Geophysical Research Abstracts
Vol. 19, EGU2017-8957, 2017
EGU General Assembly 2017

Concentrations and flux measurements of volatile organic compounds (VOC) in boreal forest soil

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Volatile organic compounds (VOC) impact soil processes as VOCs transmit signals between roots and rhizosphere (Ditengou et al., 2015), VOCs can regulate microbial activity (Asensio et al., 2012), and VOCs can also promote root growth (Hung et al., 2012). Belowground concentrations of VOCs have not been measured in situ and for this reason, knowledge of how different soil organisms such as roots, rhizosphere and decomposers contribute to VOC production is limited. The aim of this study was to determine and quantify VOC fluxes and concentrations of different horizons from boreal forest soil.

The VOC concentrations and fluxes were measured from Scots pine (Pinus sylvestris) forest soil at the SMEAR II station in southern Finland from 21th of April to 2nd of December in 2016. VOC fluxes were measured using dynamic (flow-through) chambers from five soil collars placed on five different locations. VOC concentrations were also measured in each location from four different soil horizons with the measurement depth 1-107 cm. VOCs were collected from underground gas collectors into the Tenax-Carbopack-B adsorbent tubes using portable pumps (∼100 ml min-1). The VOC concentrations and fluxes of isoprene, 11 monoterpenes, 13 sesquiterpenes and different oxygenated VOCs were measured. Sample tubes were analyzed using thermal desorption-gas chromatograph-mass spectrometry (TD-GC-MS). Soil temperature and soil water content were continuously monitored for each soil horizon.

Our preliminary results show that the primary source of VOCs is organic soil layer and the contribution of mineral soil to the VOC formation is minor. VOC fluxes and concentrations were dominated by monoterpenes such as α-pinene, camphene, β-pinene, and Δ3-carene. Monoterpene concentration is almost 10-fold in organic soil compared to the deeper soil layers. However, the highest VOC fluxes on the soil surface were measured in October, whereas the monoterpene concentrations in organic soil were highest in July and August. Organic soil is formed by organic matter which contains energy rich compounds for microbial decomposition and fine root biomass is also highest in soil surface (Helmisaari et al., 2007). With these analyses, we aim at distinguishing the VOC sinks and sources in the soil layers and quantifying the potential role of VOC uptake by soil microbiota.

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