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Ozone – plant surface reactions an important ozone loss term?

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Elevated tropospheric ozone concentrations are considered a toxic threat to plants responsible for global crop losses with associated economic costs of several billions dollar per year. Plant injuries have been related to the uptake of ozone through stomatal pores and oxidative effects damaging the internal leaf tissue. But a striking question remains: How much ozone enters the plant through open stomata and how much ozone is lost by chemical reactions at the plant surface? Until now surface losses are estimated from measured total ozone deposition fluxes and calculated stomatal conductance values. While stomatal conductance of CO_2 and H_2O is well understood and extensively used in describing plant atmosphere gas exchange, stomatal conductance of ozone is not well known. Here we use different Nicotiana tabacum varieties and find that surface reactions of ozone with diterpenoids synthesized by glandular trichomes reduce ozone flux through open stomata. Our measurements reveal that fast ozone loss at the plant surface is accompanied with prompt release of oxygenated volatile compounds. In the ozone fumigation experiments of different Nicotiana tabacum varieties the release of specific volatile oxy-VOCs allowed to identify the semi volatile precursor compounds at the plant surface. Ozone fumigation experiments with Norway spruce (Picea abies) and Scots Pine (Pinus sylvestris), two common species in the Northern Hemisphere, show also a significant ozone loss at the plant surface for Picea abies.
Fluid dynamic calculations of ozone transport in the diffusive leaf boundary layer reveal a vertical but no horizontal ozone gradient thus reducing ozone fluxes through the pores in case of efficient ozone scavenging plant surfaces. We explain this efficient ozone protection mechanism by the porous surface architecture of plants in combination with unsaturated semi-volatile compounds deposited at the plant surface. These results show that unsaturated semi-volatile compounds at the plant surface should be considered as oxygenated VOC source, impacting gas phase chemistry, as well as efficient ozone sink improving the plant's ozone tolerance