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Interactive comment on "A new method for measuring optical scattering properties of atmospherically relevant dusts using the Cloud Aerosol Spectrometer Polarization (CASPOL) instrument" *by* A. Glen and S. D. Brooks

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This is a nice paper that provides some validation results for a new, apparently commercially available aerosol instrument, the Cloud Aerosol Spectrometer with Polarization option (CASPOL). The authors suggest that this instrument can be useful in measuring and categorizing dust aerosols for in situ applications and/or for providing fundamental information to inform remote measurements or radiative transfer models. A range of dust aerosols were produced in the laboratory and some interesting and innovative data treatments were applied to the optical data. The instrument produces information

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Interactive Discussion

Discussion Paper

on single particles, which can be advantageous if enough data can be accumulated to establish statistical representativeness. The paper will be of interest to the readers of ACP.

I have a number of substantive comments that the authors should consider before final publication in ACP and one admittedly petty semantic argument (that I will start with). The authors have chosen to call a parameter (Eqn. 1) that is the fraction of the back-scattered light whose polarization has been rotated by 90 degrees from the source laser the “polarization ratio”. I understand their argument that the “depolarization ratio” is already a defined parameter used by the LIDAR community, and that this parameter is not the same; and this feels a bit like a “how many angels can dance on the head of a pin” argument, but I think their nomenclature is particularly unhelpful. I would strongly suggest calling the ratio something more descriptive like the “flipped” or “scrambled” or “rotated polarization ratio”. On a more substantive note, I am at a loss to explain how a ratio of the intensity that is in a particular unfavorable (perpendicular) polarization to the total intensity of the back-scattered light can be greater than unity. Unless there is something more subtle going on, I have to conclude that the polarized and total back-scatter detectors weren’t balanced and that the ratio is not what it appears to be. (This is not really important to the central arguments in the paper, since the absolute value of the polarization ratio wasn’t used.) I do think the authors should clarify this and also say whether the forward and back-scattering detectors were balanced, since that would impact the calculations of back-scatter cross-sections reported near the end of the paper.

I would like to see the authors “stretch” a little bit more in the final version of the paper and provide some suggestions with respect to the physical phenomena being probed in these experiments. For those readers who are not used to thinking about scattering and polarization effects, some simple explanation of how back-scattering from a dust particle can result in a 90 degree rotation of the polarization of the light would be very useful. And this explanation could be used later in the paper to try and suggest

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some level of interpretation of the observations. Admittedly, the polarization ratio is a complicated function of shape, size, composition, etc. but surely there must be some level of rationality of the observations and linkage to the dust particle characteristics that can be used to provide a more fundamental interpretation of the results, or at least some guidance in extrapolating the characterization to "similar" but previously unexplored dust types?

In Figure 4 there are error bars on the forward-scattering-determined particle sizes, but there is no discussion of the precision of the measurement that I can find. Based on the error bars in Fig. 4, it appears that the relative precision is of the order of 20 – 50% but the figure of merit for this is not clear (for example, if the error bars are +/- 1 sigma, the 95% confidence level for a single-particle size could be of the order of 100%). This should be clarified, and the ideal measurements to base it on would be the calibration results (it is my understanding that the VOAG produces a very tight monodisperse aerosol). If possible, the authors should also provide a relative uncertainty estimate for the total and polarized back-scatter measurements (just the optical part).

I also would find it useful if the authors would explain how the qualification detector determines whether a particle is in the laser beam or not (if these details are not proprietary). Some comment on the "hit rate" – i.e., the fraction of particle signals that were usable or had to be disqualified for both the (spherical) calibration aerosols and the dust particles, which are known to have problems following flow lines – would be useful in constructing a signal estimate, as explained below.

In looking at Figures 9 and 10, my eyes are trying to suggest that group C is a linear combination of groups A and B. Are there any statistical validations of the assignment of the dust aerosol types to three distinct groups? Is it possible that there is a continuum of types and the authors fortuitously sampled types at either end of that range?

My last substantive comment is inspired by the beautiful and revealing Figure 6. It appears that a single particle measurement could give virtually any "answer" suggesting that a robust analysis/characterization of the dust aerosols will require a substantial data set. Have the authors attempted a "signal calculation" based on a best case hit rate from the calibration experiments and atmospherically-relevant dust number concentrations to see if that type of data acquisition will be feasible? It seems to me that this estimate would be very useful to include in the final version of this paper to guide potential adopters of the method. (Would it be likely to succeed in an airborne application?)

There are also some technical corrections that I noted, although this was generally a well-written manuscript: Passages on page 22418 line 9 and 10 and page 22429 line 16 – 18 are not complete sentences and should be fixed. On page 22419 near the top, the paper by Baumgardner is not currently available, so this section should be rewritten to stand on its own, optimally incorporating a physical basis for the phenomena as mentioned above. Same page, line 13 – change ability to capability Line 18 change variable to variation Same page, change "total backward and polarized backward light from spherical particles, and various types of non-spherical dusts generated in the laboratory" to "total and polarized back-scattered light from spherical particles, and various types of non-spherical dust aerosols generated in the laboratory" Page 22425 line 2 – is the only possible interpretation that bigger particles are more spherical? And line 4 – the absolute differences between the sets are getting smaller, but are the relative differences? Page 22426 line 11 – it is true that size isn't the only dominant factor but the variation in backscatter with size is still bigger than with shape, etc., so this statement seems too strong. Fix the first part of the caption for Figure 4.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 22415, 2012.

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