Modeling Ground- and Aircraft-based Methane Monitoring Systems for Natural Gas Storage Facilities using LPDM-LES

A. Rybchuk[1,2], C. Alden[3,4], S. Coburn[1], R. Wright[1], D.J. Caputi[5], I. Faloona[5], J.K. Lundquist[6], and G.B. Rieker[1]

[1]University of Colorado, Department of Mechanical Engineering, Boulder, CO 80309; 201-983-8084, E-mail: alex.rybchuk@colorado.edu
[2]Precision Laser Diagnostics Laboratory, University of Colorado, Boulder, CO 80309
[3]Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, CO 80309
[4]NOAA Earth System Research Laboratory, Global Monitoring Division (GMD), Boulder, CO 80305
[5]University of California at Davis, Davis, CA 95616
[6]University of Colorado, Department of Atmospheric and Oceanic Sciences, Boulder, CO 80309

Recent literature has highlighted large discrepancies in estimates of methane emissions from the U.S. oil and gas supply chain. Methane emissions at natural gas storage facilities can be challenging to accurately quantify due to complicating factors such as time-varying emissions, multiple potential sources, and complex terrain. To investigate this complexity, we are undertaking an ongoing campaign of ground- and aircraft-based measurements at a series of natural gas storage sites in the U.S. In this campaign, a dual-comb spectrometer (DCS) provides continuous, ground-based observations of methane concentrations that provide emissions estimates on fine spatio-temporal scales. Aircraft *in situ* measurements complement the DCS by providing a facility-wide snapshot of emissions using a mass-balance approach. However, it is possible that observations from these instruments could lead to conflicting estimates, given that they sample different air masses. Here, we investigate the potential for estimate discrepancies between different platforms using simulated emissions at a real natural gas storage facility. We use a Lagrangian particle dispersion model driven by large-eddy simulation (LPDM-LES) to generate synthetic DCS and aircraft *in situ* measurements of emissions under controlled conditions. These measurements are inverted with operational dispersion models (e.g. Gaussian plume, mass balance) to produce emission rate estimates. The estimates are compared to true emission rates; bias and variance of the estimates are discussed.

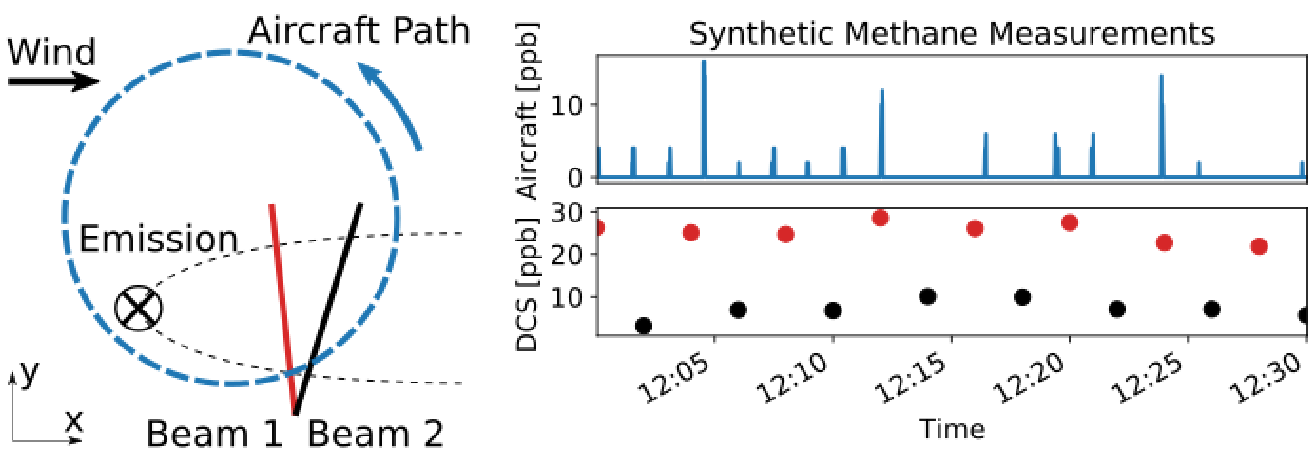

Figure 1. Synthetic aircraft and DCS measurements of a continuous point-source emission at a simulated natural gas storage facility.