Seasonal variation in particle hygroscopicity and CCN number concentration at a central European regional background site (Melpitz, Germany)

S. Henning, A. Beyer, V. Brock, W. Birmili, L. Poulain, A. Grüner, A. Wiedensohler, H. Herrmann, and F. Stratmann

Experimental Aerosol and Cloud Microphysics, Leibniz-Institute for Tropospheric Research,
Permoserstrasse 15, 04318 Leipzig, Germany
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Presenting author email: silvia.henning@tropos.de

One of the important factors influencing cloud properties and thereby the earth's radiation budget is the availability of Cloud Condensation Nuclei (CCN). However, long-term data sets are rare, which are taken at regionally representative sites. The European Aerosols, Clouds, and Trace gases Research InfraStructure Network (ACTRIS) aims at integrating European ground-based stations equipped with advanced atmospheric probing instrumentation for aerosols, clouds, and short-lived gas-phase species. Within this network, long-term observations of CCN number concentrations and particle activation properties were launched in August 2012 at the TROPOS field station Melpitz, Germany.

CCN size spectra are measured between 25 and 300 nm at 5 different supersaturation (*SS*) levels (0.1, 0.2, 0.3, 0.5, 0.7%). Therefore, the CCN counter (DMT-100, Boulder, USA) was operated downstream of a Vienna-Type Differential Mobility Analyzer (DMA). The calibration and also the setup of the monodisperse CCN measurements follow the recommendations of the ACTRIS SOP for CCN measurements (Gysel and Stratmann, 2013). In addition to the CCN data, particle number size distribution measurements, total particle number (N_{CN}), a wide variety of chemical gas and particle measurements as well as standard meteorological parameters are available on a continuous basis at the Melpitz station.

Presently, we analysed CCN data for the time period August 2012 to June 2014. The CN and CCN spectra were corrected for multiple charges and the size-dependent activation fraction (AF) was calculated dividing CCN by particle number concentration. This was done for all *SS* levels. By fitting the resulting AF at certain *SS* with the sigmoid error function, the 50% activation diameter could be derived (D_{P50}). For given *SS* and D_{P50}, the corresponding κ-value (hygroscopicity parameter) was calculated as given by Petters and Kreidenweis (2007). On average κ-values were found to be 0.313 ± 0.091 for 0.2% *SS* and 0.284 ± 0.086 for 0.3% *SS*, which compares well to the κ-value suggested by others for continental aerosol (Pringle *et al.* 2010, Wex *et al.* 2010). This two-year data set exhibits an annual cycle in κ, with lowest values in summer (κ (0.2%) = 0.219 ± 0.068) and highest values in winter (κ (0.2%) = 0.397 ± 0.078). A daily cycle was observed for the summer data, with low κ values (around 0.2) during the night hours and a maximum around noon and seems to follow thereby the daily cycle of solar radiation. In winter, no daily cycle in the κ-value was observed.

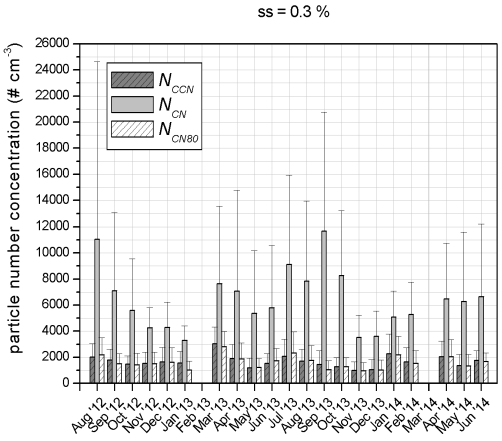

Figure 1. Time series of total particle number concentration (N_{CN}), particles larger than 80 nm (N_{CN80}) and CCN number concentration (N_{CCN}) at 0.3% *SS* from August '12 to June '14.

The total particle number concentration ranged between almost 13000 cm^{-3} (September '13) and 3500 cm^{-3} (November '13). The total CCN number concentration was found to peak in March '13 with about 3000 cm^{-3} (*SS* = 0.3%) and thereby correlating well with the maximum in the accumulation mode particle number concentration ($N_{CN80,}$ cf. Fig. 1). A cluster analysis concerning the dominating air masses showed that in the period with highest values in CCN number concentrations, the site was mainly influenced by air masses from central continental regions and might be connected to the heating period.

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