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Development and deployment of a compact PTR-ToF-MS for Suborbital Research on the Earth's Atmospheric Composition

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We report the development of a compact Proton-Transfer-Reaction Time-of-Flight Mass Spectrometer (PTR-ToF-MS) in support of NASA's suborbital research program on the Earth's atmospheric composition. A lightweight, low mass resolution orthogonal acceleration ToF-MS was developed and combined with a conventional PTR ion source to measure volatile organic compounds (VOCs) in real time. The instrument was specially designed to resist aircraft vibrations and rough conditions during boundary layer flights, take-off and landing.
The compact PTR-ToF-MS generates full mass spectral information at 1-second time resolution and below. With sensitivities of up to 150 cps/ppbv, typical 2σ detection limits in the range from 0.06 to 0.48 ppbv for a 1-second signal integration are achieved.
A mass resolving power $m/\Delta m$ of up to 1700 combined with an absolute mass accuracy and reproducibility of less than 3 mDa make it possible to distinguish isobaric ions at high time resolution, e.g. humidity- dependent isobaric background ions.
The prototype instrument was successfully deployed for in-situ measurements of VOCs onboard the NASA P-3B Airborne Science Laboratory during two DISCOVER-AQ campaigns in the San Joaquin Valley, CA, and in Houston, TX, 2013. A 1-second time resolution results in a horizontal spatial resolution of typically 110 m and a vertical spatial resolution of typically 8 m which allowed for the quantitative detection of the entire suite of VOCs in strongly localized emission plumes from industrial, agricultural and biomass-burning sources.
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