailed comments

- l 157-158: I don't underestand what this means. Where is the control simulations included in the LGM-MH difference?
- l 209: remove "non-equilibrium of"
- l 216: add a dot.
- remove "with data ... baseline".
- l 234-235: already said, remove.
- 246: define *pchip*

- l 295: clarify the rationale. Why can't there be a sampling bias in temperate regions towards the PMIP periods?
- l 296: clarify this sentence. What does "even at a global level" mean?
- l 300-302: can you explain briefly why higher latitude speleothems are more depleted than OIPC and low latitude speleothems are more enriched? l 305: "cave specific factors" cannot explain why you have such systematic differences common to wide regions.
- l 317-319: should the reader conclude that ECHAM underestimates the inter-annual variability? If so, please state this clearly. Has such a bias already been described in a previous paper, for ECHAM or for other models? Explain briefly what could be the reason for this underestimate.
- move "processes" before "within"
- l 325-328: this has already been said just above.
- l 359: replace "anomalies" by "MH values"?
- l 422: remove "utilising"
- l 440-447: this issue was not previously discussed. Add some quantification, or a map, showing what error we would make if we use only the fractionation factor for calcite?
- l 473: remove "on a global basis". Or clarify what you mean. Even at a specific cave, if the speleothem acts as a low pass filter, time scales shorter than "quasi-decadal" cannot be studied.
- l 475-476: clarify. Do you mean that the model underestimates $\delta^{18}O$ changes? l 476-477: clarify.

- l 489: “constraining structural error on the model side”: what do you mean? There are plenty of sources of errors in the model: errors on forcings, missing processes in parameterization package, tunable parameters, coarse resolution... Which one are you refering to? “true uncertainties”: beware that errors are not the same as uncertainties. Anyway, in this paragraph, I suggest to focus only on uncertainties on the observation side, because this is what is useful to evaluate models. The question of quantifying uncertainties in models is set differently and is beyond the scope of this paper.

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