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NEW PARTICLE FORMATION MEASUREMENT DOWN TO 1.2 NM AT NAOK

A. Holubová Šmejkalová[1,2,3], N. Zíková[4], V. Ždímal[4]

[1]Institute for Environmental Studies, Faculty of Science, Charles University, Prague, Czech Republic, adela.holubova@chmi.cz
[2]Czech Hydrometeorological Institute, Prague, Czech Republic
[3]Global Change Research Institute, AS CR, Brno, Czech Republic
[4]Institute of Chemical Process Fundamentals, AS CR, Prague, Czech Republic

Introduction

Atmospheric aerosols influence Earth's climatic system and human health. Role of aerosols in climatic system still includes uncertainties strongly influencing model simulations (Zhao et al. 2018). One of the uncertainties is caused by secondary aerosol formation and their consequent growth. Nucleation of aerosol particles is a process determined by presence of aerosol precursors in atmosphere and by ambient atmospheric conditions (Dada et al. 2017). Since new particle formation (NPF) events have been observed in many types of environment (Kulmala et al. 2004), we have focused on NPF events at background station in the Czech Republic, representative for central European region. In this study we investigate NPF process of aerosol clusters from 1.2 nm in size.

Methods and measurements

Measurements were conducted at National Atmospheric Observatory Košetice (NAOK – 49°34′24"N, 15°4′49"E, 534 m a.s.l.), a rural background station located in Czech-Moravian Highlands. Evaluated data cover period from 4th August 2016 to 31th October 2017.
NAOK is equipped with state-of-the-art instrumentation for monitoring atmospheric pollutants, aerosol particles, meteorological parameters and greenhouse gases. Analyses of aerosol particle formation is based on data from two main instruments: nano Condensation Nucleus Counter (nCNC, A11 Airmodus) and Scanning Mobility Particle Sizer (SMPS – custom-made by IfT TROPOS) operated at NAOK. Freshly formed clusters were measured by nCNC in scanning mode in five size categories from 1.2 to 3.4 nm (1.17 –1.26, 1.26–1.44, 1.44–1.76, 1.76–2.34, and 2.34–3.41 nm). Aerosol particle number size distribution (PNSD) were recorded by SMPS in size range from 10 to 800 nm every 5 min.
According to methodology of Dal Maso et al. (2005), daily PNSD were classified to different categories - NPF event, NON event or Undefined event day. Day was classified as NPF event day if aerosol particle formation began in nucleation mode and this new mode was recorded for more than one hour with signs of growing (Figure 1). Further analyses were carried out only for NPF event days. Formation and transformation processes of atmospheric clusters were characterized by formation rate (J), condensation (CS), and coagulation sink (F_{coag}). While J and F_{coag} were calculated for newly formed clusters in size categories from 1.2 to 3.4 nm, CS determining the condensation rate of molecules on pre-existing aerosol particles was determined from PNSD from 10 to 800 nm. J was calculated according to Dal Maso et al 2007, CS and F_{coag} by Kulmala et al. 2012.

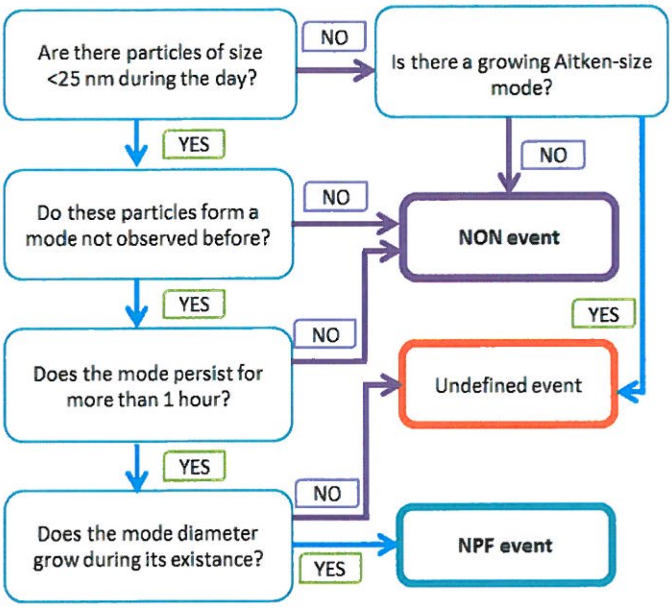

Fig 1. Diagram of the decision path for classification of the daily aerosol number size distribution. *Adopted from Dal Maso et al. 2005.*

Results

Measurement period covers 57 days for which CS, F_{coag}, and J were evaluated. Figure 2 shows daily variability of median of the condensation and coagulation sinks. CS and F_{coag} behaved in similar patterns with visible decrease around 8:00 UTC. CS fluctuated from $6.4\cdot10^{-3}$ to $1.0\cdot10^{-2}$ s^{-1}, F_{coag} in the smallest size category, 1.17-1.26 nm, varied from $2.8\cdot10^{-3}$ to $4.4\cdot10^{-3}$ s^{-1} , values in the largest size category (2.34-3.41 nm) were more than one order of magnitude lower ($9.74\cdot10^{-5}$ – $1.53\cdot10^{-4}$ s^{-1}).

