We thank the two reviewers for their constructive comments. We have made our best to address all the comments. Our point-by-point reply in below in red and reviewers' comments in black.

RC1: 'Comment on egusphere-2025-3567', Anonymous Referee #1

The study of precipitation stable isotopes is of great significance for tracing the water vapor source and studying the water cycle, and it is also of great importance for reconstructing past climatic and environmental changes. This paper investigated the characteristics and mechanisms of multi-scale variability in precipitation stable isotopes in the southern and western Tibetan Plateau. It is worth noting that this paper demonstrates that Indian Summer Monsoon (ISM) circulation homogenizes isotopic signatures across the southern and western Tibetan Plateau, while westerly dominance amplifies regional differences through distinct moisture pathways, and ENSO significantly influences the interannual variability of precipitation stable isotopes in the study area. However, the paper has some issues that require further improvement and clarification.

General comments:

1. About positive values of δ18O and δD in precipitation at the study sites. Figure 2 shows that there are a large number of positive values of δ18O and δD at the two study sites, especially at Yadong. It is necessary to analyze and explain the reasons for the occurrence of these positive values and their indicative significance.

   Reply: Thank you for your suggestion. Following the reviewer's comments, we have added analysis and explanation of the positive $\delta^{18}O$ and δD values in precipitation at both sites in lines 376-382. The new text explicitly attributes these enriched isotope values to the influence of local recycling and the intrusion of dry continental westerly winds during the pre-monsoon and westerly-dominated seasons, in contrast to the depleted signatures of ISM-sourced precipitation.

2. Regarding the selection of altitudes/heights at which the air parcels reach the study sites in backward trajectory analysis. It was pointed out in lines 200-204 that "to assess the influence of moisture sources on precipitation stable isotopes, to calculate 120 h backward trajectories for air masses arriving 200 m above ground level at Yadong and Ali stations." Another thing is that the heights used for calculating water vapor flux are from 500 hPa to 200 hPa in this study. These analyses are all intended to explain the sources and paths of water vapor, but there is inconsistency in the selection of the levels. Since this study focuses on the stable isotopes of precipitation, why not choose the condensation levels instead of 200 m above ground level to calculate the trajectory of the air parcels reaching the study sites? If the condensation levels or 500 hPa or other heights are chosen, will the backward trajectories be significantly different from the current ones? These should be analyzed and explained.

   Reply: Thank you for your comments on trajectory height selection. In our original manuscript, we followed a common method in hydrological isotope studies using HYSPLIT (e.g., Dai et al., 2021; Adhikari et al., 2024). We selected 200 m AGL to avoid the influence of complex terrain and surface friction.

   Following your comments, we have supplemented trajectory analyses at condensation level (derived from in-situ observations) and 500 hPa (aligned with water vapor flux calculations) in section 2.4 (lines 296-307) and 3.4 (lines 574-603) to address our result robustness, and also added Figure S4 and S5 in the supplement, with details below:

Condensation levels: Calculated from event-specific in-situ T/RH (Section 2.1), with mean heights of 3143 m a.m.s.l. (Yadong, 153 m AGL) and 5396 m a.m.s.l. (Ali, 1126 m AGL). This height directly reflects water vapor condensation for precipitation, highly aligning with our focus on precipitation stable isotopes.

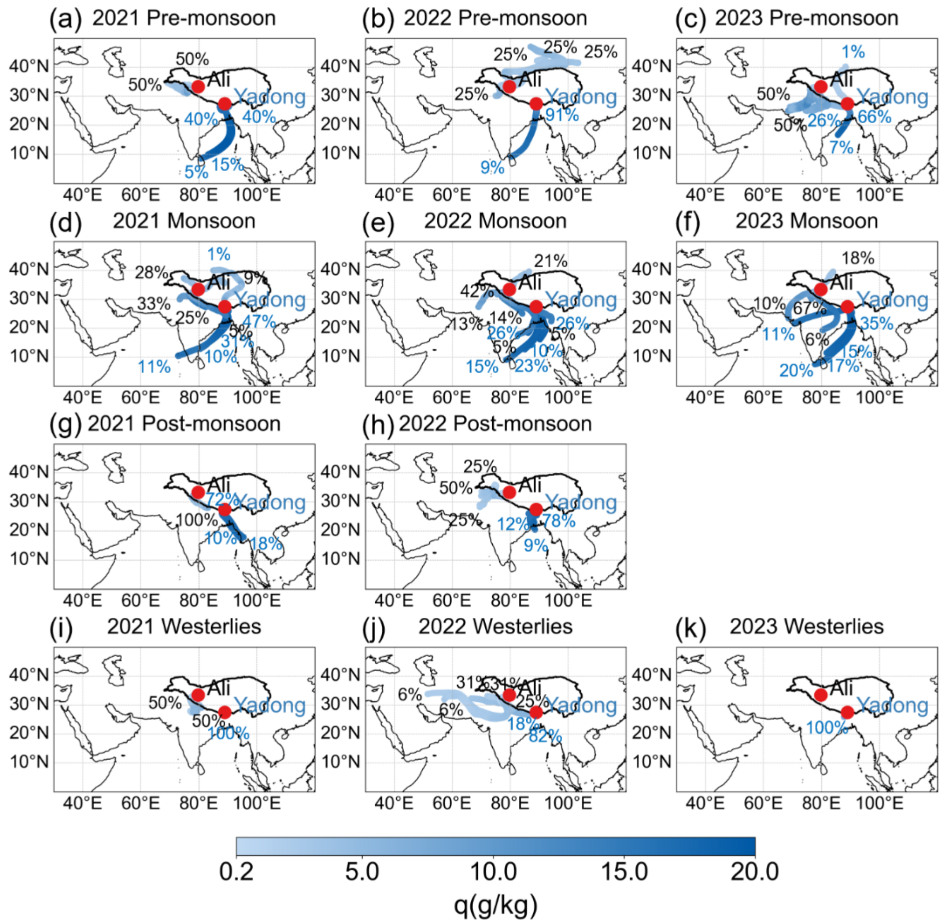


**Figure S4 Clustered 120-hour backward trajectories for air masses at condensation level at Yadong and Ali on rainy days across different seasons (pre-monsoon, monsoon, post-monsoon, westerlies season) from May 2021 to September 2023 based on the HYSPLIT model, with specific humidity value along trajectories and the proportion of each trajectory cluster. Red dots show the locations of both sites. Trajectory colors indicate changes in q, while numbers indicate the proportion of clustered trajectories to total trajectories at Yadong (blue) and Ali (black).**

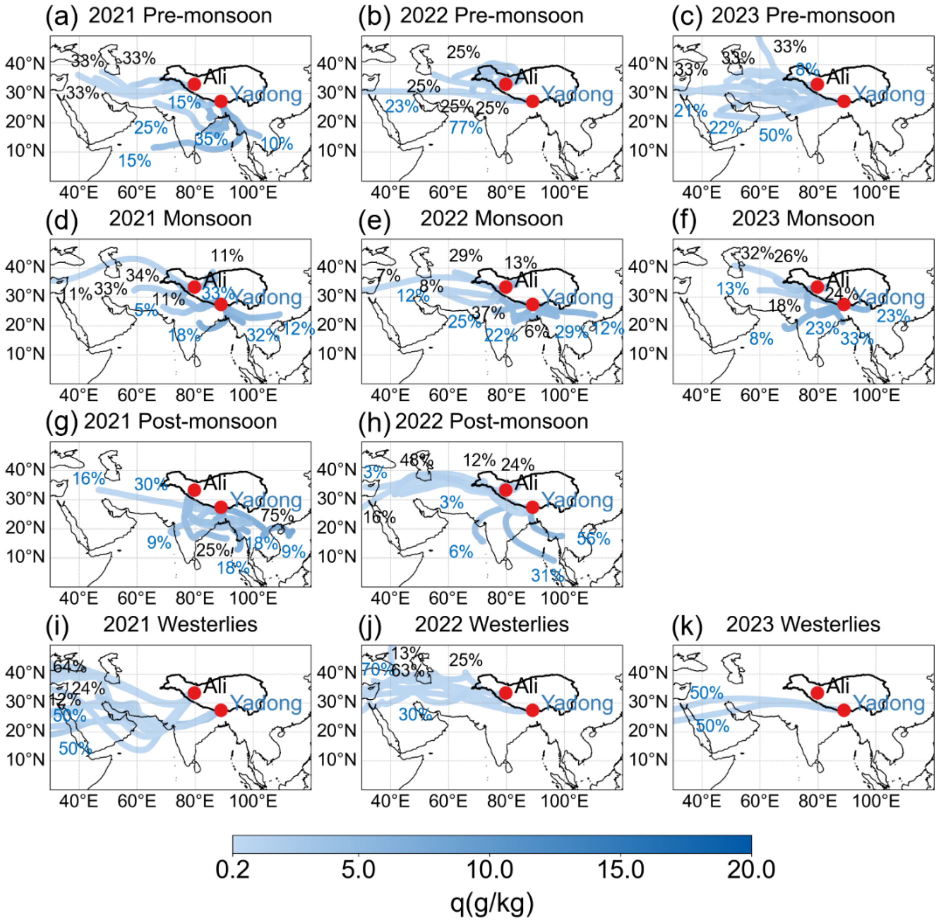

**Figure S5 Clustered 120-hour backward trajectories for air masses at 500 hPa at Yadong and Ali on rainy days across different seasons (pre-monsoon, monsoon, post-monsoon, westerlies season) from May 2021 to September 2023 based on the HYSPLIT model, with specific humidity value along trajectories and the proportion of each trajectory cluster. Red dots show the locations of both sites. Trajectory colors indicate changes in q, while numbers indicate the proportion of clustered trajectories to total trajectories at Yadong (blue) and Ali (black).**

Supplementary analyses using condensation-level and 500 hPa trajectories confirm that the dominant moisture sources of ISM and westerly are consistent across arrival heights. Minor differences appear only in transitional periods and for secondary sources such as local recycling or weak ISM intrusions, likely due to boundary-layer confinement and terrain effects. Therefore, our back-trajectory results at 200 m AGL present the information on both large-scale transport and boundary-layer moisture relevant to precipitation isotopes.

