EDDY COVARIANCE MEASUREMENTS OF METHANE FLUX AT REMOTE SITES WITH NEW LOW-POWER LIGHTWEIGHT FAST GAS ANALYZER

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INTRODUCTION

Majority of natural CH_4 production:

- remote unpopulated ecosystems
- territories with little or no infrastructure
- areas without easily available power grid
- arctic and boreal wetlands, tropical mangroves, *etc.*

Present approaches to measure fast CH_4 fluxes:

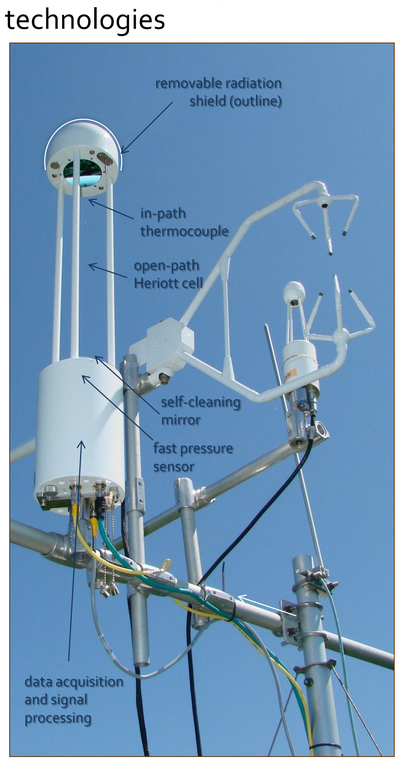
- fast and semi-fast closed-path analyzers
- have to work under significantly reduced pressures
- require powerful dry-scroll pumps
- require 300-1500 Watts and grid power

These may be reasons why CH_4 flux is often measured at locations with power, and not with high CH_4 production

New technology is needed to address this problem, and to allow researchers to measure CH_4 Eddy flux at any source

LI-7700 AT A GLANCE

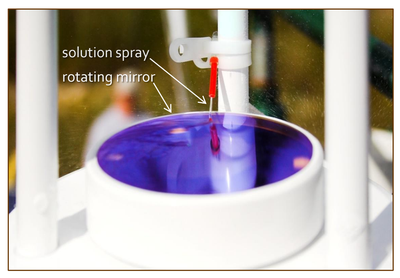
LI-7700 was developed to allow fast measurements of CH_4 flux with steady-state power consumption of about 10 W, which is 30-150 times below presently available technologies



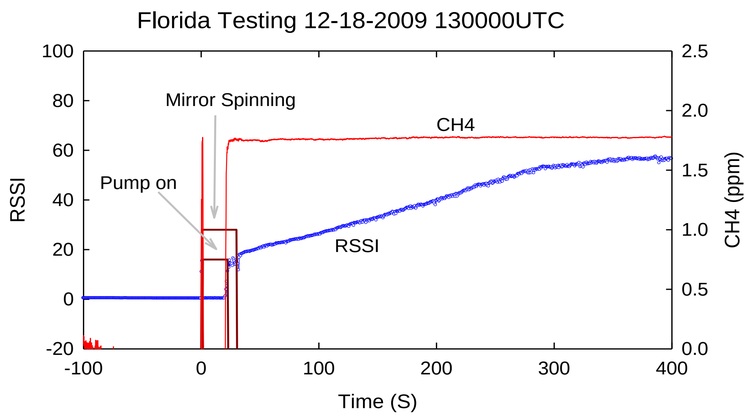
- 5 ppb RMS noise at 10 Hz and 2000 ppb
- CH_4 measurements with frequencies up to 40 Hz via Ethernet
- Air temperature and pressure measured in sampling path
- Four fast auxiliary input channels for sonic anemometer outputs
- Seven additional fast channels and USB data logging with an optional analyzer interface unit

SELF-CLEANING

- Field maintenance is minimized by a fully-programmable self-cleaning mechanism: spinning lower mirror with washer, heaters, and radiation shield



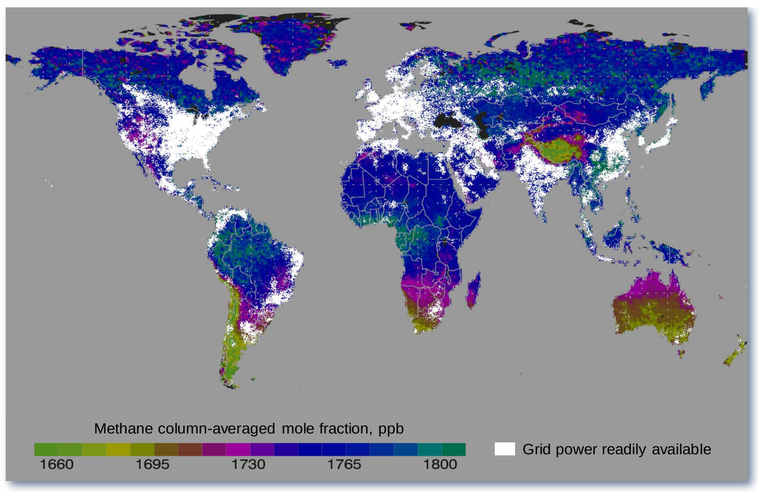
- Fully programmable heaters resolve dew formation and associated data loss
- Radiation shield minimizes both condensation and power consumption
- Self-cleaning system allows to return the instrument to full operation within 20-30 seconds after the rain event



