METHANE AND CARBON DIOXIDE MEASUREMENTS WITH NEW HIGH-PRECISION LOW-POWER LOW-MAINTENANCE CLOSED-PATH ANALYZERS: FIRST LAB AND FIELD RESULTS

G. Burba[1,2]*, A. Komissarov[1], M. Johnson[1], D. Trutna[1], W. Miller[1], K. Minish[1], R. Walbridge[1], J. Welles[1] and I. Begashaw[1]

[1]LI-COR Biosciences, Lincoln, Nebraska, United States; [2]School of Natural Resources, University of Nebraska-Lincoln, United States, *Corresponding author: george.burba@licor.com

INTRODUCTION

Global CO2 and CH4 monitoring requires instruments that must meet strict requirements for:

- Accuracy, precision and stability
- Low power consumption
- Portability and low maintenance

In 2013-2018, a new technology was developed to address these requirements.

In 2018, this technology was implemented in two new gas analyzer models:

- LI-7810 model for $CH_4/H_2O/CO_2$
- LI-7815 model for CO_2/H_2O

The key goal was to allow cost-effective low-maintenance WMO-quality [1] measurements of CH4 in the LI-7810 model, and CO2 in the concurrent LI-7815 model.

Here we report on the performance validation of the initial beta prototypes of both models.

NEW TECHNOLOGY

Optical Feedback - Cavity Enhanced Absorption Spectroscopy, OF-CEAS, detailed in [2-14]:

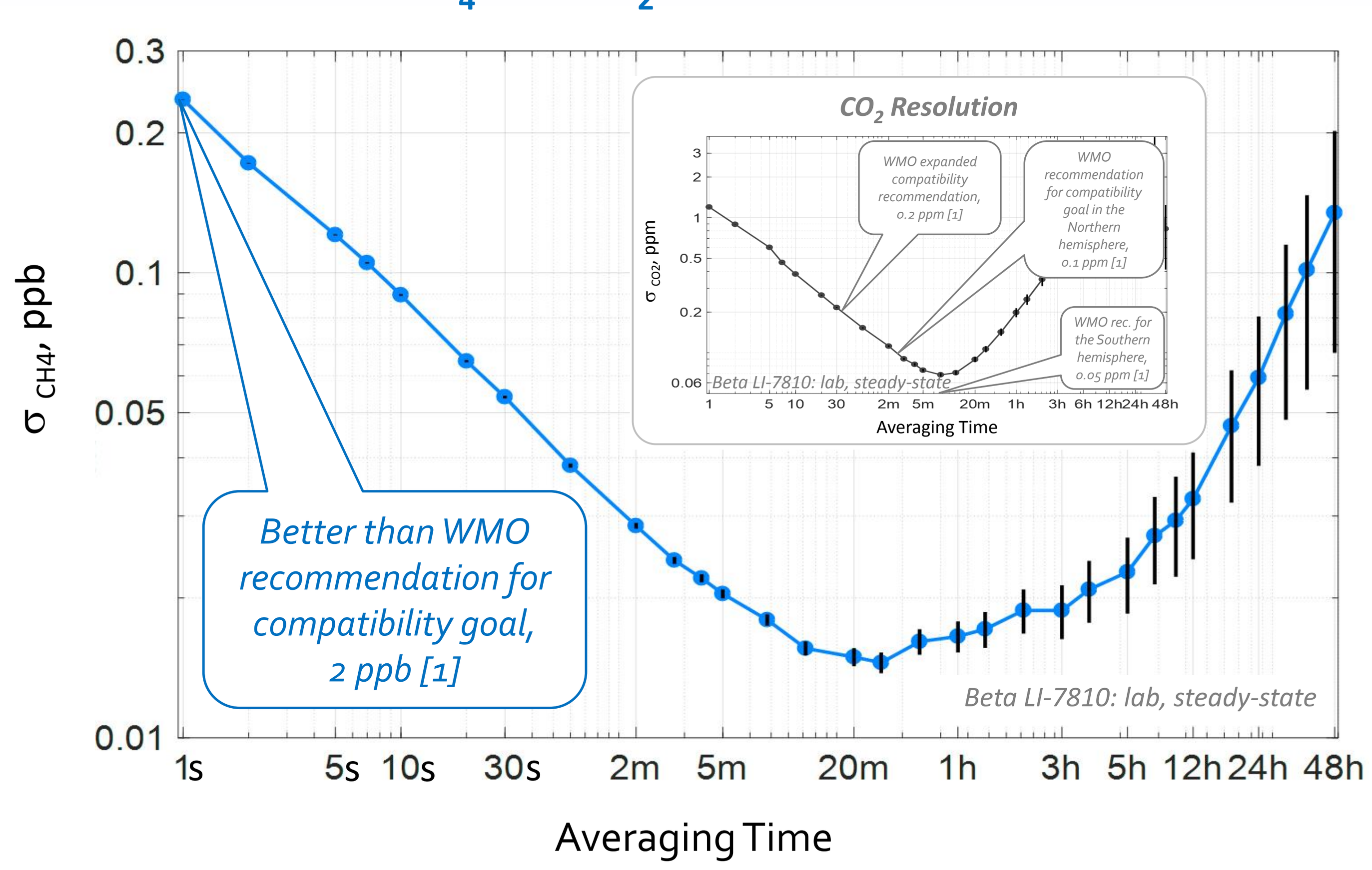
- Continuous field deployment
- Infrequent field calibrations
- Relatively low cost
- Operating temperature: -25 to 45 °C
- Operating pressure: 70-110 kPa
- System time response, 10-90%: 1-2 s
- Sampling flow rate: 280 scc min^{-1}
- Sampling cell volume: 6.41 cm^3
- Sampling system volume: 15.8 cm^3
- Power demand: 20 W nominal
- Internal battery: 8 hrs continuous
- Total weight: 11.4 kg
- Exterior size: 51 x 18 x 33 cm
- Wireless & Ethernet connections
- Embedded web server
- Data storage: ≈ 1 month'
- Low field maintenance: replacing pre-filter, chemicals, and pump

