A detailed, point-by-point response to the review comments is given below. Each review comment is repeated followed with our action to modify the manuscript. All Line numbers correspond to locations in the revised manuscript.

Editor decision from Peter Haynes:

There were three reviewers for this paper, two anonymous and one non-anonymous. One of the anonymous reviewers (1)-- who provided a second report -- and the non-anonymous reviewer -- whom I consulted off-line to save time -- were satisfied with your revisions and recommend publication at this stage. The other anonymous reviewer (2) was more critical and considered that the paper still has significant weaknesses. Having looked carefully at reviewer 2's report and your revised paper, I feel that they make some good points. One concern is clarity of the methodology -- for example the method you use to identify the 'mean vapor transport path' -- you refer to 'rules' but what where these rules? If there is an algorithm here then it should be given explicitly. If in fact there is no algorithm then that should be stated, some kind of statement should be given about how the paths were drawn and it should be admitted that there is some arbitrariness in this choice. The reviewer makes a similar point about source regions.

The general point here, as emphasised by the reviewer, is that the work should reproducible by others. If a non-algorithmic choice has been made then the basis for that choice should be clearly stated.

Response: Thank you very much for your helpful comments.

In our study, the water vapor transport paths were determined by identifying systematic vapor currents in the Q field (the vertical integral of water vapor flux). These paths were delineated along the central axis of the vapor currents, ensuring consistent directionality. While this approach involves some subjectivity, it is guided by specific criteria. Moreover, the source regions of water vapor were determined based on the conditions for the formation of air masses, which require a uniform underlying surface and stable isotopic, thermodynamic, and dynamic properties, as well as favorable circulation conditions. These regions are typically located over vast land and ocean areas and serve as the starting points of the water vapor transport paths. Our identified water vapor transport paths are conceptually similar to atmospheric rivers, which are long, narrow corridors of strong horizontal water vapor transport typically associated with low-level jets (Ralph et al., 2017; Payne et al., 2020). However, our paths are derived from the climatological mean state (multi-year monthly averages) rather than short-term events, which is a key distinction from atmospheric rivers that generally last for a few days to a week (Dettinger et al., 2013). We acknowledge that while our method is based on scientific criteria, there is some degree of empiricism and subjectivity in defining these paths and source regions. However, this approach ensures that we capture the systematic vapor currents that have the most significant influence on local precipitation and its isotopic composition. We believe this provides a reasonable basis for identifying the dominant vapor transport paths and the primary sources of water vapor contributing to precipitation in the Dongting Lake Basin.

We revise the manuscript to clarify these points and provide a more transparent explanation of our methodology: "The water vapor transport paths were determined by identifying systematic vapor currents in the *Q* field, which need to have the same directionality and draw the path along the central axis of the vapor currents. Our identified water vapor transport paths are conceptually similar to atmospheric rivers, which are long, narrow corridors of strong horizontal water vapor transport typically associated with low-level jets (Ralph et al., 2017; Payne et al., 2020). However, our paths are derived from the climatological mean state (multi-year monthly averages) rather than short-term events, which is a key distinction from atmospheric rivers that generally last for a few days to a week (Dettinger et al., 2013). The source regions of water vapor were determined based on the conditions for the formation of air masses, which need to form on a uniform underlying surface and possess stability and similarity in terms of isotopic, thermodynamic, and dynamic properties as well as circulation conditions (Smirnov and Moore, 1999). These regions are typically located over vast land and ocean areas and serve as the starting points of the water vapor transport paths. Although there is some empiricism and subjectivity, there is no explicit algorithm to determine the exact water vapor transport path and source regions of water vapor. However, this approach is based on certain criteria and ensures that we capture the systematic vapor currents that have the most significant influence on the local precipitation and its isotopic composition, and it provides a reasonable basis for identifying the dominant vapor transport directions and the primary sources of water vapor contributing to precipitation in the Dongting Lake Basin" (Line 395-415).

For a detailed exploration of these aspects, please refer to the previous publications:

Dettinger, M. D. (2013). Atmospheric rivers as drought busters on the US West Coast. Journal of Hydrometeorology, 14(6), 1721-1732.

Payne, A. E., Demory, M. E., Leung, L. R., Ramos, A. M., Shields, C. A., Rutz, J. J., ... & Ralph, F. M. (2020). Responses and impacts of atmospheric rivers to climate change. Nature Reviews Earth & Environment, 1(3), 143-157. https://doi.org/10.1038/s43017-020-0030-5

Ralph, F. M., Dettinger, M. D., Cairns, M. M., Galarneau, T. J., & Eylander, J. (2018). Defining "atmospheric river": How the Glossary of Meteorology helped resolve a debate. Bulletin of the American Meteorological Society, 99(4), 837-839. https://doi.org/10.1175/BAMS-D-17-0157.1

The other two major points made by the reviewer seem valid to me. (The first is asking what has been determined by related work in a different publication and what has not. The second is simply asking for clarification.)

Response: We appreciated the helpful comments from the editor and reviewer.

