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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Quantifying the Direct Radiative Effect of Absorbing Aerosols for Numerical Weather Prediction: A case study" *by* Mayra I. Oyola et al.

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To: Reviewer 1 Atmos. Chem. Phys., http:// editor.copernicus.org/ From: Dr. Mayra I. Oyola mayra.oyola.ctr@nrlmry.navy.mil

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Dear Reviewer 1,

We are appreciative that you have considered reviewing our article: "Quantifying the Direct Radiative Effect of Absorbing Aerosols for Numerical Weather Prediction." for publication in the Journal of Atmospheric Chemistry and Physics. Thank you for your time

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Discussion paper

and effort to make of this a much stronger manuscript. The comments and questions (along with associated changes) have been addressed below and are also reflected in the manuscript. Reviews: 1-2 are addressed now in Section 3.4 (lines 352 - 371): "The RTM results described here are dependent on vertical distribution, total aerosol loading (i.e., AOD), α, R and SZA, for which again due to the limitations of the aircraft experiment we had little clear-sky data to choose from and thus retain the BBR instruments for evaluating column closure. The impact of the vertical distribution has been addressed already within the context of the vertically resolved irradiances and heating rates in the previous two sections. Of significant importance is how the net surface SW radiances from different NAAPS versions are distinct from each other, even though neither column AOD, nor the aerosol vertical distributions vary dramatically between NAAPS runs. This is primarily due to differences in speciation classification among the profiles, not because of total aerosol loading. In other words, AOD is similar, but the speciation distribution is not, so this is a reflection of the radiative forcing efficiency of the aerosol. Notice on Table 1, that the distribution of urban aerosols is much higher in the NAAPS FREE than on its counterparts, constituting 33% of the total AOD. Urban aerosols only represent 15% of the total AOD in the operational run (NAAPS) and 6% in the NAAPS 3D. On the other hand, the smoke is distributed very differently (80% NAAPS, 87% NAAPS 3D, and 60% NAAPS FREE). FLG utilizes total AOD and the speciation distribution (percentage weights) in the calculations. Therefore, we believe difference in the surface (and in the net) SW radiances are strongly dependent on our choice in aerosol optical properties that are associated to the difference in speciation, to include the single scattering albedo (ω_o) and particle radius. The magnitude of the aerosol forcing is highly sensitive to absorption in the particle size range of anthropogenic aerosols (Nemesure and Schwartz, 1995), which influences these results. The same can be stated about the results with the HSRL extinction. Recall that the entire aerosol loading within the HSRL is made up by smoke and urban aerosols, which are concentrated in the same layer. Not only are soot aerosols highly absorbing due to the presence of black carbon, prescribed by the OPAC climatology (i.e., ω_o of 0.880 at

555 μm , Hess et al., 1998), but OPAC urban aerosols also contain a significant mass density of soot (7.8 mg m-3) and high ω_o (0.817 at 555 μm) as well".

3. Another reviewer also pointed this out, within the context of better explaining the model initialization and parameters. Now it is clear on Section 2.6 that all of the NAVGEM/NAAPS profiles used as input, correspond the previous analysis time (15-18 UTC) – which means that the match between the observed radiances (aircraft) are compared to radiances calculated with profiles from the closest analysis time. The 18Z analysis is the closest to the discussed study case. I truly appreciate you asking for this clarification. The beginning of Section 2.6 now reads (lines 194-211): "HSRL aerosol observations are matched spatiotemporally to the closest NAAPS/NAVGEM analyses profiles. All versions of NAAPS used on this paper contain extinction (α) and AOD profiles from the surface to 100 hPa at 22 (now 35) sigma levels of variable vertical resolution (higher resolution in the lower atmosphere). In order to perform comparisons between model and observed fields, the HSRL data are "reduced" to the same model vertical resolution by employing a nearest neighbour classification constrained to model top and bottom. Besides the aerosol, FLG requires input of atmospheric background fields. P, T, q, and O3 profiles are obtained from NAVGEM's previous analysis time to the flight overpass. The case study presented here (19 August 2013), uses profiles from the analyses corresponding to 15 and 18 UTC. There are four different aerosol profiles used as input: one from HSRL (taken as the true) and three that are obtained from the closest NAAPS analysis (which matches NAVGEM's analysis time). Besides extinction, both the HSRL and NAAPS datasets also contain aerosol speciation profiles. Therefore, each extinction profile is paired to a corresponding speciation profile that is matched to the FLG internal optical properties as described below. Each of the NAAPS analyses profiles correspond to a different assimilation version, as described in Section 2.2 (NAAPS 3D, NAAPS OPS, NAAPS FREE). A control run (NOAER) is set in a similar fashion, but with no aerosol feedback included. Radiative transfer calculations on FLG are performed on each profile from surface to TOA (0.1 hPa), and we assume there is no significant aerosol loading above the 100 hPa level

(aerosol layers above 100 hPa are padded to 0). This is consistent with the current HSRL observations from SEAC4RS, which are simultaneously constrained to aircraft height and surface elevation (the top of the HSRL observations is generally obtained within 7-10 km AGL)".

4. Some of this is also addressed in review statements 1-2, as discussed above. All statements pointing to smoke as a primary aerosol have been modified to include both (primarily lines 84-86 and lines 213-215). Technical corrections: Name correction in line 51 has been made to "Mulcahy et al." Line 297 has been corrected to read: "run (to the control run (no aerosols or clouds))".

Please also note the supplement to this comment:
https://www.atmos-chem-phys-discuss.net/acp-2018-284/acp-2018-284-AC1-supplement.pdf

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