**response_to_editor**

I have received two reviews on your revised version of this paper. Both reviewers point out the need for additional major revisions to the text for better clarity and to enhance the significance of the paper through an in-depth discussion of the results. In the current form, I cannot accept this paper, and I encourage you to take the additional comments as well as the remarks below on the conclusions very seriously and carefully and thoroughly implement the requested changes.

Reply: Thank you for your suggestion. We have made reply and modification item by item according to your comments, and the line number in the reply is the line number of the clean version.

In addition to the reviewers comments please carefully revise the writing in the abstract and conclusions:

- L. 28 and 32: lower and higher than what? Rewrite to "small amplitude and large amplitude" if you do not mention to what you compare these amplitudes in the same sentence.

Reply: Thank you for your suggestion. We have modified the sentence from “lower and higher” to “small and large” (lines 27-30).

- L. 813: "deficiency of water vapour isotope values" what do you mean by deficiency? That they are not useful? Or do you mean depleted water vapour isotope values?

Reply: Thank you for your suggestion. We have modified the word from “deficiency” to “depleted” (line 774) as follows.

The depleted of water vapor isotope values at Matara station in autumn and winter is consistent with findings from other coastal stations, such as Bangalore, Ponmudi, and Wayanad (Rahul et al., 2016b; Lekshmy et al., 2018).

- L. 816: here you need to make clear what you mean by OLR at 1-4 days. 1-4 days locally or along the trajectories? 1-4 days before the observation?

Reply: Thank you for your suggestion. According to the suggestion of reviewer 1, we

replaced the OLR datasets (source with ERA5) and recalculated the spatial distribution of the correlation between water vapor stable isotopes and OLR. The results show that the maximum spatial correlation coefficients occur 2–5 days before the corresponding day (n=0).

2-5 days means local and before the observation. The 2-5 days denote the period over which the spatial correlation is assessed between daily averaged in-situ $\delta^{18}O$ measurements of water vapor and OLR, starting from the current day (n=0) to the preceding n days (lines 637-639 and 765-767).

- In the conclusions I still miss an in-depth discussion of the results in view of the existing literature. I mentioned this in the very beginning of the review phase and, unfortunately, I see only now that the conclusions do still not comply with the ACP guidelines:https://www.atmospheric-chemistry-and-physics.net/policies/guidelines_for_authors.html

Most importantly, I miss a "Comparison and context": there are other publications that have been looking at the impact of convection on the isotope composition in subtropical regions, please take this literature into account and mention what the new findings are with respect to the existing literature (Bailey et al. 2015, Risi et al. 2019, Benetti et al. 2015, De Vries et al. 2022, Galewsky et al. 2023, Landshuter et al. 2024). What do the isotope signals in Matara reveal, that others have shown using conceptual models or numerical model simulations?

Furthermore, Caveats and limitations are not discussed. This is an important part of the conclusions. Please add a paragraph on the limitations of your analysis. For example, you base your interpretations on a single year of observations, and the trajectory-based analysis lacks a mass-based budgeting approach.

Finally, the implications are a bit far away from the results presented, please bridge to the last paragraph by mentioning how concretely these observations may be used in the future to address open questions about water cycle changes in this region.

Reply: Thank you for your suggestion. We have rewritten the conclusion in Section 5 (lines 735-810).

Following your suggestions, we have added the “Comparison and context” in the third paragraph in *Section 5 (Summary and Conclusion)* (line 779-791) and “Caveats and limitations” in the fourth paragraph *Section 5 (Summary and Conclusion)* (lines 766-768 and 801-803). We described the application of the observation results in solving the water cycle changes in the region (lines 792-797).

Furthermore, we also added the description of water vapor stable isotope dataset (lines 739-743) and the correlation analysis of moisture sources based on HYSPLIT (lines 753-759).

In my view, the additional requests for major changes to the text by the two reviewers and myself are clear enough for you to implement the necessary changes. Please take the time to carry out these implementations carefully.

