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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Advective mixing in a nondivergent barotropic hurricane model" *by* B. Rutherford et al.

Anonymous Referee #1

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Title: Advective mixing in a nondivergent barotropic hurricane model

Authors: B. Rutherford, G. Dangelmayr, J. Persing, W. H. Schubert, and M. T. Montgomery

This manuscript investigates Lagrangian mixing in a two-dimensional hurricane-like vortex by evaluating several diagnostic measures of mixing and shear during the transition of the vortex from an annular vorticity structure, to a polygonal structure, and finally to a monopole. Their results provide an alternative (and perhaps more mathematically eloquent) confirmation of earlier studies demonstrating that much radial mixing through the eye and eyewall regions are the result of evolving vortex-Rossby waves. I found

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the manuscript to largely be well written and the results quite interesting. However, I have noted a few concerns which, if addressed, may improve the significance, clarity, and presentation of their results. I am recommending that this manuscript be accepted by ACP after minor revisions.

Comments:

1. Page 16068, Introduction: Given the stated significance of these results to understanding of hurricane eye-eyewall mixing and the physical mechanism sustaining a hurricane, I recommend providing stronger motivation for the current, early in the Introduction, through discussion of different numerical and observational studies. The two cited papers (Montgomery et al. 2006 and Willoughby 2001) are largely peripheral to your results. In contrast, the studies of Cram et al. (2007) and Kossin and Eastin (2001) directly address horizontal mixing between the eye and eyewall in relation to simulated and observed polygonal eyewall evolutions. Furthermore, Kossin and Eastin used the same numerical model as is used here (I believe) and demonstrated that substantial mixing between the eye, eyewall and near environment occur during these polygonal eyewall transitions. Here, your results build upon their findings by providing details and clarifications as to how this mixing process evolves within the same simple framework.

2. Page 16091, Line 10: Are your results sensitive to the choice the viscosity value? You stated earlier (p. 16088, line 27) that the mixing evaluated in this model is largely diffusive. Thus, it seems plausible that your results are sensitive to this value.

3. Page 16091, Lines 17-18: Motivate the use of the Kossin and Schubert (2001) initial conditions. Some discussion as to how frequent such structure has been observed and when is it most common in a typical hurricane's lifecycle is pertinent.

4. Page 16092, and beyond: The authors should provide context regarding the use of "eye" and "eyewall" in regards to the presented results, figures, and discussion. In particular, the eyewall commonly refers to a three-dimensional cloud structure containing the most intense precipitation and near-surface horizontal winds. Given that

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microphiscal feilds are not present in the current modeling framework, how do you define the eye and eyewall regions throughout your simulations. Are these definitions constant regardless of the vorticity structure (i.e. an annular, polygonal, or monopole structure)?

5. Page 16101 and beyond: Throughout Section 5 the authors repeatedly discuss the vortex evolution in context of the vorticity field. However, the vorticity fields are not presented in Figs 8-13, and Fig 1 does not provide the necessary temporal resolution. Thus, unless I missed something, please either show the vorticity field at each time or state which presented field can be used as a surrogate for vorticity.

6. Figure 2: Evolution of the averaged angular momentum fields would be more discernable if similar scales were used on the ordinate-axis of each panel.

7. Figure 3 and beyond: Much of the discussion, and most figures, relate the observed diagnostic structure (i.e. the FTLE, Q, R, and S fields) to each periods "initial" vorticity structure. Thus, would it be possible to provide a dashed line (representing the azimuthal mean vorticity maximum) and/or markers (representing the asymmetric vorticity maxima) to each panel in order to provide a spatial context of the vorticity features to each diagnostic? In some cases, the vorticity features may need to "tracked" through the forward and backward integration periods to show their evolution.

Additional References:

Cram, T. A., J. Persing, M. T. Montgomery, and S. A Braun, 2007: A Lagrangian trajectory view on transport and mixing processing between the eye, eyewall, and the environment using a high-resolution simulation of Hurricane Bonnie (1998). J. Atmos. Sci., 64, 1835-1856.

Kossin, J. P., and M. D. Eastin, 2001: Two distinct regimes in the kinematic and thermodynamic structure of the hurricane eye and eyewall. J. Atmos. Sci., 58, 1079-1090.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 16085, 2009.