Specific comments:

1. The variation of precipitation throughout the year at Yadong is bimodal, with two peaks in April and October. What is the impact of this pattern of precipitation variation on precipitation stable isotopes? Or what characteristics of precipitation isotopes can indicate the peak precipitation information? If there is currently sufficient data available for the issues, please discuss and explain them.

   Reply: Following the reviewer's comments, we have added the discussion in lines 349-367: Yadong exhibits a pronounced bimodal precipitation regime that exerts seasonally distinct controls on the isotopic composition of precipitation ($\delta^{18}O$ and $\delta D$; Figs. 1b and 2e). During October, which corresponds to the primary precipitation maximum, extreme rainfall events (e.g., 109.3 and 43.7 mm day$^{-1}$) dominate the monthly total and induce a strong amount effect, reflected by a statistically significant negative relationship between precipitation amount and isotopic composition ($R^2 = 0.36$). As a result, October records the most depleted monthly mean isotope values ($\delta^{18}O = -16.0$ ‰; $\delta D = -123.4$ ‰), consistent with enhanced rainout and progressive isotopic depletion during intense convective precipitation. In contrast, April represents a secondary precipitation peak characterized by frequent but weak rainfall events (0.4–18.0 mm day$^{-1}$). Despite relatively high cumulative precipitation, the monthly mean isotope values are anomalously enriched ($\delta^{18}O = -0.2$ ‰; $\delta D = 13.2$ ‰). This enrichment indicates that isotopic variability during April is not primarily governed by the amount effect. Instead, it likely reflects the dominant influence of local surface evaporation and sub-cloud kinetic fractionation, which preferentially enrich heavy isotopes under warm and relatively dry pre-monsoonal conditions. These contrasting isotopic responses highlight the seasonally varying balance between large-scale moisture condensation and local evaporative processes in shaping precipitation isotope signals over the southern TP.

2. Lines 219-220, where g is gravitational acceleration, while Ps and Pt are surface pressure and top pressure, respectively. The expression of Pt is inaccurate.

   Reply: Thank you for your suggestion. Following the reviewer's comments, we have modified the sentence as follows (lines 316-317): where g is gravitational acceleration, while $P_s$ and $P_t$ are surface pressure and 200 hPa pressure, respectively.

3. In Figure 2(f), (g), (h), (i), (j), especially in (j), the units of their vertical coordinates should be displayed.

   Reply: Thank you for your suggestion. Following the reviewer's comments, we have added the units to the vertical axis of all relevant panels in Figure 2(f), (g), (h), (i), (j) to ensure clarity and proper presentation. The updated figure is provided in the revised manuscript.

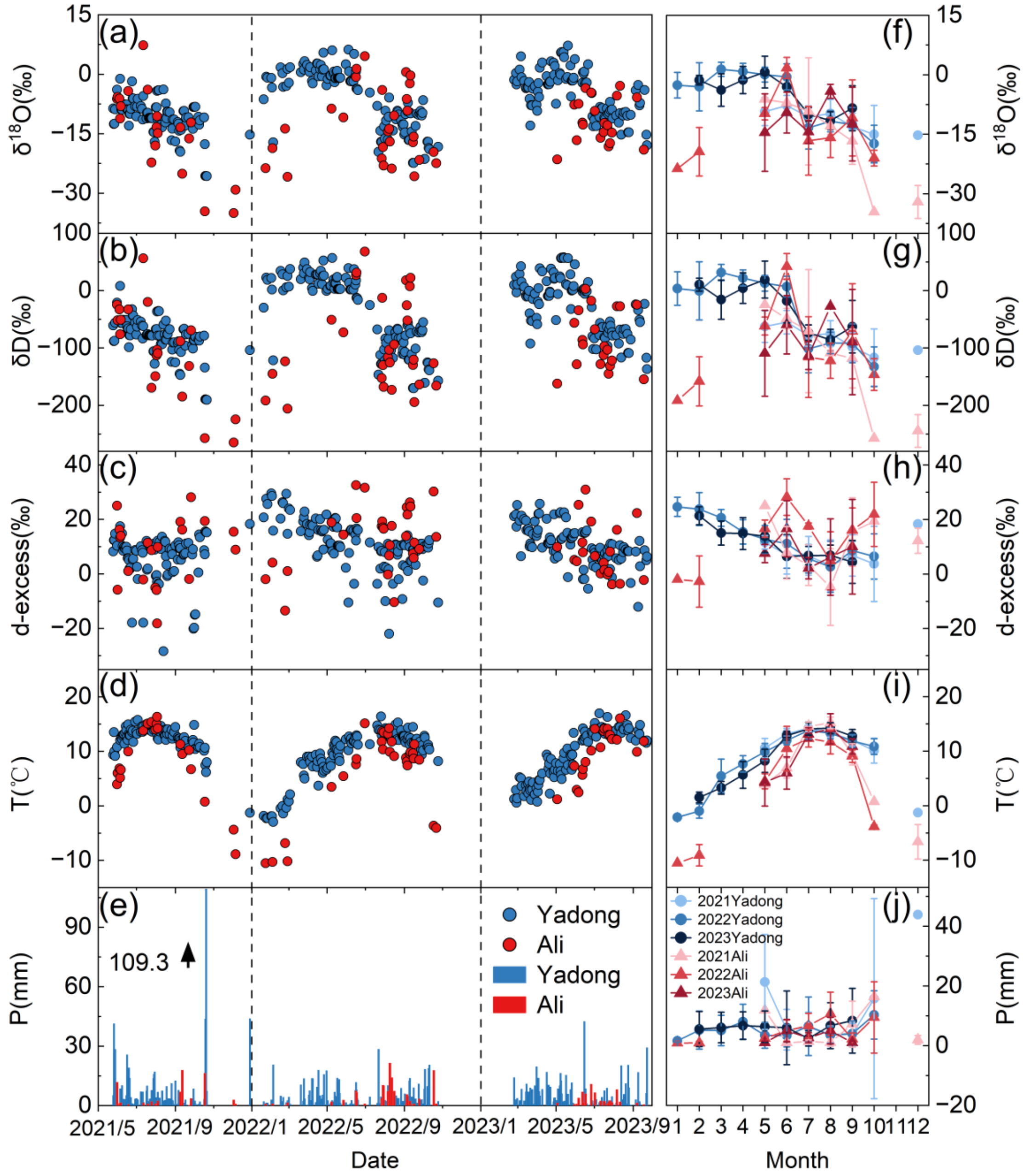


**Figure 2. Temporal variations of daily and monthly precipitation stable isotopes ($\delta^{18}O$, δD, d-excess) and local meteorological conditions (temperature, precipitation amount) at Yadong and Ali from May 2021 to September 2023. (a) and (f) Daily and monthly variations in δ18O. (b) and (g) same as (a) and (f), but for δD. (c) and (h) same as (a) and (f), but for d-excess. (d) and (i) same as (a) and (f), but for temperature. (e) and (j) same as (a) and (f), but for precipitation amount.**

4. According to the definition of seasonal division in lines 232-236, the "late monsoon (October)" should be the "post-monsoon"? And pay attention to the expression of "late monsoon" in the following text.

Reply: Thank you for your suggestion. Following the reviewer's comments, we have revised the "late monsoon" to the "post-monsoon" throughout the entire manuscript, including all figures, tables, and supplement.

5. Line 434, "ISM dominated the moisture transport during pre-monsoon of 2021". In this sentence, the first part is about the monsoon (ISM), but the second part mentions "during pre-monsoon". It seems that the logic or expression is not accurate literally. Similar expressions can also be found in other parts of the text. Please make corrections and/or clarifications. If possible, the seasons can be divided based on the specific dates of the onset and withdrawal of the Indian monsoon each year during the study period in this paper. This seasonal division might be more meaningful for the study of precipitation stable isotopes.

   Reply: Thank you for your suggestion. Following the reviewer's comments, we have revised the manuscript throughout to clarify our meaning.

   Lines 531-537: During late May 2021 (pre-monsoon), moisture transport at Yadong exhibited atypical characteristics for this season. The site experienced enhanced high-humidity southwesterly moisture flux originating primarily from the BOB and the AS, contributing approximately 55 % and 25 % of the total moisture supply, respectively (Fig. 4a). This anomalous moisture transport was associated with relatively depleted precipitation isotope values, with a mean $\delta^{18}O$ of −9.3 ‰.

   Lines 626-629: At Yadong, southwesterly moisture transport dominated during late May (pre-monsoon) 2021, with the maximum vertically integrated water vapor flux reaching 77.5 kg $m^{-1}$ $s^{-1}$ (Fig. 5a), accompanied by relatively depleted precipitation isotopic values ($\delta^{18}O$ = −9.3 ‰).

