Response to Reviewers

We appreciate your insightful comments and suggestions. These have greatly helped us refine our manuscript and improve the clarity of our key points. We also thank you for your positive feedback.

In this response letter, we have addressed each comment in detail below. Our responses are in blue, with specific changes to the text highlighted in *blue italics*. All line numbers in this document correspond to the line numbers in the updated version of the manuscript.

With best regards,
Di WANG
On behalf of all authors

AC2: 'Comment on acp-2022-223', 30 Sep 2022

Review of "Vehicle-based in-situ observations of the water vapour isotopic composition
across China: spatial and seasonal distributions and controls" by Di Wang et al. submitted to ACP

Summary:
This paper serves really well in characterizing the seasonal and spatial variability over a broad region of China over the pre-monsoon and monsoon periods using a vehicle-based isotope analyzer and other meteorological measurements. The synoptic effects from the continents and oceans along with their entanglement with seasonal characteristics are thoroughly investigated using water vapor isotope observations. This paper would be a good fit for ACP publication after the authors address some of the outstanding major and few minor issues.

Thank you very much for reviewing our paper. We appreciate your positive feedback and detailed suggestions.

Major comments:

1) The start of the introduction is strong but it still needs to incorporate a discussion about the current knowledge of synoptic and seasonal processes within the continental region. Why is it important and what do the previous studies broadly say? What is the isotope perspective adding to the traditional methods of study? An expanded version of the first paragraph of Section 2.1 is more fitting for the introduction in my opinion.

Thank you for your suggestions to make our introduction section clearer. We have integrated the first paragraph of section 2.1 into the introduction, and added the introduction about the seasonal and synoptic-scale variations (lines 66-90):

"In general, large parts of the country are affected by the Indian monsoon and the East Asian monsoon in summer, which bring humid marine moisture from the Indian Ocean, South China Sea, and Northwestern Pacific Ocean (Fig.1). During the non-

monsoon seasons, the Westerlies influence most of northern China (Fig.1). Westerlies brings extremely cold and dry air masses. Occasional moisture flow from the Indian Ocean and/or Pacific Ocean brings moisture to southern China. Continental recycling, i.e. the moistening of the near-surface air by the evapo-transpiration from the land surface (transpiration by plants, evaporation of bare soil or standing water bodies, Brubaker et al 2013), is also an important source of water vapor in both seasons. Some of the spatial and seasonal patterns of water vapor transport are imprinted in the observed station-based precipitation isotopes (Araguás-Araguás et al., 1998;Tian et al., 2007;Wright, 1993;Mei'e et al., 1985;Tan, 2014). However, precipitation isotopes can only be obtained at a limited number of stations and on rainy days. The lack of information makes it limited to analyze the effects of water vapor propagation, alternating monsoon and westerlies, and synoptic-scale processes on the spatial and seasonal variation of water isotopes. In particular, the seasonal pattern and the spatial variation of water isotopes can strongly influenced by synoptic-scale processes, through their influence on moisture source, transport, convection and mixing processes (Wang et al., 2021;Sánchez-Murillo et al., 2019;Klein et al., 2015), which requires higher frequency observations. For example, some studies founded the impact of tropical cyclones (Gedzelman et al 2003, Xu et al 2019, Battacharya et al 2022) the Northern Summer Intra-Seasonal Oscillation (BSISO) (Susskind et al., 2011;Kikuchi, 2021), local or large-scale convections (Shi et al., 2020), cold front passages (Aemisegger et al., 2015), depressions(Saranya et al., 2018), and anticyclones (Khaykin et al., 2022) on water isotopes in the Asian region. Additional data and analysis refining our understanding of controls on the spatial and temporal variation of water isotopes in low-latitude regions therefore are needed."