**response_to_reviewer1**

The new version of the manuscript is clearer, but not all reviewer comments have been properly addressed in my opinion. I suggest another round of minor revisions before the manuscript can be published.

General comments

1) I still don't understand how moisture sources are defined. Did you look at changes in specific humidity along the trajectories and grid them? If so, did you do any discounting (i.e. if moisture is lost later, does an increase in specific humidity still fully count as a moisture source)? Or did you define the end points of the trajectories as moisture sources? Please describe this clearly.

Reply: Thank you for your suggestion. To elucidate the spatial distribution of near-surface water vapor sources at the Matara station, Lagrangian backward trajectory simulations were conducted. All backward trajectories arriving at the station during the southwest and northeast monsoons were spatially clustered, with each cluster analyzed for temporal changes in parameters such as air parcel altitude and specific humidity. This approach enabled the identification of the air mass origins. Fig. 5(a, b) depict the spatial clustering of backward trajectories and the changes in specific humidity along these trajectories for the southwest and northeast monsoons, which are all gridded.

We have not done any discounting. The end points of trajectories are indicative of the moisture sources. The text has been modified in this paper (lines 530-534) and Fig. S6 has been added in *Supporting Information*.

2) The introduction is more streamlined now, but it still goes back and forth a bit. For example, I wouldn't mention isotopes in the paragraph starting at L68 yet; on L109 there is a jump from isotopes back to water cycle and back to isotopes; the paragraph starting at L136 should probably come somewhere in the beginning of the isotope part, because it is a general motivation for the use of isotopes.

Reply: Thank you for your suggestion. The introduction has been reorganized to

improve its coherence.

We have deleted the isotope part of the second paragraph (line 70).

The third paragraph (the paragraph starting at L136 in original version) now includes an explanation of the importance of water vapor stable isotope research (lines 79-84).

Furthermore, the section on the influence of sea surface evaporation on the water cycle, which originally preceded the fourth paragraph, has been omitted to create a better connection between the third and fourth paragraphs (line 113).

3) Having a discussion is a good idea, but the first section reads more like another results section than a discussion. The idea of a discussion is to set the results into a broader context. The second discussion section achieves this quite well, but the first section could be (re)moved.

Reply: Thank you for your suggestion. We reorganized the discussion section by transferring the content of the original Section 4.1 to Section 3.3 (lines 559-583). As a result, the discussion section exclusively contains the material from the former Section 4.2.

Specific comments

L28: Better “fluctuations” instead of values (also on L30)

Reply: We have modified the word (lines 28 and 30).

L37: I would change to “Furthermore, the new dataset will enable ...”

Reply: We have modified the sentence (lines 38-39).

L114 (and others): Do you mean kinetic fractionation?

Reply: We have modified the words from “dynamic fractionation” to “kinetic fractionation” (lines 116, 131, and 593).

L131: I would cite Merlivat & Jouzel (1979) instead of Bonne et al. (2019)

Reply: We have modified the reference from “(Bonne et al., 2019)” to “Merlivat and

Jouzel, 1979" (lines 133).

L211: I would move this to after ERA5 variables have been described.

Reply: Thank you for your suggestion. We have moved this text to the section describing ERA5 (lines 211-215).

L225: Since ERA5 provides OLR, I would use that instead of OLR from NCEP, for consistency with the other variables.

Reply: Thank you for your suggestion. We use OLR datasets obtained from ERA5 to analyze the impact of regional convective activity on atmospheric water vapor stable isotopes (lines 209-211) and redraw Fig. 2 (line 404) and Fig. 8 (line 678).

L232: Can you convert one of them and show both lines in the same plot (either humidity or specific humidity)?

Reply: Thank you for your suggestion. We have plotted the specific humidity obtained the AWS and ERA5 in Fig. S3 (lines 119-123 in *Supporting Information*).

L243+: I assume you mean T_2m air here as well?

