Statistical Evaluation of New Particles Formation Events at Košetice Station

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STATISTICAL EVALUATION OF NEW PARTICLES FORMATION EVENTS AT KOŠETICE STATION

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INTRODUCTION

Atmospheric aerosols have been studied extensively due to the confirmed influence of aerosols on global climate, aerosol – clouds interactions, atmospheric visibility, human health etc. (Kerminen et al., 2005; IPCC, 2007; Wichmann et al., 2000). However, the uncertainties connected to the effects of aerosols on phenomena in the atmosphere are considerable – there are various sources of aerosol particles, having different chemical compositions and particle size distributions (PSD). Concerning changes of PSD, the most important processes are new particle formation events (NPF).

A NPF event, sometimes called a nucleation event, is characterized by a formation of ultrafine particles in the size range between 3 and 25 nm. The result of the NPF event is a new mode in the PSD. The formation of particles and their further growth by condensation and/or coagulation are key processes influencing the dynamics of the atmospheric aerosol PSD (Kulmala et al. 2001).

In this work, we present a basic statistical evaluation of NPF at Košetice background station in the region of middle Europe.

METHODS

The evaluated data were collected during the first two years of measurements (2008 - 2010) at Košetice observatory, located in the Czech Highlands (49°35'N, 15°05'E, altitude 534 m a.s.l.). The observatory is a rural background meteorological station operated by the Czech Hydrometeorological Institute, and is a part of the national professional meteorological measurement network, specialized in the environmental quality monitoring. In 2008, the observatory became a part of the EUSAAR network and was equipped by an IfT-SMPS (Scanning Mobility Particle Sizer) provided by the Leibnitz Institute for Tropospheric Research (IfT) in Leipzig.

The SMPS samples every 5 minutes over the mobility size range from about 10 nm to 900 nm. Data in 5 minutes time resolution have been processed according to the EUSAAR standards into one-hour arithmetic means of particle number concentration.

The evaluation is based on the NPF classification according to Dal Masso et al. (2005). The decision path is shown in Fig. 1.

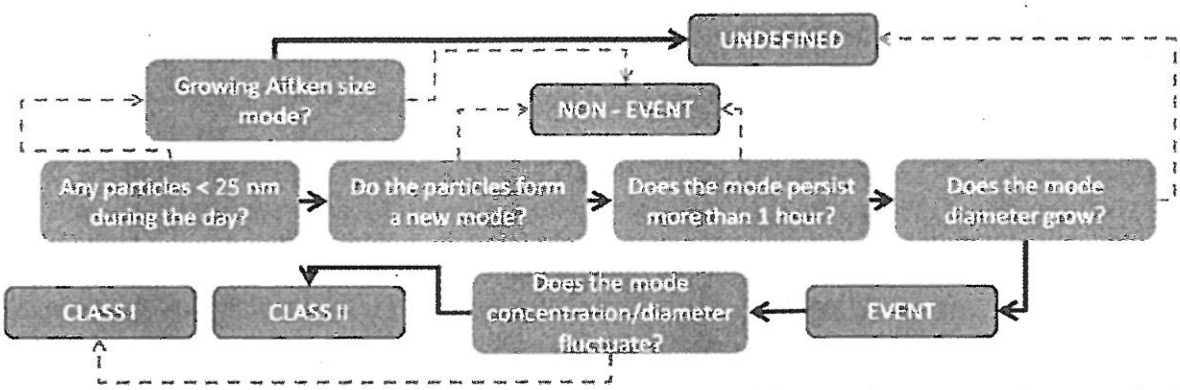

Fig. 1 Decision path used in NPF event characterization. Derived from Dal Masso et al., 2005. Thick lines denote "Yes", dashed lines "No

RESULTS

The contribution of accumulation mode changes only between 40 and 70 % of the total particle number, with quite well expressed maximum between October and March (Fig. 2). Similar maximum can be observed in the largest particles' concentrations. Greater variability has been found in the contribution of the nucleation mode particles. During the colder half of the year, the nucleation mode represents only about 20 % of the total number, whereas during the warmer half of the year, the ratio reaches up to 70%. It is an influence of NPF events that take place only rarely in winter.

