

Reply to comments

Note: the line number below refers that in the version with tracked changes:

Reviewer #1

The authors have addressed the majority of my comments on the initial version of the manuscript in a satisfactory manner, and the revised manuscript has improved accordingly. I have only a few minor remaining suggestions. For clarity, some figures (e.g., Figures 4–6, 7–9, and 10–12) could potentially be merged, which would reduce the total number of figures in the manuscript (currently 14). In addition, indicating the user-defined domains in the Supplement would further improve the reproducibility of the results. Finally, a small number of sentences that were added or modified in the revision could be refined for readability (for example, lines 65–67, 118–119, 520, and 639–643). I therefore recommend acceptance subject to technical corrections.

Reply: Yes, we merged the Figures 3-5 as Figure 3, Figure 6-8 as Figure 4 and Figure 9-11 as Figure 5 (I think there are typos of the figure number in your comment).

For sentences that need to be refined, I think it means the version with tracked change, please see changes in line 62, 102–104, 388, and 472–477 in this new version.

===

Reviewer #2

Review on "Refining the Lagrangian approach for moisture source identification through sensitivity testing of assumptions using BTrIMS1.1"

Thank you for your replies and taking my comments into account.

I have mostly small/technical comments on the new version of the manuscript.

My main comment regards the publication of the code. This is provided on github and zenodo without a README and with typos in links to connected pages. Please see comment below.

Comments:

Lines 101-103: Consider the following changes/typos:

"As offline Eulerian methods are not accurate when strong wind shear occurs, and online Eulerian methods require huge resources, making it challenging for climatological research of moisture tracking, Lagrangian methods are widely used."

Reply: Thanks for the comments, I have changed accordingly at lines 102-104.

Line 181: During February-March, -> During February-March 2022,

Reply: I have changed accordingly in line 192.

Line 193: upper high cut off → do you mean upper-level cut off?

Reply: Yes, I have changed accordingly in line 204.

Line 195: strong anomalous southwesterly → strong anomalous southwesterly winds

Reply: Yes, I have changed accordingly in line 206.

Line 197: Atmospheric river is also regarded... → The presence of an atmospheric river is also regarded...

Reply: I have changed accordingly in line 208.

Lines 265-269: Extreme precipitation over Europe is not always connected to an atmospheric river. Other phenomena such as warm conveyor belt precipitation or just generally frontal passages can lead to intense precipitation. See e.g. Catto et al. (2012, <https://doi.org/10.1029/2012GL051736>) or Pfahl et al. (2014, <https://doi.org/10.1175/JCLI-D-13-00223.1>).

Reply: Thanks for the suggestion, we have added in line 217-218 that warm conveyor belt and front can also lead to intense precipitation.

Line 214: «these assumption» → assumption regarding the moisture source tools' setup?

Reply: Yes, “these assumptions” means what we have introduced in the section of introduction.

Line 227: released per grid → released per grid point?

Reply: Yes, I have changed accordingly in line 242.

Line 242: choose kinetic → choose the kinetic Check all added sentence at the end of the method subsection for missing articles.

Reply: Thanks for finding the grammar mistakes and I have made changes accordingly in line 257.

Line 373: In following other tests → check wording

Reply: This has been changed to “in the other tests” in line 389.

Line 452-3: I am not yet fully convinced that Option 1 is better representing cloud/precipitation processes than Option 3. As I understand it, the argument is that all water species in the target region are ultimately converted into precipitation, therefore basing the tracking on all species is a good approximation? This is an interesting point, even though neglecting horizontal advection within an hourly time step, it might be able to partly circumvent the limitations due to turbulent mixing for Lagrangian methods. At the same time, I think that assuming that all species are converted into precipitation is too strong, and I would not make a recommendation based on this assumption without further sensitivity tests (e.g. with a Eulerian tagging approach). I see that further tests are beyond the scope of this study and would mainly recommend to phrase the recommendation less strongly and making clear that there are strong assumptions involved. In the end, I leave it up to the authors how strong they want to phrase the recommendations.

Reply: Thank you for your thoughtful comments and suggestions on how to better explain the rationale behind our recommendations.

We would like to clarify that, by choosing Option 1 in Section 3.1, we do not imply that all water mass in the target region will ultimately be converted into precipitation. Instead, our intention is to indicate that all water species contribute to precipitation in the target region in a proportional manner. Cloud hydrometeors represent only a temporary form of water mass, and different water species can transform into one another. Therefore, in our analysis, we treat all water species as an integrated whole, which forms the basis for our recommendation regarding the parcel release height.

Lines 455-459: Thanks for testing the standard WaterSip setup in this sensitivity test. Could a difference plot be added to Fig. 6-8 such that it can be better compared to the other options? What are the differences in release height? E.g. are different vertical layers tracked back, which could explain the big difference? Based on the description of the results, I do not immediately see how these results «prove» the conclusions above.

Reply: We have added panels (d-f) in Fig.S4 to show the difference of results between standard WaterSip and option1.

The standard WaterSip setup only tracks air parcels with a relative humidity greater than 80%. As a result, the vertical moisture profiles that are back-tracked differ substantially between Options 1 Section 3.3 and the standard WaterSip. Consequently, the inferred moisture sources also differ markedly, demonstrating that the parcel release height plays an important role. Based on our understanding of the contributions from different

water species, Option 1 is therefore chosen as our final configuration. The rationale for recommending Option 1 has been explained in our response to your previous comment.

The zenodo/github repository is missing an overall README file. It would be helpful to have an explanation of the folder structure, installation requirements, and how to find more instructions on setting up the model. Further, the link provided to J.Evans github page leads to an error (due to a typo).

Reply: Thanks for reminding, we have added an overall README file and corrected the link to J.Evans github.