   In addition, we have added the specific onset and withdrawal dates of the Indian monsoon each year during the study period in lines 172 -176 according to the India Meteorological Department (IMD, https://mausam.imd.gov.in/) as follows:

   This seasonal classification is consistent with the typical progression of the ISM as reported by the India Meteorological Department (IMD; https://mausam.imd.gov.in/). During the study period, monsoon onset dates occurred on 3 June 2021, 29 May 2022, and 8 June 2023, while monsoon withdrawal dates were 25 October 2021, 23 October 2022, and 16 October 2023, respectively.

RC2: 'Comment on egusphere-2025-3567', Anonymous Referee #2

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.

Reply: We have revised the sentence into "Specific humidity (q) was tracked along each trajectory, and the magnitude of moisture change ($|\Delta q| = |q_{end} - q_{initial}|$) ranged from 0.5 to 8.1 g $kg^{-1}$ at Yadong and from 0.1 to 16.9 g $kg^{-1}$ at Ali, indicating substantial moisture uptake and loss along transport pathways." in lines 272-275. And updated the caption of Figure 4 to clarify that "Trajectory colors indicate the values of q, while numbers indicate the proportion of clustered trajectories to total trajectories at Yadong (blue) and Ali (black)".

• How large are these changes with respect to the initial q for each trajectory?

Reply: We have calculated the absolute change in specific humidity along each trajectory ($|\Delta q| = |q_{end} - q_{initial}|$), and added the sentence in lines 272-275 as follows:

Specific humidity (q) was tracked along each trajectory, and the magnitude of moisture change ($|\Delta q| = |q_{end} - q_{initial}|$) ranged from 0.5 to 8.1 g $kg^{-1}$ at Yadong and from 0.1 to 16.9 g $kg^{-1}$ at Ali, indicating substantial moisture uptake and loss along transport pathways.

• 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.

Reply: We have added an explanation about quantifying the moisture contribution of each trajectory cluster in lines 290-295 as follows:

To quantify the moisture contribution of each trajectory cluster, we combined the relative frequency of clustered trajectories with the along-trajectory variations in q. Increases in q were interpreted as moisture uptake from surface evaporation over the ocean or evapotranspiration over land, whereas decreases in q were attributed to moisture loss associated with precipitation processes (Dai et al., 2021; Adhikari et al., 2020).

We have also added descriptions regarding the backward trajectories in the text in lines 531-573.

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.

Reply: Following the reviewer's suggestion, we have added "on rainy days from 25 May 2021 to 23 September 2023 (308 days)" and "on rainy days from 31 May 2021 to 18 September 2023 (69 days)" in the caption of figures 5 and 6, respectively. We also added the Table S3 in the supplement and a note in lines 622-626 as follows:

Figures 5 and 6 show the seasonal mean vertically integrated water vapor flux in the 500–200 hPa layer on rainy days at Yadong and Ali, respectively, illustrating the seasonal variability in both the magnitude and direction of moisture transport associated with precipitation events at the two sites. The specific rainy days included in the analysis are listed in Table S3.

• 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.

Reply: We have clarified the purpose of these figures in lines 622–625 as follows:

Figures 5 and 6 show the seasonal mean vertically integrated water vapor flux in the 500–200 hPa layer on rainy days at Yadong and Ali, respectively, illustrating the seasonal variability in both the magnitude and direction of moisture transport associated with precipitation events at the two sites.

- 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.

Reply: We thank the reviewer for this suggestion. We used backward trajectory analysis to identify moisture transport pathways and humidity changes, and water vapor flux diagnostics to characterize large-scale moisture transport under different circulation regimes. In the revised manuscript, we have strengthened the link between these two approaches by explicitly highlighting the consistency between trajectory-derived moisture supply and large-scale moisture flux patterns (lines 656–661). Both methods consistently indicate that Yadong is dominated by monsoon-derived moisture during the pre-monsoon (2021), monsoon, and post-monsoon seasons, and by westerly-sourced moisture during the westerlies season. In contrast, Ali is influenced by monsoon moisture during the monsoon season and by westerly moisture during the westerlies season. These consistent results demonstrate the robustness of our moisture source attribution.

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.

Backward trajectories were calculated with a duration of 120 h, which was selected because it sufficiently captures transport times from the major moisture source regions to the TP, as demonstrated in previous studies (Gao et al., 2013; Dai et al., 2021). Sensitivity tests using 140 h trajectories showed no significant differences in transport pathways or moisture source attribution compared to the 120 h case (Fig. S1). Therefore, 120 h was adopted as an optimal and computationally efficient choice for this study.

Trajectories were initialized four times daily (00:00, 06:00, 12:00, and 18:00 UTC) on all rainy days between May 2021 and September 2023, with one air parcel released at each start time. Specific humidity (q) was tracked along each trajectory, and the magnitude of moisture change ($|\Delta q| = |q_{end} - q_{initial}|$) ranged from 0.5 to 8.1 g kg$^{-1}$ at Yadong and from 0.1 to 16.9 g kg$^{-1}$ at Ali, indicating substantial moisture uptake and loss along transport pathways.

Cluster analysis was performed using the HYSPLIT clustering algorithm, which groups trajectories with similar spatial pathways. The optimal number of clusters was determined by minimizing the Total Spatial Variance (TSV). For each cluster, a mean trajectory represents the spatial average of all trajectories within that cluster. The percentages shown in Figures 4 and 7 indicate the fraction of trajectories assigned to each cluster relative to the total number of trajectories at each site. We have added Table S1 to show Total Spatial Variance (TSV, units: °2) of trajectory clusters at Yadong and Ali in different seasons of each year.

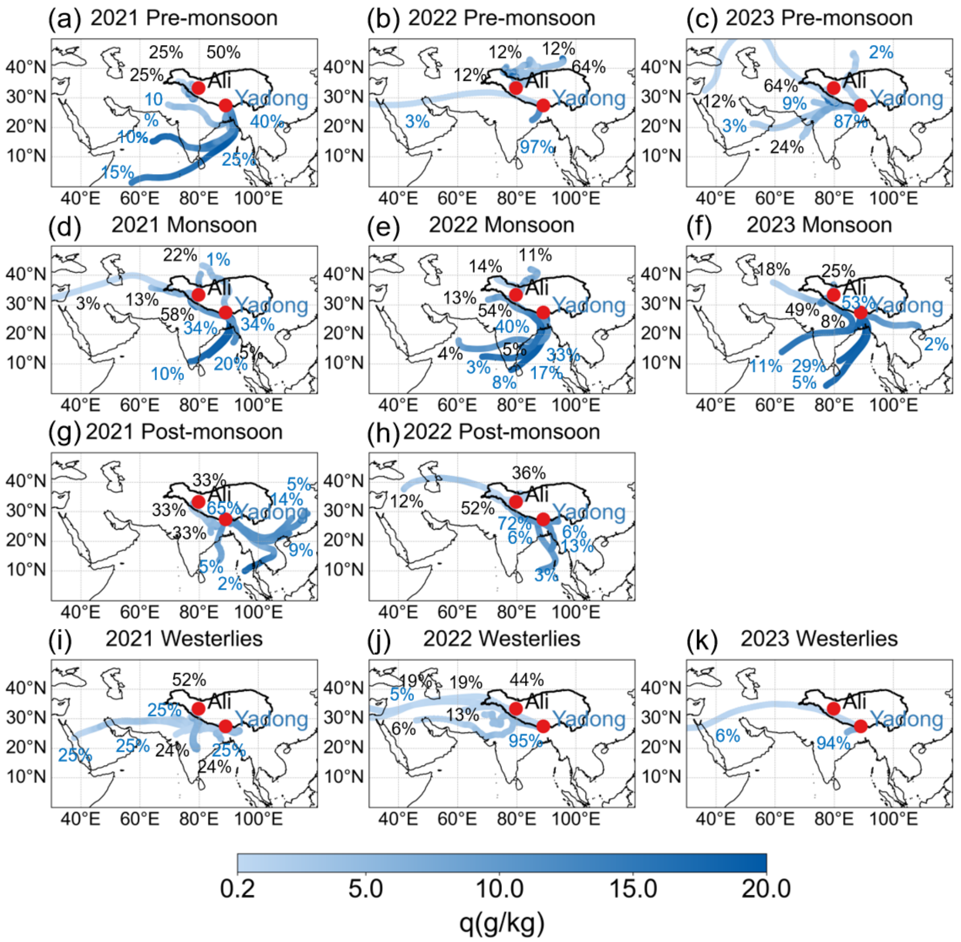


**Figure S1 Clustered 140-hour backward trajectories for air masses arriving 200 m above ground level at Yadong and Ali on rainy days across different seasons (pre-monsoon, monsoon, post-monsoon, westerlies season) from May 2021 to September 2023 based on the HYSPLIT model, with specific humidity value along trajectories and the proportion of each trajectory cluster. Red dots show the locations of both sites. Trajectory colors indicate changes the values ofin q, while numbers indicate the proportion of clustered trajectories to total trajectories at Yadong (blue) and Ali (black).**

**Table S1 Total Spatial Variance (TSV, units: °$^2$) of trajectory clusters at Yadong and Ali in different seasons of each year. - indicates insufficient trajectories for cluster analysis, all individual trajectories are displayed in Fig. 4.**

| Site | Year | Pre-monsoon | Monsoon | Post-monsoon | Westerlies |
|---|---|---|---|---|---|
| Yadong | 2021 | - | 66.4 | 37.2 | - |
| | 2022 | 154.8 | 38.4 | 30.8 | 70 |
| | 2023 | 63.0 | 39.8 | | - |
| Ali | 2021 | - | 64.4 | - | - |
| | 2022 | - | 36.5 | - | - |
| | 2023 | - | 255.1 | | |

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.

