Review of Villiger and Aemisegger, part 2

April 17, 2023

This article investigates the relative importance of the circulations at the mesoscale and at the large scale in controlling the temporal and spatial water vapor isotopic variability in trade wind regions. It contrasts the relative impact of circulations at different scales on humidity, δ^2H and second-order parameter d-excess. It relies on high-resolution isotope-enabled simulations with COSMO-iso, which were thoroughly evaluated in part 1. This article is very interesting. I think it is relevant for the water isotope community, but also for the cloud-process community in trade wind regions.

The article is well written and well illustrated. However, while I found part 1 too long, I found this paper too short. I have a few major comments.

1 Major comments

- **What is the realism of the simulated diel cycle of cloud fraction, cloud depth and water isotopes, with respect to observations?**
  I don't remember that this was evaluated in part 1. In particular the amplitude of the diel cycles and the relative phasing for different variables were not evaluated.
  Is there enough observations to evaluate the simulated diel cycle? If not, how risky is it to base all the discussion on the role of mesoscale circulation on the diel cycle?
  Isn't there a way to investigate the role of mesoscale circulation without relying on the diel cycle? e.g. by looking directly at dry-warm patches anomalies, independantly of the diel cycle?

- **Discussion in section 3 is too short**
  I think Fig 5 leads to plenty of questions and I found it very stimulating, so I was quite frustrated at the end of section 3 that the discussion was so short and that I was left with so many unanswered questions. For example:

  - is the delay of the Δz for 12h relative to 1h just the impact of the averaging back in time?
  - why is the δ^2H minimum in dry-warm patches delayed relative to the precipitation maximum and to the maximum subsidence? Is it because (1) δ^2H has some memory as it integrates processes back in time? Or is it because (2) it instantaneously adapts to some other variable that is delayed relative to the precipitation maximum, e.g. the cloud-base cloud fraction? In case of the (2), what would be the mechanism?
  - why is the cloud-base cloud fraction minimum delayed relative to the precipitation maximum? l 129-130 is not convincing because cloud fraction does not look in phase with cloud depth.

- **Relative impact of local processes and large-scale circulation on d-excess?**
  - l 177-178: "humidity gradient": where? locally, or at the moisture source? If dry intrusions are associated with a drier near-surface air locally and thus higher d-excess in the surface evaporation flux locally, we would expect a good correlations between d-excess and surface relative humidity. Is it the case?
  - l 181: "influenced by the large-scale cirulation": same question as above: is it really the large-scale circulation that directly impact d-excess? Or is it the local surface relative humidity, impacted by the large-scale circulation, that impacts d-excess?

2 Minor comments

- l 6: what is the subject of "show"? Cut this sentence into 2 sentences for clarity?
- l 126-127: this technical comment could go in the Methods section, in 2.4.
- Fig 5: I find it hard to see the relative proportions of shallow, middle and deep clouds. They all look flat. Is it possible to rather show the proportion of deep cloud as a line, like for the cloud fraction?
- l 136: why are the variations in cloudy patches small? Is it because the vapor comes from the near-surface, where the temporal variations are small?
- l 146: "subsidence rate": is it really a rate, or do you mean the altitude of origin?
  Same question l 200: "subsidence ... stronger": is the subsidence stronger or originating from a higher altitude? Or is it equivalent? (and if so, what process links the subsidence velocity with the origin altitude of air parcels?)
- l 167: we don't know for d-excess: is it possible to extend the duration of the trajectories?
  I would make 2 separate sentences for $\delta^2 H$ and d-excess, since for $\delta^2 H$ the maximum link is for 4 days, whereas for d-excess it is for 6 days or larger, we don't know.
- l 170: "not" -> "less"
- Table 1: is it possible to give some p-values associated with the correlation coefficients, or some correlation coefficient threshld to reach a given p-value?
- l 184: this is interesting. Can you also elaborate on what are the mechanisms that overwrite q faster than $\delta^2 H$?
- l 218-219: This idea is very interesting. This recalls me the study of [Brient et al., 2019] who identifies coherent structures in shallow clouds. It would be very interesting to look at the isotopic signature of these different sructures. Maybe this study could be cited.
- Fig 8: it would be useful to add a Rayleigh curve and a mixing curve to guide the interpretation of these plots.

References

[Brient et al., 2019] Brient, F., Couvreux, F., Najda, V., Rio, C., and Honnert, R. (2019). Object-oriented identification of coherent structures in large-eddy simulations: importance of downdrafts in stratocumulus. *Geophy. Res. Lett.*, 46:2854–2864, https://doi.org/10.1029/2018GL081499.