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Fluxes of biogenic volatile organic compounds measured and modelled above a Norway spruce forest

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Fluxes of biogenic volatile organic compounds (BVOCs) were investigated at Norway spruce forest at Bílý Kříž in Beskydy Mountains of the Czech Republic during the summer 2014. A proton-transfer-reaction-time-of-flight mass spectrometer (PTR-TOF-MS, Ionicon Analytik, Austria) has been coupled with eddy-covariance system. Additionally, Inverse Lagrangian Transport Model has been used to derive fluxes from concentration gradient of various monoterpenes previously absorbed into n-heptane by wet effluent diffusion denuder with consequent quantification by gas chromatography with mass spectrometry detection. Modelled data cover each one day of three years with different climatic conditions and previous precipitation patterns. Model MEGAN was run to cover all dataset with monoterpene fluxes and measured basal emission factor.

Highest fluxes measured by eddy-covariance were recorded during the noon hours, represented particularly by monoterpenes and isoprene. Inverse Lagrangian Transport Model suggests most abundant monoterpene fluxes being α- and β-pinene. Principal component analysis revealed dependencies of individual monoterpene fluxes on air temperature and particularly global radiation; however, these dependencies were monoterpene specific. Relationships of monoterpene fluxes with CO_2 flux and relative air humidity were found to be negative. MEGAN model correlated to eddy-covariance PTR-TOF-MS measurement evince particular differences, which will be shown and discussed.

Bi-directional fluxes of oxygenated short-chain volatiles (methanol, formaldehyde, acetone, acetaldehyde, formic acid, acetic acid, methyl vinyl ketone, methacrolein, and methyl ethyl ketone) were recorded by PTR-TOF-MS. Volatiles of anthropogenic origin as benzene and toluene were likely transported from the most benzene polluted region in Europe – Ostrava city and adjacent part of Poland around Katowice, where metallurgical and coal mining industries are located. Those were accumulated during the night bellow a shallow boundary layer and subsequently resuspended during the day.

We discuss here the importance of wide-spread temperate Norway spruce forests in biosphere-atmosphere exchange under climate change. Although temperate forests could play a key role in air pollutants removal, these contribute at the same time to a secondary organic aerosol formation by production of BVOCs. Measurements of trace gases are important for further parametrization of biosphere-atmosphere continuum transport models.