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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The genesis of Typhoon Nuri as observed during the Tropical Cyclone Structure 2008 (TCS-08) field experiment – Part 1: The role of the easterly wave critical layer" *by* M. T. Montgomery et al.

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This is an excellent paper that contributes substantially to the important problem of how tropical cyclones form within easterly waves. The "marsupial" paradigm of Dunkerton, Montgomery, and Wang is to my knowledge the only existing framework that systematically addresses the dynamics and thermodynamics of the process. These ideas appear to give considerable insight in idealized simulations like those in Montgomery et al. (2009 Journal of the Atmospheric Sciences). Applications to invariably noisy and complex systems in the real atmosphere are a much greater challenge. Real-

data complexities have been addressed in previous papers by Dunkerton, Wang, and Montgomery. This paper provides additional insight into how to apply these ideas operationally.

I like what the authors have done in this paper as well as in previous papers on the subject. I agree fully with the authors' analysis of the lack of importance of the monsoon trough and upper TUTT cells in the formation of Typhoon Nuri. [With regard to the monsoon trough, I would argue the term is meaningful only for time-averaged flow, and has no meaning on a day-to-day basis, when the vorticity of individual disturbances is 1-2 orders of magnitude larger than that of the monsoon trough.] I very much like the discussion concerning differences in the circulation center location in the resting and moving frame. Many misunderstandings come in operational practice from not using the moving frame. The marsupial paradigm will I hope change that practice. The section of the paper on using operational numerical forecasts to identify the pouch is helpful and worthwhile. My questions relate to other aspects of real-time application of these ideas.

1. In the marsupial paradigm, vertical wind shear seems to be treated as an external parameter, but in fact the easterly wave might influence the vertical shear as much as it influences the incipient tropical cyclone. The pouch provides protection from lateral intrusion of dry air at a given level, but in a sheared environmental flow the pouch presumably varies with elevation. Along these lines, two questions arise: a. For forecasting, how does one choose what level to evaluate the pouch? Wang et al. (2009 GRL) used 700 hPa, but the current paper uses 925 hPa. Would one simply choose the level at which the wave was strongest? If so, would the level of analysis have to change with time if the maximum amplitude of the wave changed to another level? b. Is there any useful information in the vertical variation of the location of the "sweet spot"? Would a similar location at multiple levels make genesis more likely, and differing locations less likely? In general, do the locations of the pouch and sweet spot often vary substantially with elevation? In both questions above, the intent is to find a way to make

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use of the vertical wind shear in interpreting the sweet spot and the pouch, rather than as an independent parameter.

2. Again addressing the question of real-time use of the theory: it is of course critical to evaluate the wave motion accurately, since it plays a major role in the definition of the key regions. In this paper, multiple ways of defining motion are presented, but it is not clear which would be utilized in a real-time application. This also ties back to question 1(a) with regard to the level chosen for analysis.

3. Dunkerton et al. (2009) noted that the proposed pathway to genesis fit 53 of 55 cases, but that statistic does not address false alarms. The evolution of the sweet spot in Figures 3 through 8 of this paper is of interest. As the authors acknowledge, existence of a sweet spot was not sufficient to insure cyclogenesis in Typhoon Nuri for several days. Ultimately the frequency of false alarms must be addressed before operational applications can be developed.

4. No vorticity fields were shown. Because vorticity is unchanged in the resting or moving frame, it would not suffer the limitations of the circulation center location in the resting frame. My forecaster side asks the following: if I followed the vorticity maximum and predicted development when the vorticity maximum reached a region of large ocean heat content and relatively small vertical wind shear, would I produce a forecast of comparable value to the marsupial theory? The authors have addressed this question well in principle on p. 19179, but they did not show whether and how the locations of the vorticity maximum at 925 hPa differed from the locations of the sweet spot.

Overall, the marsupial theory represents a significant advance in our understanding of tropical cyclone formation within easterly waves. I believe more effort will be needed to convince forecasters (and justifiably so) that this advance in understanding will produce superior forecasts of cyclogenesis. I personally would love to see some real-time calculations like those shown in Figures 3-8 of this paper for all of us to examine.

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Minor comments

a. The paper by Fu et al. (2007 Weather and Forecasting) would provide additional support to the arguments in the Introduction about the importance of easterly waves in the north Pacific. b. p. 19165: Not everyone mows their lawn the same way. Does a "lawnmower pattern" represent back and forth parallel tracks? Also, can an equally simple description be given for a "square spiral"? c. p. 19169 and elsewhere: 6.96 m/s for a wave speed is too precise; use 7.0 m/s? d. p. 19170, line 7: When meteorologists use "northerly", they mean "from the north", as in "a cold northerly wind". The text should say "northward". e. It would help to plot the sweet spot in Figure 4. f. Figure 3 could use at least 50% larger print, both on the axes and interior. The axis intervals could be half as often to allow space. g. The purple critical latitude and black wave trough lines are hard to see in most figures. Making them thicker by about a factor of 2 would help.

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