Review of dos Santos et al

December 16, 2023

The paper has been revised, although the responses to comments are minimal. However, there is still significant work on this paper before it can be acceptable. Through the revision process, the authors improve some aspects and deteriorate others.

There are still big issues with the language. I advice a thorough proof-reading process by an English-speaking person again.

Also, some careful proof-reading should focus on making all sentences simpler, clearer and more specific. I have given several suggestions in the minor comments, but this is a general comment that should be taken into account more broadly.

1 Major comments

1.1 Clarify section 2.6 on the sub-cloud evaporation model and use it in the discussion, or remove

- Section 2.6 needs to be clarified. For example, explain the physical basis, key equations and necessary outputs before explaining the technical details of how you calculate the inputs.
  - First explain the objectives of this model. What are the inputs? What are the outputs?
  - Then explain the physical basis for this model. Include here the key equations and explain the simplifying assumptions behind these equations.
  - Then explain the assumptions underlying how you calculate the inputs of the models. Be sure you make the difference between the hypothesis underlying the physical model, and those underlying the calculation of the inputs.
- How δ_0 and δ_A are calculated needs to be explained in the text. The underlying assumption of this calculation need to be clarified.
- This model is not really used in the discussion. There are just a few lines about it l 419-423. It is not explained how the model is used, what is the purpose, how we conclude anything from it. The reader is just sent to Table 2, without any explanation of it. The model should be used in a more convincing way, otherwise, simply remove it.

1.2 Physical meaning of $\delta_{initial}$, δ_{med} and $\Delta\delta$?

Section 2.7

- $\Delta\delta$: can the max and min be anytime in the event? If so, what physical meaning does it have? In addition, how sensitive is it to the duration of the sample collection? e.g. longer duration for sample collection may artificially reduce $\Delta\delta$? And how sensitive is it to the threshold of rain amount that could be used as samples? e.g. if smaller samples are collected at the end of events, they may be more evaporatively enriched?
- Same for δ_{med}: what physical meaning does it have? Why not simply using the precipitation-weighted δ , as in most studies? I expect that the precipitation-weighted δ of the event would be more representative of the large-scale vapor.

- It is assumed at several locations (e.g. l 212, l 351) that $\delta_{initial}$ is representative of the large-scale vapor. This is not convincing. Usually, $\delta_{initial}$ is affected by rainfall evaporation, because the first raindrops often fall with low rain rate and drier conditions, e.g. [Risi et al., 2010, Tremoy et al., 2014].

I advice to use precipitation-weighted δ for analysis at the inter-event scale. At the intra-event scale, clarify what $\Delta\delta$ mans or use something more physically relevant.

1.3 Description of the results is too lengthy

Section 3.3 is very painful to read. It would help so much the reader to present the results in a more synthetic way. The most interesting part is in the discussion, but when the reader arrives at the discussion, the results section was so long that everything is forgotten. In the results, focus on what is useful to remember to follow the subsequent discussion.

2 Minor comments

- l 25-27: Reword as: "During summer, the $\delta_{initial}$ values were lower dues to higher rainfall along trajectories from the Amazon forest, whereas during automn and spring, the $\delta_{initial}$ values were higher due to lower amount of rainfall along trajectories from the Atlantic Ocean and Southern Brazil."
- l 32: "meteorological" -> "isotopic"?
- l 32: "modelling" -> "model evaluation"
- l 45: "quick condensation "and formation of precipitation with substantial droplets heavy rainfall" -> "large condensation and precipitation rates" (it's more quantitative, and "substantial droplets" doesn't mean anything
- l 53-54: merge paragraph
- l 55: de Vries et al 2022 is for squall lines, so it is a convective systems. Other precipitating events have been well studies as well: e.g. mid-latitude cyclones, fronts... e.g.[Barras and Simmonds, 2009, Celle-Jeanton et al., 2004, Aemisegger et al., 2015, Thurnherr and Aemisegger, 2022, Landais et al., 2023, Muller et al., 2015]. They deserve to be cited.
- l 66: remove "and local evaporation effects", because it is not a weather system.
- l 67-69: this mixes too many different things. Reword as "High-resolution isotope information can provide a better insight into the isotopic variability during the life cycle of rainfall events".
- l 158: "Preliminary assessment of local processes" -> "Quantifying the impact of post-condensational processes". It's more specific.
- l 159-164: "Below ... conclusions.": avoid repetitions: suggestion: "Below-cloud atmospheric conditions are known to affect the rainfall composition through rain-vapor interactions. Since the isotopic composition of near-ground water vapor during the rainfall events was not measured, the framework proposed by Graf et al 2019 cannot be applied here." And then go on explaining what you do instead.
- l 217: suggested outline:
  - 3.1. Inter-event variability of meteorological and isotopic parameters
  - 3.1.1. Seasonal-mean climatic conditions
  - 3.1.2. Isotopic variations
  - 3.1.3. Moisture origin
  - 3.2 Intra-event variability of meteorological and isotopic parameters
  - 3.2.1. During summer
  - 3.2.2. During automn and spring
- l 233-234: reword as: "thermal convection over land lead to convective rainfall"

