Airborne measurements of aerosol particle physical, optical and chemical properties in Finland

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Because the climate effects depend on the composition and quantities of the total atmospheric column, there is a strong demand for the vertical measurements of the important climate forcers, such as aerosol particles. Therefore, a new measurement platform, equipped with instrumentation for atmospheric aerosol particle characterization, as well as for greenhouse gas and trace gas concentration measurements, was constructed in Finland. For the first time, this was used in summer 2012 to study the profiles of the atmospheric constituents over the southern Finland and the Baltic Sea. Here, the measurement concept is introduced, and a brief overview of first results with some examples is given.

An airplane used is a modified Short Skyvan SC-7 research airplane, which is a non-pressurized twin-engine turbo-propeller aircraft with a maximum operating distance of 1370 km. On board on first flights were instruments for aerosol chemical and physical characterization: a Soot Particle-Aerosol Mass Spectrometer (SP-AMS, Aerodyne Research Inc., USA) for fast high resolution particle chemical characterization, a 3-wl nephelometer model 3563 (TSI Inc., St. Paul, Minnesota, USA) for particle scattering measurements, a continuous-flow stream wise thermal-gradient cloud condensation nuclei counter (DMT-CCNC) model CCN-100 (Droplet Measurement Technologies, Inc., DMT, USA) for CCN total number measurements at fixed supersaturation of 0.34 % and two condensation particle counters (CNC) model 3010 (TSI Inc., St. Paul, Minnesota, USA). The CCN, one CNC, and SP-AMS were operated behind the Constant Pressure Inlet (CPI, DMT, USA), set to 650 mbar. Concentrations of carbon dioxide (CO2), methane (CH4) and water vapour (H2O) were measured using a Picarro G1301-m (Picarro, Inc. Sunnyvale, CA USA), using near-infrared lasers and Cavity Ring-Down Spectroscopy, and specifically designed for airplane measurements. Sample was drawn trough a BMI Isokinetic Inlet System (Model 1200, Brechtel Manufacturing Inc., USA), equipped with anti-icing system, pitot tube, and temperature and pressure sensors. Position and speed were taken from the airplane system MIDG II INS/GPS.

As an example of the results obtained, we present the CCN and CN profiles over land (Fig 1a), where near 3 km altitude a layer of small particles was present, indicating secondary particle formation taking place. Below this altitude, at around 2 km height, a sudden increase of nitrate, accompanied with an increase of ammonia, was detected. We interpret this as an indication of strong anthropogenic signal at this layer, showing simultaneously an interesting case of nitrate partitioning in aerosol phase with the decreasing temperature and humidity, as suggested e.g. by Morino et al., 2006.

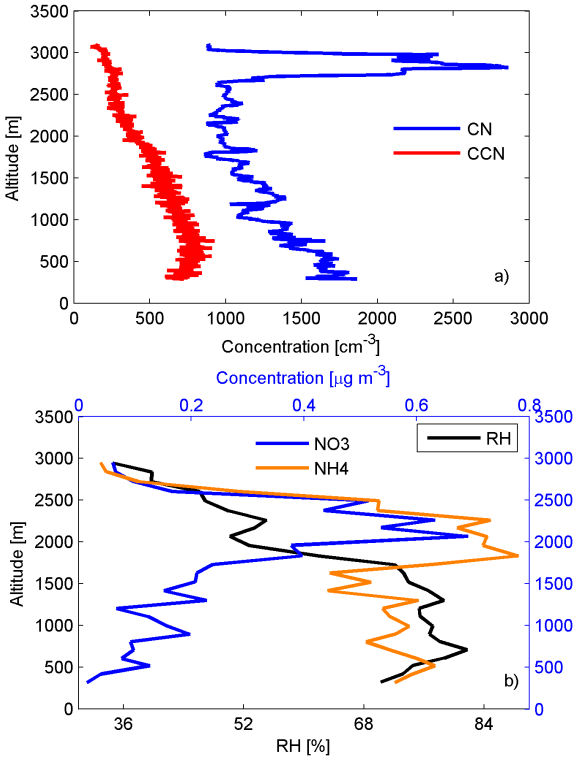

Figure 1. a) Total (CN) and CCN particle number concentration and b) relative humidity (black) and nitrate (blue) and ammonia (orange) concentrations, as measured during the first ascent over land with an altitude presented in y-axis.

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