NEW PROSPECTS FOR CH_4 STUDIES

The stand-alone LI-7700 open-path methane analyzer requires 10 Watts of power, which is 30-150 times below present closed-path fast systems for CH_4 flux

LI-7700 provides a new and unique opportunity for measuring CH_4 production where it actually occurs, rather then measuring it where power grid and roads are available



The consumption by entire open-path Eddy Covariance station in Florida Everglades was <30 Watts, including LI-7700 for CH_4, LI-7500 for CO_2/H_2O, sonic anemometer, and air temperature/relative humidity sensors and barometer

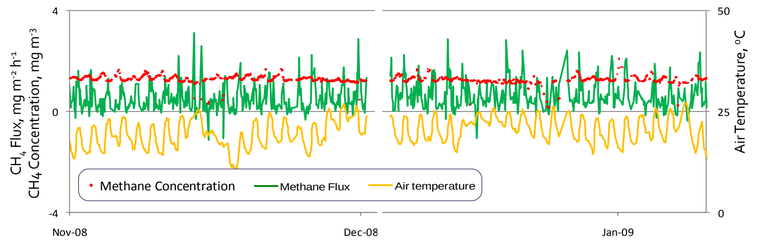
METHANE FLUX MEASUREMENTS

Eddy Covariance measurements of CH_4 flux using the four prototypes of LI-7700 were conducted in 2006-2010 during nine deployments in five ecosystems with contrasting weather, soil moisture and CH_4 production:

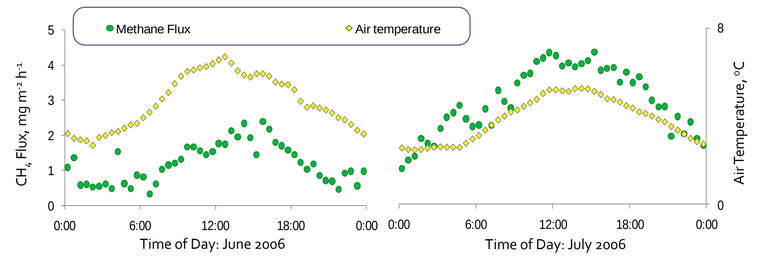
- Sawgrass wetland in Florida Everglades
- Coastal wetlands of Arctic tundra in Barrow, AK
- Pacific mangroves in Mexico
- Bare soil and maize in Nebraska : zero-flux test
- Ryegrass in Nebraska: zero-flux test

CH_4 fluxes were within the ranges reported in the literature for Everglades (Harriss *et al.*, 1988), fen in Canada (Bubier *et al.*, 1993), peatland in Minnesota (Shurpali and Verma, 1998) and bog in Alaska (Moosavi *et al.*, 1996).

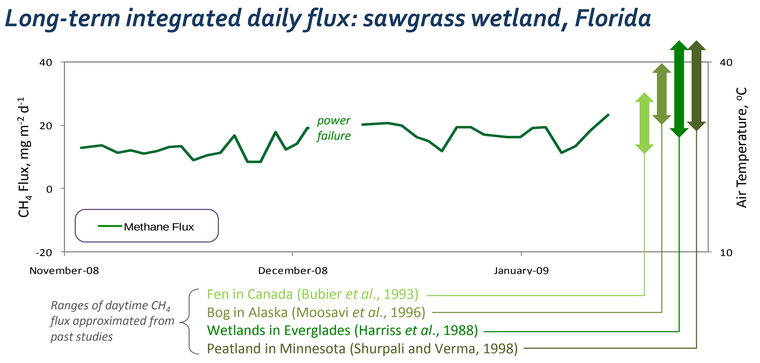
Hourly CH_4 concentration and flux: sawgrass wetland , Florida



