Response to Dr. Ruud van der Ent:

General comments:

Li and co-authors study the moisture sources of precipitation in 2 river basins for the (seemingly randomly chosen) 2022 July period with 2 moisture tracking algorithms WAM2layers and FLEXPARTWaterSip. They compare the methods and subsequently test sensitivities when changing certain parameters. The study is timely, relevant, generally easy-to-follow and substantiated with good figures and tables. However, I have two major comments:

1. The study is not at all reproducible as no detailed model settings are provided in relevant scripts. Moreover, people that use other moisture tracking models or settings would not be able to compare their results against that of the authors as no output data is provided. Only generic links to input scripts and data are available which are by far insufficient in this new era of FAIR and Open Science.

2. The authors make several strong statements and conclusions about the tracking models ability, which, in my opinion are mere hypotheses by lack of knowledge about an actual truth. These hypotheses should be substantiated by additional analysis and/or toned down.

Response: Thanks for your thorough review and valuable comments on our manuscript. We appreciate the time and effort you have dedicated to evaluating our work and are grateful for the constructive feedback provided. Please see below for our responses to your general comments and a summary of changes made in the revision:

Selection of river basins: We would like to clarify that the two river basins are not randomly selected. As suggested in previous studies, the Tibetan Plateau (TP) is influenced by the intricate interactions between the Indian monsoon and the westerlies (Yao et al., 2022). The selected two river basins exemplify the influences of these two systems. Specifically, the Yarlung Zangbo River Basin (YB) is mainly influenced by the monsoon, which travels across the Himalayas, while the upper Tarim River Basin (UTB) is mainly influenced by the westerlies after crossing the Pamirs. Analyzing these two representative basins will also facilitate a comprehensive study of the basin-scale water balance, including both atmospheric moisture dynamics and runoff.

Reproducibility of our study: We have provided all the relevant model settings and our customized algorithms/codes in the supplement. In addition, we will release our simulation results in an open-access data repository upon the publication of this work. We have further stated that all codes and data are available on request from the first/corresponding author.

Experimental designs, statements, and conclusions about the tracking models: We have: 1) conducted a detailed sentence-by-sentence revision to improve the descriptions in the research background and results sections; and 2) enhanced the manuscript by incorporating additional analyses, discussions, and sensitivity experiments to thoroughly substantiate all conclusions.

More specifically, we have made substantial changes to the manuscript. The revised structure becomes:

1. Introduction
2. Eulerian and Lagrangian approaches for moisture tracking: WAM-2layers and FLEXPART-WaterSip models
3. Moisture tracking in two representative basins
4. Comparison between moisture fluxes with WAM-2layers and particle trajectories with FLEXPART-WaterSip
5. Relationship between "actual evaporation" and simulated moisture contributions
6. Bias correction of FLEXPART-WaterSip simulations
7. Potential determinants of discrepancies in moisture tracking
8. Discussion and conclusions

In Section 1, we thoroughly revised the logic flow of the introduction section: 1) we narrowed down the scope of our current study to focus exclusively on moisture tracking over the TP; 2) we clearly pointed out potential simulation differences that may exist in previous research; 3) we emphasized that the aim of this study is to investigate potential errors/uncertainties in existing moisture tracking studies in the TP; 4) we cautioned readers against generalizing our comparison results in the TP to other regions.

In Section 2, we 1) provided detailed descriptions of the two selected models; 2) clearly specified all numerical settings for these two models and detailed their configurations in Part 2 of the supplement; 3) shared our customized code for WaterSip in Part 3 of the supplement.

In Sections 3 and 4, we 1) removed redundant content and inaccurate descriptions; 2) strengthened the logic of our analyses.

Sections 5 and 6 are newly added chapters. In section 5, we evaluated the relationship between evaporation data from ERA5 and the simulated moisture contributions to further clarify the strengths and weaknesses of the two models. Building on these comparison results, in Section 6, we presented the bias-corrected simulation results of FLEXPART-WaterSip, which substantially improved model's accuracy in simulating evaporation.

In Section 7, we included additional sensitivity experiments for WAM-2layers (including additional configurations with different spatial and temporal resolutions) and FLEXPART-WaterSip (including additional combinations of specific and relative humidity thresholds). These new analyses have strengthened the robustness of the conclusions drawn in this manuscript.

In Section 8, we removed or revised conclusions not fully substantiated by our analyses.

Specific comments:

1. L. 23: "the Eulerian or Lagrangian method"
There is no such thing as 'the XXX' method and there are many other factors (possibly more dominant factors) that contribute to differences in moisture source attribution.

Response: Thanks for pointing this out. We have carefully revised all these inaccurate statements in our revised manuscript. We changed "the Eulerian or Lagrangian method" to specific models (e.g. WAM-2layers). This is to acknowledge that the two models used in this study are examples of Eulerian and Lagrangian models/approaches (e.g., WAM-2layers is AN Eulerian model/approach for moisture tracking). For consistency, we also replaced “methods” with “approaches” or “models” in the revision.

2. L. 29-31: “The inherent ability in WAM-2layers to distinguish between evaporation and precipitation makes it more effectively in identifying varying moisture contributions arising from distinct surface evaporation sources.”
Effectively by what measure?
Response: Thanks for the comments. The effectiveness is based on quantitative assessment of simulated evaporation. In this revision, we added a new Section 5 to compare the results of the two models with evaporation data from ERA5 over the entire source regions.

3. L. 31-33: “In contrast, in regions heavily influenced by smaller-scale convective systems with high spatial heterogeneity, such as the UTB when compared to the YB, simulations from FLEXPARTWaterSip tend to be more reliable.”
Reliable by what measure?
4. L. 34: “However, FLEXPART-WaterSip is prone to introducing additional errors when using specific humidity information in particles to infer moisture uptake and loss, although it accurately depicts the three-dimensional movement of air particles.”
Accurate by what measure?
Response: Sorry for the confusion. We have carefully checked and revised all statements/conclusion to ensure that they are sufficiently supported by our results. As a result, these speculative statements have been removed from the revised manuscript.

5. L. 44-49: “In comparison, the Lagrangian method employs a particle trajectory tracking approach, inferring the movement of moisture through individual three-dimensional particle trajectories solved with differential equations. While Lagrangian models typically involves more complete physical mechanisms in particle dispersion processes, they exhibit substantially less numerical diffusion than Eulerian models, making them more adept at capturing small-scale atmospheric phenomena such as turbulence, convection, and dispersion, particularly over complex terrains (Wang et al., 2018; Tuinenburg and Staal, 2020).”
But do most or all Lagrangian models include actual diffusion through turbulence, velocity differences, rainfall re-evaporation etc.? If not, then having no diffusion either numerically or explicitly modeled would also lead to errors.
Response: Thanks for pointing this out. Indeed, both Eulerian and Lagrangian models include diffusion. By “less numerical diffusion” here we meant “less numerical diffusion error”. Eulerian models use a fixed grid system and track changes in each grid cell, which can potentially lead to less accurate results in tracking moisture movements when compared to particle (parcel)-based Lagrangian models. To avoid ambiguity, we have removed this part from our revised manuscript.

6. L. 53-55: “However, these studies have not extensively explored the limitations of different model types and the causes of discrepancies between moisture tracking results. Moreover, the studies on the generation mechanisms of model uncertainties through the moisture tracking intercomparison is severely lacking."

I think the authors' study is a good addition, but I do not think that objectively they do much more than these previous studies. So, they should tone down this comment and somewhere in the introduction explain the relevance of their own contribution. A missing moisture tracking model comparison study is also the one by Van der Ent et al. (2013).

Response: Thanks for the comment. The motivation of this study originates from the extensive literature on precipitation moisture tracking in the Tibetan Plateau (TP) (Table 1 only presents a subset of existing efforts). However, to the best of our knowledge, no effort has been made to address the discrepancies or uncertainties among these TP-focused studies. This situation has led us to develop this manuscript, aspiring to encourage future researchers to critically assess the reliability of their simulation outcomes. Toward this goal, we strive to identify potential factors contributing to discrepancies among models over the TP region. Based on your suggestions, we have thoroughly revised the Introduction section to emphasize the following two aspects:

1. We have narrowed down the scope of the present study to focus exclusively on moisture tracking over the TP. In this context, we have specifically highlighted that the most widely used numerical moisture tracking models are WAM-2layers and FLEXPART-WaterSip. The subsequent paragraphs in Introduction also focus solely on these two representative models.

2. The aim of this manuscript was to investigate potential errors/uncertainties in existing moisture tracking studies in the TP as well as to understand their underlying mechanisms/determinants. We have emphasized the significance of this study in the last paragraph of Introduction.

7. L. 64-65: "the Eulerian… the Lagrangian"

Same comment as above.

Response: Thanks. Please see our previous response to your specific comment #1 above.

8. Table 1: "Overview …"

- Please note that this overview table is non-exhaustive
- Particularly missing studies are those by Guo et al. (2019, 2020)
- Is CAM a tracking model?
- I'd say the moisture source diagnosis of WAM2layers is simply the E and P from the data (as in QIBT or UTrack)

Response: Thanks for your comments.

- In our revised manuscript, we emphasized that this overview table is non-exhaustive ("extensive studies on water isotopes in the TP with moisture tracking simulations are not include here"). In addition, we added several studies to Table 1 (including Guo et al. 2019; 2020).
- Sorry for the oversight. "CMA" here should be "CAM5.1 with a tagging method".

The authors developed a moisture tracer technology for the CAM5.1 model (Pan et al., 2017), enabling it to trace moisture source (Pan et al., 2018).

- Thanks, these blank cells were filled with "E and P" in the revised Table 1.

