MEASURING CH₄ FROM CARS, SHIPS, AIRPLANES, HELICOPTERS & DRONES USING HIGH-SPEED OPEN-PATH TECHNOLOGY

Introduction

Major sources of CH₄ include oil and gas networks, landfills and lagoons, agricultural and natural production.

The majority of emissions happen via variable-rate point sources or diffused spots in topographically challenging terrains.

Locating and quantifying distributed and point sources of CH₄ emissions in these areas is challenging when using traditional techniques.

Novel approaches are being developed to address these challenges, including high space- and time-resolution measurements of CH₄ from moving platforms.

Examples of Methane Measurements with Fast Open-Path Technology: Moving Cars, Manned Aircrafts & Drones

CSU, EDF, GOOGLE• fugitive emissions

SCAQMD• fugitive emissions

Princeton University• fugitive emissions

Li-COR• fugitive emissions

CNR• landfills

SDSU• permafrost

GFZ-Potsdam• permafrost

AmeriFlux-Atlant• Sensing wetland

Interruption

Open-path CH₄ analyzer, LI-7700, takes 8 Watts of nominal power, operates at ambient pressure.

Resolves 5 ppb of CH₄ at 10 Hz, can sample up to 40 Hz.

Originally developed for stationary eddy covariance measurements.

Increasingly used in mobile measurements due to low power consumption, high resolution, and very rapid time response.

Open-Path vs. Closed-Path Approaches

Mobile measurements using open-path technology have excellent time and space resolution, but need more care:

- excellent time response
- high-resolution mapping in time and space
- good detection of narrow peaks, sharp plume edges, etc.
- vibration, have to install on a single rigid mount
- need to clean often on rainy days, or design a splashguard

Mobile measurements using closed-path technology have reduced time and space resolution, but need less care:

- relatively slow time response
- lower-resolution mapping in time and space
- poor detection of narrow peaks, sharp plume edges, etc.
- no vibration issues since installed inside the car
- no need to clean often on rainy days; still need to clean filter

Summary

Many methodological challenges for mobile CH₄ measurements are similar for open- and closed-path devices:

- plumes are not Gaussian when moving through
- movement distorts plume shape & averages concentration signature
- mapping concentrations is easy but often inconclusive, quantifying emission rates is conclusive but not easy

However, open-path technology offers new possibilities particularly attractive for mobile mapping:

- precision mapping due to low signal attenuation and high resolution in space and time
- multiple flexible deployment opportunities due to low weight and very low power demand

When driving at variable speed with traffic up to 50 mph, maps can be generated with:

- 0.55 m or better spatial resolution
- 0.025 s or better temporal resolution
- 0.01 ppm resolution of CH₄ concentration

Acknowledgements

The instrument development was supported by the Small Business Innovation Research and Small Business Technology Transfer Program of the Department of Energy (DOE), Grant DE-FG02-05ER83285. Funding for the AmeriFlux Management Project was provided by the U.S. Department of Energy’s Office of Science under Contract No. DE-AC02-05CH11231. Multiple projects described above were supported in part by:

- Apple Computer, Cupertino, USA
- Apple Inc., Cupertino, USA
- AppleFlux-LBNL, Berkeley, USA
- Princeton University, Princeton, USA
- Colorado State University, Fort Collins, USA
- University of Florence, Italy
- Oregon State University, Corvallis, USA
- Atlatl Sensing, Corvallis, USA
- GFZ German Research Centre for Geosciences, Potsdam, Germany
- Centre for Ecology & Hydrology, Edinburgh, United Kingdom
- South Coast Air Quality Management District, Diamond Bar, USA
- National Ecological Observatory Network, Boulder, USA