Geosci. Model Dev. Discuss., 6, C1127–C1132, 2013
www.geosci-model-dev-discuss.net/6/C1127/2013/

Geoscientific Model Development Discussions Open Access

Interactive comment on "δ^{18}O water isotope in the *i*LOVECLIM model (version 1.0) – Part 1: Implementation and verification" *by* D. M. Roche

D.M. Roche

didier.roche@lsce.ipsl.fr

Received and published: 23 July 2013

Below is my answer to the comments received by reviewer #2: the initial comments are *in italic*, my response **in bold** and the subsequent changes to the text `in typewriter` where necessary.

We thank the reviewer for his/her constructive comments and kind words.

General Comments

The author describes the implementation of a scheme for representing O-18/O-16

water isotope ratios (delta O-18) in the LOVECLIM Earth system Model of Intermediate Complexity (EMIC). Such ratios have been simulated in higher and lower complexity climate models in various studies over the last 20 years or so (as cited in the manuscript), but this is perhaps the most comprehensive attempt to date to represent delta O-18 in an EMIC.

I thank the reviewer for their appreciation of the work presented. It is indeed remarkable that the GCM world as long focused on the small-scale processes for water isotopes in the clouds and related processes but that few attemps have been implemented in EMiCs. The reason behind might be the assumed complexity of the processes within the cloud microphysics that is obviously not represented within EMiCs.

The only other such attempt of which I know is an implementation in the UVic model (Brennan et al. 2012), and this paper should perhaps be cited, in either/both Introduction and/or Conclusions. To the extent that they are reliably able to reproduce most of the present-day links between delta O-18 and temperature/precipitation/salinity (as tested here), EMICs are ideally suited (rather than slower GCMs) for exploring past climate changes in ocean circulation and climate that are typically inferred from proxies, but often poorly understood or only hypothetically explained. iLOVECLIM is therefore an important addition to this developing model family. As a model description, the manuscript should be suitable for publication in GMD, subject to minor and technical revisions in response to the comments below.

Reference: Brennan, C.E., Weaver, A.J., Eby, M. and K.J. Meissner, 2012: Modelling oxygen isotopes in the University of Victoria Earth System Climate Model for Pre-industrial and Last Glacial Maximum Conditions, Atmosphere-Ocean, DOI:10.1080/07055900.2012.707611.

Thanks for pointing this reference out. To my knowledge, there are a few more attempts: I did one within the CLIMBER-2 model years ago, but also some developments where conducted within the GENIE-1 model, whose atmosphere is comparable to the UViC. Somewhat philosophically if I may, the treatment

of water is to be divided in two groups: it is comparable in CLIMBER-2 and *i*LOVECLIM with full advection of water and again comparable in the UViC and GENIE-1 the latter two being EMBMs with some assumption on the transport of water. Whether the resulting d18O field is comparable in time varying scenarios is an open question for me; an EMiC intercomparison with water isotopes would certainly be valuable in that sense.
Back to the point of the reviewer, the reference suggested was added to the introduction, with the following text:
`More recent developments (Brennan et al., 2012) showed that for present-day conditions, simplified modeling approaches could yield large-scale fields in accordance with data. The approach taken in the present study is somewhat similar, albeit with a more comprehensive treatment of water advection, precipitation and evaporation within the atmospheric component.`

Specific Comments
1. Section 2.1.1 – I think it would be helpful to specify units for the "quantity of precipitable water for the whole atmospheric column" – this seems clearly a depth (m), assuming mks
Indeed, the unit is meters, now specified in the revised version of the text.
2. p.5, l.11: specify "surface area of the cell"
Done as per suggestion.
3. p.5, eqn. (3): define $R18$
The definition was added after equation 3 as follow:
[...] where R^{18} refers to the classical simplified form $R^{18} = \frac{n^{18}}{n}$.
4. p.6, l.2: define upper-case lambda
I do not quite get the issue there. There is no lambda in the page and section cited?