Please see the revised Table 1 below:

Table 1: *Overview of Eulerian and Lagrangian moisture tracking studies in the TP and its vicinity. Note that extensive studies on water isotopes in the TP with moisture tracking simulations are not included here. "E and P" means the model diagnoses evaporation and precipitation separately, while "E – P" means the model diagnoses contributions through water budget (i.e., evaporation minus precipitation).*

	Model	Moisture source diagnosis	Study area	Forcing dataset	Study period	Reference
Eulerian	WAM-1layer	E and P	Central-western TP	ERA-I, NCEP-2	1979–2013	Zhang et al. (2017)
	WAM-2layers	E and P	Endorheic TP	ERA-I, MERRA-2, JRA-55	1979–2015	Li et al. (2019)
	WAM-2layers	E and P	Southern/northern TP	ERA-I	1979–2016	Zhang et al. (2019a)
	WAM-2layers	E and P	TP	ERA-I	1979–2015	Guo et al. (2019)
	WAM-2layers	E and P	TP	ERA-I	1998–2018	Zhang (2020)
	WAM-2layers	E and P	TP	ERA-I, MetUM	1982–2012	Guo et al. (2020)
	WAM-2layers	E and P	Major basins in TP	ERA-I, MERRA-2, JRA-55	1979–2015	Li et al. (2022a)
	WAM-2layers	E and P	TP (forward tracking oceanic evaporation)	ERA-I, MERRA-2, JRA-55	1979–2015	Li et al. (2022b)
	WAM-2layers	E and P	TP (forward tracking TP evaporation)	ERA5	2000–2020	Zhang et al. (2023)
	WAM-2layers	E and P	Five typical cells in the TP	ERA5	2011–2020	Zhang et al. (2024)
	CAM5.1 with a tagging method	E and P	Southern/northern TP	MERRA	1982–2014	Pan et al. (2018)
Lagrangian	FLEXPART	E – P	TP	NCEP-GFS	2005–2009 (summer)	Chen et al. (2012)
	FLEXPART	Areal source–receptor attribution	Grassland on eastern TP	NCEP-CFSR	2000–2009	Sun and Wang (2014)
	FLEXPART	WaterSip	Four regions within TP	ERA-I	1979–2018 (May–August)	Chen et al. (2019)
	FLEXPART	Areal source–receptor attribution	Xinjiang	NCEP-FNL	2008–2015 (April–September)	Zhou et al. (2019)
	FLEXPART	WaterSip	Southeastern TP	ERA-I	1980–2016 (June–September)	Yang et al. (2020)
	FLEXPART	WaterSip	Xinjiang	NCEP-CFSR	1979–2018	Yao et al. (2020)
	FLEXPART	WaterSip	Northern/Southern Xinjiang	NCEP-CFSR	1979–2018	Hu et al. (2021)
	FLEXPART	Areal source–receptor attribution	Source region of Yellow River	NCEP-FNL	1979–2009	Liu et al. (2021)
	FLEXPART	WaterSip	Xinjiang	NCEP-CFSR	1979–2018 (April–September)	Yao et al. (2021)
	FLEXPART	E – P	Three-rivers headwater region	ERA-I	1980–2017 (boreal summer)	Zhao et al. (2021)
	FLEXPART	E – P	Three-rivers source region	NCEP-FNL	1989–2019	Liu et al. (2022)
	FLEXPART	WaterSip	Three-rivers headwater region	ERA-I	1980–2017	Zhao et al. (2023)
	HYSPLIT	WaterSip	Three-rivers headwater region	NNR1	1960–2017 (June–September)	Zhang et al. (2019b)
	HYSPLIT	E – P	Western TP	ERA-I	1979–2018 (winter)	Liu et al. (2020)
	HYSPLIT	Maximum specific humidity	Seven regions within TP	NCEP/NCAR	1961–2015 (summer extreme event)	Ma et al. (2020)
	HYSPLIT	Contribution function and weighting	TP	NCEP-GDAS	1950–2015 (extreme precipitation events)	Ayantobo et al. (2022)
	HYSPLIT	WaterSip	Southern Xinjiang	ERA5	2021(June 15–17)	Chen et al. (2022)
	LAGRANTO	WaterSip	Southeastern TP	ERA-I	1979–2016 (winter extreme precipitation)	Huang et al. (2018)
	LAGRANTO	WaterSip	Three regions within TP	ERA-I	1979–2016 (winter extreme precipitation)	Qiu et al. (2019)
	LAGRANTO	WaterSip	Northern TP	ERA-I	2010–2018 (monsoon season)	Wang et al. (2023)

QIBT	E and P	Southeastern TP	ERA-I	1982–2011 (April–September)	Xu and Gao (2019)

9. L. 92-93: "The model prescribes a two-layer division (~810 hPa with a standard surface pressure)"
Probably good to stress that the layer separation is very different over the Tibetan Plateau.

Response: Thanks. In the revised manuscript, we have mentioned that the division varies with topography, and include a sentence to explain the situation over the TP region: "~520 hPa over the TP (~4000 m)". See Lines 120–121 in our revised manuscript.

10. Figure 1: "method"
- In WAM2layers P also goes out the upper layer
- WaterSip is not necessarily 6 hours I suppose?

Response: Thanks.
- Indeed. We have added P in the upper layer in our revised Fig. 1a.
- Yes, the output intervals can be different in FLEXPART. We used 6-hours here because it represents the most commonly used (also the default) time interval in WaterSip. This is also consistent with our illustration in "step two" in Fig. 1b.

Please see below for the revised Fig. 1:

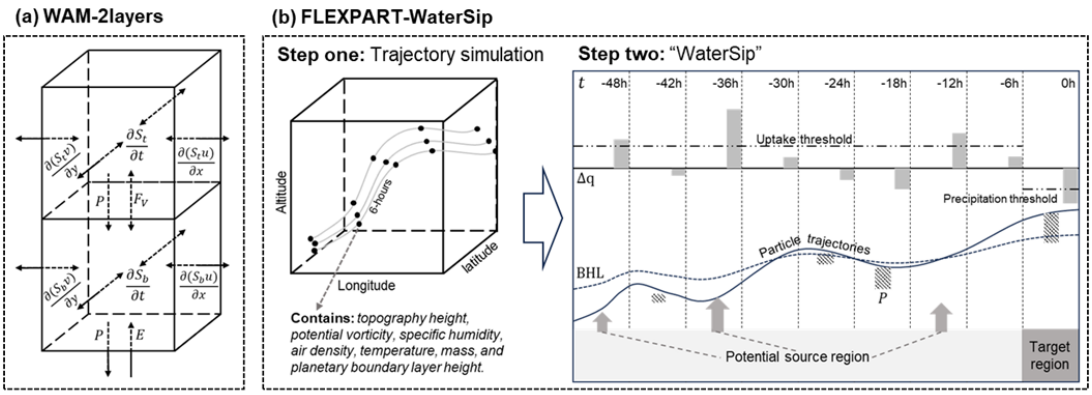


***Figure 1:** Mechanisms of (a) WAM-2layers and (b) FLEXPART-WaterSip models. "Step two" in (b) is adapted from Sodemann et al. (2008).*

11. L. 145-146: "Our numerical experiments, as illustrated in Fig. S2b, indicate that within the first 10 days (20 days), we traced 89% (99%) of the precipitation moisture in the YB and 97% (99%) in the UTB."
The amount of attributed moisture seems very high to me. Do the authors think this realistic? How does the E simulated from WaterSip compare to actual E from ERA5?

Response: Thanks for the comments.

1. We found one previous study that used the same method (FLEXPART-WaterSip) for moisture tracking in Xingjiang (north of the TP) (Yao et al., 2020), which includes a figure illustrating the relationship between tacking days and cumulative contribution rates (see the Figure below). Within 10 days, ~95% of the precipitation moisture in the region was tracked, which is consistent with our results.

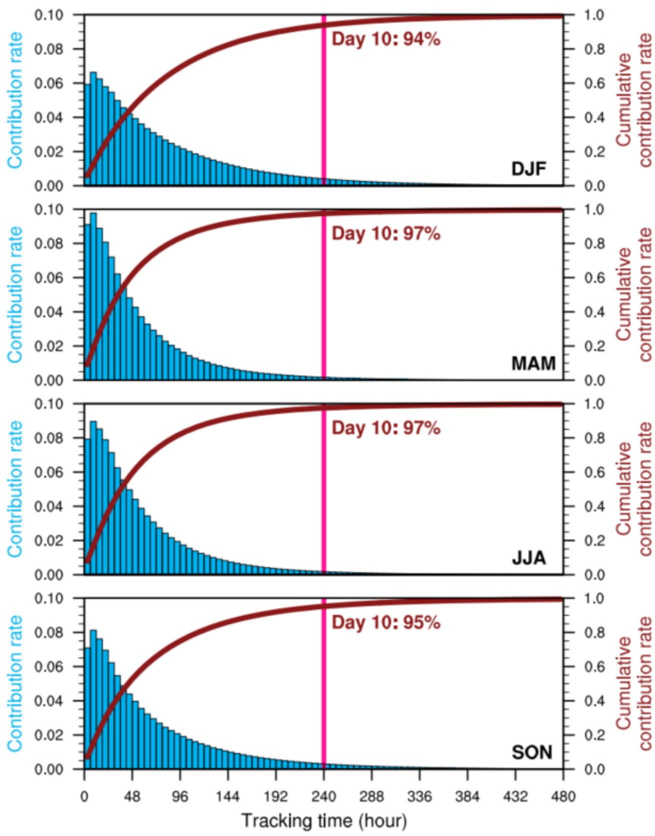


FIGURE 3 The contribution rates (bars) of moisture that can be traced by different backtracking times among seasons, together with their cumulative contribution rates (curves). The percentages are the cumulative proportions of moisture that can be traced back to 10 days

2. In the revision, we further evaluated the relationship between the simulated moisture contributions and actual evaporation from ERA5 over the entire tracking domain. Results are shown in the newly added Section 5. In general, results from WAM-2layers are more consistent with actual evaporation compared to those from FLEXPART-WaterSip.

12. L. 156-159: "Another noteworthy detail is the clear north-eastward extension of moisture sources for UTB precipitation resolved by FLEXPART-WaterSip, reaching almost to the easternmost Tianshan Mountains (Fig. 2d), a feature absent in the results of WAM-2layers (Fig. 2b)."

It is not clear exactly where the Tianshan Mountains are in Figure 2. Moreover, the word 'resolved' suggests that there is orthogonal evidence for those moistures to be the 'truth', but I fail to see where that is presented.

Response: Thanks for the comments.

