Airborne measurements of aerosol particles and greenhouse gases in southern Finland

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Introduction

The largest anthropogenic climate forcings are caused by atmospheric aerosol particles and by greenhouse gases (GHGs). Currently, the surface heating effect of increasing atmospheric GHG concentrations is nearly counterbalanced by the cooling from aerosols. The impact of aerosol particles on climate is poorly understood, which is further reflected in uncertainties in climate sensitivity to different forcings. Because the climate effects depend on the composition and quantities of the whole atmospheric column, there is a strong demand for vertical measurements of the important climate forcers, such as aerosol particles and greenhouse gases.

Methods

Figure 2. Schematics of instruments inside the Short SC-7 Skyvan airplane. Instruments onboard on first flights measured aerosol chemistry (SP-AMS), aerosol cloud activation properties (CCN counter), aerosol scattering (Nephelometer), aerosol total concentration (CPC) and greenhouse gas concentrations (Picarro). Inlet controller unit kept the inlet flow isokinetic.

Figure 3. Flight routes on July 30 (white) and July 31 (green). On 31 July, one vertical profile was done over land and three vertical profiles over the ocean close to island of Utö.

Vertical profiles over land

Figure 4. a) Total (CN) and CCN particle number concentration, b) aerosol scattering coefficients at 450 nm (blue), 550 nm (green) and 700 nm (red) wavelengths, c) relative humidity (black) and nitrate (blue) and ammonia (orange) concentrations, and d) carbon dioxide (black) and methane (green) concentrations, all measured during the first ascent over land with altitude presented in y-axis.

Indications of new particle formation are seen in free tropospheric region (figure a). Partitioning of nitrate in particle phase occurs in residual layer as the humidity decreases (figure c).

Vertical profiles over sea and comparison to lidar measurements

Figure 5. Simultaneous HALO Doppler lidar measurements made in Utö. Flight paths of skyvan are marked with black lines.

Figure 6. Vertical profiles of relative humidity (left) and aerosol scattering on blue (centre) and red (right). On black color is the 1. profile, on blue 2. profile and on red 3. profile measured with airplane.

Figure 7. Backscatter profiles of lidar during 1. (black), 2. (blue) and 3. (red) flights show decreasing aerosol concentration as a function of time, similar to what is measured with online flying instrumentation.

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