The potential role of ion-induced nucleation at a coniferous forest site in north eastern Bavaria

S. G. Gonser[1], F. Klein[1,2], W. Birmili[3], J. Größ[3] and A. Held[1]

[1] Junior Professorship in Atmospheric Chemistry, University of Bayreuth, 95440 Bayreuth, Germany
[2] Now at: Gasphase and Aerosol Chemistry Group, Paul Scherrer Institute, 5232 Villigen, Switzerland
[3]Leibniz-Institute for Tropospheric Research, 04318 Leipzig, Germany
Keywords: Ion-induced nucleation, Nucleation, Growth, Ions.
Presenting author email: stefan.gonser@uni-bayreuth.de

Mechanisms governing the nucleation process of secondary aerosol formation are widely discussed. In particular, there is no general consensus on the relevance of ion-induced nucleation. Over the last decade a set of new instruments has become available capable of measuring the number size distribution of neutral and charged clusters in size ranges relevant for nucleation. One of these instruments is the neutral cluster and air ion spectrometer (NAIS) which measures neutral clusters down to 2 nm diameter and ions down to diameters of 0.9 nm. Field based measurements in the lower troposphere using the NAIS indicate a minor impact of ions on nucleation (~10% or less, see e.g. Manninen *et al*, 2010), whereas modelling results as well as different approaches towards interpretation of the field data point at a major role of ion induced nucleation (Yu and Turco, 2011).

During an eight-week measurement campaign we applied a NAIS as well as a scanning mobility particle sizer (SMPS) to study new particle formation events at the "Waldstein" ecosystem research site in the Fichtelgebirge mountain range, NE Bavaria, Germany. The measurements were performed from mid of June to mid of August 2012. In the summer season, new particle formation is a frequently observed phenomenon at this site (e.g. Held *et al*, 2004).

The Fichtelgebirge mountains are well known for their elevated background radiation levels. The radiation originates from the bedrock, containing an increased concentration of uranium and thorium. Additionally, the fissured granitic bedrock promotes the molecular diffusion of gaseous radon. The radioactive background shows a diurnal variation with highest values during the night and decreasing radiation during day time. Thus, ion concentrations may be elevated at times and may play a role in particle nucleation.

During the campaign a total of 18 clear nucleation event days were observed with nucleation rates J_{2nm} between 1-38 cm^{-3} s^{-1} and growth rates in the range of 0.5-5 nm h^{-1}. In Fig. 1 the evolution of a new particle formation event is shown. The lower panel shows the ion fraction of the total particle number in the diameter range 2-3 nm. An increase in the ion fraction was observed shortly prior to the onset of the nucleation event, indicating the potential role of ions on nucleation.

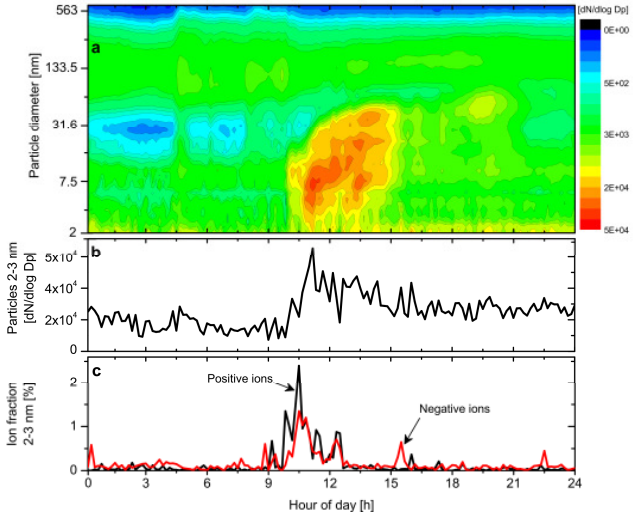

Figure 1. Time evolution of a new particle formation event on 4th July 2012. **a**) total particle number size distribution, **b**) total particle sum in the diameter range 2-3 nm, **c**) fraction of positive and negative ions of total particle number between 2-3 nm.

Daily mean small ion (< 2 nm mobility diameter) concentrations were found to be in the range from 90 cm^{-3} to more than 400 cm^{-3}. Further detailed analysis of the role of ion-induced new particle formation at this forest site will be presented.

This work is funded by the Deutsche Forschungs-gemeinschaft (DFG) under grant DFG HE 5214/3-1.

Held, A., Nowak, A., Birmili, W., Wiedensohler, A., Forkel, R., and Klemm, O. (2004) *J. Geophys. Res.* **109**, D23204.

Manninen, H. E., Nieminen, T., Asmi, E., Gagné *et al.* (2010) *Atmos. Chem. Phys.* **10**, 7907–7927.

Yu, F. and Turco, R. P. (2011) *Atmos. Chem. Phys.* **11**, 9451-9463.