1. We have labeled all the mountain ranges around the study areas in the revised Fig. S1 (see below).

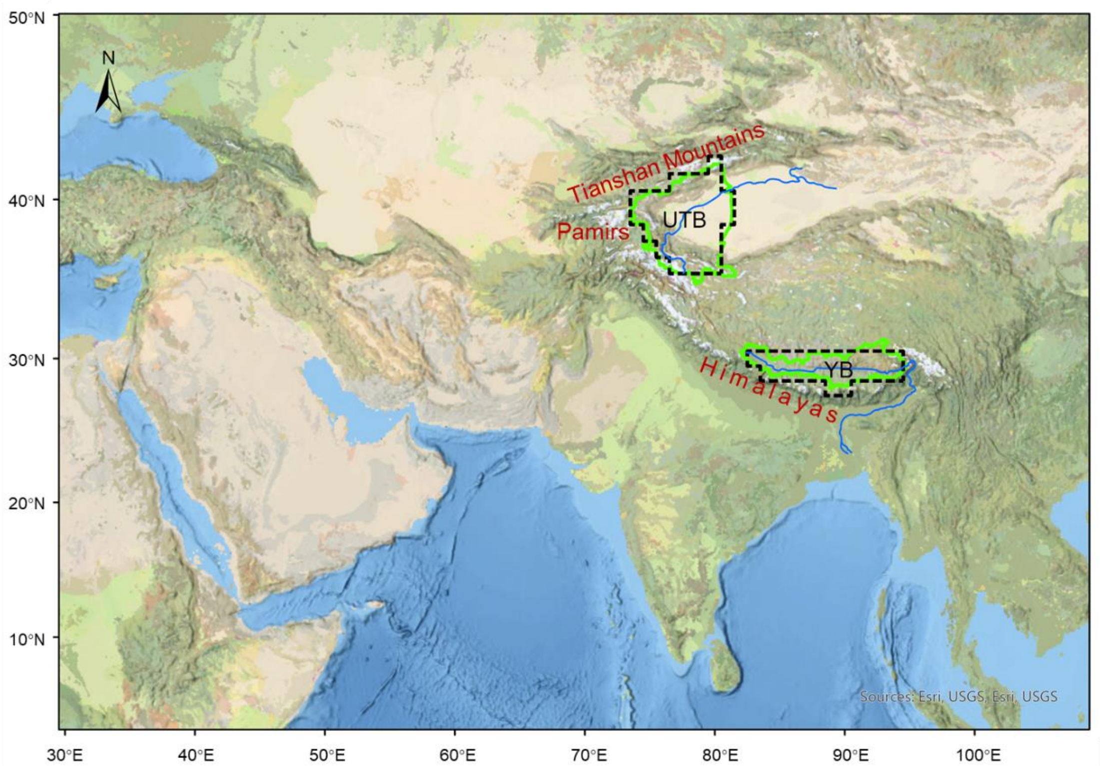


Figure S1. *Topography of the Yarlung Zangbo River Basin (YB) and the upper Tarim River Basin (UTB). Cyan solid lines represent the actual watershed boundaries. Dotted black lines depict the computational boundaries. Blue lines represent the rivers. Generally, the monsoon impacts the YB after traveling across the Himalayas, while the westerlies impact the UTB after crossing the Pamirs and Tianshan Mountains.*

2. Based on the newly added analyses in Section 5 and Section 6 in the revision, we found this "north-eastward extension of moisture sources for UTB precipitation" partially stems from simulation errors in FLEXPART-WaterSip model. We have pointed this out in the revision: "For the UTB, the uncorrected FLEXPART-WaterSip simulations mainly estimate higher moisture contributions from the target region and its surrounding areas (Fig. 10f), including the northeastward stretch of moisture sources observed in Fig. 3d." (Lines 364–365 in our revised manuscript). For further details, please see Sections 5 and 6 in our revised manuscript.

13. Figure 2: "Spatial distributions …"

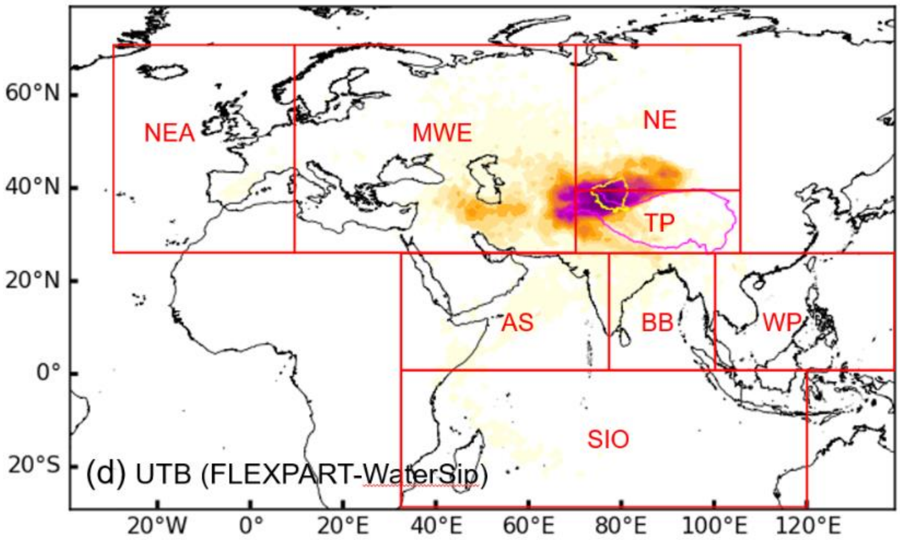
- FLEXPART-WaterSip attributes vast areas of evaporative sources from as far away as the Arabian Desert and the Sahara in the same order of magnitude as evaporative contributions from the Red Sea, Gulf of Aden and Gulf of Oman. With actual evaporation being several orders of magnitudes lower in the desert, this feature is completely unrealistic and warrants more investigation by the authors. What does this tell in general about the trustworthiness of this method?
- The blank area between MWE and AS seems not a very logical way to separate regions.

Response: Thanks for the comments.

1. Indeed, this "unrealistic" phenomenon warrants further investigation. In our revised manuscript, we added a new Sections 5 to evaluate the relationship between

actual evaporation from ERA5 and the simulated moisture contributions, and a new Section 6 to bias-correct the results of FLEXPART-WaterSip. These two sections are designed to improve our understanding of the reliability of these two moisture tracking models. Based on our new analyses, we found that FLEXPART-WaterSip is somewhat biased in simulating evaporation. However, these biases can be partially corrected using actual surface fluxes. The bias correction also substantially reduces evaporative contributions from Arabian Desert and the Sahara. For more details, please see Sections 5 and 6 in our revised manuscript.

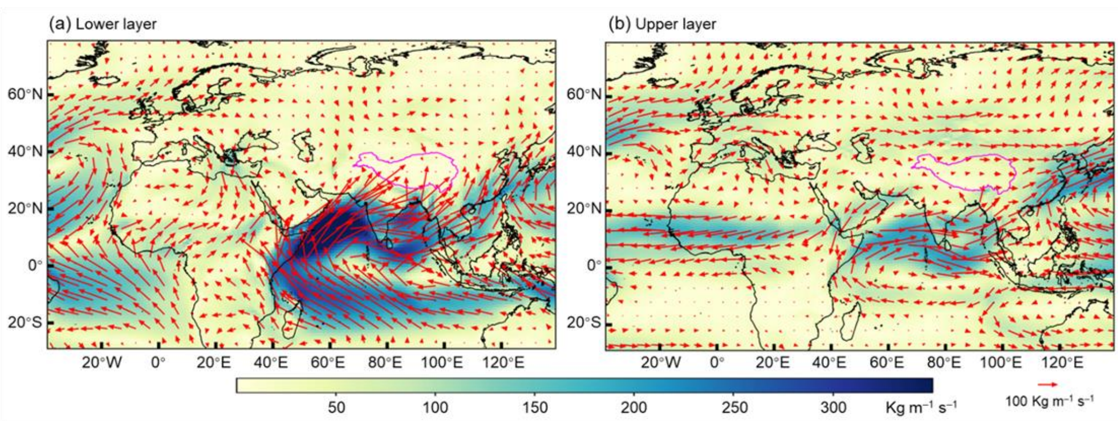
2. In the revision, we have modified the division of the eight major moisture sources to cove the blank area between MWE and AS (see figure below). All relevant figures and results have been updated accordingly.



14. Figure 5 and 6:

What is the exact meaning in a quantitative sense of the red arrows?

Response: Sorry for the confusion. In the revised manuscript, we have added a quantitative legend for the red arrows (see the revised figure below).



In original Fig. 6, the red arrows in (a) and (b) are somewhat redundant. To avoid confusion, we have removed these arrows. Note that the original Fig. 6 becomes Fig. 7 in the revised manuscript.

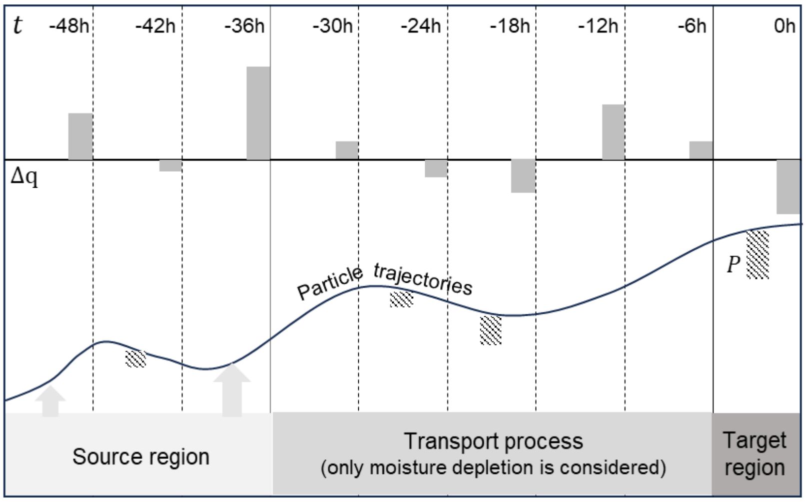
15. L. 242-244: "This further implies that the modelling capability of WAM-2layers for moisture sources of the UTB may be less robust than for the YB, consistent with the observation that the simulation disparities between the two models are more pronounced in the UTB than that in the YB (Fig. 4)."
As mentioned before, this hypothesis is not substantiated by any quantitative analysis. Alternatively, my hypothesis would be that while moisture goes to the northeast (back in time), there was very little evaporation in that area from the ERA5 data, so it wasn't identified as a source, whereas FLEXPART-WaterSip erroneously assigns an imbalance in its Lagrangian moisture budget as surface evaporation which may also have be caused by, for example, convergence. I do not have any evidence directly for my hypothesis either, but it is up to the authors to investigate the matter in more detail before jumping to conclusions.
Response: Thanks for your insightful comments. In our revised manuscript, we have included additional analyses and discussions to substantiate these hypotheses. This includes the comparison between actual evaporation from ERA5 and simulated moisture sources (Section 5) as well as the bias correction for FLEXPART-WaterSip results (Section 6). Please also see our responses to your specific comment #13 and general comments above.

