Atmos. Chem. Phys. Discuss., 7, S6217–S6221, 2007
www.atmos-chem-phys-discuss.net/7/S6217/2007/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Optical particle counter measurement of marine aerosol hygroscopic growth" *by* J. R. Snider and M. D. Petters

D. Baumgardner (Referee)

darrel@servidor.unam.mx

Received and published: 22 October 2007

The authors make a valiant effort at extracting additional information about the properties of aerosol from measurements with optical particle counters (OPC), in particular the PCASP and the FSSP-300. In the end, the results are convincing and they have done a very nice job of constraining the uncertainties. The style of writing, however, is at times obtuse and difficult to understand. Examples are listed below.

Growth factors have been derived using a variety of methods in previous studies. The authors should put their results in the context of what has been previously published. For example, using two nephelometers, Hegg et al. (1997) measured the GF of aerosols in almost the same region off the coast of California, under and over marine stratocumulus and during the same season, but nine years earlier. They determined

that the GF could vary between 1.2 and 2.4 (their Table I), but concluded that they were consistent with what being used to evaluate the impact of marine aerosols on radiative fluxes. Comparing their results using a technique different than those used in previous studies is not only a good sanity check that the technique is producing reasonable results but is also necessary if the intent of the submission is more than just an evaluation of another method for determining GF.

The use of the FSSP300 for deriving GF is not an entirely new idea, although comparing it with the PCASP is. Perhaps it would still be relevant to the current submission to read the paper by Baumgardner and Clarke (1998) who discuss many of the same issues with the FSSP-300 but take a somewhat different approach to look at how humidity changes the particle volume and at one point in the paper show measurements that are consistent with the Tang et al. laboratory studies of common salts.

Specific comments and questions

Page 12384, line 29: "Sampling conducted in dry air above the marine boundary layer (RH$<$40%) reveal GF values that are approximately equal to unity, as expected." Why would the growth factor above the boundary layer have an expected value of unity?

Page 12387, lines 9-27: The discussion of how the sample area of the FSSP-300 is derived by comparing the counting statistics of PCAS and FSSP300 is very difficult to follow. Why are counting frequency statistics being used as opposed to comparing the absolute number of particles counted in the overlapping size range? The methodology here is very difficult to follow and too brief to understand how the final value of sample area is obtained, a value that turns out to be within area reported by the manufacturer, within the uncertainty of technique used in the derivation. The independent derivation I think is a critical aspect of this paper as it shows that the concentrations measured by the PCASP and FSSP-300 are consistent and hence there is no major instrument issues to resolve before the derivations of GF. What is missing is a more succinct explanation. It should also be noted in this section of the paper that obtaining the overlapping

ACPD
7, S6217–S6221, 2007

EGU

size intervals is very sensitive to the assumed refractive indices for both the PCASP and FSSP-300. The fact that the derived sample area is so close to that measured by the manufacturer in the laboratory and derived from optical considerations, is further proof that differences in refractive indices from those that are assumed and actuality will probably have a very small impact on the derived GF.

Page 12388: The discussion about the differences between the wing=mounted instruments and the internally operated LAS has no relevance to the objectives of this paper and should be removed as it only confuses the issue.

Page 12389: How was the Poisson sampling error derived in equation 3? The usual way to calculate the sampling error is via the binomial probability distribution and is typically stated as N1/2/N.

Page 12390: Line 28. What is "Vida Infra";?

Page 12392, line 5: The assumption that there is no BC is probably not warranted for two reasons: 1) OC abd BC are usually very highly correlated and the conclusion of this manuscript is that between 40 and 80% of the aerosol mass is non-hygroscopic material, i.e. OC, hence there must most likely be significant BC in the particles and 2) recent studies, i.e. Ace Asia and PacDex have shown that there is a significant amount of OC and EC that is transported from Asia. It could well be that the BC in the core of some of the aerosol particles is quite small and the subsequent effect on the size threshold definitions also negligible. It would be much more convincing if the authors ean a few refractive indices through the Mie code for the scattering angles of the FSSP-300 and varying amounts of BC, using the volume mixing rule, to show the potential effect.

Page 12393: The derivation of the growth factor uses a comparison of the coefficients from curve fits of a power law to the regions of the size distributions from the PCASP and FSSP300 that overlap and are monotonically decreasing in concentration with size. This definition assumes that the slopes of the two distributions are identical and only a

ACPD

7, S6217–S6221, 2007

scaling factor separates the two, a scaling factor that used to define the GF. This section has to be expanded with a more clear explanation for the basis of this way of defining the GF. Previous studies have used diameter, volume or scattering coefficient defined at two RH values to determine the GF. There has to be some explanation between these previous definitions and the one used in this paper. It is not at all clear how this definition of the GF is truly a measure of the change in particle diameter or volume as a function of RH. This definition obviously is what brings about the assumption that the GF should be equal to unity above the boundary layer when the RH is low, but is very deceiving to the reader who is accustomed to a growth factor that is not related to the RH but is related to the properties of the aerosol particle itself. It was not until reaching section 3 that I finally realized that all the references to a growth factor in previous sections had to do with the unique way of defining hygroscopic growth but can not be directly related to what others have used as a definition. This has to be clarified and in fact I recommend that the term "growth factor" not be used but that some other term is defined that is relevant to how the value is derived in equation 6.

Secondly, the theoretical underpinning of this new definition is not clear. Why should one expect that the slopes of the two distributions be the same when the RH of the PCASP is low and that in the FSSP 300 at the ambient? The particles that are falling in the size range of the FSSP300 are smaller particles measured by the PCASP that have grown into the size range of the 300. In the paper by Strapp et al., I believe they actually try to look at the shift in the size distributions between the PCASP and FSSP-300 as a function of RH. It would seem to me that plotting the volume as a function of size from the two OPCs and then calculating the necessary shift in diameters between PCASP and FSSP-300 to match the two spectra would be a more relevant measure of the GF. Regardless, the explanation of how this technique produces a relevant measure of hygroscopic growth requires more detail that given at the moment.

References

Baumgardner, D. and A. Clarke, 1998: Changes in aerosol properties with relative

ACPD

7, S6217–S6221, 2007

humidity in the remote southern hemisphere marine boundary layer, J. Geophys. Res., 103,16525-16534. Hegg, D.A., D.S. Covert, M.J. Rood, and P.V. Hobbs, Measurements of aerosol optical properties in marine air, J. Geophys. Res., 101, 12,893-12,903, 1996.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 12381, 2007.