

## ***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.***

**N. A. J. Schutgens et al.**

schutgen@ccsr.u-tokyo.ac.jp

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Reply to comments by referee 2:

General comments:

C: The referee asks if a fine dust mode is included and what happens to it

A: In SPRINTARS, both a seasalt and dust fine mode is included (0.178 and 0.13  $\mu\text{m}$  are the lowest bin radii for seasalt resp dust). For the purpose of assimilation, we have grouped this fine mode into the coarse mode (so our coarse mode contains all seasalt and dust). For dust, this choice has likely not much influence. Only the lowest two

C10285

bin radii contribute to a large AE, but their total mass is small: if we take the average dust size distribution (from SPRINTARS),  $\text{AE} = 0.0$ . For seasalt, the lowest size radii can have either large or small AE depending on relative humidity. Again, the average seasalt size distribution in SPRINTARS has  $\text{AE} = 0.0$ .

Still, this issue is one that we hope to explore further. In the second paper, for instance, we have done an experiment with 3 analyzed variables (coarse mode, carbon and sulfate) since Fig. 1 (paper 1) suggests that might be better. However, this does not lead to significantly better AE (or AOT).

C: The referee ask how many levels are included in the state vector

A: 20 levels, just like the model. Of course, AOT and AAE are column integrated variables, so redistribution of aerosol mixing ratio is based on model information (this is done by the Kalman filter).

C: The referee requires a better explanation of Sect 4.1 and 4.2

A: Our basic idea is that AERONET variability within 1 or 2 hours is essentially random noise around a constant value. SPRINTARS should be able to predict this constant value, but not the noise, which is caused by small scale aerosol physics.

Fig 3 argues this by comparing variation in both SPRINTARS and AERONET, but one problem is that we do not have data available at the same time scales. Our SPRINTARS experiments had a time sampling of three hours, but we really want to average AERONET observations over 1 or 2 hours (and so need an estimate of representation error for these time windows).

Anyway, the most important issue is the observed variability of AERONET around the SPRINTARS sampling times. It stands to reason that this variability increases with time, so we consider AERONET variability in both a central hour and in two “wings” of 30 minutes. All together that makes for a time window of 2 hours, over which we want to average AERONET.

C10286

So we collect all two hour intervals of continuous observations within one year of AERONET observations, and calculate the relative difference between observations in the central hour and the central hour average. The standard deviation over all found intervals is the representation error within one hour. Next, we calculate the relative difference between observations in the “wings” and the central hour average. The standard deviation over all found intervals is the representation error within 2 hours (but not within 1 hour). These values are shown in Fig. 3 for all AERONET sites.

Now, within 1 hour this representation noise is about 5% (see Fig 3), and within 2 hours it grows up to 10% (these values are averages for all available AERONET sites). An individual AERONET observation within a two hour window is thus assigned a 5% representation error if it is within 30 min of the central time, and a 10% error if it is outside 30 min and inside 60 min of the central time. Eq 7 is a convenient FORTRAN code representation of the previous statement.

C: The referee ask about the impact of AERONET site density and availability.

A: These are very interesting questions that warrant a separate study. We have already begun such a study (it will not be part of the second paper mentioned in the current paper). Clearly AERONET is limited to certain regions and mostly over land. Operational assimilation systems will have to rely on multiple datasets to obtain the best possible coverage (e.g. MODIS, MISR, AERONET). Using all datasets simultaneously however precludes (or at the very least: makes more difficult) a meaningful validation. To study observational sampling impacts, we are now conducting so-called OSSEs (observing system simulation experiments), where various datasets are simulated and a well-defined truth exists. The impact of the current AERONET network maybe assessed from a picture prepared for the second paper and here included for the reviewer's sake (Fig. 1). It shows a monthly average of the ratio of ensemble spread for two experiments, one with assimilation and one without assimilation (free ensemble run). The white dots are the AERONET sites. Clearly around these sites assimilation strongly reduces ensemble spread (i.e. knowledge is gained by adding observations).

C10287

Note that not all sites provide observations which explains results for e.g. Canada and South America.

Technical corrections:

C: Change ‘quite a bit’ on p 23850, line 21. How much is ‘quite a bit’ anyway?

A: Valid points but for such a limited set of validation sites (8), we do not wish to provide error statistics. We are currently making exactly such error statistics for studies where: 1) MODIS Aqua is assimilated and error statistics derived from all AERONET sites; 2) MODIS Aqua and AERONET are assimilated and error statistics derived from MODIS Terra.

Technical reviewer comments that we did not specifically address, were used to improve the paper.

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Interactive comment on Atmos. Chem. Phys. Discuss., 9, 23835, 2009.

C10288

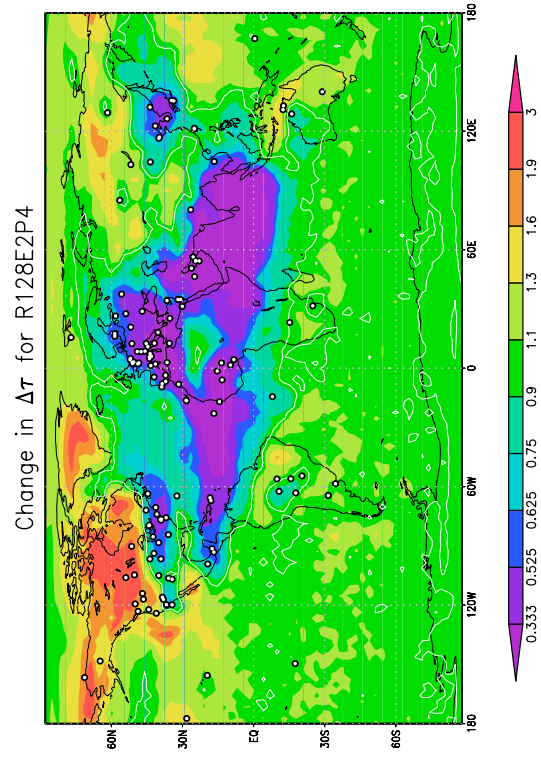


Fig. 1. Impact of assimilation

C10289