For the second major issue made by the reviewer, it is mainly related to the time scale of the different studies. In our manuscript, we focus on the climatological mean state of atmospheric processes over four representative months (January, April, June, and October, which representing winter, spring, summer, and autumn, respectively) from 1979 to 2017. Our analysis is based on the monthly average values of vertical integral water vapor flux *Q*, precipitation amount *P*, and isotopic compositions of water vapor and precipitation. The goal is to reflect the general characteristics of water vapor transport paths and their influence on precipitation in the Dongting Lake Basin for each month, rather than focusing on individual precipitation events. This approach is valid because the magnitude of water vapor flux *Q* is directly related to precipitation amounts *P*. For example, in January and October, the low values of *Q* correspond to low precipitation amounts *P* (Figs. 4 and 10), indicating that the overall transport conditions are less conducive to precipitation formation. Therefore, our analysis does not require differentiation between precipitating and non-precipitating days, as we are examining the climatological mean state for each month. In contrast, our previous study (Xiao et al. 2024, DOI: 10.1175/JHM-D-23-0084.1) focused on the daily scale and specifically examined the relationship between precipitation isotopes and precipitation types during precipitation events. This study required differentiation between precipitating and non-precipitating events to understand the influence of convective and advective processes on isotopic compositions. However, this previous work does not conflict with the current manuscript. Instead, it complements our analysis by providing insights into the processes occurring during individual precipitation events, while our current study examines the broader climatological context.

Therefore, we followed the comments and added the relevant statements in the manuscript: "In this study, we focus on the climatological mean state of water vapor transport and its influence on precipitation in the Dongting Lake Basin over four representative months (January, April, June, and October, which representing winter, spring, summer, and autumn, respectively) from 1979 to 2017. Our analysis is based on the monthly average values of vertical integral water vapor flux *Q*, precipitation amount *P*, and isotopic compositions of water vapor and precipitation. This approach reflects the general characteristics of water vapor transport paths and their influence on precipitation for each month, rather than focusing on individual precipitation events. The magnitude of water vapor flux *Q* is directly related to precipitation amounts *P*, and thus, our analysis does not require differentiation between precipitating and non-precipitating days. For example, low values of water vapor flux *Q* in January and October correspond to low precipitation amounts, indicating that the overall transport conditions are less conducive to precipitation" (Line 787-799).

For the third major issue made by the reviewer, we apologize for the unclear statement and have clarified the water vapor isotope ratios: "The water stable isotope simulation data used in this study are from isoGSM2 (January 1979 to December 2017, totaling 468 months), including monthly precipitation amount (*P*, mm), stable isotopes (δ^2H and $\delta^{18}O$) in the precipitation (δ^2H_p, $\delta^{18}O_p$), the vertical integral of water vapor isotopes (δ^2H_v, and $\delta^{18}O_v$) of 17 pressure levels from 1000 hPa to 10 hPa, and the calculated deuterium excess in water vapor and precipitation (d_v and d_p)" (Line 263-268).

The referee makes other good points of detail. In particular I have some sympathy with their view that whilst the abstract states 'In different seasons, the variations in water stable isotopes along water vapor transport paths adhered to Rayleigh fractionation and water balance principles.' -- it is difficult how exactly this paper verifies that. Perhaps you simply mean that there some agreement between the model (which incorporates Rayleigh fractionation and water balance principles) and the observations e.g. as shown in your Figure -- but has your paper provided any new evidence on this point. I can't see any detailed analysis of the relative importance of these effects? The seasonal variation could result from many different effects.

Response: We appreciate the helpful comments from the reviewer and editor. We apologize for any confusion caused by our wording and appreciate your feedback. You are correct that our study does not provide direct evidence to verify that the variations in water stable isotopes along water vapor transport paths strictly adhere to Rayleigh fractionation and water balance principles. **Instead, our findings show that there is some agreement between the model (which incorporates Rayleigh fractionation and water balance principles) and the observations. This agreement suggests that the model is capable of capturing the general trends in isotopic variations, but we acknowledge that this does not constitute direct proof of the underlying mechanisms.**

We have revised the abstract and the relevant sections of the manuscript to

clarify this point and avoid any misleading implications. Following the comments and suggestions, we have revised the related sentences "In different seasons, the variations in water stable isotopes along water vapor transport paths adhered to Rayleigh fractionation and water balance principles", "Verifying whether the stable isotopic composition of water vapor undergoes changes consistent with Rayleigh distillation during transport, and assessing the impact of this transport on the isotopic composition of regional precipitation, constitute significant research objectives", and "In these four months that representing different seasons, variations in the $\delta^{18}O$ and deuterium excess of precipitation and water vapor along these water vapor transport paths adhered to principles of Rayleigh fractionation and water balance principles, underscoring the complex transport paths and processes that influence isotopic variations in precipitation in the Dongting Lake Basin" to "In different seasons, the variations in water stable isotopes along water vapor transport paths show some agreement with Rayleigh fractionation and water balance principles, as reflected in the model simulations and observations" (Line 25-28), "Assessing whether the stable isotopic composition of water vapor shows changes consistent with Rayleigh distillation during transport, and evaluating the impact of this transport on the isotopic composition of regional precipitation, are important research objectives" (Line119-122), and "In these four months representing different seasons, variations in the $\delta^{18}O$ and deuterium excess of precipitation and water vapor along these water vapor transport paths show some agreement with Rayleigh fractionation and water balance principles. This highlights the complex transport paths and processes that influence isotopic variations in precipitation in the Dongting Lake Basin" (Line 923-927).

