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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Comparison of surface and column measurements of aerosol scattering properties over the western North Atlantic Ocean at Bermuda" *by* R. P. Aryal et al.

Anonymous Referee #2

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The manuscript summarizes the results of a 6-month comparison of surface-level and column-averaged aerosol radiative properties measured at Tudor Hill, Bermuda. The aerosols arriving at the site arise from a wide range of sources with significantly different optical properties. Ayral et al employed standard remote sensing techniques developed by AERONET and MPLNET, along with measurements of surface-level light scattering at 530nm for two size cuts (sub-10μm and sub-1μm aerodynamic diameters). Temperature profiles from twice daily radiosonde launches from a nearby site were also used. In situ measurements of aerosol light absorption were also made but the data was not used in the study. Likewise, there were no days with sufficient

aerosol optical depth to reliably retrieve the imaginary refractive index (and hence absorption information) from the AERONET retrievals, although the results were used in Mie scattering calculations. In spite of these limitations and the lack of in situ – derived aerosol intensive properties, the measurements possess the capability to provide scientifically-relevant information regarding the degree to which some lower tropospheric aerosol properties (scattering coefficient and sub-micron scattering fraction) measured at an important marine site are representative of related column-averaged aerosol properties. Despite the potential for scientific impact, missing information on key aspects of the employed methods, lack of meaningful analysis of the results, questionable choice of some presented data products, and the failure to place the study or results in the context of other similar studies (of which there are several) conducted in other regions results in a minimal contribution to scientific progress, as defined by Atmospheric Chemistry and Physics (substantial new concepts, ideas, methods, or data). These points are outlined in the following section and discussed in more detail in the subsequent comments. Scientific Significance: As stated above, the topic of the paper is very scientifically relevant. The degree to which complimentary datasets measured at strategic regional sites can be merged to maximize knowledge of aerosol/climate interactions can provide valuable information for validating satellite-based aerosol retrievals and (in some cases) CTMs. However, the choice of questionable methods in cases (Mie calculations derived from AERONET size distributions and then compared to AERONET AOD), poorly-described in situ sampling methods„ lack of meaningful analysis of discrepancies, and data products with limited usefulness lead to a fair/poor rating for scientific significance. Scientific Quality: I believe that this is the major weakness of the paper and leads to results with very limited scientific significance. In situ sampling protocol was poorly described, leading to at best questionable usefulness of the scattering data. Minimal analysis regarding discrepancies between surface and column-averaged aerosols was provided and very little consideration of related work was provided, resulting in poor scientific quality. Presentation Quality is fair, in that results and conclusions are clear and most of the figures are of acceptable quality (except

Figure(s) 1, as discussed below). Though concise and well-organized, the analysis and conclusions were lacking in detail. In summary, the manuscript in its current state lies in the poor/fair range and requires major revisions (as outlined below) to the analysis, methods, and in relating the work to the results of others in order to be acceptable for publication.

Specific Comments:

1. The abstract is concise and provides a reasonably complete summary but contains some misleading (although not completely inaccurate) phrases regarding the absorption measurements and the complex refractive index. Absorption measurements were made but only at one wavelength and they were not used in the study so the reference to 'spectral absorption measurements' should be re-phrased or better yet, omitted. Furthermore, there were no days where the optical depth was sufficient for reliable complex refractive index retrievals so the reference to column-averaged Angstrom exponent derived using a column-averaged size distribution and complex refractive index should also be re-worded to more accurately describe the study.

2. The Introduction section is brief and consists primarily of a few generic comments regarding well-known aerosol impacts on climate and the utility of co-located surface in situ and remotely-sensed aerosol measurements. No mention is made of results from any of several similar studies conducted in other regions to assess the representativeness of the surface-based aerosol measurements. A few examples are (i) Quinn et al,JGR-2004; (ii) Sheridan et al, ACP-2012; (iii) Andrews et al, JGR-2004. A reference to the Voss 2001 paper and a few others is included along with obvious comments regarding paired measurements of optical properties but no mention is made of any conclusions from these studies or how the current work will add to these results. For these reasons, the Introduction section requires significant revisions to place the current work in the context of previous works and to emphasize the novel contributions of the study to the current state of knowledge.

