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Regular, Fast and Accurate Airborne In-Situ Methane Measurements Around the Tropopause

Christoph Dyroff (1), Armin Rauthe-Schöch (2), Tanja J. Schuck (2), and Andreas Zahn (1)

(1) Karlsruhe Institute of Technology, Institute of Meteorology and Climate Research, Karlsruhe, Germany (christoph.dyroff@kit.edu), (2) Max Planck Institute for Chemistry (Otto Hahn Institute), Mainz, Germany

We present a laser spectrometer for automated monthly measurements of methane (CH_4) mixing ratios aboard the CARIBIC passenger aircraft. The instrument is based on a commercial fast methane analyzer (FMA, Los Gatos Res.), which was modified for fully unattended employment. A laboratory characterization was performed and the results with emphasis on the precision, cross sensitivity to H_2O, and accuracy are presented.

An in-flight calibration strategy is described, that utilizes CH_4 measurements obtained from flask samples taken during the same flights. By statistical comparison of the in-situ measurements with the flask samples we derive a total uncetrainty estimate of ~ 3.85 ppbv ($1\,\sigma$) around the tropopause, and ~ 12.4 ppbv ($1\,\sigma$) during aircraft ascent and descent.

Data from the first two years of airborne operation are presented that span a large part of the northern hemispheric upper troposphere and lowermost stratosphere, with occasional crossings of the tropics on flights to southern Africa. With its high spatial resolution and high accuracy this data set is unprecedented in the highly important atmospheric layer of the tropopause.