

**2<sup>nd</sup> Review** of “Tornado-Scale Vortices in the Tropical Cyclone Boundary Layer: Numerical Simulation with the WRF-LES Framework”, by Liguang Wu, Qingyuan Liu, and Yubing Li.

**General Comments:** The authors have satisfactorily addressed most of my comments, and this manuscript has been substantially improved. I have some remaining minor comments and technical corrections that the authors should address. I think the most important remaining issue relates to the claimed relationship between the tornado-scale vortices and boundary layer rolls, and I remain unconvinced that the authors have shown such a relationship (and there is some inconsistency in how they discuss this). I would like the authors to consider revising this aspect of their discussion, but I won't object if they decide not to. I look forward to seeing the publication of this study.

**Specific Minor Comments:**

1. P5 l120-123

It is unclear what the authors mean by referring to track fluctuations here. I think they are referring to the trochoidal oscillation of the storm center as observed in Hugo by Marks et al. (2008). However, this feature is distinct from the Eyewall Vorticity Maximum (EVM) that Marks et al. (2008) documented, and Marks et al. (2008) argue that these two phenomena are likely not directly related. So I don't think there is much evidence to suggest that the track of TCs should be affected by tornado-scale vortices. The sentence as written is also grammatically incorrect (track fluctuations are implied to be a mechanism for intensification), and it would need to be rewritten. However, I think it would simplest and most accurate to just remove “and track fluctuations”.

2. P6 l127

I suggest changing “the numerical simulation” to “a semi-idealized numerical simulation”.

3. P6 l129-134

The method and motivation of this semi-idealized framework is now much clearer. I suggest that the authors consider adding a sentence somewhere in this paragraph to emphasize that they are not attempting to simulate a specific real storm.

4. P7 l147-148

Are the authors setting the SST to be constant at 29C while maintaining a land surface where it really exists within the domain? Or are they removing all land from the model domain as well? This needs to be clarified.

5. P8 l190

Though there is some evidence of linear structures in Fig. 2b, I'm still not quite convinced that the wind speed field is *dominated* by quasi-linear structures in the eyewall region, and in the zoomed in region in Fig. 3, it doesn't look that dominated by linear structures to me.

The authors remain unclear/contradictory about what they consider to be a roll vortex, and whether they consider the tornado-scale vortices to be manifestations of roll vortices or not. My current belief is that these are distinct phenomena, and while it remains an open question as to whether they are related, I'm unconvinced that the authors have demonstrated any such relationship within this study.

6. P9 I195-196

In my view, I don't think the streaks of high and low wind speeds are as clear as the authors argue that they are. I agree that there are some semi-coherent regions of stronger and weaker winds, but the very strongest winds do *not* seem to me to be oriented in the same way as these more linear features. Since the authors are arguing for the dominance of the quasi-linear features, I suggest that they add a few lines to Fig. 3a to illustrate where they believe that the linear features exist and show their orientation.

7. P9 I201

Please clarify that the statement "the wind speeds generally increase with the increasing window size" is specific to the locations of the vortices. I don't think that it can be true that the perturbation winds increase generally with increasing window size. For example, in a region of the eye with relatively weak absolute wind speed, increasing the window size will include more of the eyewall in the definition of the mean, and so the perturbation wind would decrease there. Whether the perturbation increases or decreases with window size will depend on the variation of the spatial gradient.

8. P10 I217-219

The authors give the magnitude of the updraft in Isabel as 25 m/s, which is the value given in Aberson et al. (2006). However, it is apparent from the figure in Aberson et al. (2006) that this value is somewhat approximate, and not as precise as the 31 m/s given for Felix. The same Isabel sonde is shown in Fig. 4h of Stern and Bryan (2018), and it can be seen that the peak vertical velocity is closer to 22 m/s.

The authors might be interested to note that the strongest dropsonde measured updraft is 27 m/s in Hurricane Patricia (2015) (Rogers et al. 2017).

I suggest giving the approximate altitude instead of the approximate pressure here.

9. P10 I232

Change “in the 11-hour output” to “at the 11 hourly output times”.

10. P12 I274

Change “east” to “southeast”, as a semicircle from the northwest would extend to the southeast.

11. P15 I348-349

I don't really agree with the characterization of the updraft-downdraft couplet as a horizontal roll vortex. Although this feature possesses horizontal vorticity, the term “roll vortex” is generally used to distinguish quasi-linear features, and the tornado-scale vortices shown in this study do not have such a structure.

12. P16 I364-36

I'm not sure that the phrase “due to” is correct here. Studies have associated quasi-linear bands with horizontal rolls, and these rolls are characterized by a transverse circulation with alternating upward and downward motion. But the rolls are not “due to” (i.e., caused by) the momentum transports. I think this might simply be imprecise language. For clarity, rewrite as “Some previous studies....in the TC boundary layer, with alternating upward and downward momentum transport on either side of the rolls”.

