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Modelling stress induced emission of biogenic volatile organic compounds

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The – so called constitutive - emissions of the biogenic volatile organic compounds (BVOCs) mainly depend on plant species-specific potentials that vary with seasonal and phenological conditions. These emissions are modelled using plant-specific emission factors and prevailing temperature and radiation conditions. However, various plant stressors such as oxidative agents and insect feeding often lead to stress-induced emissions that excel constitutive ones by more than an order of magnitude. Stress-induced emissions are usually short-lived but may prolong under continuous stress for longer time changing emission strengths and composition pattern. Importantly, those emissions are generally not considered in models since up to date no consistent mechanism has been described.

Stress-induced emissions are originating from only a handful of biosynthetic pathways which produce specific groups of compounds such as monoterpenes, sesquiterpenes, and green leave volatiles. We hypothesize that the emission response of all of these groups and compounds can be described with a single type of function that scales with stress intensity. The differences between the groups can be accounted for by choosing different parameters for the response delay and the form of the function which can be parameterized with literature data. The overall emission amount then derives from the intensity and frequency of the stress impulse.

We present a number of cases from literature and own measurements that are used to parameterize the new model as well as a selection of evaluations for single- and multiple-stress inductions. Furthermore, coupling and interaction with constitutive emission models as well as limitations and possible further developments are discussed.