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Discussions

Interactive comment on "Experimental investigation of ion-ion recombination at atmospheric conditions" *by* A. Franchin et al.

Anonymous Referee #2

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The manuscript by Franchin et al. aims investigating ion-ion recombination in laboratory conditions in the Cosmics Leaving Outdoor Droplets (CLOUD) chamber. In their experiments the authors have had excellent facility and suitable instrumentation. The carried experiment and subsequently presented results are well within scope of the journal, and are very interesting for the readership. English of the text was good. Though, I recommend the authors to double check text in the Sections 4 and 5.

I recommend this manuscript to be published in the Atmospheric Chemistry and Physics after the authors have considered, in addition to comments given by referee 1, following minor comments and suggestions to further improve their manuscript.

Minor comments

Abstract

1. Page 3669: Although the abstract nicely reflects made experiments and results of the paper, I would highlight the most important results even more. i) I think that mentioning ion-ion recombination coefficient value that is most commonly used in recent atmospheric applications in literature would put the newly obtained laboratory results into relevant context (lines 12-13). ii) Currently, the reader does not get information how recombination coefficient depends on temperature and RH (lines 15-16, and 18-19).

Introduction

In general, I like style of the introduction and reasonable background information is provided for the readership. However, following improvements could be considered.

1. Page 3669, starting from line 21: I think that the starting paragraph should be revised to make it more interesting, meaningful and to better justify atmospheric relevance of the current study.

2. Page 3670, lines 15-20: Currently, the text gives very uninformative picture of contributions of various ionization mechanisms and their altitude dependence. Readers of this manuscript would benefit from a schematic figure showing profile(s) of ionization rate(s) through the troposphere (including the lowest part, i.e. the atmospheric boundary layer), and illustrating at least total amount of ionization rate. Such a figure would also put the experiments better into the atmospheric context.

Experimental methods

1. Page 3672, line 8: I believe that instead of 'beam settings' authors mean 'beam intensity'.

2. Page 3675, line 4: I do not think that Kulmala et al. (2007) is right reference for the NAIS. Instead, Manninen et al. (2011), which is already cited in the manuscript elsewhere, Asmi et al. (2009) and Gagné et al. (2011) would be more appropriate references. In order to trace the NAIS to its calibration (e.g. Asmi et al., 2007; Gagné

et al., 2011), identification number of the instrument should be mentioned in the text.

Theoretical methods

I think that this section needs substantial revision to better create transparency and facilitate potential repeatability for the applied retrieval.

1. Page 3676, line 22: Clarify reasons behind number concentration differences between positive and negative ions in Fig. 2 and large variation in time (Page 3698, Figure 3). How was 10 % concentration difference defined? To me variation range seems large, and 25, 50, and 75 percentiles of differences should be shown at least in caption of the Fig. 2. Are shown ion concentrations of positive or negative ions in Figs. 3-4 and in calculations behind Figs. 3-7?

2. Page 3677, lines 9-12: This paragraph requires complete revision since it raises so many questions. E.g. what is fraction of analyzed cases when statistics were too poor to determine the linear loss term? Subsequently, what are implications of such poor statics on retrieved ion-ion recombination coefficient?

3. Page 3677, lines 13-14: Fig. 3 shows that made assumptions work nicely in the particular example case. How representative is this example case? I think Fig. 5 is introduced before Fig. 3.

4. Explain uncertainty estimations shown in Figs. 4-5 and Tables 1-2 more in detail.

Results

1. Tables 1-2 and Figs. 4, 6-7: The results are very interesting. However, all results for changing RH and temperature are shown only at one temperature and RH, respectively. If the authors cannot create temperature variations of Fig. 4d or RH variations of the Fig. 4c, then more careful and precise discussion of temperature and RH variations in recombination coefficient in Sections 4 and 5 (e.g. on page 3683, lines 17-20) should be provided.

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2. Page 3679, lines 8-10: This sentence is not reasonable (... which is higher than...?).

References

Asmi, E., Sipilä, M., Manninen, H. E., Vanhanen, J., Lehtipalo, K., Gagné, S., Neitola, K., Mirme, A., Mirme, S., Tamm, E., Uin, J., Komsaare, K., Attoui, M., and Kulmala, M.: Results of the first air ion spectrometer calibration and intercomparison workshop, Atmos. Chem. Phys., 9, 141-154, doi:10.5194/acp-9-141-2009, 2009.

Gagné, S., Lehtipalo, K., Manninen, H. E., Nieminen, T., Schobesberger, S., Franchin, A., Yli-Juuti, T., Boulon, J., Sonntag, A., Mirme, S., Mirme, A., Hõrrak, U., Petäjä, T., Asmi, E. and Kulmala, M.: Intercomparison of air ion spectrometers: an evaluation of results in varying conditions, Atmos. Meas. Tech., 4, 805-822, 2011.

Manninen, H. E., Franchin, A., Schobesberger, S., Hirsikko, A., Hakala, J., Skromulis, A., Kangasluoma, J., Ehn, M., Junninen, H., Mirme, A., Mirme, S., Sipilä, M., Petäjä, T., Worsnop, D. R., and Kulmala, M.: Characterisation of corona-generated ions used in a Neutral cluster and Air Ion Spectrometer (NAIS), Atmos. Meas. Tech., 4, 2767–2776, doi: 10.5194/amt-4-2767-2011, 2011.