2) Since synoptic vs seasonal influences on the isotope observations is the major conclusion of this paper (it literally is in the title of the manuscript), it would help to talk and explain these influences in the introduction. Mention all the factors that you are examining for the two categories. I see that you have classified them in the abstract but it would serve the readers well to know about them from early on. Are there earlier studies that you can compare your results with?

   We introduced the seasonal and synoptic-scale variations and the factors that we are examining for the two categories. (Same lines as for the last response. Because the responses to the first and second advice are interrelated, they are not listed separately).

Also, whenever you use terms like "altitude effect" and "continental-recycling", use a line or two to give the readers a gist. This would make it convenient for the readers lest they need a jolt to their memory or are not acquainted with the terms well.

We added the gist for "altitude effect", "continental-recycling" and "temperature effect":

Lines 513-514: "the altitude effect (the heavy isotope concentrations in fresh water decreasing with increasing altitude, Dansgaard 1954)".

Lines690-691: "During the pre-monsoon period, all observations taken together *exhibit a "temperature effect" (the δ's decreasing with temperature, Dansgaard 1964)".*

Lines 72-74: "Continental recycling , i.e. the moistening of the near-surface air by the evapo-transpiration sfrom the land surface (transpiration by plants, evaporation of bare soil or standing water bodies, Brubaker et al 2013)".

3) Another point regarding the synoptic vs seasonal comparison is that although this is the focal point of the paper, and it is only talked about formally in section 4.7. This leaves the readers hanging for the major part of results and discussions. I understand that you talk about the seasonal effects followed by the synoptic effects individually, and then you use Iso-GSM to compare the two effects. However, for more clarity, once you end discussing the seasonal/synoptic effects, write a summary sentence or two to tie up the results to the final seasonal vs synoptic comparison. This will keep the audience' attention till they reach section 4.7. No major editing is necessary. Just adding/shuffling some summary sentences at the end of subsections of sections 3 and 4 would do.

We agree that the analysis of the seasonal vs synoptic is important to interpret the observed variations. We now moved this section earlier in the manuscript. We put it as section 3.3, just after the description of the raw data in section 3.1 and 3.2, on this basis, and before the seasonal variations in section 3.4 and analyzing the factors controlling the spatial and seasonal distributions in section 4.

For our main results, we also focus on a better understanding the factors controlling the spatial and seasonal distributions, not only the relative contribution of seasonal-mean and synoptic variations. Synoptic vs seasonal influences is part of result and a basis for the analysis of controlling factors.

To clarify this we have reworded the last paragraph of introduction (lines 112-119):

"After describing our observed time series along the route (section 3.1 and 3.2), we quantify the relative contributions of seasonal-mean spatial variations and synoptic-scale variations that locally disturb the seasonal-mean to our observed time series (section 3.3). We show that our observed variations during the pre-monsoon period are dominated by spatial variations but significantly influenced by synoptic-scale variations during the monsoon period. On the basis of this, we then focus on analyzing the main mechanisms underlying these distributions (section 4)."

4) Paragraph 3 of Introduction is important since it provides a transition from previous work to your work. However, the phrasing seems weak. If it is a first of its kind study conducted using the isotope analyzers over the continental China, then you should emphasize it, by all means. Readers would appreciate the new science and techniques that this work is doing.

Thank you very much for your suggestion. Now we place more emphasis on the novelty of our measurements (lines 107-111):

"However, in situ observations documenting continuous spatial variations at the continental scale do not exist. This paper presents the first isotope dataset

documenting the spatial variations of vapor isotopes over a large continental region (order 10000 km) both during the pre-monsoon and monsoon periods, based on vehicle-based in-situ observations."

(5) It is scientifically sound to not use the city datasets that may have been impacted by the traffic pollution. However, I am curious, if you can totally eliminate the role of water vapor emitted from country sources like irrigation, farms, power plants etc. in affecting the water vapor isotope or the humidity measurements in any way? If this is an assumption made, then please state it somewhere.

