Review of « Isotopic measurements in water vapor, precipitation, and seawater during EUREC4A » by Bailey and others.

This manuscript presents a synthesis of isotopic composition of atmospheric vapour, precipitation and sea water acquired during the EUREC4A campaign, near Barbados. The ambitious scale of the project, including seven vapour infrared spectrometers monitoring the vapour isotopic composition together on land, three ships and two aircrafts, created an invaluable set of timeseries which will be used to study convection in tropical environments.

The manuscript adequately reports the methods and carry out rigorous uncertainty evaluation. The huge dataset leads to a difficult to grasp ensemble of time series, and at times, the manuscript is difficult to follow, especially for people not involved in the project. It seems like the actual use of the produced data might be difficult: indeed, while the authors were careful to provide an exhaustive access to the data, which is commendable, the manuscript describes large part of the dataset that shouldn't be used, or should be used with care, but does not provide a flagged version of the dataset. Considering the size of the dataset, this might be excessively complicated to produce, but probably also reduces the reach of the dataset and the manuscript.

Due to the high quality of the dataset and the post-treatment, validations, and uncertainty evaluation, I recommended to accept the manuscript after the following modifications have been implemented.

General Comments:

1. The manuscript really provides a complete overview of everything that has been measured. I agree that including easily accessible calibrated "relatively raw" datasets is great, so other scientists can in the future explore the datasets. But considering that the manuscript provides a detail overview of when the data shouldn't be trusted at face value, a flagged version of the dataset, or alternatively a filtered version of the dataset, would be useful to ensure that other users will not over-interpret data.
2. The general organisation seems relevant, but is sometimes difficult to follow due to the large number of details, and that the analysis and post-treatments were all realised differently, which is how it is. For the sake of using the data, and comparing the different datasets, the same key elements are needed though, regardless of how they were obtained. While the information is clearly provided here, if it was provided in a more systematic manner, it might help the reader.

Specific Comments:

Lines 46 to 47: "Moreover, water vapor isotope ratios were measured from a few meters to nearly 8 km above sea level."

      While this is true, the quality of the vapour isotopic ratios measured above 5 km might not be sufficient to be used (see comment below). At this point, wouldn't it be fairer to provide the altitude range where you are confident of the trustworthiness of the dataset?

Lines 83 to 85: "As a result, oxygen and hydrogen isotope ratios in vapor (i.e. 18O/16O, D/H) lower with progressive condensation and rainout, while evaporation from the ocean (or another liquid reservoir) and subsequent moisture transport replenish the atmosphere with relatively heavy water. (Although the evaporative process itself discriminates against heavy water, the ocean is isotopically enriched relative to the atmosphere.)"

      This is a very complicated way to say that the vapour is more depleted than the ocean water, and gets more depleted in heavy isotope each time a precipitation event occurs.

Lines 86 to 87: "One outcome is the ability to differentiate boundary layer and free tropospheric air and to quantify the exchange of moisture between these layers. "

      Can you really differentiate these solely based on the isotopic composition?

Lines 86 to 94: For this whole part of the paragraph, I would say that the description is a little bit optimistic. Water isotopic composition is an integrated variable that is sensitive to all the phase transitions, as well as to diffusion and mixing of air masses, which means that under some assumptions, you would be able to test hypothesis about the history of the air masses, and in particular, which processes to moistening them.

Lines 99 to 100: "We will also use the deuterium excess parameter, defined as $d = \delta D - 8 \times \delta 18O$, to describe variations in one isotope ratio relative to the other."

> The definition of d-excess seems limited. Why 5 then? I guess maybe considering changing for "To describe relative variations of both isotopes which do not follow the "meteoric water line"."

Lines 104 to 105: "A total of seven water vapor isotopic analyzers, sampling at 0.5 Hz or faster, were deployed during the campaign on two research aircraft"

> The 0.5 Hz sampling rate seems peculiar and an explanation of why could this be important is probably needed. I presume it is for the processing of the aircraft measurements, but clearly, when seeing the performances of the BCO infrared spectrometers, from the same inlet, at high sampling rate, it seems like there is very limited "climatic interpretation" for data with 0.5 Hz sampling rate.

