EGUsphere, referee comment RC1
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Comment on egusphere-2022-904

Anonymous Referee #1

Referee comment on "Moist available potential energy of the mean state of the atmosphere and the thermodynamic potential for warm conveyor belts and convection" by Charles G. Gertler et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-904-RC1, 2022

Summary

The authors calculate 2d maps of mean/moist available potential energy (MAPE) from time-averaged reanalysis data. They then partition the MAPE in two different ways: 1) Non-convective MAPE is found by restricting the vertical rearrangement of parcels, and the remaining MAPE is convective MAPE, and 2) A local MAPE is calculated by restricting the distance over which the parcels can be rearranged. The authors then connect the non-convective local MAPE, and associated ascent, with warm conveyor belts (WCB), including example instantaneous snapshots as well as time-averaged data.

The calculations of MAPE are well described and the partitioning into different components is interesting. However, the interpretation of the results, in particular the explanations in terms of CAPE and WCBs are lacking in depth and insight. This could be a very good paper, and the calculations of MAPE are interesting in their own right, but to justify some of the statements in the abstract and having “warm conveyor belts” in the title, further work is needed. So, I have recommended major revisions

Major Comments

The connection of convective MAPE to a high percentile of instantaneous CAPE looks weak. Is there a reason you didn’t also calculate CAPE from the mean state? In DJF the contour chosen seems to somewhat match the regions of high MAPE, but since only one value is contoured it looks like the value has been chosen to fit rather than an actual correspondence. It would be useful to show more values in the contours.

In JJA the MAPE has very little correspondence to the contour shown and looks more like it picks out regions of more tropical/convective storms: western pacific and Atlantic tropical storms and the Indian monsoon. I think the DJF map could also have similar explanations. My knowledge of Southern Hemisphere meteorology is not so good, but the local maxima seem like they could also relate to tropical storm regions. Also, there appears to be a strong signature of the African Easterly Jet in DJF. It may be useful to explain the convective MAPE in this way rather than just in terms of CAPE. Rather than connecting MAPE to "instantaneous atmospheric convection", it could be connected with convectively driven storms.

The statement in the abstract that the maximum potential ascent in the MAPE calculation "skilfully identifies the necessary conditions for WCBS" is misleading. All that has really been shown is that there is some correlation between WCB genesis regions and the ascent in the MAPE calculation. To me, it looks like the MAPE picks out the storm tracks, and because WCBs are associated with storms there is some relation.

The idea that WCBs will relate to ascent in the MAPE calculation makes sense as they are the ascending air in extratropical cyclones and therefore will relate to this instability but the results don't show that MAPE is adding any value to this. The authors state that they interpret the non-convective local MAPE as energy available for the "generation of large-scale eddies through moist baroclinic instability" and show that it has a similar pattern to the Eady growth rate. So my question is what does value does MAPE add over the Eady growth rate (which is much easier to calculate) in predicting/explaining warm conveyor belts? I wonder if this could be shown by relating the ascent predicted in the MAPE calculation with the actual ascent in the WCB trajectories.

I would also like some discussion of the large areas where there is ascent predicted by the MAPE calculation, and presumably large Eady growth rate, but no warm conveyor belts. Presumably this is just related to where cyclones do and don't actually form, but if the MAPE calculation or some additional variable can't predict this then I don't see how it can be described as skilfully predicting warm conveyor belts.

Minor Comments

- P3L60 – "More than half of extratropical cyclones are associated with a WCB in northern hemisphere winter…". This seems very low. I would expect most cyclones to be associated with a WCB. One reason this could be so low is that the Madonna et al. (2014) climatology uses the strict 600 hPa criteria for identifying WCB trajectories and so miss weaker WCBs. Madonna et al. (2014) acknowledge that they are not aiming to identify the full WCB airmass in their climatology and test the sensitivity of using a 500 hPa threshold instead. As far as I can tell, Madonna et al. (2014) doesn't go into quantifying the co-occurrence of WCBs with cyclones, so I don't know where this number, or the other details about WCBs and cyclones in the sentence, has come from.
- Figure 2 – The caption states that (a,b) shows 796 hPa but the figure says 864 hPa.