Reply: Yes. This refers to the 2m air temperature obtained from the ERA5 datasets (lines 207-211). Therefore, we have modified the formula from "$T_{air}$" to "$T_{2m\ air}$" (lines 229 and 232 and Equation 7).

L244: Shouldn't the right hand side of the equation be q_s(sea surface salinity of 0 PSU)?

Reply: According to Curry and Webster (1998), $q_{sat}$ (SST) is the saturation specific humidity at a sea surface salinity of 35 PSU. We have explained in the parameter description below the Equations 7-8 (lines 229-235).

L248: What do you mean by calculated?

Reply: The calculation here refers to Equation 7. What we mean is that the sea surface

pressure value is taken as atmospheric pressure value to participate in the Equation 7 (lines 233-235).

L318: These equations should be normalized by VSMOW.

Reply: Yes. The data used for these formula calculations has been calibrated by VSMOW. We have added the description as follows (lines 307-308).

The isotopic ratio and isotopic δ in the Eq. 14 and Eq. 15 have been calibrated by VSMOW.

L342: And also from higher levels. It's enough to mention the release heights only once (but all of them).

Reply: We have made deletions and adjustments to this paragraph, mentioning the release heights only once (lines 325-331).

L348: This is a repetition from L340.

Reply: We have removed this sentence (lines 327-331).

L375: I still don't find this seasonal cycle very clear. I would choose a different wording.

Reply: We have modified the description (lines 357-359) as follows.

We demonstrated the monthly variations of the average relative humidity, specific humidity, monthly precipitation, and water vapor isotopic composition ($\delta^{18}O$, δD, and d-excess) (Fig. S3 and Table 1).

L403: "Consequently": This is a consequence of what?

Reply: We have modified the word to "Therefore" (line 387).

L415: How do you know that the high values of d-excess are related to moisture recycling?

Reply: This sentence has been deleted in the revised version.

L433: “n” missing.

Reply: We have corrected the word of “in” (line 412).

L461: Remove “is”

Reply: We have removed “is” (line 447).

L482: I don’t think “leaching” is the correct term. Is this really what you mean? https://en.wikipedia.org/wiki/Leaching_(chemistry)

Reply: Thank you for your suggestion. The word has been deleted in the revised version (line 468).

L496: A verb is missing in this sentence.

Reply: We have modified the sentence (lines 481-485).

L523: Where is Lena station?

Reply: The Lena River station is located in eastern Siberia. We have indicated the specific location in the paper (lines 508-510).

L584: Marara -> Matara

Reply: We have modified the word from “Marara” to “Matara” (line 597).

L587: How did you define these regions?

Reply: We have made the relationship between the near surface water vapor d-excess at Matara station and the relative humidity of the surrounding sea area during the observation period (Fig. S9). The water vapor d-excess has a significant negative correlation with the relative humidity in the BoB and the northern Indian Ocean. This is consistent with the trajectory tracking results (Fig. 5), which proves that the water vapor at Matara station is mainly supplied by the surrounding ocean. Therefore, we selected “Region a” and “Region b” (Fig. S9).

L764: 2040 mm per year?

Reply: Yes. We have added the words of “per year” in this sentence (line 714).

L780: Better “that in general agree with...”

Reply: We have modified the sentence as follows (line 730).

We could also identify seasonal patterns that in general agree with previous findings for tropical equatorial regions (Midhun et al., 2013; Rahul et al., 2016b; Lekshmy et al., 2018).

**response_to_reviewer2**

The authors show one year of near-surface water vapor stable isotope data observed in Sri Lanka, which is undoubtedly very important. However, there are still some parts of the paper that need to be improved.

Specific comments:

Line 79: Why mention “river water”? It’s not relevant to the topic of this paper.

Reply: Thank you for your suggestion. We have moved the words of “river water” (line 84).

Line 202: It should be added why the LCL is calculated; another reviewer similarly raised this issue, but the author’s response was not clear. In the latest version of the paper, it is still not clear that there is a need to discuss the LCL, and there is little connection to the topic of the paper.