16. L. 268-270: "A notable difference between WAM-2layers and FLEXPART-WaterSip, as highlighted in Fig. 2, is that FLEXPART-WaterSip model fails to capture most moisture source regions across the entire northwestern Eurasia for both basins when compared to WAM-2layers."
The word fails suggests that we know that WAM2layers would be more correct, but we don't know, do we?
Response: Sorry for the inaccurate description. We have carefully checked and revised all statements/conclusion to ensure that they are sufficiently supported by our results. As a result, these speculative statements have been removed from the revised manuscript.

17. L. 281-287: "Experiment 1 …"
This is a nice sensitivity test, however, its results can only be interpreted in case we also know how the timestep was adjusted, which together with spatial resolution drives the numerical diffusion and hence the average travel distance.
Response: To better understand how the spatiotemporal resolutions of forcing dataset could influence moisture tracing results, in the revision, we conducted two additional sensitivity experiments for WAM-2layers model. The Experiment 1 in Section 7 now has four different configurations: 3h and 1°×1°, 1h and 1°×1°, 3h and 0.25°×0.25°, and 1h and 0.25°×0.25°. Through these tests, we found that increasing the spatial and temporal resolutions of forcing data for WAM-2layers can reduce the moisture tracking discrepancies between the two models. For further details please see Section 7 in our revised manuscript.

18. L. 297-304: "Experiment 3 …"
More details on the areal source-receptor attribution method are needed here as well.

Response: In the revision, we have added a new schematic diagram for the "areal source-receptor attribution method" to the Supplement (Figure S11; see below). Together with Fig. 1b, this clearly illustrates the differences between WaterSip and the "areal source-receptor attribution method".



19. Figure 8: "Relative moisture contributions …"
- What is the remaining percentage from other regions?
- What is the remaining percentage from outside the domain?
- What is the remaining percentage unaccounted for altogether?
- The labelling should be more precise for WAM2layers in terms of resolution for both exp 1 and the original run.

Response: Thanks for the questions. In the revision, we added an extra set of histograms to show the moisture contributions from areas outside the eight selected regions (shown as the "Remaining" regions in Figs. 5 and 11 in our revised manuscript). We have also renamed all the experiments to include resolutions, e.g., WAM-2layers (1h, 0.25°×0.25°) and WAM-2layers (3h, 1°×1°). The revised Fig. 8 (now Fig. 12 in our revised manuscript) is shown below:

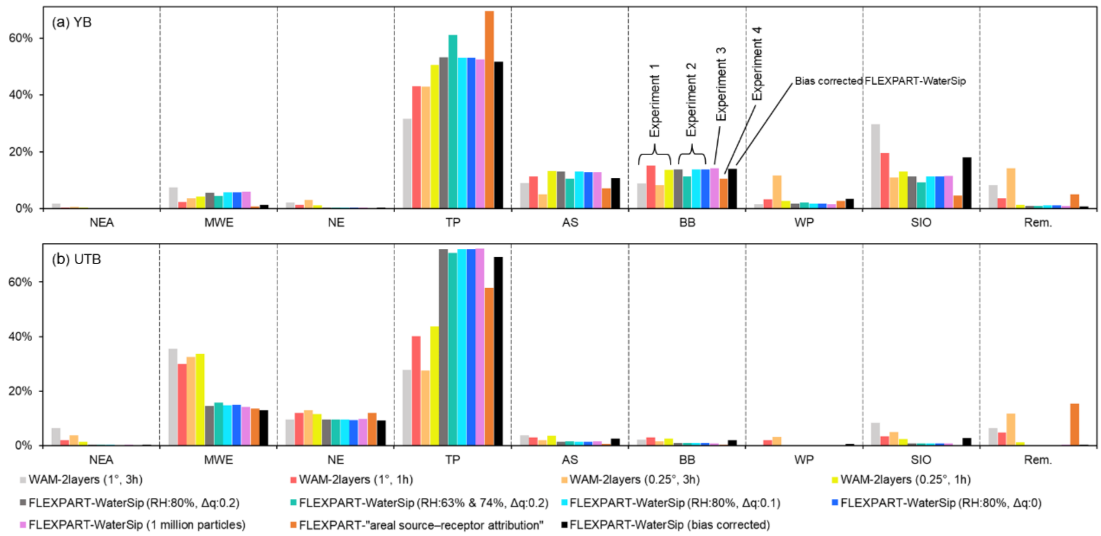


***Figure 11:** Relative moisture contributions (%) to precipitation over the YB (a) and UTB (b) from the eight selected source regions and the remaining regions, simulated by four sets of numerical experiments (including different configurations in WAM-2layers and FLEXPART-WaterSip, FLEXPART-"areal source–receptor attribution", and bias-corrected FLEXPART-WaterSip). Black histograms represent the bias-corrected FLEXPART-WaterSip.*

20. L. 328: "original WAM-2layers"
I think both experiments are WAM-2layers with different settings, so the word 'original' is perhaps a bit misleading.
Response: Thanks for pointing out this. We have renamed all experiments to include resolutions. Please see Fig. 11 in our revised manuscript.

21. Fig. 10. "Time series …"
- Please improve the caption to make sure all details are explained.
- Is precipitation and evaporation the ERA5 data, or the inferred data from the WaterSip algorithm.
- If the latter, how does it compare to actual ERA5 data?
Response: Thanks.

1. We have revised the caption to: "Time series of particle heights, 1.5 BLH, specific humidity changes, vertical velocities at 700 hPa, precipitation, and evaporation at a 6-hourly interval in the selected trajectories: (a) a trajectory from SIO to YB between 12:00 21-July (arrival time) and 12:00 1-July; and (b) a trajectory from NEA to UTB between 12:00 14-July (arrival time) and 12:00 24-June. Note that particle heights, 1.5 BLH, specific humidity changes are from FLEXPART-WaterSip, while vertical velocities at 700 hPa, precipitation, and evaporation are from ERA5. The time series is in reverse order." Considering Dr. Sodemann's suggestion, we have moved this figure to supplement.
2. The particle heights, 1.5BLH, and changes of specific humidity are all from FLEXPART simulation, while the vertical velocities at 700 hPa, precipitation, and evaporation are from ERA5 data. The interpretation of this figure has been also moved to supplement.

22. L. 382-385: "Its effectiveness in regions with complex weather conditions is generally inferior to that of FLEXPART-WaterSip when operating with forcing datasets of the same resolution."
By lack of a clear benchmark 'truth', observational or orthogonal evidence, these conclusions are not substantiated. The authors should refrain from using words like 'inferior' and/or provide additional analysis to substantiate or revise such conclusions.
Response: Thanks for the suggestion. We have carefully checked and revised all statements/conclusion to ensure that they are sufficiently supported by our results. As a result, this speculative statement has been removed from the revised manuscript.

23. L. 402-405: "Nevertheless, compared to WAM-2layers, FLEXPART-WaterSip offers a precise depiction of the three-dimensional distribution of moisture sources, especially in capturing smaller-scale convective systems with high spatial heterogeneity."

In the lines before the authors discuss the shortcomings of WaterSip, but then they go on to conclude that FLEXPART-WaterSip offers a precise depiction … This reasoning does not seem logical to me.

Response: Thanks for pointing this out. We have carefully checked and revised all statements/conclusion to ensure that they are sufficiently supported by our results. As a result, this speculative statement has been removed from the revised manuscript.

24. L. 415-420: "Code availability … data availability …"

This is insufficient. The authors should revisit the policy of sharing data https://www.atmosphericchemistry-and-physics.net/policies/data_policy.html and make the actual code and data they used during their research publicly available to the community. If software is used, they should refer to exact versions with doi's and the scripts the authors used themselves to run the models, so not to generic websites that are subject to change. All data underlying the figures should also be deposited meaning numeric values for moisture sources, masks for the tagging region etc.

Response: In the revision, we have strictly adhered to ACP's policies and specified all used data and algorithms. Specifically, we revised our code availability and data availability sections (lines 494–504 in our revised manuscript). We also provided the detailed configurations of WAM-2layers and FLEXPART in Part 2 of the Supplement and customized algorithm for WaterSip in Part 3 of the Supplementary.

Technical corrections:

1. Equation (1): The equation as used by Findell et al. (2019) is more correct than the one in Van der Ent et al., (2014)

Response: Thanks. This Equation has been revised to " $\frac{\partial S_{g,lower}}{\partial t} = \frac{\partial (S_{g,lower}u)}{\partial x} + \frac{\partial (S_{g,lower}v)}{\partial y} + E_g - P_g \pm F_{v,g}$" to be consistent with Findell et al. (2019). Please see line 115 in our revised manuscript.

2. Figure 3: "Absolute differences ..."

The green outline with red underlying data is not color-blind friendly.

Response: Thank you for pointing this out. We have revised this color combination to ensure color-blind friendly. All other figures with similar color combination have also been revised.

3. L. 380: "WAM-2layers model"

The WAM2layers model

Response: We have added "the" in the revision.

Response to Dr. Harald Sodemann:

General comments:

The authors perform a sensitivity study of two methods to identify moisture origin for one selected summer month over two regions in the Tibetan plateau. From the comparison between the two methods, the authors see differences with regard to moisture contributions from Eurasia and over coastal regions, that are explored in a sensitivity study. The authors then draw conclusions about the consistency and validity of the two methods. The manuscript is overall written coherently and in a well-readable manner. However, I find the conclusions are too general given the episodic evidence presented in the manuscript itself. The authors could consider changing this paper to a shorter, research letter format. I also have some comments about the structure of the manuscript, the precision of the language, reference to code and use of literature, and the presentation and interpretation of the results. I hope my comments will help the authors to prepare an improved version of their manuscript.

Response: We are very grateful for your thorough review and comments, which provide excellent guidance on our revision and future research. Per your comments, we have thoroughly revised this manuscript in terms of language, content, and logic coherence. We hope that the revised manuscript aligns more closely with the requirements of a research article. The revised structure becomes:

1. Introduction
2. Eulerian and Lagrangian approaches for moisture tracking: WAM-2layers and FLEXPART-WaterSip models
3. Moisture tracking in two representative basins
4. Comparison between moisture fluxes with WAM-2layers and particle trajectories with FLEXPART-WaterSip
5. Relationship between "actual evaporation" and simulated moisture contributions
6. Bias correction of FLEXPART-WaterSip simulations
7. Potential determinants of discrepancies in moisture tracking
8. Discussion and conclusions

In Section 1, we thoroughly revised the logic flow of the introduction section: 1) we narrowed down the scope of our current study to focus exclusively on moisture tracking over the TP; 2) we clearly pointed out potential simulation differences that may exist in previous research; 3) we emphasized that the aim of this study is to investigate potential errors/uncertainties in existing moisture tracking studies in the TP; 4) we cautioned readers against generalizing our comparison results in the TP to other regions.

