Review for "Impact of environmental moisture on tropical cyclone intensification,"

by Longtao Wu, et al.

Summary:

This paper explores the effects of changes to the environmental moisture field on a developing tropical cyclone. In particular, rather than changing the moisture field everywhere, changes ahead of and behind the cyclone are considered separately. Each particular case is represented by a mini-ensemble of 5 simulations with small variations to the initial condition; this is a considerable improvement over many previous studies.

It is found that an increase in moisture ahead of the storm can lead to overall weakening, while an increase in moisture behind the storm leads to strengthening. However, the mechanisms for the changes are, in hindsight, due to the unrealistic formation of secondary, satellite vortices around the storm caused by the strong and deep moisture perturbations.

Recommendation: May be acceptable after major revisions

Major comments:

1. The general modeling framework and initialization are fairly reasonable, except for one problem: The simulations are initialized with global model data, but then run for only 48 hours. When a high-resolution model like WRF is initialized from global models, there is generally a "spin-up" or adjustment period of about 12 hours. This means that 1/4 of the whole simulation includes this adjustment period.

2. The strategy for the moisture perturbations seem reasonable at first, but turns out to have unrealistic effects: they initiate convection so strong that they generate new circulations outside of but fairly close to the storm. For the MF case, the vortex is very strong, with a mean tangential wind of about 8-10 m/s (as best as I can tell from the plots) averaged over 0-5 km height. This is practically a tropical cyclone in its own right. For the MR case, the vortex is weaker but the net result is the same.

The height-varying experiments further prove the point: large changes only occur if the moisture perturbations extend into the boundary layer. So, if the instantly imposed moisture perturbations are strong and extend into the boundary layer, then in the first 12 hours (the adjustment period), they generate convection which is strong enough to significantly change the circulation around the primary TC, in one case causing it to be affected by dry air, and in the other case to be affected by moist air, leading to intensity changes in each case.

But this not how moisture interacts with real storms. For example, in this case, if the air to the north of the storm (Earl) had not been dry and there was no dry slot in front of it, that does not mean a burst of convection would occur creating a small vortex which then would have caused changes (weakening, in fact) to Earl. Or, to put it another way, similar effects could have been created by adding vortices to the flow instead of moisture changes. The question of how Earl or similar hurricanes might have evolved if there had been no dry slot in front, or an extra moist slot behind, is unfortunately not answered by the paper in its present form.

While I am always reluctant to ask for new simulations when reviewing a paper, I see little choice in this case. I recommend repeating the simulations with the following changes: 1) Use a 72 hour simulation, with the first 24 hours for an adjustment period; then add the moisture changes at t = 24 h. This separates the adjustment and moisture responses. 2) Use less radical moisture changes, which are more representative of the variations that occur in the Tropical Atlantic.