Atmos. Chem. Phys. Discuss., 10, C1361–C1366, 2010
www.atmos-chem-phys-discuss.net/10/C1361/2010/

ACPD

10, C1361–C1366, 2010

Interactive Comment

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

R. J. Vong et al.

VONG@COAS.oregonstate.edu

Received and published: 8 April 2010

Response to interactive comment by Anonymous Referee #3 on "Size-dependent aerosol deposition velocities during BEARPEX'07" by R.J. Vong et al. ACPD 10, 4649-4672, 2010.

This referee states that measurements such as presented here for BEARPEX "are a valuable contribution to the field."

ACPD Review page # (also referenced by the letter used by the reviewer: a through f)

p. C774, a) ∼The paper uses a different sign convention for Vd than others have. Over a number of past publications (e.g.„ in Tellus B, in 1995 and 2004; QJRMS in 1999) the first author has chosen to use a sign convention where both turbulent fluxes and Vd

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

have the same sign as each other and the vertical velocity (negative is downwards). This is a result of bidirectional flux observations and the ease of making statements general to both the fluxes and Vd (e.g., see current text, p.4659, lines 21-23) . The earlier derivation of the hygroscopic growth correction (eq. 2 here; also in Vong et al, Tellus 2004) has the assumption that ΔVd has the same sign convention as does w'S'. The entire analysis and wording within the text are based on this sign convention. We strongly prefer to retain the current sign convention while adding extra wording to make sure that no confusion exists among future readers. The current version of the text already identifies this employed sign convention in that negative Vd and fluxes are downward in the caption to Figure 1, and in section 3.8 (lines 16-17) and that same sign convention for w'S' is given on p.4659, line 18. We will add additional notes to the effect that "downward is negative" to the captions for Figures 5, 6, and 7, in the text where Figure 6 is introduced on p.4659, lines 26-28, and in section 3.9 p.4660, line 25. We expect that the sign convention will not cause any confusion with this additional labeling.

p. C774, b) "Explain in more detail. . .how the OPCs were set and controlled" The text states on p.4652, line 15 that "the two OPCs . . .(achieve). . .RH that bracket the ambient RH". Thus the hygroscopic growth was measured for the RH range appropriate to that particular day and time of day. We have added three additional references by Hegg et al. (GRL 33, L21808, 2006; AS&T 41, 873, 2007; ACPD 8, 7193, 2008) on this same twin OPC, aerosol hydration, system to the text on p. 4652, at lines 15-18 in order to more fully describe the measurements that determine gamma. We will add a brief statement concerning the inability of measurements to distinguish between any differences in gamma between up and downdrafts but we already note on p.4657, lines 21-22 that aerosol composition is not expected to vary rapidly in time for stationary conditions. We are revising the wording in the text to reflect the range in values for gamma including adding the words "between 0 and 0.14 for 95% of the measurements" on p. 4658, near line 12. Note that in the figure we have chosen to plot the exponent in eq.1 (-gamma); the text will now be changed to also refer to the exponent

ACPD

10, C1361–C1366, 2010

Interactive Comment

rather than ïĄğ. Regarding the Gaussian fit: the sample of gamma data is clearly not distributed normally, not bimodal, but rather scattered. Our point was simply to illustrate the observed variation around the mean value of gamma. We respectfully decline to add Junge slopes to Figure 4 because this would not be a clear presentation in our estimation due to overplotting of the data line with several slopes. We have added a reference to Junge for this type of plot (also at the request of reviewer #4) . On p.4659, line 1-2 of the text we modify that statement that "β decreased with increasing particle diameter (β = 10.1, 6.1, and 3.9 for Dp = 0.35 μm, 0.45 μm, and 0.55 μm, respectively)" by adding this size dependence of β in parenthesis.

p. C774, c) FAST aspiration velocity was determined by the blower setting and the inlet cross sectional area. A series of nozzles with ratios of cross sectional area of 1.5 were selected when the boom direction was changed to approximately match the most recent 30 min. ambient wind speed. This was generally done less than 3 times per day due to the steady nature of the daytime, upslope winds. The FAST face velocity was thus close (usually within $\sim$25%) to ambient wind speed but not fully isokinetic. Using formulas from Barron,P. and Willeke,K. (Aerosol Measurement: Principles, Techniques, and Applications", Wiley-Interscience, 2005) for non-isokinetic flow inlet collection efficiency at 1 μm diameter, 2 m/sec wind speed, and 25% non-isokinetic match of face and wind velocities the loss is 0.3% at 25 deg C. Other aspiration loses for accumulation mode particles are not significant because the inlet was pointed into the prevailing wind direction (twice per day usually, but up to 3-5 times) by orienting the sampling boom direction and because of this match of velocities. Losses at the inlet are negligible.

p. C775, d) "…last sentence of section 3.3 (regarding counting uncertainties) seems to be an understatement". This sentence will be clarified to indicate that "counting uncertainties are acceptable for the smaller (< 0.5 um) particles but are large enough to substantially reduce confidence in the results for the larger particles". Note that these counting uncertainties for Dp > 0.5 um in terms of the uncertainty in the mean

