

## ***Interactive comment on “EUCAARI ion spectrometer measurements at 12 European sites – analysis of new-particle formation events” by H. E. Manninen et al.***

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We would like to thank the referee for the constructive comments to help us to improve the manuscript.

1) The manuscript could benefit from a short overview in the Introduction section on previous ion spectrometer measurement within and outside Europe. This would give a more global picture.

We added a short overview to the introduction section (before last paragraph of the section): ‘Prior to EUCAARI project the ion spectrometers were measuring continuously mainly in boreal forest region in Finland and Estonia (Hörrak et al., 2003; Hirsikko et al. 2005, 2007; Manninen et al., 2009). Shorter time series have been measured in France (Venzac et al., 2007), Himalayas (Venzac et al., 2008), Australia (Suni et al., 2008), South-Africa (Laakso et al., 2008), Ireland (e.g. Vana et al., 2007), Boulder in Colorado (Iida et al., 2006), Atlanta in Georgia (Eisele et al., 2006), Mexico City (Iida et al., 2008) and Antarctica (Virkkula et al., 2007). Furthermore, ion spectrometers have been used in a moving train between Moscow-Vladivostok in Russia (Vartiainen et al., 2007), in a hot-air balloon over Finland (Laakso et al., 2007), on a ship over North Atlantic (Ehn et al., 2010), and onboard the aircraft over Europe (Mirme et al., 2010). In these studies, ion spectrometers were found to be important tools for observing new-particle formation in atmosphere. New-particle formation event analysis – event classification, particle formation and growth rates calculations – for ion spectrometer data has already firm guidelines (Hirsikko et al. 2005, 2007; Kulmala et al., 2007; Manninen et al., 2009).’

2) p.11265, l.8. Why is the specific reference Aalto et al., 2001 used for the DMPS?

Aalto et al. (2001) reference was supposed to be just an example of DMPS systems used during the EUCAARI measurements. The DMPS described in Aalto et al. (2001) was and still is used in Hyytiälä. Confusing reference was removed from the manuscript.

3) p.11265, l.19, sentence starting with: “The average charged. . . . “Improve the structure of the sentence. You use “and” several times. Next sentence as well needs grammatical improvement.

We revised these two sentences: ‘The charged particle growth rates were calculated for three diameter classes (1.5-3 nm, 3-7 nm and 7-20 nm) from AIS data. In case of BSMA measurements, only the two first size classes were used. GR calculations were possible only during particle formation events, when we observed high enough concentrations of ions. These calculated growth rates (Hirsikko et al., 2005) can deviate from the real atmospheric growth rates by up to the factor two because of observational

uncertainties.’

4) Section 3.1.1 needs to be proof read. There are a number of grammatical mistakes. For example: p.11267, l24 “A day was classified as an event days. . .” Should be day instead of days. Same sentence was should be were.

The section 3.1.1 was proof read and grammatical mistakes very corrected.

5) p.11268, l.9. Using just the total number of events could be confusing as it also depends on the length of your campaign as is pointed out in the next sentence. For example the lowest number of events 59 were observed at Pallas. If the campaign at Pallas went as long as the campaign in Finokalia there could have been more observed events. I am not sure if it is worth presenting only the number of events.

In Figure 3a we have presented the results as the fraction events days relative to all available days. These numbers are more comparable between different sites. The total number of events on some sites is mentioned to demonstrate the massive data package we collected; we had the total of ~1100 new particle formation events to analyze around Europe.

6) p.11269, l.9, “The monthly event to non event ratio had a clear maximum during late spring. . .”. This is not obvious when one looks at the ratios (figures in the appendix) at individual sites. How was the average from Fig 4b calculated?

I apologize that we have submitted old versions of the event classification figures in appendix (A1-A12). We have replaced the wrong figures.

7) p.11270, l.15, “. . .Weingartner et al (1999) suggested. . .”, Wiengartner et al. did not suggest but have observed the most frequent number of events in winter. Please comment the difference between your study and Weingartner et al. study. Could this be just natural variability?

Weingartner et al. (1999) never mentioned in their paper anything about the seasonal variation of total number of new-particle formation days. They only said that the con-

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centration of nucleation mode particles exhibit a maximum during the winter months. In our study we classified these days as undefineds days, because it's still open question whether these events were really new-particle formation due to gas-to-particle conversion or just snow storm episodes or ice-crystals carried by high wind during the winter months (similar feature observed for the first time in Antarctica by Virkkula et al. 2007). The sentence was revised: ‘However, Weingartner et al. (1999) observed that new-particle formation events at JFJ are most enhanced in winter. We speculate that this is related to “wind/snow-induced events” which are mentioned later.’

8) p.11279, l.11. Were the “bump” events observed in other coastal locations besides Mace Head or is it something typical for this station?

We thank the referee for this comment. The ‘bump’ events were observed occasionally also in some other sites, whereas in Mace Head the ‘bump’ events were very typical event class indicating coastal/marine NPF origin. A closer study shows that occasional “bumb” type events seemed to be characteristic for in high elevation sites: Pallas, Jungfrauoch and Puy de Dôme. Perhaps, this relates with measuring at intervals both boundary layer and free tropospheric air masses. Condensable vapour concentrations change with the air mass. We added following sentence to the manuscript: ‘Occasional “bump” type events seemed to be characteristic for high elevation sites.’

9) Section 3.3, I find the observation that the ion induced nucleation starts at different times than neutral nucleation very interesting. This was previously only observed at Hyytiälä but now it was observed in different locations, but what is important with different starting times. It would be nice if the authors would discuss this in more detail and maybe suggest some explanations for the different observations.

We revised old text and added few new sentences on p. 11274, l. 21: ‘In Mace Head and Melpitz, the formation of charged 2-nm particles started earlier than that of neutral 2-nm particles, whereas negatively and positively charged 2-nm particles started to be formed at about the same time. A similar pattern has been observed earlier in Hyytiälä

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(Manninen et al., 2009a). Contrary to this, no different timing between formation of charged and neutral 2-nm particle could be observed in Cabauw, Hohenpeissenberg or Jungfraujoch. A possible explanation for the earlier formation of charged 2-nm particles as compared with neutral ones in some of the sites might be the preferential activation of charged cluster over neutral ones when the concentration of nucleating/condensing vapors is increasing during the morning. Such a phenomenon has been confirmed in laboratory experiments (Winkler et al., 2008), but requires that the principal particle formation route is the activation of pre-existing clusters (Kulmala et al., 2006). Another possibility is that there are multiple pathways for neutral 2-nm particle formation, and that some of them require higher precursor vapor concentrations than the charged particle formation. Analyzing the different timings of the formation of charged and neutral particle clearly deserves further attention.'

10) p.11256, l.22. the word discovered is a bit to strong. Suggest using "found".

Correction done.

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