Review of "Aerosol optical depth assimilation for a size-resolved sectional model: impacts of observationally constrained, multi-wavelength and fine mode retrievals on regional scale forecasts"

P. E. Saide *et al*, 2013

1. General summary

This paper presents results from a regional assimilation system (WRF_CHEM) with a detailed aerosol model. The aim of the paper is, on one hand, to investigate the impacts of different aerosol optical depth (AOD) data-sets based on MODIS data on the quality of the analysis, and, on the other, to explore the use of multi-wavelength AOD retrievals and fine/total AOD retrievals from the MODIS standard algorithm. Verification with independent AOD observations from the AERONET network over California/Nevada and with PM2.5 and concentration observations from the AQS and IMPROVE networks is performed to assess those impacts. Non-assimilated MODIS data are also used for forecast verification.

The study shows that using de-biased AOD products from NRL-UND and NASA Neural Network Retrievals is beneficial to the analysis over using the standard products, although the number of data points is reduced by the strict quality controls. The authors observe that assimilation of AOD does not improve the inter-species balance in the model, as compared ground-based observations. This is only due to the fact that the aerosol assimilation is an under-constrained problem with more unknowns than available observations for assimilation, which implies that the species distribution is entirely determined by the model - this is a general problem, independent of the system used. The authors also show the beneficial impact of fine-mode and multi-wavelength, particularly the latter, assimilation to improve the size representation of the aerosols. This impact was verified with independent observations of Angstrom Exponent. However, the fit to the total AOD is generally worse.

Overall the paper is well-written and pleasant to read. The scientific subject extremely interesting and is treated with a lot of care in the details (i.e. the construction of the background error covariance matrix, the choice of the control variable, etc.). The results are carefully explained and documented with plenty of figures. The only thing that I would like to see expanded is the analysis of the impact of the assimilation of the different datasets on the forecast - I only saw one figure 9 which shows the verification of the 21h forecast). It seems that the authors have mainly focused on the verification of the analysis, and the comparison between the run with and without assimilation. Otherwise, this is a very good paper and I would recommend publication in its present form with perhaps a slight change in title from "Aerosol optical depth assimilation for a size-resolved sectional model: impacts of observationally constrained, multi-wavelength and fine mode retrievals on regional scale forecasts" to "Aerosol optical depth assimilation for a size-resolved sectional model:

impacts of observationally constrained, multi-wavelength and fine mode retrievals on regional scale **analyses and forecasts**" .

2. Minor questions/typos

p.12223 l.14: "successfully" is spelled wrongly.

p.12235 ll. 24-28: Where do the dust boundary conditions come from?