Biogenic VOCs in a mixed forest in Järvselja, Estonia: Can state of the art models capture this?

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Biogenic emissions of trace gases contribute substantially to atmospheric processes such as ozone formation and they largely determine the state of secondary organic aerosols in the atmosphere. Therefore, proper modelling of the atmospheric state is in need of input about the amount of natural emitted trace gases. Biogenic volatile organic compounds (BVOC) such as isoprene, monoterpenes and sesquiterpenes are major reactive trace gases emitted by many tree species. Trees actively to their environment and therefore the emissions are follow a multitude of environmental parameters, either abiotic such as light and temperature or biotic such as insect or pathogen attacks. In either case, the trees are exposed to stress and they react with changes in the pattern and amount of the emitted BVOCs.

Within a forest ecosystem, the emission of BVOCs, photosynthetic gas exchange and evapotranspiration by plants are controlled by processes on several levels of organisation or scales. The most prominent monitored scales are the leaf, branch and finally ecosystem scale. While measuring on leaf or branch level enables one to exclude atmospheric processes, this is not possible on ecosystem scale. Furthermore, the larger the scale, the more potential sources contributing to trace gas emissions are present (leaf litter, soil fluxes, trunks). Additionally, atmospheric chemistry and physics are adding processes such as transport, dilution, changes in boundary layer height, and photochemistry. The trees themselves are again partners determining the atmospheric processes for example by shading and changes in the mixing of air within the forest canopy, especially with mixed and deciduous forest.

Current models used to characterise BVOC emissions in connection to ecosystem (SWAT) and climate models (including CTM, DGVM) rely almost exclusively on parameterisations in mathematical terms. The most prominent one has the form

$$E(\rho) = E_0 \prod_{\rho} \phi_\rho \chi_\rho \qquad (1)$$

where ϕ_ρ are scaling factors and χ_ρ are scaling functions according to a subset of parameters $\rho \subseteq \mathbb{E}$ of environmental variables. The main drawback of that approach is to properly parameterise the scaling functions χ_ρ and the use of a product generally requires that all parameters used in the scaling functions are normally distributed and independent.

Here we present a data set of ambient BVOC measurements conducted over one year in a mixed forest stand in Järvselja, Estonia and link the outcome to questions and hopefully discussions how to appropriately describe processes that may lead to the observed values.