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Interactive Comment

Interactive comment on "Trajectory analysis on the origin of air mass and moisture associated with Atmospheric Rivers over the west coast of the United States" *by* J.-M. Ryoo et al.

Anonymous Referee #2

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Review of "Trajectory analysis on the origin of air mass and moisture associated with Atmospheric Rivers over the west coast of the United States" by Ryoo et al.

The authors use a quasi-isentropic trajectory model to investigate atmospheric transport properties to the US west coast. Calculations are performed using different reanalysis data sets. In addition, it is attempted to use the locations of last saturation along trajectories for the construction of humidity fields. While the overall subject is relevant for and could fit the scope of ACP, unfortunately the manuscript has a number of severe issues that in my view prevent publication in its current state, as is detailed below.

Major issues:

1. The scope of the paper is not clearly defined. While the motivation focuses on atmospheric rivers, part of the manuscript is written as sort of a comparison of the influence of different reanalysis datasets, and a test of the last saturation approach for identifying moisture sources. However, the manuscript discusses none of the three topics in sufficient detail. In a revised manuscript, the main focus should be clearly on only one of these aspects.

2. Quasi-isentropic trajectories are calculated from 3 different reanalysis data sets. From the approximate agreement between trajectories calculated from the three data sets in just one case, the authors conclude that the trajectories are realistic. There are several problems with this. First, diabatic heating rates are calculated differently for each data set, and contain different terms. These differences need to be investigated and discussed in much more detail, for example by directly comparing diabatic heating rate fields. Second, the correlation between trajectories is just evaluated for one specific day. The finding that correlation is good up to day -7 and becomes much lower thereafter may just be a coincidence for that example, because some atmospheric process caused large differences in diabatic heating at that location and point in time. It could be investigated what process is taking place at that time that causes the divergence of the trajectories. Finally, the relative agreement between three quasi-isentropic trajectory models does not allow to conclude that the calculation is reliable by itself, a comparison against fully 3-dimensional kinematic trajectories that are commonly used in the troposphere would have to be carried out to prove that point.

3. Water vapour sources are identified from an identification of the regions of last saturation. This approach has commonly used in the relatively dry regions of the subtropical and tropical upper troposphere. An application to cases of heavy precipitation seems beyond the scope of the method, as the results shown in the manuscript actually demonstrate (in contrast to the interpretation of the authors). In the case of a heavy precipitation event such as studied here, most of the air masses causing rainfall

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will be saturated at the start point or close to the target area. The last saturation is then very close to or at the start location. The trajectories where last saturation occurs at some distance from the arrival region are then necessarily the ones that are relatively unsaturated, but consequently also drier and thus not relevant for the heavy precipitation event. This is seen in Fig. 8a,b where the target domain occurs in intense red shading in all panels. It may also be the reason why Fig. 4 appears so spotty, because the moistest trajectories are locally saturated and don't contribute to the humidity reconstruction. In fact, Fig. 4 and 5 demonstrate that the approach does not work, the agreement is too poor to be of practical use. If you calculated the difference in % between panels a-c and b-c in Fig. 4 it would become clearer how severe the problems are. A much simpler and more appropriate approach would be to trace specific humidity along the trajectories, as previous studies have shown.

4. Many figures, in particular ones containing maps, are poorly drafted. World maps become almost unreadable if the latitude-longitude aspect ratio is heavily distorted, such as in Fig. 2,3,6,7,8. The writing needs copy-editing. The last paragraph of the Conclusions section discussing further research topics is not relevant to what is presented in the paper and should be completely removed.

5. The target region appears far too large for the analysis. It is not clearly described at what spatial and horizontal interval trajectories are started. It would seem necessary to consider only a subset of the trajectories in that large domain for each case, otherwise the analysis is dominated by trajectories without relevance for the actual heavy precipitation event.

6. The conclusion that high-altitude trajectories contribute to heavy precipitation is unsubstantiated, if not wrong. How large is the specific humidity of the cluster 2 trajectories compared to cluster 1? If anything, I would assume that due to the descending motion of air parcels, cluster 2 contributes dryness, but not humidity to the meteorological situation during heavy precipitation events.

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