A PORTABLE DUAL FREQUENCY COMB SPECTROMETER FOR ATMOSPHERIC APPLICATIONS

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Dual frequency comb (DFC) spectroscopy is a new technique that combines broad spectral bandwidth, high spectral resolution, rapid data acquisition, and high sensitivity. In addition, unlike standard Fourier-transform spectroscopy, it has an almost ideal instrument lineshape function, does not require recalibration, and has no moving parts. These features make DFC spectroscopy well suited for accurate measurements of multiple species simultaneously. Because the frequency comb lasers can be well collimated, such a system can be used for long open-path measurements with path lengths ranging from hundreds of meters to several kilometers[a]. This length scale bridges the gap between point measurements and satellite-based measurements and is ideal for providing information about local sources and quantifying emissions.

Here we show a fully portable DFC spectrometer operating over a wide spectral region in the near-infrared (about 1.5-2.1 μm or 6670-4750 cm^{-1} sampled at 0.0067 cm^{-1}) and across several different open-air paths up to a path length of 11.8 km. The current spectrometer fits in about a 500 L volume and has low power consumption. It provides simultaneous measurements of CO_2, CH_4, and water isotopes with a time resolution of seconds to minutes. This system has several potential applications for atmospheric measurements including continuous monitoring city-scale emissions and localizing methane leaks from oil and gas wells.

[a]G. B. Rieker, F. R. Giorgetta, W. C. Swann, J. Kofler, A. M. Zolot, L. C. Sinclair, E. Baumann, C. Cromer, G. Petron, C. Sweeney, P. P. Tans, I. Coddington, and N. R. Newbury, Frequency-comb-based remote sensing of greenhouse gases over kilometer air paths, Optica, 1(5), 290-298 (2014).