Atmos. Chem. Phys. Discuss., 12, C13054–C13059, 2013
www.atmos-chem-phys-discuss.net/12/C13054/2013/

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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Received and published: 1 March 2013

The authors wish to thank the Anonymous Referee for Their comments concerning our manuscript. Particularly the comments concerning Figure 17 and the corresponding text in the Summary and Conclusions were important and the modifications done due to this comment removed misleading and speculative parts from the manuscript. Also, we agree that it was important to add a description of the different event types to the text as it is important for the reader to understand the differences between them.

MAJOR COMMENTS

Comment 1 *(Discussion of contamination from human activities in Antarctic coast More careful discussion about influence of contamination from human activities around*

each station is needed, because many operating stations are located in the coast in 15W – 15E. Although some stations (Aboa, Neumayer, Sanae, and Troll) were shown in Figure 8, the other operating stations (Halley, Wasa, Novo-air base, Novolazarevskaya, and Maitri) were not shown. Locations of the other stations must be shown in Figure 8. Furthermore, many mobile contamination sources were operated usually around the research areas during summer, particularly, airplane operation in DROMLAN. Without discussion about influence of these contamination sources, new particle formation by other processes cannot be discussed.

As shown in Figures 2-4, new particles formation events must be found at Aboa Station. Authors attempted to discuss influence of local contamination from comparisons between the number size distributions in new particles formation (Figs. 2-4) and those in very local contamination (Fig. 12). It is true that very local contamination from Aboa and Wasa Stations as "point sources" may be insignificant to these events, because large variability (short peaks) appeared clearly. Features of the concentrations of atmospheric species derived from the point sources have usually large variability as shown in Figure 12. In addition, distance among Aboa, melt-water ponds, and the other neighboring stations was similar (scales of several hundred km). Considering that the melt-water ponds and the other neighboring stations are also "point sources", variability of aerosol concentrations derived from both the melt-water ponds and the other neighboring stations is expected to be similar in cases that aerosols and precursors from the melt-water ponds and/or the other neighboring stations were not mixed and diffused well during the transport. When aerosols and precursors from the melt-water ponds and/or the other neighboring stations are mixed and diffused well during the transport, subsequent features might be observed at Aboa Station in both cases. Therefore, more careful discussion about influence of the contamination is needed before discussion about likelihood of contribution of bioactivity from the melt-water ponds to new particle formation.)

Stations Novolazarevskaya (and Novo air base) and Maitri are now included to the

Figure 8. Halley is further South and not in the area of the map.

There are several reasons why we can exclude human activities as a source of observed new particle formation. Firstly, the local NPF events that are not lasting over several hours / days, have to originate very close by. The smallest observed (charged) particles were directly grown from the continuously existing cluster mode, indicating that the formation took almost at the site of observation.

Secondly, in order to observe NPF and subsequent growth over several hours or even days, continuous and large-scale emissions of condensable gases are needed. In our case, the emissions originate from a large area of meltwater covered ice caps (blue-ice zone) and mountainous areas in Dronning Maud Land as shown in Figure 8. If the observed regional events were caused by station emissions, a line of research stations parallel to the air mass trajectories would be needed, which is obviously not the case.

The airplane operation in DROMLAN can be easily discarded as the source of observed regional events. In addition to the above mentioned discussion about the needed scale of emissions, the only intercontinental flights on January that were made while our measurement campaign was on-going were performed 6th (in) and 8th (out) of January, 2010. All feeder flights were flown in conjunction with these, thus not during the days we observed NPF.

Comment 2 *(Estimation of growth rate Growth rate was estimated using gaseous H2SO4 concentration in this study. Actually, previous works (referred in this paper) showed the H2SO4 concentration ranged in 0.60-1.5x106 molecules cm-3. However, this range seems to be underestimated in the Antarctic coast during summer. According to Jefferson et al. (1998a), mean H2SO4 concentration was 1.61x106 molecules cm-3 (highest conc. 107 mole cm-3). Additionally, gaseous CH3SO3H (MSA) can act as condensable vapour because of the low vapor pressure. Mean concentration of gaseous MSA reached to 9.5x105 molecules cm-3 in the Antarctic coast during summer (Jefferson et al., 1998b). Thus, gaseous MSA should be taken into account in*

estimation of growth rate. Previous works by Jefferson et al. are as follows.)

Even if the measured values of H2SO4 and MSA in Jefferson et al (1998a b) were correct, the total vapour concentrations would then be 1.61 x 106 + 9.5 x 105 cm-3 = 2.56 x 106 cm-3, and not sufficient enough to explain our growth rates alone (the H2SO4 concentrations needed to explain the growth rates are 1-2 orders of magnitude higher than that). We have now included those two references to the text in chapter 3.3.1 and included a sentence discussing about the contribution of MSA to the growth.

MINOR COMMENTS

Comment 1 *(Measurement section: Shallow ponds around Aboa station was described in the text. More information about distributions and the number density of both ponds around Aboa station slight-far ponds and should be added in the text and/or Figure to understand circumstances in the Antarctic coast during summer. Because pond-derived precursors were discussed, this information is useful for readers.)*

Unfortunately, we don't have any information on the distributions and number density of the melt-water ponds.

Comment 2 *(Section of "Chemical analysis" How large is the yield of each chemical constituent in sample treatment?)*

All the analytical methods used in this research were previously validated using a two-step methodology which involves standard addition and comparison of the results achieved with the developed methodology with those provided by a previously validated method. Recoveries for all studied compounds ranged between 94.7-104.3

Comment 3 *(Page 32751 line 1-3 What are apple-type, bump-type, and banana-type? More explanation (or definition) about them is useful for readers.)*

We have added a more detailed description of different event types to the revised version of the text, to section 2.3 followingly:

NPF events can be visually classified based on the shape of the particle size distribution into different types (Dal Maso et al., 2005; Yli-Juuti et al., 2009; Manninen et al., 2010; Kulmala et al., 2012). The different types of events are signatures of NPF happening on different spatial and temporal scales and their shape is caused by the Eulerian way of measuring the air mass. Traditional "banana"-events are typically observed when NPF happens over geographically large area. A "banana" event appears in the size distribution as a wide band which starts from the lower limit of the size distribution and curves smoothly towards higher sizes. This kind of appearance requires formation and growth that lasts over several hours or even days. Other types (e.g. "apple", "bump" and "wind-induced" all of which were observed at Aboa during FINNARP 2009 expedition) represent more local NPF. Common for each of these is that they appear as round- or obscure shaped short-time increases in particle concentration in the lowest particle sizes. Due to their shape, it is not possible to obtain growth rate for these events.

Comment 4 *(Page 32752 line 1 Typo: bump type)*

Corrected.

Comment 5 and 6 *(Page 32763 Line 21-23 DMS emission from Nostoc commune was mentioned in "summary and conclusions". However, DMS emission from Nostoc commune was not presented and discussed in "results and discussion" in this study, though micro-algae-origin organics in aerosols were discussed. I suggest to add discussion about DMS emission from Nostoc commune in section of "results and discussion", or remove the description about DMS emission from Nostoc commune from the text and Figure 17. Page 32763 Line 25-26 Description of DMS emission from snow surface is high speculation. Nutrient concentrations (e.g., nitrates and phosphates) are too low in surface snow around the Antarctic coasts to propagate microalgae to engender significant DMS emission. I suggest that description about DMS emission from snow surface is removed from text and Figure 17, because the processes were not discussed in this paper.)*

We agree with the Referee that the Figure and figure caption 17 and corresponding text are misleading and partly speculative. Conclusions and Figure 17 have been revised and highly speculative and unnecessary parts have been taken away.

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