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The development and evaluation of airborne in situ N2O and CH4 sampling using a Quantum Cascade Laser Absorption Spectrometer (QCLAS)

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Spectroscopic measurements of atmospheric N2O and CH4 mole fractions were made on board the FAAM (Facility for Airborne Atmospheric Measurements) large Atmospheric Research Aircraft. We evaluate the performance of the mid-IR continuous wave Aerodyne Research Inc. Quantum Cascade Laser Absorption Spectrometer (QCLAS) employed over 17 flights conducted during summer 2014. Two different methods of correcting for the influence of water vapour on the spectroscopic retrievals are compared and evaluated. Test flight data demonstrating the sensitivity of the instrument to changes in cabin pressure is presented, and a new in-flight calibration procedure to account for this issue is described and assessed. Total 1σ uncertainties of 1.81 ppb for CH4 and 0.35 ppb for N2O are derived. We report a mean difference in 1 Hz CH4 mole fraction of 2.05 ppb (1σ = 5.85 ppb) between in-flight measurements made using the QCLAS and simultaneous measurements using a previously characterised Los Gatos Research Fast Greenhouse Gas Analyser (FGGA).