Reply: Thank you for your suggestion. We have moved the part of LCL. Accordingly, we modified Table 1 (line 423), Fig. 4 (line 511), and Fig. S3 (line 119 in *Supporting Information*).

Line 381: This Celsius unit has a different font than the others.

Reply: We have corrected it (line 365).

Lines 401-403: It is mentioned that δ18O values are higher during the Southwest Monsoon, but Lines 557-558 mention that δ18O values are lower during the Southwest Monsoon, so why are the results opposite?

Reply: Thank you for your suggestion. We are so sorry for the mistake caused by previous negligence. At present, we have carefully examined the original data, modified the sentence (lines 545-546), and revised the Fig. 5.

Lines 404-405, Lines 410-411: “δ18O decreases during ... periods”; “d-excess increases during ... periods”. These statements are confusing, and no decrease or

increase trend can be seen from Figure 2.

Reply: According to Table 1, we revised these two sentences as follows, please see lines 388-390 and lines 394-396.

During the southwest monsoon, the northeast monsoon, and the non-monsoon periods, the average values of $\delta^{18}O$ are -11.1‰, -12.2‰, and -11.9‰, respectively.

Furthermore, during the northeast monsoon, the southwest monsoon, and the non-monsoon periods, the average values of d-excess are 12.4‰, 13‰, and 14.7‰, respectively.

Line 414: Line 412 mentions that the maximum d-excess value occurs in November; what is the logic of singling out April here? Is the reason for both November and April d-excess values being high the same? Are they both caused by local recycling?

Reply: Thank you for your suggestion. We have moved the sentence of "d-excess peaks in April 2020 at 19.1‰, indicating potential contributions from local recycling." We determined that the higher d-excess in November was due to local recycling.

Figure 2: The word 'pressure' is incomplete.

Reply: Thank you for your suggestion. It is corrected in Fig. 2 (line 404).

Line 438: "δ" → "δ18O"

Reply: We have modified the word from "δ" to "$\delta^{18}O$" (line 417).

Lines 436-438: "Over the 75-day period spanning from … between -22‰ and -11‰." The beginning of the paragraph mentions that there were abrupt changes in stable isotopes during this period, related to synoptic events. Here it should be summarized exactly what events are associated with it, rather than simply describing the isotopic signature.

Reply: Thank you for your suggestion. A single weather event is discussed in lines 412-415 and 417-419.

Lines 438-443: “During the southwest monsoon from July 12 to August 7…below the minimum in the Bay of Bengal (Midhun et al., 2013).” Why do you single out the period from July 12 to August 7 for analysis of isotopic changes? Is there anything special about this period? Is it related to the abrupt changes or synoptic events mentioned at the beginning?

Reply: From July 12 to August 7, there was a significant oscillation and fluctuation in the water vapor stable isotopes at Matara station, with a sharp depletion of $\delta^{18}O$ (Fig. 2). Corresponding to heavy precipitation events during the same period. Therefore, it will be described here as a weather event and related to the synoptic events mentioned at the beginning.

Lines 443-445: “Other coastal stations such as Bangalore, Ponmudi, and Wayanad also exhibit … observations at Matara (Table 2).” These analyses of the characteristics of autumn or winter changes, not synoptic changes, should be placed in the previous paragraph.

Reply: Following your suggestion, we have removed this sentence to the end of the third paragraph in Section 3.1 (lines 401-403).

Lines 454-457: Regarding the interpretation of the slope, it seems to be different from previous studies, which suggested that lower slopes are usually associated with evaporation.

Reply: Thank you for your suggestion. We checked the previous statement and found some errors. Therefore, we reanalyzed the causes underlying the variability in the slope and intercept of LMWL during the southwest monsoon and northeast monsoon as follows (lines 437-443).