'Most but not all countries; 'Logging full dataset

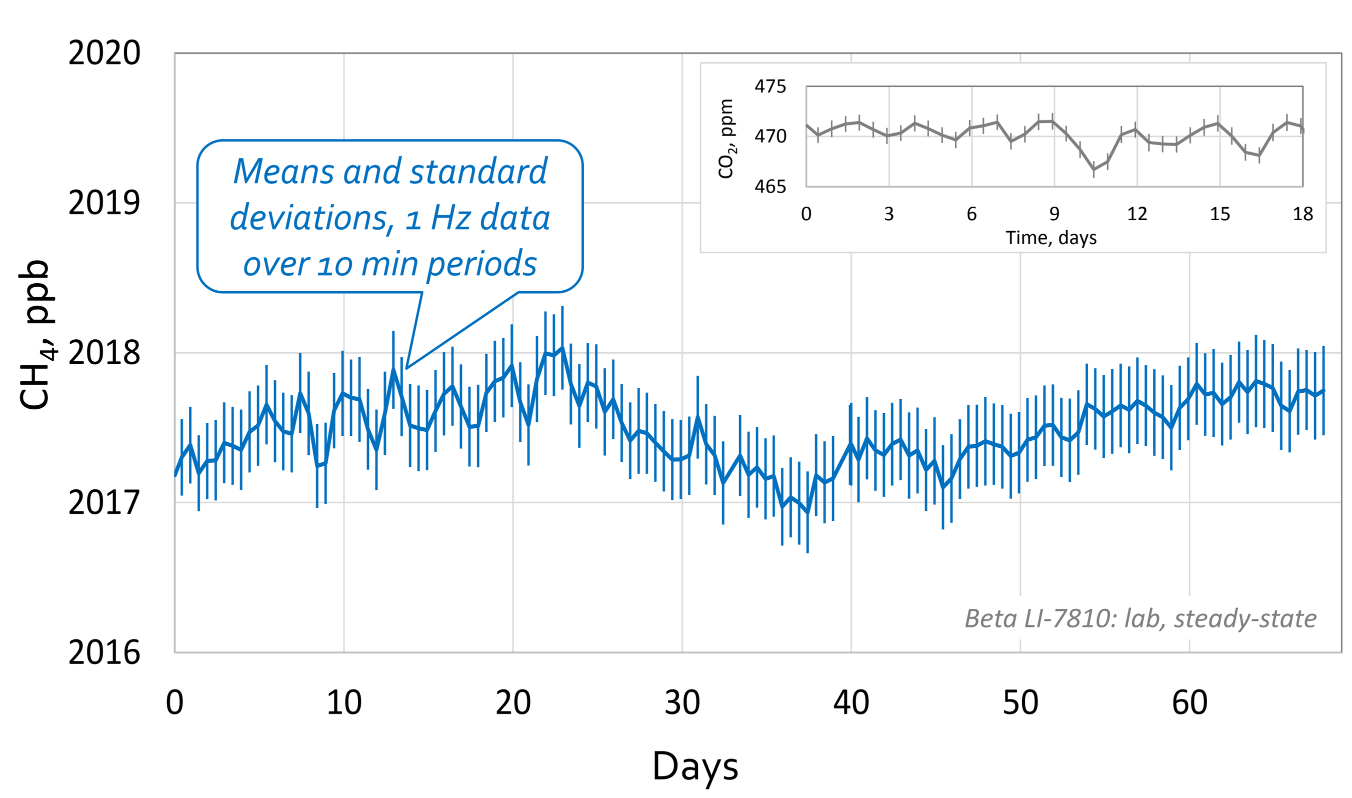
CH_4-CO_2-H_2O

LI-7810 Range	Precision	Accuracy
CH_4: 0.1-50 ppm	≈0.25 ppb@ 5 s	2 ppb@ 2000 ppb, 25 °C
CO_2: 1-10000 ppm	≈1.5 ppm@ 5 s	1.5 %@ 300-700 ppm, 25 °C
H_2O: 0.100-60 ppT	≈20 ppm@ 5 s,	1.5 %@ 0.5-60 ppT, 25 °C

