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Atmospheric Measurement Techniques Discussions

Interactive comment on "Retrievals of Aerosol Optical and Microphysical Properties from Imaging Polar Nephelometer Scattering Measurements" *by* W. Reed Espinosa et al.

Anonymous Referee #1

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General comments:

The inversion algorithm GRASP is applied to airborne and laboratory measurements made with the novel Polarized Imaging Nephelometer PI-Neph. The final goal is to retrieve airborne aerosol size distributions, complex refractive indices, and percentage of spherical particles. The airborne measurements were made aboard the NASA DC-8 aircraft during the SEAC^{4}RS experiment. The selected set of data contains the highest aerosol scattering levels during fifty separate sampling periods over the course of ten different flights. It represents a wide range of aerosols including urban pollution, organics, Saharan dust, and biomass burning. Simultaneous measurements with other two optical and one aerodynamic particle sizers aboard the aircraft are used for

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Discussion paper

inter-comparison with PI-Neph retrievals.

The combination of the complex inversion algorithm GRASP with the PI-Neph airborne measurements of the P_{11} and -P_{12}/P_{11} elements of the scattering matrix at three different wavelengths mark a significant step forward in retrieving physical properties of atmospheric aerosols. The manuscript provides a detailed description of the experimental approach and methodology in the retrieval procedure. Moreover, it gives a quite critical presentation of their own results which is highly laudable. Therefore, I strongly recommend publication of this paper on Atmospheric Measurements Techniques. However, there are some minor issues that I would like the authors to clarify before publication.

Specific comments

- Page 3, lines 19-20: “This compact device (PI-Neph) is capable of measuring scattering matrix elements with an angular resolution and range that has previously been unavailable in polar nephelometers.” As mentioned in page 4, lines 5-6, "PI-Neph measurements are generally made over and angular range of 3 to 177 degrees in zenith scattering angle, with an angle resolution of less than one degree”.

The authors do not seem to be aware of the polar nephelometer that is in operation for more than six years covering the scattering angle range from 3 to 177 degrees with an angular resolution of 1/8 degrees (Muñoz et al. Icarus, 211, 894-900, 2011).

- Page 4, line 4: β_{sca} must be defined.

- Page 4, line 9. “.. the nearest neighbor technique used to extrapolate the P_{11} at the truncated regions around 0 and 180 degrees”.

A meaningful extrapolation of the experimental diffraction forward peak (0-3 degrees) is not trivial see e.g. Liu et al. JQSRT 79-80, 911-920, 2003. Please, include the description of the extrapolation procedure.

- Figure 6 (top panel) presents the spectral dependence of the absolute phase functions

in BB plume1 together with the GRASP fits. How are the absolute phase functions obtained out of the measured values?

- Page 9, lines 25-30. It is claimed that the overestimated imaginary part of the refractive index for the ammonium nitrate, ammonium sulfate, and sodium chloride may be due to an unrealistically high retrieved real refractive index. The imaginary part of the refractive index is also overestimated in the Polystyrene spheres case reported in page 10, lines 12-16, even when the retrieved real part of the refractive index is in agreement with the nominal values. That seems to indicate that GRASP could produce a systematic overestimation of the imaginary part of the refractive index. As claimed in the paper "a detailed analysis of the sensitivity of the GRASP/Pi-Neph retrieval to absorption is beyond the scope of this paper". I agree that a more detailed study is needed and it is beyond the scope of this paper. In any case as a future work I recommend the work of Zubko et al. JQSRT, 151, 38-42, 2015, where the location and amplitude of the negative polarization minimum is used to retrieve the complex refractive index for dust grains.

- Page 10. A figure with the spectral dependence of the measured P_{11} and -P_{12}/P_{11} elements and corresponding fits for the monodisperse PSL spheres must be included.

- Figure 6 proves the accuracy of GRASP in reproducing the spectral dependence of the P_{11} and -P_{12}/P_{11} elements in the case of fine mode biomass particles i.e. BB plume1. A similar figure must be included for the Forested BL case that presents a size distribution with coarse mode. That would be an important test for the performance of GRASP and the spheroidal model. As mentioned in the paper, the scattering of non-spherical particles tends to deviate less from that of spherical particles as particle size decreases.

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