Reply: Thank you for your suggestion. We have added the null hypothesis ($H_0$) for each p-value as follows:

line 411: $H_0$: no linear relationship between $\delta^{18}O$ and $\delta D$

line 446: $H_0$: no linear correlation

line 740: $H_0$: no spatial linear correlation

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.

Reply: We have added a summary sentence for each figure caption as follows:

Figure 1: Map showing the geographical locations of Yadong and Ali, the mean integrated water vapor flux (500-200 hPa) during the 1994 to 2023 monsoon seasons, and the monthly mean temperature and precipitation at both sites from May 2021 to September 2023.

Figure 2: Temporal variations of daily and monthly precipitation stable isotopes ($\delta^{18}O$, $\delta D$, d-excess) and local meteorological conditions (temperature, precipitation amount) at Yadong and Ali from May 2021 to September 2023.

Figure 3: Scatter plot of daily $\delta^{18}O$ versus q at Yadong and Ali, with mixing and Rayleigh fractionation curves.

Figure 4: Clustered 120-hour backward trajectories for air masses arriving 200 m above ground level at Yadong and Ali on rainy days across different seasons (pre-monsoon, monsoon, post-monsoon, westerlies season) from May 2021 to September 2023 based on the HYSPLIT model, with specific humidity value along trajectories and the proportion of each trajectory cluster.

Figure 5: The magnitude and direction of seasonal mean integrated water vapor flux (500-200 hPa) over Yadong on rainy days from 25 May 2021 to 23 September 2023 (308 days) across seasons using ERA5 reanalysis data.

Figure 6: The magnitude and direction of seasonal mean integrated water vapor flux (500-200 hPa) over Ali on rainy days from 31 May 2021 to 18 September 2023 (69 days) across seasons using ERA5 reanalysis data.

Figure 7: Comparative analysis for simultaneous rainy days at Yadong and Ali, including $\delta^{18}O$ and precipitation amount, backward trajectories, and mean integrated water vapor flux (500-200 hPa) during the monsoon season.

Figure 8: Concurrent time series of the monthly Niño 3.4 index and monthly amount-weighted $\delta^{18}O$ at Yadong and Ali, and the spatial correlation between the monthly Niño 3.4 index and monthly mean integrated water vapor flux (surface to 200 hPa) from May 2021 to September 2023.

Figure S1: Clustered 140-hour backward trajectories for air masses arriving 200 m above ground level at Yadong and Ali on rainy days across different seasons (pre-monsoon, monsoon, post-monsoon, westerlies season) from May 2021 to September 2023 based on the HYSPLIT model, with specific humidity value along trajectories and the proportion of each trajectory cluster.

Figure S2: A comparison between the annual Local Meteoric Water Line (LMWL) of Yadong and Ali and the Global Meteoric Water Line (GMWL).

Figure S3: A heatmap showing the correlation coefficients between precipitation $\delta^{18}O$ and temperature (T), precipitation amount (P), and wind speed (WS) for Yadong and Ali during different months.

Figure S4: Clustered 120-hour backward trajectories for air masses at condensation level at Yadong and Ali on rainy days across different seasons (pre-monsoon, monsoon, post-monsoon, westerlies season) from May 2021 to September 2023 based on the HYSPLIT model, with specific humidity value along trajectories and the proportion of each trajectory cluster.

Figure S5: Clustered 120-hour backward trajectories for air masses at 500 hPa at Yadong and Ali on rainy days across different seasons (pre-monsoon, monsoon, post-monsoon, westerlies season) from May 2021 to September 2023 based on the HYSPLIT model, with specific humidity value along trajectories and the proportion of each trajectory cluster.

Figure S6: 120-hour backward trajectories of 5 clusters on simultaneous rainy days during the monsoon season at Yadong (a) and Ali (b) based on the HYSPLIT model.

Specific Comments

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

Reply: Thank you for your suggestion. We have added content about what the slope and intercept represent in lines 55-58 as follows:

The slope reflects the fractionation ratio of δD and δ18O, and the intercept represents the mean d-excess, which signals kinetic fractionation during ocean evaporation and serves as a tracer of moisture source conditions (Merlivat and Jouzel, 1979).

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.

Reply: We have added the seasonal divisions and the characteristic variability of key meteorological variables for each season in lines 166–192 of the revised manuscript, as detailed below.

To account for the respective influences of the ISM and the mid-latitude westerlies on precipitation stable isotopes, the year is divided into a monsoon season (June–September) and a non-monsoon season (October–May of the following year). The non-monsoon season is further subdivided into the pre-monsoon (March–May), post-monsoon (October), and westerlies (November–February) seasons, following previous isotope-based studies over the Tibetan Plateau (Axelsson et al., 2023; Dai et al., 2021). This seasonal classification is consistent with the typical progression of the ISM as reported by the India Meteorological Department (IMD; https://mausam.imd.gov.in/). During the study period, monsoon onset dates occurred on 3 June 2021, 29 May 2022, and 8 June 2023, while monsoon withdrawal dates were 25 October 2021, 23 October 2022, and 16 October 2023, respectively. Meteorological conditions at both Yadong and Ali exhibited pronounced seasonal cycles. Air temperature at both sites peaked during the monsoon season (July means of 14.1°C at Yadong and 13.3°C at Ali) and reached minima during the westerlies season (January means of −2.1 °C and −10.5 °C, respectively). Precipitation patterns differed markedly between the two sites: Yadong experienced substantial rainfall with maxima during both the pre-monsoon (118.2 mm) and post-monsoon (127.8 mm) seasons, whereas approximately 70 % of Ali's annual precipitation occurred during the monsoon season (Fig. 1b). Relative humidity remained consistently high at

Yadong throughout the year (pre-monsoon: 93 %; monsoon: 94 %; post-monsoon: 95 %; westerlies: 92 %), while at Ali it was substantially lower overall and exhibited a seasonal maximum during the post-monsoon period (pre-monsoon: 67 %; monsoon: 59 %; post-monsoon: 81 %; westerlies: 70 %). Wind speeds at Yadong were persistently low with minimal seasonal variability (pre-monsoon: 1.6 m $s^{-1}$; monsoon: 2.2 m $s^{-1}$; post-monsoon: 1.5 m $s^{-1}$; westerlies: 1.7 m $s^{-1}$). In contrast, Ali experienced generally stronger winds, with maxima during the pre-monsoon (2.7 m $s^{-1}$) and monsoon (2.9 m $s^{-1}$) seasons (post-monsoon: 1.6 m $s^{-1}$; westerlies: 1.7 m $s^{-1}$)

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.

Reply: Thank you for your suggestion. We have added the study period to the Figure 1b caption, along with a note stating that the absence of precipitation events at Yadong in November and at Ali in March, April, and November during the study period as follows:

(b) Monthly mean temperature (lines) and precipitation (bars) at both sites from May 2021 to September 2023. Note the absence of precipitation events at Yadong in November and at Ali in March, April, and November during the study period.

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

Reply: Thank you for your suggestion. We have added a detailed description of the calibration and quality-control procedures in lines 212-228 as follows:

Stable isotope measurements were calibrated and quality-controlled following a standardized analytical protocol. Each analytical batch comprised 27 precipitation samples and 4 laboratory reference standards, with each sample measured six consecutive times. To minimize instrument memory effects, the first three injections were discarded. The remaining three injections were required to meet strict precision criteria, with a standard deviation (SD) of < 0.08 ‰ for $\delta^{18}O$ and < 0.5 ‰ for $\delta D$; samples that did not meet these thresholds were remeasured. For calibration, 4 laboratory reference standards calibrated against Vienna Standard Mean Ocean Water (V-SMOW) ($\delta^{18}O$ = -0.9 ‰ and $\delta D$ = -5.3 ‰, $\delta^{18}O$ = -10.9 ‰ and $\delta D$ = -77.0 ‰, $\delta^{18}O$ = -19.7 ‰ and $\delta D$ = -147.0 ‰, $\delta^{18}O$ = -29.4 ‰ and $\delta D$ = -224.6 ‰) were used to cover the isotopic range of ambient precipitation samples at both sites, with reference standard values spanning a similar range to those used in recent precipitation isotope studies from the same TP region (Wang et al., 2023). For each analytical batch, a univariate linear regression was established between the measured isotope values and the assigned values of the reference standards. The resulting calibration equation was then applied to correct the raw isotope measurements of the co-analyzed precipitation samples, ensuring consistency and traceability of the final dataset..

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

Reply: Thank you for your suggestion. We have added a note in lines 237-238 as follows:

The definition of $\delta D$ follows a form analogous to Eq. (1), and its precipitation amount-weighted average is calculated identically using Eq. (2).

Line 174: Is this the best SMOW reference??

Reply: Thank you for your suggestion. We have added a detailed description of the laboratory reference standards in lines 218-224 as follow:

For calibration, 4 laboratory reference standards calibrated against Vienna Standard Mean Ocean

Water (V-SMOW) ($\delta^{18}O$ = -0.9 ‰ and δD = -5.3 ‰, $\delta^{18}O$ = -10.9 ‰ and δD = -77.0 ‰, $\delta^{18}O$ = -19.7 ‰ and δD = -147.0 ‰, $\delta^{18}O$ = -29.4 ‰ and δD = -224.6 ‰) were used to cover the isotopic range of ambient precipitation samples at both sites, with reference standard values spanning a similar range to those used in recent precipitation isotope studies from the same TP region (Wang et al., 2023).

