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Atmospheric Measurement Techniques Discussions

Interactive comment on "Aerosol effective density measurement using scanning mobility particle sizer and quartz crystal microbalance with the estimation of involved uncertainty" *by* B. Sarangi et al.

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Anonymous Referee #3

Page no. 12909, the percentage range of error in density measurement of inorganic salts using SMPS-QCM setup should be mentioned in the abstract.

Response: Using SMPS-QCM setup, the effective density of laboratory generated ammonium sulphate, sodium chloride and ammonium nitrate particles with combined uncertainty is found to be 1.76±0.24 (±13.6%), 2.08±0.19 (±9.13%) and 1.69 g cm-

3±0.28 g cm-3 (±16.6%), respectively. We mentioned (both in conclusion (page no. 12917 and line no. 17) and Table 3 (page no. 12924)) the percentage of uncertainty contribution in the density of individual salts (i.e. AS, SC and AN). The percentage contribution of error in the measurement of effective density range is 9 to 17%. As suggested by the reviewer this percentage range is incorporated in the revised manuscript. Please see red ink in the abstract.

Page 12888, Line no. 10 ∼ :One is sent to a condensation particle counter (CPC) to measure particle number concentration, whereas other one is sent to QCM to measure the particle mass concentration simultaneously. Based on particle volume derived from size distribution data of SMPS and mass concentration data obtained from QCM, the mean effective density (eff) with uncertainty of inorganic salt particles (for 15 particle count mean diameter (CMD) over a size range 10 to 478 nm), i.e. AS, SC and AN is estimated to be 1.76 ± 0.24, 2.08 ± 0.19 and 1.69 ± 0.28 g cm−3 , which are comparable with the material density () values, 1.77, 2.17 and 1.72 g cm−3 , respectively. Using this technique, the percentage contribution of error in the measurement of effective density is calculated to be in the range of 9 to 17%. Among individual uncertainty components, repeatability of particle mass obtained by QCM, QCM crystal frequency, CPC counting efficiency, and equivalence of CPC and 20 QCM derived volume are the major contributors to the expanded uncertainty (at k = 2).

Page no. 12909, line no. 20, a '/' is missing. The correct form is "particle concentration accuracy is ±10 % for 400 000 #/cm−3"

Response: Done

Page no. 12892, line no. 16, author should mention the cutoff size range with the details of impactor used.

Response: We use different nozzle sizes for different sample flow rates in SMPS. For flow rate 0.2 to 0.8 L min-1, 0.0457 cm nozzle size is recommended. We use a flow rate 0.24 L min-1 in our measurements, the cut-off size (D50) of the impactor at this flow rate is 472 nm. Following the comment we have modified the text as:

Page 12892, Line no. 15 $\sim$: SMPS consists of an electrostatic classifier (EC, TSI 3080, including an impactor (0.0457 cm, TSI 1 502 296) and Kr-85 bipolar charger (TSI 3077), differential mobility analyzer (DMA, TSI 3081) and condensation particle counter (CPC, TSI 3788). Different nozzle sizes for different sample flow rates are used in SMPS, e.g. for flow rate 0.2 to 0.8 L min-1, 0.0457 cm nozzle size of the impactor is recommended. We use a sample flow rate 0.48 L min-1 in all the measurements, the cut-off size (D50) of the impactor at this flow rate is 472 nm.

Page no. 12894, line no. 4, the flow of the CPC 3788 should be either 0.6 lpm or 1.5 lpm, unless a custom configuration was used. Authors stated the flow was only 0.24 lpm, please clarify in the manuscript.

Response: We used the CPC 3788 which is also equipped with bypass flow regulator where we can regulate the desire flow rate apart from the custom configuration (i.e. 0.6 or 1.5 lpm). We used sheath flow rate 4.8 lpm and the sample flow rate is 0.48 lpm (i.e. 0.24 lpm to CPC and 0.24 lpm to QCM). The purpose of selecting 0.24 lpm for the CPC is to keep its flow the same as the flow rate of QCM (works only at 0.24 lpm for better size segregation).

Page 12894, Line no. 1 $\sim$: One was connected to CPC and other one to QCM, which were placed at equal distances from DMA (the tube length between DMA exit and inlet of CPC or QCM = 25 cm). The sample flow rate of SMPS was set to 0.48 L min$-$1, which is a sum of flow rates of CPC and QCM, i.e. 0.24 L min$-$1 each. The purpose of selecting 0.24 L min$-$1 for the CPC to keep its flow rate equals to the flow rate of QCM (works only at 0.24 L min$-$1 for the recommended size segregation). Sheath flow rate of SMPS was set to 4.8 Lmin$-$1. Particles of size range 10–478 nm were segregated by DMA and number concentration was measured by CPC. Simultaneously, corresponding mass distribution was obtained from QCM.

Page no. 12906, line no. 2, the version of TSI-AIM software mentioned is needed to

be mentioned in correct format.

Response: We thank reviewer for pointing out this. Following the comment, we have incorporated the version in two places.

Page 12906, Line no. 1 $\sim$: "particle loss on the impactor inlet, the bi-polar neutralizer, internal plumbing, the tubing to the DMA and CPC. Using inbuilt TSI-AIM (version 9.0.0.0, 15: 32: 53, November 11, 2010) algorithm, the diffusion correction was done and corrected number concentration of the particles is obtained."

Page 12907, Line no. 1 $\sim$ "allows the particle to be incorrectly binned into a smaller-sized particle channel. Therefore, multiple charge correction is performed using inbuilt TSI-AIM (version 9.0.0.0, 15: 32: 53, November 11, 2010) algorithm (which is based on Wiedensohler, 1988; Kim et al., 2005) that attempts to correct the sample data from the effects of the multiple charged 5 particles."

Page no. 12911, line no. 10, the section 3.2.3 is already a part of section 3.2.2, and is apparent in Table 3. Therefore section number can be omitted.

Response: Done

Page no. 12924, Table 3, authors should further check the relative standard uncertainty in AN column, and u4(m) row as it appears to be incorrect.

Response:We thank reviewer for pointing out this typo mistake. Following the comment, we have corrected the value. Also we found one more typo mistake just above this column. This correction is also incorporated in Table 3 in the revised manuscript.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 12887, 2015.