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In this manuscript, the technique used to generate a nature run that is representative of a tornado outbreak in the southeastern United States is introduced. Since past studies conduct OSSEs to simulate evolution of supercellular convection by generating a "warm bubble" into an unstable and highly sheared environment, it is meaningful to perform idealized OSSE that simulates the evolution of a convective line initiated via a frontal boundary in a highly-sheared and modestly-unstable environment. Creating OSSEs that simulate different storm modes and environments can help better understand how assimilated observations impact the environment and the subsequent evolution of convection. Forecasts that assimilate radar and environmental observations are found to be more skillful than assimilating radar data only. Environmental observations help correct wind profile error and increase convergence. The authors introduce a new method to create initial ensembles, however, it is not addressed very clearly. I recommend accepting this paper after a minor revision.

We thank the Reviewer for their helpful feedback. We tried to incorporate as many suggested changes as possible and as a result believe the manuscript is improved. If a change was not enacted fully, we justify our position in the reply.

The first question is about the nature run. It is not very clear what the final setup of the nature run is. It looks to me like the nature run is initialized from the environmental sounding shown in Fig. 1a. A frontal boundary is added to provide a mechanical forcing for convection initialization. A turbulence simulation is conducted to help introduce more realistic eddies. Then the perturbations of the u,v,w, qv, and theta fields from the 12-h forecasts of the turbulence simulation are added back to the initial condition of the nature run. I think it is better to specify more clearly what the final setup of nature run is before section 2.4, similar to the setup descriptions (step 1 to 4) in section 3.

We agree with the Reviewer that this was confusing. We added a list at the start of Section 2 as in Section 3. We also swapped Section 2.2 and 2.3 to better match the order of operations.

It is unclear to me how the 40 initial ensembles are generated. It is mentioned in 200, cold and warm sector simulations for each ensemble member are assigned a land surface type. How many warm and cold sector simulations are conducted? Based on the captions in Fig. 7, it looks to me there is only one warm sector simulation and one cold sector simulation (the ones that use the unperturbed sounding). Are the 24-h forecasts from cold and warm sector simulations blended together in different ways (with different times and locations) to form different initial cold front boundary for 40 different ensemble members? In line 360, it is mentioned that each forecast member is initialized from the same sounding. Is it the same sounding as the nature run? What are the perturbed soundings in Fig. 7 used for? Are there 40 perturbed soundings in warm sectors and another 40 ones in cold sectors? It is better to summarize the setup descriptions of the initial ensembles before section 3.3 instead at the beginning of the section 3. Summarize what are the difference in the 40 initial ensembles (e.g., do they use the same or different sounding, cold front boundary, land surface type, and potential temperature perturbations, etc., for simulation?). The timeline is also not very clear to me. What is the time setup for nature and the runs to generate initial ensembles? Fig. 9 only shows the time setup after generation of the initial ensembles.

We understand that this section is verbose and appreciate the Reviewer's patience. First, we believe summarizing the steps is best left at the start of the section because it directs the reader in plain language as they progress through the subsections. We believe the questions raised here are addressed in the Section 3 intro list and in Section 3.1. We will review the procedure here based on the text and hope that it now makes sense.

- For each of the 40 members, a cold-sector and warm-sector simulation are initialized.
    - The warm-sector initial sounding is from the nature run initial sounding.
    - The cold-sector initial sounding is made by applying perturbations to the warm-sector initial sounding.
- Each member is assigned a land-use category (see Table 1), which are identical for the cold- and warm-sector simulations (except for open-water bodies—warm sector only).
- Additionally, random perturbations of potential temperature are added.
- For each member, the cold- and warm-sector simulations are integrated forward 24 hours using the ensemble model physics settings.
- Figure 7 shows the domain-averaged profiles of wind and temperature at the conclusion of those simulations (thin lines). The bold lines are the soundings used to initialize each of the cold- and warm-sector simulations.
- The cold- and warm-sector simulations are then blended together using the described weighting function for each member to arrive at the initial conditions used to create the ensemble.

Line 235: should be "Due to the idealized nature".

Fixed.

Usually for OSSEs, model forecasts are verified against the true state instead of the observations due to the errors of the observations. Did you conduct verification using observations or the "true" state from nature run? If using the latter, RMSE instead of RMSI should be used.

We updated Fig. 11 to state root mean square error.. We agree RMSE is a more appropriate phrase since we are not comparing the prior/posterior against simulated observations.

It seems assimilating conventional observations together with radar data produces much stronger updraft relative to assimilating radar data alone. Environmental observations help correct wind profile error and increase convergence. Which one do you think has more influence on the analysis of the updraft, sounding, or surface observations?

We believe that radar observations have the largest impact on the initial updraft intensity. After, the assimilated sounding observations enhance convergence and thus help maintain updraft intensity.