Anonymous Referee #1

General comments: While the potential of this dataset is very promising, the current manuscript does not deliver much interpretation. The authors do characterize vertical profiles of water vapor isotopes, but they do not comment on their interactions with clouds and aerosols. Nor do they discuss lake evaporation and atmospheric advection processes. It is clear that the data interpretation work is underway and planned for a future publication. This manuscript appears to be mainly the dataset description of many different types of observations during an intensive field campaign and presents observed ranges of isotopic values for vapor and liquid samples. Having said that, this reviewer is not sure whether it meets the scope of ACP. "The journal scope is focused on studies with general implications for atmospheric science rather than investigations that are primarily of local or technical interest." Perhaps this would be more appropriately published as a dataset rather than a research paper? I will defer to the journal editor on this particular question. If this limited interpretation is within the scope of ACP, here are some suggestions for making the value more apparent to the readers.

The paper is indeed an overview article, describing the overall objectives of the L-WAIVE campaign and detailing what we believe is an innovative and comprehensive experimental sampling strategy as well as the instrumental assets involved. There are plenty such papers in ACP. In addition, the paper also provides an overview of the measurements acquired during the campaign as well as provides the local and regional context in which they have been gathered. Preliminary highlights of some of the outstanding observations made during the campaign are presented as well as some interpretation of the results. Finally, the paper is meant to be a reference article on which future articles pertaining to case studies can build on (without having to describe at length the experiment and the instrumental assests), to inform broadly the scientific community and make it aware of the availability of the data existence.

1. Why is the water vapor field in mountainous regions important to study? Societal importance? Local moisture recycling?

The reason why it is important to study the water vapour field and the origin of its variability appears partly in the beginning of the introduction but can indeed be made more explicit. We have added a rationale for this at the beginning of the introduction:
"The regions surrounding mountain lakes are poorly documented, yet they are highly anthropized, as in the case of Alpine mountain lakes, which are suffering from significant ecological upheavals probably linked to climate change, which influences the rates of precipitation and ice melt. Water resources and biodiversity are under threat. Lake/atmosphere interactions significantly regulate the climatic conditions in the valleys. There is therefore an obvious societal importance in studying the undeniable role of this ecosystem on the water cycle, which makes a major contribution to maintaining biodiversity in these regions.
Why is the vertical structure of the water vapor field in the lower troposphere is only sparsely documented above Alpine lakes? …"

2. The authors could highlight their analysis linking large scale circulation from ERA to local wind patterns rather than declaring the aim of this manuscript to "gain understanding on the vertical structure of atmospheric water vapour above mountain

lakes and to assess the respective influence of evaporation and advection processes” which they do not deliver in this particular manuscript.

Indeed, we do not give, in this article, quantitative results on the origin of the water or on the influence of the evaporation of the lake. This work is in progress using appropriate modelling tools. We appreciate the reviewer's suggestion and we have modified the text in the introduction accordingly, to better highlight the link made in this article between large-scale and local circulation. This aspect was already mentioned in the introduction but perhaps not clear enough. We have also placed more emphasis on the originality of the approach using airborne observation. Finally, we have also highlighted the potential effect of the lake evaporation using examples in the end of Subsection 5.2.5 where the link with the local dynamic is now presented. Material summarizing these aspects has been added at the end of the abstract, in the form:

“ A significant variability of the isotopic composition was observed within the first 1.5 km above ground level (a layer defined as the lake region of influence, below the average height of the mountains surrounding the lake) depending on weather conditions, as well as local and synoptic atmospheric circulations. We highlight that fairly well-mixed conditions prevailed in the lower free troposphere, between the lake surface and the first 1.5 km of atmosphere above it, except when the wind is very weak above the lake. In this case, a marked depletion in heavy isotopes is observed in the lake boundary layer. It is also shown that strong gradients of isotopic composition can be observed at higher altitudes depending on the mean mountains height, the vertical local stability and the synoptic circulation.”

3. “The influence of the lake evaporation was mainly detected in the first 500 m of the atmosphere.” What data did the authors use to support this conclusion?

The new discussion added in section 5.2.5. clarifies this aspect.

4. “A CRDS water vapour isotope analyser performed measurements during one day at the end of the experiment just above the lake surface in parallel with the lake water sampling.” Was this data omitted?

These data have been added in Fig. 17 with the whisker boxes located at ~1m above the lake surface and presented in the associated text in Subsection 5.2.5.

