

Interactive comment on “Characterisation of corona-generated ions used in a Neutral cluster and Air Ion Spectrometer (NAIS)” by H. E. Manninen et al.

Anonymous Referee #2

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In the manuscript, the distribution of ions produced in the NAIS corona charger is studied in a laboratory at different operating conditions, namely relative humidity and carrier gas composition. In addition to this, the composition (m/z ratio) of ions and the effectiveness of NAIS electrical filter in removing these ions are studied for selected cases. The manuscript is a very welcome addition to previous, recent calibration works of this still relatively new instrument which is used by several groups. This work helps to understand the instrument technical limitations and possibilities when operated at the edge of the measurement range, i.e. in studies of small neutral particles and clusters, and further, to interpret the obtained results properly. The manuscript is therefore

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of high scientific importance. The methods used are up-to-date and the results are presented fluently and discussed thoroughly. I support publication of this work, after the authors have addressed my minor comments below regarding some points which became not crystal clear to me. I hope these will help to clarify the conclusions from this work.

Specific comments:

2.2. How was the HDMA calibrated for the voltage range?

3.1. p. 2106: The mobility distributions presented in Figure 3 seem confusing to me. Are these solely single examples or averaged over several measurements? As they are the first distributions presented I got an impression they describe a “typical” case. However, the distributions in Figure 3 are different, in terms of peak mobility concentrations, than any of those presented in Figure 5. Was something changed in the conditions or is this normal variation between different experiments? I understand, the experiments were demanding and probably, not too many repetitions were done per each measurement. Still, if applicable, could the authors provide short comments on the repeatability of the measurements, since this is indeed an important point if the results are to be applied for wider use? Based on the presented results, it seems the absolute concentrations remain not as stable as the locations of the major mobility peaks in the spectra. Is this a correct interpretation? Another question on Figure 3 (and in fact, almost all the Figures after) relates to the scale of the y-axis: For me, it is always weird to see DMA results presented with raw concentrations in the y-axis, without any normalization. I understand, the HDMA provides nearly (but not fully) monomobile sizing. Since the characterized ions are not standards, I became wondering if the measured voltage bins are actually equal in width, and if not, can this have an effect on the shape of the mobility distributions. However, since I’m not familiar with HDMA in detail, here might be a misunderstanding from my side.

3.1. p. 2107: In the end of 3.1. authors say: “In these experiments, the pre-filter was

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used to remove all sub-4 nm charged particles” Does this apply to all results presented in 3.1. and was there a reason for this additional filtering? I understood the incoming air was already filtered with HEPA so probably this was just double-checking?

3.2. p. 2108: The number of peaks and the shift in mobility with RH in Figure 5 are explained in very simplified manner. For example, I'm not convinced of the shift of negative ions towards smaller sizes with RH if the whole mobility distribution is considered. Also for positive ions, neglecting the RH 0%, for me the shift in mobility seems not so consistent towards larger sizes.

p. 2108 On lines 17-18 the conditions (dry compressed air with RH close to zero) for experiments presented in Figure 3 are mentioned. Could these be added on 3.1. already?

p. 2108 lines 20-24: This is an interesting result. Please check again the lines, legends and colors in Figure 6. No discussion on green line is given.

3.3. Were there any remarkable differences in mass spectra of 0.98, 1.06 and 1.33 nm negative ions?

3.4. p. 2110 lines 7-8: “Clearly, the figure indicates that the electrical filtering is size dependent”. This was at first glance slightly confusing, comparing with the statement in p. 2107 lines 19-20, where it is said: “increasing the filter voltage ... decreased the concentration of the ions equally for all the sizes”. Maybe this sentence could be reformulated to indicate more precisely that here the increase of the NAIS cut-size with voltage is meant, instead of purely the corona ion filtering?

p. 2111 lines 19-22: “The electrical filtering of the corona-generated ions seemed to be more sensitive to the particle size than to the absolute concentrations. These results suggest that if we would have generated WOx particles at 2-3 nm size range the post-filtering with lower voltages would have been more efficient.” It was not easy to understand the meaning of this sentence and I'm not convinced the results in Figures 8

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and 9 prove it. Could the authors explain more carefully how this conclusion is deduced from the results (and also to which concentrations, corona ion or generated particles they refer)? If I understood correctly, the conclusion was drawn by comparing negative and positive polarities showing different corona ion concentrations but equally effective filtering? Does the statement in conclusions p. 2112 lines 20-25 also refer to this particular result? If not, to what?

2111 line 24: Could the authors repeat here the NAIS normal filtering voltage range (it was mentioned to be 70-100 V earlier, I think)?

Conclusions: Good points for further studies are raised in conclusions following the results of this study. Knowing the group of authors has all the tools available to conduct these, I'm looking forward to see continuation for this work.

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