ACPD

10, C1361–C1366, 2010

Interactive Comment

values are actually 6% of the plotted errors in Figure 7 (as noted in the text already on p.4655, lines 16-17). Adding the two words "counting" and "substantially" to the quote above will clarify and modify the statement. Also note that later in the text on p.4661, lines 26-27, and on p.4662 line 1, and in the conclusions on lines 14-15 we highlight this counting uncertainty for the larger particles. In addition as we now add a table on regression fits to Vd vs U* , at the request of several reviewers, and in this new Table 2 we will omit the two larger diameters and so state that it is because of higher uncertainties. We feel that a reader cannot miss the fact that the results for these larger particles are not held in high confidence.

p. C775, e) $\sim$ “Sonic temperature is not the same as Tv”. We will add to the text on p.4655, in line 22 that “Fig.2 presents... spectra of ... sonic temperature (which is a close approximation to Tv), ...”.

The reviewer makes a good point that the text stated that “flattening ... in the (particle) spectrum suggests that noise is present and that the FAST did not fully (the word "fully" have been added in the revised version) resolve ...at the higher frequencies” and that this flattening (begins to occur) at 0.05 (Reviewer 4) and 0.1 Hz instead of our statements of 0.2 Hz on p.4656 lines 3-4, line 13, line 15 and line 23. These increase this particular estimate of lost flux due to lack of frequency response above the value of 15.6 % as was stated by us. The text on p.4656, middle paragraph will be revised to acknowledge that this particular method for estimating loss of flux gives a range of values from 15 to 50% for the spectrum flattening at the range of frequencies between 0.2 and 0.05 Hz.

However, the above discussion does not change the better of the two estimates of lost flux due to frequency response and the exact point of flattening in the spectrum perhaps is less critical than suggested in the text now. The smaller error estimate (6-9%) that is based on cospectral similarity between particles, heat, and water vapor is more valid and unchanged by this improved interpretation of the implications of the top panel in Figure 2. In fact the bottom panel of Fig.2 demonstrates that the FAST

ACPD

10, C1361–C1366, 2010

Interactive Comment

captured ca. 50% of the covariance at frequencies above 0.1 Hz, suggesting that the spectrum only appears to be white noise above 0.1 Hz. A random variable ("white noise") will not display covariance. That is to say, the cospectrum is more relevant to loss of flux (a reference on co-spectral similarity has been added in the revisions: Eugster and Senn, 1995) and the capture of flux at $f > 0.1$ Hz indicates that the FAST is not completely noise above 0.1 Hz despite the appearance in the top panel Figure 2. Text is added to this effect in several places in the revisions including changing the parenthetical statement on p.4656, line 23 to read "(where the spectrum appears to become mainly white)". In the conclusions we will modify the statement referred to by the reviewer to read "A comparison of the cospectra for particles with those for heat and water vapor suggests that the measured aerosol fluxes are underestimated by a minimum of 6-9 % and these underestimates may be larger ". We think that it is best to not correct the final results for frequency response due to irregularities in the particle cospectrum but of course we document and acknowledge these errors in the text. The word "substantially" will be deleted from the conclusions (line 12). We do not believe that the spectrum looks completely white at 0.05 or 0.1 Hz and at any rate covariance is captured at higher frequencies such that the FAST has to produce more than random noise despite the appearance of the spectrum. The cospectra comparisons provide the better estimate of flux loss (see also: reviewer 4).

p. C775, f) We will add the words "accumulation mode" as requested to sections 3.8 and 3.9. We will modify the text to state that "larger accumulation mode particles that move at the fluid velocity, as assumed by EC, have more momentum than smaller particles in the same fluid parcel". We are unaware of any reason, given this corrected statement, that would invalidate this assertion and we ask for the details in the referee's thinking if there is still any disagreement here. More mass at the same velocity means more momentum and more impaction is all that is intended in that statement really. We will add to the text on (p.4662 near line 5) a comparison of Slinn model values for Vd to those reported here but prefer not to plot them in Fig.7 in part because the model results are not our own nor likely "best estimates" at this point in time. The cited review

ACPD

10, C1361–C1366, 2010

paper by Pryor et al. does a good job of both summarizing past measurements and comparing them to models and this citation will be repeated on p.4662 in the discussion section.

At the reviewers' request, we will add a new Table 2 showing average concentrations, deposition velocities as f(Dp), and regression statistics for Vd vs. U* for the four best determined diameters (Dp < 0.49 um) from BEARPEX.

We thank the reviewer for the useful technical corrections listed on p. C776 and will include these in the revised manuscript. References: Vong and Kowalski, Tellus 47B, 331-351, 1995. Kowalski and Vong, Q.J.RMS 125, 2663-2684, 1999. Vong et al., Tellus 56B, 105-117, 2004.

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