5. p.6, l.3: clarify "surface specific humidity immediately above the ocean" (if that is what you mean); clarify "humidity of atmospheric layer 1"
Modified in the revised version as per suggestion.
6. p.6, eqn (5): Is Ri_E *equivalent here to* $R18_E$*?*
Yes, this has been corrected in the revised version.
7. p.8, eqns. (11)-(13): define the alphas – I assume these are fractionation coefficients?
Yes, this has been specified in the revised version.
8. P.9, l.3: lower-case lambda is noted as a tunable parameter – what value was used to obtain the verification results? How sensitive might these results be to lambda?
This has been specified in the text of the revised version.
9. Section 3.1.1, eqns. (19)-(30), seems like standard theory – is this all necessary here? It may be OK to keep this in the paper, but which of the equations are actually implemented and used in iLOVECLIM?
Following a similar remark from the other reviewer, this part has been moved to the appendix in the revised version.
10. Fig. 2: Perhaps zoom-in on the erroneous decrease of delta O-18 with increasing humidity (highlighted in the text), in the ranges 0.000 to 0.001 m and -20 to -40 per mil, and show it in an insert to Fig. 2?
A zoom-in was added to the revised version to increase readability as per suggestion.

Technical Corrections
I have corrected the revised manuscript following the suggestions unless otherwise stated.
1. p.3, l.15: "resources"
2. p.6, l.19: "that exchanges"
3. p.8, l.14: Clarify "Thus our fractionation scheme for large-scale or convective precipitation, and snow, may be summarized as"

4. p.8,9, eqns. (15), (16): Choose a symbol other than S, as this was previously used for surface area in eqn. (1) – alternatively use A for area in Eqn. (1)
I chose the latter option since S is the standard formulation for equation 15 & 16.
5. p.10, l.22: "fractionation"
6. p.11, l.10-11: Improve clarity as "In order to assess implementation of all above fractionation factors, we now ..."
7. p.11, l.12-13: ": : : and selected simulated ..."
8. p.11, l.16: "as follows"
9. p.11, l.17: "loses"
10. p.12, l.3: "yields"
11. p.13, l.5: "recharged"
12. p.13, l.14: "Another"
13. p.16, l.22-23: "... yields a very positive result, enabling detection of some defects ..."

References

Brennan, C. E., Weaver, A. J., Eby, M., and Meissner, K. J.: Modelling oxygen isotopes in the University of Victoria Earth System Climate Model for Pre-industrial and Last Glacial Maximum Conditions, Atmosphere-Ocean, 50, 447–465, doi:10.1080/07055900.2012.707611, 2012.

Interactive comment on Geosci. Model Dev. Discuss., 6, 1467, 2013.

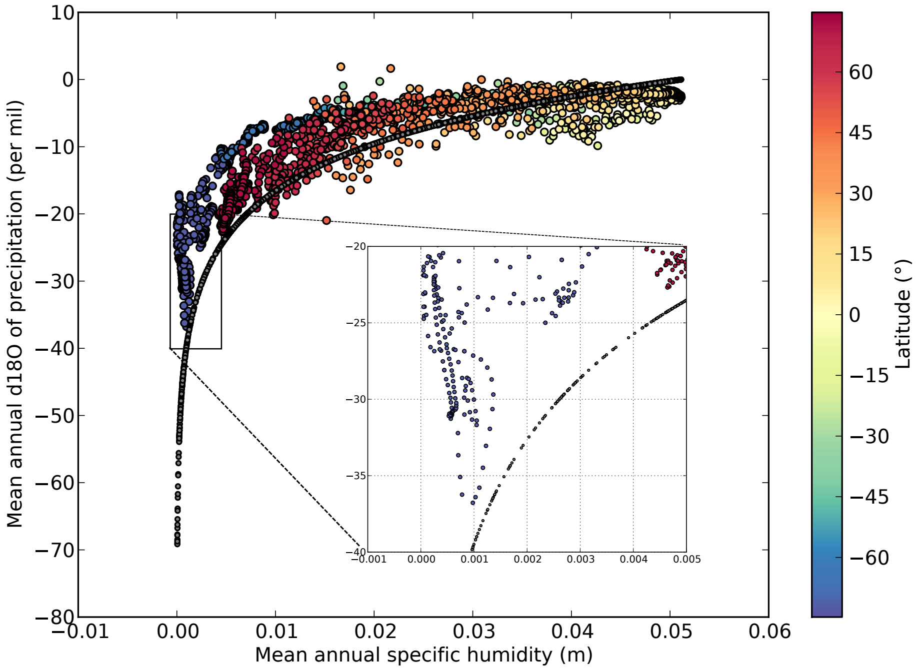

Fig. 1.