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Methane Measurements with High-Precision Low-Power Low-Maintenance Closed-Path CH_4-CO_2-H_2O Gas Analyzer: First Lab and Field Results

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The major sources of methane include agricultural and natural production, landfill emissions, oil and gas development sites, and natural gas distribution networks.

The majority of agricultural and natural methane production occurs in areas with little infrastructure or easily available grid power (e.g., rice fields, wetlands, mangroves, etc.) Past methane measurements in these settings relied on: (i) closed-path analyzers, which typically required powerful pumps and grid power, and (ii) open-path analyzers (e.g., LI-7700), which required minimal power but needed an in-field mirror cleaning every 2-4 weeks depending on the environment.

Power and labor demands, and difficulty in maintaining the instrumentation in remote locations may be among the key reasons why the vast majority methane measurements are still done at relatively accessible locations with good infrastructure and grid power, and not necessarily with high methane production.

Landfill methane emissions were traditionally assessed via point-in-time measurements taken at monthly or longer time intervals using techniques such as the trace plume methods, etc. These are subject to large uncertainties because of the snapshot nature of the measurements while installing a continuously operating flux station in the middle of an active landfill requires a low-power approach with no cables stretching across the landfill.

The majority of oil and gas and urban methane emission happens via variable-rate point sources or diffused spots in topographically challenging terrains, such as street tunnels, elevated locations at water treatment plants, vents, etc. Locating and measuring methane from such sources is challenging when using traditional micrometeorological techniques, and requires the development of novel approaches. The most promising of the latter include distributed sensor networks and mobile mapping.

In 2017, a new lightweight high-precision closed-path technology was developed with the goal of allowing the WMO-quality measurements of methane with a time response of 1 Hz, the power consumption of about 15 W, with very minimal maintenance and calibration requirements, and a relatively low cost. This new technology enables the multitude of methods and approaches including the following:

(i) Approaches relying on very high precision methane concentrations, encompassing those often employed by WMO-GAW and EPA communities, such as a family of the Inverse Flux Methods, Lagrangian Modeling, Mass Balance Method, Fence-Line Monitoring, etc.

(ii) Micrometeorological tower methods relying on relatively slow but well-resolved methane concentrations, such as Disjunct Eddy Covariance, Relaxed/Eddy Accumulation, Aerodynamic, Resistance, Integrated Horizontal Flux, Control Volume, Bowen Ratio, etc.

(iii) Eddy Covariance method from towers taller than about 10 m when long intake tubes are deployed.

(iv) Chamber Flux measurements, including both methane and CO_2 from the same CH_4-CO_2-H_2O gas analyzer.

(v) Distributed Sensors techniques being currently developed for Megacities and Green Cities projects.

(vi) Mobile monitoring, including measurements from various moving platforms.

This presentation will describe key instrument principles and elements of the design, and show first laboratory and field results on methane from a new high-precision low-power CH_4-CO_2-H_2O gas analyzer, and CO_2 results from a new high-precision low-power CO_2-H_2O analyzer.