Having looked more carefully at the paper myself, a specific question is what is the lower axis in Figure 4 and similar Figures supposed to represent? What do the numbers mean? I can't find any explanation of that. (In general I felt that Figure captions should be clearer -- the reader should be told in the caption what they are seeing -- they should not have to guess.

Response: We appreciate the helpful comments from the reviewer and editor and apologize for any confusion caused by the lack of explanation in the captions. **The lower axis in Fig. 4 and similar figures represent the grid points along the water vapor transport path from the source region to the endpoint (i.e., the Dongting Lake Basin). The numbers on this axis indicate the serial numbers corresponding to the grid points from the source region to the Dongting Lake Basin along the water vapor transport path, which were selected at almost equal intervals**. At each of these grid points, we derived the variations of six factors (*Q*, *P*, $\delta^{18}O_v$, $\delta^{18}O_p$, d_v, and d_p) from the corresponding factor fields. These points help us analyze the changes in these factors along the transport path.

For the aims to ensure that readers can easily understand the information presented, we have revised the figure caption and main text to provide clearer explanations as "Fig. 4 Mean variations of *Q* (a), *P* (b), $\delta^{18}O_v$ (c), $\delta^{18}O_p$ (d), d_v (e), and d_p (f) along the vapor transport path in January. The numbers at the lower axis represent the serial numbers corresponding to the grid points along the water vapor transport path from the source region to the Dongting Lake Basin, and the points along the path were selected at almost equal intervals to capture the variations of each factor, hereinafter the same" (Line 450-454) and "In analyzing the variations along the water vapor transport paths, we selected several points along the path from the source region to the Dongting Lake Basin, spaced at nearly equal intervals. Six series of factors at the grid points along the water vapor transport path were derived from each factor field in January, including the variations of *Q*, *P*, $\delta^{18}O_v$, $\delta^{18}O_p$, d_v, and d_p, these points allow us to examine the changes in these factors along the transport path. Moreover, the grid points along the water vapor transport path were identified on the central axis of the path and based on the principle of uniform distribution of the scatter points, and the factors at the grid points were obtained from these scatter points. Besides, the factors at the grid points along the water vapor transport path exhibit, in spatial terms, average characteristics of conditions over multiple years, and, in temporal terms, sequential characteristics of these factors along the water vapor transport path" (Line 430-441).

In summary, my view is that, whilst reviewer 2's views and comments are different from the other reviewers, they are valid and you should consider them further. Please provide clear responses to the reviewer comments and an appopriately revised version of the paper and I will then consider the paper further.

Response: We appreciate the helpful comments from the reviewer and have revised the manuscript accordingly, the details can be found in the responses to the specific concerns.

Comments from Anonymous Referee #1:

Upon my thorough review of the revised manuscript submitted by the authors, I am pleased to report that the paper has undergone significant and commendable improvements. The manuscript primarily investigates the water vapor sources from the perspectives of meteorology and isotope hydrology, a field of study that is both routine and critical, particularly within meteorological departments. The seasonal differences in water vapor sources are a major cause of the seasonal variations in the stable isotopes of precipitation. Therefore, a correct understanding and recognition of water vapor sources and transport are of paramount importance for accurately assessing the water cycle and implementing effective precipitation forecasting. As the authors have mentioned, and as my understanding aligns, previous studies have often favored the use of HYSPLIT or wind field diagrams for water vapor tracing. However, HYSPLIT and wind fields typically indicate the movement of air particles under the influence of wind forces or else forcing factors, which may not be effective sources of precipitation, especially when the air masses are dry. For instance, in the East Asian monsoon region, the prevailing northerly winds during winter bring continental air masses that are cold and dry, thus not conducive to effective precipitation. Many geographical researchers conducting atmospheric precipitation isotope source studies, often lack a meteorological background and may overlook this pattern. The current paper addresses this gap by analyzing the water vapor sources and their impact on regional precipitation isotopes based on the water vapor flux field. It reveals that the isotopic abundance of precipitation is influenced by the rainout effect along the water vapor transport path, en route water vapor replenishment, and the isotopic compositions of the source region. This analysis adheres to both the water mass balance and the stable isotope balance. The paper offers valuable insights and references in both methodology and conclusions. Overall, the manuscript employs a rich dataset, employs appropriate computational methods, and demonstrates a certain level of innovation and broad inspiration. I recommend the publication of this paper.

Response: We appreciate the positive comments from the reviewer and the reviewer's recommendations for this manuscript. Additionally, we have revised the format of the references in the manuscript to comply with the reference format requirements of ACP, as requested by another editor.

Comments from Anonymous Referee #2:

I remain concerned about two central aspects of this work, one related to the methodology and the other related to the study design.

1. The methodology remains unclear, and consequently the science is not reproducible.

The revision states: "The water vapor transport path was determined by the rules to find the systematic vapor currents in the *Q* field, which need to have the same directionality and draw the path along the central axis of the vapor currents." This is not clear. What rules do these refer to? My suspicion is that the paper simply identifies dominant patterns of moisture fluxes by eyeballing the moisture flux fields (e.g. looking at the qualitatively coherent direction of the vectors). This may be sufficient, but it is worth clarifying if this is what is actually done, especially now that we can explicitly tag moisture sources in simulations. Would we expect the transport paths identified in this work to agree with sources identified by tags? Would they agree with particle dispersion models or back trajectory models? Without clarification regarding what the "systematic vapor currents" are or what "rules" are followed, I remain concerned that the results of this study cannot be reproduced.

