Origin of the aerosol nanoparticles in the marine boundary layer over south-eastern Baltic Sea

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Keywords: aerosol formation, aerosol size distribution, marine aerosols, nucleation, particle formation and growth.

The aim of this study was to compare variation of marine aerosol size distribution and total aerosol concentration under the influence of different air masses over the south-eastern Baltic Sea and in the Lithuanian coastal zone. The measurements were performed at the Environmental pollution research station in Preila (Lithuania) and in the Baltic Sea about 10 km wide from the coast from 7 to 12 of May, 2006. The total aerosol particle concentration was measured by using condensation particle counter (CPC) UF-02, which can register 4.5 nm particles (Plauškaitė et al., 2006). Over the same period the measurements of the aerosol particle number concentration and size distribution in the 10 – 200 nm size range were performed using differential mobility particle sizer (ELAS-5Mc; Ulevičius et al., 2002) at the Preila station. The series of two-day air mass backward trajectories were calculated for the entire period using the Hybrid Single - Particle Lagrangian Integrated Trajectories model Version 4 (HY-SPLIT)(NOAA, www.arl.noaa.gov/ready.html).

During the experiment the formation of aerosol particles and further their growth in the ambient air was observed on the 8, 9 and 11 of May, 2006. At the Preila station the aerosol particle concentration was lower and without such sharp short-term increases of particle concentration as in the Baltic Sea. These short-term increases of the particle concentration could be related to the air ionisation due to wave break and also to the pollution from ocean(sea)-going ships, which may influence the chemical composition of the marine boundary layer. However, due to enough strong mixing of air masses (median wind speed was over 5 m/s) and/or low condensation sink newly formed aerosol particles suddenly disappears. The aerosol size distributions were plotted as contour plots for each day (as a function of time). The nucleation event days were on 8, 9 and 11 of May, 2006.

For each event, the particle growth rate, new particle formation rate and the condensation sink were calculated graphically from the contour plots, and furthermore, from the growth rate the source rate of condensable vapour was estimated by using methodology given in Kulmala et al. (2001) (Table 1). Since the exact identity of the condensable vapour is unknown, the source rate was estimated by using transport values of sulphuric acid.

<table>
<thead>
<tr>
<th>Date</th>
<th>GR, nm/h</th>
<th>J, cm⁻³ s⁻¹</th>
<th>CS, 1/s</th>
<th>Q, 1/(cm³ s⁻¹)</th>
<th>Traj.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006.05.08</td>
<td>1.8</td>
<td>0.07</td>
<td>2.60·10⁻²</td>
<td>6.41·10⁻¹</td>
<td>NE</td>
</tr>
<tr>
<td>2006.05.09</td>
<td>2.9</td>
<td>1.53</td>
<td>3.26·10⁻²</td>
<td>1.30·10⁰</td>
<td>NE-N</td>
</tr>
<tr>
<td>2006.05.11</td>
<td>1.1</td>
<td>0.05</td>
<td>3.05·10⁻⁴</td>
<td>4.60·10⁻⁵</td>
<td>N-NW</td>
</tr>
</tbody>
</table>

At the Preila station was observed new aerosol particle formation and growth events with enough low particle growth and formation rates (the means were 1.9 nm/h and 0.55 cm⁻³ s⁻¹, respectively). The mean condensation sink and the mean condensable vapour source rate values were 0.0297 s⁻¹ and 8.00·10⁹ cm⁻³ s⁻¹, respectively. This type of nucleation seems to be typical for the marine and coastal environments. It was estimated, that the total aerosol particle concentration over the Baltic Sea was higher than at the Preila station. Before the start of nucleation process was observed the decrease of the total particle concentration. The short-term increases of the total particle concentrations in the marine environment could be related to the new particle formation, which could be accelerated by the air pollution from ships and ionization due to wave break. Usually the formation of new aerosol particles in the marine and coastal environments was observed when the clean air masses present at the site.

This work was supported by the FP6 project ACCENT and by the EUSAAR.

