1) It is stated in the response that mid-level RH does "NOT PRECEDE" the increase of low-level vorticity. According to their figures, it increases from 65 to 80% from hours 48-55. Later, they say they are interested in the formation of a tropical storm, not some arbitrary point of genesis. But clearly mid-level RH increases substantially before a tropical storm forms.

REPLY: Please note that we have never denied the increase of mid-level RH with time. What we found and stated in the mss. was that that the increase of RH “DOES NOT PRECEDE" the increase of low-level vorticity or low-level convergence. In other words, the increase of midlevel RH is the consequence of persistent convection that eventually leads to genesis, instead of being the trigger for genesis.

ACTION: NO CHANGE TO THE MANUSCRIPT IS BELIEVED NECESSARY.

2) The response to my point about the different RH values on the figures is not addressed. If the formulas are the same, how can they explain the radically different upper level RH values in Fig 16 vs Fig 18? Or, as a corollary, if the formula and figures are correct, how can they say that the warm-rain evolution is essentially equivalent to the ice-physics evolution?)

REPLY: “Essentially equivalent” refers to the broad picture of storm development described herein. While the RH field in the warm-rain and ice experiments does show a qualitative difference in the upper levels, this does not by itself mean that the development sequence presented herein is fundamentally altered. Our evidence suggests that the development sequence is basically the same.

Motivated by the reviewer’s comments, we have traced the difference in the RH field in the upper troposphere near 200 hPa to the air temperature (see enclosed Figures 1 - 3 below). Although the water vapor mixing ratio in the warm rain experiment is slightly greater than in the ice microphysics experiment, the total mixing ratio of cloud water, rain water, ice and snow is greater in the ice microphysics experiment than in the warm rain experiment (see Figure 3 below). The higher total mixing ratio in the ice experiment leads to a strong radiative cooling. As a result, in the warm rain experiment, the upper troposphere is warmer and more moist (in terms of water vapor mixing ratio) than in the ice microphysics experiment (compare Figs. 1 and 2). Note also that the absolute difference of water vapor mixing ratio between the two simulations at 200 hPa is small. However, this small difference implies a large difference in the relative humidity on account of the very cold air temperature.

ACTION: NO CHANGE TO THE MSS. IS BELIEVED NECESSARY

3) Finally, my "minor comments" were ignored.

Please accept our apology for this oversight. Please see our replies below:

1. p. 26152/fig 4f: I propose showing profiles of RH instead of mixing ratio, who can possibly look at a plot of mixing ratio and see if the air is "dry" or "moist." Is there a mid-level minimum in RH? (vs. ice or water?)

REPLY: The RH profile follows Kurihara and Tuleya (1981, hereafter KT81). KT81 used the mean RH profile from GATE Phase III at 80W, and assigned the following RH values of 10, 20, 30 38, 51, 61, 71, 78, 82, 83 and 84% to their 11 model levels (see section 3c of KT81).

ACTION: NO CHANGE TO THE MSS. IS BELIEVED NECESSARY.

2. pp. 26160-26161: The authors state that the low values of theta-e near the surface deny the importance of surface fluxes and the WISHE mechanism before genesis. This is a mis-interpretation of WISHE: it is not about high theta-e values, but about large fluxes. Lower theta-e values actually cause larger fluxes, so that the ocean can more rapidly communicate its heat energy to the atmosphere. Without the fluxes, the low-level theta-e values would be even lower (like for convection over land).

REPLY: We find this series of remarks to be largely incomprehensible. For a start, it is unclear to what “it” refers. Second, we never stated that surface fluxes are unimportant. Our discussion merely points out that one of the signatures of the WISHE mechanism, namely, the increase of the boundary layer theta_e with time (see Emanuel et al. 2004, Montgomery et al. 2010, their Figure 1), is absent at the early stages of the simulated evolution.

The WISHE mechanism is much more than “…about large fluxes.” As an illustration of this point, in a significant observational study by Molinari et al. (2004, J. Atmos. Sci.), the authors describe WISHE as follows: “…development occurs basically as a feedback between surface wind and wind-speed dependent surface moist entropy flux.” This feedback process has been carefully articulated in our recent paper (Montgomery et al. 2009).

ACTION: NO CHANGE TO THE MSS. IS BELIEVED NECESSARY.

3. p. 26164: It will be interesting to see the vorticity budget analysis for the ice physics simulation.

REPLY: The vorticity budget analysis of the control run shows that the spin up of the low-level vorticity results primarily from the low-level convergence. Although the moisture evolution is different due to different microphysics schemes (see detailed discussion in point (2) above), the low-level convergence leads the increase of vorticity in both experiments. On the basis of this finding we concluded that we did not repeat the calculation for the ice physics simulation.

