

Assimilation of lidar planetary boundary layer height observations

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Response to reviewer 3

1. Line 212 – “: :the assimilation reduces the RMS differences with sonde profiles significantly by 22 UTC for both models.” From Fig. 2, the RMS difference of potential temperature, WVMR and V component of velocity have reasonable impact but there is little or no impact on U wind. Please correct the statement if it was a mistake, or, if not, please elaborate how the impact is significant. Also please adjust the Y axis limits of V wind to the same as that of U wind.

We have made some changes here due to changes in the solution in this revision. Please see the response to the last item from reviewer 2. We have made the y-axis limits the same for the U and V plots.

2. In Figs. 3 and 4 both analysis and forecasts profiles of potential temperature, WVMR and velocities, U and V, coincide each other at 4 UTC. However, in Fig. 1, the PBLH at 4 UTC is not the same for MYNN forecast although MYJ forecast PBLH has the same value as the radiosonde. The PBLH difference of MYNN forecast to radiosonde is around 300 m from Fig. 1 which creates a doubt regarding Fig. 4 (MYNN scheme) at least if not Fig. 3. May be the innovation was not large enough to create an impact in the assimilation system. Also another reason for doubt is due to the significant magnitude of covariance of PBLH with the variables for 4 and 8 UTC. Hence, I would suggest the author to create the same Figs. 3 and 4 with an additional background profile (may be use a dashed line of the same colour) for each of the variables to remove the doubt.

We have made some corrections to the code, which has changed both the innovations and the corrections to the profiles. We have also put the lidar observation levels (in pressure) on the profile plots to make more clear the magnitude of the innovations. There are now some what larger corrections to the profiles in the early morning, and none of them is zero.

Minor Comments:

1. I would suggest the author to include a brief description of Doppler lidar just after the ceilometers. A brief description on the pros and cons of Doppler lidar (with references to the system used) and how it is superior to ceilometers could be added.

We have added further details on the Doppler lidar.

2. Line 134 - Please add some more details regarding the assimilation design in the methodology section. The sentence “: :experiments are all less than 24 hours from the most recent global analysis” is not clear enough for readers. Line 98 - “The assimilation is done on 22 hourly WRF forecast fields: : :” may be omitted or modified after the above addition in the methodology section.

We have added further explanation as to where the forecasts start (0 UTC) from the NOAA global forecast system (GFS) with a final initialization at 0 UTC.

3. Line 178 – Radiosonde launches were 6 times in total. The reader understands MYJ has 5 radiosonde comparisons since it stopped at 22 UTC whereas MYNN has 6 radiosondes. Please clarify this point.

The missing radiosonde has been added to the PBLH plot.

Typos and corrections:

1. Line 59 – “Wulfmeyer et al. 2015” not found in the reference section.

Added.

2. Line 67 - Please check “Brooks, 2003”. I could not find the reference in the reference section.

Added.

3. Line 144 – The sentence “Instead we use: :error statistics” should be corrected.

We have changed this sentence, but we think you had meant line 115.

4. Line 119 – “We use profiles from: : :” feels like repetition from line 115.

We think you meant line 144 here. And we have shortened and simplified the sentence to avoid repetition.

5. Line 129 – Please describe “W”.

W is the vertical velocity, but we are not showing it here because there are not observations to validate it. So we have removed it.

6. Line 220 – Please change “plue” to “blue”.

Done.

7. Line 244 – “Demoz et al 2006; Crook, 1996” could not be found in the reference section.

These citations have been added to the reference list.

8. Line 272 – “an” is used twice, please correct.

Done.

9. The following references were found in the reference section without citation in the manuscript. Please cite these wherever necessary.

“Banks, R. F., J. Tiana-Alsina, F. Rocadenbosch, and J. M. Baldasano (2015) Performance evaluation of the boundary-layer height from lidar and the Weather Research and Forecasting Model at an urban coastal site in the north-east Iberian Peninsula. *Bound.-Layer Meteor.*, 157, 265–292, <https://doi.org/10.1007/s10546-015-0056-2>.”

“Cohen, A.E., S.M. Cavallo, M.C. Coniglio and H.E. Brook (2015), A Review of Planetary Boundary Layer Parameterization Schemes and Their Sensitivity in Simulating Southeastern U.S. Cold Season Severe Weather Environments, *Wea. Forecast.*, 30, 591-612.”

“Tucker, S.C., S.J. Senff, A.M. Weickmann, W.A. Brewer, R.M. Banta, S.P. Sandberg, D.C. Law and R.M. Hardesty (2009), Doppler Lidar Estimation of Mixing Height Using Turbulence, Shear, and Aerosol Profiles, *J. Atmos. Ocean Tech.*, 26, 673-688.”

These References have been removed.