(52-220415-C) **City-scale Remote Sensing of CO_2 and CH_4 using Open-path Dual Comb Spectroscopy**

K. Cossel, E. Baumann, F. Giorgetta, I. Coddington, and N. Newbury

National Institute of Standards and Technology (NIST), Boulder, CO 80305; 720-597-0592, E-mail: kevin.cossel@nist.gov

Open-path dual frequency comb spectroscopy (DCS) combines high-resolution and broad spectral coverage with no instrument lineshape and near perfect frequency calibration. This enables accurate measurements of multiple species simultaneously over long open-air paths. Previous work has utilized an out-and-back geometry with single transmitter/receiver and a remote retroflector; however, it is challenging to extend the path length much beyond 5 km in this configuration due to losses from beam divergence and turbulence. For many applications such as monitoring of emissions from urban areas or from large, distributed surface sources as well as for comparison with satellites and atmospheric models, it is desirable to have path lengths >10 km.

Here, we show measurements across a 14-km path one-way path between NIST and the Table Mountain site in Boulder, CO (see figure). In this configuration, light from the dual comb system is sent from a transmitter telescope (10-cm aperture) at NIST across a 14.25-km open-air path and collected with a 12.5-cm aperture commercial telescope. After photodetection, the resulting dual comb interferogram is digitized, phase corrected, and averaged at the remote receiver site. As shown in Fig. 1b) and c), the resulting spectrum has reasonable signal-to-noise ratio even at 30 s of averaging, which provides good retrievals for the path-averaged temperature and H_2O, CH_4, and CO_2 concentrations. Even without active alignment, the system is capable of operation with high up-time. We will discuss potential applications of this system to city-scale GHG monitoring.

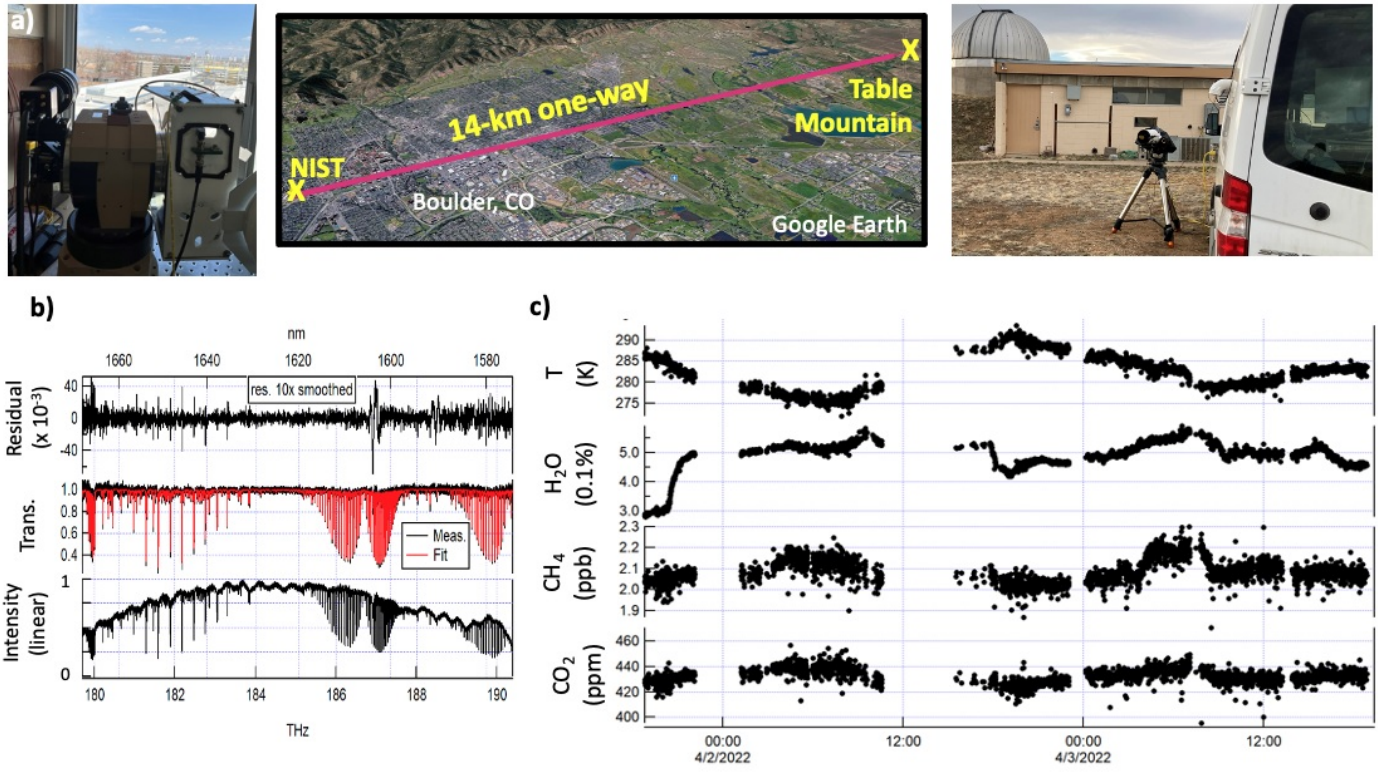

Figure 1. *Open-path dual comb spectroscopy across a one-way path. (a) Setup showing 14-km measurement path from NIST to Table Mountain in the middle pane. The transmitter telescope system at NIST is shown on the left and the receiver system is shown on the right. (b) Raw transmission spectrum at 30 s averaging time (bottom) showing water, CO_2, and methane features. The spectrum after normalization is shown in black in the middle and a fit is shown in red. The fit residuals are shown in the top panel. (c) Retrieved path-averaged T, H_2O, CH_4, and CO_2 at 30 s time resolution over a weekend measurement series. The gaps are primarily due to launch telescope alignment drift.*