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The VOC-Ozone connection: a grassland case study

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Trophospheric ozone (O3) is formed in the presence of sunlight through the interaction of volatile organic compounds (VOCs) and NOx (NO, NO2). O3 damages plants in several ways, most importantly by reducing net photosynthesis and growth. The extent of this damage depends on the time-integrated absorbed O3 flux (i.e. the dose), which is a function of leaf stomatal conductance and ambient O3 concentration, and further influenced by plant species specific defence mechanisms. VOCs are produced by plants through a variety of pathways and in response to a large number of different driving forces. A large variety of VOCs are emitted by plants in response to stress conditions, including the foliar uptake of O3.

Here we present preliminary data from an ongoing study where concurrent measurements of the fluxes of VOCs and O3 are made above a managed mountain grassland in Tyrol/Austria. Fluxes of several different VOCs and O3 are measured by means of the eddy covariance method and a proton transfer reaction mass spectrometer (PTR-MS) and an ozone analyser, respectively. Our findings show that the Methanol (MeOH) flux is correlated with the daily time-integrated O3 uptake by vegetation (integrated daily from sunrise - a surrogate for the O3 dose absorbed and the oxidative stress experienced by plants) – MeOH deposition and emission prevailing at low and high time-integrated O3 uptake rates, respectively. Fluxes of other VOCs were not related to the time-integrated O3 uptake. Integrated over longer time scales (several weeks) no correlation between the O3 uptake and MeOH emissions were found.

Our study thus confirms earlier leaf-level studies, who found that MeOH emission increase with O3 dose, at the ecosystems scale. As the reaction with the hydroxyl radical (OH), which is responsible for the destruction of the greenhouse gas methane (CH4), is the major sink of atmospheric MeOH, this process provides a potentially important indirect radiative forcing.