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Atmospheric Measurement Techniques Discussions
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Interactive comment on "Tandem configuration of differential mobility and centrifugal particle mass analyzers for investigating aerosol hygroscopic properties" *by* Sergey S. Vlasenko et al.

Anonymous Referee #2

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The authors describe the use of a DMA-HCPMA to measure the hygroscopic properties of aerosol particles. The paper is well written and structured, easy to read, and clearly explains most of the benefits of such a system.

Major comments:

A more thorough study into the uncertainties of measurement would be ideal, perhaps even as an appendix or SI. Though not common (arguably it should be), error propagation for measurement data would be very helpful in drawing conclusions as to the benefits or drawbacks of measurement techniques. How accurate is a standard HTDMA, for example? Few papers involving the use of HTDMA quantify the errors, yet draw conclusions regarding cloud formation and aerosol hygroscopicity, which in turn

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propagate through to κ values and into models. This is not good practice, and it would be useful to at least include some kind of error propagation (e.g. flows, voltages, etc etc) through to final values. The authors state that the difference between experiment and theoretical growth factor values does not exceed 10%. If the uncertainties are above 10% for the system (likely), then this is indeed good agreement.

The authors make no mention of the ZSR assumption of volume additivity. This seems like a near-ideal experimental setup to more accurately probe this conventional assumption. Perhaps ideally, dual-CPMA or CPMA-HDMA would be employed as the first DMA is still dependent on shape factor and morphology whereas particle mass is always particle mass. Comment?

Minor comments:

Final sentence of the abstract is muddled. It would read better as: “Direct measurements of particle mass avoid the typical complications associated with the commonly used mobility-diameter based HTDMA technique (mainly due to poorly defined or unknown morphology and density).”

Page 2 Line 6: arguably the aerosol is quasi-monodisperse and not truly monodisperse, due to multiple charging

Page 2 Line 32: This would be the ideal location to introduce the CPMA in more detail. E.g. “Mass classifiers started with the APM and improved with the CPMA” – the CPMA has a higher penetration efficiency for any given mass than the APM

Page 3 Line 1: Please check Kondo et al. 2006 for more references; and note that McMurray et al. 2002 conclude the DMA-APM to have around 5% uncertainty (this paper is already referenced)

Page 3 Line 4: Novel application

Page 3 Line 19: quasi-monodisperse rather than near-monodisperse

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Page 4 Line 5: technically, the CPMA classifies particles by their mass:charge ratio, not merely mass

Page 4 Line 11: the CPMA outer cylinder spins 3% faster ((33/32)-1)*100=3.125 %)

Page 4 Line 15: arguably, this is not actually a number-mass distribution. It is a distribution of average masses. No inversion has been performed. This terminology should be thoughtfully considered throughout the manuscript.

Page 4 Line 25: “were directly entered” should be “entered”

Page 5 Line 13: Though I understand it’s common, it’s sloppy/confusing to write AS for ammonium sulphate, as that would make sodium chloride SC. (NH4)2SO4 would be correct.

Page 5 Line 26: Not enough emphasis is placed on mass error of 10% translating to size error of 3%. This is where the DMA-HCPMA technique has the potential for significant benefit over some HTDMA measurements, should other issues be addressed.

Page 6 Line 6: . . . artefact of this technique

Page 6 Line 17: It is important to note that, as with the DMA, any change of the particle water uptake. . .

Further comments:

Though it is really the place of the authors to address referee comments, the first Referee is not correct in stating that the “transfer function of the APM or CPMA is even broader than the DMA”, and this should be addressed. The transfer function of an instrument is the relationship between its input and its output. For the CPMA, it relates the mass setpoint to the ratio between the concentration of aerosol downstream and upstream of the CPMA. The resolution of the CPMA is set by the width of the transfer function, and the maximum penetration by its height.

For the case of neutral stability the transfer function of the CPMA is essentially triangu-

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lar, and theoretically extends to 100% transmission at its peak (Figure 1):

It is of course possible to pre-classify with a DMA, but the highest resolution of the CPMA in size terms is much higher than any available DMA. However, broadening as with HTDMA instruments is non-trivial and should be discussed.

