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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 3: Dynamics of low-level spin-up during the genesis" *by* L. L. Lussier III et al.

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We wish to thank the Reviewer for their many perceptive and constructive comments. We have done our best to address each of the substantive points below.

Review of "The genesis of Typhoon Nuri as observed during the Tropical Cyclone Structure 2008 (TCS-08) field experiment – Part 3..." by Lussier, Montgomery, and Bell

Major comments: 1. A question lingering in my mind when reading through the

manuscript is what causes the differences between the results presented in this study and those by Raymond. Besides the different analysis frameworks and methods (such s circulation center and averaging areas), visual differences are also evident in the vorticity field between this study and RL11 (see their Figs. 5 and 6). Does the difference in the analysis data contribute to any significant differences in the results?

Reply: As the reviewer notes, the main reason for showing several of the figures (7, 8, 9, 10) in our paper is to illustrate that there are subtle differences produced by the two analysis schemes. However, the two analyses appear to be overall, qualitatively similar. One of the main differences we note is that, quantitatively, there appear to be smaller magnitudes of both low and mid-level vorticity maxima in our analysis (see our Figs. 7, 8) compared to the analysis of RL11 (Figs. 5, 6). The main reason for the weaker magnitudes is thought to be due to smoothing intrinsic to the spine analysis methodology. Without performing exactly the same calculations on the Raymond data set we cannot say with absolute certainty whether these analysis differences significantly contribute to the results.

As a reasonable test to examine whether the analysis schemes were similar enough to draw robust conclusions, we first attempted to exactly replicate Fig. 15 from RL11 (called Fig. 1 below). As illustrated in Fig. 1 below, the results are similar between Fig. 1 and Fig. 15 in RL11. For circulation, both analyses exhibit a weak maximum in the absolute circulation near 4 km altitude. The circulation tendencies also look broadly similar in both analyses (and in the additional RSL11 analysis). In addition, the mass flux profiles look broadly similar with the exception of the weak area of negative mass flux in the lower troposphere in the RL11 analysis (as discussed in our manuscript).

2. While this study provides detailed analyses to test Raymond's theory, it is desirable to include a brief review of other theories for TC genesis, such as Wang (2012) and Davis and Ahijevych (2013). Wang (2012) is particularly relevant to this study since the thermodynamic control mechanism proposed by Raymond was also discussed in that study and a new theory was proposed.

Reply: This is a good suggestion. We have now referenced relevant portions of Wang (2012) pertinent to the problem of the spin-up of Nuri. The findings of Wang (2012) support the findings of our study.

Specific comments: 1. P26797: Isn't it better to cite "AMS Statement"?

Reply: Adjusted as suggested.

2. P26798, L28: Did you mean global model analyses?

Reply: Changed as suggested.

3. P26799, L14: Change to "larger scales".

Reply: Changed as suggested.

4. Introduction: Wang (2012) also discussed the circulation tendency presented in RL11. She suggested that the vorticity or circulation evolution is different at different spatial scales. Due to the concentrated convection near the pouch center, spin-up occurs in the inner pouch region first while the low-level circulation at the meso-alpha scale (or the wave pouch scale) may spin down at the early stage of tropical cyclone formation.

Reply: The following paragraph was added to the introduction: "Wang (2012) suggested that the evolution of circulation dynamics and thermal stabilization differ on different spatial scales within the wave pouch. In the inner region, where convective processes dominate, Wang (2012) showed that low-level spin-up occurs and thermal stabilization is not present. On the larger pouch scale, however, Wang (2012) showed that the outer pouch region is characterized by weak thermal stabilization and is accompanied by low-level spin-down."

5. P26805: add "the" before "flux form".

Reply: Changed as suggested.

6. P26805- P26806: Aren't the horizontal advection term and the vertical advection term also included in the vorticity and circulation equations?

Reply: Yes, as illustrated in our Eq. 9.

7. P26807, L14: Did you mean different spatial scales (or radii)?

Reply: This point is now clarified in the revised text: "One of the objectives of this work is to quantify how the circulation dynamics varies within the wave pouch at different distances from the sweet spot."

8. P26807, L18: It is better to move the justification for using 1.5 km to section 2.1

Reply: Moved as suggested.

9. Section 3.2: Does the SAMURAI analysis include any model analysis or reanalysis data? The data coverage shown in Figs. 5-8 is larger than what is shown in RL11.

Reply: No, they do not. The domain shown is the domain that SAMURAI is run over. Areas outside of the observational area are unreliable. When we performed the quantitative calculations, (i.e., the circulation tendency) we used the areas encompassed by the observations (similar areas to those used in RL11, and as shown in Fig. 1).

10. Fig. 9: What feature of the vorticity PDF represents vorticity aggregation, a small spread (a sharp peak) or large frequency of occurrence of strong vorticity? Since aggregation is an upscale growth process and the PDF here does not provide any information about the spatial scale, the large values of low-level vorticity within small radii are mostly a reflection of strong convection organized near the pouch center. I am also wondering if the sample size is large enough in Fig. 9a.

Reply: We thank the reviewer for pointing this out. The sentence has been changed to read as follows: "…low-level cyclonic vorticity is concentrated near the sweet spot position…"

11. P26813, L2: This sentence is misleading as vorticity advection does contribute to

the local tendency of vorticity.

