Single-blind Testing of a Regional, Continuous Monitoring System for Finding Methane Leaks from Oil and Gas Operations

C. Alden[1,2], S. Coburn[3], R. Wright[3], E. Baumann[4], K. Cossel[5], C. Sweeney[2], A. Karion[4], K. Prasad[4], I. Coddington[5] and G.B. Rieker[3]

[1]Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, CO 80309; 719-930-5281, E-mail: caroline.alden@noaa.gov
[2]NOAA Earth System Research Laboratory, Global Monitoring Division (GMD), Boulder, CO 80305
[3]University of Colorado, Department of Mechanical Engineering, Boulder, CO 80309
[4]National Institute of Standards and Technology (NIST), Gaithersburg, MD 20880
[5]National Institute of Standards and Technology (NIST), Boulder, CO 80305

Advances in natural gas extraction technology have led to increased U.S. production and transport activity, and, as a consequence, an increased need for monitoring of methane leaks. Known intermittency in fugitive methane emissions means that continuous monitoring is critical for emissions quantification and mitigation. Here, we present the results of single-blind testing of a new leak detection method that employs dual frequency comb spectrometry coupled with atmospheric inversions to offer continuous, autonomous, leak detection and quantification over large (square-km) regions. In the tests described here, the dual frequency comb spectrometer is situated > 1 km away from a field of “Hollywood” natural gas pads (sets of decommissioned oil and gas facilities plumbed with known, controlled leaks) at the METEC test site in Fort Collins, CO. A series of retroreflectors around the field direct light back to a detector. The laser light spans 1620-1680 nm with 0.002 nm resolution, simultaneously measuring hundreds of individual absorption features from multiple species, and resulting in high-stability trace gas (here methane, carbon dioxide, and water vapor) measurements over long (1 km+) open paths through the atmosphere. Measurements are used in an atmospheric inversion to estimate the locations (at well pad, sub-pad, and component-level scales) and rates of emissions in 18 single-blind tests. The measurement framework and inversion solve explicitly for background concentrations, which vary through time due to changes in upwind sources. The frequency comb–inversion system successfully detects 18 of 18 leaks. The system also successfully quantifies most leaks, which range in size from < 1 g min^{-1} to 11 g min^{-1} (average reported emissions from pneumatic controllers found on well pads fall within this range), to within 20% of the actual rate. All leak locations are attributed to the correct well pad or sub-pad, and in many cases the system also correctly identifies which component (that is, wellhead, separator, or tank) is leaking. We present the methods and results of the METEC test site experiments, as well as results of experiments examining the effects of the choice of transport model on leak detection and quantification.

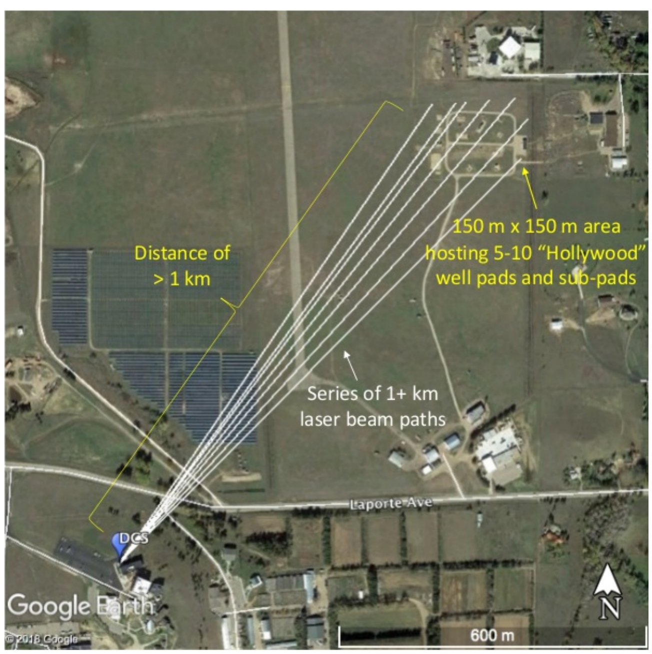

Figure 1. Map showing dual frequency comb spectrometer (labeled “DCS”) location and the location of the METEC test site. White lines show the paths of laser light beams measuring integrated open-atmosphere concentrations of methane gas.