

Interactive comment on “Characterization of air ions in boreal forest air during BIOFOR III campaign” by U. Hörrak et al.

Anonymous Referee #1

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In this manuscript, the authors presented the concentrations of positive small cluster ions and charged nanoparticles measured in a boreal forest during the BIOFOR III campaign in April 1999, and analyzed the processes controlling the concentrations and variations of these cluster and aerosol ions during the nucleation event days and non-event days. The average ionization rate and charge fractions of nanoparticles (<20 nm) were derived. In addition to ion loss due to recombination and aerosol attachment, the authors found that an extra ion loss term, presumably due to small ion deposition on coniferous forest, is needed to explain the observations. This extra ion loss term is significant as it is approximately equate to the mean ion sink induced by aerosol particles. The data and analyses presented in this paper provide useful information

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about the properties of cluster and aerosol ions and the processes controlling these properties. These data are also relevant to the investigation of the evolution of charged and neutral clusters/nanoparticles that is important to understand the nucleation mechanisms. I recommend the publication of this paper in ACP after the following concerns are satisfyingly addressed.

(1) This paper only deals with the positive ions and positively charged small particles. First, the word “positive” should be added before “air ions” in the title. Second, the authors should discuss briefly the properties of negative ions and how they may differ from the positive ones. There is no indication in the measurements section whether negative ions were measured or not during the period. I assume that negative ions were not measured during the BIOFOR III campaign. As I know, both negative and positive ions were measured in other campaigns in the same site (for example, see Laakso et al, ACP, 2004a,b). The authors should summarize these published results about negative ions in this paper.

(2) In the summary, it is stated that “No clear indication of ion-induced nucleation was found considering the behavior of positive small ions during nucleation events.” The abstract contains similar statement. I find that this statement is vague and not justified. I didn’t find relevant discussion in the main text about the “no clear indication”. The authors should first describe what should be a clear indication of ion-induced nucleation and then demonstrate in a little more details how their measurements show the lack of such indication.

As the authors pointed out in the last paragraph of section 4.1, the homogeneous nucleation should be accompanied by ion nucleation. If the measurements do give “no clear indication” of ion nucleation and the authors believe that ion nucleation happened during the nucleation events, then the possible reasons for the “no clear indication” should be discussed.

(3) In summary, fourth paragraph (page 2772, lines 13-15). The authors conclude that

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the contribution of recombination to the total ion loss was about 16% in average with the maximum of 75%. These two numbers may be reduced by a factor of more than 2 (which is very significant) when the wet sizes of particles and the extra ion loss term are considered. The final numbers with these two factors considered should be estimated and discussed here.

(4) The authors should emphasize in the abstract that extra ion loss term (magnitude equal to the average ion loss to pre-existing particles) is needed to explain the observations.

(5) Figure 6. I suggest that the authors add a curve for the variation of the total concentration of particles within the size range 2.5-8 nm (maximum values were shown in Table 3) in each panel. It will provide useful additional information.

Technical corrections:

(1) Page 2750, lines 20-21. Why correlation between “the concentrations of particles” and “their charged fraction”? Should “charged fraction” be changed to “charged particle concentrations”?

(2) Page 2758, line 8. Change “(Hörrak et al., 1998b)” to “Hörrak et al. (1998b)”.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 2749, 2005.

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