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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Size-dependent aerosol deposition velocities during BEARPEX'07" *by* R. J. Vong et al.

Anonymous Referee #3

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Vong et al. present size-dependent aerosol deposition velocities measured by eddy covariance with an optical aerosol spectrometer (FAST) during the BEARPEX field measurements in 2007. They discuss the frequency response of the aerosol spectrometer on the basis of spectral analyses, the effect of hygroscopic growth on size-segregated aerosol flux measurements, and the dependence of the aerosol deposition velocity on the friction velocity. Until now, size-segregated aerosol flux measurements are not routinely carried out. Thus, such measurements are a valuable contribution to the field. While the analysis procedure and the discussed corrections are comprehensive, I find the presentation and discussion of the results quite short. Therefore, I would like to ask the authors to add more details, a few clarifications, and some additional discussion as outlined in the following comments:

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a) Calculation of the deposition velocity: vd=flux/mean particle concentration (negative as downward) is inconsistent with the commonly used sign convention vd = - flux/mean particle concentration (positive as downward, e.g. Pryor et al., 2008; Seinfeld and Pandis, 1998). It is explained in section 3.8 that negative vd implies downward transfer towards the ground. However, this is especially confusing when comparing the size dependent deposition velocities of Fig. 7 with modeled deposition velocities. When looking at Fig. 7, I was misled by the negative slope of the size dependence when comparing with the typical shape of the deposition velocity size dependence. Therefore, I suggest using the conventional definition of vd for better comparability of this work.

b) Hygroscopic growth: Explain in more detail on p. 4652, l.14, how the RH conditions of the two WELAS OPCs were set and controlled? In section 3.5 it is stated that hygroscopic growth is determined by the chemical composition of the aerosol and does not vary rapidly in time. It may be worth adding that a correction based on a "bulk" growth factor implies that the hygroscopic properties of updraft and downdraft particles are the same. However, it cannot be ruled out that updraft and downdraft particles differ in chemical composition, and thus, in their hygroscopic properties. This should be briefly mentioned in the manuscript. The presentation of the variation of the hygroscopic growth parameter in Fig. 3 is somewhat confusing. Why do you discuss positive values in the text (section 3.6) and present negative values in the Fig. 3? The range of values is given as 0 to 0.12 in the text while Fig. 3 indicates that values outside of this range have been observed at times. Please discuss the Gaussian fit to the frequency distribution. Finally, it may be instructive to add the "Junge" slope fit to each FAST diameter interval in the average size distribution presented in Fig. 4.

c) FAST inlet: In the last sentence of section 2.2 it is mentioned that inlet nozzles of varying diameter matched the aspiration velocity to ambient wind speed. Please add some more information about the FAST aspiration velocity and how often inlet nozzles were changed to achieve isokinetic sampling.

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d) Counting statistics: When discussing counting uncertainties in section 3.3 it should also be taken into account that counting statistics are not the only source of uncertainty of the flux estimate. Therefore, the last sentence of section 3.3 seems to be a great understatement. It should be made clear in this section and in the discussion section that the results are afflicted with a considerable uncertainty, and the results for the larger particles (diameter > 0.5 μm) are not reliable.

e) Spectral analysis: In Fig. 2, the authors present normalized power spectra of virtual temperature. I assume these spectra actually represent sonic temperature which is indeed almost identical with virtual temperature, but not the same. In general, I find the presentation of the spectral analysis very brief, and the discussion of the particle spectra in Fig. 2 (top panel) somewhat misleading: While it is true that the particle spectra flatten out at a certain frequency, one could argue that this starts already at 0.1 Hz. When comparing the flux contribution of higher frequencies in Fig. 2 (bottom panel), one then arrives at much higher flux losses than stated in the text. Due to the steep slope of the particle cospectrum in this frequency range, I find an approximate 50 % contribution of frequencies higher than 0.1 Hz instead of the stated 15.6 % above 0.2 Hz. This should be discussed in the text. In addition, the similarity of the spectral shape of particle spectra and "well-behaved" vertical velocity spectra at lower frequencies is not discussed at all even though a distorted spectrum would contribute additional uncertainty. Taking this into account, the conclusion that the lack of high frequency response of the FAST did not substantially affect the measured fluxes (section 5) cannot be maintained.

f) Deposition velocities: It should be made clearer that the discussion of particle removal by inertial impaction in sections 3.8 and 3.9 is focused on the accumulation mode size range. The general statement that "larger particles have more momentum" (p. 4660, l. 19/20) is not true. In the discussion section, it is stated that the observed deposition velocities are larger than values predicted by the Slinn (1982) model. Could you directly compare the numbers and add the corresponding Slinn (1982) size depen-

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dence to Fig. 7 for better comparison? In addition, an overview table including average deposition velocities in the different size bins and parameters of regression analyses for the deposition velocities as a function of u* could illustrate the similarity with the findings of Gallagher et al. (1997) as mentioned in the discussion section.

Technical comments

p.4651, l.11: change "at 1315m. elevation" to "at 1315 m elevation"

p.4651, l.20: change "125m. to the N" to "125 m to the N"

p.4652, l.18: change "air at 12 l/m" to "air at 12 l min-1"

p.4653, l.16/17: change "40 particles in the for the smaller (e.g., 0.3 μm) particles" to "40 particles in the smaller intervals (e.g., 0.3 μm)"

p.4654, l.8 and p. 4659, l. 10: specify vapor fluxes as water vapor fluxes

p.4656, l.10: change "in Fig, 2 presents" to "in Fig. 2 presents"

p.4657, l.15: change "slope of the distribution" to "slope of the size distribution"

p.4659, l.9: Define the new variables introduced in equation 3.

p.4659, l.25: change "aerosol diameter particles plotted" to "aerosol diameter plotted"

Fig. 5: change the label of the vertical axis, e.g. to "number of occurrences"

References

Gallagher, M. W., Beswick, K. M., Duyzer, J., Westrate, H., Choularton, T. W., and Hullmmelshoj, P. (1997) Measurements of aerosol fluxes to Speulder Forest using a micrometeorological technique. Atmos. Environ. 31, 359–373.

Pryor, S. Gallagher, M. W., Sievering, H., Larsen, S. E., Barthemie, R. J., Birsan,F., Nemtiz, E., Rinne, J., Kulmala, M., Gronholm, T., Taipale, R., and Vesala, T. (2008) A review of measurement and modelling results of particle atmosphere-surface ex-

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change. Tellus 60B, 42–75.

Seinfeld, J. H., and Pandis, S. N. (1998). Atmospheric chemistry and physics: From air pollution to climate change. New York: Wiley, 1326pp.

Slinn, W. G. N. (1982) Predictions for particle deposition to vegetative canopies. Atmos. Environ. 16, 1785-1794.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 4649, 2010.