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Biotic, abiotic and management controls on methanol fluxes above a temperate mountain grassland

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It was previously hypothesised that (i) stomatal conductance and plant growth play a key role in the emission of methanol (Hüve et al. 2007, Niinemets et al. 2004), (ii) methanol fluxes increase with air temperature (Niinemets and Reichstein 2003), and (iii) during cutting (leaf wounding) events and during drying high amounts of methanol are emitted into the atmosphere (Davison et al. 2008).

Methanol fluxes were measured above a managed, temperate mountain grassland in Stubai Valley (Tyrol, Austria) during two growing seasons (2008 and 2009). Half-hourly flux values were calculated by means of the disjunct eddy covariance method using 3-dimensional wind-data of a sonic anemometer and mixing ratios of methanol measured with a proton-transfer-reaction-mass-spectrometer (PTR-MS). The surface conductance to water vapour was derived from measured evapotranspiration by inverting the Penman-Monteith combination equation (Wohlfahrt et al., 2009) for dry canopy conditions and used as a proxy for canopyscale stomatal conductance.

Methanol fluxes exhibited a clear diurnal cycle with closetozero fluxes during nighttime and emissions, up to 10 nmol m^{-2} s^{-1}, which followed the diurnal course of radiation and air temperature during daytime. Higher emissions of up to 30 nmol m^{-2} s^{-1}were observed during cut events and spreading of organic manure. Methanol fluxes showed positive correlations with air temperature, stomatal conductance, and photosynthetically active radiation (PAR), confirming previous studies (e.g. Niinemets and Reichstein 2003). All three previously mentioned factors combined together were able to explain 40% of the observed flux variability. The influence of rapid changes in stomatal conductance on methanol fluxes, pointed out in earlier studies at the leaf-level (e.g. Niinemets and Reichstein 2003), could not be confirmed on ecosystem scale, possibly due to within-canopy gradients in stomatal conductance and the fact that fluxes were determined as half-hourly averages. As methanol is produced in expanding cell walls, the change in the measured green area index (ΔGAI) was used as a proxy for plant growth. However ΔGAI was poorly correlated with methanol fluxes, possible explanations will be discussed.

References:

Davison, B., Brunner, A., Amman, C., Spirig, C., Jocher, M., Neftel, A. Cut-induced VOC emissions from agricultural grasslands. Plant Biol. 10, 76–85, 2008.

Harley, P., Greenberg, J., Niinemets, Ü., and Guenther, A..: Environmental controls over methanol emission from leaves. Biogeosciences, 4, 1083–1099, 2007.

Hüve, K., Christ, M., Kleist, E., Uerlings, R., Niinemets, Ü., Walter, A. and Wildt, J.: Simultaneous growth and emission measurements demonstrate an interactive control of methanol release by leaf expansion and stomata. doi:10.1093/jxb/erm038, Journal of Experimental Botany, 2007.

Niinemets, Ü. and Reichstein, M.: Controls on the emission of plant volatiles through stomata: A sensitivity analysis. J. Geophys. Res., 108, 4211, doi:10.1029/2002JD002626, 2003.

Niinemets, Ü., Loreto, F. and Reichstein, M.: Physiological and physicochemical controls on foliar volatile organic compound emissions. Trends in Plant Science,9, 2004.

Wohlfahrt G., Haslwanter A., Hörtnagl L., Jasoni R.L., Fenstermaker L.F., Arnone J.A. III, Hammerle A. (2009)

On the consequences of the energy imbalance for calculating surface conductance to water vapour. Agricultural and Forest Meteorology 149, 15561559.