ACTION: NO CHANGE TO THE MSS. IS BELIEVED NECESSARY.

4. p. 26166: It is not clear what the convective-versus stratiform analysis adds to the paper. Furthermore, it is generally known that numerical models have too much deep versus stratiform convection in the tropics and tropical cyclones. The relative absence of stratiform precipitation before t = 96 h is very surprising. There could be some bias here.

REPLY: Convective precipitation and stratiform precipitation are associated with different vertical profiles of horizontal convergence/divergence (Mapes and Houze 1995). As suggested by Tory and Montgomery (2006), the transition from stratiform to convective heating/divergence profile is critical for tropical cyclone formation, as the latter favors the low-level spinup and the former tends to enhance the mid-level vorticity. The small amount of stratiform convection before t = 96 h in the experiment with ice microphysics is most likely an artifact of the microphysics scheme in the WRF model.

ACTION: NO CHANGE TO THE MSS. IS BELIEVED NECESSARY.

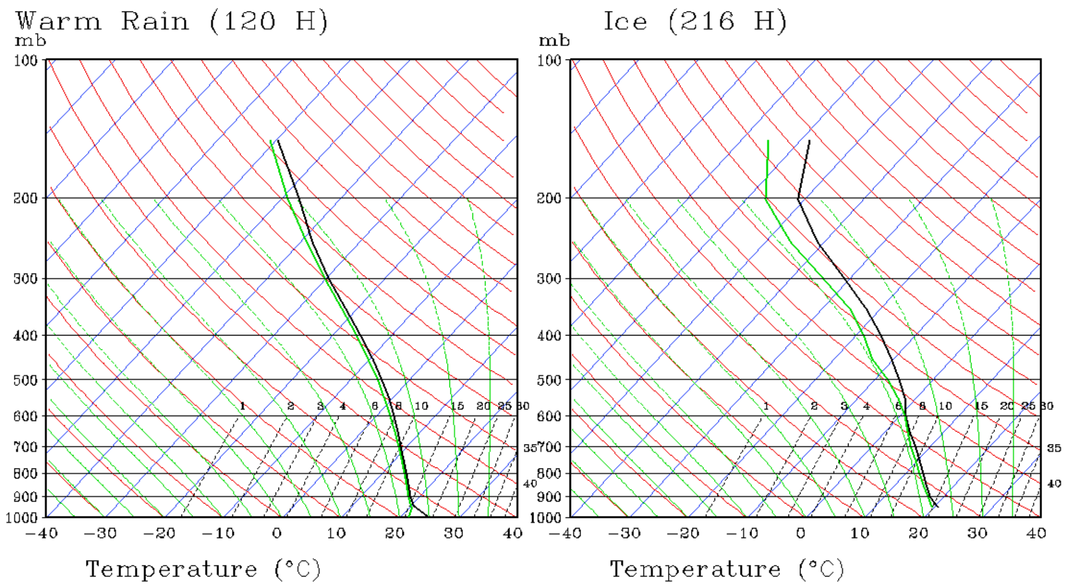

Figure 1 Skew-T log P diagrams based on the 2°X2° box average in the warm rain experiment (at 120 h) and ice microphysics experiment (at 216 h) runs.

