Forests as protection against airborne immissions

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Abstract

The effect of a spruce forest in the Solling-hills (Germany) on the concentration of airborne trace compounds in the atmospheric boundary layer is discussed. The discussion is based on field measurements of vertical concentration profiles and vertical fluxes of reactive trace gases and particles in and above a spruce forest and on numerical modelling. Measured SO2-, O3- and PAN-concentrations are 10 % to 20 % lower near the forest floor than just above the canopy. NO2 is emitted from the forest into the atmospheric boundary-layer and NO is transported both from the atmosphere and from the forest floor into the spruce canopy air space. The net NOx-flux between the atmosphere and this spruce forest can be neglected compared quantitatively to other N-fluxes. Numerical experiments using two models show that a 1000 m long spruce forest reduces the near surface concentration of an airborne trace substance with a deposition velocity of about 0.7 cm/s by up to 6 % as compared to the upwind SO2-concentration. If a forest is replaced by a meadow the SO2-concentration at the former downwind side of a forest increases by about 10 %.

1 Introduction

Forests are today seen as land-use systems with multifunctional effects: they produce wood and non-wood products; they form habitats for micro-organisms, plants and animals; they serve as recreation environments for children and adults; they protect source areas for drinking water; and they reduce noise and local climate extremes. One further effect is their filtering of airborne substances. In Germany, forests can be declared by federal and state laws as protection forests, if they prevent or reduce danger and hazardous effects by immission of airborne substances. The law, however, does not quantify, which effects a forest should have on airborne substances to be classified as a protection forest. Before setting thresholds to qualify a forest as a protection forest it is, therefore, necessary to quantify the influence of a forest on concentrations of airborne trace substances.

The mere presence of a forest prohibits at the same site direct emissions from anthropogenic sources like vehicles, industries, enterprises and households. Forests themselves emit, however, a large variety of biogenic compounds in gaseous and particulate form. Forests do, however, also adsorb and absorb atmospheric trace constituents, so that the atmospheric burden of these trace substances can be reduced by forests. The effect of a spruce forest on the vertical concentration difference of some trace substances between the atmospheric layers above and below the canopy is characterised in this investigation by the results of field measurements. Most of the field measurements were part of thesis-investigations at the Institute of Bioclimatology (JACobi, 1993; WASCHEK, 1994; MÖLDERs, 1997; SCHU, 2001; BERTRAM, 2002). In addition results of model simulations on the concentration decrease of an airborne trace substance when traversing a 1000 m long spruce forest are discussed as well.