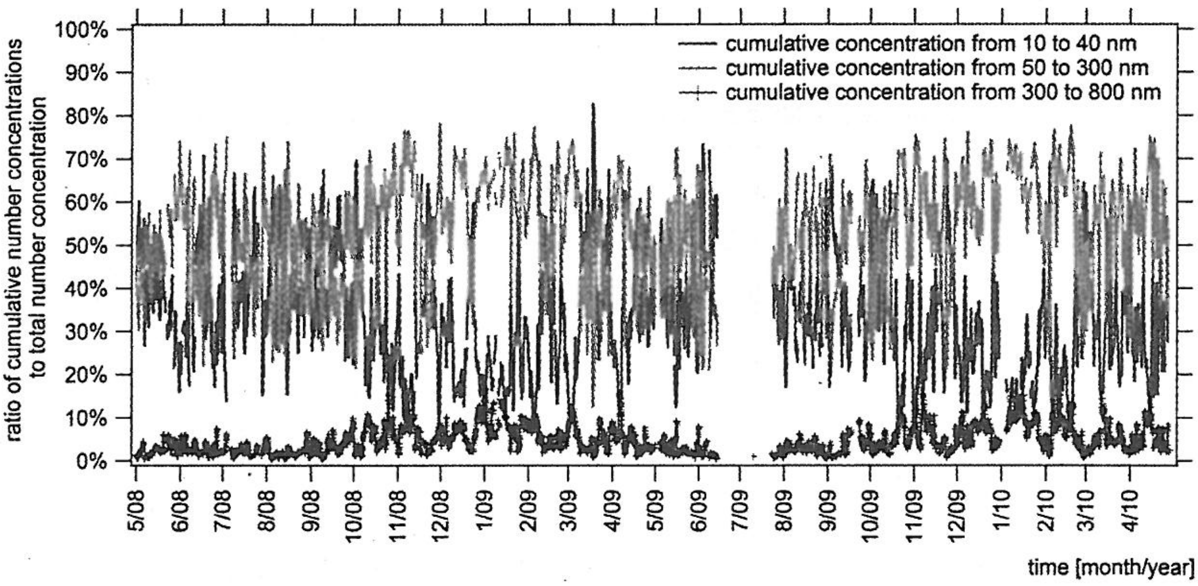

Fig. 2 Cumulative concentrations for particles smaller than 40 nm, between 50 nm and 300 nm, and particles larger than 300 nm in diameter, compared to the total particle number concentrations. The hourly means were replaced with daily medians for a better readibility.

The average annual cycle of NPF events (Fig. 3) has two maxima, the first in April and the second between July and September. The main minimum is located in the colder part of the year. The Non-event days follow an inverse annual cycle; Undefined days are spread more evenly over the year.

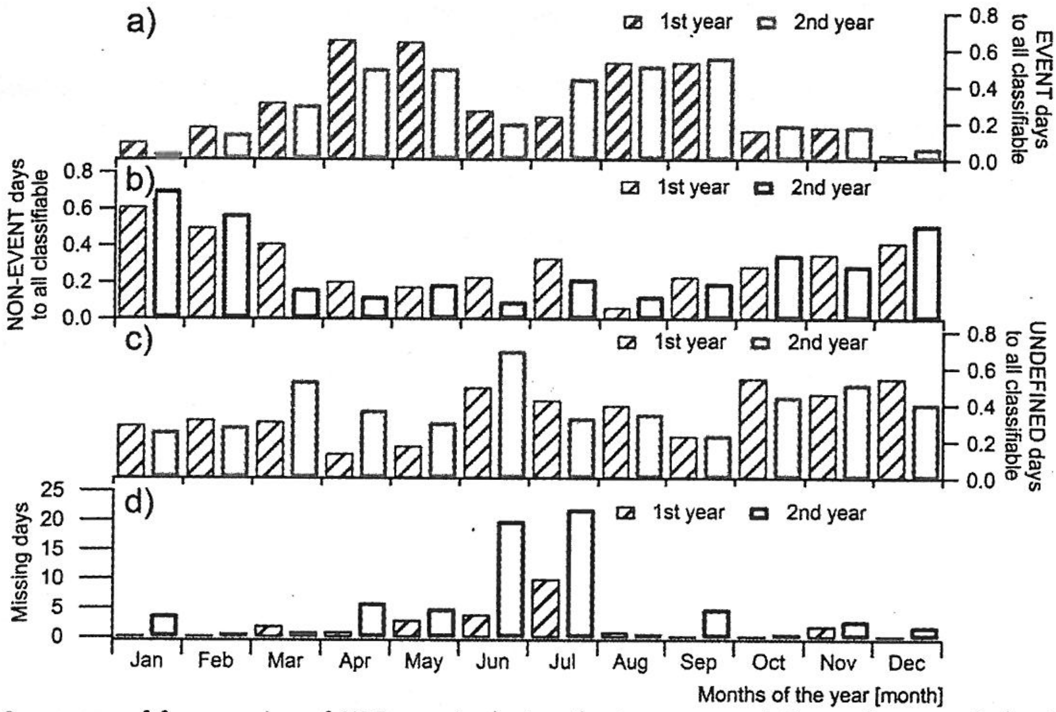

Fig. 3 Summary of frequencies of NPF events during the two years. a) Event days to all classifiable days. b) Non-event days to all classifiable days. c) Undefined days to all classifiable days. d) Missing days

The results were compared to the results of Hyytiala station, background station with long-term NPF definition time series (Dal Masso et al., 2005). Results of the two stations are surprisingly similar (Tab. 1), although geographical position of the measurement sites and also measurement period (1996 to 2003 in Hyytiala, 2008 to 2010 in Košetice) differ within the stations.

	Event	Non-event	Undefined
Košetice	31.0	34.4	34.7
Hyytiala	24.2	29.3	37.3

Tab. 1 Comparison of NPF event frequencies at Košetice observatory and Hyytiala station. Hyytiala data derived from Dal Masso et al., 2005.

CONCLUSIONS

Analysis of NPF event frequencies according to Dal Masso et al., 2005 was done on SMPS data from Košetice observatory, collected between 5/2008 and 4/2010. Clear annual cycle of NPF events was found. The annual cycle has two maxima, in April and between July and September. Main minimum is located in the colder part of the year. Non-event days follow an inverse annual cycle (maximum in winter, minimum from spring to summer). Undefined days are approximately evenly spread over the year.

Variability between the two years is not high, especially ratio of NPF events to all classifiable days varies only by several percents between the two years.

Results from Košetice station are very similar to those from Hyytiala station (Finland), despite different geographical location and different time periods.

ACKNOWLEDGEMETS

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