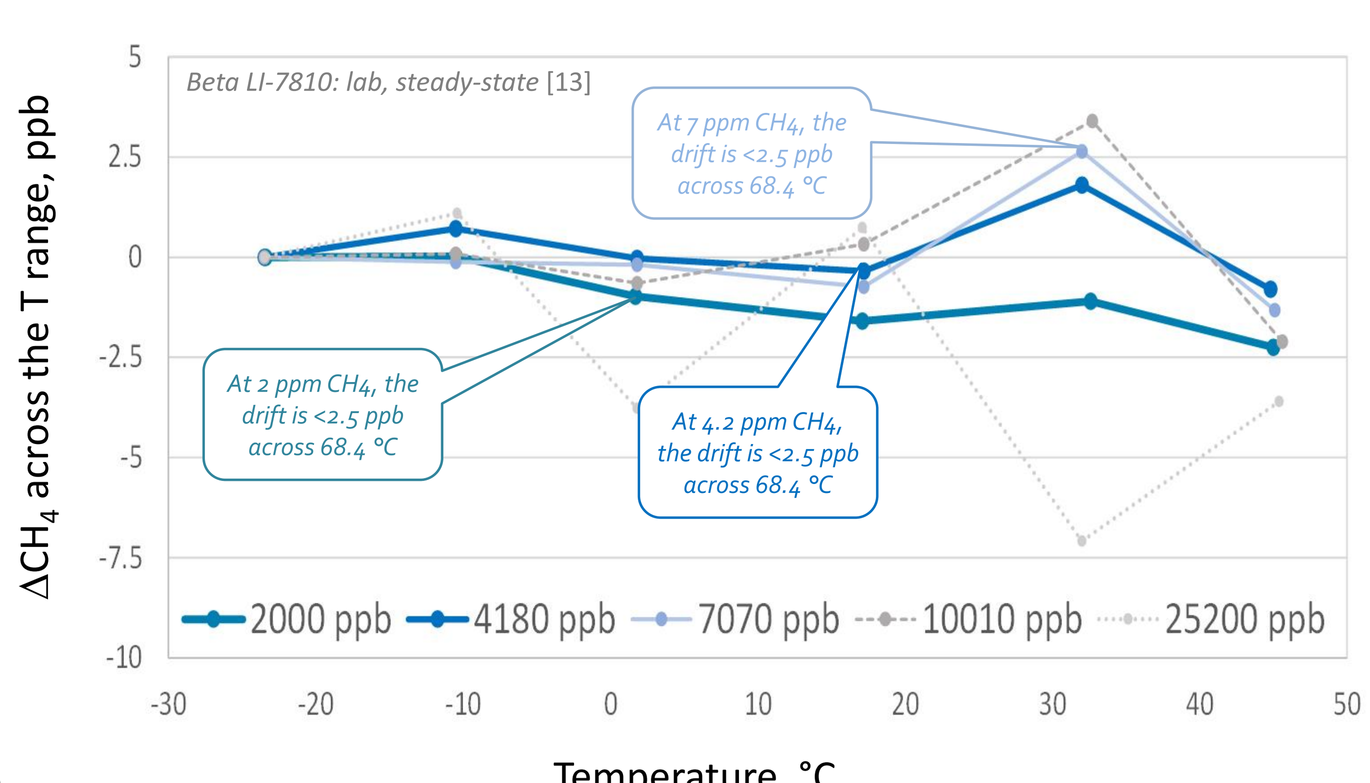
CH_4 and CO_2 Allan Deviation



CH_4 Stability at Constant Temperature