Specifically taking the integrated moisture flux vectors in Fig. 3a as an example, some of the moist flux vectors enter the study region from the SW, suggesting that moisture over the Lake Basin is a confluence of westerly and southwesterly advection. Is the westerly path considered dominant because it arrives at the "center" of the red box? It is not clear to me what justifies its selection as the dominant pathway influencing precipitation isotope ratios.

The following description also remains ambiguous: "The source regions of water vapor were determined based on the conditions for the formation of air masses, which need to form on a uniform underlying surface and possess stably in terms of isotopic, thermodynamic, and dynamic properties as well as circulation condition, typically located over vast land and ocean regions (Smirnov and Moore, 1999)". There is not enough guidance in this statement for another research team to try to replicate finding these source regions. If the paper is simply identifying source regions qualitatively by looking at where the vertically integrated moisture flux appears to originate from in the figures, then it needs to state this.

Response: We appreciated the helpful comments from the reviewer and provided a more transparent explanation of our methodology: "The water vapor transport paths were determined by identifying systematic vapor currents in the *Q* field, which need to have the same directionality and draw the path along the central axis of the vapor currents. Our identified water vapor transport paths are conceptually similar to atmospheric rivers, which are long, narrow corridors of strong horizontal water vapor transport typically associated with low-level jets (Ralph et al., 2017; Payne et al., 2020). However, our paths are derived from the climatological mean state (multi-year monthly averages) rather than short-term events, which is a key distinction from atmospheric rivers that generally last for a few days to a week (Dettinger et al., 2013). The source regions of water vapor were determined based on the conditions for the formation of air masses, which need to form on a uniform underlying surface and possess stability and similarity in terms of isotopic, thermodynamic, and dynamic properties as well as circulation conditions (Smirnov and Moore, 1999). These regions are typically located over vast land and ocean areas and serve as the starting points of the water vapor transport paths. Although there is some empiricism and subjectivity, there is no explicit algorithm to determine the exact water vapor transport path and source regions of water vapor. However, this approach is based on certain criteria and ensures that we capture the systematic vapor currents that have the most significant influence on the local precipitation and its isotopic composition, and it provides a reasonable basis for identifying the dominant vapor transport directions and the primary sources of water vapor contributing to precipitation in the Dongting Lake Basin" (Line 395-415).

For the comment "Is the westerly path considered dominant because it arrives at the "center" of the red box? It is not clear to me what justifies its selection as the dominant pathway influencing precipitation isotope ratios". In our study, the identification of the dominant water vapor transport path is based on the vertical integral of water vapor flux (i.e., the *Q* field), with the Dongting Lake Basin (represented by the red box) as the endpoint. Specifically, the vector cluster of the water vapor flux (i.e., the *Q*) directed towards the Dongting Lake Basin delineates the path of water vapor transport. This approach allows us to identify the systematic vapor currents that converge towards the basin, thereby influencing the local precipitation and its isotopic composition. The westerly path is considered dominant because it represents the primary direction of water vapor convergence towards the Dongting Lake Basin, as indicated by the strongest and most consistent flux vectors in the *Q* field. This path is not simply chosen because it arrives at the "center" of the red box, but rather because it reflects the dominant atmospheric circulation pattern influencing the region during the respective season. The selection of this path is based on the physical significance of the *Q* field, which integrates both the magnitude and direction of water vapor transport. Therefore, we added the relevant discussion in the manuscript: "In the *Q* field (Fig. 3a), regarding the Dongting Lake Basin (represented by the red box) as the endpoint, the vector cluster of the vertical integral of water vapor flux (i.e., the *Q*) directed towards the Dongting Lake Basin delineates the path of water vapor transport in January (black arrow lines in Fig. 3)" (Line 392-395) and "The westerly path is considered dominant because it represents the primary direction of water vapor convergence towards the Dongting Lake Basin, as indicated by the strongest and most consistent flux vectors in the *Q* field. The selection of this path is based on the physical significance of the *Q* field, which integrates both the magnitude and direction of water vapor transport and reflects the dominant atmospheric circulation pattern influencing the region in this season" (Line 416-421)

For the comments "Would we expect the transport paths identified in this work to agree with sources identified by tags? Would they agree with particle dispersion models or back trajectory models?", we believe that the water vapor transport paths should be primarily determined by the *Q* field (the vertical integral of water vapor flux), which reflects the direction and magnitude of water vapor transport in the atmosphere. This approach is distinct from particle dispersion models or back-trajectory models, which focus on the movement of air particles. As we discussed in the manuscript: "The water vapor flux *Q* reflects the direction and magnitude of water vapor transport in the atmosphere, while wind *V* reflects the direction and magnitude of the movement of air particles in the atmosphere (Feng et al., 2009; Zhang et al., 2012; Zhang et al., 2016). There are both differences and connections between the two factors. Water vapor is transported by wind, and the wind carries water vapor from one place to another, and the directions of water vapor and wind may be consistent, inconsistent, or even opposite. In the East Asian monsoon region, the prevailing wind direction during the summer monsoon period is generally consistent with the average water vapor transport direction, both being southwest or southeast direction (Barker, et al., 2015; Wu et al., 2015; Tang et al., 2015). In this study, the water vapor transport path was consistent with the prevailing wind direction in June (Figs. 1a and 9). However, during the winter monsoon period, the prevailing wind direction may not be consistent with the average transport direction of water vapor—that is, the prevailing wind direction in January was northwest or northeast direction, while the average transport direction of water vapor in this period was southwest or southeast direction (Figs. 1a and 3)" (Line 853-867).