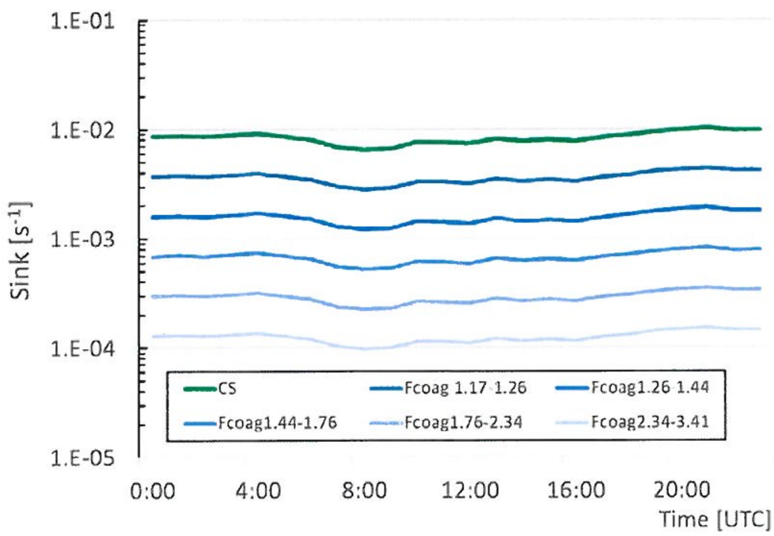

Fig 2. Median daily variability of CS, and F_{coag} in individual size categories.

Aerosol cluster formation rate started to rise between 7:00 and 9:00 UTC. Daily variability was better pronounced by clusters larger than 1.76 nm (Figure 3). Formation rate reached maximum around noon - 2.2 $cm^3 \cdot s^{-1}$ (cluster size 1.17–1.26 nm), and 0.57 $cm^3 \cdot s^{-1}$ (cluster 2.34–3.41 nm).

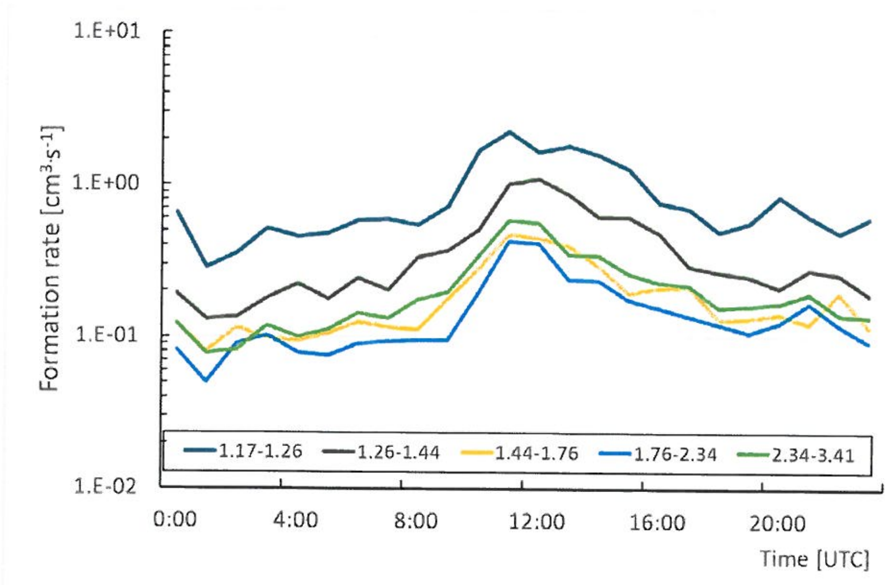

Fig 3. Median daily variability of J in individual size categories.

Results indicate connection with meteorological conditions. Lower CS were measured when mixing layer in atmospheric boundary layer started to develop in the morning hours. Increasing formation rate is connected with rising values of global radiation that favour photochemical reactions.

Acknowledgment

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