Voigt and coauthors investigate the water balance and chemistry of a small lake in an arid environment with dynamic, seasonal hydrology. This is an interesting and timely subject because small arid lakes are prone to changes in the face of anthropogenic climate change and are rarely in hydrologic steady state. Voigt and coauthors characterize the hydrologic conditions in the lake with the following modeling and empirical efforts: 1) collection of water samples for isotopic (d18O, d17O, and d2H) and anion/cation analysis, 2) simulations to match the water isotopes, and 3) isotope mass balance considering lake levels, and 4) model water in the lake via satellite imagery, bathymetry, and an estimate of input water from soil moisture. The lake water balance is controlled by evaporation, precipitation, and basin discharge. There is pronounced seasonality in the water isotopes, including in triple oxygen isotopes. Evaporation and relative humidity are two main controls on the isotopic composition of the lake water.

This paper is an impressive combination of empirical data (isotope and environmental monitoring) and modeling approaches. ic hydrological processes in a small, arid lake. Combined, these results yield a comprehensive description of the dynam Their use of triple oxygen isotopes to identify non-steady state hydrological processes is exciting and demonstrates the value of this novel technique in applications to modern hydrology. Furthermore, I think that while it is not surprising that water isotopes vary in a small catchment throughout a year, it continues to be important to point this out to the paleoclimate community. I recommend publication of this manuscript with very minor revisions. Below I offer some comments and suggestions for improvement.

We thank the reviewer for his insightful comments that will help significantly to improve the manuscript. Below, we respond to each of the specific comments (blue) and indicate how the comment will be addressed in the revised manuscript (yellow).

Specific Comments

Line 135: How are you estimating measurement precision? Is this the S.D. of the seven injections for a single vial, or is it the S.D. of multiple replicates of the standards run over time? I would recommend using the latter, and also incorporating an estimate of error in your normalization scheme, to arrive at an accurate estimate of error. See Hutchings and Konecky (2023).

The long-term precision is based on multiple replicates of an analytical standard that was measured alongside with the samples as control. We will specify this in the manuscript as follows:

"The long-term precision for $\delta^{17}O$, $\delta^{18}O$, and $\delta^{2}H$ was 0.08‰, 0.15‰, and 0.7‰, respectively, based on the analysis of an analytical standard (n=35) conducted alongside the samples during the analysis period (April 2021 to April 2022). For ^{17}O-excess and d-excess, the precision was 13 per meg and 1‰, respectively."

Line 330: the spatial variation in lake water isotopes is a very interesting finding. I would like to see this emphasized for paleoclimate applications. Paleoclimate workers often sample lacustrine sediments at a single location (one outcrop, one core). This *result implies that, for small lakes in the geologic record, we should be sampling horizontal transects.*

This comment has also been raised by the second reviewer. We will add a short discussion on the implication of the spatial variations for the paleo-data in the discussion section:

"Spatial variations in the isotope composition of lake water should be considered when interpreting isotope data obtained from paleo-archives from lake sediments. Recently, gradients in the isotope composition of gypsum hydration water from the lake margin to the centre have been linked to increasing lake water evaporation due to decreasing water level (Cañada-Pasadas et al., 2024). Sampling lake sediments along horizontal transects can thus provide information at different evaporation stages."

Further, we will point out implications of our study for paleoclimate studies in the conclusions:

"Our results have significant implications for interpreting isotope data retrieved from lake sediment archives in paleoclimate studies. Lake evaporites, such as gypsum, capture the isotopic composition of the lake water at the time of their formation. Recently, Cañada-Pasadas et al. (2024) demonstrated that surface gypsum samples of an Andalusian wetland reflect lake water isotope conditions during spring and early summer, rather than the annual average. Determining the timing of gypsum formation is thus essential to ensure accurate paleo-interpretations. Additionally, spatial variations in the isotope composition of lake water must be considered. Lake sediment sampling along horizontal transects can reveal information on paleo-environmental conditions at different evaporation stages."

Line 365: this finding points to a strong need to measure triple oxygen isotopes in water vapor. You may consider highlighting this result in the conclusions.

Indeed, long-term isotope records of atmospheric water vapor are scarce, especially in semarid regions, where precipitation is rare, and only one continuous record of ^{17}O-excess$_V$ has been published so far (Voigt et al., 2023). These records would help to better constrain this variable and it's seasonal variability, and reduce the model uncertainty.

