

Interactive comment on “Simulated European stalagmite record and its relation to a quasi-decadal climate mode” by G. Lohmann et al.

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General Comments

Lohmann et al. aim to simulate a stalagmite proxy record for a cave in western Germany. In doing so they use a coarse resolution atmospheric model (ECHAM4) with an embedded water isotope module to extract the local climate information and the oxygen isotope signature. The climate and d18O information calculated by ECHAM4 feed the stalagmite model (ODSM) that simulates the changes in the d18O of precipitation due to processes occurring in the soil and karst. The authors claim that the local response in the simulated d18O of calcite in western Germany is linked to large scale changes in surface temperature and the hydrological cycle. The authors try to show that the link between the sea surface temperature over the North Atlantic and the d18O record at a

C1631

cave site in western Germany follows a quasi-decadal mode.

This manuscript fits well in the scope of Climate of the Past. The results provide a valuable attempt in understanding what signal stalagmites over Europe record. Therefore, in my opinion it would deserve publication, after, however, a major revision not only related to the analysis of the data but also about the way is written that represents a concern. In fact it strongly undermines the understandability of the paper. Statements in the introduction and the discussion are superficial and at times imprecise. Moreover, the reference to previous related works is strongly deficient.

Major concern:

1) The authors in the attempt of writing a concise abstract, forget some important information. I would encourage the authors to carefully rewrite it also following these comments:

- L 1 Should everybody be aware of where Bunker cave is? Please specify right at the beginning where it is in the world.

- L 1 the authors could be slightly more precise on the climate-stalagmite modeling approach used.

- LL 8-9 The sentence is not clear. The pattern propagates eastwards affecting European temperature. I think a logical step is missing: do the authors mean that the SST tripole affects the atmospheric circulation and in turn the temperature over Western Europe; in this way, its signal is captured by the cave?

2) I would invite the authors to craft the introduction in a more rigorous and clear way, giving also more appropriate credit to related work and indicate more clearly their own new original contribution:

- P 3514 LL 16-23 The authors affirm the importance of stalagmite in understanding past climate variability and that is important to understand whether they record local or large-scale atmospheric variability. In this context, I would invite the authors to credit

some previous efforts in the recent literature that have tried to do so (e.g., LeGrande and Schmidt, 2009 (CP), Lewis et al., 2010 (CP), Dayem et al. 2010 (EPSL), Pausata et al., 2011 (NGS)). This would also help the authors to make clear the difference with previous studies.

- P 3514 L 17 The authors mentions several papers related to how speleothems have been used to reconstruct past climate variability but they do not mention earlier and well-known papers such as Wang et al. 2001 (Science) or Yuan et al. 2004 (Science).

- P 3514 L 24 where the authors discuss about the modes of climate variability, they should cite some other fundamental references for the North Atlantic Oscillation that is the leading mode of atmospheric variability in this sector (Walker and Bliss, 1932, Hurrell 1995 and Hurrell et al. 2003).

- P 3515 LL 2-4 The authors barely mention the factors that can affect the signal recorded in the speleothems. It's not just large-scale surface temperature and/or rainfall amount. There are several local and non-local processes (transport, seasonality of precipitation and so forth) that can play a role. Please, acknowledge them.

- P 3515 L 4 The authors present the work of Baker et al. that found a relationship between local rainfall $\delta^{18}O$ and atmospheric circulation but they don't mention neither where Baker found that relationship nor go a bit in the details of that study that they use as inspiration for their work. I believe a more appropriate description of this study is necessary.

- P 3515 L11-24 The authors affirm that atmospheric circulation over the North Atlantic is predictable if global SST variability can be predicted. Actually, it is not that simple, internal variability of the atmosphere plays a really important role in determining atmospheric circulation over the Atlantic sector. Although, there are links between the underlying SST and the atmospheric circulation the mechanisms are by no means well understood and it's more likely that is the atmosphere that is influencing the ocean (e.g., Mignot and Frankignoul, 2005). However, on decadal time scales the SST may

C1633

well help predicting the atmospheric circulation (e.g. Keenlyside et al. 2008). Finally, I think, the references - the authors have cited - refer to winter NAO and its link with the SST. Is it only winter variability that affects the signal at the cave? Or also summer atmospheric circulation plays a role in affecting the $\delta^{18}O$? I would invite the author to clarify this point and to rewrite in a more appropriate and precise way the entire paragraph.

