

## ***Interactive comment on “Tropical cyclogenesis in a tropical wave critical layer: easterly waves” by T. J. Dunkerton et al.***

### **Anonymous Referee #2**

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#### General comments

I recommend that this paper be published in Atmospheric Chemistry and Physics (ACP) after major revisions.

This paper concludes interestingly amongst many other points that the critical layer dynamics paradigm is an essential characteristic of tropical cyclogenesis. This necessary condition for tropical cyclogenesis results from a lengthy and erudite discussion where many other aspects of tropical cyclogenesis are discussed with the help of an exhaustive series of case studies of named tropical storms. My main concerns are the following:

1) The paper is difficult to read and frequently interrupted by side discussions (e.g.

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choice of gauge, Lorenz invariant ...) that distract the attention of the reader. It could be that all these side discussions are more fundamental than it seems, but that is difficult to judge given the speculative nature of the analysis. I suggest that the authors reduce significantly the length of the paper by making some of the arguments more concise and minimizing redundancy. All the discussion on visualization, the phase speed calculation, the tracking algorithm, the five tropical storm case studies (25 figures) and the conclusion (more than 6 pages) could be significantly condensed.

2) The paper undoubtedly addresses a very important issue of tropical dynamics. I have no doubt that the analysis produces very relevant information that will help us to understand this important tropical cyclogenesis problem. The difficulty is that the paper doesn't introduce a mathematical framework to clearly lead the discussion; this is probably why at the end the authors need to rely on a very long argument to make their point. The paper would improve immensely if the flow equations were provided within the context of a multiscale analysis or with a PV equation decomposition of the low- and high-frequency projections of the variable time series. The observational survey could be used to pin down the important PV equation terms (including the effect of changing the reference frame) and justify the utilization of the critical layer paradigm. As an example, this would immediately and naturally lead to quantitative discussion on the gradient of absolute vorticity, including its climatology for the 55 cases and its specific zonal distributions for all the studied tropical storms. This would permit the identification of the best wave dynamic characterization of the different cases: are we in the presence of linearly unstable waves (see for example, Tsuyoshi and Yanai, 69, A note on barotropic instability of the tropical easterly current, Journal of the meteorological Society of Japan 47, No. 2, 127-130) or neutral sheared waves? A multiscale analysis or PV equation decomposition framework would also permit the authors to address and discriminate the relevance of other proposed "triggering mechanisms" as in L. Shapiro (1977, Tropical storm formation from easterly waves: a criterion for development, JAS, 34, 1007-1021) and L. Shapiro (1980, The effect of nonlinearities on the evolution of barotropic easterly waves in a uniform environment, JAS, 2631-2643).

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It is quite certain that tropical cyclogenesis is a complex issue with many possible factors contributing to its definition. In its actual form, it is difficult to assess objectively the scientific relevance of the proposed argument. Systematic flow equation decomposition or multiscale analysis approaches combined with solid observational data would help to quantify the importance of the different possible tropical cyclogenesis triggering mechanisms. In my view this paper needs a more quantitative framework that PV equation decomposition could provide.

Nevertheless without a detailed quantitative and statistical analysis of the different flow dynamical processes the paper could be a very good dissertation on the matter after significant condensation and polishing.

Technical corrections: The text needs to be reviewed carefully for the sake of clarity and completeness. For examples:

- Acronym definitions are needed in many places in the document (e.g. Beta\*).
- A reference for the Orr mechanism should be given on p. 28
- p.18: l+11 "(magenta)" is not linked to any figures.

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Interactive comment on Atmos. Chem. Phys. Discuss., 8, 11149, 2008.

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