Review of Federer et al. for WCD

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The manuscript analyses reanalysis data using tracked extratropical cyclones, parcel trajectories, a tracer tracking algorithm, and a *warm conveyor belt* definition to show where the moisture ascending in WCBs over the North Atlantic ocean originates from. The authors show that anomalously moist (more specific humidity) WCB ascent features tend to draw on airmasses arriving from the subtropics, compared to the anomalously dry (less specific humidity) WCB ascent where the inflow trajectories more often originate from the extratropics, typically within what is commonly defined as a *cold air outbreak*. Although the trajectories entering the anomalously moist and dry cases are of a different origin, the authors show that what determines whether the WCB will be anomalously moist or dry is whether the trajectories overall are moist or dry. Further, the authors show that whether the trajectories are moist or dry depends on the time spend in a domain of evaporation.

Overall, I find the manuscript well written and generally clearly structured. The findings raise some interesting questions about moist stormtrack dynamics that the authors discuss towards the end of the manuscript. The amount of results are kind of sparse for a 24 page manuscript, or in other words, the analysis is very thorough. I believe it will be an important stepping stone for future work on moist storm track dynamics.

I would like to see the manuscript published. Yet, I have a few comments and suggestions that I appreciate if the authors will consider first.

General comments

- Introduction: I find it well written and clearly structured. For someone familiar with these "features" (AR, TME, CAO etc.), I think it is easy to follow, but I am not sure whether it is easy to follow for someone not familiar with these constructs. To make the content of this manuscript available to an even broader audience, I suggest adding a schematic with all the relevant features that the introduction can point to.
- Introduction: the authors describe moist air, air that becomes moist and so on, without explicitly mentioning how they quantify that moisture. In the Methods, the authors quantify moisture as specific humidity. In the Introduction, however, "moisture" and "moist air" are still abstract concepts. The authors could be more precise about what you mean by moist air in the Introduction (and whether you talk about solid, liquid, or gas).
- It is currently quite trendy (and in my option important) to "bridge" the weather and climate views; *Weather and Climate Dynamics* seems like the place to do it. This manuscript is currently more heavily anchored in Weather than Climate. Some of the analysis is this manuscript have very interesting tangents to Pauluis et al. (2010) and particularly Laliberté et al. (2012) and this manuscript supplements their analysis by including the zonal and temporal dimensions. I think that a comparison to their work would be very interesting for the more "Climate than Weather" part of the community.

Specific comments

- 8-10 "We find that moist..." I had to read this sentence a few times to get it. It is a bit hard to follow this sentence and the following explanation. I suggest trying to simplify this and the following sentences. Since

the authors ask "why are some WCBs anomalously moist" on line 8, I suggest that the following sentence has a short answer to that and then the following sentences can give more detail first focusing on the important mechanisms and then the the less important mechanisms, if the authors think they're worth mentioning.

- 23 (e.g. Wernli and Gray 2024) as it is a review paper.
- 116: How sensitive are the results to how you choose the cyclone mask? How many bundles do you end up discarding? Only requiring one trajectory to intersect seems like a weak criterion. Would be nice to be explicit about how the cyclone mask is defined, if the results are sensitive to that.
- 145: I think a quick reminder that WCB inflow time is t=0 would be good here.
- 202: Still case-study or climatological study?
- 207: Have you checked this from analysing the temperature tendencies in ERA5 or do you infer this from the $\Theta - T$ diagram? Perhaps worth mentioning the different dynamical and parametrised temperature tendencies (as well as model increments) in ERA5 and why the authors choose to discuss them or leave them out of the analysis.
- 215: Or entrainment into the moist BL?
- Figure 2: It would be good to reference the same times on the trajectories in each panel. Currently, (a) has fewer dots than (b), so I suspect they don't match each other. It would then be easier to see when the cooling in (a) is related to evaporation.
- Figure 2: Should the vertical axis be flipped? Now the trajectories start at 100% and then drop to 0? I'm perhaps confused, but I would expect the cumulative percentage to increase as time moves forward.
- 307: Is this analysis still with respect to the local climatological mean WCB specific humidity? How do I understand the mean latitude of the inflow if the anomalous specific humidity is calculated differently at different latitudes?
- Figure 7: I suggest organising the columns such that time increases towards the right.

References

Laliberté, F., T. Shaw, and O. Pauluis (2012). "Moist Recirculation and Water Vapor Transport on Dry Isentropes". In: *Journal of the Atmospheric Sciences* 69.3, pp. 875–890. DOI: 10.1175/JAS-D-11-0124.1.

Pauluis, O., A. Czaja, and R. Korty (2010). "The Global Atmospheric Circulation in Moist Isentropic Coordinates". In: *Journal of Climate* 23.11, pp. 3077–3093. DOI: 10.1175/2009JCLI2789.1.

Wernli, H. and S. L. Gray (2024). "The Importance of Diabatic Processes for the Dynamics of Synoptic-Scale Extratropical Weather Systems – a Review". In: *Weather and Climate Dynamics* 5.4, pp. 1299–1408. DOI: 10.5194/wcd-5-1299-2024.