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Atmospheric Measurement Techniques Discussions

Interactive comment on "A new high transmission inlet for the Caltech nano-RDMA for size distribution measurements of sub-3 nm ions at ambient concentrations" *by* A. Franchin et al.

Anonymous Referee #3

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This manuscript reports a modified aerosol inlet for the Caltech nano-RDMA which appears to improve the penetration of sub 3nm particles. The improvement was evidenced by measuring laboratory generated tetra-alkyl ammonium ions and by measuring particles newly formed in the CLOUD chamber. This manuscript qualitatively explains how electrostatic potential inside transport tubing affects the loss of highly mobile sub 2 nm ions and charged particles. This study is interesting and important. Most conclusions are sound. The manuscript is generally well written. However, there are the following comments to be addressed before its publication in AMT.

1.) When developing the Caltech nano-RDMA, Brunelli et al. (2009) reported that elec-

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trospray generated tetra-alkyl ammonium ions including THAB ions were measured by the Caltech nano-RDMA with good resolutions. During their experiments, the electrospray chamber was grounded and connected to the nano-RDMA directly. However, this manuscript claims that the spectra of electrosprayed THAB solution can not be detected with the nano-RDMA when the ES chamber is grounded (Fig. 4). More information needs to be added in the manuscript to explain this discrepancy. Did the authors use the same nano-RDMA aerosol inlet to Brunelli et al. (2009)? Is the nano-RDMA the same? Are there any differences in experimental setup and conditions which may cause the above discrepancy? In addition, an illustration of the original nano-RDMA aerosol inlet needs to be added in Fig 2 to complement the comparison between chamber results reported in Figs. 3 and 10.

2.) Terms such as “Transmission”, “Penetration”, “Transfer function”, and “Resolution” are used frequently through the manuscript without proper definitions. The reviewer found them confusing in several places. Please clearly define them in the manuscript. In addition, the authors made mistakes in estimating the nano-RDMA transfer function (section 3.3). Similar mistakes occur in Brunelli et al. (2009). Please refer to the second paragraph in Page 484 of Jiang et al. (2011a) for details.

3.) The reviewer has some reservations on the qualitative explanation illustrated by Fig 5. When the ES chamber is grounded (left and right sub-figures), the electric potential at ES chamber is zero rather than several thousand volt shown in these figures. When the ES chamber is floating, how to justify that the electric potential at ES chamber is several thousand volt? High voltage of several thousand volt was applied on the liquid. If the ES chamber is at several thousand volt, one may not have the cone-jet ES. Once this mistake is corrected, the authors need to rethink how to explain the high transmission when the ES chamber is floating. Does this have something to do with the high space charge density at the outlet of electrospray? In addition, the non-linear (vs. linear?) decrease in the electric potential in the right sub-figure needs to be justified.

4.) Although the improvement in CLOUD chamber measurement was obvious when

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comparing Fig 3 and Fig 10, the reason why the Caltech nano-RDMA with the original aerosol inlet can not measure sub 3 nm particles from the CLOUD chamber was not clearly summarized in the manuscript. The authors imply that this is due to bipolar ions are present when sampling from the CLOUD chamber, while the good performance of Brunelli et al. (2009) and Jiang et al. (2011a) are achieved with unipolar ions, e.g., electrosprayed tetraalkyl ammonium ions. The charge saturation effect may explain the observed high ion transmission. If this is the case, will clear signal be observed for ES gnd (Fig 4) when running the system for a long time since they are also unipolar ions?

5.) More information is needed to explain how ion size distributions were estimated from the nRDMA-PSM measurement (as reported on Fig 10). Which inversion method was used? What penetration efficiencies and transfer functions were used during the inversion? In addition, the inlet design with the core sampling may bias nanoparticle sampling (especially for highly mobile ions) from the inlet flow with the presence of the electric potential gradient. An analogy is the iso-kinetic sampling in a flue gas system. Please discuss how to address this possible bias during size distribution measurement.

A few minor comments are given below, a) Lines 9-11 in page 5856: what is discussed here applies to a bipolar charger only. Please be precise. b) Line 24 in page 5858: was this a mistake? i.e., I anticipate that you put the electrometer upstream from the insulator (rather than downstream from it as described here) c) Line 13 in page 5860: high ion transmission was observed not only by Jiang et al. (2011a), but also explicitly by Brunelli et al. (2009). d) Lines 4-8 in page 5856 are repeating Lines 24-27 in page 5855. e) Figure 7 can be improved to make it self-explaining. For instance, which data is from electrometer? Which y-axis? f) Figure 10 can be improved. For instance, what is the y-axis in the right figure? What is the difference between (b) and (d)?

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 5847, 2015.