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Atmospheric Chemistry and Physics Discussions

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Interactive comment

# *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 3 Atmos. Chem. Phys., http:// editor.copernicus.org/ From: Dr. Mayra I. Oyola mayra.oyola.ctr@nrlmry.navy.mil

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Dear Reviewer 3,

We are appreciative that you have considered reviewing our article: "Quantifying the Direct Radiative Effect of Absorbing Aerosols for Numerical Weather Prediction." for



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Discussion paper

publication in the Journal of Atmospheric Chemistry and Physics. Thank you for your time 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: This is discussed on (now) Section 3.5 “On the impact on NWP” “One final question for future consideration arising from this work relates to how changes in the vertical distribution of aerosol-induced forcing and heating can potentially impact a forecast cycle, particularly if heating rates of the magnitude exhibited in this case are sustained within one or several data assimilation cycles within the global modelling system. We emphasize this potential in the context of differences in the vertical impact for NAAPS, HSRL and scale-height aerosol. The distribution of the modeled aerosols (Fig. 2) puts most of the aerosols within 700 hPa, which is a forecast level that is mostly associated with forecast of precipitation and surface temperatures; while scale height distribution of aerosols would put most aerosols within the boundary layer (BL), something that would potentially influence near-surface dynamics and diurnal cycles in a model. On the other hand, the “aerosol true” (HSRL) peak loading is in the middle of the atmosphere (∼500 hPa), which can possibly impact 1000-500 hPa thickness (influencing temperatures and mid-level jets) and advection fields. The influence of using near real-time aerosol fields in the data assimilation and NWP fields, and their sensitivity to optical properties, is being studied further, not only for absorbing aerosols, but a full aerosol suite and not constrained to a study region, but globally. Two follow-up publication specifically address these issue, but within the context of dust and seasalt profiles. Using a 1D-Var, biases of up to 2K in temperature and 8K in dew point were found as a function of optical depth. Additionally, the newly retrieved profiles were substantially improved when compared to aerosol observations. We are also finalizing the inclusion of aerosols perturbed satellite radiances in the Navy’s data assimilation system, where we have observed significant impacts on the relative humidity and temperature innovations, and an increase of more than 20% in the number of observations that pass quality and control for all hyperspectral sensors across the board”. Yes, the magenta lines are correct. The magenta lines





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represent the standard albedo used operationally in every case, something that is not well-explained in the paper. Therefore it has been clarified in lines 285-287: “It is noteworthy to mention the control run does not vary the albedo and it is representative of the operational parameters used in NAVGEM (Table 1)”. That is an excellent question. This has been addressed now in lines 353-371: “The RTM results described here are dependent on vertical distribution, total aerosol loading (i.e., AOD), $\alpha$, 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 distribution 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. 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 ($\omega$_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,





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prescribed by the OPAC climatology (i.e., $\omega$_o of 0.880 at 555 $\mu$m , Hess et al., 1998), but OPAC urban aerosols also contain a significant mass density of soot (7.8 mg m-3) and high $\omega$_o (0.817 at 555 $\mu$m) as well". Technical corrections: Sentence 286 has been changed to read: "R strongly influences the SW RT estimates. From Figs. 3-6, despite obtaining near-closure in the SWâĘŞ term (Figs. 3a, 4a, 5a, 6a), only the outputs with the MAIAC 555 $\mu$m BRF (Fig. 5a) approach closure in the SWâĘŚ. That is, here we compare radiances with the airborne NRL radiometers mounted on the DC-8". Units have been added to Tables 2 and 3 as requested.

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