The boreal forest canopy and aerosol eddy covariance fluxes

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In this study data from Hyytiälä in southern Finland during late winter 2003 are used to compare the aerosol dry deposition above and below the forest canopy at this site. Additionally, data from Värriö in northern Finland during spring this same year are used to compare the aerosol deposition in Värriö, where the canopy is relatively thin, with the deposition in Hyytiälä where the canopy is more compact. Aerosol fluxes were determined by using the eddy covariance method, in Hyytiälä at altitudes of 23 m and 2 m (above and below canopy) and in Värriö at an altitude of 15 m (above the canopy), using similar ultrasonic anemometers and CPCs with a cut at 10 nm diameter.

In figure 1 below (Hyytiälä), “canopy” represents the difference between the fluxes at 23 m and 2 m and “ground” represents 2 m flux. In this figure fluxes have been separated to emissive (upper figure) and deposition fluxes (lower figure). For the deposition cases, fluxes to the canopy are larger than the fluxes to the ground, which means that a large part of the deposition takes place in the canopy. In fact around 80 % of the deposition during this period was estimated to take place in the canopy and consequently only around 20 % on the forest floor. Clearly this must be because the canopy offers a much larger surface for deposition than ground.

For a period from late April to the middle of May 2003 aerosol fluxes were generally much larger in Hyytiälä than the fluxes in Värriö and at both sites the fluxes were mostly indicating net deposition. Since the friction velocities had similar mean values at the two sites during this period, the larger fluxes in Hyytiälä must be explained by the much higher number concentrations in Hyytiälä where the anthropogenic influence is more significant. Also the deposition velocities were higher in Hyytiälä. During this period the ground was snow covered most of the time in Värriö but not in Hyytiälä. Snow cover may be expected to reduce the deposition because of reduced leaf area. The higher presence of anthropogenic sources in Hyytiälä also affects the deposition since they generally result in smaller particles with a more efficient Brownian diffusion and thereby higher deposition velocities.

However our primary concern in this study is the influence of the canopy density on aerosol deposition. Therefore we now intend to compare the deposition during this period from late April to the middle of May 2003 in Värriö with other earlier periods this year in Hyytiälä with similar weather conditions at the two sites and also similar surface conditions regarding snow cover. In order to avoid the influence of particle size on deposition velocities we also will use data from differential mobility analysers (DMA) with size-dependent concentrations from both Hyytiälä and Värriö. A canopy model (Slinn, 1981) for aerosol dry deposition will be used and model results will be compared to measured data.

Figure 1: Emissive and deposition aerosol fluxes for canopy and ground in Hyytiälä from the middle of March to late March 2003.


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