**Atmospheric
Chemistry
and Physics
Discussions**

Interactive comment on "Applying an ensemble Kalman filter to the assimilation of AERONET observations in a global aerosol transport model" *by* N. A. J. Schutgens et al.

Anonymous Referee #1

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1 General comments

The paper presents an interesting and novel study on assimilation of aerosol optical thickness (AOT) and Angström exponent (AE) from the AErosol RObotic NETwork (AERONET) within the context of an Ensemble Kalman filter assimilation system. The Ensemble method presented in the study seems to be quite suitable for assimilation of aerosol-related quantities as it allows for the explicit representation of the model prediction error covariance matrix. In other assimilation systems (OI, 3D-Var and 4D-Var) this error covariance matrix (often referred to as background error covariance matrix) has to be prescribed statically. Observations errors are discussed in depth. The en-

semble is constructed by varying the emission scenarios of specific species using a random factor drawn from a log-normal distribution.

Overall the paper is good and enjoyable to read. A great emphasis is given to the validation of the system using independent observations (AERONET observations that were purposely excluded from the assimilation, SKYNET observations and MODIS AOTs). The comparisons with ground-based data are very detailed and exhaustive, whereas the comparison with MODIS data are too qualitative. The figures are hard to interpret, perhaps color figure might help. The MODIS data could be extracted over the 8 AERONET sites used for validation (at least the daily means) and plotted along with the simulated data (before and after assimilation). This direct comparison can be helpful in understanding the performance of the system. Moreover, some summary statistics of mean bias and RMSE for all the validating sites and the whole study period would also be helpful. Although the assignment of observational errors was dealt with in great detail, the discussion of how the authors arrived at the expressions in equations (7) and (8) was not as clear to me. It would be very helpful if the authors could expand on section 4.1.

As a side note, it would be very interesting to see an analysis of the characteristic of the ensemble runs, for example the spread, to understand how the ensemble performs. Also I would personally find it interesting to see the type of correlation structure shown by the model prediction error covariance matrix.

2 Specific comments and technical corrections

Abstract: Remove 'the' in front of 'prescribing'.

Introduction: I would say "poorly understood cloud-aerosol interactions".

Change '.' into ',' after 'new field of research'.

Footnote command after 'MODIS' was not executed correctly.

Section 2.1: Reword sentence starting with 'Returning to the model prediction error covariance...' to make it more readable.

Briefly explain the reasons for the choice of the parameters n_e, g, l_p, and l_h. It is fine that the sensitivity of the LETKF is investigated in another paper, but it would be useful for the reader to know why certain values of parameters were chosen for the current study. Also it would help understanding the different experiments that are summarized in Table 1 (otherwise a bit cryptic).

Section 2.3: Out of curiosity: have you looked at how correlated coarse and fine mode aerosol mixing ratios are?

Removed 'now' in front of 'defined as'

Replace 'forecasted' with 'forecast'

Section 4: Replace colloquial expression 'All in all' with 'At that time,'

Section 4.1 and 4.2: I appreciate the effort that went into the AERONET error analysis, but there are aspects of it that are not very clear to me. For example how from examining figures 3, you derive equation (7). Could the steps be outlined more clearly? In general, it would be helpful if the whole procedure for assigning errors were to be explained in more detail.

Section 5.1: It is interesting how assimilation of AE does not appear to have much of an impact. Is is because the repartition of the analysis increments into the different species is done using a fixed fractional contribution? Please speculate on this point. Also elaborate on why you think that AE assimilation does not perform well especially in low AOT cases.

Replace 'discrepcancies' with 'discrepancies'

Replace 'nor' with 'as well as'

Interactive
Comment

Section 5.3: Comparison with MODIS data is too qualitative. Please use color figures if possible. As already mentioned consider extracting MODIS AOT values at the 8 AERONET stations used in the verification and over-plotting on top of the AERONET data.

Section 6: Replace 'depsoition' with 'deposition'. Check for other typos of this kind.