In Section 2, we 1) provided detailed descriptions of the two selected models; 2) clearly specified all numerical settings for these two models and detailed their configurations in Part 2 of the supplement; 3) shared our customized code for WaterSip in Part 3 of the supplement.

In Sections 3 and 4, w: 1) removed redundant content and inaccurate descriptions; 2) strengthened the logic of our analyses.

Sections 5 and 6 are newly added chapters. In section 5, we evaluated the relationship between evaporation data from ERA5 and the simulated moisture contributions to further clarify the strengths and weaknesses of the two models. Building on these comparison results, in Section 6, we presented the bias-corrected simulation results of FLEXPART-WaterSip, which substantially improved model's accuracy in simulating evaporation.

In Section 7, we included additional sensitivity experiments for WAM-2layers (including additional configurations with different spatial and temporal resolutions) and FLEXPART-WaterSip (including additional combinations of specific and relative humidity thresholds). These new analyses have strengthened the robustness of the conclusions drawn in this manuscript.

In Section 8, we removed or revised conclusions not fully substantiated by our analyses.

Main comments:

1. In their introduction, the authors set forth a basic distinction into Eulerian and Lagrangian methods for "moisture tracking". I find this distinction too coarse with regard to the results presented in this study. The two methods that are being compared are broadly seen part of the respective categories, but there are many (other) approaches within the Lagrangian category (see for example the discussions in Keune et al., 2022), and many other within the Eulerian category, that are not compared here. For example, moisture tagging in a regional model (Yoshimura et al., 2004), or the E-P Lagrangian approach of Stohl and James (2004), and so on. The authors claim that the two methods they compare are most widely used - I think this is debatable, plus they are focussing here on the Tibetan Plateau only.

Response: Thanks for the comment. The motivation of this study originates from the extensive literature on precipitation moisture tracking in the Tibetan Plateau (TP) (Table 1 only presents a subset of existing efforts). However, to the best of our knowledge, no effort has been made to address the discrepancies or uncertainties among these TP-focused studies. This situation has led us to develop this manuscript, aspiring to encourage future researchers to critically assess the reliability of their simulation outcomes. Toward this goal, we strive to identify potential factors contributing to discrepancies among models over the TP region.

As you mentioned in the comments, the descriptions of some concepts (e.g., those related to Eulerian and Lagrangian methods) in this manuscript are not accurate. In the revision, we have thoroughly revised the Introduction section to emphasize the following two aspects:

1. We have narrowed down the scope of the present study to focus exclusively on moisture tracking over the TP. In this context, we have specifically highlighted that the most widely used numerical moisture tracking models are WAM-2layers and FLEXPART-WaterSip. The subsequent paragraphs in Introduction also focus solely on these two representative models.

2. The aim of this manuscript was to investigate potential errors/uncertainties in existing moisture tracking research on the TP as well as to understand the underlying

mechanisms/determinants. We have emphasized the significance of this study in the last paragraph of Introduction.

2. The study now only compares one month (July 2022) and two specific catchment areas of the Tibetan Plateau. It remains thus unclear if the findings here can be generalised, or are rather coincidental. Therefore, it would be adviseable to tune down the quite authoritative/concluding language and formulate more modestly, such that it be in agreement with the somewhat anecdotal evidence that is actually investigated and presented here. This concerns both the Abstract, Introduction, and Conclusions.
Response: Thank you. Both you and Dr. Ruud van der Ent have expressed similar concerns on this. We have thoroughly revised our manuscript to address this issue:

1. We have made every effort to ensure that the manuscript maintains accuracy and logical coherence. Additionally, we have either tuned down or removed any authoritative/concluding statements that are not fully supported by our results.
2. We have strengthened the manuscript by incorporating additional analyses, discussions, and sensitivity experiments to ensure that all conclusions are well substantiated.

For more details, please also see our response to your General comments above.

3. The authors state that they use the FLEXPART-WaterSip method. I don't think this is correct, since the WaterSip code is a specific implementation of the Sodemann et al. (2008) moisture source diagnostic in C++ language which is currently not yet available publicly. The WaterSip code has first been used by Sodemann and Stohl (2009) and later my many other studies (Bonne et al., 2014; Läderach and Sodemann, 2016; Sodemann 2020 to name a few). The authors also state that all original codes are available from the official websites - this is not correct for the WaterSip method. A separate publication on this actual "WaterSip" code is in preparation by this reviewer. My impression is that the authors have written their own implementation of the algorithm of Sodemann et al. (2008), which they then use for this study. This must be stated clearly and correctly, and the authors' own code should be linked to in the Code availability section. In any case, the reference to the website at University of Bergen is no proper code reference to the WaterSip method.
Response: Sorry for the confusion. Yes, we developed our own Python implementation of the algorithm described by Sodemann et al. (2008). In the revised manuscript, we have provided the models' settings in Part 2 of the Supplement and our Python code for WaterSip in Part 3 of the Supplement. We have also updated "Code availability" and "Date availability" sections (see lines 494–504 in our revised manuscript).

4. The immense literature review presented in Table 1 is never properly described and hardly used in the manuscript. I also note that a similar table has been presented already in the supplement material of Li et al. (2022), a study by the same authors that is not cited in this manuscript. I do appreciate the effort put into this table. Currently, however, there are just two sentences in the introduction that make general remarks about this table. A more systematic discussion of what was found during the literature review would be needed to justify including this table in the main manuscript. In addition, it would be useful to tie the results from this study up agains the reviewed literature in a Discussion section in the end.

Response: Thanks for the comments. When compiling Table 1, our objective was not only to categorize different studies but also to derive insights by contrasting their methodologies, forcing datasets, and geographical focuses (i.e., different parts of the TP region). Initially, we did not find an effective method to comprehensively compare these diverse studies beyond what was presented in Table 1. However, after re-examining these studies, particularly their results of long-term average spatial distributions of moisture sources, we identified several contrasting findings among these studies. These have been added to the revised Introduction section: "First, moisture sources tracked by Eulerian models tend to cover a large part of the western Eurasian continent and can stretch southward to the southern Indian Ocean (Zhang et al., 2017; Li et al., 2019; Li et al., 2022a; Zhang et al., 2024). In contrast, moisture sources tracked by Lagrangian models predominantly extend southward (Chen et al., 2012; Sun and Wang, 2014; Chen et al., 2019; Yang et al., 2020), with broader westward extensions observed in the moisture tracking for the westernmost TP and Xinjiang region (Zhou et al., 2019; Liu et al., 2020; Yao et al., 2020; Hu et al., 2021). Second, areas with higher evaporation rates, such as the ocean surface, in general contribute more moisture compared to surrounding land areas. While the moisture sources simulated by Eulerian models aligns well with the land–sea distribution (Zhang et al., 2017; Li et al., 2019; Li et al., 2022a; Zhang et al., 2024), this alignment is less pronounced for Lagrangian models (Chen et al., 2012; Sun and Wang, 2014; Chen et al., 2019; Zhou et al., 2019; Liu et al., 2020; Yang et al., 2020; Yao et al., 2020; Hu et al., 2021). In this context, we speculate that different moisture tracking methods (both Eulerian and Lagrangian ones) may involve certain unrecognized uncertainties or errors when applied to the TP region. This underscores the pressing need for further exploration to examine the discrepancies among these models to better characterize the complex hydrological processes of the TP." (see lines 60–72 in our revised manuscript).

We did not include Li et al. (2022) in Table 1 because our summary primarily focuses on studies using backward moisture tracking over the TP, whereas Li et al. (2022) mainly focuses on forward tracking. The revised Table 1 now further includes forward tracking studies (including Li et al. 2022). In addition, Table 1 does not include moisture tracking studies in the TP focusing on water isotopes. We have pointed out this limitation in the table caption.

Please see below for the revised Table 1:

Table 1: *Overview of Eulerian and Lagrangian moisture tracking studies in the TP and its vicinity. Note that extensive studies on water isotopes in the TP with moisture tracking simulations are not included here. "E and P" means the model diagnoses evaporation and precipitation separately, while "E – P" means the model diagnoses contributions through water budget (i.e., evaporation minus precipitation).*

	Model	Moisture source diagnosis	Study area	Forcing dataset	Study period	Reference
Eulerian	WAM-1layer	E and P	Central-western TP	ERA-I, NCEP-2	1979–2013	Zhang et al. (2017)
	WAM-2layers	E and P	Endorheic TP	ERA-I, MERRA-2, JRA-55	1979–2015	Li et al. (2019)
	WAM-2layers	E and P	Southern/northern TP	ERA-I	1979–2016	Zhang et al. (2019a)

