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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Antarctic new particle formation from continental biogenic precursors" *by* E.-M. Kyrö et al.

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We are grateful for the Anonymous Referee for Their good comments that increased the value of this paper. Especially the comment concerning Figure 8 and its caption was very important since this is among the most important figures in the text and its understanding is the key to understand the conclusions. The authors have now concerned all of the comments and made the following corrections.

Comment 1 *(Page 32747, lines 18-26: Calculation of condensation and coagulation sink (CS and CoagS). I accept that the authors refrain from describing in detail the formalism to calculate CS and CoagS, but instead provide some references. However, I suggest specifying at least the measured parameters and assumptions to calculate CS and CoagS.)*

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This is a good comment, since it is important to understand the meaning of these two parameters. We have now added following few lines of text to Chapter 2.3 about the calculation of CS and CoagS:

“CS is dependent on the effective surface area of the particles and pre-existing size distribution whereas CoagS is a function of the diameter of the scavenged particle and pre-existing size distribution (Lehtinen et al., 2007). Thus, essentially they represent the same phenomenon, but the other one (CS) is for gases and the other (CoagS) for particles.“

Comment 2 *(Page 32748-9, chapter 2.4.1 Figure 1: As far as I have understood, you could identify about 261 individual (chemical) compounds in your aerosol samples. In which way the classification presented in Figure 1 has been accomplished? For example, there are surely plenty of compounds with simultaneous hydroxyl, carboxyl,. . . etc. functional groups. Furthermore: what is really meant with the statement at the end of the paragraph “In comparison with the results provided in the literature for aerosol particles collected at the SMEAR II station (Ruiz-Jimenez et al., 2011b), the total number of identified compounds in the Aboa samples was smaller, but the relative composition of the particles in terms of number of compounds was the same”! Finally, please specify the abbreviations “BSTFA” and “TMCS”.)*

Two steps classification was used to organize the identified compounds. In the first one, identified compounds were classified in a sequential and exclusive way as a function of their elemental composition as can be seen in the following table.

	Atoms present in the molecules	Other atoms which could be present
Hydrocarbons	C, H	
Halogenated compounds	C, H, X	S, N, O
Sulphur compounds	C, H, S	N, O
Nitrogenated compounds	C, H, N	O
Oxigenated compounds	C, H, O	

where X equals F, Cl or Br.

The second step was used for the classification of the oxygenated compounds (C, H and O) into carboxyl, carbonyl or hydroxyl compounds in agreement with the highest oxidation state of the functional groups present in the molecules.

We also added this explanation of the two-step classification to the end of chapter 2.4.1.

The statement in the end of the last paragraph in 2.4.1 is not important for this paper and has now been removed from the text. The abbreviations BSTFA and TMCS are now defined in the text.

Comment 3 *(Page 32750, chapter 3, last section: Awkward sentence! Please reword.)*

The clearly awkward sentence in the last paragraph of chapter 3 has now been rewritten followingly:

"Some compounds that were found from both cyanobacterial mat and water samples as well as filter samples were present only during the second event period (1 to 3 January 2010) whereas some were enhanced during all event periods (Fig. 2). These were called Group 1 and Group 2, respectively. Also, the relative fraction of Group 2 compounds was greatest during the second event period."

Comment *4 Page 32752, chapter 3.1.2 lines 18-25: I agree that contamination originating from snow mobiles could be easily identified by their spiky appearance. But* *close to the main station, which is only 200 m away from the measuring site (chapter 2.2), I guess a diesel operated current generator was in continuous duty. Hence exhaust fumes from the generator are a huge source for particle nucleation, probably much larger than biogenic emissions from melting ponds. During very low wind velocities ("stagnant flow"), continuous (!) emissions from the diesel engine could be very well a potential contamination source. How could this impact be excluded or certainly identified?*

From Figs. 3 and 4 one can see that during each local NPF event, the wind speed was at least several meters per second and clearly not from contamination sector. In fact, in Fig. 4 in the beginning of 19th of January, the wind direction turned for a moment to the contamination sector and during that time wind speed was also quite low (however, there was no NPF event) and the resulting contamination is very clear in the particle size spectrum. Even in this case, the observed diesel (or in fact kerosene) exhaust particles are not even visible in the AIS but are all larger than 10 nm in size.

