Long-term cloud condensation nuclei (CCN) activity, variability and closure analysis at a meteorological tower in Western Europe

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Aerosol-cloud interactions contribute large uncertainties in understanding anthropogenic influence on climate change. A better understanding of observationally derived representative aerosol properties, especially cloud condensation nuclei (CCN) spectra and their spatial and temporal variation, is essential to evaluate the performance of climate models and improve climate projections. To obtain a comprehensive information of temporal variability and vertical distributions of CCN properties, concurrent measurements of sufficient types of aerosol properties (e.g., particle number concentration and size distribution, CCN number concentration and activity, and chemical composition) were conducted at a 120m tall meteorological tower in Forschungszentrum Jülich, Germany, over a year period (September 2016-November 2017). The instrumentation setup consisted of a CCN-counter from Droplet Measurement Technologies (DMT), a TSI SMPS comprised of a differential Mobility Analyzer (DMA) and an ultrafine water-based Condensation Particle Counter (CPC), and an Aerosol Mass Spectrometer (AMS, Aerodyne Research Incorporated, USA). Aerosols were collected from the same inlets at three different altitudes of 10 m, 50 m, and 120 m above ground, respectively. The altitude-resolved sampling permitted the additional investigation on influences of vertical mixing processes of the boundary layer on aerosol properties. Our preliminary results indicated that 1) Physical properties of particles showed obvious monthly variations throughout the year, but not strong and consistent seasonality; 2) Stratification (influence of vertical mixing processes) was more pronounced in winter; 3) Aerosol chemical composition showed a relatively obvious seasonality; and 4) The hygroscopicity parameter (κ, a quantitative measure of aerosol water uptake characteristics and CCN activity) calculated from CCN-C measurement varied from 0.1 to 0.4 in this study, exhibiting similar variation tendency with chemical species (especially nitrate and ammonium). Detailed temporary variabilities and stratification of different aerosol properties, as well as relationships between κ and chemical compositions will be further discussed. A closure study based on κ -Kohler theory will be also presented with comparison of measured and predicted CCN number concentrations using chemical composition data from AMS.