I agree that the inversion developed by Rawat et al. (2016) should at least be discussed in this paper. Regarding point (3) raised by Referee 1; the CPMA transfer function is not broad in mass-space. I agree that a broad range of masses enter the CPMA from the DMA, as the DMA's output will cover a range of masses as it's a mobility classifier. I refer the authors to my earlier comment regarding "average particle mass", though "modal mass" is probably more accurate as stated by Referee 1. For proper mass distributions the inversion by Rawat et al., or similar, should be used.

Kondo, Y., Komazaki, Y., Miyazaki, Y., Moteki, N., Takegawa, N., Kodama, D., Deguchi, S., Nogami, M., Fukuda, M., Miyakawa, T., Morino, Y., Koike, M., Sakurai, H., and Ehara, K. (2006). Temporal Variations of Elemental Carbon in Tokyo. J. Geophys. Res. 111:D12205, doi:10.1029/2005JD006257.

McMurry, P. H., X. Wang, K. Park, and K. Ehara (2002), The relationship between mass and mobility for atmospheric particles: A new technique for measuring particle density, Aerosol Sci. Technol., 36, 227–238.

Rawat, V. K., D. Buckley, S. Kimoto, M.-H. Lee, N. Fukushima and C. J. Hogan Jr. (2016). "Two-dimensional size-mass distribution function inversion from differential mobility analyzer-aerosol particle mass analyzer (DMA-APM) measurements." Jounrnal of Aerosol Sci. 92: 70-82.

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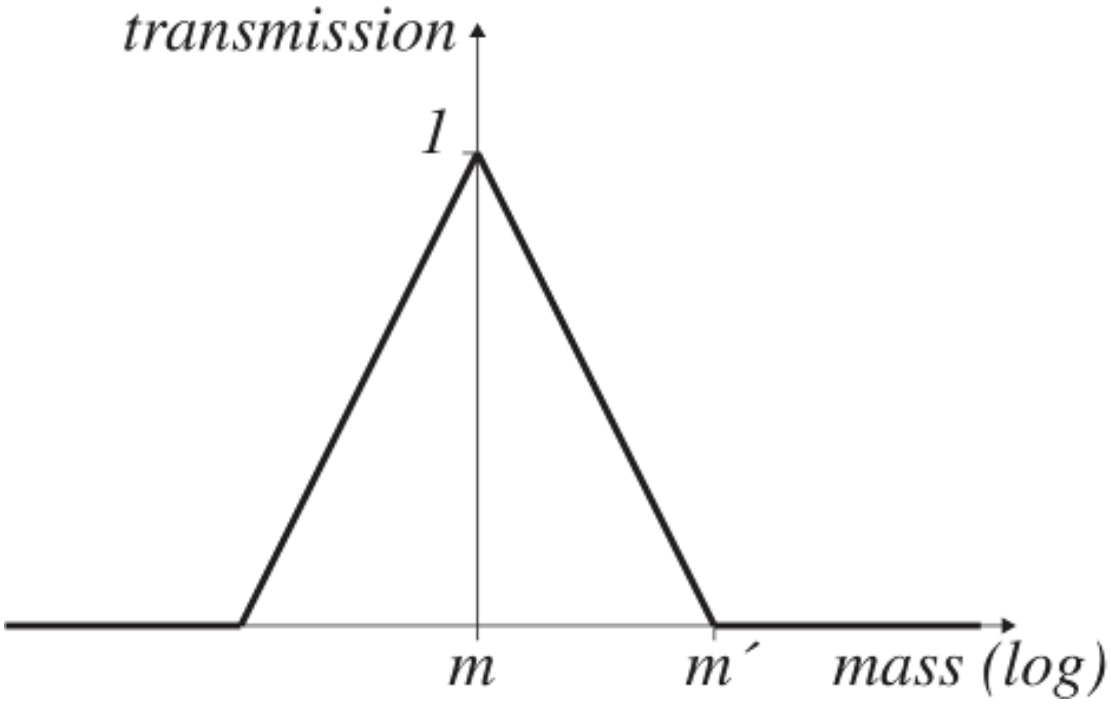

Fig. 1.

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