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

Reply: As suggested, we have clarified the reason for selecting a 120-hour duration in lines 264-267 as follows:

Backward trajectories were calculated with a duration of 120 h, which was selected because it sufficiently captures transport times from the major moisture source regions to the TP, as demonstrated in previous studies (Gao et al., 2013; Dai et al., 2021).

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

Reply: Thank you for your suggestion. Upon review, we have added the main description of precipitation and temperature features in lines 177-183, which is associated with Figure 1b.

Lines177-183: Air temperature at both sites peaked during the monsoon season (July means of 14.1°C at Yadong and 13.3°C at Ali) and reached minima during the westerlies season (January means of −2.1 °C and −10.5 °C, respectively). Precipitation patterns differed markedly between the two sites: Yadong experienced substantial rainfall with maxima during both the pre-monsoon (118.2 mm) and post-monsoon (127.8 mm) seasons, whereas approximately 70 % of Ali's annual precipitation occurred during the monsoon season (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.

Reply: Thank you for your suggestion. We have dropped the day from the x-axis labels, and added vertical lines at the start of each new year through these panels in Figure 2.

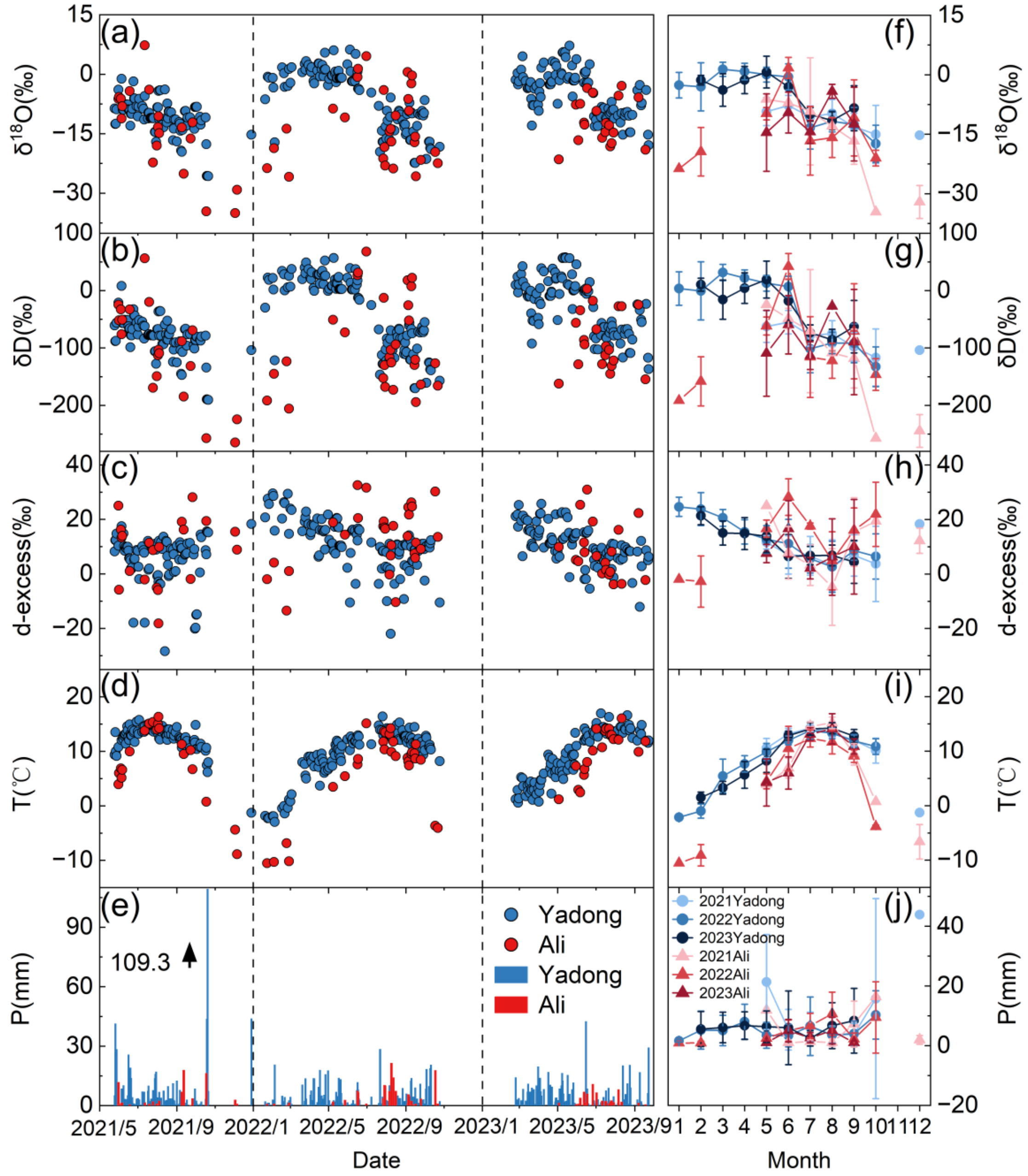


**Figure 2. Temporal variations of daily and monthly precipitation stable isotopes (δ18O, δD, d-excess) and local meteorological conditions (temperature, precipitation amount) at Yadong and Ali from May 2021 to September 2023. (a) and (f) Daily and monthly variations in δ18O. (b) and (g) same as (a) and (f), but for δD. (c) and (h) same as (a) and (f), but for d-excess. (d) and (i) same as (a) and (f), but for temperature. (e) and (j) same as (a) and (f), but for precipitation amount.**

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.

Reply: Thank you for your suggestion. We have used total least squares (TLS) regression to all LMWLs, accounting for measurement precisions to estimate slope and intercept errors, and added explanations in lines 414-415 of the manuscript, revised the corresponding text in Section 3.2, as well as Table 1 and Figure S2 in the supplement.

The relevant explanations, Table 1 and Figure S1 in the supplement are as follows:

Lines 414-415: We used total least squares (TLS) regression to calculate all LMWLs, accounting for measurement precisions to estimate slope and intercept errors.

**Table 1. Local Meteoric Water Line (LMWL) for Yadong and Ali, including coefficient of determination ($R^2$) and p-value ($H_0$: no linear relationship between $\delta^{18}O$ and $\delta D$).**

| Station | Yadong | Ali |
|---|---|---|
| Full year | $\delta D = 8.43 \pm 0.07 \times \delta^{18}O + 12.70 \pm 0.70$, $R^2 = 0.98$, $p < 0.001$ | $\delta D = 8.38 \pm 0.16 \times \delta^{18}O + 15.41 \pm 2.46$, $R^2 = 0.98$, $p < 0.001$ |
| Pre-monsoon | $\delta D = 8.11 \pm 0.14 \times \delta^{18}O + 14.77 \pm 0.56$, $R^2 = 0.97$, $p < 0.001$ | $\delta D = 8.62 \pm 0.67 \times \delta^{18}O + 21.50 \pm 8.20$, $R^2 = 0.98$, $p < 0.01$ |
| Monsoon | $\delta D = 7.89 \pm 0.11 \times \delta^{18}O + 5.24 \pm 1.22$, $R^2 = 0.96$, $p < 0.001$ | $\delta D = 8.57 \pm 0.20 \times \delta^{18}O + 16.85 \pm 2.71$, $R^2 = 0.97$, $p < 0.001$ |
| Post-monsoon | $\delta D = 6.92 \pm 0.34 \times \delta^{18}O - 12.41 \pm 5.76$, $R^2 = 0.96$, $p < 0.001$ | $\delta D = 8.44 \pm 1.00 \times \delta^{18}O + 32.37 \pm 26.46$, $R^2 = 0.99$, $p > 0.05$ |
| Westerlies | $\delta D = 8.39 \pm 0.22 \times \delta^{18}O + 24.31 \pm 1.39$, $R^2 = 0.99$, $p < 0.001$ | $\delta D = 6.87 \pm 0.31 \times \delta^{18}O - 25.10 \pm 7.74$, $R^2 = 0.99$, $p < 0.001$ |