13. P16 I367-368

It is unclear to me how Fig. 8b demonstrates a relationship of the tornado-scale vortices with boundary layer rolls, as the authors claim here. That the winds increase sharply across the vortices is consistent with this being a vortex, but don't demonstrate anything about whether these features are related to quasi-linear boundary layer roles.

Change “cross section of winds” to “radial profile of winds”, as this is not a two-dimensional cross section.

14. P17 I382

The authors refer to vertical motion of  $>12$  m/s extending to 2 km height. This doesn't seem correct to me; it looks like perhaps the 8 m/s contour extends this high.

Also, the authors still need to clarify here whether the values of vertical velocity (here and elsewhere) refer to the total or a perturbation value. It appears that this must be a perturbation

vertical velocity, because otherwise these magnitudes wouldn't satisfy the 20 m/s threshold for vortex identification that the authors are using. The use of the perturbation vertical velocity may be unclear to the reader, and so the authors need to be explicit.

15. P19 l428-429

This sentence is repetitive with the content of the previous paragraph, and it also just gives the chosen definition, not an independent result, so I would suggest removing it.

16. Fig. 1

Clarify both here and in the text that *both* of these measures of the wind speed are instantaneous. As written, it is implied that there is a contrast between the "instantaneous" winds and the "azimuthal-mean" winds, but the azimuthal-mean winds are also (as far as I can tell) instantaneous. The distinction between them is that the red curve shows the local (point-value) maximum, and the blue line shows the maximum of the azimuthally averaged wind.

17. Fig. 2

The box shown here is actually 80x80 km, not 40x40 km as stated. The units should be "km", not "km<sup>2</sup>". The font size on l654 appears to be different from the rest of the caption. Remove "(27h)" from l656.

**Technical Corrections:**

1. P2 l50-51, and elsewhere

"rolling vortices" should be "roll vortices".

2. P6 l136

I think it would clearer if "centered at 30.0N, 132.5E" were placed within parentheses.

3. P6 l145, and elsewhere

Where domain sizes are given such as here, the proper units should be "km", not "km<sup>2</sup>", because this is expressing a length scale, not an area. So this should be written as "90x90 km", and similarly throughout the manuscript.

4. P7 l164, and elsewhere

I suggest changing “figure not shown” to just “not shown”, as that is the more conventional usage (it’s also fine to keep this as is, if the authors prefer).

5. P8 l176, and elsewhere

This is actually a 10-hour period, *not* an 11-hour period, as it is the length of time between  $t=26$  h and  $t=36$  h. Though there are 11 output times, the period is 10 hours. So “11-hour period” should be changed to “10-hour period” throughout the manuscript.

6. P8 l187

Change “landfall on Florida” to “landfall in Florida”, as this is the conventional expression.

7. P9 l193

“feature” should be “features”.

8. P9 l193

For consistency with convention, I think “7x10 km” should be written as “10x7 km”, to give the zonal (x) dimension first.

9. P9 l199

Change “compare” to “compared”.

10. P9 l203-204

For clarity, rewrite this sentence to say “The simulated small-scale circulations are similar to those found from instead calculating the perturbations by subtracting the symmetric and wavenumber 1-3 components with respect to the TC center (not shown).”

11. P9 l209-210

Change “Compared to Figure 3a” to “Comparing Figs. 3a and 3b, it can be seen that”.

12. P9 l214

“boundary” should be “boundary layer”.

13. P10 l216

Change “the small scale vortex” to “a small scale vortex”.

14. P10 I222

“treat” should be “treated”. Insert “a” prior to “tornado-scale”.

15. P11 I258

Is this really the “30<sup>th</sup> hour”? Or is it starting from  $t=30$  h? These are different, as the 30<sup>th</sup> hour would be  $t=29-30$  h.

16. P12 I264

Change “1-hour” to “hourly”. Remove the word “Besides”, and start the sentence with “The durations of...”

17. P12 I278

Suggest changing “the two” to “these two”.

18. P14 I327-328

Change “its vertical” to “their vertical” (in two places). “extension” should be “extent”.

19. P17 I383

“the near surface” should be “near the surface”.

20. P18 I399-400

Change “seems to be” to “is”.  
There is a missing space after the period after “1km.”

21. P18 I400

Remove “the” after “conducted”.

22. P18 I401

Insert “(not shown)” after “an experiment”. Change “In the experiment” to “In this experiment”.

23. P18 I402

Insert “the” before “TC”. Combine the two sentences on lines 402-403, such as “In this experiment, the vertical and horizontal resolutions are comparable in the boundary layer, and the tornado-scale vortices can still be found.”

24. P18 I404

Change “that the” to “if these”.

25. P18 I405

Insert “and” prior to “since”.

26. P18 I413

I think conventionally, this simulation would be considered to have “seven nested grids”, not six, as the parent domain is itself generally included in the total.

27. P19 I420

Change “11-hour” to “11 hours of”.

28. P19 I430

“Nearly in all” should be “In nearly all”.

29. Fig. 6

Change “cycle” to “oval”.