Continuous Methane Leak Detection in Oil and Gas: Recent Progress Toward a Regional Approach with Dual Frequency Comb Spectroscopy and Inversions

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A current major area of focus for science, industry, and regulators is methane emissions from the oil and gas supply chain in the United States. Recently, substantial advances have been made in 1) scientific understanding of the magnitude and distribution of emissions across this sector, and 2) new technologies and programs for leak detection and repair, with complementary efforts toward frameworks for comparison of their efficacies and suitability for industrial use. Here we provide an update on recent progress of one such new technology and leak detection method. We use dual frequency comb spectroscopy to detect very small changes in the dry air mole fraction of methane (and other trace gases) along open-path transects of the atmosphere (up to 2 km in length). The trace gas measurements are coupled with atmospheric inversions to yield rapid leak detection, attribution, and quantification. The technology and leak detection methods have been validated in two separate rounds of single-blind testing at the Methane Emissions Test and Evaluation Center test site in Fort Collins, CO. The observing system includes a series of retroreflectors placed in the field to direct light back to a detector. A gimbaling system rotates the laser light to sample the atmospheric path to each individual retroreflector in a sequential pattern, so that a 360º view of surrounding pads and facilities is allowed. 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 CH_4, CO_2, and H_2O) measurements over the long, open paths through the atmosphere. The system is operated continuously and autonomously, allowing for continuous observations; known intermittency in fugitive methane emissions means that continuous measurements are critical for effective emissions quantification and mitigation. By contrast, "snapshot" observation programs may miss important emission signals or overestimate total emissions if the measurement occurs during daytime operations or, for example, a liquid unloading event. Extreme variability in our long-term, continuous time series of emissions from a production site and a natural gas storage facility confirm the literature-stated needs for continuous observational coverage. Here, we present a summary of recent field testing and observations of both natural gas production and underground natural gas storage sites.

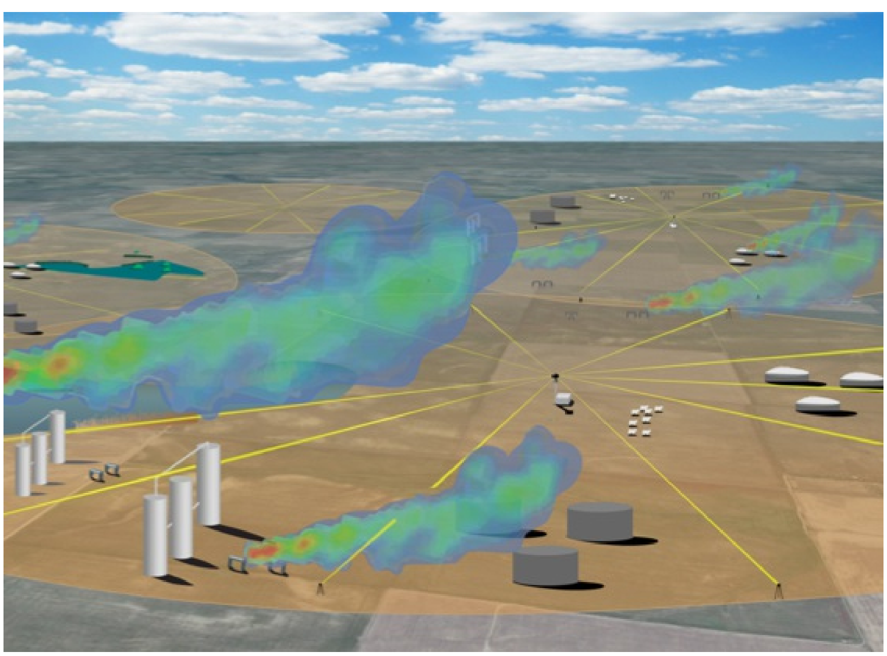

Figure 1. Schematic showing dual frequency comb spectrometer in the center of an observed area of potential methane sources; yellow lines show the paths of laser light beams measuring integrated open-atmosphere trace gas concentrations.