Thank you for your suggestion, we added (lines 233-235):

"*Outside towns, country sources, such as irrigation, farms, and power plants, cannot be completely ruled out. However, we expect their influence to be much smaller than large-scale spatial variations."*

(6) I have some concerns regarding the use of Iso-GSM for the disentanglement of seasonal and synoptic influences. From figures 11 and 12, the model does not seem to simulate the observations well, especially in the monsoon period. Moreover, the grid spacing for the models is way coarser compared to the observations. I would suggest using the observations to perform the same analysis discussed in 4.7, and only use model inputs where observations are not available. Then in table 2, compare the Iso-GSM vs observation-based fractions. This would be far more accurate. Since the main result of this paper is disentangling the seasonal vs synoptic effects, I think it is crucial to be thorough with your methods here.

We assessed the relative contribution using multi-year averages from 2010 to 2020 and a new estimation method that takes into account model bias and gives upper and lower bounds on the value of the contribution.

We modified (lines 327-361):

"2.6 Method to decompose the observed daily variations

The temporal variations observed along the route for a given period represent a mixture of synoptic-scale perturbations, and of seasonal-mean spatial distribution:

$$\delta^{18}O_{\_daily} = \delta^{18}O_{\_seaso} + \delta^{18}O_{\_synoptic} \quad (4)$$

The first term represents the contribution of seasonal-mean spatial variations, whereas the second term represents the contribution of synoptic-scale variations. Since these relative contributions are unknown, we use outputs from Iso-GSM. The daily variations of $\delta^{18}O$ *simulated by Iso-GSM also represent a mixture of synoptic-scale perturbations and seasonal-mean spatial distribution, but with some errors relative to reality:*

$$\delta^{18}O_{\_daily\_Iso\text{-}GSM} = \delta^{18}O_{\_daily\_Iso\text{-}GSM} + \epsilon = (\delta^{18}O_{\_seaso\_Iso\text{-}GSM} + \epsilon_{\_seaso}) + (\delta^{18}O_{\_synoptic\_Iso\text{-}GSM} + \epsilon_{\_synoptic}) \quad (5)$$

where $\delta^{18}O_{\_daily\_Iso\text{-}GSM}$ *is the daily outputs of* $\delta^{18}O$ *for each location,* $\delta^{18}O_{\_seaso\_Iso\text{-}GSM}$ *is the multi-year monthly outputs of* $\delta^{18}O$ *for each location, and* $\delta^{18}O_{\_synoptic\_Iso\text{-}GSM} = \delta^{18}O_{\_daily\_Iso\text{-}GSM} - \delta^{18}O_{\_seaso\_Iso\text{-}GSM}$, $\epsilon_{\_seaso}$ *and* $\epsilon_{\_synoptic}$ *are the errors on* $\delta^{18}O_{\_seao\_Iso\text{-}GSM}$ *and* $\delta^{18}O_{\_synoptic\_Iso\text{-}GSM}$ *relative to reality, respectively,* ϵ *is the sum of* $\epsilon_{\_seaso}$ *and* $\epsilon_{\_synoptic}$.

These individual error components $\in_{\_seaso}$ and $\in_{\_synoptic}$ are unknown, but we know the sum of them ($\in$), i.e. the difference between daily outputs and observations. For the decomposition, we made two extreme assumptions to estimate upper and lower bounds on the contribution values:

1) We assume that the error is purely seasonal-mean, i.e. $\in = \in_{\_seaso}$, and $\in_{\_synoptic}=0$:

$$\delta^{18}O_{\_daily} = \delta^{18}O_{\_seaso\_Iso\text{-}GSM} + (\delta^{18}O_{\_synoptic\_Iso\text{-}GSM} + \in) \quad (6)$$

To evaluate the contribution of these two terms, we calculate the slopes of $\delta^{18}O_{\_daily}$ as a function of $\delta^{18}O_{\_seaso\_Iso\text{-}GSM}$ ($a_{\_seaso}$), and of $\delta^{18}O_{\_daily}$- $\delta^{18}O_{\_seaso\_Iso\text{-}GSM}$ ($a_{\_synoptic}$). The relative contributions of spatial and synoptic variations correspond to $a_{\_seaso}$ and $a_{\_synoptic}$ respectively. This will be the upper bound for the contribution of synoptic-scale variations, since some of the systematic errors of Iso-GSM will be included in the synoptic component. This is equivalent to using the seasonal-mean of Iso-GSM and the raw time series of observations.

