Review of the article by Dahinden et al

July 11, 2021

This study presents an evaluation of an isotope-enabled regional model simulation over Canary Islands compared to airborne, ground-based remote-sensing and satellite observations. Using this simulation, it investigates the variability in humidity and isotopic composition using back-trajectories. The main result is that humidity and isotopic composition mainly depends on the origin of air masses, which is associated with synoptic weather patterns.

The article is well-organized, well-written, well-illustrated. The rationales are sound. The methods are extensively described.

This study will be interesting for the people in the water isotope community. It provides a methodological framework for investigating observed synoptic variability in isotopic composition. It adds to the studies showing the importance of synoptic-scale weather patterns in controlling the humidity and isotopic composition in subtropical regions.

Apart from more discussion of the results with respect to previous studies, I recommend mostly minor revisions.

1 General comment: discuss more the results with respect to previous studies

More discussion of the results would be valuable. A discussion section could be added before the conclusion. This discussion section could also help make the conclusion section more concise by moving some paragraphs from the conclusion to the discussion.

- The study by [Lacour et al., 2017] was on a very similar topic. It is cited in the introduction but never after. It diserves to be more discussed. To what extent are your results consistent with their study? What is the added value of this study compared to their study? What new do we learn?
- Section 4.3 on large-scale flow has no citation. I would be surprised that none has ever investigated the origin of air masses and synoptic weather patterns in this region. How do your results compare with previous studies? What is the added value of this study relative to the state of the art?
- The introduction advertises about the added value of water isotopic observations. What do we learn in this study that we couldn't learn without isotopic observations? Couldn't the back-trajectory analysis and the q_v along trajectories alone be sufficient? The isotopic simulation is useful to interpret the isotopic observations, but is there any usefulness of isotopic observations or simulations for people beyond the isotopic community? A few examples:
  - l 500: "added value of water vapor isotopes": what would fig 8a look like with q_v? Wouldn't we get distinct signature as well? Fig 8b suggests that q_v and δD are strongly correlated...
  - fig 9: would it be insightful to show these trajectories in a q_v- δD plot?
  - l827: Can't q_v be similarly regarded as an integral measure of West AFrican Dynamics?

  ⇒I suggest to add some discussion about to what extent water isotopic observations provide an added value compared to q_v , or not.

2 Minor comments

- l 116: Blossey et al 2010 did not use a regional circulation model and did not study synoptic-scale variability. It was a cloud resolving model (higher resoution) in a very idealized setting that allows the simulation of the tropical circulation in a stationary state. I wouldn't list it with the other studies here.
- l 228: can you give more details about your cloud filtering? e.g. what threshold, what altitude for the cloud fraction? Is the fraction of selected scenes in the model similar to this fration in reality? This could go in an appendix.
- l 249: same here: can you give more details about your cloud filtering? Why is it different from that for FTIR? What thresholds do you use? Is the fraction of selected scenes in the model similar to this fration in reality? This could go in the same appendix as above.
- l 252-253: what does this mean? Variability of what? Of the averaging kernels? Or of δD? Do you mean retrieval simulator combined with COSMOiso, or is it an intrisic property of te simulator?
- l 323: I didn't follow why there are only seven trajectories. I thought there were seven days with many trajectories for each day?
- l 343-344: it must be clarified here that most of the apparent variability is associated with the vertical gradient in humidity and δD. "short-term variability" is confusing here because it evokes temporal variability, whereas here the vertical variability is probably dominant.
- l 345-347: "$\Delta ln(q_v)$ " -> "Δq_v", since the values are in g/kg. The values for $\Delta ln(q_v)$ would have no unit, or in %.
- l 351: does this sampling includes vertical variations? If so, clarify that the shading probably mainly reflects the vertical variations?
- l 364: I don't understand this rationale. Why couldn't be the over-estimated q_v and δD due to the dry and depleted tongue around 15W that does not reach far enough towards the equator (around 30N in COSMO and 25N in ERAI)?
- l 411: "despite small" or "in spite of small"
- l 421: Couldn't there be an enriched bias for δD observed by FTIR, and to a lesser extent by IASI? The comparison with in-situ data suggests that the model has an enriched bias, not a depleted bias. Previous studies cross-comparing different datasets have shown that the FTIR observations are often the most enriched ([Risi et al., 2012, Lacour et al., 2015]).
- Are the COSMOiso simulations and observations used in the comparison available in a repository?

References

[Lacour et al., 2015] Lacour, J.-L., Clarisse, L., Worden, J., Schneider, M., Barthlott, S., Hase, F., Risi, C., Clerbaux, C., Hurtmans, D., and Coheur, P.-F. (2015). Cross-validation of iasi/metop derived tropospheric ?d with tes and ground-based ftir observations. *Atmospheric Measurement Techniques*, 8(3):1447–1466.

[Lacour et al., 2017] Lacour, J.-L., Flamant, C., Risi, C., Clerbaux, C., and Coheur, P.-F. (2017). Importance of the saharan heat low in controlling the north atlantic free tropospheric humidity budget deduced from iasi δd observations. *Atmospheric Chemistry and Physics*, 17:9645–9663.

[Risi et al., 2012] Risi, C., Noone, D., Worden, J., Frankenberg, C., Stiller, G., Kiefer, M., Funke, B., Walker, K., Bernath, P., Schneider, M., Wunch, D., Sherlock, V., Deutscher, N., Griffith, D., Wernberg, P., Bony, S., Jeonghoon Lee, D. B., Uemura, R., and Sturm, C. (2012). Process-evaluation of tropical and subtropical tropospheric humidity simulated by general circulation models using water vapor isotopic observations. Part 1: model-data intercomparison. *J. Geophy. Res.*, 117:D05303.