Furthermore, we provided an example from a weather-scale analysis to illustrate this point, as demonstrated in the manuscript: "Previous studies have shown that the most common weather systems and most precipitation events in the East Asian monsoon region are caused by cold fronts resulting from the interaction of warm and cold air masses (Chen et al., 2020). According to classical meteorological theory (Zhou et al., 1997), in a cold front system, there appears the wind from the southwest direction blows ahead of the front, and a northwest wind blows behind the front as shown in the schematic diagram in Fig. 12a. Warm and moist air from low latitudes lifts along the front and leads to rainfall, while cold and dry air from high latitudes moves southward beneath the front and lifts the warm and moist air. At different heights and positions, the directions of air particle movement and water vapor transport are different. For example, at point A located above the warm and moist air side of the cold front surface, both air particles and water vapor are transported by southwest wind. At point C located below the cold, dry air side of the cold front surface, both air particles and water vapor are transported by northwest wind. However, at point B located within the front zone, the wind direction and speed are uncertain (Fig. 12b). Specifically, this front zone marked the transition from a warm air mass to a cold one, or vice versa, where meteorological factors have undergone rapid changes. Mixing between cold and warm advected air could occur within this zone, manifesting as a shear zone in wind fields, or as alternating southerly and northerly winds. Therefore, the dominant wind directions may not always align with the average water vapor transport direction, especially in frontal weather systems that dominate precipitation in the East Asian monsoon region.

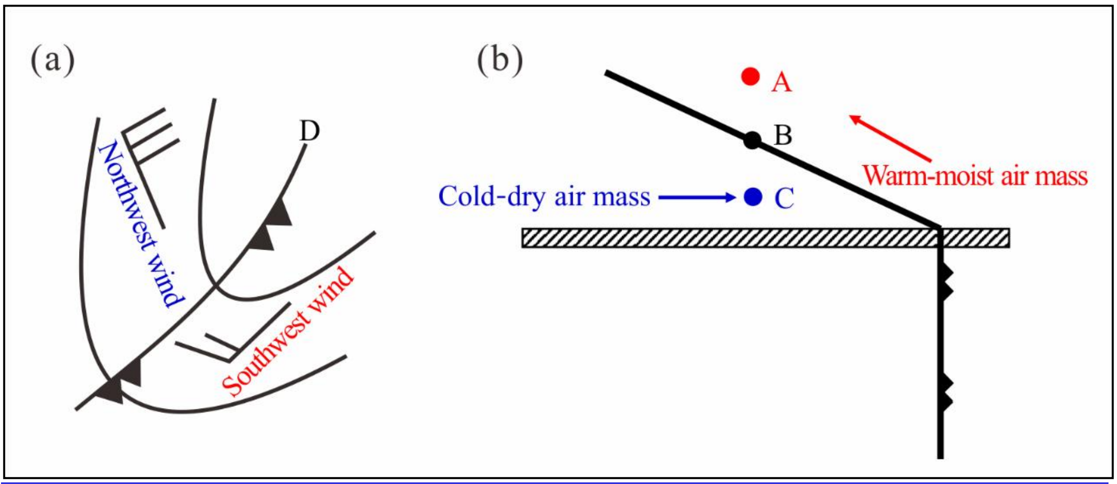

Fig. 12 Schematic diagram of a cold front system in East Asia (based on Zhou et al., 1997)" (Line 868-897).

In summary, while particle dispersion models and back-trajectory models provide valuable insights into air particle movement, they may not fully capture the complexities of water vapor transport, which is influenced by both large-scale atmospheric circulation and local weather systems. Our approach, based on the *Q* field, aims to address these complexities by focusing directly on the transport of water vapor rather than relying solely on wind direction. We hope this explanation clarifies our methodology and addresses your concerns. In addressing the potential discrepancies between our identified water vapor transport paths and those derived from particle dispersion models or back-trajectory models, it is important to emphasize the fundamental differences in the approaches used, thus we added the relevant demonstration in the manuscript: "Our study focuses on the *Q* field (the vertical integral of water vapor flux) to determine water vapor transport paths, which directly reflects the direction and magnitude of water vapor transport in the atmosphere. This method is distinct from particle dispersion models or back-trajectory models, which are based on the movement of air particles (wind direction). As discussed earlier, water vapor is transported by wind, but the directions of water vapor transport and wind may not always align, especially in complex weather systems such as cold fronts" (Line 888-894).