Specific comments:

Line 63 – See also this paper on tall tower measurements: Griffis, Timothy J, Jeffrey D Wood, John M Baker, Xuhui Lee, Ke Xiao, Zichong Chen, Lisa R Welp, et al. “Investigating the Source, Transport, and Isotope Composition of Water Vapor in the Planetary Boundary Layer.” Atmospheric Chemistry and Physics 16, no. 8 (2016): 5139–57. https://doi.org/10.5194/acp-16-5139-2016-supplement.

Thanks, the reference has been added (line 79 of the revised MS).

Line 115 – Is the cloud water sampler discrete or passive (integrating the entire flight)? I think later it’s mentioned that the collector opens while in the clouds only.

Yes, the reviewer is right, the collector opens only in clouds. In Subsection 2.1, we have replaced " ...and to collect cloud water samples." by : "... and to collect cloud water samples. The latter were collected during specific cloud flights (when meteorologic conditions were favorable) and the cloud collector was opened only in clouds."

Line 150 – the ULA's flew to 4 km amsl! That's amazing! Do pilots need O2?

Yes, above 4 km a.m.s.l. the pilot uses O_2.

Line 181 – what is ALiAS?

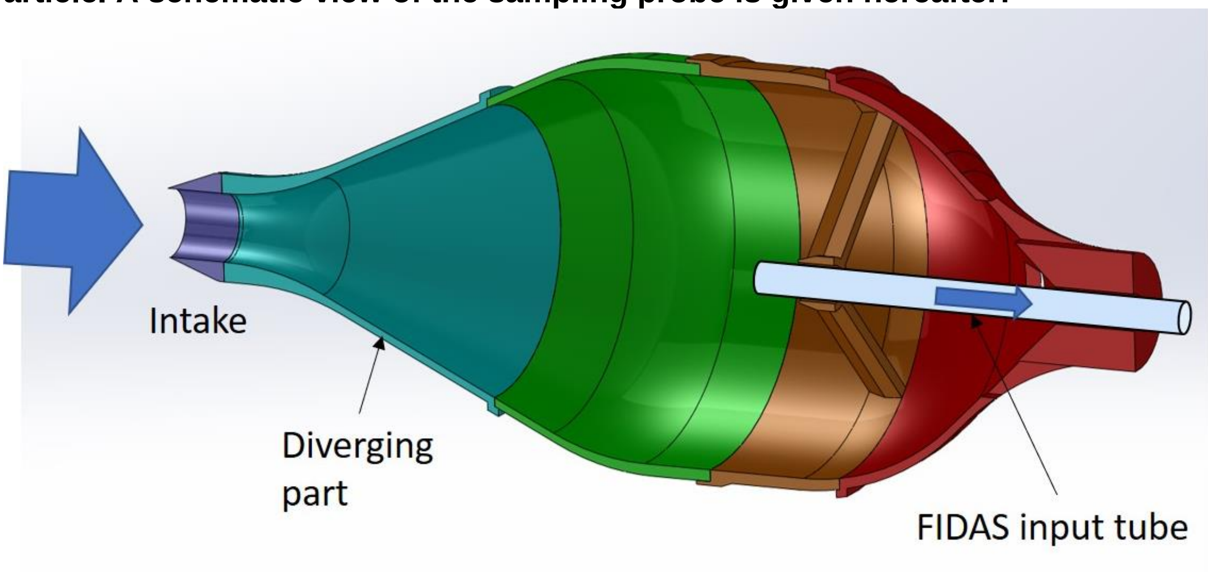
The acronym is now defined at line 192 of the revised MS.

Line 190 – flux instead of flow?

Agreed, the correction has been done.

Line 205 – more details about the particle sizer inlet?

The inlet has been designed to ensure that at the relative air speed the sampling is as close as possible to isokinetic. The sampling head is quite classical, with a divergent, followed by a convergent. The inlet diameter is adapted to the flow rate of the device. This is a technical aspect which is out of the scoop of this article. A schematic view of the sampling probe is given hereafter:



As this is a classical design, we have not added this information in the paper. We are only proving the information for the sake of clarity with respect to the reviewer's comment.

Line 215 – were calibration functions designed specifically for this instrument? How do they change with cell pressure? Did cell pressure change with altitude?

Mixing ratio-isotope ratio dependency correction functions were specifically determined for this analyzer (ser no. HIDS2254), and checked repeatedly over time, as described in Weng et al. (2020). Under laboratory conditions, the measurement cell pressure is regulated to 50 +/- 0.02 Torr. We have included a figure in the appendix D that illustrates that measurements during the slow

ascent profiles and level segments had increased variability, but no substantial, systematic changes in the cavity pressure.

