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Climate of the Past Discussions

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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Answer to referee #1 (Clim. Past Discuss., 8, C1547–C1549, 2012) related to the manuscript "Simulated European stalagmite record and its relation to a quasi-decadal climate mode" (Clim. Past Discuss., 8, 3513-3533, 2012) by Gerrit Lohmann, Anne Wackerbarth, Petra M. Langebroek, Martin Werner, Jens Fohlmeister, Denis Scholz, Augusto Mangini.

We thank the referee Andy Baker for the constructive review. The main critics from the referee was that the manuscript only provides limited and inconsistent information on both input datasets and modelled output. We therefore rewrote some texts and we have re-done most of the analysis. In the following, we provide details to the referee's points:

1) Answer: Yes, there is already a quasi-decadal signal in the input. We now show the time series of d18O, precipitation, evaporation in Fig. 1. The decadal variability in the temperature and d18O can be seen by the spectra for the input and output in Fig. 4. The local temperature and δ18Oprecip indicate pronounced interannual variability, whereas δ18Odrip and δ18Ocalc exhibit pronounced decadal variability (Figs. 3, 4). The spectra of the temperature, speleothem δ18Ocalc as well as the local δ18Oprecip values show interannual (with peaks at about 3 and 5 years) and quasi-decadal variability (at about 14 years). The decadal peak is not significant for temperature and δ18Oprecip (Fig. 4a, c), in contrast to δ18Odrip and δ18Ocalc where the interannual variability in δ18Odrip, δ18Ocalc is suppressed (Fig. 4b, d) and the power spectra emphasise pronounced peaks at about 14 years. The variability of δ18Oprecip has a flatter spectrum as compared to δ18Odrip, δ18Ocalc (Fig. 4).

2) We now show more details oft he model, as well as the in δ18Odrip. Furthermore, the model section is revised and contains more details now.

3) We now provide more detailed analysis of the results. The pronounced quasi-decadal d18O signal is introduced into the stalagmite already in the input series.The lag of about 3-5 years (Fig. 5) is related to the infiltration of a water parcel and its inflow into the cave. This value is consistent with earlier work at Bunker cave (Kluge et al., 2010; Wackerbarth et al., 2010).

The referee asked for more information related to the climatic interpretation. Indeed, we completely have rerun the analysis to show the main results in a more coherent way.

1) We have now based our analysis on correlation and not on composite maps. Composite map analyses contain a (subjective) theshold. The main results are robust. Fig. 6a shows now the in-phase correlation of the simulated local δ18Oprecip values and SST, whereas Fig. 6b the 3-year lag correlation of the simulated δ18Ocalc values and SST. In order to understand the coherence in the SST correlation (Fig. 6), we apply

an Empirical Orthogonal Function (EOF) analysis (von Storch and Zwiers, 2003) of observed SSTs using the updated GISST sea surface temperature data set (Rayner et al., 2006). Fig. 8 shows two distinct variability patterns in the North Atlantic Ocean: the first EOF explains 38% of the variance (Fig. 8a) with pronounced decadal and multi-decadal timescale variability in the principle component (PC1) (Fig. 8c). The second EOF explains 9% of the variance and shows zonal bands of SST stacked in the meridional direction (Fig. 8b). This mode is dominant on quasi-decadal timescales (Fig. 8d). Both EOFs account for a substantial amount of North Atlantic variability, and their signature can be recovered in the coherent correlation fields (Figs. 6, 7).

2) We avoided to show the lag composite maps because there were indeed confusing. We explore now the lag once (Fig. 5, due to the construction of the model) and emphasize the patterns. Mixing processes in the soil and karst above the cave represent a natural low-pass filter of the speleothem climate archive. Stalagmite δ18O values at Bunker Cave lag the regional surface climate by 3-4 years.

3) We focus on the SST pattern. We see that the main relation between the stalagmite and climate is through temperature. The effect due to precipitation is rather weak (Fig. 2). We emphasize that the longer the timescale, the more the variability is related to the ocean. On interannual time scales, internal variability of the atmosphere plays an important role in determining atmospheric circulation over the Atlantic sector (e.g., Mignot and Frankignoul, 2005). Modeling studies with atmospheric general circulation models (AGCMs) of different complexity forced by global SST variability over the last century show that the atmospheric circulation over the North Atlantic is at least partly predictable on decadal timescales if global SST variability can be predicted (Rodwell et al., 1999; Latif et al., 2000; Robertson et al., 2000; Sutton and Hodson, 2003; Grosfeld et al., 2007; Keenlyside et al. 2008).

We restructured the paper and the content is now more consistent and logical. We directly show the source of quasi-decadal periodicity in stalagmite records. Finally, we include more details about the Wackerbarth model in the text. The attached paper

plus figures show also the changes in the paper.

Please also note the supplement to this comment:
http://www.clim-past-discuss.net/8/C2945/2012/cpd-8-C2945-2012-supplement.pdf

Interactive comment on Clim. Past Discuss., 8, 3513, 2012.