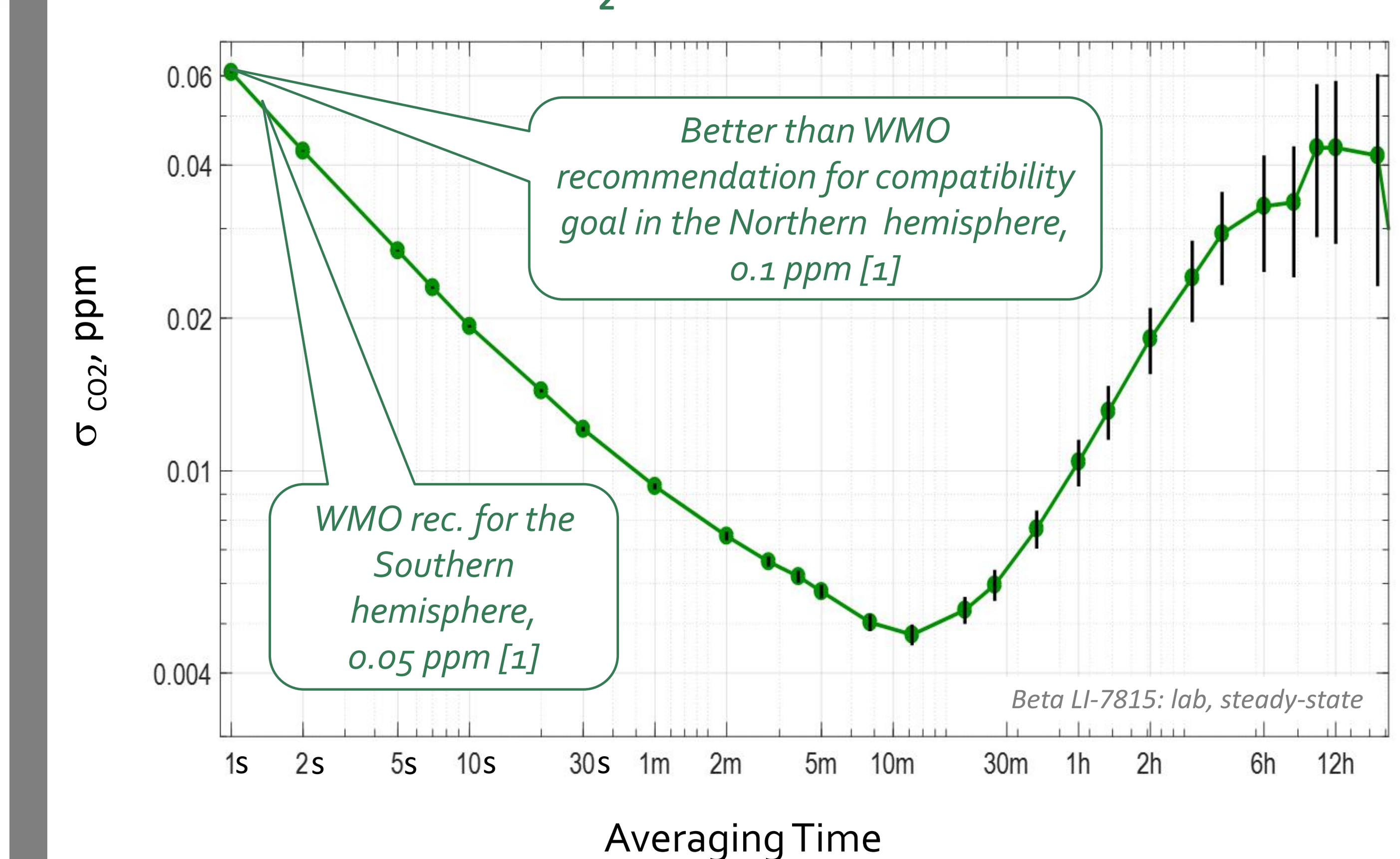
CH_4 Stability Across Wide Temperature Range