> Overall, it seems like there is a dichotomy between the measurements which took place in certain conditions, and the data which are meaningful only in subset of the range of observed conditions. In the case of the resolution of the produced data, it seems like the recommendation would be to use them at a resolution of several minutes or an hour?

Lines 110 to 112: "This wealth of observational data will aid interpretation of the isotopic signals, just as the isotopic information will provide a new lens through which to evaluate microphysical and dynamical controls on trade wind cloudiness."

> Totally agree with this, which is why tuning down the previous paragraph of the introduction makes sense: isotopic signals are very complicated to interpret on their own since it's integrating a potentially important number of processes, and thus they are very useful with hypothesis to test/other observations.

Lines 143 to 144: "The BCO water vapor isotopic measurements were set up to serve as a high-frequency (1 minute) reference dataset at a location with extensive meteorological in situ and remote sensing observations,"

> I agree with the statement that 1 minute is high frequency measurement in the case of atmospheric boundary layer dynamic. But then, this is very slow compared to the 0.5 Hz mentioned in the introduction.

Lines 424 to 425: The uncertainties given here are very surprising, in particular compared to the values given lines 413 to 414. Is this due to the rather old model of the Picarro analyser?

Lines 431 to 432: "The effect of this oscillation is not included in the OA-ICOS analyzer's isotopic uncertainty estimates."

> If the effect of an oscillation that seems to be an artefact is not included in the uncertainty estimates, the datapoints should be flagged out.

Lines 490 to 495: This is very confusing. Wouldn't the difference between the correction functions obtained in the field vs the ones derived post campaign be related to accuracy while the standard deviation at 1Hz be linked with precision?

Lines 679 to 684: "Surprisingly, the BCO's two analyzers are 1.5 and 4.5‰ different in $\delta 18O$ and δD, respectively, even though they sampled from the same inlet and were calibrated using the same standards and procedure. This unexpected discrepancy highlights the challenge of accurately estimating biases and uncertainties in water vapor isotopic field measurements using typical calibration approaches and suggests it may be necessary to measure a larger number of standards or to measure the standards for longer periods while in the field."

> Isn't these results contradicting with the uncertainty propagation? These values are larger than the ones shown in section 3.1, and thus, would suggest that the uncertainties are clearly underestimated. This is furthermore problematic that these values are of the same order of magnitude than the daily and synoptic variations.

Lines 686 to 689: "Despite their sizable mean offsets, time series from the two BCO analyzers are strongly correlated for both water vapor concentration and δD, bolstering our confidence in the variability captured in their respective signals (Fig. 11, Table 2). (Correlation between the δ18O time series is diminished by the oscillation in the OA-ICOS signal but can be increased by applying a low pass filter or averaging to longer time steps.)"

The correlation of 0.94 between the dD of the BCO CRDS and BCO OA-ICOS appears at odds with Figure 11. Since the dataset stored at Galewsky, J. (2020). BCO LGR Water Vapor Isotopic Composition. [Dataset]. Aeris. https://doi.org/10.25326/309 is faulty, it was impossible to reproduce the calculation. Did you evaluate the correlation on hourly resolved data ?

If you compare to (Leroy - Dos Santos et al., 2020), where two instruments were measuring from two different inlets, and located at neighbouring site, almost 4km away, and with a difference of 470m of altitude, the correlations are larger than 0.9 for humidity and d18O. In your case, it with such large difference for both instruments measuring from the same inlet, either one or both are faulty. It is essential to investigate which of the two datasets is to be trusted, and potentially at which resolution, because clearly here, the 0.5 Hz data do not contain climatic signal.

The correlation between the BCO OA-ICOS and the meteor (and with the other available datasets when they were nearby) could be useful, because it appears that the agreement is actually better for both dD and dexcess than between BCO CRDS and BCO OA-ICOS, excluded the periods with the weird d18O oscillations.

This part is a key weakness of the manuscript, and would really justify an additional effort to provide a safe dataset.

Bibliography

Leroy - Dos Santos, C., Masson-Delmotte, V., Casado, M., Fourré, E., Steen-Larsen, H. C., Maturilli, M., Orsi, A., Berchet, A., Cattani, O., & Minster, B. (2020). A 4.5 year-long record of Svalbard water vapor isotopic composition documents winter air mass origin. *Journal of Geophysical Research: Atmospheres*, e2020JD032681.