

MEASUREMENT OF VOCs USING OPEN-PATH MID-INFRARED DUAL-COMB SPECTROSCOPY

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Dual frequency comb spectroscopy (DCS) is a rapidly evolving technique that provides a high-resolution, broadband spectrometer with no instrument lineshape and near perfect frequency calibration^a. These features make DCS 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. Open-path measurements of atmospheric gas species over these path lengths are well suited to quantify emissions from sources like oil and gas, forest fires, and industry.

Previous demonstrations of open-path DCS have primarily been in the 1-2 μm spectral region; however, in order to reach the sensitivity necessary to detect many atmospheric trace constituents, including volatile organic compounds, operation in the mid-infrared is required. Here, we show a mid-infrared open-path dual comb spectrometer operating in the 3-5 μm spectral region. We have used this spectrometer to measure methane, ethane, propane, and butane isomers (arising primarily from oil and gas activity) across a 1-km-long path in Boulder, CO for 1 week with an ethane sensitivity of ~ 0.1 ppb for a 2-minute time resolution. In addition, we show quantitative measurements of intentionally released acetone and isopropanol with a $1\text{-}\sigma$ sensitivity of $5.7 \text{ ppm} \cdot \text{m}$ and $2.4 \text{ ppm} \cdot \text{m}$, respectively.

^aCoddington I, Newbury N, Swann W. Dual-comb spectroscopy. *Optica*. 2016 Apr 20;3(4):414.