- P 3515 L21-24 Actually, using a proxy with changed boundary conditions to infer link between the north Atlantic climate modes and a proxy site can be quite risky because changed boundary conditions lead to a complete different reorganization of the atmospheric as well as ocean circulation as shown in several studies (e.g. Justino and Peltier, 2005 (GRL), Li and Battisti 2008 (J. Clim.), Pausata et al 2009, 2011 (CP)). Therefore, what the proxy record in a different climate state with different boundary conditions may well be different from present day (as shown for example in Pausata et al. 2009 (CP)). Again the authors should be careful with their statements and try to substantiate them with references.

3) The result section seems almost like a repetition of the figure captions. I would invite the authors to not just present the figures in the result section but also analyze more in depth the results, providing some more justifications.

For example:

In the light of your results (Fig 4) discuss why ~ 14 -yr oscillation is seen in the $\delta^{18}O$ but not in the temperature. In this section the authors just say that the interannual variability in the cave is suppressed without providing any further explanation.

The cave is acting as a filter or are there other reasons behind it (e.g., changed temperature at the source may well lead to a different $\delta^{18}O$ of precipitation falling at the cave)? To rule this out, the authors could perform a power spectrum analysis for the $\delta^{18}O_{prec}$ and see whether the $\delta^{18}O_{prec}$ spectrum is more similar to the temperature or to $\delta^{18}O$ of calcite. Anyway, the signal must come from somewhere in the model too

C1634

(e.g., the input data at least), the authors should show it.

Why the threshold of $d_{18}O > -5.2$ is chosen?

4) Important omissions in the figure's captions that make it difficult to clear understand what is shown.

- Fig. 1a is it really shown annual mean surface temperature? Or is it monthly? If it's a monthly mean, I think maybe for clarity the annual mean may be better. I would suggest to rewrite the captions in a more communicative and concise way e.g. (but the authors may find a better way):

Fig.1 (a) Time series of annual (?) mean surface temperature ($^{\circ}C$), (b) net precipitation minus evaporation (mm/month), and (c) simulated $d_{18}O_{prec}$ (‰) at Bunker cave (or the cave site). The red . . . values.)

- Fig. 2 "monthly values as in Fig. 1a and c", so the values in figure 1 are monthly then? Clarify.

- Fig. 3 Time series of annual or monthly data? Please proof-read the manuscript! I assume monthly because the authors then plot a 12-month running mean.

- Fig. 5: I suppose the authors meant "correlations between . . . and annual mean SST". Why not showing the 12-month running mean also for panel a)?

- Fig. 6 I would suggest to put a minus in front of 2 year and 1 year otherwise the reader may have some problems understanding that is 2 year and 1 year before. I would put the unit ($^{\circ}C$) near the colorbar; likewise for figure 7.

- I wonder why the SST anomalies are seen also well into the continent. Do the authors use surface temperature or SST?

Minor comments

- I would suggest to define at the beginning as $d_{18}O_{prec}$ the simulated $d_{18}O$ of pre-

C1635

cipitation and $d_{18}O_{calcite}$ or $d_{18}O_c$ the simulated $d_{18}O$ of calcite of the speleothem and stick to them throughout the paper.

- P 3518 L 15 what kind of temporal evolution the authors are talking about? Monthly, annually? Please specify.

- P 3519 L 10 is missing "of" $d_{18}O$ of calcite.

- P 3520 L1 name the cave after western Germany for clarity: western Germany (Bunker cave).

- P 3521 LL 16-23 I feel like this part belongs more to a discussion than to a conclusion section.

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C1636