2) We assume that the error is purely synoptic, i.e. $\in = \in_{\_synoptic}$, and $\in_{\_seaso}=0$:

Then $\delta^{18}O_{\_daily} = (\delta^{18}O_{\_seaso\_Iso\text{-}GSM} + \in) + \delta^{18}O_{\_synoptic\_Iso\text{-}GSM}$. (7)

To evaluate the contribution of these two terms, we calculate the slopes of $\delta^{18}O_{\_daily\_Iso\text{-}GSM}$ as a function of $\delta^{18}O_{\_seaso\_Iso\text{-}GSM}$ ($a_{\_seaso}$), and of $\delta^{18}O_{\_daily\_Iso\text{-}GSM}$ - $\delta^{18}O_{\_seaso\_Iso\text{-}GSM}$ ($a_{\_synoptic}$). This will be the lower bound for the contribution of synoptic-scale variations, since we expect Iso-GSM to underestimate the synoptic variations.

The same analysis is also performed for the Iso-GSM simulation q (Table 2) and reanalysis q (Table 3).”

We updated the discussion on disentangling seasonal-mean and synoptic variations in section 3.3 (lines 446-466):

*“ **Table 2** The relative contribution (in fraction) of spatial variations for a given season ($a_{\_seaso}$) and of synoptic-scale variations ($a_{\_synoptic}$) to the daily variations of q and $\delta^{18}O$ simulated by Iso-GSM. We checked that the sum of $a_{\_seaso}$ and $a_{\_synoptic}$ is always 1.*

Period	variables	Controbutions	
		$a_{\_seaso}$	$a_{\_synoptic}$
Pre-monsoon	q	0.73~1.05	0.27~-0.05
	$\delta^{18}O$	0.54~0.70	0.46~0.30
Monsoon	q	0.63~0.71	0.37~0.29
	$\delta^{18}O$	-0.50~0.10	1.5~0.9

***Table 3** The same as Table 2, but for reanalysis q.*

Period	variables	Controbutions	
		$a_{\_seaso}$	$a_{\_synoptic}$
Pre-monsoon	q	0.77~0.88	0.23~0.12
Monsoon	q	0.69~0.88	0.31~0.12

During the pre-monsoon period, based on both the Iso-GSM simulation and NCEP/NCAR reanalysis, we can find that the seasonal-mean contribution to q is higher than the synoptic-scale contribution: $a_{\_seaso}$ is 73%-105% for Iso-GSM and 77%-88% for reanalysis, whereas $a_{\_synoptic}$ is 27%~ -5% for Iso-GSM and 23%~12% for reanalysis (Table 2 and Table3). The relative contribution of seasonal-mean spatial variations to the total simulated variations of $\delta^{18}O$ (54%-70%) is also much higher than that of synoptic-scale variations (27%- -5%). This suggests that the observed variability in q and $\delta^{18}O$ is mainly due to spatial variability, and marginally due to synoptic-scale variability. During the monsoon, seasonal-mean spatial variations is also the main contribution to the observed q variations. But it is different for $\delta^{18}O$: the relative contribution of synoptic-scale variations (90%-150%) dominates the total simulated variations of $\delta^{18}O$."

Minor comments:

1) Line 76: Isn't Bailey et al. (2013) a Hawaii-based study? Are there other studies based on larger continental settings?

