<u>Anonymous Referee #2</u>

The paper poses a series of interesting questions to begin: “What is the role of lakes [in] the...water cycle...? What is the relative contribution of evaporation from the lake to the atmosphere...downwind...?” but quickly pivots away from these questions and does not return to them in the conclusions. Instead, the paper describes in detail the measurement platforms involved in the L-WAIVE experiment, provides an overview of the synoptic conditions from reanalysis, and gives readers a first look at the various types of measurements made. There were clearly a lot of exciting new data collected as part of L-WAIVE. Perhaps it would be most appropriate if the paper stated upfront that this is a campaign overview paper and that much of the investigation of lake evaporation will take place in future work.

In the introduction, we mention the objectives of L-WAIVE and the questions/reflexions from which they stemmed in broader context. These must be differentiated from the objectives of the present article itself. Our intend here is to set the scene of forthcoming articles that will be dedicated to tackle in more details the questions posed in the Introduction. The purpose of the article is to present the experimental strategy designed for the campaign as well as the instrumental assets (and their complementarity) and to provide the first scientific highlights. We have modified the introduction to focus more on the objective of the article and to insist more on the links between the dynamics and the isotopic observations.

Major comments

Section 4.1 argues that a high pressure ridge brought warmer temperatures to the study site on the 14th of June, and a surface low over the British Isles brought colder temperatures on the 17th of June. However, it is not clear from the reanalysis maps that this was the case. Figure 9 shows equivalent potential temperature, which is also a measure of moisture content, not strictly temperature. Meanwhile, Figure 8 shows the study site more squarely within the center of a high pressure ridge on the 17thcompared to the 14th. The British Isles appear to sit under a low on both days. In addition to these concerns, I wonder whether it wouldn’t be simpler to show maps for each of the “golden” days (approximately one week), since it was such a short experiment, rather than seeing geopotential height for some days and RH for others. That way readers could see the progression from one synoptic state to the next clearly. Space could be saved by combining maps, for example, by adding geopotential height contours to temperature shading.

We agree that the transition is not clear on the Figures provided in the original version of the MS. As proposed by the reviewer, we constructed a 12-day sequence (shown in Figs 8-10) with temperature, geopotential, and wind, all at 700 hPa which corresponds to the free troposphere just above the mountains. The text has been rewritten accordingly in section 4.1.
However, the potential temperature does not depend on water vapor, it is the equivalent potential temperature that depends on it.

The paper thoroughly describes measurement and collection methods for nearly all observations except the precipitation samples, which are mentioned near line 412. How were these collected and analyzed? On which days were they collected?

The reviewer is right, the collection methods for precipitation samples were omitted in the original version of the MS.
We have added a new section (Section 3.4) dealing with precipitation samples, in which we have added the following text:
"Precipitation samples were taken throughout the campaign period. The sampling device consisted in a pre-cleaned HDPE funnel directly connected to a pre-cleaned HDPE sampling bottle. The precipitation samples were manually operated: after each precipitation event, the sample was aliquoted into 1.5 ml glass vials with rubber/PTFE septa and stored at 4°C prior to 345 isotopic analysis, while the rest of the sample was stored at -18°C. Precipitation sampling times lasted from 20 min to several hours, depending on rainfall rate.".
The days on which they were collected are indicated in Table A1, where "Rainwater sampling" have been replaced by "Precipitation sampling".

Section 5.2.1 argues that strong vertical gradients in dD were observed on flights 5-10 and well-mixed conditions during flights 13-15; however, it is not clear Figure 16 supports this. First, Fig 16b shows vertically uniform isotope ratios for nearly all flights within the bottom 2 km of the atmosphere. (Flight 2 seems to be the exception.) This would indicate well-mixed conditions at these lower elevations. Most flights then show a near-step change at some height above 2km, but the gradient is still hard to gauge because, in most cases, there is almost no data from the free troposphere. Thus, the isotopic change in the vertical cannot be quantified. Perhaps the clustering of points Fig 16a could be used to estimate the degree of mixing within the lower atmosphere, but the number of observations at each altitude would have to be taken into account. An important related question: if the atmosphere is essentially well-mixed up to about 2km, wouldn't lake evaporation also influence the atmosphere to that height? What evidence is there that evaporated moisture only reaches 500 m?

Fig. 14b (in the revised MS, Fig. 16b in the original version of the MS) does not make it easy to follow the evolution of isotope abundance with altitude. We have moved the color contrasts. The figure has therefore been redrawn. The gradients in altitude are related to the transition to the free troposphere, and they are corroborated by the lidar observations (co-located aerosol backscatter gradients), but above all by the independent meteorological measurements on the two ULAs. The variation in altitude of the gradient is linked to the time of day when the flights were made.