2. Transport pathways during non-precipitating and precipitating conditions are not differentiated. I remain concerned that the analysis draws conclusions about transport pathways influencing precipitation isotope ratios using climatological transport characteristics representative of all weather conditions, regardless of whether or not precipitation occurs. The response-to-reviewer file suggests that another study (Xiao et al. 2024, DOI: 10.1175/JHM-D-23-0084.1) has already looked at conditions during precipitation days only; however, Xiao et al. evaluate the effect of precipitation type on precipitation isotope ratios. That paper does not look at transport pathways affecting precipitation over Dongting Lake Basin. I strongly recommend testing whether the results of this study are insensitive to whether or not non-precipitating days are included in the determination of transport pathways. If other studies have

already shown that shifts in transport pathways do not occur when precipitation is observed in Dongting Lake Basin, then citing those works would also address my concern satisfactorily.

Response: Thank you for raising this important point regarding the differentiation between transport pathways during precipitating and non-precipitating conditions.

In our study, **we analyze the climatological mean state of water vapor transport over four months (January, April, June, and October) from 1979 to 2017**, using monthly averages of vertical integral water vapor flux *Q*, precipitation amount *P*, and isotopic compositions of precipitation and water vapor. Our focus is on the general transport characteristics and their influence on precipitation in the Dongting Lake Basin, rather than individual events. This approach is justified because *Q* is directly related to *P*, with low *Q* values corresponding to low precipitation amounts in January and October (Figs. 4 and 10). Thus, we do not differentiate between precipitating and non-precipitating days. **Our previous study (Xiao et al. 2024) examined daily-scale variations and the relationship between precipitation isotopes and precipitation types during specific events, requiring differentiation between precipitating and non-precipitating days**. This complements our current analysis by focusing on individual events, while our manuscript examines the broader climatological context.

To address your concern, we have clarified in the manuscript that our analysis is based on the climatological mean state and does not differentiate between precipitating and non-precipitating days: "In this study, we focus on the climatological mean state of water vapor transport and its influence on precipitation in the Dongting Lake Basin over four representative months (January, April, June, and October, which representing winter, spring, summer, and autumn, respectively) from 1979 to 2017. Our analysis is based on the monthly average values of vertical integral water vapor flux *Q*, precipitation amount *P*, and isotopic compositions of water vapor and precipitation. This approach reflects the general characteristics of water vapor transport paths and their influence on precipitation for each month, rather than focusing on individual precipitation events. The magnitude of water vapor flux *Q* is directly related to precipitation amounts *P*, and thus, our analysis does not require differentiation between precipitating and non-precipitating days. For example, low values of water vapor flux *Q* in January and October correspond to low precipitation amounts, indicating that the overall transport conditions are less conducive to precipitation" (Line 787-799).

Furthermore…

3. It is not clear what height the isotope ratios in vapor represent in the text and figures. Are these from a specific level? Or do they represent a mass integration of the tropospheric column?

Response: **In the isoGSM2, the water vapor isotope ratios (such as $\delta^{18}O_v$ and $\delta^{2}H_v$) are indeed derived from an integration throughout the entire atmospheric column**. This approach provides a comprehensive representation of the isotopic composition of water vapor across different levels, rather than focusing on a specific level. The integration accounts for the vertical distribution of water vapor and its isotopes, capturing the overall influence of atmospheric processes on the isotopic signatures. We apologize for the unclear statement and revised the relevant descriptions to "The water stable isotope simulation data used in this study are from isoGSM2 (January 1979 to December 2017, totaling 468 months), including monthly precipitation amount (*P*, mm), stable isotopes ($\delta^{2}H$ and $\delta^{18}O$) in the precipitation ($\delta^{2}H_p$, $\delta^{18}O_p$), the vertical integral of water vapor isotopes ($\delta^{2}H_v$, and $\delta^{18}O_v$) of 17 pressure levels from 1000 hPa to 10 hPa, and the calculated deuterium excess in water vapor and precipitation (d_v and d_p)" (Line 263-268).

It is difficult to evaluate the study in much more detail without the aforementioned issues being clarified. That said, there are at least a few places that I will flag (minor comments, which build off concerns from my first review of this work):

1. Figure 6 is accompanied by a statement I flagged earlier: "following the variation rule of deuterium excess during water vapor transport—that is, as the rainout effect progressed, the heavier isotopes preferentially left the water vapor parcel…" If heavier isotopes are preferentially leaving the parcel, why is the isotope ratio of

precipitation increasing? This is inconsistent with the significant dehydration that would be required to raise the d significantly. (Also, it's not clear to me what the x-axis represents in this figure or where exactly the Lake Basin lies.)

Response: We appreciate the reviewer for pointing out the inconsistency in our explanation related to Fig. 6. We apologize for the incomplete description of our results, which may have led to confusion. The reviewer is correct that during the precipitation process, heavier isotopes preferentially leave the water vapor parcel or cloud due to the rainout effect. This process would typically result in a depletion of the remaining water vapor isotopes. However, **the increase in the isotope ratio of precipitation observed in our study can be attributed to the influence of additional factors. Specifically, the increase in precipitation isotope values may be related to the horizontal convergence of more enriched water vapor, which counteracts the depletion effect caused by rainout**. As shown in Figure 6a, before entering the Dongting Lake Basin along Path II, there is a significant increase in both the water vapor flux (*Q*) and precipitation amount (*P*). This suggests that the horizontal convergence of enriched surrounding water vapor plays a crucial role in influencing the isotopic composition of precipitation. The enriched water vapor from the surrounding water vapor contributes to the overall increase in the isotope ratios of both water vapor and precipitation, despite the ongoing rainout effect.

