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Interactive comment on "Modelling oxygen isotopes in the University of Victoria Earth System Climate Model" *by* C. E. Brennan et al.

Anonymous Referee #1

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Formal review of Modelling oxygen isotopes in the University of Victoria Earth System Model, by Brennan et al.

In the manuscript, Brennan and co-authors describe the implementation of water isotopes in all components of the UVIc coupled climate model of intermediate complexity. They describe the performance obtained for present-day and LGM equilibrium and compare it to some extent to available data.

Though the implementation and use of water isotope in the hydrological cycle is in principle of prime importance to interpret paleo-evidence arising from ice-core as well as oceanic cores, I regret to say that the present manuscript fails to bring convincing

evidence that the UVIc model is able to simulate the water isotopes in a predictive manner. The method employed (as described below) though ensuring results that compare favorably with present-day data do not allow to predict the LGM distribution (see model –data comparison for LGM below). In my opinion, the conclusions brought by the authors that "the isotope-enabled UVic ESCM may be best utilized [...] with determining oxygen isotopic anomalies (between climatic states)" and that "the model may be well suited to improving the interpretation of oxygen isotopes records from the ocean sediment cores" (p. 2559) is simply wrong, as shown by their LGM analysis already.
I do not recommend the manuscript for publication until the authors show that:

1 The model is able to compute a prognostic water transport in the atmosphere that could bring some information to the precipitation and its fractionation

2 The model has some skills in predicting the deuterium excess, a secondary parameter of the water isotope cycle that is tightly linked to the fractionation of water vapor at evaporative regions and to water transport.

3 Modeled water and isotopic species are treated in the same way, that is without tuning of the diffusivity of one specie with respect to the other.

4 The model has some skills in reproducing paleo-evidences for the LGM, in a prognostic manner, including d18 of seawater as derived from the MARGO database.

General Comments
I have three main general comments that undermine all the presented work as stated

hereabove.

1 The model as described in page 2547 – 2548 of the current manuscript uses, in the atmosphere, water transport prescribed from NCEP winds and prescribed diffusivities to represent a moisture transport that is in broad consistency with present-day evidences. The evolution of d18O in precipitations at the surface of the Earth being mainly determined by the transport and fractionation that occurs in the atmosphere, it is thus no surprise that using a water transport tuned to present-day, simulated d18O favorably compares with present-day data. Even more so as the authors are using a **tuned diffusivity coefficient** for H218O relative to H216O (cf. their figure 1) where physically the two isotopes are transported in exactly identical manner. The use of such a tuned diffusivity introduces additional fractionation for the d18O, without any physical sense. Overall, the fact that d18O favorably compares with the observation is thus just a matter of tuning of present-day fields to the observation. There is **no** predictive skill in the simulation presented.

2 Concerning the LGM simulation, I see to major points that need attention. One is of course the fact that using a model with tuned present-day water transport and diffusivities in an LGM climate will not result in simulating the LGM distribution of d18O in precipitation at the LGM. This will only indicates the d18O in precipitation with identical water transport as for today, but in a globally colder climate. Hence, the comparison to d18O in precipitation to data is meaningless. That might explain why the ice-sheet are seeing a positive fractionation between LGM and PI and not negative as expected. The fact that the model has no skill in predicting d18O in precipitation for the LGM is apparent in Table 2: for mid and low latitudes d18O in precip the model in all case but one is giving a sign opposite to the one arising in the data. The case for the model to be able to reproduce the data is

evidently no.

3 The distribution of d18O of seawater in the ocean is depending on the input function (Precipitation minus Evaporation, grossly) and is then advected as a passive tracer in the ocean. The fact that the model is unable to reproduce the d18O in precipitation for different climate but the present-day one to which it is tuned implies that it is similarly impossible for UVic to simulate the d18O of seawater under different climate condition, a fact that directly contradicts the conclusions brought by the authors.

Interactive comment on Geosci. Model Dev. Discuss., 4, 2545, 2011.