Thurnherr and Aemisegger provide a detailed, well-written manuscript that seeks to investigate the process-level causes of low vapor d-excess observed during the 2016/17 Antarctic Circumnavigation Expedition. They apply three single-process models representing impacts on isotope ratios from (a) ocean evaporation, (b) dew formation and deposition, and (c) upwind distillation, and demonstrate that these three processes follow diagnostic pathways in $\delta^{18}O$/d-excess space. They then also compare the results from their process models to a regional NWP model simulation including isotopes to validate these models. Taken together, they suggest a larger than previously appreciated role for dew formation over the ocean for altering the d-excess of near-surface water vapor, particularly in the warm sector of extratropical cyclones.

Their analysis is rather detailed, and the process modeling provides interesting insights into the evolution of d-excess in near-surface water vapor. This paper represents a nice contribution, and only have a handful of suggestions for revision below.

Line-by-line notes

- L. 36 – there appears to be an extra ‘2’ in the denominator for R here.
- L. 44-46: might be good to cite a few of the observational studies that dew formation is a non-equilibrium process (e.g., Deshpande et al., 2013; Wen et al., 2012), since condensation processes are still (often) thought of as equilibrium to first order.
- L. 61-62: d can also change purely due to equilibrium effects when the Rayleigh f is very low (e.g., Bony et al., 2008; Dütsch et al., 2017)
- L. 104: which laser spectrometer was used and how was it calibrated?
- L. 115: could the authors clarify what explicit treatment of deep convection means
L. 136-137: These seem to be fairly unusual choices for the isotope ratio of the ocean, could the authors clarify how these values were chosen? This is of particular note for this manuscript as it could be in part responsible for producing evaporation fluxes with a lower d-excess than might be expected. For example, using values for SMOW (δ^{18}O = 0‰, δ^2H = 0‰), the water undergoing evaporation has a d-excess of 0‰, but an ocean initial condition of (δ^{18}O = 1‰, δ^2H = 1‰) has a d-excess of -7‰, which would seem to bring down the d-excess of the evaporative flux by ~7‰ as well.

L. 169: there is often a lot of confusion regarding α_k, often stemming from whether it is defined based on D/D_i (and hence, α_k < 1) or D/D_i (hence α_k > 1) (e.g., Benetti et al., 2014), where D_i is the diffusivity of the isotopologue with a substituted atom (^2H or ^18O). Obviously, both can be correct depending on how the equations are cast, but it may be worth specifying that you are referring to an α_k value based on D/D_i in your work, since the alternative definition is also widely used.

L. 235: I think the supplemental figures are not numbered in text in the order they appear.

L. 251-252: I think this sentence could be a bit more clear – clearly rainout could play a role in altering SWIs, but it’s not clear why you might expect to see these at the ocean-water interface, cf. (Bailey et al., 2019)? Presumably this would be through mixing and/or subsidence, but it’s not made clear here.

L. 304 – is THE a misrendered θ_e? (Also, there appears to be some inconsistency in case: a capital Θ is used in Fig. 5 and L. 340 instead of the lower-case θ used elsewhere)

L. 437-441 – this is an interesting point! In addition to the mixing process here, I wonder if the more turbulent coupling between the surface and the near-surface atmosphere could have the effect of altering the ‘effective’ kinetic fractionation factor here as well and alter d independent of mixing, for example by changing the value of the exponent used on the ratio of diffusivities (eq. 5 in (Pfahl & Wernli, 2009), also (e.g., Gat, 1996; Mathieu & Bariac, 1996; Merlivat & Jouzel, 1979; Riley et al., 2002)

References