Comment 5 *(Page 32755, chapter 3.2.1 and Figure 8: As to me, the meaning of the bewildering different markers is far from being comprehensible; please clarify! How many trajectories were typically followed back in time for each nucleation event?)*

The authors agree that the Fig. 8 can be difficult to interpret. We have now rewritten the caption and the meaning of the different markers has been clarified. The new caption text is as follows:

Figure 8 Origin of Aitken mode particles associated with the observed regional nucleation events. Panel A shows the estimated source areas of Aitken mode particles calculated along back trajectories by assuming that the particle grew in size during their atmospheric transportation at the same rate as observed in our measurement site. The "initial diameter" of these particles was assumed to be 5 nm (circle), 10 nm (square) or 15 nm (triangle), which represents the uncertainties in the very fast growth of nucleated particles in the immediate vicinity of their emission source as seen dur-

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ing the local events in Figs. 3 and 4. The different colours of the markers (see the legend) refer to different nucleation events or, in case of 10 January, to two separate Aitken modes observed during the same event. For each event, we visually selected 6 spots in the particle size vs. time space that we followed using trajectories: the lower (light-coloured marker) and upper (dark-coloured marker) end of the Aitken mode in the middle (large marker) of the event or at the beginning or end (small marker) of the event. Panels B and C show LANDSAT-satellite images over the same area showng larger areas of meltwater in the border between the shelf-ice and ice sheet. Satellite images are downloaded from LIMA (Landsat Image Mosaic Of Antarctica) webpage, http://lima.usgs.gov/.

Comment 6 (Page 32759, line 19-21: Please shortly discuss a potential reason for the mentioned correlations. Does this simply mean that Aitken and accumulation mode particles are the dominant CS?)

The referee is right; the Aitken and accumulation mode particles are the dominant contribution to CS. This has also been now written to the revised text in the last paragraph of Section 3.2.3

Comment 7 *(Page 32762, chapter 3.3.2: The authors argue that the depletion of particles above about 60 nm diameter is caused by the fact that these particles acted as cloud condensation nuclei. In this regard the potential role of particle scavenging by existing cloud droplets should be considered and discussed.)*

This is a valid point. We added a paragraph into section 3.3.2 to discuss this issue and modified the remaining text accordingly. Scavenging of aerosol particle by cloud droplets is not expected to influence the obtained value of the activation diameter in our measurements. The section 3.3.2 is now entirely as follows:

Particle number size distribution measurements can be used to investigate the size-dependent activation of aerosol particle into cloud droplets (Komppula et al., 2005; Lihavainen et al., 2008; Anttila et al., 2009). More specifically, such measurements

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make it possible to determine the activation diameter (D50), i.e. the "dry" particle diameter above which the probability for cloud droplet activation exceeds 50

During our measurement campaign, a sequence of cloud droplet action events from 17 to 18 January showed that even fairly small particles were able to act as cloud condensation nuclei. The station was inside a cloud three times during these days: from 19:30 to 22:00 on 17 January, and from 03:00 to 07:00 and from 10:30 to 12:00 on 18 Janurary (Figure 15). We can see the smallest size bin where some activation occurred was 48 nm. The median value of D50, determined following Komppula et al. (2005), was 60 nm during the three cloud periods. Such a small activity diameter can be explained by the low number concentrations of particles larger than 100 nm in diameter which, compared with more polluted air, allows the development of a higher cloud supersaturation (McFiggans et al., 2006).

Comment 8 (Table 4: Abbreviations "VP" and "AHvap (most probably delta-Hvap is meant)" should be explained.)

VP is the vapour pressure (rewritten as P0) and AHvap (rewritten as ΔHvap) is the vaporization enthalpy. Both are now explained in the caption of Table 4.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 32741, 2012.