We think we are the first to acquire large-scale in-situ observations. We modified as (lines 104-105):

"One study made vehicle-based in-situ observations to document spatial variations, but this was restricted to the Hawaii island (Bailey et al., 2013)."

2) Section 2.1, 1st paragraph: Include continental recycling as well.

We added the role of continental recycling (lines 72-74):

"Continental recycling, i.e. the moistening of the near-surface air by the evapo-transpiration from the land surface (transpiration by plants, evaporation of bare soil or standing water bodies, Brubaker et al 2013), is also an important source of water vapor in both seasons."

4) Line 124: Maybe write a few lines about the advantage of using d-excess, how does d-excess vary in comparison with d18O.

We added how people usually interpret d-excess (lines 141-144):

"The second-order d-excess parameter is computed based on the commonly used definition (Dansgaard, 1964). The d-excess is usually interpreted as reflecting the moisture source and evaporation conditions (Jouzel et al., 1997), since the d-excess is more sensitive to non-equilibrium fractionation occurs than $\delta^{18}O$".

5) Line 146: What is the value of calibration humidity correction term f? Is equation 3 a standard equation for these calculations? Any references?

We added the expiation and reference for f (lines 177-180) :

" f is the equation of δ as a function of humidity, and humidity is in ppm. E.g., if we measured that f is $\delta = a*\ln(\text{humidity})+b$) by measuring standard water with different humidity, then the full equation for humidity-dependent isotope bias correction would be $\delta_{\_measured} - \delta_{\_humidity\ calibration} = a*\ln(\text{humidity}_{\_measured})+b - (a*\ln(20000)+b)$."

We added following reference for f:

(Schmidt et al., 2010;JingfengLiu et al., 2014)

JingfengLiu, CundeXiao, MinghuDing, and JiawenRen: Variationsinstablehydrogenandoxygenisotopesinatmosphericwatervaporinthemarineboundarylayeracrossawidelatituderange, Journal of Environmental Sciences, 26, 2266-2276, 2014.

Schmidt, M., Maseyk, K., Lett, C., Biron, P., Richard, P., Bariac, T., and Seibt, U.: Concentration effects on laser-based $\delta^{18}O$ and $\delta^{2}H$ measurements and implications for the calibration of vapour measurements with liquid standards, Rapid Communications in Mass Spectrometry, 24, 3553-3561, 2010.

6）Figure 2,3: Have you tried using the same y-scale for pre-monsoon and monsoon period?

We tried, but it was too hard to see the spatial variations for the monsoon period.

7) Figure 2: Are the meteorological observations also 10-minute average?

We clarify the resolution of meteorological observations (Lines 241-242):

"And all of them also had been averaged to a 10-min temporal resolution."

What is the resolution of P-daily and P-mean respectively? It is not clear to me how P-mean is calculated. If P-mean is the temporal-mean of the precipitation amount over the sampling days, then P-mean should have a single value for each season. Please clarify. Also, mention the grid size of the GPCP precipitation. How is the grid average precipitation calculated?

We clarified the grid size (1-deg) of the GPCP in line 253.

P-mean is the average value over the entire observation period of about one month for each observation location, so it is not a single value for each season but for each position. We clarified the method to calculate the P-mean in lines 256-259:

"When compare the time series of GPCP data with our observed isotopes, we linearly interpolate the daily GPCP data to the location of each observation location (P-daily).We also used the average of the GPCP precipitation over the entire observation period of about one month for each observation location (P-mean)."

8） Is the humidity (figure 2e,f) and q (figure 2i,j) obtained from the Picarro sampler and the rooftop weather station, respectively? Do they correlate well? Can the humidity (ppm) also be expressed in (g/kg) for ease of comparison?

