Identifying and Quantifying Air Emissions from Organics Recovery Operations in the Bay Area

EMISSIONS DETECTION AND ATTRIBUTION

1) Mobile Measurement Approach

- Direct measurement technique – collects and analyzes samples
- Continuous, real-time measurement at emission hotspots
- Measures CO_2, CH_4, N_2O concentration enhancements
- Spatial scale - source or facility-wide

- Perform source attribution with chemical tracers including CO, ethane and $^{13}C/^{12}C$ (isotopic ratio of carbon in CH_4)

2) Portable Analyzer Surveys

- Battery-operated analyzers for in-situ detection of CH_4 and CO_2 (or NH_3 and H_2S)
- Direct measurement technique – collects sample and analysis
- Continuous, real-time measurement
- Measures over a wider emission range and hence more suitable for characterizing leaks / vents
- Spatial scale - source or facility-wide

3) Airborne Remote Sensing

- Aerial measurement of ground methane using spectrometer combined with optical camera imagery
- Detects CH_4 plume and likely source location
- Spatial scale - facility-wide or regional
- Snapshots can be verified with follow-up ground inspection

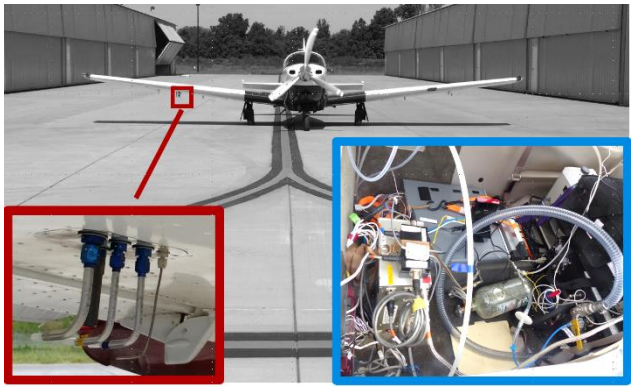
[Methane plume over a landfill]

[Methane plume from a sewage treatment plant]

MASS EMISSIONS FLUX QUANTIFICATION

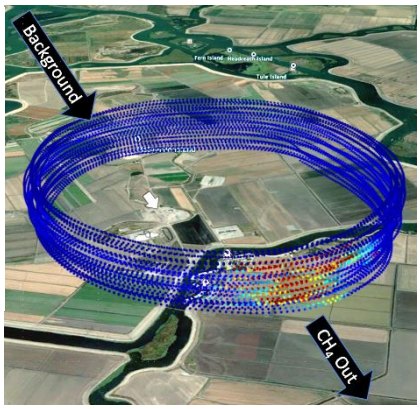
1) Airborne Mass Balance Approach

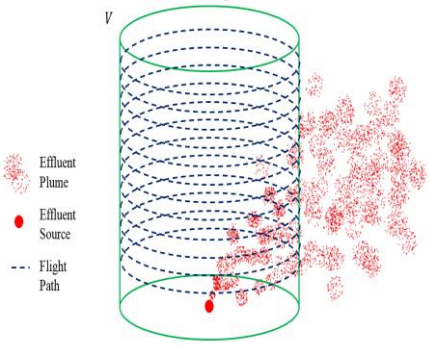
- Direct measurement technique – collects and analyzes samples
- Continuous, real-time measurement of a snapshot in time
- Spatial scale - facility-wide



- Measures CH_4 and CO_2, and wind speed, direction
- Mass balance algorithm quantifies emission rates

[Curtain flights over a Bay Area composting facility]

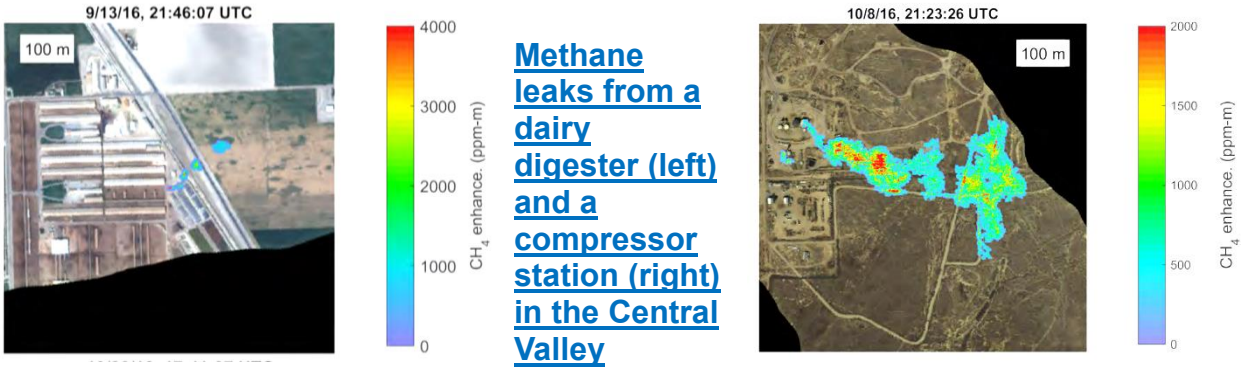




Sketch of flight path pattern for source leak rate estimation

Courtesy – Scientific Aviation, LLC

2) Airborne Remote Sensing with LIDAR Wind Field Observations



Methane leaks from a dairy digester (left) and a compressor station (right) in the Central Valley

Courtesy – NASA JPL AVIRIS-NG;
https://ww2.arb.ca.gov/our-work/programs/methane/ab1496-research

- Airborne remote sensing methods to detect and characterize CH_4 emissions at 1-3 m spatial resolution (equipment-scale)
- Initial analysis products include size (expressed as average atmospheric enhancement over path length, ppm-m)
- Integrating over the physical area of the plume yields total observed mass of methane above the ambient background (Integrated Methane Enhancement in kg)
- In-depth analysis yields quantitative point source emissions fluxes and uncertainties

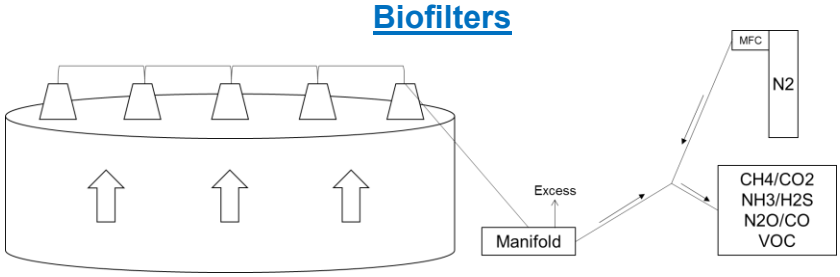
3) Process-specific methods like Dynamic Plume (using FTIR Absorption Spectroscopy) combined with VOC characterization using Gas Chromatography / Mass Spectrometry / High-performance UV and Liquid Chromatography

- AgBag enclosed aerated windrows
- Control pressure, ventilation rate
- Sample at single effluent point
- Aggregate effluents from several points across surface
- Combine with volumetric flow

Courtesy – Kirchstetter et al., LBNL

Compost Windrows

Biofilters



4) Flux Chamber Sampling Methods

- Traditional and extensively adopted approach
- Species measured include organic air toxics, POC, NH_3, CH_4, N_2O, reduced sulfur compounds etc.

Flux chamber measurements being conducted at various organics recovery facilities in the Bay Area

Courtesy – Schmidt et al.