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PTR-3-TOF a novel in-situ instrument for studying the lifecycle of reactive organic carbon in the atmosphere

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Existing proton transfer reaction time of flight (PTR-TOF) instruments are known to detect volatile organic compounds (VOCs) and could in principle also detect highly oxidized organic compounds such as low volatility organic compounds (LVOC) but PTR-TOF inlets were not optimized to avoid wall losses of such low volatility compounds. In addition PTR-TOF is not sensitive enough to quantify second order and even higher order oxidation products at atmospherically relevant concentrations. To solve this problem, as well as to enable bridging the gap in understanding how atmospherically relevant BVOC form SVOC, LVOC and even ELVOC, we developed the PTR3, a compact and field deployable ultrasensitive instrument based on chemical ionization mass spectrometry.
Here we report first results from PTR-3-TOF measurements at Hyytiälä where we measured concentrations and fluxes of precursor gases (BVOC) and their oxidation products: semi and low volatile organic compounds. The recently developed PTR-3-TOF instrument uses a discharge ion source coupled to a contact free inlet system running at high sample flow rates through the novel reaction chamber at 80 mbar. The PTR-3 front part is coupled to TOFWERK's newest Long-TOF mass analyzer. The first prototype has sensitivities of up to 20.000 cps per ppb and a mass resolution of 8.000 m/Δm. The instrument has been successfully tested at CERN for the CLOUD campaign in 2015. During pure α-pinene ozonolysis experiments at low NO_x conditions we observed in total several hundred peaks in the mass spectrum, including α-Pinene present in the ppb range, first and higher order oxidation products present in the ppt range and highly oxydized α-pinene monomers and dimers (e.g., C20H30O18H+; m/z = 559.1506 Th) in the low ppq range and even sub-ppq range. The advantage of this new technology based on positive ion chemistry is the capability to measure precursor gases as well as condensing- and even nucleating vapors.