Yes, the humidity (figure 2e,f) and q (figure 2i,j) is obtained from the Picarro sampler and the rooftop weather station, respectively. We expressed the humidity (ppm) in (g/kg) and compare the q obtained from the Picarro, the rooftop weather station and NCAR in Figure 1. We added (lines 165-169):

"The specific humidity measured by Picarro is close to that measured by an independent sensor installed in the vehicle (Fig.4). The correlation between the

humidity measured by the Picarro and the independent sensor are over 0.99, the slopes are approximately 1 and the average deviation are less than 1 g/kg both during pre-monsoon and monsoon periods."

9) Line 249: "During the pre-monsoon…..than in any other regions". Here you say that in the pre-monsoon period, the humidity, P-mean and d18O are higher in southwestern China than in other regions. However, since the data is not available for the entire pre-monsoon period in the northeast and northwest regions, are you assuming that the humidity, p-mean and d18O remain consistent for the entire pre-monsoon period? Have you estimated a sampling bias? It would be good to write this assumption too.

The time solution is 10min for humidity for each observation location. The P-mean is the average of the GPCP precipitation over the entire observation period of about one month for each observation location. The temporal 10-min average humidity when we measured have the same variation with the P-mean, so that we would like to show that the humidity we observed could reflect the information of seasonal mean precipitation. Since we have clarified the method to calculate the P-mean, I believe that this part should have been accurately expressed.

10) Line 277: Alternatively, the high d-excess in south China could also be coming from the moisture flow from Indian/Pacific Ocean as is talked about later. Or, it could be resulting from the deeper convective mixed layer in south China compared to north China where vapor with high d-excess is transported towards the surface as shown in figure 9.

We added it as the potential reason for the high d-excess in south China (lines 412-414):

"Alternatively, the high d-excess in south China could also result from the moisture flow from Indian/Pacific Ocean, or from the deeper convective mixed layer in south China compared to north China."

11) Line 314: I find it exciting to see that the controls on d18O (temperature correlation) and d-excess (precipitation-line correlation) can be differentiated so well just based on the observations alone.

Thank you. We highlighted this in the abstract by modifying lines 30-34 as:

"During the pre-monsoon period, the spatial variations of vapor δ18O are mainly controlled by Rayleigh distillation along air mass trajectories. The North-South gradient observed during the pre-monsoon period is counteracted by different moisture sources, continental recycling processes and convection during moisture transport during the monsoon period."

12) Change reference Noone and David, 2012 to Noone, 2012.

We have modified this reference.

13) Figure 6: Can you explain the reason for a significant number of WR_1 dried and depleted dots below Rayleigh curve? Are they within the uncertainty range of the Rayleigh curve?

Thank you for your suggestion. In current Figure 9, we added the uncertainty range of the Rayleigh curve calculated for different initial conditions of key moisture source regions: during March 2019, light red and light blue Rayleigh curve are calculated for key moisture source regions of westerlies ($\delta^2H_0 = -168.04‰$, T=5°C) and BoB (δ^2H_0= -77.37‰, T=26.46°C) separately in (a); during July-August 2018, ight red and light blue Rayleigh curve are calculated for key moisture source regions of westerlies (δ^2H_0= -149.64‰, T=6.16°C) and BoB (δ^2H_0= -82.75‰, T=27.69°C) separately in (b). These initial δ^2H are derived from iso-GSM, the initial temperature and RH are derived from NCAR/NCEP 2.5-deg global reanalysis data.

We added following discussion in lines 581-583:

"The observations in the WR_1 region (Fig.3c) are closer to the q-δ^2H Rayleigh distillation curve calculated for the key moisture source regions of westerlies, providing further evidence of the influence of water vapor source on vapor isotopes."

14) Since figure 10 is referred at multiple places in the paragraph starting at line 413, maybe change index of figure 10 to 7 to maintain the flow of the paper.

We moved Figure 10 to an earlier position in the manuscript (Section 2.4) due to the multiple references to the figure in the analysis and the fact that it is one of the results of the backward trajectory tracking, i.e., the meteorological data on the backward trajectory.

