Supplementary Information to "Influence of orbital forcing and solar activity on water isotopes in precipitation during the mid and late Holocene" by S. Dietrich et al.

Our aim for this study was to make the first attempt to evaluate the interference of solar activity and orbital forcing on $\delta^{18}O$ in rainwater that drives the calcite $\delta^{18}O$ signal in speleothems. It could be shown that this interference lead to highly non-linear responses basing on ten years long simulations with the AGCM ECHAM5-wiso (Werner et al. 2011). ECHAM5-wiso has already shown in a number of publications to perform well when comparing simulated results for present-day conditions with observational data (e.g. Werner et al., 2001, Langebroek et al., 2011).

In order to demonstrate that a model bias due to internal variability can be neglected we investigated results of a 40 years long ECHAM5-wiso simulation (CTRL). Therefore we split up this simulation in four 10 years long ensemble members of CTRL. The ensemble members ens1 to ens4 represent one decade each and their mean values are compared with those of the 40-year control experiment using the Student's t-test. The mean values of the surface temperature, the precipitation, as well as $\delta^{18}O$ in precipitation do not differ significantly - neither at the location of the Bunker record, nor when comparing European or global means (Fig. 1, Tab. 1 in this comment). Thus, we argue that ten model years are long enough to calculate an adequate representation of mean $\delta^{18}O$ values in precipitation if ECHAM5-wiso is forced with climatological mean boundary conditions.

Table 1. P-values derived from Student's t-test in order to compare the mean values of the single ten years long ensemble members with the 40 years long control simulation (CTRL). All values larger than α=0.05 means that the null hypothesis cannot be rejected and thus the mean values does not differ significantly from each other. The t-test is applied on time series from the Bunker Cave location, from mean values covering Europe (30°-70°N, -15°-45°E), and from global mean values.

Surface temp.	**BU**	**Europe**	**global mean**
ens1 vs CTRL	0.29	0.29	0.99
ens2 vs CTRL	0.85	0.85	0.91
ens3 vs CTRL	0.31	0.31	0.79
ens4 vs CTRL	0.07	0.07	0.89
δ^{18}O_prec			
ens1 vs CTRL	0.31	0.43	0.82
ens2 vs CTRL	0.21	0.69	0.07
ens3 vs CTRL	0.39	0.86	0.13
ens4 vs CTRL	0.55	0.56	0.63

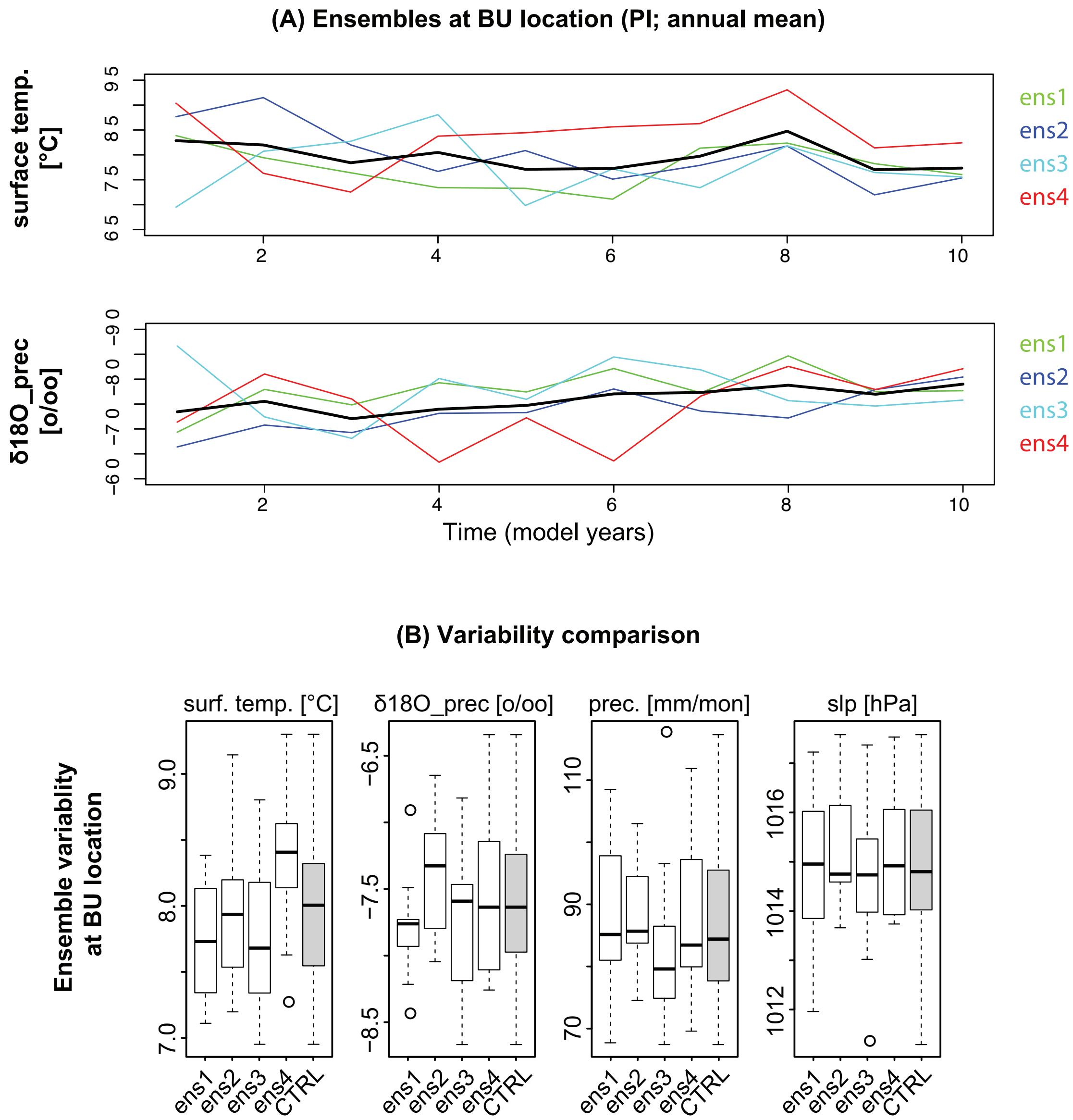

Figure 1. We have calculated a 40-year control experiment (CTRL) simulation for pre-industrial (PI) conditions. Subsequently, this experiment is spitted up into four 10 yeas rlong ensemble members (ens1-ens4). The bold black line show the ensemble means (A). The boxplots (B) show that the mean values at the location of the Bunker Cave (BU) do not differ significantly for various climate parameters. The boxplots summarise the smallest (largest) observation with the lower (upper) end of the whiskers, the lower (upper) quartile with the lower (upper) end of the box, and the median (bold black line), as well as outliers (circles) of a sample distribution.

References

Langebroek, P. M., Werner, M. and Lohmann, G.: Climate information imprinted in oxygen-isotopic composition of precipitation in Europe, Earth and Planetary Science Letters, 311(1-2), 144–154, doi:10.1016/j.epsl.2011.08.049, 2011.

Werner, M., Langebroek, P. M., Carlsen, T., Herold, M. and Lohmann, G.: Stable water isotopes in the ECHAM5 general circulation model: Toward high-resolution isotope modeling on a global scale, Journal of Geophysical Research, 116(D15109), 1–14, doi:10.1029/2011JD015681, 2011.