Second Review for WCBs paper – Minor revisions
Dear Authors,

Many thanks for spending time towards addressing my comments. I am happy with most of the responses although unfortunately I am still not convinced by all of them.

In particular, a key area for improvement in the manuscript is still the description of the cyclones (presumably western/'westerly' disturbances) associated with WCBs. I don't think Fig7 goes far enough in showing their features. As I said in my previous review, if one of the novelties of this study resides in the month-by-month focus, then greater emphasis will need to be placed on the characterisation of short-timescale features affecting precipitation. WCBs are certainly part of the story, but without a link to the cyclones they're associated with the analysis does not seem complete to me.

I wouldn't want to this to be too much of a stumbling block for the acceptance of this otherwise nice work, so I would just ask you to add a couple of figures showing the horizontal and vertical structure of those cyclones, for example along the lines of https://doi.org/10.5194/wcd-2-1303-2021, figs 9-10. They used ERA5 data so you should have access to the same fields. You won't necessarily have track locations for the cyclones as they do, but you could just centre your plots (let's say) 500km west of WCB locations. You could just focus on one time (heavy prec days, possibly subtracting light prec days as in your fig7) instead of the whole lifecycle as they do, and compare cyclone structures between different months.

Without doing this (or equivalent analysis) it seems difficult to me that you can go beyond just inferring causes of WCB development (as you do at lines 214-217) and shed light on what drives their frequency/strength/shape, which I think would substantially improve the manuscript and, in my view, bring it towards acceptance.

Response: We greatly appreciate your continued attention to our manuscript and the clarification for what additional information would benefit the manuscript. Using the reference you provided as a guide, we have included a new figure including cross sections of the relative vorticity and potential temperature fields, in addition to modified text (copied below, now lines 227-250 and Figure 8). We believe that showing the horizontal and vertical structure of the vorticity differences and associated streamfunction effectively illustrates the equivalent barotropic structure of the circulation associated with heavy precipitation and highlights how the strength and depth of the upper- and lower-level vorticity differences change from month to month.

New text:
'Vertical cross sections of the relative vorticity difference between wet and dry days, taken through the main dipole comprised of the positive vorticity difference located over Iran and Turkmenistan and negative difference located over northern India, Pakistan and southern China, indicates that the upper and lower vorticity fields are vertically collocated during all months, reflecting an equivalent barotropic structure (Fig. 8e-h). In-between these two vorticity anomalies is strong forcing for ascent (Martin 2006 and references therein) and thus the location of WCB formation and precipitation. The equivalent barotropic structure contrasts the vertical variation of the vorticity differences observed farther to the east over southern China indicative of a baroclinic structure. The upper-level cyclonic vorticity anomaly that is key in driving ascent and forming WCBs over Afghanistan is strongest between 350-200 hPa in all months and extends lower into the troposphere in January and February than March and April, despite strengthening in amplitude during the latter months. Conversely, the downstream

negative, anticyclonic vorticity difference remains of similar strength in all months. Considering how the streamfunction fields in Fig. 7 are the aggregate effect of all of the features in the vorticity field, it becomes clear why the cyclonic streamfunction differences are also stronger in April than in January. It also appears that the circulation associated with the two cyclonic vorticity features overwhelms the anticyclonic vorticity feature in-between (Fig. 8a-d), as the streamfunction fields mainly show the cyclonic differences (Fig. 7e-h). Composite isentropes on wet days tilt downwards towards the surface moving from the cyclonic to anticyclonic vorticity differences, reflecting warmer temperatures beneath the anticyclonic feature and cooler temperatures beneath the cyclonic feature.’

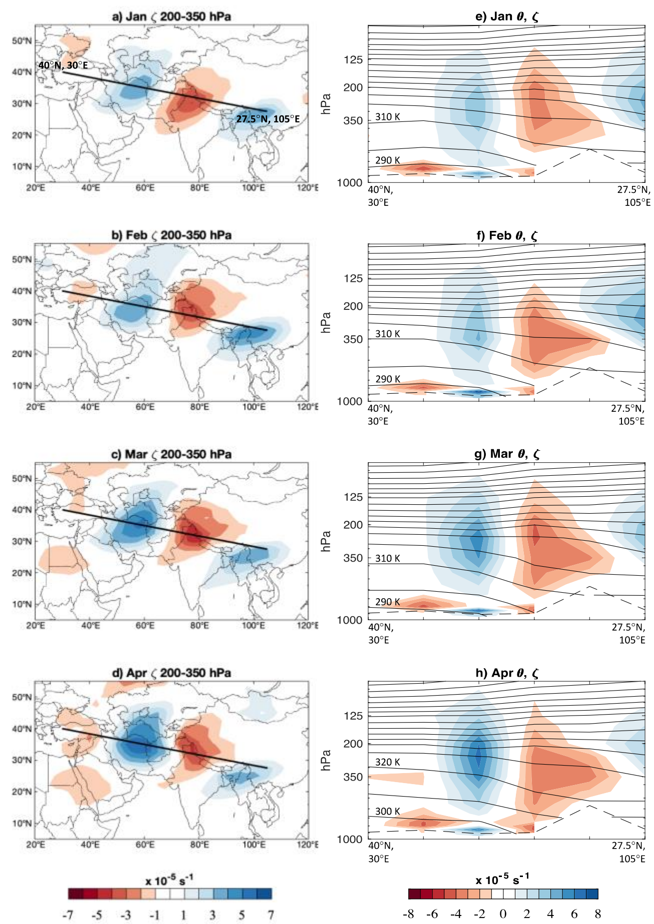

Figure 8: Panels a) – d) the color shading shows the 200-350 hPa mean relative vorticity, ζ, difference, wet – dry days, for a) January, b) February, c) March, d) April, and the thick black lines show the location of the cross sections in panels e) – h). The color shading in panels e) – h) show the mean ζ difference, wet – dry days, and the black contours show the composite potential temperature, θ, on wet days. Units of ζ are 10^{-5} s^{-1}, and units of θ are K, contoured every 10 K. The think dashed black line is the location of topography along the cross section.