Assessing fugitive methane quantification systems by blind controlled releases for midstream applications

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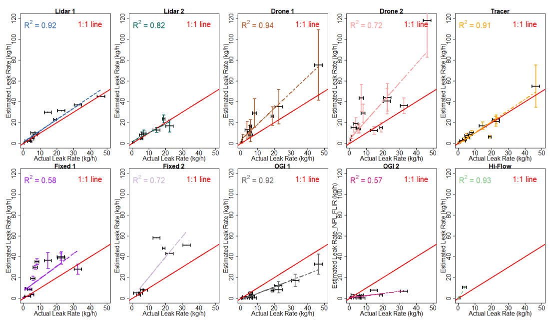
Controlled release experiment site

Fugitive emissions from natural gas systems are increasingly scrutinized. Accurate reporting requires site- and source-level, measurement-based leak quantification. Here, **we evaluate 10 currently available, site-scale CH4 emission quantification approaches against a blind controlled release experiment.**
The experiment consisted of for a series of **17 blind, 2-hour source releases** at single or multiple simultaneous exhaust points. The controlled releases covered a **range of flow rates from 0.01 kg/h to 50 kg/h.** Measurement platforms included airborne, ground-based mobile and fixed atmospheric measurements, as well as handheld systems.
We analyse individual and comparative performances, as well as the influence of wind speed, node shape, and multiplicity of releases.

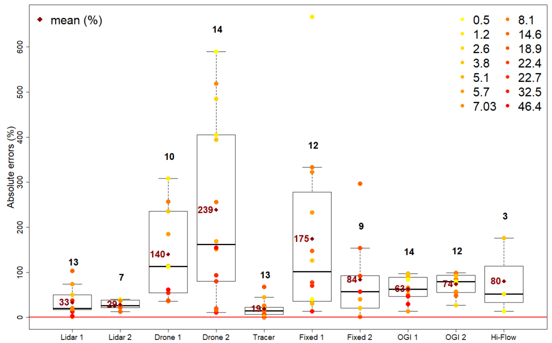
Systems engaged in the exercise

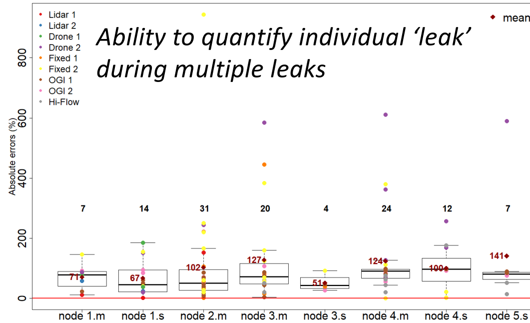
Name	Platform	Sensor	Quantification algorithm	Assessment type
Drone 1	Matrice 300 RTK from DJI	Tunable Diode Laser Spectrometry	Inverse dispersion modelling, considering the location of the plume, sensor measurements and local weather data	Site-level
Lidar 1	Helicopter (AirLloyd)	LiDAR DIAL	Direct estimation by multiplying the integrated gas concentration, the respective wind speed and the sine of the angle between fence line and wind direction	Site-level
Tracer	Van	Off-axis integrated cavity output spectroscopy	Calculated as the integrated signal of CH_4 concentration relative to the integrated signal of tracer gas concentration	Site-level
Lidar 2	Truck	Differential absorption lidar	Determined by combining the concentration map with wind speed and direction	Site-level
Drone 2	DJI M300 UAS	An in-situ tunable diode laser absorption spectrometer	Proprietary data algorithms based on an engineering control volume model	Site-level
Fixed 1	ground	Laser dispersion spectroscopy operating in the midIR region	The algorithm combines gas concentration data of each retroreflector with meteorological data	Source-level
Fixed 2	Unmanned carmers	Two OGI cameras: an uncooled LWIR detector and a cooled MWIR detector	Depends on three variables: thermal contrast between the plume and the background; column density; absorption peak of the target gas	Source-level
Hi-Flow	handheld	A venture tube supplied by a compressed air cylinder	Determined by the gas concentration and the suction flow rate of the venture	Source-level
OGI 1	A handed camera	Optical gas imaging camera	EyeCSite 2.0 quantification software	Source-level
OGI 2	a handed camera	OGI camera	Determined by the QL320 tablet	Source-level

Individual techniques performance



Comparison of mean errors





Synthesis of KPIs

Systems	Absolute errors (%)	Provided uncertainty (%)	0.5-2x (%)	0.1-10x(%)	Release coverage (%)
Lidar 1	33	N/A	92	100	88
Lidar 2	29	17	100	100	41
Drone 1	140	55	40	100	71
Drone 2	239	29	36	100	94
Tracer	19	15	92	100	82
Fixed 1	175	13	50	100	82
Fixed 2	84	N/A	78	100	53
OGI 1	63	36	36	79	94
OGI 2	74	N/A	25	69	82
Hi-Flow	80	12	33	100	29

Only three technologies demonstrated average errors below 50 % (LiDAR 1 and 2, Tracer).
- 'LiDAR' requires deployment of helicopter or heavy truck.
- 'Tracer' requires positionning gas near single source to obtain this performance.

The tested drones underperformed. This might be due to challenging low wind condition, poor wind measurement protocol, or self generated washdown plume interference.
Questionable distinction between site level and source level techniques. Site level techniques are challenged to precisely quantify/attribute in multiple source exercises.
→ Several techniques will likely be further challenged in other mid-stream contexts (e.g. LNG terminals or industrial clusters with several emitters).
This study paved the way for next steps including measurements in real life and TD-BU reconciliation efforts.