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Interactive comment on “Investigation of nucleation events vertical extent: a long term study at two different altitude sites” by J. Boulon et al.

J. Boulon et al.

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The authors thank referee #1 for his comments and remarks which contribute to improve and clarify the present paper.

Referee’s comment (RC): Please indicate clearly in the abstract (on page 8250) and introduction (on page 8251) that the particle formation events were characterized at the puy de Dôme station, and the data from Opme station were utilized when studying the vertical extend of particle formation event frequency. In the conclusions (starting on page 8268, on line 12) this was clearly explained.

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Author's reply (AR): Actually, the new particle formation events were characterized at both station in term of GR and J calculations but the atmospheric composition analysis and events seasonality were only done for the PdD site. Precisions were added in abstract, introduction and conclusion sections to avoid misunderstandings.

RC: The presented average particle formation and growth rates (on pages 8256-8258) at the puy de Dôme station were unconnected with the results and discussion of the vertical extend of the particle formation (Sect. 5). There were 87 particle formation events measured at both stations simultaneously, 70 events only at the puy de Dôme station and 4 events only at the Opme station. Therefore, I think that the authors should extend their analysis and discussion of particle formation and growth rates at the Opme and puy de Dôme stations (e.g. compare Fig. 6 on page 8282).

AR: In case of events at both sites (D_x events), no difference were found in GR and J values between the two sites. This result suggests that the nucleation process is homogenous between the two sites. In case of the nucleation at the Opme station only, no calculations of GR and J were possible because of the nucleation shape (calculations are possible for Ia and Ib cases) so the comparison between "P" and "O" type events is not possible. However, we add an analysis and a table of GR and J between P and D_x type of events at the end of the section 5.

RC: On page 8257, starting on line 11: The NAIS has large uncertainty when measuring particle (sum of neutral and charged particles) concentrations down to 2 nm (Asmi et al., 2009; Gagneé et al., 2011). CoagS2 is typically determined from SMPS data to be able to include the effect of larger particles. Therefore, I strongly recommend including discussion and estimation of uncertainties in $J_2(\text{neutral} + \text{ion})$ and $J_2(+/-\text{ion})$ presented in the manuscript. Does this change the conclusions of IIN fraction?

AR: The main error source in the calculation of the formation rate is in the computation of the number concentration of total particles from NAIS. Based on the analysis of

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Gagné et al. (2011), the concentration can vary by 10% within the same instrument and compared to other instrument types, the NAIS can overestimate the concentration by a factor of 2 to 3. To estimate the error in formation rate calculation we compared the computed J_2 value with the one that can be derived J_{15} calculation from SMPS measurement using the relation given by Lehtinen et al. (2007). We found that the J_2 computed using the NAIS is in average 2.38 ± 1.67 times higher than the ones derived from SMPS data. Thus the IIN fraction could be underestimated by the same factor. This results have been added to the manuscript.

RC: In general, English was good. However, please proofread the manuscript to avoid any misspelling.

AR: We corrected typos.

RC: I recommend including only one topic in each paragraph to help the reader (e.g. Introduction on page 8251, or new topic on page 8257 starting on line 11).

AR: When it was necessary, we splitted the paragraph into different one-topic-paragraphs.

RC: Abstract (on page 8250, on lines 6-7), introduction (on page 8251, on line 28) and particle measurement devices (on page 8253, on line 25): different diameter ranges were given for AIS/NAIS. Please indicate clearly, did you have one NAIS and SMPS at both of the sites. Now the reader may get confused between the AIS and NAIS.

AR: Sorry about the different diameter ranges. The confusion comes from NTP-conditions and real conditions inversions. We only have a SMPS at the PdD site but the two sites were equiped with NAIS or AIS depending on the period.

RC: On Page 8256, on lines 22-24.: "Different steps can describe the NPF process.

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We chose 4 different boundary diameters (1.3, 3, 7 and 20 nm) as representative of different growth steps and to compute growth rates between 1.3–3, 3–7 and 7–20nm for Ia and Ib classes of event." I think that this should be rewritten to better describe the method.

AR: The method was firstly introduced by Hirsikko et al. (2005) and a detailed calculation method could be found in Hirsikko et al. (2005) and Boulon et al. (2010). References were added in the text.

RC: On page 8258, on lines 8-9: " in comparison to boundary layer sites (Manninen et al., 2010 and Iida et al., 2006, 2.6% in average on both study)" and on page 8268, on line 21: "Compared to other European low elevation sites ($IIN = 3.55 \pm 3.73$)". This is confusing. Please, check these IIN fractions.

AR: The first value take into account the data published by Iida et al. (2006) in Boulder, Colorado and the EUCAARI low elevation sites (Manninen et al. 2010). The second value is only for EUCAARI low elevation sites (Manninen et al. 2010). I only use the first value to avoid confusion.

RC: On page 8258, on line 12: A short (i.e. one sentence) description of the applied parameterization should be included. AR: The following sentences were added: " This parametrization give an estimation of sulfuric acid concentration from SO_4 and UV-radiations. It uses a conversion parameter measured at the Hyytiälä boreal forest station hence H_2SO_4 real concentrations could be different from our calculations, but their time variations should be respected."

RC: Comment 8 and 9.

AR: References were corrected.

RC: On page 8260, on lines 17-27: This paragraph should be written more clearly.

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Please, reconsider which of the presented percentage values are the most important. The Table 3 (on Page 8276) was unnecessary, and could be removed.

AR: We tried to improve the way we first wrote this paragraph. However, we think that all percentage values are useful since they give different informations about total and partial frequencies. The table 3 summarizes the main ideas of the paragraph. Hence we think it could help the reader.

RC: On page 8262, on line 9: Please give reference for the condensation sink.

AR: We added the reference Pirjola et al. (1999).

RC: On page 8277, Fig. 1: Please include the unit for the color bar.

AR: Correction done (m a.s.l.).

RC: On page 8283, Fig. 7: The results of the figure are well presented in text (on page 8262, lines 8-25). Therefore, I recommend removing the figure.

AR: We think that the figure 7 could help the reader and we decided to keep this figure in the manuscript.

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