We have modified the text:

"These strong gradients in altitude are related to the transition to the free troposphere, and are confirmed by the lidar observations and meteorological measurements on the two ULAs. The observed vertical gradients in isotope ratios evolved as a function of the different isotope composition of boundary layer vapor, free-troposphere vapor, and the stratification in the lower troposphere above the valley which depends on the meteorology (as for example rainy events) but also on the time of day when the flights were made. In the early afternoon, the boundary layer is shallower and less buoyant, leading to a transition at lower altitude (flights 5 and 6). Flights 5 and 6 also took place in the aftermath of heavy thunderstorms occurring in the morning of 16 June that led to a cooling of the surface. In the late afternoon, thermal convection is generally more efficient, and the transition may occur at higher altitudes (flight 10 on 18

June 1700 LT). Flight 9 on 18 June 1200 LT does not seem to follow the same rule. As shown in the vertical lidar profiles in Fig. 10, the clouds around 4 km a.m.s.l. seem to exert a forcing on the boundary layer which moves its top to higher altitudes (~3.5 km a.m.s.l.)."

What defines the different atmospheric layers over the valley are the vertical profiles of WVMR, potential temperature (even temperature), aerosol and wind. There is clearly a layer of at least 500 m above the lake that defines its influence on the atmosphere. Now, the reviewer is right that this influence is certainly not limited to this layer and evaporative water vapor can be moved higher in altitude depending on wind and vertical stability conditions. We have therefore reviewed this aspect in subsection 5.2.5.

In further reference to “vertical gradients,” is Section 5.2.1 essentially talking about the height of the well-mixed boundary layer changing with synoptic conditions? The Section suggests these “gradients” change with air mass transport, but isn’t atmospheric stability the more fundamental factor?

The explanation is given in the answer above. We agree with the reviewer that it is indeed the stability of the atmosphere that explains the location of these gradients at altitude. However, the advection of dry air at higher elevations probably enhanced gradients by transporting isotopically depleted air to the observation area on one of the days. This has been phrased more clearly in the revised manuscript.

In Section 5.2.4, it is not clear how equilibrium fractionation is being calculated for lake water. Is the assumption here that water vapor condenses onto the lake as dew? This seems unlikely as a dominant mechanism. Clarification would be appreciated. Also, the relative depletion of lake water on Jun 18 and 22 is attributed to another (external) source. Yet, couldn’t the depletion be caused by upwelling of water from lower depths from within the lake?

Following the suggestion of Reviewer 1, we have changed this comparison to vapor from equilibrium evaporation from the lake on the one hand, and the vapor measurements from ULA and boat on the other hand. Changes in lake water composition can indeed play a role, and this has been included as a potential factor of influence in the revised manuscript.
Furthermore, the lake waters are highly stratified, and the temperature profiles show that there were no upwellings during the period of the experiment. The ’Petit Lac’ is also little influenced by the tributaries and our measurements were taken in its center.

Section 5.2.5 argues that this is the first paper to present in-situ samples of cloud water and water vapor in cloud. This is certainly not the case. Presumably, the paper intends to say “isotopic” samples. Even so, previous studies have reported in-cloud water isotopic measurements. Examples include Lowenthal et al. 2011 (https://doi.org/10.1016/j.atmosenv.2010.09.061) and Lowenthal et al. 2016 (https://doi.org/10.1175/JTECH-D-15-0233.1). Also, Noone et al. gave presentations at the 2012 and 2017 Fall Meetings of the American Geophysical Union on isotope ratios collected in cloud water during two aircraft campaigns: the NSF ICE-T mission (2011) and the NASA ORACLES mission (2016-2018).

Indeed, the referee is right, we intended 'isotopic' samples. The 2 papers by Lowenthal et al. describe in-cloud isotopic measurements made in vivo using the instrumentation available at the permanent mountain-top facility of Storm Peak Laboratory in the Rocky Mountains at 3220 m above mean sea level. In this paper we describe isotopic samples that are made from an airborne facility.
We were not aware of the AGU presentations given by Noone et al.

Minor Comments

Abbreviating "Alpine mountain lakes," which is redundant in and of itself, seems unnecessary. "Alpine lakes" could easily be shortened to "lakes" without confusion. Similarly, I would not abbreviate "water vapor mixing ratios." There are enough other new acronyms associated with the various measurement platforms.

Agreed, the correction was made for "Alpine lake" without introducing an acronym. On the other hand, for "water vapor mixing ratios", which is often used, we preferred to leave the acronym.