15) Line 439: replace 'bring' with 'brought'.

We have modified 'bring' to 'brought'.

16) Line 442: "As continental….". Wrong grammar.

We modified the grammar (lines 639-641):

"As continental recycling is known to enrich the water vapor (Salati et al., 1979) and is associated with high d-excess (Gat and Matsui, 1991;Winnick et al., 2014)."

17) Continental recycling from WR2, SR1 and SR3 is a strong factor influencing the isotope ratios. Perhaps, defining it in one line or so will help the readers.

We summarized the influence of continental recycling onWR2, SR1 and SR3 (lines 782-784):

"Except SR_3 region, continental recycling also has a strong influence on isotopes in the WR2 and SR1 regions, which suggested by the high values of $\delta^{18}O$ and d-excess, back-trajectories, the location on the q-δ diagram, and the higher slopes and intercepts of $\delta^{18}O$-δ^2H relationship."

18) Line 458: "…with a steepest slope….". Replace 'a' with 'the'.

We have modified "with a steepest slope" to "with the steepest slope".

19）Line 493: Not all observations exhibit temperature effect. WR3 does not.

We modified "all observations" to "all observations taken together".

20）Line 509: Another factor for the dominating effect of q at least for SR2,3,4 can be rain evaporation.

We incorporated this idea (lines 707-709):

"The absence of correlation with T suggests that the variations in q mainly reflect variations in relative humidity that are associated with different air mass origins or rain evaporation."

21）Line 512: Explain the altitude effect in a separate line.

We added the explanation of altitude effect when it first occur in lines 513-514:

"the altitude effect (the heavy isotope concentrations in fresh water decreasing with increasing altitude, Dansgaard 1954)"

22）What is the difference between daily precipitation amount (P-daily) and temporal-mean precip amount for sampled dates (P-mean)?

We clarified the definition and method to calculate the P-daily and P-mean in lines 256-259:

"When comparing the time series of GPCP data with our observations, we linearly interpolate the daily GPCP data to the location of each observation location (P-daily).We also used the average of the GPCP precipitation over the entire observation period of about one month for each observation location (P-mean)."

23) Line 540: Define 'dtra'.

We defined "dtra" in the figure description of Figure 9 (lines 729-732):

"The x-axis "dtra" represents the number of days prior to the observations (from 1 to 10 days). For example, when the number of days is 2, the correlations is calculated with the temporal mean of meteorological data along the air mass trajectories during the 2 days before the observations."

24) Section 4.7: Going back to my major comment, why start the spatial vs synoptic comparison so late in 4.6 when you introduced the concept at the beginning of section 3? Tie this section with the previous sections.

We re-organized the manuscript and put the spatial vs synoptic comparison as section 3.3.

25) Table 2 description is incomplete.

We added "period" as the title of the 1st column, and "variables" as the title for the 2nd column (line 449).

26) I really like the summary plot 13. It provides a summary of all the meteorological processes described in the paper. Two questions: What is the significance of upward

and downward pointing triangles for d-excess?

We would like to use the upward and downward pointing triangles to represent high and low values of d-excess, different colours correspond to high and low relative humidity. The idea is that the high relative humidity source of water vapor leads to low values of d-excess and vice versa.

Please explain all the colored arrows in the figure description.

We explained all the colored arrows in the figure description (lines 852-857):

"Colored arrows from red to blue represent the initial to subsequent extension of the Rayleigh distillation process along the water vapor trajectory, corresponding to high to low values of $\delta^{18}O$*; green arrows represent high relative humidity and yellow arrows represent low relative humidity; orange twisted arrows represent continental recycling; blue-sized clouds represent strong and weak convective processes; triangle colours representing high and low values of d-excess correspond to the corresponding relative humidity."*

27) 'Bay of Bengal' spelt wrong in the figures 5 and 13

Thanks you, we corrected the spelling.