BOUNDARY LAYER NUCLEATION EVENTS AT AN ANTARCTIC SITE

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INTRODUCTION

During the Finnish Antarctic Research Program (FINNARP) 2009 expedition several aerosol and atmospheric composition measurements were carried out. The expedition took place at the Finnish Antarctic Research Station, Aboa (73°03′S, 13°25′W, Fig. 1), some 130 km away from the Antarctic coast, during the Antarctic summer 2009-2010 and lasted for about 2 months. The station is built on a nunatak Basen on Queen Maud Land. A small container, where the measurement devices were kept, is built some 200 m away from the main station, 496 m ASL. The station is located approximately South-East from the container.

The measurements were part of the four-year Finnish Academy project, where the purpose is to study the new particle formation and the climatic effects of the newly formed particles in Antarctic conditions, the transport of different components from the atmosphere to the snow and their distribution in snow. The measurements that were carried out during the FINNARP 2009 expedition, strive to answer the first part of the research plan; how the aerosol particles are formed in Antarctica and what are their climatic effects.

Figure 1. Landsat-satellite images over Basen and its surroundings.
METHODS

The concentrations of neutral and charged particles as well as their size distribution, ozone concentration and filter samples were taken from the atmosphere, about 3 m above the ground level. Different chemical components from the filter samples will be analyzed later in Finland. In addition, two Radon films were placed to both Basen and to the glacier. Also one Radon film was set to Basen to be collected during the Finnarp 2010 expedition.

The neutral particle size distribution from 10 to 500 nm was measured using a Differential Mobility Particle Sizer (DMPS), which classifies the particles according to their mobility and then calculates the corresponding particle concentration with a Condensation Particle Counter (CPC), by condensing butanol into the particles and thus making them optically big enough to be observed. Air-Ion Spectrometer (AIS) was used to measure the charged particle size distribution from 0.8 to 40 nm. The AIS divides the positive and negative particles and then calculates their concentration according to their mobility. A UV-photometric monitor was used to measure the ozone concentration.

RESULTS AND DISCUSSION

During the measurement period 8.12.2009-23.1.2010, 17 nucleation events were observed. The observed particle concentrations were low. The median and mean total particle concentration were 221.4 and 611.1 # cc\(^{-1}\), respectively (Table 1), and 90% of the data was between 99.5 to 1778.1 # cc\(^{-1}\). The median and mean nucleation mode (10-25 nm) concentrations were 14.9 and 254.3 # cc\(^{-1}\), respectively. Here we concentrate to investigate a 3-day period of very intensive nucleation, which occurred on 1.1.-3.1.2010 (Fig. 2) and during which 5 nucleation events, both banana- and apple-type, were observed.
During the 3-day intensive nucleation period, the mean wind direction was 50° (North-East) and the air masses were arriving to the station along the Antarctic coast (Fig. 3). The mean wind speed was 8.1 m s\(^{-1}\), which is slightly higher than the average for the whole measurement period. The nucleation mode and total particle concentrations were higher than on average, the first being over 40 times and the latter being nearly 4 times larger than the medians for the whole campaign period. AIS typically showed more negative particles in the beginning of the events, which is also reported by Asmi et al. (2009). The growth rate (GR) on 1.1.2010 at 18:00 was as high as 5.4 nm h\(^{-1}\) and settled later to about 2 nm h\(^{-1}\). The values are higher than observed by Asmi (2009) and Virkkula (2009) but the same order of magnitude.

Figure 3. 48-h back-trajectories arriving to Aboa on 1.1. to 4.1.2010 00 UTC.

On contrary to observations by Virkkula et al. (2009), the events were not associated with ozone increase, which is a tracer of a tropospheric fault. Also, this was the first time that apple-type events were observed with a DMPS at Aboa.

During summertime, snow on top of the nunatak melts into several small, shallow ponds, where plenty of non-specified algae grow. During the examined period the wind was blowing straight from these ponds, which are just 2 km away from the container. This raises a scientific question: is it possible that some organics evaporate from the algae and cause the intense apple-type nucleation events? Samples of the algae and water were taken and they will be later analyzed.

Our next major step is to put together the statistics of all the events observed during campaigns, the first of which was done already in 1999 (Koponen et al., 2002).
<table>
<thead>
<tr>
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<th>Entire campaign mean / median</th>
<th>1.1-3.1.2010 mean / median</th>
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</thead>
<tbody>
<tr>
<td>Temperature [°C]</td>
<td>-4.8 / -5.0</td>
<td>-4.5 / -4.6</td>
</tr>
<tr>
<td>Wind direction [°]</td>
<td>33.5 / 41.0</td>
<td>44.9 / 50.0</td>
</tr>
<tr>
<td>Wind speed [m s⁻¹]</td>
<td>5.7 / 4.6</td>
<td>8.1 / 8.8</td>
</tr>
<tr>
<td>Relative humidity [%]</td>
<td>75.0 / 76.0</td>
<td>80.1 / 85.0</td>
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<tr>
<td>Total number concentration [# cc⁻¹]</td>
<td>611.1 / 221.4</td>
<td>212.9 / 850.4</td>
</tr>
<tr>
<td>Nucleation mode (10-25 nm) number concentration [# cc⁻¹]</td>
<td>254.3 / 14.9</td>
<td>45.0 / 625.9</td>
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</table>

Table 1. Mean and median values for the entire campaign and for 1.1-1.3.2010.

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