Atmos. Chem. Phys. Discuss., 15, C9760–C9764, 2015
www.atmos-chem-phys-discuss.net/15/C9760/2015/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Development of the Ensemble Navy Aerosol Analysis Prediction System (ENAAPS) and its application of the Data Assimilation Research Testbed (DART) in support of aerosol forecasting" *by* J. I. Rubin et al.

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Received and published: 25 November 2015

This paper treats the subject of ensemble analysis applied to aerosol forecasting. The system used is the Ensemble Navy Aerosol Analysis Prediction System (ENAAPS) coupled with the Ensemble Adjustment Kalman Filter from DART. The optimization of the 20-member ensemble is described in detail, with particular emphasis on the choice of covariance inflation (adaptive versus constant) and the perturbation approach used (perturbed source versus perturbed meteorology or a combination of both). Tests were also performed with an 80-member ensemble. MODIS AOT were assimilated

in the system and results were analysed against independent observations from the AERONET in terms of RMSE, bias and correlations. Results indicate the optimality of using an ensemble with both source and meteorology perturbations as well as the use of an adaptive covariance inflation over a constant inflation. The 80-member ensemble was also shown to perform better than the 20-member ensemble. The optimized ensemble's analysis and 24h forecast ware compared to the current operational 2D-Var analysis and forecast to assess performance. While statistically the differences between the two approached were not very large, the ensemble showed better capacity in capturing features with sharp gradients than the variational system thanks to the flow-dependent background error covariance matrix used in the analysis. The potential of the ensemble to assign forecast uncertainty is also an attractive feature of the ensemble approach. Not being an expert in ensemble analysis, I appreciated reading this paper very much and learned a lot from it. It is written very clearly and pleasantly. All the different set-ups were well explained and the results and conclusions were discussed in an effective and factual manner. I appreciated that the authors tried to keep the length of the paper to a manageable size. However, it would have been interesting having more details on the implementation. Perhaps the authors could consider a companion paper in Global Model Development which would allow the inclusion of more technical details for the benefit of the scientific community. I list minor comments below, and strongly recommend publication of this manuscript.

Page 4

Line 33.I would say "research" arena rather than "operational" arena as to my knowledge at the moment there are no operational ensemble systems for aerosols (although the situation may soon change).

Page 5

Line 10. Here, like elsewhere where the comparison between the ensemble and variational systems was made, I thought it would be good to see the background error co-

variance matrices for the ensemble and the variational system side by side. Perhaps, if possible, for future work as well, it would be interesting showing the increments from a single observation experiment to show how the different background error statistics affect the distribution of the increments and spread to neighbouring points the information from a single observation.

Page 6

Line 22. How is the adaptive inflation estimated? Is it based on first guess departures? I know that the reader can look up the references, but just a sentence to explain briefly what the estimation is based on would be welcome.

Page 7

Line 12. 25% seems like a large perturbation, although later you say that it might be small for certain emissions (for example fires). How is this value assigned? I am surprised that location-dependent perturbations did not help with the ensemble performance, as you later mention that for localized sources the ensemble had the problem of over-correlating them. Perhaps the perturbations should be a function of the source spatial extension and intensity. I really do not know, just wondering.

Page 11

Line 9. Please do explain briefly the methodology behind AI.

Line 19. That points to model shortcomings which are not likely to be corrected with DA.

Page 12

Line 11. Well phrased. This is another one of the issues related to the fact that the aerosol problem is under-constrained.

Page 15

Line 35. An interesting conclusion about the observation errors being too large for small AOTs. Perhaps the methodology of Desroziers et al (2005) could be applied to ascertain so in a more mathematical way. [Desroziers, G., Berre, L., Chapnik, B. and Poli, P. (2005), Diagnosis of observation, background and analysis-error statistics in observation space. Q.J.R. Meteorol. Soc., 131: 3385–3396. doi:10.1256/qj.05.108]

Page 19

Line 12. The fact that the RMSE values of the two analysis are not statistically different might also mean that the system is driven more by the observations than the background, and perhaps the observations errors are too small. This may seem to contradict what said on page 15 line 35, but the two things may co-exist as the balance is to be obtained between the background errors and the observation errors and it is possible that the analysis draws too much to the observations (i.e. the background errors are large with respect to the observation errors). Again, perhaps an analysis of the departures of both the variational and ensemble analyses could offer some insight on this particular aspect.

Line 15. Please use another verb other than “produced”, like “displayed”.

Line 39. As already mentioned, it would be good to see a plot of the background error covariance matrices for the variational and the ensemble system (single observation experiment increments would also do the job). Figure 15 shows some of this, but it would be good to have a dedicated single observation experiment.

Page 20

Line 16. To be fair to the variational system, it is definitely not tuned at all to capture sharp gradients. I presume the 2D-Var background error covariance matrix is spatially homogeneous, constant and with fixed correlation length. It seems to be asking too much of the system.

Pag. 24

Line 32. Have you looked what happens at longer forecast ranges than 24h?

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 28069, 2015.