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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Ion – particle interactions during particle formation and growth at a coniferous forest site in central Europe" *by* S. G. Gonser et al.

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In this paper measurements of ions and neutral particles in a location with presumed high ionisation rates are shown. The dataset appears to be excellent and the paper is well presented. The interesting part is an elevated growth rate of the neutral particles compared to the ionised ones which stands in contrast to theoretical expectations. An explanation including ion recombination and ion attachment to neutrals is offered after a very nice and extensive overview of ion-ion and ion-neutral interactions. I've got another possible explanation that I would like to suggest, along with a few other comments/questions.

SPECIFIC COMMENTS

Elevated growth rates of neutral particles

Six of the eight analysed events occur in the morning. From Fig. 2 I estimate that there is about a 1 hour delay between the onset of ion growth (looking at the black circles) and the growth of neutrals. In the morning concentrations of condensable gas (sulphuric acid) is increasing due to photolytic production. I therefore suggest that the observed difference in growth rate could be due to differences in condensable gas concentrations - since the ions grow earlier in the morning where less material is available for growth they grow slower than the neutrals. Looking at Table 2 it seems that the enhanced growth of neutrals is indeed only observed in the morning events (except Aug. 17 – maybe this was a cloudy day?), whereas the two noon events do not show this difference in growth rates – in fact they show the opposite behavior as predicted by theory. From Fig. 7 and 8 it also appears that the growth rate anomaly is most pronounced in the events with a large Δt. Maybe the authors have some direct measurements of condensable gas concentrations that can be used to test if this idea has merit or not, but I think it should be considered in any case.

Estimation of ion production

Due to limitations in the NAIS the ion production rate Q is underestimated, as explained by the authors. I was wondering if it was possible to estimate the expected ionisation rate, depending on if Radon measurements are available. For cosmic rays the muon flux would need to be known. If so then the ionisation can be estimated using the energy deposition ($\sim$2 MeV/(g/cm2)) and ionisation energy (34 eV/ion pair). Something similar was done by Laakso et al (ACP 4, p. 1932, 2004).

Efficiency of NAIS

On p. 182-183 it is described how the AIS performs better than the NAIS – if you know the difference in efficiency (preferably size-dependent), could you use this to calibrate

the NAIS-measurements? It would certainly be nice to see how much of the total particle formation could be due to the ions. Maybe you could make some kind of “best” case scenario to estimate an upper limit for the ion contribution?

Figure 2

Are the smoothed fits used to find the growth rates? If so I suggest splitting the fit for total and neutral particles in 2 parts since there appears to be a very steep part up to $\sim$7 nm followed by a more flat line.

TECHNICAL COMMENTS

The term “temporal advance” sounds a bit off to me. I’m not sure what to suggest instead, maybe something like “time difference” (this would require a bit of rephrasing). If the phrasing “temporal advance” is kept then p. 186 l12 should be: “advanced”->”advance”.

p.183 l7: “bended” -> “bent”

Fig. 1: Why not show the lines for the 10 nm ions down to 1.5 nm like the solid lines?

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 171, 2014.