Review of "Assimilation of lidar planetary boundary layer height observations"

This manuscript describes a study of assimilating lidar PBLH data into 22 hourly forecasts from NU-WRF model on July 11, 2015 in Greensburg, Kansas. The tests are performed in a stand-alone approach, where the analysis results don't feed back to the forecast. The use of ensemble background error covariance for multi-variable relationships is commonly used in the ensemble and 4DEnVar data assimilation systems. This study is a good example to demonstrate the advantage of this approach. The results show that the PBLH data have little impact during the early morning but improve the temperature and velocity in the later afternoon. The manuscript is well written, and test results are clearly presented.

Having said that, I have some comments listed below:

1. The definition of PBLH. As described on lines 77-82, for PBLH data calculation, the Doppler shift of the backscattered signal is used to calculate wind speed as a function of range, which can then be used to produce a multitude of wind and turbulence variables useful for PBL characterization (e.g. vertical velocity variance and signal-to-noise ratio variance). The PBLH algorithm applied for this study combines several such aerosol and wind variables for PBLH measurement and was described at length in Bonin et al. (2018). The PBLH in the model is estimated using the total kinetic energy (TKE) method. The two definitions are different but seem close enough. Is there a way to show to what extent the two PBLH definitions are comparable?

2. The vertical localization factor. How is the parameter alpha in equation (6) chosen? According to the equation, this parameter works the same way for layers both above and below the PBL height, for example, if k_PBLH=4, then C_loc at layer 3 is the same as C_loc at layer 5. However, that seems not the case in Fig. 5.

3. Equation (7). Where is number "8" coming from? The top of boundary layer is not a constant during the 22 hours, which can be seen clearly in Figures 3-6.

4. In the abstract, it states that water vapor is improved by assimilating lidar PBLH. However, Fig. 5 shows that it is degraded.