Manuscript entitled "Impact of Multiple Radar Wind Profilers Data Assimilation on Convective Scale Short-Term Rainfall Forecasts: OSSE Studies over the Beijing-Tianjin-Hebei region” by Juan Zhao , Jianping Guo , and Xiaohui Zheng

The study investigates the benefits of using radar wind profiler (RWP) observations for forecasting convective initiation (CI) in small-scale boundary layer convergence zones. The research employed the Weather Research and Forecasting (WRF) model along with the NSSL3DVAR data assimilation (DA) system. Synthetic RWP data, generated through Observing System Simulation Experiments (OSSE), were assimilated for three summer heavy rainfall events in the Beijing-Tianjin-Hebei region. The results indicated that assimilating RWP observations improved model initial conditions and enhanced short-term severe weather forecasts. Notably, improved forecasting outcomes were observed when combining operational, foothill, and ridge RWP data. Multiple sensitivity experiments were conducted to evaluate the impact of vertical resolution and maximum detection heights. The study identified optimal configurations for future real-time RWP data assimilation.

The research and results of the study are both interesting and significant. The manuscript is well-structured and clearly presented, offering a thorough analysis using the OSSE method. It is well-written and will be ready for publication after a few minor revisions and responses to my questions.

Comments:

1. In lines 144-145, ‘so we did not use the ensemble derived background error covariance, which is also incorporated in the variational framework’. What method is used to compute the background error statistics? What control variables are utilized to calculate the B-matrix? Is the covariance matrix a day or wet matrix. Write a few details about the calculation of the B-matrix.
2. Line 135, ‘total precipitable water' are the products or sources of observations used for assimilating total precipitable water? The author needs to include appropriate references for each observation.
3. Authors need to include additional information about the NSSL3DVAR assimilation system. This should encompass the minimization cost function, control variables, and the calculation of the B-matrix.
4. Line 132: Add a few references after the phrase water path, total precipitable water, and atmospheric motion vector.

Jones, T. A., Wang, X., Skinner, P., Johnson, A., & Wang, Y. (2018). Assimilation of GOES-13 imager clear-sky water vapor (6.5 μm) radiances into a warn-on-forecast system. Monthly Weather Review, 146(4), 1077–1107. https://doi.org/10.1175/MWR-D-17-0280.1

Mallick, S., & Jones, T. A. (2020). Assimilation of GOES-16 satellite derived winds into the warn-on-forecast system. Atmospheric Research, 245, 105131. https://doi.org/10.1016/j.atmosres.2020.105131

5. Did the authors use any additional conventional observations or satellite observations in their assimilation system?
6. Line 201, rewrite the line ‘meridional wind components (u and v)’ to ‘meridional wind (u and v) components’.
7. Line 217, ‘The perturbations are assumed to be normally distributed Gaussian random errors with a mean of zero and a standard deviation of 2 m/s’ , How do you calculate the observation error for each location?
8. In the summary section, write a few words on how incorporating flow-dependent background error covariances in data assimilation (DA) systems can enhance precipitation forecasting compared to the static background errors used in 3DVAR.
9. Based on OSSE results, what are the key considerations for designing and deploying optimal RWP networks in complex terrain regions?