Line ~~66~~ 61-63 - I don't understand this sentence or why tall towers would provide "incomplete information" about evaporation. Is the suggestion here that they are not tall enough?

The point is that tall towers provide point measurements at one or several heights, whereas airborne observations provide complete profiles over a height range. Moreover, there is no tower that reaches up to the free troposphere, except perhaps at the top of the mountain. On the other hand, it is usually not in the middle of the lake. It is therefore preferable to use a boat or a small aircraft such as an ULA.

Line 80 - No need for "so".

The correction has been done.

Line 85 - no need for "a" after "original."

The correction has been done.

Line 161 - "of" is required after "out."

The correction has been done.

Figure 2b - could the lines be colored by aircraft to distinguish the two flight patterns? What do the red and purple straight lines represent?

The two types of flights are already colored differently. An explanation has been added in the legend for the red straight lines and purple arrows.

Line 206 - is "flow" the right word?

The correction has been done.

Line 268 - It appears there is some redundancy in the next few lines.

The correction has been done.

Line 379 - Values are given for the EVAP standard, why not for GSM1?

The values for standard GSM1 have been added in the revised manuscript.

Line 423 - Substitute "gives" for "allows to get."

The correction has been done.

Line 440 - Should this read “at altitude?”

The correction has been done.

Line 441 - It’s not clear how the labels “Rain” and “Thunderstorm” provide information about cloud type.

The sentence has been rewritten.

Line 446 - Should this read “above 3.5 km?”

No, larger particles are observed from ~2.5 km a.m.s.l. in Fig. 12.

Figure 11 - The white shading and labels make it difficult see the aerosol scattering ratio signals. Also, the caption says that dust and pollution aerosols are labeled, but where?

The white shading is used to show profiles influenced by clouds. The dusts and pollution aerosols are not labelled. They can be located using the VDR. The strong VDRs are associated with dusts and the weakest with pollution aerosols. The information has been added in the figure caption.

Line 469 - It would help to remind the reader of when the “dust transport” event occurred.

We have modified the sentences to link the dust presence to the date.

Figure 15 - Can the flight humidity profiles be overlain on top of the lidar (Figure 14a) for easier cross-comparison?

Fig. 15 has been removed as it does not provide significant information with respect to the lidar measurements and model outputs. The agreement between the measurements of the two ULAs is already shown in Fig. 4. It should also be noted that the ULA flights were not necessarily vertical to the lidar.

Line 535 - What does “partly” mean here? Some of the time? Somewhat strong?

The correction has been done. We have removed ’partly’ from the sentence.

Line 635 - “reservoir” seems somewhat confusing here, as I’m not sure most readers would think of distinct atmospheric layers as being distinct reservoirs.

Yes, that is not an appropriate term and we have made the change: "…for each sampled altitude range in the atmosphere […] in the depth of the lake".

Line 642 - Could the confidence interval equation be referenced? Also, seeing where the notches end in Fig 19 is not easy.

The resolution of Fig. 18 has been degraded in the pdf, at high resolution you can easily see the limits of whiskers boxes. The definition of the confidence interval is quite classical and can be found in all statistics books. It is, among others, the definition adopted by the Matlab or Python environments. One is free to choose another criterion as long as it is clearly defined.

Fig 16 - Is the “mean mixing line” actually a best fit through all observations?

The mixing line has been computed using Noone (2012) and we have added the information in the caption of the figure.

Fig 17 - It is not clear to me where the highlighting is for the gas-phase and liquid water samples.

A clearer explanation was given in section 5.2.5 where the interest of measurements in the lake water and in the atmosphere is better highlighted.

Fig 18 - perhaps add “estimates” after “equilibrium condensate”

The caption of Fig. 18 (now 15) has been revised as
" Figure 1. $\delta\,^{2}H$ - $\delta^{18}O$ plots of liquid samples with the vapor isotope estimates. (a) Cloud water samples (circles), equilibrium condensate (squares), and precipitation samples (grey triangles). (b) Equilibrium vapor from lake water samples at different depth (dots and diamonds) compared to vapor isotope measurements from ULA-IC (upward triangle) and boat (downward triangle). Colour denotes matching dates. Gray colours show data where the vapor samplings are not available. Black line denotes the Global Meteoric Water Line (GMWL)."

Line 702 - Is it fair to say this is “local” water vapor, which could have a lake source?

It is not the water vapour that is said to be local, but the topography (modified by local topography).

Appendix A is not particularly intuitive. What do the numbers represent in the table?

Agreed. We have simplified the notations in the table and used colours to highlight special cases.