- l 279-280: "This study... lack of pattern": I don't understand this sentence. Remove. The second sentence is more specific.
- l 283: "intra-events" -> "intra-event variation of XX".
  Intra-event is an adjective, not a noun. This applies everywhere.
- l 282: "unique temporal patterns": be more specific or remove.
- l 287: "$\Delta\delta$ values for d-excess" -> "Δd" and define this earlier (sec 2.7).
- l 291: "specific local factors" -> "sub-cloud evaporation". It's more specific.
- l 293: "consistent" -> "similar"
- l 294: ". In contrast, these events showed" -> "But different d-excess evolution."
- l 304: "dis displayed in a vertical profile, illustrating these changes, with, " -> "shows"
- l 308: "parameter" -> "parameters"
- l 322: "increase trend" -> "increasing trend"
- l 346: "Detailed" -> "description"
- l 346: "were provided by both inter- and intra-events" -> "was provided at both inter- and intra-event scale"
- l 346-348: "Such... rainfall." Remove, I don't understand what it means.
- l 353: "of moist" -> "from moist"
- l 373: "representing" -> "during"
- l 375: "enhanced ... processes" -> simply "enhanced evapotranspiration"
- l 380: "Now ... its is possible ..." -> "In the extreme case where all the water vapor that is lifted by convection and condenses comes from evapotranspiration, it is possible ..."
- l 381: the assumption of isotopic equilibrium may be relevant for the first condensate, but the first condensate is not relevant to represent convective precipitation, which integrates condensation at all altitudes. This is why the calculated values are completly unrealistic for precipitation.
- l 379-390: I would replace all this calculation with unrealistic assumptions and unrealistic results by simply citing previous studies that have properly investigated the impact of evapotranspiration on the vapor and rainfall composition, e.g. [Salati et al., 1979, Worden et al., 2007, Brown et al., 2008, Levin et al., 2009, Risi et al., 2013, Worden et al., 2021]
- l 400: "Rayleigh distillation governs the depletion": clarify what this means. Depletion relative to what? What is different for this event relative to other events?
- l 402: "exchange": between what and what? Rain-vapor?
- l 405: "varying profiles": of what?
- l 407: "during a specific time of the event": be specific: which time?
- l 407: remove "was"
- l 408: "during" -> "at"
- l 413: "diverse": be more specific
- l 414: "under low humidity conditions": this sentence suggests that rainfall patterns depend mainly on RH. This is not true. Same l 421: the RH is not the only/main control on the vertical structure of rainfall. Reword to explain that both the vertical structure of rainfall and the humidity impact the local isotopic composition of rain?

- l 413-415: Reword: I think the point to make here is that when the rain evaporates in a dry environment, rain evaporation favors enrichment of the rain.
- l 435-436: "demonstrating...": Remove. Grammar problem, and not really true (convection and evapotranspiration may impact the isotopic composition even if these two processes don't interact)
- l 437: "During ... rainfall" -> "Within convective events"
- l 437: grammar problem.
- l 438-439: "The critical ... rainfall": remove or be more specific. Generally, this study doesn't convincingly argues for the impact of the vertical structure.
- l 439: "certain specific conditions of low humidity of ambient." -> "low ambient humidity."
- l 443-444: remove. This study did not investigate the conditions of convective rainfall, rather its isotopic composition.
- l 445-447: clarify. You mean that applying linear regressions based on present-day observations for paleoclimate applications should be taken with caution? Is this due to an issue with the time scale? If so reword and clarify.