Line 228 – Appears an accompanying data report is panned with further details of the data processing and calibration procedure.

We have included Appendix D that provides details of the calibration procedure and instrument stability extracted from the above-mentioned data report.

Lines 246-250 are repetitive

The sentences have been rearranged as:
"A pre-cleaned Caltech Active Strand Cloud Water Collector (CASCC, Demoz et al., 1996) was mounted on ULA-IC, modified to efficiently collect cloud water (Fig. 3b) at the relative cruising speed of the ULA (85 to 100 km h-1). The CASCC was modified to efficiently collect cloud liquid droplets from the ULA."

Line 245 – plastic other than HDPE? Specify material.

We have replaced the sentence "All sampling materials used were plastic or HDPE" by: " All parts necessary to adapt the HDPE cones on the CASCC were made of plastic ".

Line 325 – surface microlayer sampling was interesting. Is this method previously published?

Yes, the method was published previously, and the reference (Cunliffe et al., 2013) is given in the text.

Line 329 – was the cross section within the lake (liquid) or above the lake (vapor)?

We have modified the sentence as " …the CRDS isotope analyser was taken on board the boat to sample a cross-section in the atmospheric layer just above the "Petit Lac…".

Line 348 – cite IAEA recommendations

The citation has been included as given below:
IAEA (2009): Reference Sheet for VSMOW2 and SLAP2 international measurement standards. Issued 2009-02-13, International Atomic Energy Agency, Vienna , 5 p., http://curem.iaea.org/catalogue/SI/pdf/VSMOW2_SLAP2 .pdf.

Line 434 -WL?

WL has been replaced by "wind lidar".

Line 451 - The influence of the lake is thus seen mainly up to altitudes between 1 and 2 km a.m.s.l. during the day and significantly lower the rest of the time (âL'š 0.5 km a.m.s.l.). How do the authors make that conclusion?

We have modified this part, which is now discussed more clearly in subsection 5.2.5. The effect of the lake is more easily observable in low wind conditions. We have made a better link with local dynamics by using lidar measurements.

Line 525 – Nice validation description, but Fig 18 shows large differences on Aug 20 and no vapor on Aug 21?

First, the 'Aug' tags were erroneous and have been modified to 'Jun' in the revised version of this Figure (now Fig. 15 in the revised MS). The morning flight

on 20 June was affected by a saturated inlet and should not be interpreted, the data point has been removed in the revised manuscript. The flight on 21 June took place without the vapour analyzer. This is now stated in the revised manuscript.

Line 559 – Would it make more sense to calculate vapor in equilibrium with the lake water? To show kinetic evap influence?

Yes, we have modified Fig. 18 (now Fig. 15 in the revised MS) and the comparison to show equilibrium vapour rather than condensate. We also have updated the corresponding text.

Line 591 – Actual values for Lake Superior is a strange comparison here given it's in a completely different location.

Yes, we have removed this comparison.

Fig 13 and 14 - Why does the lidar data availability with altitude change over time?

The range of lidars depends on atmospheric transmission and the presence or absence of clouds. If the cloud is too dense (i.e. has an optical depth in excess of ~3), then the laser beam is total extincted shortly after having penetrated the cloud and the atmosphere above the cloud base cannot be probed.

Fig 15 – not easy to compare the 2 ULA platforms. Different plot needed to compare. I'm not sure these figures show the profiles very well. The authors could consider plotting altitude vs WVMR for individual times with 2 ULAs and Lidar measurements as separate lines/colors.

It is true that this colour level figure does not sufficiently show contrasts. Moreover, we have already shown the correct agreement in Fig. 4 for a coordinated flight. The 2 ULMS did not always fly together and did not necessarily follow the same trajectories. This figure (Fig. 15 of the original MS) of limited interest has therefore been removed in the revised MS.

Fig 18 – 2m deep samples are heavier than 10-20 cm deep? Why such tight values at 10-20 cm?

The thermocline was measured at a depth of at least 7 m (Fig. 7 or the original MS, now Fig. 6). As we are interested in exchanges across the interface between the lake and the atmosphere, we wanted to check whether there were any notable differences between the surface waters and the waters located a little deeper, at a depth of around 2 m. The samples at 10-20 cm depth were only acquired during one day at the end of the campaign, unlike other liquid water samples. For the sake of not introducing a bias in the interpretation of the data we have decided to remove the time-limited dataset from Figure 17 (Fig.19 in the original MS).