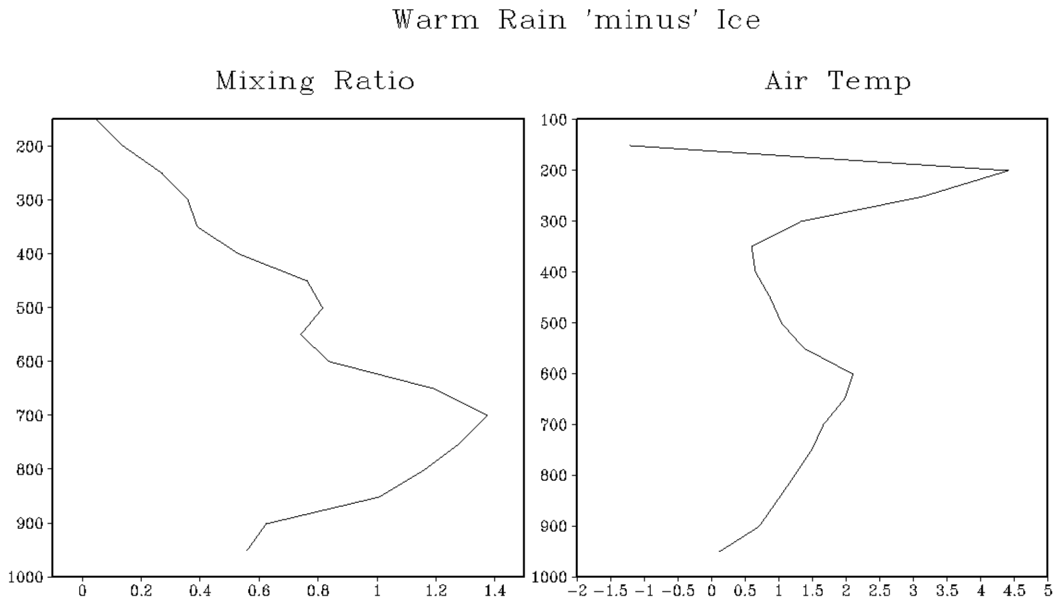

Figure 2 Difference of water vapor mixing ratio (units: g/kg) and air temperature (units: K) between the warm rain and ice microphysics experiments (defined as "warm rain minus ice microphysics").

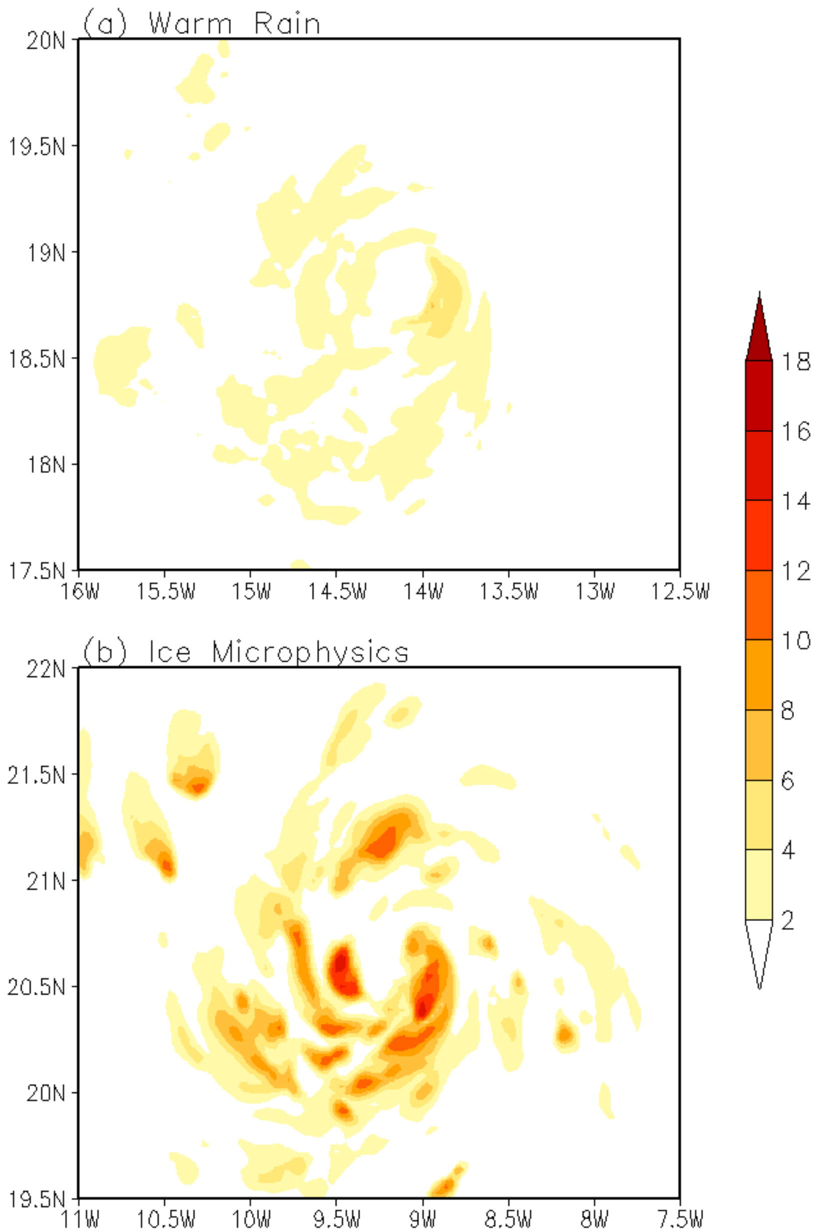

Figure 3 The total mixing ratio of cloud water, rain water, ice and snow at 250 hPa in (a) the warm rain experiment and (b) the ice microphysics experiment (units: 0.1 g/kg).