	WAM-2layers	E and P	TP	ERA-I	1979–2015	Guo et al. (2019)
	WAM-2layers	E and P	TP	ERA-I	1998–2018	Zhang (2020)
	WAM-2layers	E and P	TP	ERA-I, MetUM	1982–2012	Guo et al. (2020)
	WAM-2layers	E and P	Major basins in TP	ERA-I, MERRA-2, JRA-55	1979–2015	Li et al. (2022a)
	WAM-2layers	E and P	TP (forward tracking oceanic evaporation)	ERA-I, MERRA-2, JRA-55	1979–2015	Li et al. (2022b)
	WAM-2layers	E and P	TP (forward tracking TP evaporation)	ERA5	2000–2020	Zhang et al. (2023)
	WAM-2layers	E and P	Five typical cells in the TP	ERA5	2011–2020	Zhang et al. (2024)
	CAM5.1 with a tagging method	E and P	Southern/northern TP	MERRA	1982–2014	Pan et al. (2018)
	FLEXPART	E – P	TP	NCEP-GFS	2005–2009 (summer)	Chen et al. (2012)
	FLEXPART	Areal source–receptor attribution	Grassland on eastern TP	NCEP-CFSR	2000–2009	Sun and Wang (2014)
	FLEXPART	WaterSip	Four regions within TP	ERA-I	1979–2018 (May–August)	Chen et al. (2019)
	FLEXPART	Areal source–receptor attribution	Xinjiang	NCEP-FNL	2008–2015 (April–September)	Zhou et al. (2019)
	FLEXPART	WaterSip	Southeastern TP	ERA-I	1980–2016 (June–September)	Yang et al. (2020)
	FLEXPART	WaterSip	Xinjiang	NCEP-CFSR	1979–2018	Yao et al. (2020)
	FLEXPART	WaterSip	Northern/Southern Xinjiang	NCEP-CFSR	1979–2018	Hu et al. (2021)
	FLEXPART	Areal source–receptor attribution	Source region of Yellow River	NCEP-FNL	1979–2009	Liu et al. (2021)
	FLEXPART	WaterSip	Xinjiang	NCEP-CFSR	1979–2018 (April–September)	Yao et al. (2021)
Lagrangian	FLEXPART	E – P	Three-rivers headwater region	ERA-I	1980–2017 (boreal summer)	Zhao et al. (2021)
	FLEXPART	E – P	Three-rivers source region	NCEP-FNL	1989–2019	Liu et al. (2022)
	FLEXPART	WaterSip	Three-rivers headwater region	ERA-I	1980–2017	Zhao et al. (2023)
	HYSPLIT	WaterSip	Three-rivers headwater region	NNR1	1960–2017 (June–September)	Zhang et al. (2019b)
	HYSPLIT	E – P	Western TP	ERA-I	1979–2018 (winter)	Liu et al. (2020)
	HYSPLIT	Maximum specific humidity	Seven regions within TP	NCEP/NCAR	1961–2015 (summer extreme event)	Ma et al. (2020)
	HYSPLIT	Contribution function and weighting	TP	NCEP-GDAS	1950–2015 (extreme precipitation events)	Ayantobo et al. (2022)
	HYSPLIT	WaterSip	Southern Xinjiang	ERA5	2021(June 15–17)	Chen et al. (2022)
	LAGRANTO	WaterSip	Southeastern TP	ERA-I	1979–2016 (winter extreme precipitation)	Huang et al. (2018)
	LAGRANTO	WaterSip	Three regions within TP	ERA-I	1979–2016 (winter extreme precipitation)	Qiu et al. (2019)
	LAGRANTO	WaterSip	Northern TP	ERA-I	2010–2018 (monsoon season)	Wang et al. (2023)
	QIBT	E and P	Southeastern TP	ERA-I	1982–2011 (April–September)	Xu and Gao (2019)

5. Section 2 discusses the generalities of the two selected methods. I think the broad description of these two examples as Eulerian and Lagrangian methods in general does not fit the two specific methods that are applied here. Also, how these specific methods work are described sufficiently elsewhere in the literature. Instead, the authors would need to describe more clearly how exactly the respective simulations have been set up. Specifically regarding the FLEXPART-WaterSip like method, was a domain-filling setup selected in FLEXPART? Was the calculation run in forward mode? Has convection parameterisation been used? What domain has been used? All these details are important. Furthermore, the WaterSip code is currently not available publicly, and the website pointed out in the data section only provides a manual. What code has then been used to diagnose the moisture sources from the FLEXPART particle trajectories, and where is this code accessible? How were Lagrangian moisture sources gridded? What output interval and humidity thresholds were used? These aspects are all essential aspects for reproducibility of the work, and to understand the preconditions of this comparison.

Response: Thanks for all the questions. We recognize the importance of providing specific descriptions of the methods used in this manuscript. In our revised manuscript, we provided further details of the two moisture tracking models (see revised Section 2), and outlined specific numerical settings in Part 2 of the Supplement. We also released our WaterSip algorithm written in Python in Part 3 of the Supplement. We further revised the "Code availability" and "Date availability" sections (see lines 494–504 in our revised manuscript).

6. The difference in moisture source contribution from Eurasia between the two methods is quite interesting. We don't know what is the truth from the two approaches, but a gridded map of air parcel location density for trajectories arriving in the study domains could help indicate if FLEXPART (based on ERA5) does identify transport pathways from Europe. In this context, I find the sensitivity of the WAM2layer method to finer resolution quite striking. What is possibly going on that leads to such a strong senstivity to grid resolution in the results? Maybe be there is numerical diffusion at coarser resolution (see Sodemann 2020, Sec. 7)? Additional sensitivity experiments or analyses of different time snapshots could be useful.

Response: Thank you for the comments. To address these issues, we made three major improvements in our revised manuscript:

1. We added a new Section 5 to evaluate the relationship between actual evaporation from ERA5 and the simulated moisture contributions.
2. We added a new Section 6 to bias-correct simulations from FLEXPART-WaterSip.
3. In Section 7, we incorporated additional sensitivity experiments for WAM-2layers and FLEXPART-WaterSip. In particular, we found that increasing the spatial and temporal resolutions of WAM-2layers can partly reduce the moisture tracking discrepancies between the two models.

These modifications have strengthened the robustness of our conclusions.

7. The sensitivity study in Sec. 5 is quite interesting, but does not really include the most important sensitive parameters of this approach, as discussed widely in the literature. Instead of number of particles (Fremme et al., 2023), it would be more important to test the threshold of specific humidity (dqc in Sodemann et al., 2008) as well as the relative humidity at arrival (RHc in Fremme and Sodemann, 2019). The areal source-receptor attribution method comes a bit out of the blue here. It is an entirely different method of the Lagrangian category. The difference between this method and the others should be described in the methods.

Response: Thanks for the suggestions.

1. In the newly added Section 6, we tested the sensitivity of the simulated precipitation in YB and UTB to thresholds of changes in specific humidity and relative

humidity. Results are shown in Fig. 10 in our revised manuscript (see below):

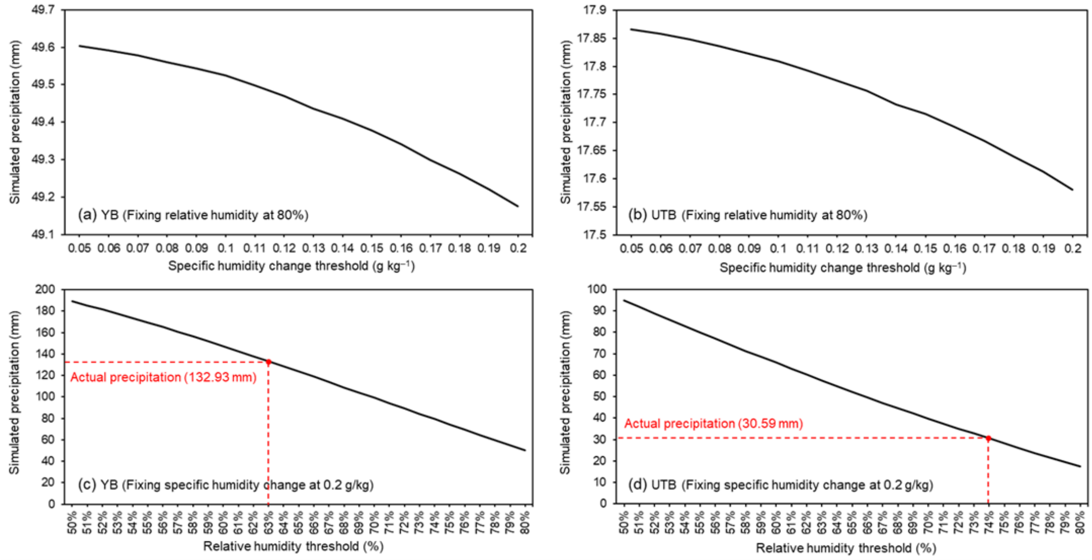


Figure 9: *Sensitivity of the simulated precipitation in the (a and c) YB and (b and d) UTB to (a and b) the threshold of specific humidity change and (c and d) the threshold of relative humidity.*

In revised Section 7, we included additional numerical experiments to examine the sensitivity of moisture source diagnosis to these two thresholds; see Experiment 2 in the figures below (Fig. 11 in our revised manuscript):

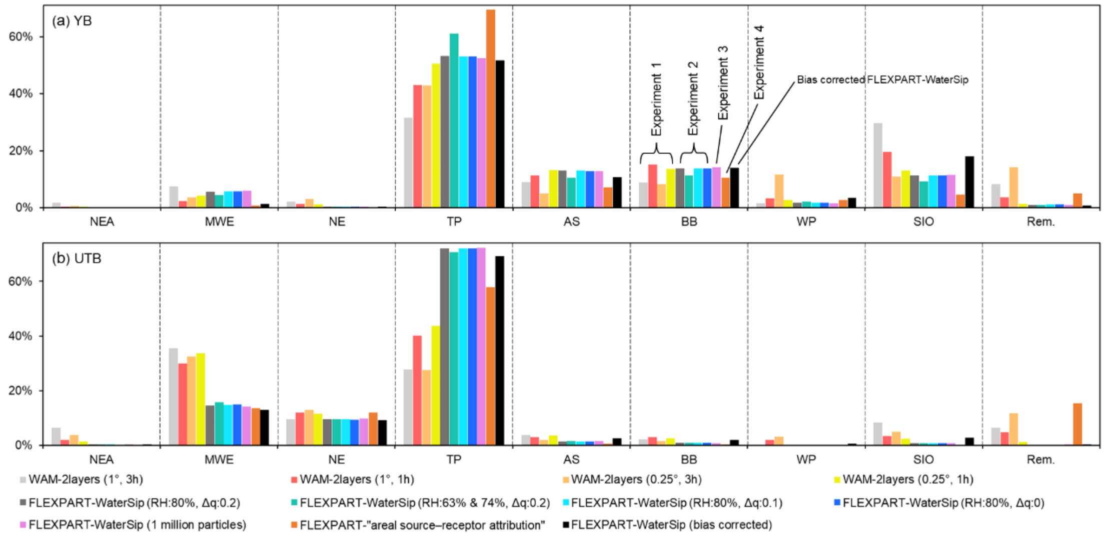
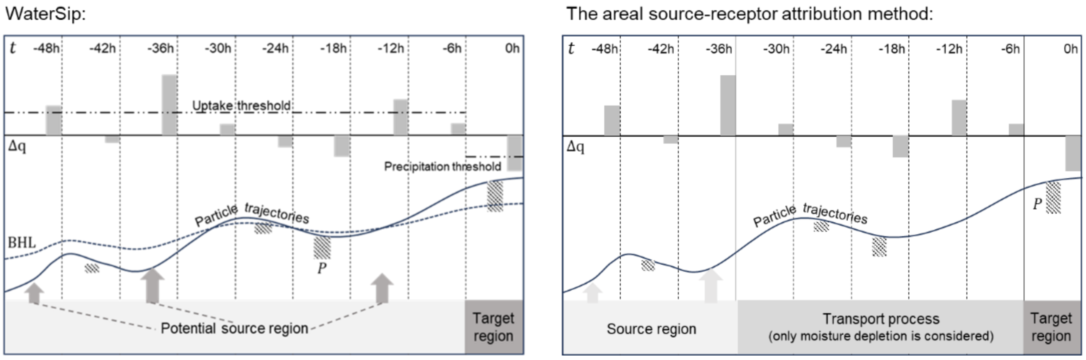


Figure 11: *Relative moisture contributions (%) to precipitation over the YB (a) and UTB (b) from the eight selected source regions and the remaining regions, simulated by four sets of numerical experiments (including different configurations in WAM-2layers and FLEXPART-WaterSip, FLEXPART-"areal source–receptor attribution", and bias-corrected FLEXPART-WaterSip). Black histograms represent the bias-corrected FLEXPART-WaterSip.*

In addition, we also added a Section to bias-correct the FLEXPART-WaterSip simulations. We hope these new revisions could meet your expectations. For details, please also see our response to your General comments above.