We revise the manuscript to provide a clearer and more comprehensive explanation of these processes: "Moreover, there was a large increase in both the *Q* and *P* before entering the Dongting Lake Basin along Path II, and the increase in the isotope ratio of precipitation may seem inconsistent with the rainout effect, which typically leads to the depletion of heavier isotopes in the remaining water vapor. However, this increase can be attributed to the horizontal convergence of more enriched water vapor. Path II showed a significant increase in both the *Q* and *P* before entering the Dongting Lake Basin (Fig. 6a). This suggested that the enriched water vapor from the surrounding water vapor contributed to the overall increase in the $\delta^{18}O_v$ and $\delta^{18}O_p$. The influx of this enriched water vapor counteracts the depletion effect caused by rainout, resulting in the observed increase in precipitation isotope values" (Line 538-547).

Moreover, for the comment "Also, it's not clear to me what the x-axis represents in this figure or where exactly the Lake Basin lies", we have revised the figure caption and main text to provide clearer explanations: "Fig. 4 Mean variations of *Q* (a), *P* (b), $\delta^{18}O_v$ (c), $\delta^{18}O_p$ (d), d_v (e), and d_p (f) along the vapor transport path in January. The numbers at the lower axis represent the serial numbers corresponding to the grid points along the water vapor transport path from the source region to the Dongting Lake Basin, and the points along the path were selected at almost equal intervals to capture the variations of each factor, hereinafter the same" (Line 450-454) and "In analyzing the variations along the water vapor transport paths, we selected several points along the path from the source region to the Dongting Lake Basin, spaced at nearly equal intervals. Six series of factors at the grid points along the water vapor transport path were derived from each factor field in January, including the variations of *Q*, *P*, $\delta^{18}O_v$, $\delta^{18}O_p$, d_v, and d_p, these points allow us to examine the changes in these factors along the transport path. Moreover, the grid points along the water vapor transport path were identified on the central axis of the path and based on the principle of uniform distribution of the scatter points, and the factors at the grid points were obtained from these scatter points. Besides, the factors at the grid points along the water vapor transport path exhibit, in spatial terms, average characteristics of conditions over multiple years, and, in temporal terms, sequential characteristics of these factors along the water vapor transport path" (Line 430-441).

2. With regards to the two April source regions, the Discussion states: "Clearly, the oceanic air mass with low deuterium excess had a relatively more significant impact on the precipitation isotopes in April in the Dongting Lake Basin region." This is overstated, given that both "source" regions have identical isotope ratios and differ in d-excess by only 1 permil. Any number of processes could influence the isotopic composition of these air masses as they travel many hundreds of kilometers to the observation site. This example illustrates a tendency for the paper to draw rather strong conclusions from what is overall a very qualitative analysis of climatological output from a GCM.

Response: Thank you for your insightful comments and for highlighting the need for more clarity in our discussion. Regarding the two source regions in April, our conclusion that the oceanic air mass with low deuterium excess had a relatively more significant impact on the precipitation isotopes in the Dongting Lake Basin region is not solely based on the isotopic compositions at the source regions. As you correctly pointed out, the isotopic ratios at the source regions are nearly identical, and the difference in deuterium excess is minimal (only 1‰). This underscores the complexity of isotopic variations along the water vapor transport paths, where numerous processes can influence the isotopic composition of air masses over long distances, and such variations are a continuous process with cumulative effects. These processes include rainout, evaporation recharge, mixing with other water vapor sources, and changes in temperature and humidity, all of which contribute to the cumulative isotopic variations along the transport paths.

However, **our primary criterion for determining the relative impact of these transport paths is the magnitude of the water vapor flux *Q* transported along each path**. Specifically, as shown in Fig. 6a, the water vapor flux *Q* associated with Path II is significantly higher than that of Path I before reaching the Dongting Lake Basin. This larger flux indicates that Path II contributes more water vapor to the region, thereby having a more substantial influence on the local precipitation isotopes. Therefore, we concluded that the oceanic air mass with low deuterium excess (associated with Path II) had a more significant impact on the precipitation isotopes in the Dongting Lake Basin region in April.

We have revised the relevant sections of the manuscript to clarify this point and avoid any potential overstatement: "Besides, it is worth noting the complexity of isotopic variations along the water vapor transport paths, where numerous processes can influence the isotopic composition of air masses over long distances, and such variations are a continuous process with cumulative effects. These processes include rainout, evaporation recharge, mixing with other water vapor sources, and changes in temperature and humidity, all of which contribute to the cumulative isotopic variations along the transport paths. Therefore, the primary criterion for determining the relative impact of these paths is the water vapor flux *Q*. As shown in Fig. 6a, the water vapor flux *Q* associated with Path II is significantly higher than that of Path I before reaching the Dongting Lake Basin. This larger flux indicated that Path II contributed more water vapor to the Dongting Lake Basin, thereby having a more substantial influence on the local precipitation isotopes. Clearly, the oceanic air mass with low deuterium excess had a relatively more significant impact on the precipitation isotopes in April in the Dongting Lake Basin region" (Line 773-786).

3. Line 807-811: This doesn't sound right. D-excess in the vapor of air masses is usually positive under most conditions observed near Earth's surface.

