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Interactive comment on "The impact of aerosol optical depth assimilation on aerosol forecasts and radiative effects during a wild fire event over the United States" *by* D. Chen et al.

Anonymous Referee #1

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The authors assimilate MODIS observations of AOD at 550 nm into a coupled meteorological and atmospheric chemical transport model. They chose a wildfire event in North America for their study period, and they analyse the achieved improvements in PM2.5, OC, and EC forecasts, as well as the changes in meteorological parameters caused by the changes in aerosol concentrations. The paper is clear and concise, the methodology is state-of-the-art, and the results are quite interesting. I have only one point that could help to clarify the description of the methodology and results.

It is quite remarkable that the assimilation of AOD-550 improves not only the total mass concentration, but also OC and EC concentrations. I wonder how exactly this is achieved; the discussion in the manuscript does not really help me in understanding

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this. It would be very helpful to know how the aerosol concentration field is corrected by the assimilation. Do you allow each chemical species to be corrected independently (essentially by distributing the innovations to the various chemical components in model space according to the background error covariances)? Or does your assimilation only correct (i.e. scale) the total aerosol mass PM2.5, thus applying the same scaling factor to each chemical species? The latter approach has been pursued, e.g., by [A] (cited below), the former was tested, e.g., by [B], and the conclusion was that observations of optical parameters do contain sufficient information to retrieve PM2.5, but not for retrieving the chemical composition. If your assimilation algorithm only corrects PM2.5, while constraining the relative proportions of the different species to those predicted by the model, then the improvements achieved for OC and EC by assimilating AOD-550 are, most likely, the results of OC and EC being strongly correlated to PM2.5 in your case. On the other hand, if you allow EC and OC to be corrected independently by the assimilation algorithm, then the good result is quite surprising. Surely, an AOD observation at a single wavelength does not contain sufficient information to allow you to retrieve the chemical composition of the aerosols!?

In summary, the paper can be published as is. I would leave it up to the authors if they want to take the opportunity to revise their paper before publication in GMD.

References:

[A] Benedetti, A. and Fisher, M. 2007. Background error statistics for aerosols. Q. J. R. Meteorol. Soc. 133, 391-405.

[B] Kahnert, M. 2009. On the observability of chemical and physical aerosol properties by optical observations: Inverse modelling with variational data assimilation. Tellus 61B, 747-755.

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