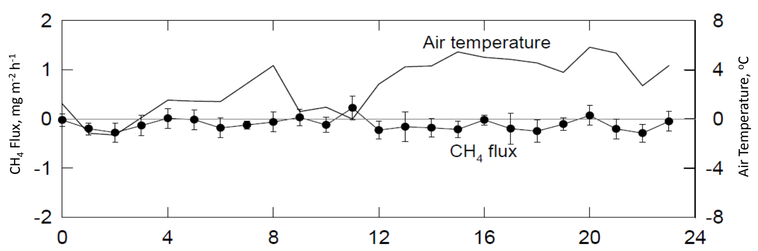
Ensemble averaged hourly flux: arctic tundra wetland, Alaska



Long-term integrated daily flux: sawgrass wetland, Florida

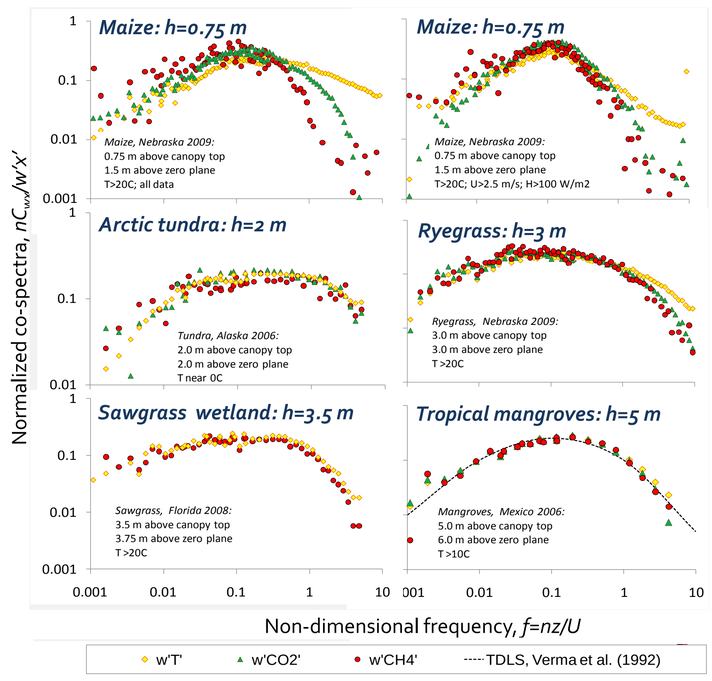


Zero-flux test: ensemble averaged hourly flux, Nebraska



FREQUENCY RESPONSE

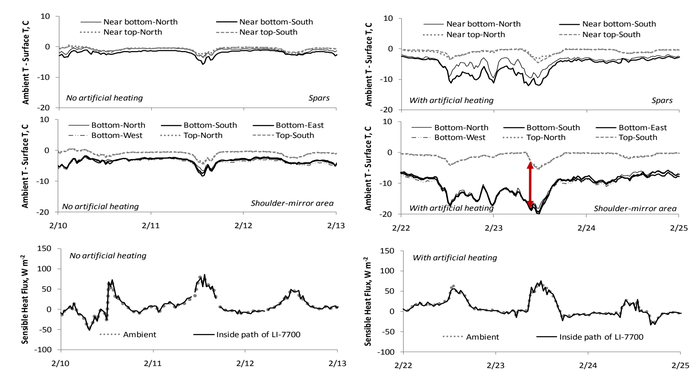
Ensemble averages of normalized midday co-spectra are plotted below versus non-dimensional frequency for 5 contrasting ecosystems and setups



- At extremely low measurement height of 0.75 m above canopy top, there was a noticeable high frequency loss
- With strong turbulence (U>2.5 m s^{-1} and H >100 W m^{-2}), CH_4 flux co-spectra became comparable to that of CO_2 from LI-7500 even at such a low height
- In all other experiments with heights >0.75 m, CH_4 flux co-spectra behaved similar to CO_2 from LI-7500

SURFACE HEATING

In the field experiment with artificial heater, surface heating was not seen in LI-7700, even when bottom mirror was heated >17 °C above ambient air temperature



Not artificially heated **Added heat: 1000 W m^{-2}**

SUMMARY

- Open-path measurements of CH_4 flux using Eddy Covariance approach were conducted in nine experiments in four contrasting ecosystems
- CH_4 fluxes ranged from near-zero at night to 4.0 mg m^{-2} h^{-1} in arctic tundra and pacific mangroves (not shown), and to 3.5 mg m^{-2} h^{-1} in sawgrass wetland
- Diurnal patterns were similar to those from closed-path sensors (Kim *et al.*, 1998; Hendriks *et al.*; *etc.)*
- **The extremely low-power technology allows placing LI-7700 in the middle of the source (wetland, rice paddy, forest, etc.) in the absence of the grid power**
- **LI-7700 could significantly expand Eddy Covariance CH_4 flux coverage, and could significantly improve the estimates of global CH_4 emissions and budget**

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