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VOC emissions from a temperate mixed forest in Belgium measured by eddy-covariance

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Forest ecosystems are known to be important emitters of Biogenic Volatile Organic Compounds (BVOC). They play an important role in the atmospheric chemistry and may contribute to the formation of ozone and aerosols with consequences on air quality and on climate. In order to better understand the effects of environmental parameters on the emissions, micrometeorological flux measurements were carried out above a mixed forest (Fagus sylvatica, Pseudotsuga menziesii, Abies alba, Picea abies) at the Vielsalm experimental site (Belgium) from July to November 2009. The flux measurements were obtained by the eddy-covariance technique using proton transfer reaction mass spectrometry. In our first measurement campaign, among other VOC compounds, isoprene (m/z 69) and monoterpenoid compounds (m/z 137) have been measured continuously with a data coverage of 75 and 58 % respectively, allowing robust statistical analysis.

In our analysis, we focused on these two main emissions. A footprint analysis showed that Fagus sylvatica seems to be the main emitter of m/z 137 and Abies alba seems to be the main emitter of m/z 69. BVOCs fluxes present an exponential response to temperature. This response is more pronounced for m/z 69 while it shows the strongest seasonal evolution for m/z 137. A light dependence of m/z 69 and m/z 137 fluxes was observed but the relationship did not exhibit the same behaviour before (hyperbolic relation) and after midday (linear relation). This behaviour difference induced a hysteresis effect on the daily evolution of averaged fluxes. A robust local minimum was also observed just before midday for m/z 69 (less obvious for m/z 137) during July-August period. This minimum is not observed in the CO2 fluxes which are also measured in Vielsalm. The light dependence of BVOC emissions suggests that m/z 69 and m/z 137 emissions are directly linked to the photosynthetic cycle but the presence of the midday local minimum suggests that other processes influence the measured BVOC fluxes. As for the relation with air temperature, a seasonal evolution of flux-light dependence was far more evident for m/z 137 than for m/z 69. This seasonal variation could be explained by a phenological effect. As Fagus sylvatica is the main m/z 137 emitter, its flux is probably influenced by leaves ageing while m/z 69, as mainly emitted by Abies alba, is less influenced by needles ageing.

A wind speed dependence of BVOCs fluxes was also observed, the flux increasing linearly with wind speed. This surprising result will be discussed.