Response: We apologize for the unclear statement and appreciate the opportunity to clarify. **What we intended to convey is that in oceanic air masses, the isotopic values of water vapor (such as $\delta^{18}O$ and $\delta^{2}H$) are relatively higher compared to those in continental air masses. At the same time, the deuterium excess in oceanic water vapor is typically lower than that in continental water vapor**. In contrast, continental air masses generally have more depleted isotopic values due to the influence of rainout and other fractionation processes during transport. Therefore, we agree with your comment that d-excess in the vapor of air masses is usually positive under most conditions near Earth's surface, which can be found in the Figs. 3e, 3f, 5e, 5f, 7e, 7f, 9e, and 9f. We revised these sentences to "In oceanic air masses, the isotopic values of water vapor are relatively higher compared to those in continental air masses, while the deuterium excess of water vapor is typically lower. Conversely, in continental air masses, water vapor isotopes are relatively depleted but the d-excess can be higher (Rozanski et al., 1993; Araguás-Araguás et al., 1998)" (Line 811-815).

4. Line 829 - I'm still not convinced "modificatory" is the right word. This suggests an air mass that is influencing something else, not an air mass that is being modified by a process. What is intended?

Response: We apologize for the unclear statement and appreciate the opportunity to clarify. The term "modificatory" was intended to describe an air mass that undergoes modification during its movement, primarily due to interactions with the underlying surface. This includes changes in temperature, pressure, humidity, and other properties as the air mass travels across different regions. We understand your concern that the term might imply an air mass influencing something else rather than being modified itself. **To address this, we have replaced "modificatory" with a more appropriate term "modified" to better convey the intended meaning. We have also provided a clearer explanation in the main text to ensure that the concept is well understood**: "East Asia is primarily controlled by the "modified" air masses, which were commonly used to describe the properties (e.g., temperature, pressure, and humidity) of air masses that have changed as they move through different regions (Ding, 1990; Chang et al., 2012). For instance, as an air mass moves from a warm and moist region to a cooler and drier region, its temperature and humidity can change significantly. Similarly, interactions with topography and varying surface conditions can lead to modifications in the air mass properties. This concept is particularly relevant in regions like East Asia, where air masses can be significantly altered as they pass through different climatic zones. Whether cold and dry air masses moving southward or warm and moist air masses moving northward, the isotopic composition of water vapor in the "modified" air mass continues to become more negative, while the deuterium excess of water vapor continues to become more positive than the original air mass, following the variation rule of stable isotope and deuterium excess during water vapor transport (Vasil'chuk, 2014; Zhou et al., 2019; Xu et al., 2019; Jackisch et al., 2022). In this study, interactions between "modified" oceanic air mass and "modified" continental air mass result in the water vapor isotope in Region V that differed from oceanic air masses and continental air masses (Table 1; Fig. 11)" (Line 830-846).

5. As noted in my first review, the Abstract claims that "the variations in water stable isotopes along water vapor transport paths adhered to Rayleigh fractionation and water balance principles." However, this is never tested and thus remains conjecture. Consequently, I do not feel that Objective 3 ("reveal the mechanisms by which water

vapor sources and transport paths in the monsoon region influence precipitation amounts and isotopes") is achieved.

Response: We appreciate the helpful comments from the reviewer and editor. Following the comments and suggestions, we have revised the sentence in the Abstract "In different seasons, the variations in water stable isotopes along water vapor transport paths adhered to Rayleigh fractionation and water balance principles" to "In different seasons, the variations in water stable isotopes along water vapor transport paths show some agreement with Rayleigh fractionation and water balance principles, as reflected in the model simulations and observations" (Line 25-28).

You are correct that our study does not provide direct empirical evidence to verify that the variations in water stable isotopes along water vapor transport paths strictly adhere to Rayleigh fractionation and water balance principles. Instead, our findings show some agreement between the model (which incorporates Rayleigh fractionation and water balance principles) and the observations. It reveals that the isotopic abundance of precipitation is influenced by the rainout effect along the water vapor transport path, en route water vapor replenishment, and the isotopic compositions of the source region. This analysis adheres to both the water mass balance and the stable isotope balance. This suggests that the model is capable of capturing the general trends in isotopic variations, but we acknowledge that this does not constitute direct proof of the underlying mechanisms. We have revised the abstract and the relevant sections of the manuscript to clarify this point and avoid any misleading implications. Objective 3 was revised to "(3) determine the influences of different water vapor sources and transport paths on the regional precipitation amounts" (Line 158-160) to better conform to the content of our manuscript.

6. Finally, I recommended previously and continue to recommend that the authors use traditional notation for deuterium excess: dp in place of Ex_dp.

Response: **We followed the comments and revised Ex_dp and Ex_dv to the traditional notation for deuterium excess in the main text, figures, and tables**. For instance we revised the relevant descriptions of the isoGSM2 dataset to "The water stable isotope simulation data used in this study are from isoGSM2 (January 1979 to December 2017, totaling 468 months), including monthly precipitation amount (*P*, mm), stable isotopes (δ^2H and $\delta^{18}O$) in the precipitation (δ^2H_p, $\delta^{18}O_p$), vertical integral of water vapor isotopes (δ^2H_v, and $\delta^{18}O_v$) of 17 pressure levels from 1000 hPa to 10 hPa, and the calculated deuterium excess in water vapor and precipitation (d_v and d_p)" (Line 263-268).