Determination of biogenic organic compounds in airborne particles

INSTITUT FÜR TROPOSPHÄRENFORSCHUNG
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A.Plewka, D. Hofmann, E. Neumann, and Hartmut Herrmann
Institut für Troposphärenforschung e.V., Permoserstr. 15, 04318 Leipzig, Germany
e-mail: plewka@tropos.de

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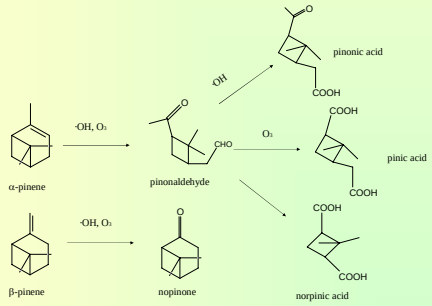
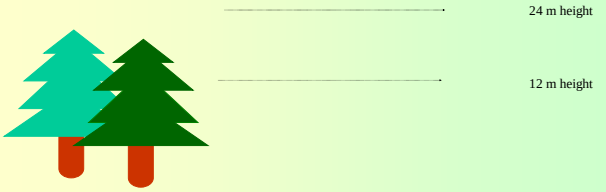
Introduction

Biogenic hydrocarbons, especially terpens, emitted by trees are expected to be an important source of secondary organic particulate matter. Recent reviews on global VOC emissions estimate that the magnitude of volatile organic compounds of biogenic origin could exceed that of anthropogenic origin by an order of magnitude. Numerous secondary compounds have been identified in laboratory studies as photooxidation products. On a global basis, vegetation is believed to be the largest contributor to the organic fraction of fine particulate matter, either through direct primary emissions of plant waxes or through secondary organic aerosol (SOA) formation due to the oxidation of emitted terpenes. We identified and quantified some terpene oxidations products and other biogenic compounds in high volume samples, collected in summer 2001 in a coniferous forest near Weißenstadt (Fichtelgebirge, Germany). The formation mechanism of the detected terpene oxidation products is shown in these reaction equations:



Sampling

The samples were collected in 12 m and 24 m height at the same time on quartz fibre filters with high volume samplers (500 l/min; Digitel).



Analysis

The quartz fibre filters were soxhlet extracted and than seperated into five fractions with different polarity after flash chromatography. The analytical procedure ist shown in the scheme in Fig 1. Fig. 2 shows a chromatogram for the acidic fraction.

Fig. 1: Sample preparation, according Gogou 1998

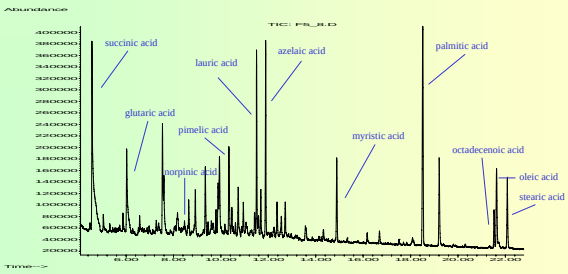


Fig. 2: Chromatogram of the acid- fraction

Results

Fig. 3 shows the particle mass on the filters for the two sampling heights and the ambient temperature during sampling. No significant differences for the particle mass could be observed for 12 m and 24 m. The ambient temperatur and the particle mass seems to be correlated. We identified alkanes, ketones, esters and acids. The concentrations are shown in Fig. 4,5 and 6 . The highest concentrations were found for succinic acid.

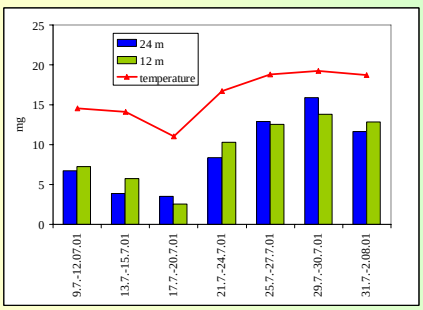


Fig. 3: Particle mass on the quarz fibre filters and the sampling temperature

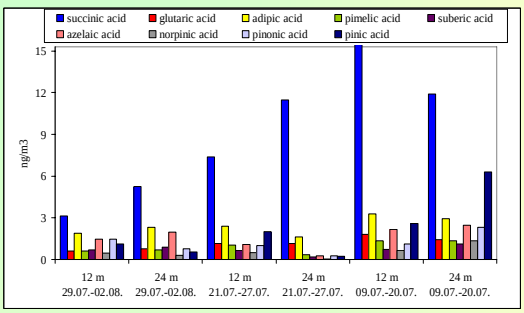


Fig. 4: Concentrations of carboxylic acids in diffrenent sampling heights

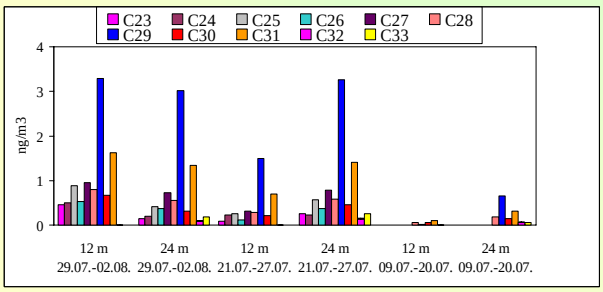


Fig. 5: Concentrations of alkanes

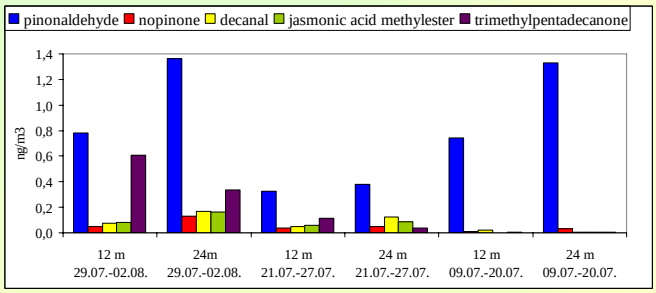


Fig. 6: Concentrations of ketones in different sampling heights

Discussion

- many single compounds were detected
- the highest concentrations were found for the polar components, especially for the dicarboxylic acids
- differences between 12 m and 24 m were observed for the alkanes and pinonaldehyd
pinonaldehyd shows higher concentrations above the treetops → photochemical formation
C_{32} and C_{33}-alkanes were only found above the treetops
- concentrations of terpene oxidation products are low in comparison to the terpene concentrations because of: high vapor pressure
many different oxidation products
further oxidation and degradation of these products
- more primary than secondary biogenic organic compounds were identified

Trimethylpentadecanone is described in the literature as photooxidation product from chlorophyll. Jasmonic acid and it methyl esters are ubiquitous in plants. They have hormone properties, help regulating plant growth and development and they seem to participate in leaf senescence and in the defence mechanism against fungi.

Acknowledgements

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