2. In the revision, we have added a new schematic diagram for the "areal source-receptor attribution method" to the Supplement (Figure S11; see the second subplot

below). Together with Fig. 1b (the first subplot below), this will help readers better understand the differences between WaterSip and the "areal source-receptor attribution method".



8. I am puzzled that the authors do not discuss nor cite their own study in NHESS about the spatial distribution of moisture sources for the Tibetan Plateau using the WAM2layer model (Li et al., 2022). In the supplementary material of that paper, they show a map with Eurasian moisture sources, just as discussed here from the two methods. What could possibly be the reason that you do not discuss this previous work done with the WAM2layers method? Is this not a golden opportunity to balance or rectify any conclusions drawn in Li et al. (2022) in the light of new evidence? I also note that Li et al. (2022) contains a table similar to Table 1 presented here. A discussion of the relation between this work and your own previous work is definitely required.

Response: Thanks for noticing our earlier work (Li et al., 2022) published in HESS. In the supplementary material of Li et al. (2022), we tracked long-term moisture sources of the entire TP using WAM-2layers driven by ERA-I, MERRA2, and JRA55. In comparison, this manuscript focuses short-term moisture tracking using two models driven by ERA5. The differences in the forcing datasets, study areas, and study periods have presented substantial challenges for directly comparing these results. Nevertheless, we have included Li et al. (2022) in the revised Table 1. Further discussion on the reviewed studies has also been added to Introduction (please also see our responses to your main comments #4 above). We would like to point out that Table 1 in Li et al. (2022)'s supplement focuses on oceanic contributions to precipitation over the TP, while Table 1 in the present study focuses on the comparison between Eulerian and Lagrangian moisture tracking models. In addition, Table 1 in the present study covers 32 studies, which substantially expands our previous summary in Li et al. (2022) (17 studies).

Detailed comments:

1. Figure 2: The gridding of the FLEXPART-WaterSip results in Fig. 2 looks more spotty than the WAM2layers - I would argue that either a larger grid spacing or larger gridding radius of the identified sources should be used, or the number of particles increased to mute these distracting artifacts. Maybe just show the same resolution as used in Fig. 3 where the same grid was used for both models?

Response: Thanks for noticing this. In the initial submission, we used an output resolution of 1°×1° in Figs. 2a and 2b (consistent with the resolution of the original forcing dataset used in WAM-2layers) but 0.25°×0.25° in Figs. 2c and 2d (FLEXPART-WaterSip). Unlike the gridded results from WAM-2layers, FLEXPART-WaterSip outputs particle-level data. Initially, we interpolated these particle-level data to a 0.25°×0.25° resolution for visualization, which may have caused confusion. Following your comments, we have standardized all outputs to a 1°×1° resolution in our revision (all relevant figures and analyses have been updated).
For example, here is the revised Fig. 2 (now Fig. 3 in our revised manuscript):

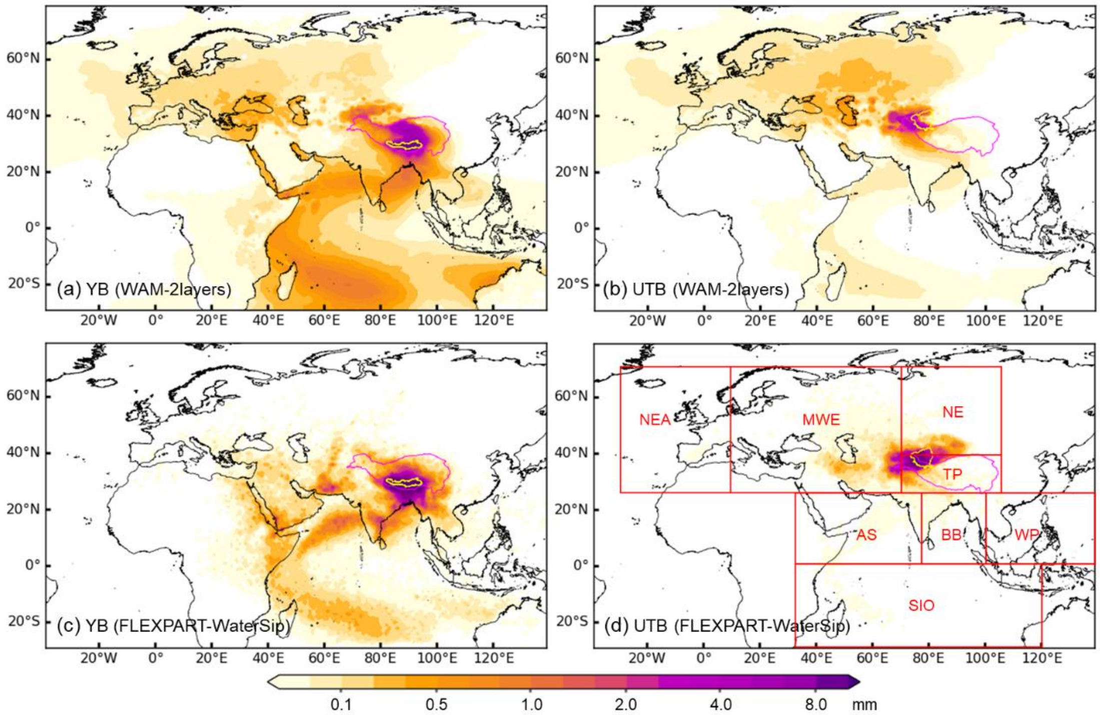


Figure 3: *Spatial distributions of moisture contribution (equivalent water height over source areas) to precipitation in July 2022 in (a and c) YB and (b and d) UTB, simulated by (a and b) WAM-2layers and (c and d) FLEXPART-WaterSip. Purple lines represent the TP boundary and yellow lines represent the boundaries of the two basins. Red boxes in (d) delineate the division of the eight source regions: North-eastern Atlantic (NEA), Midwestern Eurasia (MWE), Northern Eurasia (NE), TP, Arabian Sea (AS), Bay of Bengal (BB), Western Pacific (WP), and Southern Indian Ocean (SIO).*

2. Figure 6: I find panels a and b hard to interpret objectively, as there are subjective/conceptual arrows superimposed on the panels. Are these two panels adding new information compared to the trajectory examples shown in panels c-f?

Response: Thanks for pointing this out. Panels a and b were meant to show the spatial distribution of particles. However, we acknowledge that the conceptual red arrows do not contribute additional information beyond what is already explained in the paper. We have removed these arrows from our revised manuscript to avoid confusion.

Please see below for the revised Fig. 6 (now Fig. 7 in our revised manuscript):

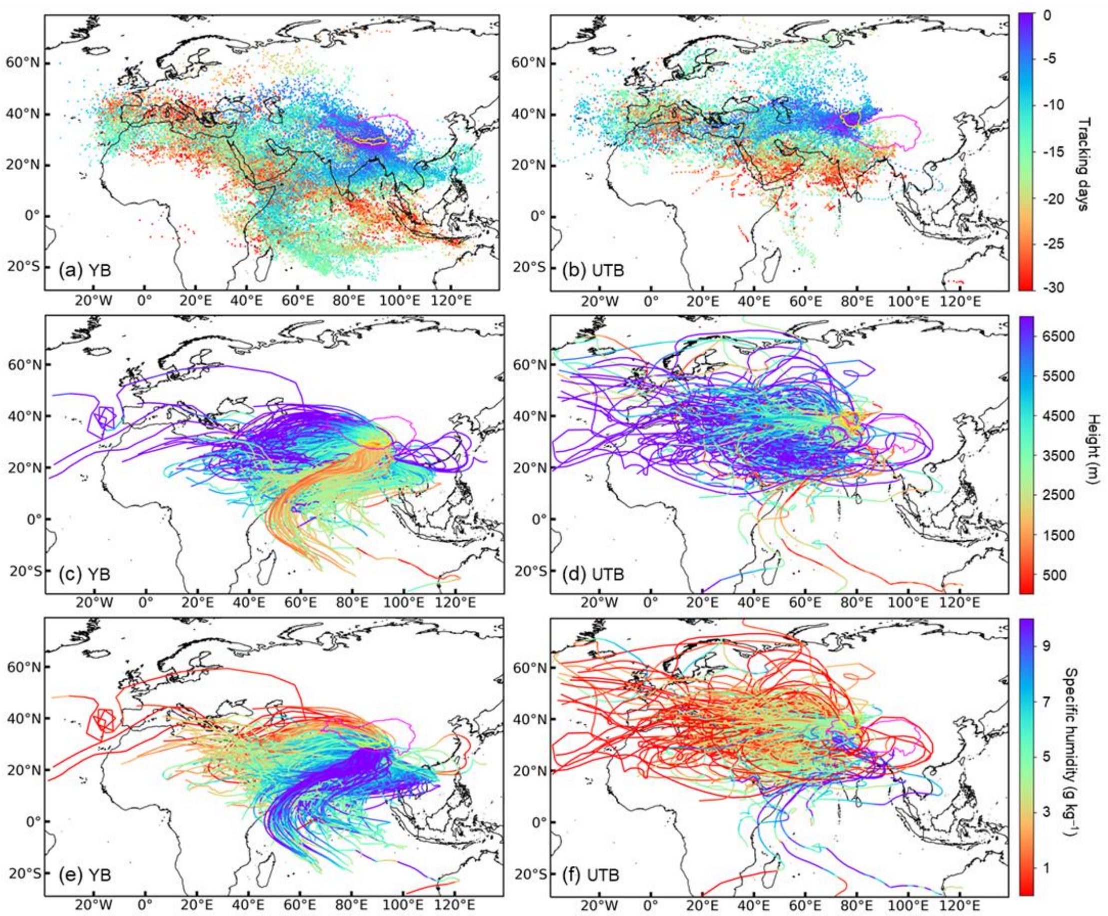


Figure 7: *Spatial distributions of (a and b) particles and (c–h) trajectories that bring moisture to precipitation over (a, c, and e) YB and (b, d, and f) UTB, as simulated by FLEXPART. (a and b) are particles color-coded by backward-tracking days (0–30 days). (c and d) are trajectories color-coded by height (m, above ground) at each numerical step. (e and f) are trajectories color-coded by specific humidity (g kg^{-1}) at each numerical step.*

3. Figure 7: Why do you show 300hPa vertical velocity in panel b? Maybe it would be more useful to add a figure that shows the average/median vertical air motion as a view of trajectory (pressure) altitude vs time arriving at the two selected regions. These vertical pathways seem to be quite different.

