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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The importance of low-deformation vorticity in tropical cyclone formation" *by* K. J. Tory et al.

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This study tested the hypothesis that tropical cyclones all form in low-deformation/enhanced-vorticity regions. To provide an objective and simple measure to identify such regions, the authors defined the OWZ parameter, which is the product of the normalized OW and absolute vorticity. A TC detector was proposed based on OWZ, vertical shear and moisture thresholds. The diagnosis using the ERA-Interim data suggested that low-deformation vorticity may be a necessary condition for all TC formations. The manuscript is well-written, and the performance of the TC detector is very impressive. The implication that the marsupial theory can extend to all TC formations is an important result.

Minor comments:

1. To reduce or eliminate the downdraft CAPE or D-CAPE, it is necessary to have a neutral atmosphere as illustrated by Tory et al. (2008) and Tory and Frank (2010), but the numerical model simulations in Nolan (2007) and Wang (2012) did not suggest that this is a necessary condition for TC formation. Nolan (2007) emphasized the importance of nearly saturated column near the core, and Wang (2012) emphasized the mid-level moistening at the inner pouch region. Wang (2012) also showed that a mid-level theta_e minimum is still present even after genesis in model simulations and field observations. Both studies show that downdrafts strengthen as approaching the genesis time. What really matters is that the updrafts are dominant so that the net upward mass flux and the low-level mass convergence increase with time. Downdraft -free convection is thus not necessary for TC formation.

1. P17543, L27-29: "It follows that in a breaking wave the enhanced LDV must occur over a large enough area for the streamlines to rotate through 360." This is true for coarse resolution data. For high-resolution data, one would see high LDV is very localized and associated with convective vortices or their remnants.

2. P17543, L1-3: A region of enhanced and sustained LDV is important because it gives enough time for the thermodynamic transition to take place. But what does this have to do with whether fluid parcels complete a full rotation or not? The circulation may help to mix moisture inside the pouch but mixing does not happen for solid body rotation.

3. P17544, L6-8: "It follows that the larger in horizontal extent and the greater the magnitude of an enhanced cyclonic LDV anomaly the greater the potential for TC formation." I agree that strong LDV is favorable, but a large area may not always be. The pouch needs to be large enough so that the dry air entrainment or intrusion at the pouch periphery does not readily affect moist convection at the inner pouch region, but if a pouch is too large, it may extend to the dry regions and directly advect dry air from the north (Wang et al. 2012; MWR, 140, p1144–1163).

4. P17544, L14-15: I would like to draw the authors' attention to a recent study by Wang et al. (2012; MWR, 140, p1144–1163). This study examined the vertical structure of the wave pouch for some named storms during 2008-2009, and it was suggested that a deep, diabatically activated wave pouch extending from the middle troposphere (600–700 hPa) down to the boundary layer is a necessary and highly favorable condition for tropical cyclone formation. Wang et al. (2012) also discussed why a deep pouch is important for TC formation (first paragraph of section 4d). I would like to hear the authors' insights in this. Could you elaborate on why the depth of enhanced LDV is important?

5. 3.3 Detector: i) Why did the authors choose 850 and 500 hPa for OWZ? Do these levels produce the best results or there is some dynamic basis? ii) For the 850-200 hPa shear, did you calculate the vector difference between the two levels or the total shear with respect to a reference level averaged over the layer?

6. P17557, last paragraph: It may be worth pointing out that a "miss" rate is irrelevant for "sufficiency" test.

7. Footnote #8: What is the typical value of "a" in Fig. 1? The inner pouch region emphasized by Wang (2012) is likely within the green area in Fig. 1 based on a quick look at the tangential wind profile.

8. L17563, L18: "11 circulations"?

9. L17564, L6-9: Is the sustain time period checked following the propagating clumps or at a fixed location? The former should be more reasonable.

10. It is a little hard to follow the detection procedures. It would be helpful to create a flow chart.

11. P17568, L20: The thresholds, especially OWZ thresholds, must be sensitive to the model resolution. For high-resolution data, such as ECMWF 25-km forecasts, the OW field and vorticity field are very noisy. Do the authors plan to convert all the model data

to the 1X1 degree resolution?

12. P17571, last paragraph: when applying this index to GCMs or operational forecasts, the performance of the TC deector inevitably depends on the performance of the model.

Reference: Wang, Zhuo, Michael T. Montgomery, Cody Fritz, 2012: A First Look at the Structure of the Wave Pouch during the 2009 PREDICT–GRIP Dry Runs over the Atlantic. Mon. Wea. Rev., 140, 1144–1163.

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