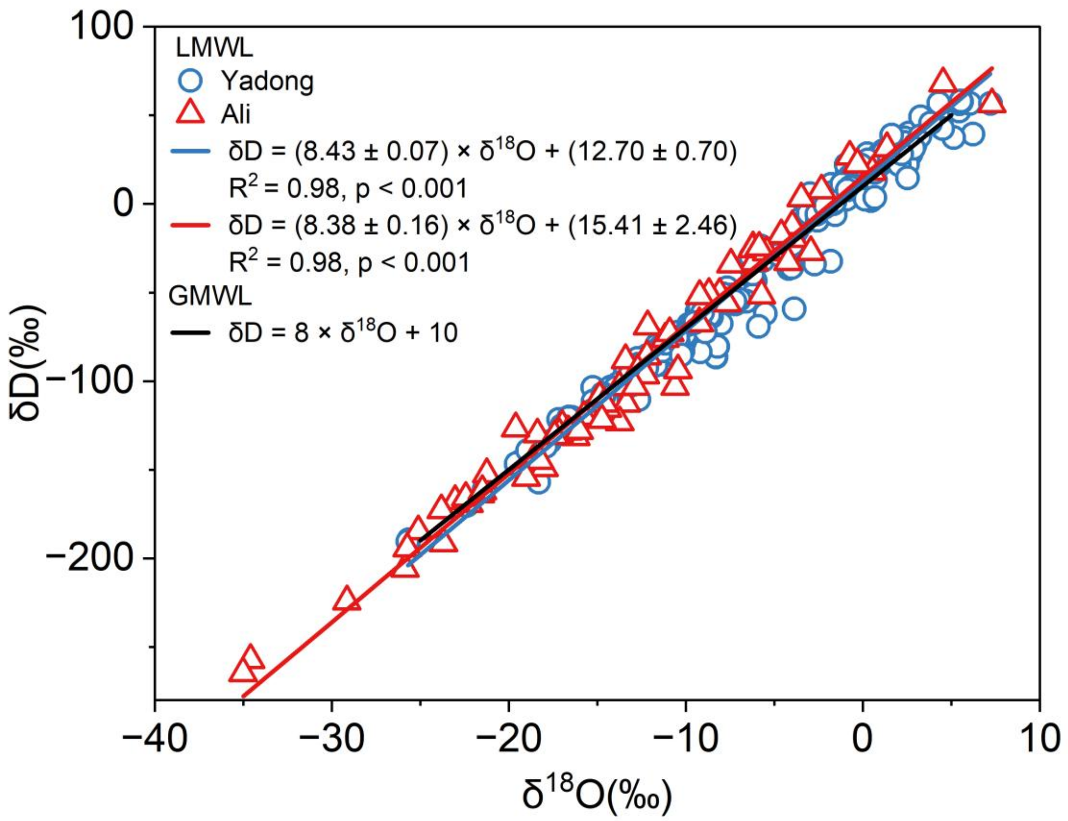


**Figure S2 A comparison between the annual Local Meteoric Water Line (LMWL) of Yadong and Ali and the Global Meteoric Water Line (GMWL).**

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?

Reply: Thank you for your suggestion. We have represented Yadong as circle, Ali as triangle, pre-monsoon season in red, monsoon season in blue, post-monsoon season in purple, and westerlies season in gray in Figure 3.

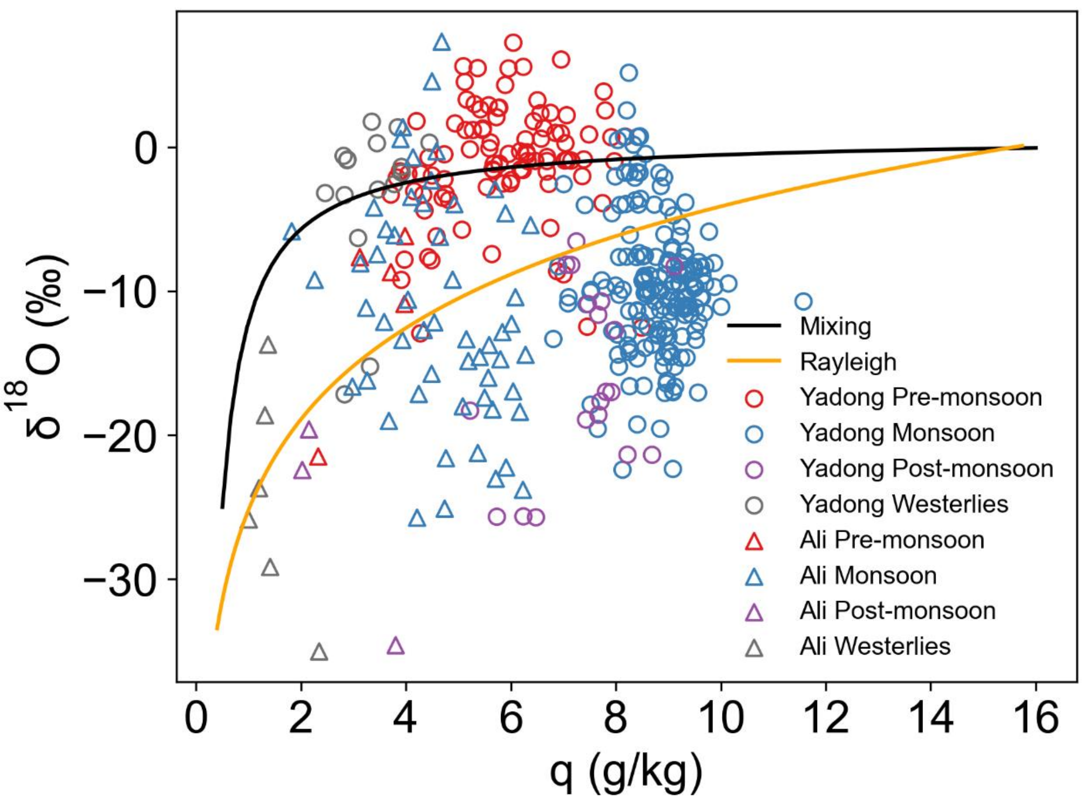


**Figure 3. Scatter plot of daily $\delta^{18}O$ versus q at Yadong and Ali, with mixing and Rayleigh fractionation curves. Black and orange lines represent the mixing and Rayleigh fractionation curves, respectively. The Rayleigh starting point is set at −0.07 ‰ and 16 g kg−1 at 25 °C, assuming equilibrium conditions for precipitation from sea-level air with 80 % relative humidity. The mixing curve uses the same wet end-member; the dry end-member is set at −25 ‰ and 0.5 g kg−1.**

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.

Reply: Thank you for your suggestion. We have added a note in the caption in lines 521-523 as follows:

Trajectory colors indicate the values of q, while numbers indicate the proportion of clustered trajectories to total trajectories at Yadong (blue) and Ali (black).

We also have made 'Yadong' blue in Figure 4.

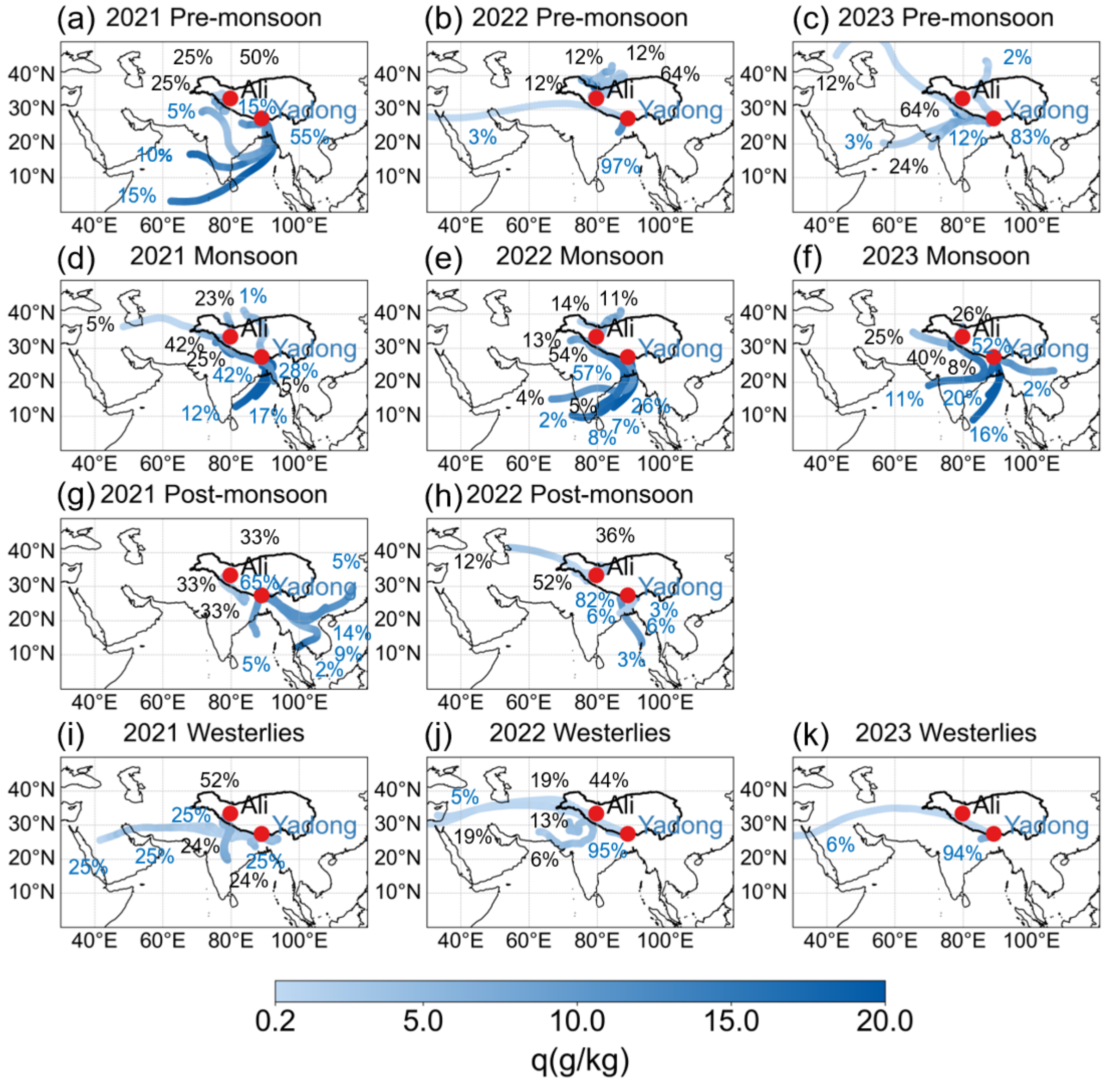


**Figure 4. Clustered 120-hour backward trajectories for air masses arriving 200 m above ground level at Yadong and Ali on rainy days across different seasons (pre-monsoon, monsoon, post-monsoon, westerlies season) from May 2021 to September 2023 based on the HYSPLIT model, with specific humidity value along trajectories and the proportion of each trajectory cluster. Red dots show the locations of both sites. Trajectory colors indicate the values of q, while numbers indicate the proportion of clustered trajectories to total trajectories at Yadong (blue) and Ali (black).**

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.

