Drought induced methanol emission from grassland

Mario Walser[1], Ines Bamberger[1,2], Lukas Hörtnagl[3], Georg Wohlfahrt[3], Armin Hansel[1] **mario.walser@uibk.ac.at**

1 Institute of Ion Physics and Applied Physics / University of Innsbruck, Austria
2 currently at: Department of Environmental Systems Science, Institute of Agricultural Sciences, ETH Zürich, Switzerland
3 Institute of Ecology / University of Innsbruck, Austria

Background

Volatile organic compounds (VOCs) play a decisive role in atmospheric chemistry as they are involved in the production of ozone and the formation of secondary organic aerosols (SOA) [1], which affect cloud formation. 90% of the global VOC emissions are of natural origin [2] but there are still important gaps in detailed understanding of sinks and sources of organic trace gases, which makes accurate climate modelling and valuation of the global carbon budget challenging. As grasslands cover around 40% of the ice-free terrestrial surface [3] the recent long term campaign aims to quantify VOC emission and deposition over grassland with all natural incidents occurring during a whole vegetation period.

Study site and methods

As in 2008 and 2009 [4] VOC-flux measurements were performed above a managed mountain meadow in the middle of a flat valley bottom at an altitude of 970m above sea level, close to the village of Neustift (47°07'N, 11°19'E) in Stub ai valley. Fluxes were calculated by the disjunct eddy covariance method using VOC-concentrations measured with a PTR-QMS and wind data from a sonic anemometer.

Results

In consequence of a drought period in May 2011 the soil water content dropped below 0.1m³/m³ and daily averaged methanol flux increased by a factor of 3 reaching values up to 14.8nmol/m²/s.

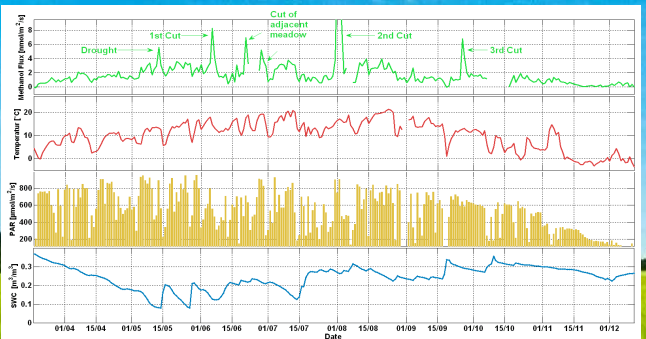

Fig.1: Time series of the methanol flux,air temperature, photosynthetically active radiation (PAR) and soil water content (SWC) during the whole measurement campaign 2011

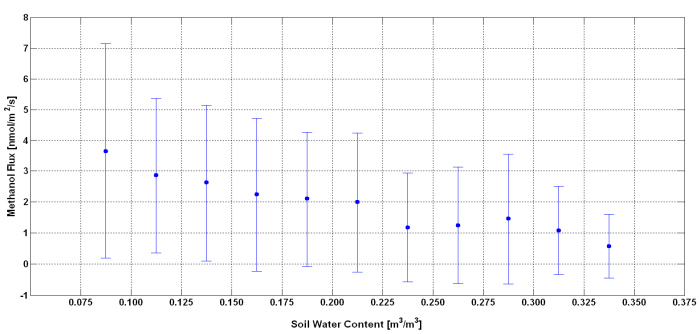

Fig.2: Averaged values of all measured methanol fluxes as a function of SWC

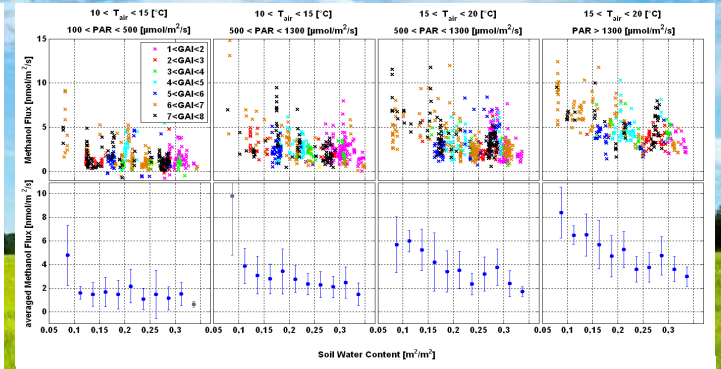

Fig.3: Half-hourly based and averaged methanol fluxes as a function of SWC for different classes of the main drivers air temperature and PAR

Conclusions

Beside the main methanol driving factors air temperature and PAR [5] the soil water availability also plays a role in the methanol emission of plants. Fig. 1 and 2 show that methanol fluxes strongly increase for small SWC. This enhancement doesn't depend on air temperature and PAR (fig.3). As the air temperature is expected to rise, growing conditions could become more arid in several parts of the world and drought induced methanol emission could alter the global VOC-budget in near future.

Outlook

Methanol-consuming microorganisms in the soil and on the plants have been isolated [6], but their relevance for the global methanol budget is poorly understood. As these microorganisms are expected to be strictly aerobic they also depend on the availability of water and should have a maximum of activity at a certain SWC-level which results in a flux minimum. Our data indicate a local minimum of the methanol flux at a SWC around 0.24m³/m³ which is interpreted as a hint for these microorganisms.

References

[1] Sillman S., The relation between Ozone, NOx and hydrocarbons in urban and polluted rural environments, Atmospheric Environment 33, 1334-1343, (1999)
[2] Guenther A., Hewitt C.N., Erickson D., et al., A global model of natural volatile organic compounds emissions, Journal of Geophysical Research 100, 8873-8892 (1995)
[3] White R., Murray S., Rohweder M., Pilot analysis of global ecosystems (PAGE): grassland ecosystems. Wahsington, D.C.: World Resource Institute (2000)
[4] http://www.biomet.co.at
[5] Hörtnagl L., et al., Biotic, abiotic, and management controls on methanol exchange above a temperate mountain grassland, Journal of Geophysical Research 116, G03021, (2011)
[6] Lee JD & Komagata K., Pichia cellobiosa, Candida cariosilignicola, and Candida succiphila, new species of methanol-assimilating yeasts. Int J Syst Bacteriol 30: 514-519 (1980)