Geosci. Model Dev. Discuss., 8, C2579–C2582, 2015
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Geoscientific Model Development Discussions
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GMDD
8, C2579–C2582, 2015

Interactive comment on "Glacial–interglacial changes of $H_2^{18}O$, HDO and deuterium excess – results from the fully coupled Earth System Model ECHAM5/MPI-OM" *by* M. Werner et al.

Anonymous Referee #1

Received and published: 21 October 2015

Werner et al., present first results of the newly developed isotope-enabled version of the Earth System Model ECHAM5/MPI-OM. They focused on two equilibrium simulations under the pre-industrial and last glacial maximum period and compare the model results with observational data and paleoclimate records in the atmospheric/continental and oceanic components. Overall, isotope variations (δ18O, δD) for the PI and LGM climate are in good agreement with available data, although some bias are identified and discussed in the manuscript. The paper is well write, clear and the results interesting. In particular, the authors highlight interesting results that could be further explored in the future. Among them, the assessment of the stability of the δ–T relation for LGM-PI climate changes reveals that the temporal δ–T gradient might have been substantially

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lower than the modern spatial one for most mid- to high-latitudinal regions. Such a deviation, could indeed causes a strong bias in the “classical” δ-paleothermometry approach. Also, the remarkable improvement in modelling the deuterium excess signal allows to question the approach by Merlivat and Jouzel (1979), question the cooling of SST during the LGM and support the “classical” interpretation of dex changes in Antarctic ice cores as a proxy for SST changes in the source regions of water transported to Antarctica. I think this paper is suitable for publication in GMD and I recommend publication after the authors have adressed the moderate/minor comments below.

Comments :

1) page 8837 Lines 15-19 : Some studies concerning Chinese speleothem suggest that d18O variations reflect changes to regional moisture sources and the intensity or provenance of atmospheric transport pathways (LeGrande and Schmidt, 2009; Dayem et al., 2010; Lewis et al., 2010; Maher and Thompson, 2012; Caley et al., 2014; Tan, 2014).

2) page 8841 lines 25-26 : Âń under pre-industrial and LGM, defined as the period 23 000–19 000 years before present Âż A reference is needed here.

3) page 8846 line 12 : Âń with a prescribed glacial increase of δ18O of +1 ‰ (δD: +8 ‰ Âż Here, the authors prescribed a glacial increase of 8 ‰ in δD for the LGM period. According to Schrag et al., 2002, the glacial increase would be around 7.2‰Ȧlso, if all the GISS data (depth< 3000 meters) (Schmidt et al., 1999) are used, the present day relationship between δ18O and δD give a glacial δD increase of 7.3‰ for a δ18O value of 1‰ (assuming that this relationship is still valid during the LGM). Therefore, the two independant approches lead to a δD increase of 7.2‰ rather than 8‰ during the LGM. What could be the implications of such a different value on the deuterium excess calculation presented in this manuscript in part 4.2.4?

4) page 8848-8849 Kim and O'Neil 1997 equation. I don't understand how the data-

model comparison is done. Does the authors have used the temperature in the model and the d18O of the calcite from speleothem data to calculate a d18Owater value and then compare this to model values in Figure 1 ? On figure 1, there is only a scale of d18O in precipitation and the speleothem records are included. Please explain in more details how the d18Owater of speleothems are calculated (which temperature values are used ?). In the legend of the figure 1, the Table 1 and Table 2 do not refer to the corresponding dataset, please inverse. On Figure 8, I am again confused because the speleothem data are presented in green on a d18Oprecipitation scale but the figure caption mention that the d18Ocalcite changes are shown. I recommend to use atmospheric temperature to calculate the d18Op of speleothem and then plot this on figure 1 or 8. Alternatively, the authors could separate the speleothems data and compare the d18Ocalcite data with d18Ocalcite of the model (calculate from temperature and d18Op from the model) as it was done for marine carbonates.

5) Page 8849 Shackleton (1974) equation. There is a conversion between the two scale (PDB and SMOW) : expressed as d18O water(VPDB)= d18O water(VSMOW))−0.27 (Hut, 1987) that is not describe here and that is necessary.

6) Conclusion part, page 8866, line 29 Âń CLIMAP Âż. I think this is cooler than MARGO, not Âń CLIMAP Âż.

7) Figure 4 : Âń arbitrary subset of 300 data Âż. I rather suggest to the authors to revise the figure and show the model results without data on a new panel a) and add on a secondary panel with all the GISS data (Atlantic Ocean: n = 5811, Pacific Ocean: n = 2985) with or without model results. The comparaison between model and all the GISS data will be possible with readability.

References :

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Interactive comment on Geosci. Model Dev. Discuss., 8, 8835, 2015.