References

[Aemisegger et al., 2015] Aemisegger, F., Spiegel, J., Pfahl, S., Sodemann, H., Eugster, W., and Wernli, H. (2015). Isotope meteorology of cold front passages: A case study combining observations and modeling. *Geophysical Research Letters*, 42(13):5652–5660.

[Barras and Simmonds, 2009] Barras, V. and Simmonds, I. (2009). Observation and modelling of stable water isotopes as diagnostics of rainfall dynamics over southeastern Australia. *J. Geophys. Res., accepted*, 114:D23308, doi:10.1029/2009JD012132.

[Brown et al., 2008] Brown, D., Worden, J., and Noone, D. (2008). Comparison of atmospheric hydrology over convective contnental regions using water vapor isotope measurements from space. *J. Geophys. Res.*, 113.

[Celle-Jeanton et al., 2004] Celle-Jeanton, H., Gonfiantini, R., Travia, Y., and Solc, B. (2004). Oxygen-18 variations of rainwater during precipitation: application of the Rayleigh model to selected rainfalls in Southern France. *J. Hydrol.*, 289:165–177.

[Landais et al., 2023] Landais, A., Agosta, C., Vimeux, F., Magand, O., Solis, C., Cauquoin, A., Dutrievoz, N., Risi, C., Leroy-Dos Santos, C., Fourré, E., et al. (2023). Abrupt excursion in water vapor isotopic variability during cold fronts at the pointe benedicte observatory in amsterdam island. *EGUsphere*, 2023:1–33.

[Levin et al., 2009] Levin, N. E., Zipser, E. J., , and Cerling, T. E. (2009). Isotopic composition of waters from Ethiopia and Kenya:Insights into moisture sources for eastern Africa. *J. Geophys. Res.*, 114:D23306, doi:10.1029/2009JD012166.

[Muller et al., 2015] Muller, C. L., Baker, A., Fairchild, I. J., Kidd, C., and Boomer, I. (2015). Intra-event trends in stable isotopes: Exploring midlatitude precipitation using a vertically pointing micro rain radar. *Journal of Hydrometeorology*, 16(1):194–213.

[Risi et al., 2010] Risi, C., Bony, S., Vimeux, F., Chong, M., and Descroix, L. (2010). Evolution of the water stable isotopic composition of the rain sampled along Sahelian squall lines. *Quart. J. Roy. Meteor. Soc.*, 136 (S1):227 – 242, DOI: https://doi.org/10.1002/qj.485.

[Risi et al., 2013] Risi, C., Noone, D., Frankenberg, C., and Worden, J. (2013). Role of continental recycling in intraseasonal variations of continental moisture as deduced from model simulations and water vapor isotopic measurements. *Water Resour. Res.*, 49:4136–4156, doi: 10.1002/wrcr.20312.

[Salati et al., 1979] Salati, E., Dall'Olio, A., Matsui, E., and Gat, J. (1979). Recycling of water in the Amazon basin: An isotopic study. *Water Resources Research*, 15:1250–1258.

[Thurnherr and Aemisegger, 2022] Thurnherr, I. and Aemisegger, F. (2022). Disentangling the impact of air-sea interaction and boundary layer cloud formation on stable water isotope signals in the warm sector of a southern ocean cyclone. *Atmospheric Chemistry and Physics Discussions*, pages 1–31.

[Tremoy et al., 2014] Tremoy, G., Vimeux, F., Soumana, S., Souley, I., Risi, C., Cattani, O., Favreau, G., and Oi, M. (2014). Clustering mesoscale convective systems with laser-based water vapor delta18O monitoring in Niamey (Niger). *J. Geophys. Res.*, 119(9):5079–5103, DOI: 10.1002/2013JD020968.

[Worden et al., 2007] Worden, J., Noone, D., and Bowman, K. (2007). Importance of rain evaporation and continental convection in the tropical water cycle. *Nature*, 445:528–532, DOI; https://doi.org/10.1038/nature05508.

[Worden et al., 2021] Worden, S., Fu, R., Chakraborty, S., Liu, J., and Worden, J. (2021). Where does moisture come from over the congo basin? *Journal of Geophysical Research: Biogeosciences*, 126(8):e2020JG006024.