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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A data assimilation method of the Ensemble Kalman Filter for use in severe dust storm forecasts over China" *by* C. Lin et al.

C. Lin et al.

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The paper first suffers from poor grammar and vocabulary, but it would be unfair to judge the article on this aspect only, since the scientific content is good. The authors ought to get hold of a fluent english speaker and improve the language to reach their audience.

Response: We have tried our best to improve the quality. In addition, we will ask a fluent English speaker to improve the language in the revised manuscript to be submitted to ACP.

Analogous works in atmospheric chemistry could be referred to, on particular Hanea et al. (MWR 2007) and Blond and Vautard (JGR-D, 2004) The prior on the initial error as uncertain location of the clouds makes sense a priori, but still the ensemble spread is insufficient. The implications of filter convergence are a serious for all ensemble methods and the authors should suggest more satisfactory means to overcome this limitation. For example there are no explicit model errors in the system as if the model dynamics were perfect. Is that a realistic assumption? Why not include errors in meteorological fields?

Response: Thank you for your suggestion. We will refer these references in the introduction as following. Vautard et al. (2004) investigated the potential of data assimilation of surface ozone concentrations in a chemistry-transport model over European continent using statistical interpolation and showed that the analyses and the 1˜2 days forecast are improved. Hanea et al. (2007) used a hybrid Kalman filter algorithm combining the reduced-rank square root (RRSQRT) and the ensemble Kalman filter (EnKF) in European Operational Smog (EUROS) atmospheric chemistry transport model. The hybrid algorithm showed better results with more than 30 model evaluations than RRSQRT due to impact of nonlinearities and than EnKF due to less statistical errors.’

For the insufficient ensemble spread, we used the simple method-covariance inflation method in this paper, which is often used in atmospheric data assimilation with EnKF. It is not a realistic assumption that there are no model errors. However, due to the difficulty to explicitly specify the model errors, we just used the covariance inflation method. In the conclusion, we suggested that more satisfactory mean to overcome this limitation would be to try our best to specify the model errors (e.g., errors in meteorological fields, dust emissions, dry deposition velocity) and consider them in the system. This would also be included in future study.

There is one minor error the initial ensemble P6, l. 10: 1 + _ may take negative values, you should consider another distribution than the normal for this parameter (an exponential for example) and be aware of possible biases.

ACPD

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Interactive Comment

Response: Thank you for pointing out this. In fact, we have transformed it into an exponential form that would not take negative values and have checked the bias. We are sorry to miss mentioning it in the manuscript and have complemented the description in the revised version.

The authors show in Figure 9 that the differences between Qinghuandao and Dalian can be large at times especially in periods when concentrations are high. The two points are merely separated by one grid cell and clearly points to insufficient model resolution. Why arguing for denser observations, then? It seems useless to have observations denser than the model grid.

Response: Thanks to point out this. We agree with you that the way to solve it should be to increase the model resolution. The argument for denser observations is wrong and we deleted in the revised version.

It is puzzling that the method performs better at validation points (Figure 4) than at the assimilation points (Figure 5). I conclude that the three validation points are located in areas where the errors are lower and not representative. Please comment on that.

Response: We are sorry that the captions for Figure 4 and 5 are not clear and have now revised them in the revised version. In Figure 4, the RMS errors for the results with assimilation (shaded rectangle) at three validation points are the errors between the analyses and the observations. While, in Figure 5, the RMS errors for the results with assimilation (shaded rectangle) at all sites when the observations pass through quality control are the errors between the 24h-averaged forecasts and observations. It is certain that it performs better for the analyses than the forecasts. The discussion of results is too often qualitative, for example in Figure 6, the improvement of the vertical structure must be supported by the RMS errors and correlation, given as a function of H.

Response: We will follow your comments and calculate the RMS errors and the correlation in the revised manuscript.

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In Figure 7, the (negative) correlations with the visibility time series should be given.

Response: We have added the correlations in the revised version. The correlation between the 3h surface visibility and dust concentrations is -0.62 without assimilation and -0.64 with assimilation during the period of 19-21 March. It is -0.69 without assimilation and-0.73 with assimilation during 20-21 March. The correlations above all exceed the significance of 99%.

In Figure 11 and 12, it is uneasy to compare the colours with the dots sizes. please put the dots in colour for clarity.

Response: We will put the dots in color for clarity in Figure 11 and 12.

Comments on technical corrections Response: We have corrected them in the revised version.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 17511, 2007.