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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Modelling and intepreting the isotopic composition of water vapour in convective updrafts" *by* M. Bolot et al.

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Answer to referee #3

We thank referee #3 for his comments and suggestions, and respond to specific comments below. (In the text below, comments by the referee are in bold face and our answers in regular font.)

1. ***Introduction: To draw attention to the difference from the recent modeling work, it is better to briefly explain how water isotopes are incorporated into state of art GCMs. The most of convective scheme in the GCM do not take into account mixed phase zone, so that, as mentioned in the text, the de-***

gree of supersaturation is parameterized as a function of temperature. In addition, the appropriate parameter is often chosen to reproduce the observed isotope behavior in the cold region (e.g., Hoffmann et al., 1998). The authors should add these problems in the introduction.

We agree with the reviewer that it would be useful to better highlight the differences between our approach and GCM work from the beginning, and have added language to this effect. We mention approximations used in the representation of water isotopes in GCMs in several locations scattered in the text, but we agree that we should add discussion in the introduction, and are doing so in the revised manuscript.

2. ***P22461 L.24: Does Fig?? mean FigB1?***

   Yes, apologies for the LaTeX glitch. Now corrected.

3. ***P22464 L12: "total water be conserved"*** $->$ ***"total water must be conserved"***

   We liked the subjunctive tense, but it seems confusing, so we propose to replace the phase by "requires the conservation of total water."

4. ***P22474 L7: The word of "generalised" is correct? I think this is "generalized". . .***

   Because ACP is a European journal we have used British English spelling throughout the manuscript, assuming that this is the ACP editorial standard. (British spellings that can seem jarring include "modelling" instead of the American "modeling" and "..ised" instead of "..ized").

5. ***P22490 L21: "This works also suggests"*** $->$ ***"This work also suggests"***

   Corrected.

6. ***Section 6: To conclude that the cloud parameters can retrieve from isotopic values obtained from both cloud base and cloud top, the uncertainty arising from the adiabatic assumption should be discussed in this section. Undiluted updraft is an ideal case, and convective entrainment cannot be disregarded in the real convective systems.***

   We agree with the referee that entrainment is an important component of real convection. Both reviewers have expressed a desire to see better motivation of our assumptions and discussion of their limitations, a suggestion that we agree with, and we have added discussion to this effect.

   The question of whether convective plume reach their detrainment level undiluted is not yet a settled issue. Tracer studies and the fact that the distribution of equivalent potential temperature at cloud top more or less follows that at the ocean surface have long been used to support the undiluted hypothesis, but recent work has questioned this hypothesis (Romps and Kuang, 2010, DOI: 10.1175/2009JAS3184.1). It is not known, however, whether the arguments of Romps and Kuang apply to large mesoscale convective systems which reach the highest levels in the tropical region and are the most relevant for our work. We therefore did not find it unrealistic to assume an undiluted ascent as a first step, though we have now added discussion of the complications that could result from entrainment.

7. ***In addition, the authors must mention how to obtain the isotope data of updrafted air. We can obtain spatially averaged isotopic values from satellite or aircraft observation, but cannot partition between updraft and downdraft region. I think that the discussion in this section is too ideal to apply to the real world.***

   We have added more specific language about the measurement of potential tracers. While the horizontal resolution of satellite observations generally precludes separation of updraft and downdraft regions, high-altitude aircraft measurements

   appear to be able to sample outflow from cumulus anvils that is sufficiently recent that neither strong mixing with the environment nor evaporation of lofted ice has occurred. Some degree of mixing is of course inevitable, but anvil outflow has been seen to be isotopically distinct from its surrounding environment, giving hope that aircraft instruments can provide the type of measurements we envision in the text.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 22451, 2012.