Reply: We agree. We have changed the sentence as follows to: "The first term on the LHS of Eq. (9) is the advection of absolute vertical vorticity in the horizontal; this process merely redistributes the vorticity in the horizontal plane."

12. P26813, L8: High mid-level radar reflectivity does not necessarily represent deep convection, and strong stretching may not be associated with cumulus congestus (see Wang 2014). Also note that large stretching is not well collocated with strong reflectivity in Nuri 1.

Reply: The reviewer raises a valid point in that in principal high mid-level radar reflectivity alone may not confirm the presence of deep convection. However, IR satellite imagery (with corresponding cold brightness temperatures) as shown in Montgomery et al. (2010a, Fig. 10) confirms the presence of deep convection in the areas discussed in Fig. 10.

13. P26813, L28: see comment #9. I don't think the analysis provides a strong support for vorticity aggregation.

Reply: This analysis, combined with the horizontal vorticity distributions in figures 7 and 8 suggests that vorticity aggregation is operative.

14. P26814, L6: Is the net tendency here simply the sum of the three terms on the rhs of Eq. 7?

Reply: Correct. The terminology used in our manuscript is as in RL11.

15. P26814, How is the circulation tendency in Fig. 12 compared to Fig. 4?

Reply: Please recall that the circulation tendency analysis represents the tendency during Nuri 1 and cannot be directly compared with the resultant spin-up 24 hours later. Additionally, comparison of the SAMURI derived circulation tendency with dropwindsonde-only tangential wind profiles is problematic due to the spatial sam-

pling differences between the ELDORA and dropwindsonde observations. With that being said, the tendency results from Fig. 12 are broadly consistent with the observed spin-up in both the dropwindsonde tangential wind profiles (Fig. 4) and the SAMURAI derived tangential wind cross-sections (Fig. 13). Specifically, at the outer distances, there is spin-up throughout the lower and mid troposphere. There are also areas of neutral or weak spin-down (in 3 of the 4 panels) in the tangential wind profiles near 4-6 km generally, broadly consistent with small or negative values in the circulation tendency.

16. Section 4.1: Wang (2012) examined the evolution of virtual temperature at different radii from the pouch in a model simulation, and showed that the inner pouch region is characterized by mid-level warming and that weak cooling is only found at larger radii at the early TC formation stage.

Reply: This is an excellent point. We have added a summary of Wang's findings in our revised Section 4.1: "These findings are consistent with the numerical simulations of Wang (2012) who show that the inner pouch region is characterized by mid-level warming and that weak cooling is only found at larger radii at the early TC formation stage."

17. P26818, L13: remove "the".

Reply: Done.

18. P26819, last few lines: doesn't the mid-level warming also stabilize the lower troposphere?

Reply: Agreed. We have changed the wording to "thermal stabilization" rather then worrying about specific vertical levels.

19. P26821, L16: see comment 9. 20. P26821, L21-22: Fig. 4 shows that the maximum increase in the tangential wind occurs around 600 hPa, which is not close to the top of the PBL.

Reply: This statement was referring to the SAMURAI analysis (Fig. 13) and has been clarified in the text.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 26795, 2013.

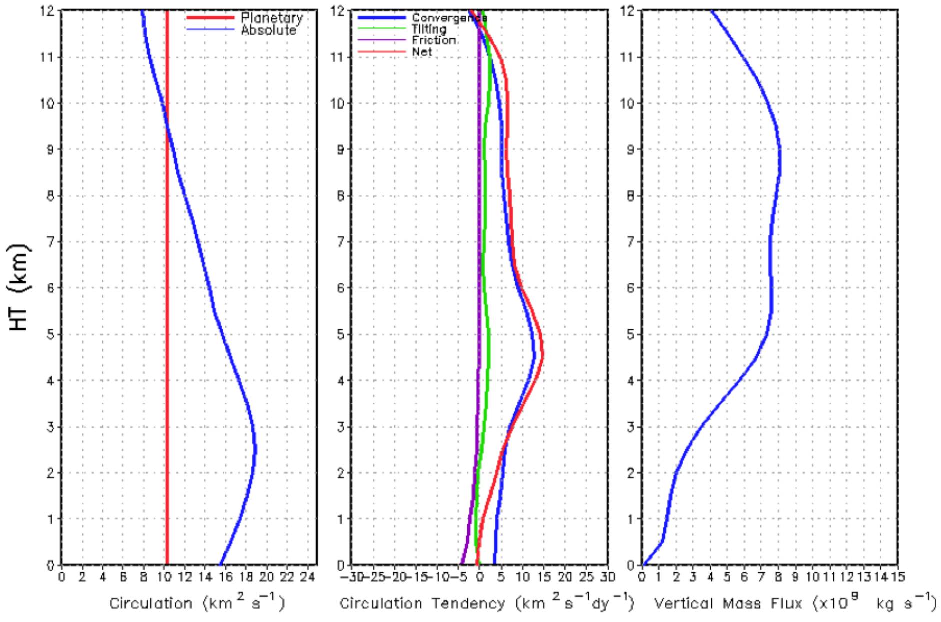

Fig. 1. Three panel plot of circulation (left; planetary [red], absolute [blue]), circulation tendency (middle), and vertical mass flux (right) from the Nuri 1 SAMURAI analysis. The layout of the figure is co