We added the following paragraph to the conclusions:

"Sensitivity analyses showed that the isotope composition of atmospheric water vapor is a key parameter determining isotope fractionation of lake water during evaporation. In the absence of direct measurements, it is often estimated from precipitation data assuming isotope equilibrium. However, in semi-arid regions, the seasonality of precipitation challenges accurate estimation of the isotope composition of atmospheric water vapor. Establishing long-term records of atmospheric water vapor

isotopes, particularly in regions of low or highly seasonal rainfall, would help to better constrain this variable, enhancing model simulations and reducing uncertainty in lake isotope mass balance calculations."

Line 385: Do you have any thoughts on why the C-G evaporation model is unable to match the isotope data given the measured parameters?

Model-data deviations can be mostly attributed to uncertainty in the effective relative humidity, but also in the isotope composition of atmospheric water vapor and the turbulence coefficient.
In our model simulations, we used daily average relative humidity values from a nearby meteorological station. The local relative humidity may deviate from these observations due to 1) microclimate created by the lake environment, 2) diurnal variations in the evaporation rate or 3) moisture build-up in the atmosphere due to evaporation of lake water.
Uncertainty in the isotope composition of atmospheric water vapor mainly arrise from the lack of direct measurements. We estimate the isotope composition of atmospheric water vapor from monthly precipitation data, assuming equilibrium. However, these data does not account for intramonthly variability. The isotope composition of atmospheric water vapor can change rapidly on daily or sub-daily scale, e.g., due to 1) change in air mass sources, 2) rainout or 3) local mositure recycling (evapotranspiration).
Finally, the turbulence coefficient is an empirical parameter, whose variability is not well understood. We used a value of 0.5, which within the range of previously suggested values (Gonfiantini, 1986). However, seasonal variations may occur due to changes in wind activity.
All these factors are discussed in new line 430-456.

Line 430 - 455: this discussion text mostly answers my above question. This data highlights that diurnal fluctuations are important to semi-arid lake hydrology, perhaps more so than seasonal or annual conditions. This finding could be useful for understanding which/how anthropogenic climate changes will impact arid environments, and which parameters should be considered when examining model predictions.

See reply to the question above.

Line 444: Is there a citation showing water vapor build up above lakes during periods of high evaporation that could support this idea? This set of sentences is confusing - why does more wind correspond to lower turbulence? This is the opposite of what I would expect.

The turbulence coefficient n that describes the proportion of molecular diffusion on total diffusion is weighted by a factor θ, which accounts for the vertical mixing of the atmosphere. This factor usually equals unity and is therefore neglected. However, a large evaporation flux from the lake surface can lead to a vertical gradient in the atmospheric water content and leads to a decrease in θ and thus n (Gat et al., 1994). Moderately to large

lakes have been shown to modify their boundary layer due to admixture of evaporated water into the overlying air mass (Gat et al., 1994; Vallet-Coulomb et al., 2008; Jasechko et al., 2014).
We modified this paragraph in the main text as follows:

"In contrast, in summer, the model requires a relative humidity higher than the observed value to achieve a better agreement between the modelled and the observed isotope composition of lake water. This counterintuitive observation may result from strong evaporation during summer, which increases atmospheric relative humidity. The upward evaporation flux contributes to moisture buildup and perturbs the atmospheric boundary layer. This perturbation can be accounted for in the model by weighting the turbulence coefficient with a transport parameter, θ (Gat et al., 1994; Gibson et al., 2016b). For the Great lakes region, Gat et al. (1994) found θ to be 0.88. However, values closer to 1 are expected for smaller lakes (Gibson et al., 2016b). Alternatively, the lower turbulence coefficient in summer may result from stronger atmospheric turbulence caused by a higher frequency of windy days."

Line 468 - Could the "end of the dry season" gray dots also be explained by evaporation from a different source? The points do not quite match up with the concave up prediction from the model - they form more of a cluster, not a trend. While the concave-up/looping prediction matches with previous data (Voigt et al., 2023), the data in this paper do not strongly support that prediction. I would suggest modifying the text to describe this slight disagreement, and possible offer an explanation for the offset.

