

Interactive comment on “Water isotopes – climate relationships for the mid-Holocene and pre-industrial period simulated with an isotope-enabled version of MPI-ESM” by Alexandre Cauquoin et al.

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cp-2019-72 Water isotopes – climate relationships for the mid-Holocene and pre-industrial period simulated with an isotope-enabled version of MPI-ESM Author(s): Alexandre Cauquoin et al.

General comments This manuscript describes the enhanced isotope-enabled version of the MPI-ESM Earth-system model. Climate models associated with isotope diagnostics are becoming more common. They are an increasingly important component

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of the palaeoclimatological ‘toolkit’. Given prevalence of isotopic proxies within palaeoclimate archives and the difficulties that are often associated with converting palaeoclimate proxies, including those based on stable isotopes, into estimates of temperature and precipitation, it makes sense to equip the models with isotope diagnostics rather than attempt to cover the proxies into more ‘traditional’ estimates of palaeoclimate. Comparison of different isotope-enabled models is well established through the Stable Water Isotope Intercomparison Group (Phase 2 - <https://data.giss.nasa.gov/swing2/>). Comparisons of isotope records from marine, ice core and terrestrial archives with output from isotope-enabled models have been completed for the present and past (see, for example, Sturm et al., 2010; Werner, 2010; Jones and Dee, 2018). Detailed descriptions and performance evaluations for new or enhanced models are important, hence this MS is well suited to CoP. The paper is well structured and generally well argued and written. I have a few specific comments on the content as well as some minor suggestions for improvement in the language, which are detailed below.

The authors begin with a well-reasoned account of the rationale behind isotope-enabled models. They then describe the isotope-enabled MPI-ESM model in some detail, along with the results of simulations for the pre-industrial and mid Holocene (=6ka) intervals and the modern-day and paleo-water isotope datasets used for model evaluation. They finally examine pre-industrial – 6ka differences in the data and in the model and compare spatial and temporal gradients in the atmosphere and oceans, which have particular relevance to the interpretation of paleo-isotope records.

I have general familiarity with isotope-enabled models, but do not have the technical expertise to be able to comment in detail on the model setup and simulations: I focus instead on the data-model comparisons.

Specific comments Page 2, line 30-32. You could also cite Pfahl and Sodemann (2014), which you cite elsewhere, and also Fröhlich et al. (2002), which additionally lists moisture recycling and evaporation of falling raindrops as controls on the deuterium excess. Also, isn't d a more usually symbol for the deuterium excess?

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Page 3 line 35 – page 4 line 4. You could add reference to the freshwater hosing experiments in HadCM3 (Tindall and Valdes, 2011) and the comparison of the results of those experiments with palaeo-isotope data from lake sediments (Holmes et al., 2016).

Section 2.3 Observation data. How representative of pre-industrial conditions are the observation data? The ocean water and GNIP data are certainly not pre-industrial: the speleothem data span the pre-industrial and the post-industrial period. None of the datasets could be exclusively pre-industrial. While this may not be a problem, the authors should at least discuss the mismatch and any implications.

Page 13 Line 24 – rephrase, as it appears that low values are found both in dry and in humid regions if I interpret your results correctly.

Page 13 Line 24 – Rajasthan (India)

Page 14 Line 19 – Not clear what you mean by ‘on one side’

Page 26 Line 3 – Isn’t this quite surprising given that most rainfall occurs in summer in such regions?

Page 27 Line 1-2 – isn’t there a similar pattern, but not as well expressed, in the Arabian Sea?

References Holmes, J. A., Tindall, J., Roberts, N., Marshall, W., Marshall, J. D. Bingham, A., Feeser, I., O’Connell, M., Atkinson, T., Jourdan, A-L., March, A., Fisher, E. H. (2016) Lake isotope records of the 8200-year cooling event in western Ireland: Comparison with model simulations. *Quaternary Science Reviews*, 131, 341-349.

Jones, M.D. and Dee, S.G., 2018. Global-scale proxy system modelling of oxygen isotopes in lacustrine carbonates: New insights from isotope-enabled-model proxy-data comparison *Quaternary Science Reviews*. 202, 19-29

Froehlich, K., Gibson, J.J., Aggarwal, P.K., 2002 Deuterium excess in precipitation

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and its climatological significance. International conference on study of environmental change using isotope techniques; Vienna (Austria); 23-27 Apr 2001, p.54-66.

Pfahl, S., Sodemann, H., 2014. What controls deuterium excess in global precipitation? *Climate of the Past*, 10, 771-781.

Sturm, C., Zhang, Q., Noone, D., 2010. An introduction to stable water isotopes in climate models: benefits of forward proxy modelling for paleoclimatology. *Climate of the Past*, 6, 115-129.

Tindall, J.C., Valdes, P.J., 2011. Modeling the 8.2 ka event using a coupled atmosphere-ocean GCM. *Glob. Planet. Change* 79, 312-321.

Werner, M. 2010 Modelling stable water isotopes: Status and perspectives *EPJ Web of Conferences* 9, 73–82

Technical corrections General The authors make common use of phrases that would undoubtedly disturb isotope ‘purists’: examples include ‘depletion in isotopic composition’ (p1, line 19), ‘depleted isotopic values’ (p1, line 22 and elsewhere), ‘depletion of delta18Op’ (p10, lines 9 and 11, and elsewhere) amongst others. I know that opinion is divided over such terminology and that some authors regards its use as heretical, whereas others regard such authors as puritanical pedants. I leave it to the present authors and editor to decide in this case. Table 2.1 in Chapter 2 of *Principles of Stable Isotope Geochemistry*, 2nd Edition, by Zachary Sharp (available for free download at https://digitalrepository.unm.edu/unm_oer/1/ provides careful guidance in case the authors wish to follow the purists, or should the editor compel them to do so!

Specific Page 1 Line 12 and passim ‘In link with’ is a slightly strange phrase – ‘linked to’ would be better.

Page 4 Line 12 ‘...seasonal changes in insolation...’ perhaps?

Line 15 Which part? The Monsoon domain? Clarify.

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Line 21 'near-surface air temperature' Also 'ocean salinity'

Page 7 Line 28 '...are both at 0%.

Page 13 Line 24 'are found' rather than 'happen'

Line 31 'distinguish between' rather than 'distinct the'

Page 18 Line 12 Taylor

Line 14 Siple Dome

Page 19 Line 18 '(not shown) is...'

Page 23 Line 21 '...a higher'

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