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VOC emission into the atmosphere by trees and leaf litter in Polish forests

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It is generally recognized at present that the vegetation of continents is the principal source of reactive volatile organic compounds (VOC) of the atmosphere. The upper limit of the evaluation of global phytogenic VOC is 1100-1500 Tg/yr (Isidorov, 1990; Guenther et al., 1995). Although these global evaluations showing the place of phytogenic emission among of other VOC sources are important, evaluations for individual countries are also very important.
This poster represents the results of the estimation of VOC emission from Polish forests. Calculations took into account the composition and age of forests. According to our estimation, the total VOC emission by the arboreal vegetation differs from 190 to 750 kt/yr, depending of weather conditions in different years.

There are only few studies conducted on decaying plant material as a source of atmospheric VOCs, but still they are able to give evidence of the importance of this source. For Polish forests, the litter mass is estimated to be (16-19)[U+F0B4]106 t/yr. These organic materials undergo decomposition by mesofauna and microorganisms. In these processes volatile organic compounds (VOC) stored in the litter and secondary metabolites of litter-destroying fungi are emitted into the atmosphere. The scale of the phenomenon makes leaf litter an important VOC source in the atmosphere. The filling of numerous gaps in researches of VOC emissions from decomposing leaf litter demands carrying out of long term field experiments in various climatic conditions. In this communication we report also the results of 3.5-year experiment on qualitative and quantitative GC-MS investigations of VOC emitted into the gas phase from leaves litter of some species of deciduous and coniferous trees of Polish forests.

Apart from terpenes and their oxygenated derivatives, which are usual in plant tissues, leaf litter intensively emits vast amounts of lower alcohols and carbonyl compounds. We suppose that these volatile substances are products of vital activity of fungi which decompose leaf litter. Verification of the hypothesis was carried out in the frames of a long-term experiment on decomposition of Scots pine and common spruce litter. The experiment was conducted in natural conditions by placing litter bags on undisturbed topsoil in a forest area where pine and spruce trees prevailed. Part of the needles placed were taken out of the litter bags on the 30th, 282nd, 490th, 630th and 920th day of the experiment for subsequent isolation of fungi which colonize the litter (overall there were identified 98 species which belong to 48 genera of fungi). The experiment revealed that species composition of the fungi colonizing pine and spruce litter varies considerably. At the early stages of decomposition, dematiceous hypnomycetes, which belongs to Cladosporum, Alternaria genera as well as Hormonem genus, capable of utilizing pectin, were dominant species. At the later stages they were substituted with phycomycetes (Mucor sp.), ascomycetes (Penicillium sp.) and basidiomycetes (Trichderma sp.), the most significant group of “secondary saprophytes” able to carry out biodegradation of polysaccharides and lignin.

In volatile emissions of all the 15 species of fungi there were identified 80 VOCs of different classes: terpene hydrocarbons and their oxygenated derivatives, C6-C14 aliphatic and C6-C10 aromatic hydrocarbons, C1-C8 alcohols, C2-C9 carbonyls, esters, furans, and halocarbons. VOC composition was specific for each fungi species and depended on the litter of a particular tree species from which it had been isolated. For instance, the emission rate of terpenes, alcohols and carbonyl compounds by Trichoderma polysporum isolated from pine and spruce litter was 3-5 times different. Differences in composition of VOCs emitted into the gas phase by “primary” and “secondary” fungi species which colonize pine and spruce litter are also discussed.

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