3. The discussion of near-surface aerosol light scattering measurement (section 2.1) and the air sampling was lacking in some key areas. (a) The internal RH of the nephelometer used to make the scattering measurements was never mentioned and is critical to interpreting the results. The authors do state that the air was heated to temperatures of 28$\pm$50C, which could lead to a very wide range of RH values. Was there any sort of RH control employed? My guess is that at these temperatures and at ambient temperatures and RH typical of the region, the internal RH could often be significantly above 50% and at the very least can take on a wide range of values. This in turn results in a poor assumption of dehydrated aerosols for several aerosol types, especially for air masses with continental influence, where aerosols often exhibit a slower (but non-negligible) scattering versus RH portion of the growth curve for RH $\sim$30-60%. (b) Insufficient information was provided regarding the sampling infrastructure. Unlike NOAA-GMD sites, which all employ the same instruments (TSI nephelometers, Radiance Research PSAPs), tubing diameter/type, impactors,etc., the setup at the site of the study does not appear to follow standard protocols with well-estimated particle losses and uncertainties. For this reason, details regarding air sampling should be provided. Simple references to papers regarding AERONET and MPL NET protocols is acceptable for the column-averaged and vertically-resolved aerosol measurements, respectively.

4. The methodology for Mie-based scattering calculations in section 2.3.3 is mystifying. The authors applied size distributions from AERONET to the Mie calculations to calculate column-averaged scattering contribution to AOD, which would be acceptable if not for the fact that the resulting scattering was used for comparison with AERONET AOD. The use complex refractive indices derived by AERONET that are highly uncertain at the measured AODs is questionable, at best. The authors did acknowledge the high uncertainty but the benefit of the results from the Mie calculations are debatable

5. The analysis is often incomplete and in some cases prone to misinterpretation. Take for example the discussion of AOD versus in situ-measured bulk aerosol scattering co-

efficient in section 3.1. In general, the results exhibit some degree of correlation but this will nearly always be the case. The authors gave one example (March 23) of poor agreement and illustrated the likely reason on for the poor agreement on that day using vertical profiles of aerosol extinction coefficient. This should have been supplemented with a vertical profile of RH derived from the radiosonde to provide context for the lidar-measured aerosol profiles (i.e. Was the deviation due to an elevated aerosol layer or perhaps hygroscopic growth present in a moist layer?). Furthermore, such results were then extrapolated to other periods of poor agreement, using only references to a few other studies conducted in different regions and with little substance. The level of agreement could have been investigated in more detail using, for example, comparisons of the level of agreement for days with no upper level aerosol layers versus that for days with upper-level aerosol layers measured by the lidar. The degree of correlation will also depend on RH inside the nephelometer and the vertical profile of ambient RH. neither of which was discussed, despite the availability of radiosonde-measured RH profiles. These omissions make interpretation of the correlations extremely difficult.

6. The Conclusion section is brief and weak. The main result emphasized was reasonably good correlation between variables that are expected to have a fair degree (on average) of correlation. Deviations were simply attributed to vertical structure in the lidar profiles. The final sentence “The generally good agreement between the paired measurements suggest that, in most cases, aerosol optical properties measured at the surface can be extrapolated with reasonable confidence to the overlying atmosphere” overstates what can be concluded based on measurements of only size-segregated aerosol light scattering at a single wavelength, which may or may not have been conducted at well-known and controlled RH values (not stated).

Technical Corrections:

1. Figure(s) 1 are difficult to read, when viewed at 100%. I needed to magnify to 200-300% to clearly see the figure details. Please consider using larger font and perhaps making the font bold to enhance readability, or else increasing the size of the figure.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 1791, 2014.