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Atmospheric Measurement Techniques Discussions

Interactive comment on "A novel inversion algorithm for mobility particle size spectrometers considering non-sphericity and additional aerodynamic/optical number size distributions" *by* S. Pfeifer et al.

Anonymous Referee #3

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This manuscript describes a new electrical mobility spectrometer inversion algorithm that accounts for contributions of particles outside of the singly charged size range using data from complementary instruments. Without such correction, the rightmost portion of a calculated distribution will be biased high, with significant error possible if the particle concentration outside the mobility spectrometer size range is comparable to that inside its range. The sensitivity of the algorithm to artificial measurement noise is also assessed.

Electrical mobility spectrometers are widely used for both laboratory and ambient measurements. A number of inversion algorithms have been described in earlier journal articles. Still, some in the community may benefit from a new publication, particularly because of the emphasis on the influence of multiply charged particles that is more appropriate today as improvements in measurement accuracy increase the importance of sources of error that were comparatively small decades ago. Even so, this manuscript has several weaknesses that may limit interest. The writing would have to be cleaned up quite a bit prior to publication. Some errors are expected because the authors are not native English speakers, but there are others that seem careless. Overall, I identify only minor revisions, with the resulting improvement in likely manuscript impact also minor.

Though the title suggests that the manuscript presents a novel data inversion algorithm, it is almost entirely focused only on calculation of the response matrix. The approach used to invert the data is to simply calculate the inverse of that response matrix and multiply it by the measurement array. This is a simple and efficient approach, but one that is rarely used because it can amplify noise in the distributions and can lead to physically unrealistic negative concentrations. These complications are evident in the "conventional inversion" distribution shown in Figure 3. The well behaved distribution determined using the "enhanced inversion" is certainly not proof that such problems will necessarily be absent when accounting for larger multiply charged particles.

The calculated "efficiency" values, E, that contain most of the terms used to calculate the response matrix elements are quite simplistic. Specifically, these are calculated assuming the transfer function is narrower than the bin width and can be effectively approximated as a rectangle spanning the bin and having an area equivalent to the actual triangle or Gaussian profile. The authors do not presume this to be true, but rather that the error introduced by doing so will be small for typical ambient distributions that possess only broad features. No support for this is provided. There is also minimal consideration of things like CPC efficiency.

More specific issues:

- I don't see the delta term introduced in Equation 5 defined.

- More clearly state that Equation 6a is the Wiedensohler approximation and 6b is the Gunn distribution.

- The transfer function area, A, is left out of Equation 7.

- It might be helpful for some readers to show the result of Equation 7 graphically.

- The term A is defined in section 2.1 as a dimensionless area and then in section 2.3 as an efficiency.

- The brief mention of using a CCNC in place of a CPC will probably lead to confusion for some readers and doesn't seem to add much to this description. Why not just comment on inclusion of the CPC efficiency?

- The repeated mention of coarse particles outside of the mobility spectrometer size range is overly specific and could be misleading. An SMPS configured to measure up to 200 nm would be impacted by multiply charged particles just beyond that, which are far from being considered coarse by most readers.

- Starting at the top of page 4746 it is implied that agreement of the mobility spectrometer and complementary instrument (e.g., APS) provides evidence of the accuracy of the measurements and inversion. Maybe, but for more typical size distributions in which the concentration is falling with size the impact of multiply charged particles outside of the size range is probably in the noise (literally) and, consequently, agreement or lack thereof won't say much about the inversion.

- Line 10 on page 4754: Calculating the inverse of a matrix with entries on both sides of the diagonal wouldn't be too computationally demanding, as asserted in the manuscript.

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 4735, 2013.