Geophysical Research Abstracts
Vol. 15, EGU2013-8222, 2013
EGU General Assembly 2013

Dynamic relationship between the VOC emissions from a Scots pine stem and the tree water relations

Anni Vanhatalo (1), Tommy Chan (1), Juho Aalto (1), Pasi Kolari (1), Kaisa Rissanen (1), Hannele Hakola (2), Teemu Hölttä (1), and Jaana Bäck (1)

(1) University of Helsinki, Department of Forest Sciences, P.O.Box 27, FI-00014 Helsinki, Finland (jaana.back@helsinki.fi), (2) Finnish Meteorological Institute, Air Quality Laboratories, P.O. Box 503, FI-00101 Helsinki, FINLAND (hannele.hakola@fmi.fi)

The stems of coniferous trees contain huge storages of oleoresin. The composition of oleoresin depends on e.g. tree species, age, provenance, health status, and environmental conditions. Oleoresin is under pressure in the extensive network of resin ducts in wood and needles. It flows out from a mechanically damaged site to protect the tree by sealing the wounded site. Once in contact with air, volatile parts of oleoresin evaporate, and the residual compounds harden to make a solid protective seal over damaged tissues. The hardening time of the resin depends on evaporation rate of the volatiles which in turn depends on temperature. The storage is also toxic to herbivores and attracts predators that restrict the herbivore damage. Despite abundant knowledge on emissions of volatile isoprenoids from foliage, very little is known about their emissions from woody plant parts. We set up an experiment to measure emissions of isoprene and monoterpenes as well as two oxygenated VOCs, methanol and acetone, from a Scots pine (Pinus sylvestris) stem and branches. The measurements were started in early April and continued until mid-June, 2012. Simultaneously, we measured the dynamics of whole stem and xylem diameter changes, stem sap flow rate and foliage transpiration rate. These measurements were used to estimate A) pressure changes inside the living stem tissue and the water conducting xylem, B) the refilling of stem water stores after winter dehydration (the ratio of sap flow at the stem base to water loss by foliage), and C) the increase in tree water transport capacity (the ratio of maximum daily sap flow rate to the diurnal variation in xylem pressure) during spring due to winter embolism refilling and/or the temperature dependent root water uptake capacity.

The results show that already very early in spring, significant VOC emissions from pine stem can be detected, and that they exhibit a diurnal cycle similar to that of ambient temperature. During the highest emission period a sudden decrease in stem diameter was observed, which we hypothesize could either indicate a decrease in the pressure of living cells in connection with stem VOC emissions, or result mechanically from exudation of oleoresin from the stem. We also found that the stem water stores and xylem water transport capacity increased during periods of VOC emissions, which indicates xylem embolism refilling during times of VOC emissions. A qualitative difference was found between VOC emissions from pine stem and thick branches, the stem emissions containing more sesquiterpenes.

Most of the tree biomass is in the lower part of the stem, and as stem tissues are lacking green photosynthesizing tissue the emissions are supposed to be related to damage. Our results show that emissions from tree stems are connected to the tree water relations and that they are important during the period when the foliage still is rather inactive.