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Exchange of volatile organic compounds in the boreal forest floor

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Terrestrial ecosystems, mainly plants, emit large amounts of volatile organic compounds (VOCs) into the atmosphere. In addition to plants, VOCs also have less-known sources, such as soil. VOCs are a very diverse group of reactive compounds, including terpenoids, alcohols, aldehydes and ketones. Due to their high reactivity, VOCs take part in formation and growth of secondary organic aerosols in the atmosphere and thus affect also Earth's radiation balance (Kulmala et al. 2004).

We have studied boreal soil and forest floor VOC fluxes with chamber and snow gradient techniques we were developed. Spatial and temporal variability in VOC fluxes was studied with year-round measurements in the field and the sources of boreal soil VOCs in the laboratory with fungal isolates. Determination of the compounds was performed mass spectrometrically.

Our results reveal that VOCs from soil are mainly emitted by living roots, above- and belowground litter and microbes. The strongest source appears to be litter, in which both plant residuals and decomposers play a role in the emissions. Soil fungi showed high emissions of lighter VOCs, like acetone, acetaldehyde and methanol, from isolates. Temperature and moisture are the most critical physical factors driving VOC fluxes. Since the environment in boreal forests undergoes strong seasonal changes, the VOC flux strength of the forest floor varies markedly during the year, being highest in spring and autumn. The high spatial heterogeneity of the forest floor was also clearly visible in VOC fluxes. The fluxes of other trace gases (CO_2, CH4 and N2O) from soil, which are also related to the soil biological activity and physical conditions, did not show correlations with the VOC fluxes.

These results indicate that emissions of VOCs from the boreal forest floor account for as much as several tens of percent, depending on the season, of the total forest ecosystem VOC emissions. This emphasises that forest floor compartment should be taken into consideration when assessing ecosystem level VOC fluxes. These results can be utilized also in air chemistry models, which are almost entirely lacking the below-canopy compartment.

Kulmala, M., Suni, T., Lehtinen, K.E.J., Dal Maso, M., Boy, M., Reissell, A., Rannik, Ü., Aalto, P., Keronen, P., Hakola, H., Bäck, J., Hoffmann, T., Vesala, T. & Hari, P. 2004. A new feedback mechanism linking forests, aerosols, and climate. Atmospheric Chemistry and Physics 4: 557–562.