Summary

This work presents and interprets a stable isotopic record of precipitation from two locations on the Tibetan Plateau. These results are relevant to a variety of disciplines, and show the utility of water isotopologues in identifying moisture transport pathways and processes.

Specifically, these results provide observational constraints on stable water isotopes in precipitation at two sites, which are then used to assess the origin of the moisture sources and their relationship to, for example, ENSO.

This reviewer thinks this isotopic record is worth describing and publishing, but that more work is needed to clarify the methodology, provide or clarify statistical backing for several assertions, and remake several figures.

Major Comments

Line 206: "Specific humidity (q) variations along each trajectory were also analyzed." This assertion does not appear to be supported clearly in the manuscript. Figure 4 shows clustered back trajectories into various source regions and notes that the trajectory colors indicate changes in q. This raises several questions:

- These figures only make sense if the blue shading represents *the value of q* along the back trajectories, and not the change in q. If that is the case, it needs to be stated clearly.
- How large are these changes with respect to the initial q for each trajectory?
- In lines 391-394, for example, it is asserted that evapotranspiration dominates the contribution from a certain set of trajectories. How is this (and other similar statements) justified? By the change in q over a land segment? More insight into this would be helpful.

Relatedly, figures 5 and 6 present moisture flux fields for Yadong and Ali. These figures raise several questions.

- Why are the flux fields different in equivalent panels, e.g., Figures 5g and 6g are both labeled '2021 Late monsoon' but show wildly different flux fields. The reviewer guesses that these fields are averages related to the specific days on which precipitation occurred at Yadong and Ali, respectively. At the very least, this needs to be made clear in the text, and the days over which the averages are taken should be noted in a table in the supplement.
- The utility of these figures is not so clear. If these figures are averages of the flux fields on precipitation days, then only the flux at the measurement site is really relevant and the rest of the flux field is unnecessary. Again, more detail about what exactly is being shown here and how it influences the observations would be very helpful.
- It seems like the essential piece of information needed here is how the back trajectories interact with the moisture fluxes, but it is not clear how to assess this from Figures 4, 5, and 6. Consider some other way of representing how the moisture flux fields interact with the back trajectories if that is actually the goal here.

Line 207: More detail is needed about the cluster analysis. This part of the work plays a large role in interpretation of the results, and more detail is necessary. How many parcels were released at each time interval? Regarding Figures 4 and 7, how are the percentages calculated? Why was 120 hours chosen? How were the trajectories initialized? How does the analysis change if the trajectories are run for only 100 hours, or 140 hours or 160 hours? The trajectories shown are presumably spatial averages of the

back trajectories that are presented – how much spatial variation is there in each cluster? This should be numerically characterized in the text, and shown with a figure in the supplement.

In general, P-values are reported throughout the manuscript, but it is unclear what these numbers represent, as a null hypothesis is never defined. It is not always obvious that the null hypothesis is that R = 0. For example, in Section 3.2 p values for the LMWL lines are reported. It is unclear what these values are with respect to. The GMWL? No correlation? This needs to be clarified in this section and wherever p values are described in the text.

In general, the figures need more descriptive captions. The reader should be able to get the gist of a figure from the caption alone, without significant consultation to the text. Several figures lack adequate description in the text or in the caption. Consider a summary sentence for each figure caption that tells the reader the most important point it makes.

Specific Comments

Lines 47-48: State clearly here what the GMWL slope and intercept represent. Subsequent lines rely on this unstated information.

Lines 145-153: A brief description of the time interval lengths and typical variability of these quantities within each interval would be in order here.

Line 153: Although the study period spans May – September, it would be helpful to the reader to address the data gaps apparent in Figure 1b. In addition, consider mentioning the study period in the figure caption as well.

Section 2.2: What are the effective accuracies of these isotopic measurements, or alternatively, how are calibrations performed?

Lines 173 – 180: Either generalize these equations, or note that a similar equation holds for delta-D.

Line 174: Is this the best SMOW reference??

Line 203: Why was 120 hours chosen? Presumably this time encompasses transport from the major moisture sources?

Lines 237-247: This text should be associated with Figure 1b, as that is where it is first introduced in the manuscript. It is fine to reiterate a key point here, but the main description of precipitation and temperature features should accompany Fig. 1B

Figure 2, left panels: The x-axis dates are very hard to read. Consider dropping the day from the label, e.g., 2023/1/1 → 2023/1. Consider adding a vertical line at the start of each new year through these panels to guide the eye and aid in interpretation.

Lines 287-289: Are these differences significant based on the precisions and accuracies of your measurements? Possibly this is what the quoted p-values are supposed to assess, but it is currently unclear. For properly calculating the errors associated with both the slope and intercept given the precisions of the measurements, consider using something like a total least squares fit.

Figure 3: This figure is hard to read, especially where, for example, blue squares overlap blue circles. Maybe consider giving each site a shape, and coloring by season instead?

Figure 4: It is not clear from the caption or the text what the color coding of the percentages corresponds to. By inspection, I think percentages associated with Ali are black and those associated with Yadong are blue. Consider color coding by location, e.g., make 'Yadong' blue as well. This color coding should be noted in the caption. In general, the reader should be able to comprehend the basics of a figure from the caption.

Figures 5 and 6: It is very difficult to interpret the panels in which there is significant overlap of the arrows. Consider decreasing the maximum magnitude of the arrows, and color coding them by speed to aid the eye in interpretation.

Figures 5 and 6: It is generally unclear why both the scalar water flux and the vector arrow are both presented. This needs more explanation.

Figure 7a: Do the bars represent precipitation or the isotopic composition? This is not clear from the Figure 7 caption or the text.

Figures 7b and 7c: Consider combining these panels, which are identical except for the sampling location, with the color coding scheme suggested for Figure 4.

Figures 7d and 7e: Combine these, they are identical except for the sampling locations.

Lines 391-404: Somehow the fraction of backtrajectories which pass into a certain sampling region is equated with the predominant moisture source. It is never made explicitly clear in the manuscript how this is justified. Are the moisture fluxes calculated along the back trajectories according to equation 6? In any case, that equation appears to be a horizontal flux. Even if they are, it is not obvious that 97% of the 120 h back trajectories being in a certain region means that they are completely representative of evapotranspiration, for example.

Lines 518-527: These statements can't be evaluated without error bars. Note that the error bars should not just include instrumental uncertainty, but some estimate of natural variability as well.

Lines 524-526: "The most pronounced increases in $\delta^{18}O$ occurred between the La Niña and El Niño monsoon seasons indicate that ENSO significantly influences the interannual variability of precipitation stable isotopes at both sites." An assertion of 'significant influence' should have some statistics to back it up.

<u>Language/Typographical</u>

Line 36: Stable isotope → Stable isotopes

Line 66: Generally show → Generally shows

Line 104: "Bangladesh, which significantly impact" → "Bangladesh significantly impact"

Line 168: "until isotope measurements" → "until isotope measurements were made."

Line 218: “to calculated” → “to calculate”

Line 278: “are probably resulted” → “probably result”

Lines 287 – 300, and generally through the manuscript: Include units on all intercepts and slopes.

Line 543: ‘anomalously convection’ → anomalous convection