The LMWL slope and intercept vary significantly between monsoon and non-monsoon seasons, peaking in the northeast monsoon with values of 7.3 and 3.86, and nadir in the southwest monsoon with 6.93 and 1.18, respectively. This suggests increased humidity over sea surface vapor sources from the northeast to southwest monsoon, attributed to heightened evaporation and reduced dynamic fractionation

effects. During the northeast monsoon, LMWL slope and intercept are higher compared to other periods, indicating significant moisture recirculation.

Lines 490-491: In addition to convective processes, is the effect of raindrop re-evaporation considered? In addition, is it possible to demonstrate that convective activity is stronger during the northeast monsoon through the spatial distribution of the OLR? Finally, Section 4.1, lines 716-717 mentions that the air brought by the northeast wind is drier during the northeast monsoon. Does dry air contribute to the enhancement of convection?

Reply: This article only considers the convective process and does not take into account the impact of raindrop re evaporation. According to the spatial distribution of the correlation between OLR and $\delta^{18}O$, the results reveal that the correlation is significantly stronger during the northeast monsoon, which indicates that convective activity is stronger during the northeast monsoon period compared to the southwest monsoon period. However, the Matara station in Sri Lanka remains moist throughout the year, with a specific humidity range of 17-22 g/kg.

Our work does not delve deeper into the potential role of dry air in enhancing convection. We sincerely acknowledge the reviewer's insightful feedback and plan to incorporate this aspect into our future investigations.

Line 587: Why not choose the region with stronger negative correlation within the 50-60 °E range in Figure S6 for "Region a"?

Reply: Thank you for the reviewers' suggestions. We modified the selection of regions and selected regions with stronger negative correlation in Fig. S9. We have calculated the values of $RH_{SST}$ and the relationship between the values of $RH_{SST}$ and d-excess during the southwest monsoon. The calculation results (Fig. 7) and the expression (lines 596-621) in the paper are modified.

Lines 636-638: In Figure 7, the correlations between δ18O and precipitation, OLR during the northeast monsoon are also very high on the west of the study site, which is

inconsistent with the results of the moisture trajectory (from the northeast), why?

Reply: Thank you for the reviewers' suggestions. We have replaced the OLR dataset from ERA5. And the spatial distribution of correlation coefficients between $\delta^{18}O$ and OLR was recalculated. The results of the correlation during the northeast monsoon are consistent with the moisture trajectory in the revised version (Fig. 5 and Fig. 7).

Line 643: There are only temporal correlation results in Figures 7e and f. Where are the spatial correlation results? In addition, a 5×5 region could be presented in the figure, which would be more intuitive.

Reply: Thank you for your suggestion. At present, after adjustment, Fig. 7 is changed to Fig. 8. Figures 8a-d show the temporal and spatial correlation, while Figures 8e-f only show temporal correlation. The wording in the text has been revised (lines 654-656). In addition, a 5×5 region has been presented in Fig. 8 (lines 678-689).

Lines 677-678: Section 3.4 is titled Influence of Convective Activity, but the last two paragraphs discuss the relationship between stable isotopes and temperature and relative humidity, respectively, which is not relevant to the topic and does not add valid information, so it is recommended that it be deleted.

Reply: Following your suggestion, we have removed the last two paragraphs in *Section 3.4* and the related figures in *Supporting Information*.

Lines 739-744: Moisture from the northeast during the southwest monsoon? During the northeast monsoon, the moisture comes from the southwest? It's the opposite, isn't it?

Reply: Following your suggestion, we have rewritten these sentences (lines 569-580).

The headings of Sections 3.2, 3.4, 4.1 and 4.2 are not specific and it is recommended that they be revised.

Reply: Following your suggestion, we modified the heading of Section 3.2 to "The Variation Characteristics of Diurnal Cycles" (line 477), the heading of Section 3.4 to

“The Influence of Regional Convective Activity” (line 628), and the heading of Section 4 to “Discussion: Comparing Main Features and Identifying Influencing Factors” (lines 691-692), respectively.