Reply: We have modified the figure 5 and 6 by standardizing the arrow lengths. In the revised figure, the direction of the black arrows indicate the direction of water vapor flux, while the blue shading represents the magnitude of the water vapor flux. We have modified the captions of figure 5 and 6 to "the blue shading and the direction of the black arrows indicate the magnitude and direction of water vapor flux".

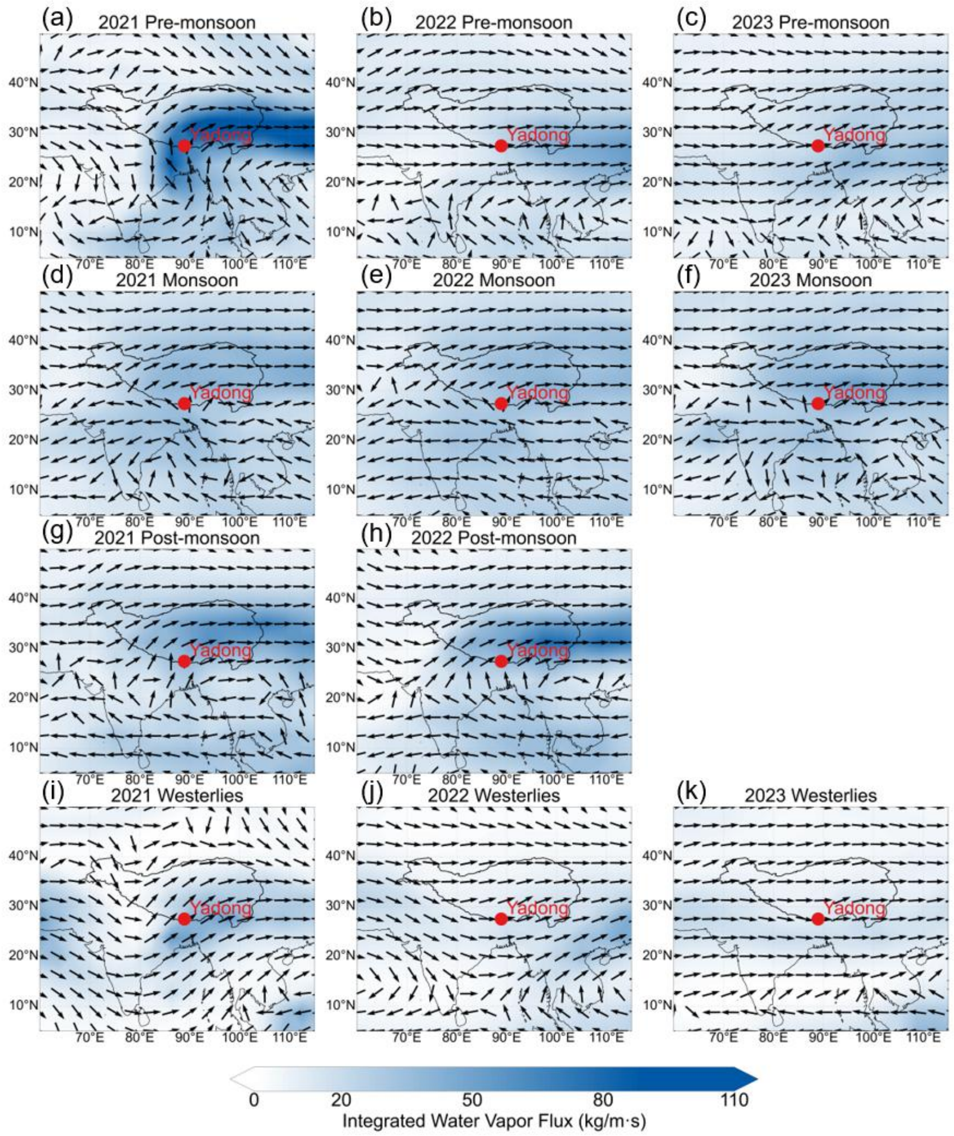


**Figure 5. The magnitude and direction of seasonal mean integrated water vapor flux (500-200 hPa) over Yadong on rainy days from 25 May 2021 to 23 September 2023 (308 days) across seasons (the blue shading and the direction of the black arrows indicate the magnitude and direction of water vapor flux).**

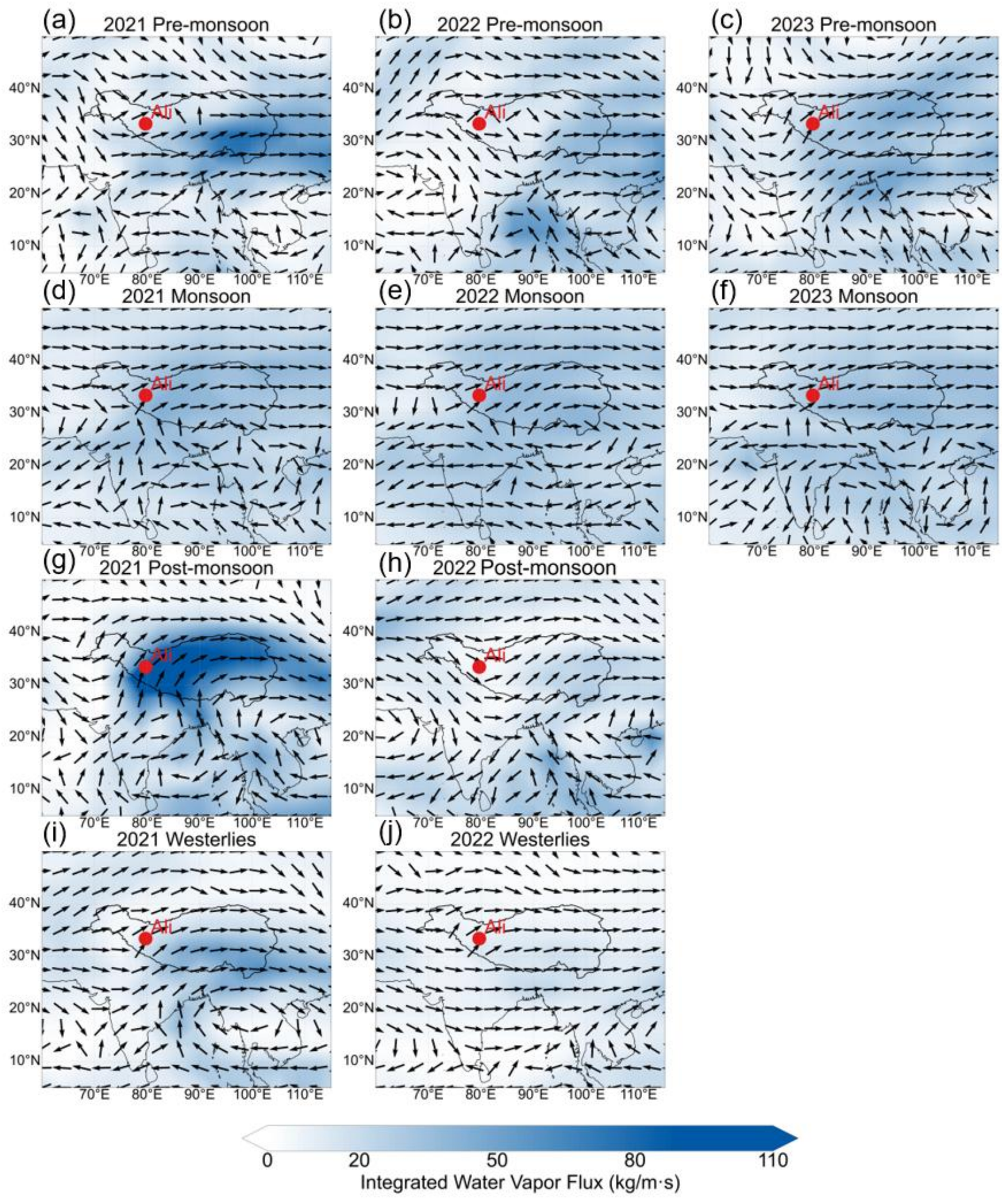


**Figure 6 The magnitude and direction of seasonal mean integrated water vapor flux (500-200 hPa) over Ali on rainy days from 31 May 2021 to 18 September 2023 (69 days) across seasons (the blue shading and the direction of the black arrows indicate the magnitude and direction of water vapor flux).**

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.

Reply: We have modified the figure 5 and 6 by standardizing the arrow lengths as mentioned in the previous issue.

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

Reply: Thank you for your suggestion. We have added a note that bars represent precipitation amount and points represent $\delta^{18}O$ values in the caption in lines 678-679.

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.

Reply: We have combined Figures 7b and 7c and Figures S5a and S5b with the coding scheme suggested for Figure 4.

