Biogenic VOC exchange in a mixed forest stand during the ECHO field campaign 2002

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Introduction

Vegetation plays a major role within the biosphere atmosphere exchange of several volatile organic compounds. But there is still a lack of knowledge concerning the amount of reactive trace gases being emitted or deposited by a temperate forest stand as well as the chemical processing of these compounds within the canopy. For this reason VOC measurements of primary emissions and atmospheric mixing ratios were conducted in a small mixed forest stand at the terrain of the research centre Jülich as part of the ECHO (Emission and CHemical Transformation of Biogenic Volatile Organic Compounds) field campaign 2002. To evaluate emission rates of several volatile organic compounds the predominant tree species of this forest (*Fagus sylvatica* and *Quercus robur*) were investigated by enclosure techniques. Additionally vertical and horizontal gradients of atmospheric mixing ratios were derived by simultaneously conducted profile measurements at two tower sites.

Experimental setup and site description

The Research Centre Jülich is located in the north-western part of Germany in about 35 km distance from the Dutch and Belgian border. The region is dominated by agricultural land and forests account only for a small percentage (10%, Jülich) of the total area. Three towers were erected in a small mixed forest stand (Stetternicher Forest) with heights ranging from 28 m (East- and Westtower) to 36 m (Maintower).

Figure 1: Area of the Research Centre Jülich and the measurement sites (original map edited by Forstverwaltung Gräfin Bernhild Poppendorf).

A detailed map of the terrain and the forest area is given in Figure 1. The measurement sites for East-, Main- and Westtower were located in an area dominated by beech (*Fagus sylvatica*) and oak trees (*Quercus sp.*). Another measurement site (Small Tower) was located outside of this forest on a small meadow near to an accumulation of several oaks.

To provide an insight into the vertical and horizontal distribution of volatile organic compounds within the forest, VOCs were measured simultaneously at four heights on the Maintower and additionally at two heights on the Westtower. Cuvette studies for VOCs were conducted at the Easttower in about 28 m height on *Fagus sylvatica* and at the Small Tower on *Quercus robur*. Figure 2 gives an overview of the experimental setup at the Forest site.

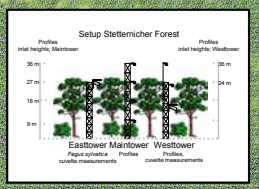
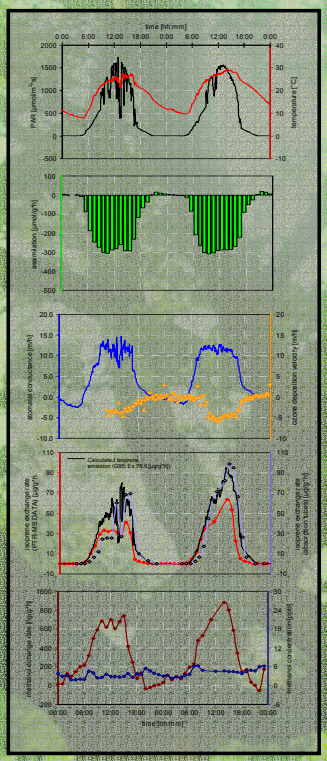


Figure 2: Experimental Setup at the site Stetternicher Forest

Figure 3: Pictures of the experimental setup during cuvette measurements on Fagus sylvatica. Left: Easttower, right (top): sample cuvette. Right (bottom): automatic sampling system for VOCs.

For the characterisation of exchange parameters, cuvette studies were carried out by the use of a dynamic cuvette system. VOCs were sampled on absorption tubes and were analysed by GC-FID/GC-MS in the laboratory later on. Carbonyls were trapped on DNPH-coated cartridges and analysed on site by an HPLC-UV system. Additionally to the use of absorption tubes, online emission measurements of various VOCs were conducted by PTR-MS on *Quercus robur*. For a detailed description of the PTR-MS system used during these experiments see: Neftel et al.. The use of Proton Transfer Mass Spectrometry to measure ambient VOC concentrations (poster presentation).

Cuvette measurements: *Quercus robur* and *Fagus sylvatica*



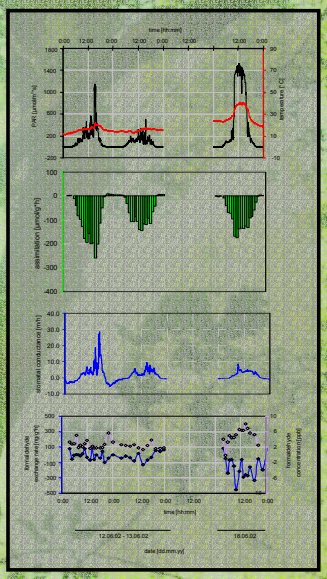


Figure 5 shows data of the formaldehyde exchange, measured on *Fagus sylvatica* in about 30 m height at the Easttower. In contrast to acetaldehyde and acetone (data not shown), formaldehyde exchange rates are correlated to ambient mixing ratios. Calculated deposition rates for formaldehyde ranged at -11 ng/g*h*ppb on average.

Figure 4 shows two days of measurement during the enclosure of *Quercus robur*. Diurnal cycles for isoprene and methanol were measured by PTR-MS. Additionally measurements for isoprene were conducted by the use of absorption tubes. Standard emission factors, calculated using both data sets, account for isoprene emissions of 49.5 µg/g*h (PTR-MS) and 74.7 µg/g*h (absorption tubes).

Vertical and horizontal profiles: acetone

Figure 6 gives an overview about the horizontal and vertical profiles measured simultaneously at two tower sites (Main- and Westtower) with a two hour time resolution. Gradients for acetone show extremely high mixing ratios (> 100 ppb) at both tower sites during night. Profiles derived from the measurements at the maintower show higher mixing ratios at lower levels.