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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Assimilation of lidar signals: application to aerosol forecasting in the Mediterranean Basin" *by* Y. Wang et al.

Anonymous Referee #2

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1 General summary

The study presents an in-depth analysis of a lidar assimilation test case for July 2012. Continuous observations of backscatter power over 72 hours from 9 EARLINET/ACTRIS lidar systems throughout Europe were assimilated in the chemical transport model POLAIR3D using an Optimal Interpolation approach. Subsequent forecasts from the model were verified using independent ground-based measurements of PM2.5 and PM10, and Aerosol Optical Depth (AOD). Sensitivity tests to assumptions on error correlation length, assimilation window and vertical range for the assimilated observations were performed. Best results for this case were obtained for a correlation length of 100 km and a vertical range of 1.0-3.5 km up to a forecast range

of 36 hours where most improvements were obtained. In general, the results show improvements in PM10 and, to a less degree, in PM2.5 due to the inclusion of lidar data. The impact of the data seems to persist longer than 36 hours into the forecast, in contrast with previous studies which estimated a shorter duration of the impact. Some points that needs to be addressed concern the generality of the results given that only one case study was presented, as well as the impact of changing the boundary conditions on the DA results. Overall this paper is interesting and the topic is novel and of high importance. I recommend it for publication subject to addressing the comments and the revisions listed below.

2 Specific comments

p.5 l.127 : Could also add these to the list of references on lidar DA:

Campbell, J.R., Reid, J.S., Westphal, D.L., Zhang, J., Hyer, E.J., Welton, E.J., 2010. CALIOP aerosol subset processing for global aerosol transport model data assimilation. Journal of Selected Topics in Applied Earth Observations and Remote Sensing 3, 203-214. doi:10.1109/JSTARS.2010.2044868.

Zhang, J., J. R. Campbell, J. S. Reid, D. L. Westphal, N. L. Baker, W. F. Campbell, and E. J. Hyer, 2011: Evaluating the impact of assimilating CALIOP-derived aerosol extinction profiles on a global mass transport model, Geophys. Res. Lett., 38, L14801, doi:10.1029/2011GL047737.

p.6 l. 177 Are the boundary conditions on dust derived from the EMEP inventory? Please explain. In the case of the regional models, DA results strongly depend on boundary conditions (BC). For example, it would be interesting to investigate how the use of different BCs (from global models, or different inventories, or different reference year, etc.) would influence the DA results. Please comment on this in the text.

p.8 l.232 Were the observations averaged over 1 hour? Did you try different averaging intervals? What about in the vertical?

p.9 l.275 The analysis of the case study using backward trajectory can only go so far as far as the species attributions: can the authors use different tools (for example global aerosol models) to assess what type of aerosols were likely present at the lidar stations during the campaign period?

p.10 l.306 Would you have had the same improvements if more dust was already present in the BCs? The influence of the BCs should not be neglected. This is part of assessing the goodness of the background.

p.11 l.321 : Add “should" before “24-hour".

p.11 l.324 : Why did you choose 60 hours for the total forecast length?

p.12 l.374 What is the vertical resolution of the data? Did you perform any averaging? If yes, did you look at the sensitivity to the choice of averaging interval (the same question applies to the temporal averaging, see question above). Why did not not assimilate from the surface? Are there intrinsic problems with the use of the ground-based lidar observations close to the surface? Please comment.

p.13 l.404 Please summarize the results in a table, section 5.1 is hard to read. Please do the same for sections 5.2 and 5.3.

p.13 l.417 How do you assess the significance of the improvements?

p.14 l.431 From these results it appears that the radius of influence of the lidar measurements is rather small. Could you comment on how what type of density of lidar stations would be desirable? Where would having more lidar stations bring the highest benefits? It is probably situation-dependent. Could you comment on using a denser network such as the ceilometer network? What type of accuracy is

needed from the lidar measurements to have a significant impact on the surface PM concentrations?

p.15 l.478 Can this be generalized?

p.15 l. 484 Remember the possible role played by the BCs, you only experimented with one set of BC and one case.

3 Figures

Figure 2-3 It would be good to see the model equivalent of the lidar PR^2 before and after assimilation alongside the observations.

Figure 13 Could you also show the time series for AOD at a few stations rather than only the scatterplot. Are the obs matched to forecast time?

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 13059, 2014.