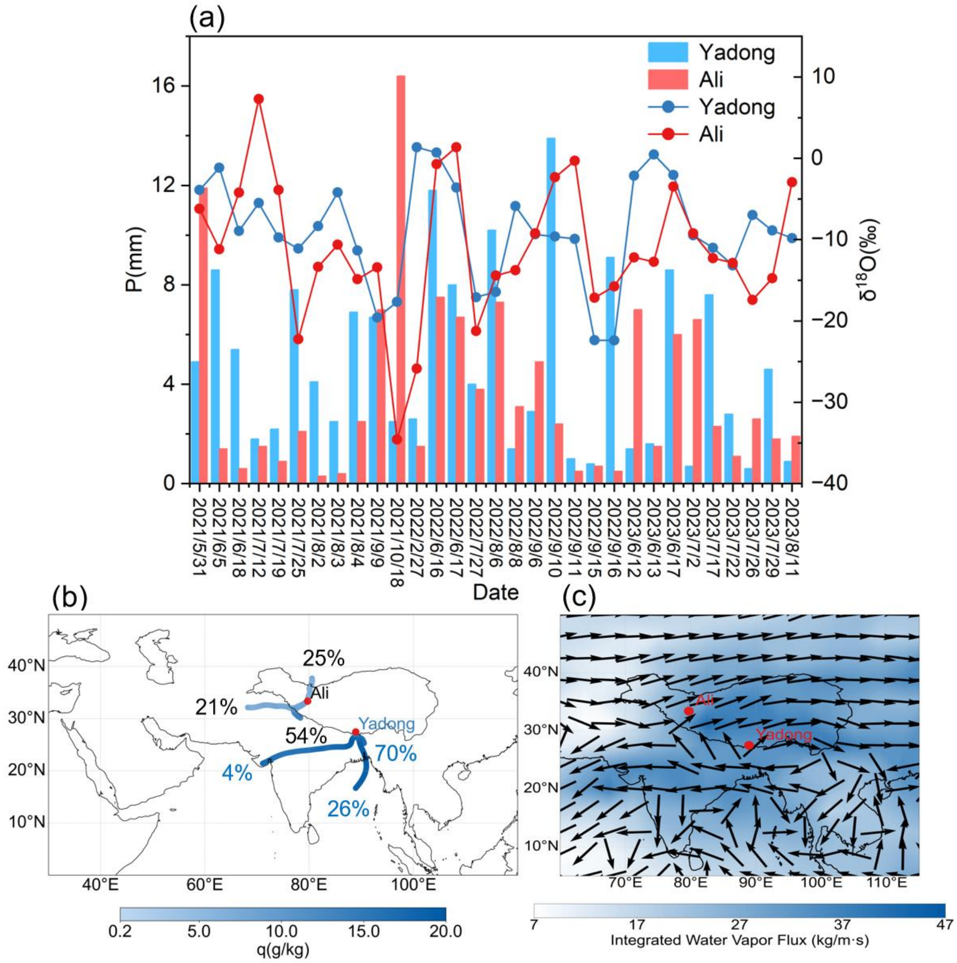


**Figure 7. Comparative analysis for simultaneous rainy days at Yadong and Ali, including $\delta^{18}O$ and precipitation amount, backward trajectories, and mean integrated water vapor flux (500-200 hPa) during the monsoon season. (a) δ18O and P on simultaneous rainy days at Yadong and Ali, bars represent precipitation amount and points represent $\delta^{18}O$ values; backward trajectories on simultaneous rainy days at Yadong (b) and Ali (c) during the monsoon season; integrated water vapor flux from 500 hPa to 200 hPa on simultaneous rainy days at Yadong (d) and Ali (e) during the monsoon season.**

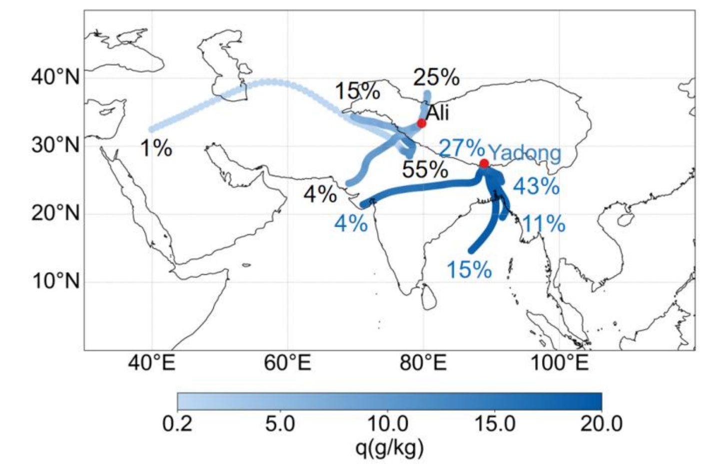

**Figure S6 120-hour backward trajectories of 5 clusters on simultaneous rainy days during the monsoon season at Yadong (a) and Ali (b) based on the HYSPLIT model.**

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

Reply: We have combined Figures 7d and 7e as mentioned.

Lines 391-404: Somehow the fraction of back trajectories 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.

Reply: As mentioned, we have added an explanation about quantifying the moisture contribution of each trajectory cluster in lines 290-295 and descriptions regarding the backward trajectory in the text in lines 531-573.

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.

Reply: We have added error bars to Figure 8a ($\delta^{18}O$ values) representing combined uncertainty (instrumental uncertainty and natural variability).

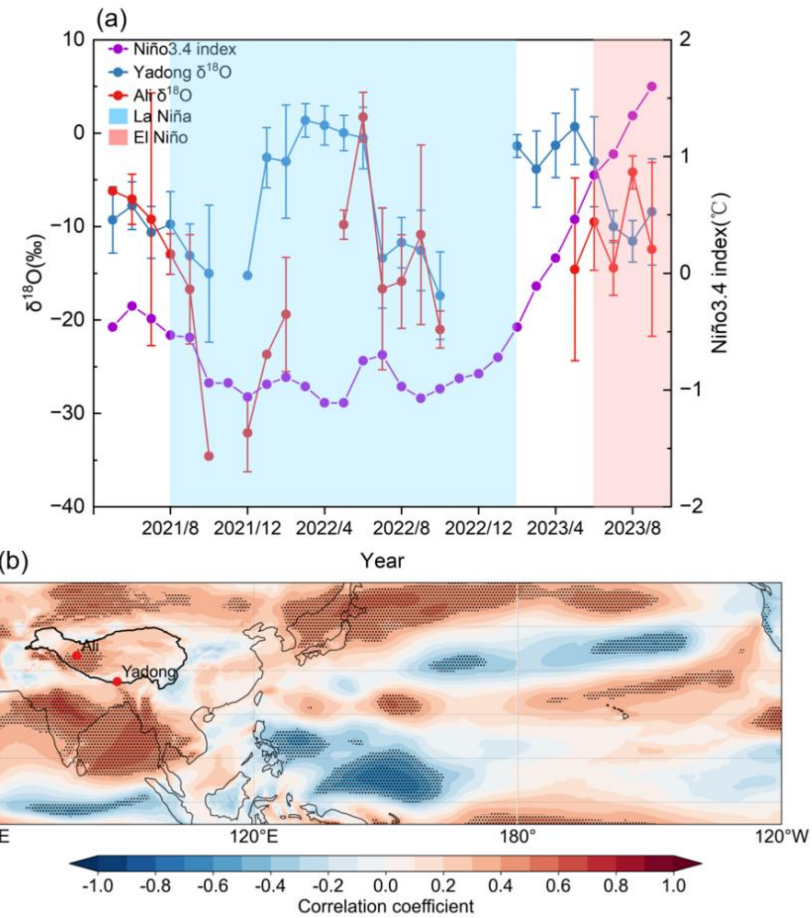


**Figure 8. Concurrent time series of the monthly Niño 3.4 index and monthly amount-weighted $\delta^{18}O$ at Yadong and Ali, and the spatial correlation between the monthly Niño 3.4 index and monthly mean integrated water vapor flux (surface to 200 hPa) from May 2021 to September**

**2023. (a) Time series of the monthly Niño 3.4 index and monthly amount-weighted δ18O values at Yadong and Ali from May 2021 to September 2023. El Niño and La Niña periods are highlighted in red and blue shading, respectively. (b) Spatial correlation between the monthly Niño 3.4 index and monthly mean integrated water vapor flux (surface to 200 hPa) during the same period. The correlation coefficient reveals regions of enhanced or suppressed moisture transport associated with ENSO phases.**

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.

Reply: Thank you for your suggestion. We have modified the sentence to "The most pronounced increases in $\delta^{18}O$ occurred between the La Niña and El Niño monsoon seasons indicate that ENSO noticeably influences the interannual variability of precipitation stable isotopes at both sites, which is consistent with previous studies (Gao et al., 2018) (Fig. 8a)" in lines 732-736.

Language/Typographical

Line 36: Stable isotope → Stable isotopes

Reply: Corrected (line 43).

Line 66: Generally show → Generally shows

Reply: Corrected (line 75).

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

Reply: Corrected (line 112).

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

Reply: Corrected (line 207).

Line 218: "to calculated" → "to calculate"

Reply: Corrected (line 314).

Line 278: "are probably resulted" → "probably result"

Reply: Corrected (line 405).

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

Reply: Thank you for the suggestion. In the revised manuscript, we have added units for all slopes and intercepts. Specifically, the slopes of the LMWLs are dimensionless, while the intercepts are expressed in per mil (‰). These units are now clearly indicated throughout the manuscript.

Line 543: 'anomalously convection' → anomalous convection

Reply: Corrected (line 753).