Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2022-392

Anonymous Referee #2

Referee comment on "Measurement report: Increasing trend of atmospheric ion concentrations in the boreal forest" by Juha Sulo et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-392-RC2, 2022

The article by Sulo et al. describes and discusses the long term measurement of size resolved atmospheric ion concentrations in Hyytiälä/Finland for a time period of 16 years. The data set further includes the condensation sink, meteorological parameters and different parameters contributing to the ionization rate. Interestingly, a trend analysis shows that the ion concentrations increase over time. Atmospheric ions are relevant due to their ability to form new particles and grow them to larger sizes. Therefore, the findings discussed by Sulo et al. are important and fit well into the scope of the journal. I strongly suggest that the manuscript should be published in ACP after the points listed below have been considered.

Recommendation for further analysis:

Given the unique data set, I think the authors should use it for a further analysis. They decided to show equation (1) but actually never use it. The equation could, however, be used to derive α (ion-ion recombination rate) from the measured n, CoagS and q by assuming steady-state conditions (dn/dt = 0). By plotting α as a function of time, significant deviations from the literature value (~ 1.7e-06 cm3 s-1) would indicate that a data point is not suitable for the further analysis (and should be filtered out). Or put differently, agreement between the literature value for α and the derived (calculated) values would indicate that the relevant data sets have been measured accurately.

Minor points:

Line 34/35: not a complete sentence, reformulate to, e. g. "…, typically the ions initially form from nitrogen and oxygen due to their high abundance in the atmosphere."

Line 40: please specify in the beginning that all diameters refer to "mobility diameters"

Line 43: "ions of this size are connected to …, snow fall or rain"; does this mean that ions initiate snow fall or rain or that they are produced from precipitation? Please clarify

Line 63: Please move equation (1) to section 2 and provide a value and reference for α.

Line 98: "data are available"

Line 106: 0.82 nm are a rather small lower size limit, however, are smaller ions also existing, and if yes, how would their negligence in the measurement effect the outcome of the results?

Line 119/120: It is unclear what is meant by "if not necessarily its order of magnitude".

Line 150/151: Do you have any ideas what the exact reason for the relation between noise and ageing is?

Line 158: "particles"

Line 163/164: Please provide references for the MK test and the Sen's slope calculation. I also agree with referee 1 that the manuscript would benefit from further description of the analysis methods.

Line 180: It seem that the diameter range is not correct here as the mentioned ion concentration is too low for these small diameters.

Line 195: “polarities”

Table 3: Please replace the “-“ sign by the word “to” otherwise it can be confused with a minus sign.

Figure 5: For the ionization rates: Does the sum of all three rates correspond to the value of q in equation (1)? What is the reason for the minimum in I_Radon between 2012 and 2014? I am not experienced in Radon measurements but I would assume that its value should not show a strong inter-annual variation. There also seem to be strong spikes for I_gamma, are these from known sources?

Figure 6 and Figure 7: The figures are hard to read when printed out. It is also not clear to me what the red crosses indicate.

Line 260: “about 50%”

Line 328/329: I do not think that this (BSMA/humidity effect) was mentioned before.

Figure A1: What are the units on the y-axes in this plot? It seems that the smallest and largest size channels are missing (or at least the diameters do not agree with the size range mentioned in section 2.1.1).