At the end of the dry season, the lake water level has dropped to only 0.6 m so that changes in atmospheric boundary conditions, especially reative humidity, can rapidly affect the isotope composition of lake water. For example, in Figure 5, the simulated $\delta^{18}O$ (black line) decreases by more than 10 ‰ at the end of October/beginning of November 2021 only due to an increase in RH from about 50 % to close to 100% associated with a a few days of precipitation. Notably, the admixture of precipitation has only a minor impact on the isotope composition of lake water due to mass balance consideration. The variability is largely driven by changes in relative humidity. Rapid changes in relative humidity, e.g. between rainy and non-rainy days may explain the large variability of the isotope composition of lake water at the beginning of the rainy season. The dashed gray line in Figure 6 only represents exemplary the average for a three-months periods and does not capture these variations.

Furthermore, why do you think that the January 2022 samples do not 'complete' the cycle, and end up agreeing with the Jan 2021 samples? Are the conditions (or antecedent conditions) different comparing the two Januaries?

Indeed, the conditions are different. In January 2022, the lake water level is 0.6 m lower than at the beginning of the study period. That's why the lake water is more evaporated in terms of its isotope composition.

Figure 5 caption: there is only a central panel, rephrase

Done.

Figure 6- It might be useful to add a gradient of color within your time blocks to demonstrate that these isotopic values are evolving towards the steady state. This might be a challenge, though, with the rainbow in the background.

We will add a gradient of color to the illustrated isotope data:

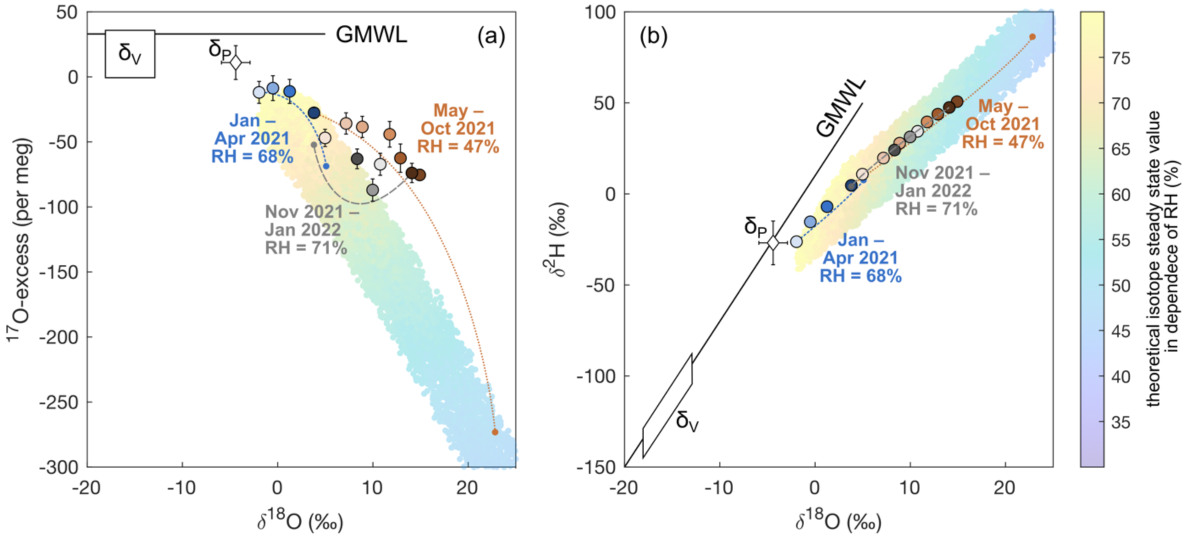

Table S3: Please report d17O and d18O to the third decimal point as this information is needed to calculate D17O in per meg.

We will modify the supplementary tables according to the journal guidelines.

Technical corrections

*Line 26 (and elsewhere): Minor grammar error. The triple oxygen isotope system allows to identify non-steady state conditions --> The triple oxygen isotope system allows **us** to identify non-steady state conditions. Alternate grammatically correct structure: The triple oxygen isotope system allows the identification of non-steady state conditions.*

Line 60: Anthropogenic climate change (delete "the")

Line 360: remove comma after Both

We thank the reviewer for noting these grammatical mistakes. We carefully revised the manuscript and corrected the respective parts.