Response: Thanks for the comment. We chose ~300 hPa (~9000 m) as an illustration of the vertical air motion over the TP region (cf. ~700 hPa for the entire domain), which is indeed a bit arbitrary. To further illustrate the vertical air motion at different pressure levels, in the revision, we included two additionally levels: 500 hPa (~5500 m) and 850 hPa (~1500 m), corresponding to moisture transport for the westly region (and the TP) and the monsoon region, respectively.

The revised figure was moved to supplement as Fig. S3 (see below):

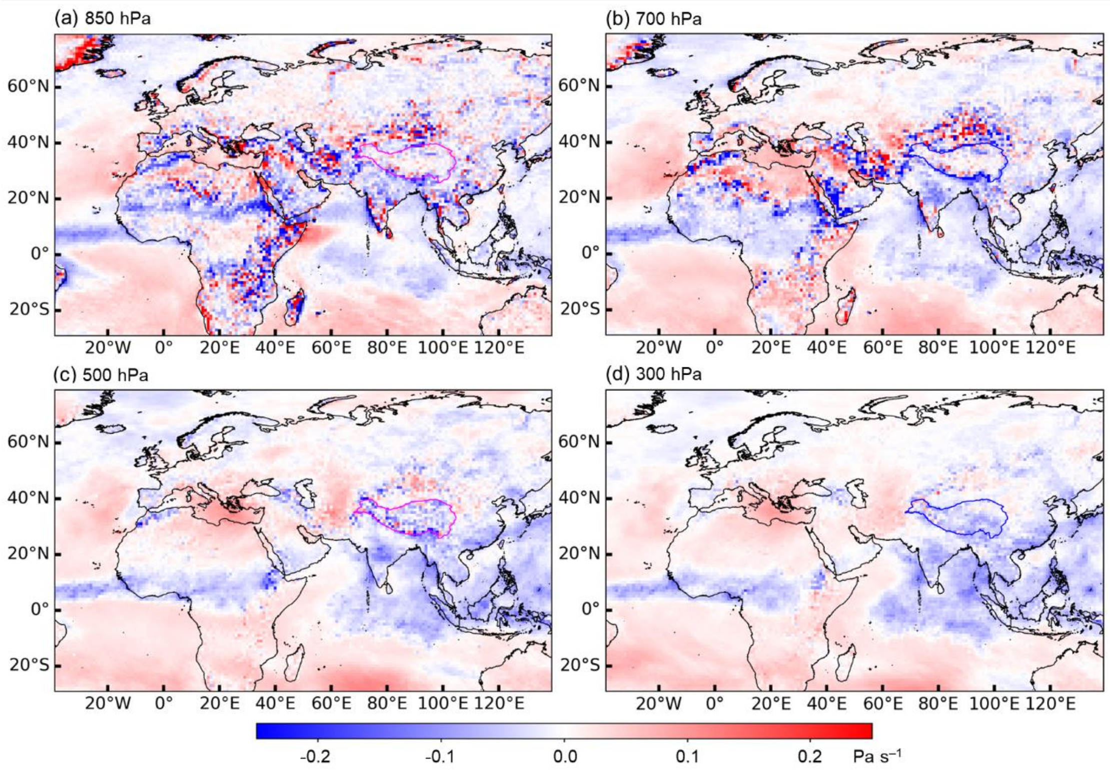


Figure S3. *Vertical velocities (Pa s^{-1}) at (a) 850 hPa and (b) 500 hPa across the entire study domain. Note the negative values indicate upward motion (ascent).*

4. Figure 10: These two examples from a set of 5 million trajectories can hardly be considered representative. What is really the value of discussing exactly these two examples? It does not become entirely clear to me what to take away from these examples, and I think i is not justified to draw as general conclusions about the weaknesses of the Lagrangian diagnostics (L. 399 onward) as the authors do on this basis alone. Also, I got confused by the time axis at first, it should be made clear where the arrival point is. Winschall et al. (2014) have discussed with similar examples before that (deep) convection can contribute to moistening at upper levels that is not captured by motion of individual trajectories. Is this the case here as well? Do you use a convection parameterisation in FLEXPART? Are these locations over land or ocean? It would also be helpful to indicate the specific humidity threshold adopted in this study, and maybe include specific humidity and relative humidity in addition.

Response: Thanks for your questions.

1. We did use a convection parameterization scheme in FLEXPART (the configuration settings of all the models are now included in Part 3 of the revised supplement). In the revision, we mentioned the arrival time and additional details in the figure caption and marked out the range of land/ocean in the figure. Given that the two trajectories shown here are only illustrative examples, we moved Fig. 10 to supplement as Fig. S6 (see below):

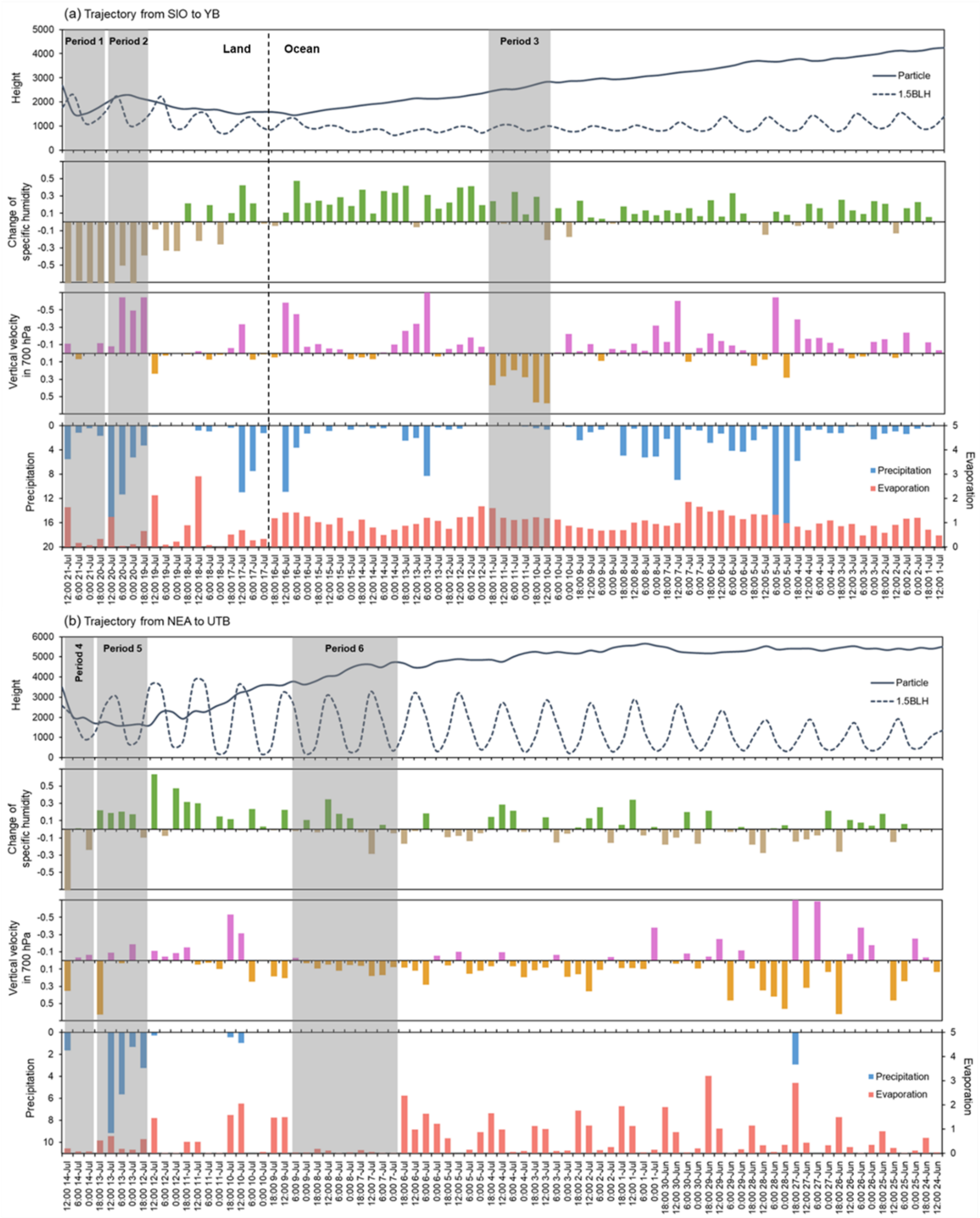


Figure S6. *Time series of particle heights, 1.5 BLH, specific humidity changes, vertical velocities at 700 hPa, precipitation, and evaporation at a 6-hourly interval in the selected trajectories: (a) a trajectory from SIO to YB between 12:00 21-July (arrival time) and 12:00 1-July; and (b) a trajectory from NEA to UTB between 12:00 14-July (arrival time) and 12:00 24-June. Note that particle heights, 1.5 BLH, specific humidity changes are from FLEXPART-WaterSip, while vertical velocities at 700 hPa, precipitation, and evaporation are from ERA5. The time series is in reverse order.*

2. To more thoroughly examine the characteristics and discrepancies between the two models, we added two new sections (Sections 5 and 6 in our revised manuscript) with additional sensitivity experiments for both models (e.g., Fig. 11 in our revised

manuscript). For details, please also see our response to your general comments above.

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