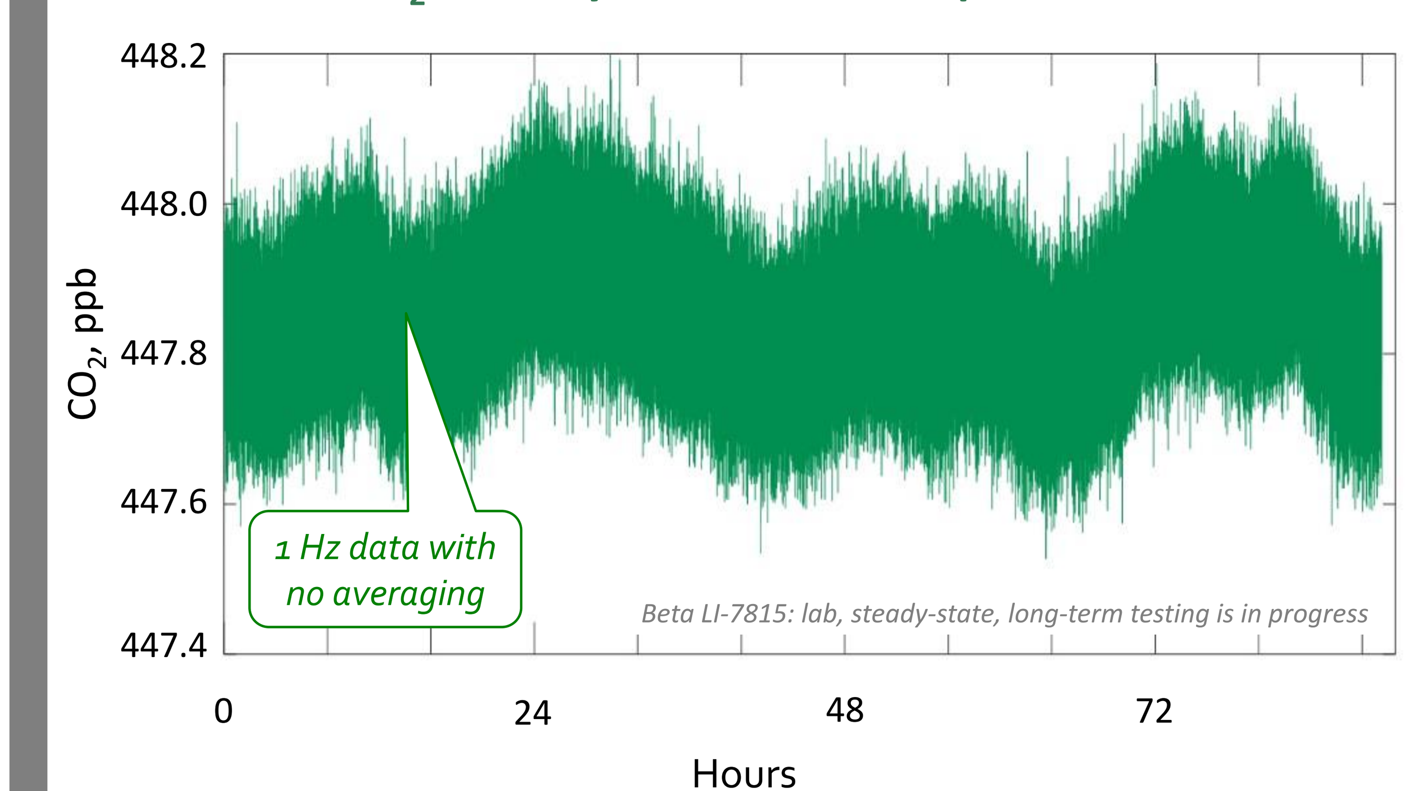
CO_2-H_2O

LI-7815 Range	Precision	Accuracy
CO_2: 1-10000 ppm	≈0.04 ppm@ 5 s	0.4 ppm@ 400 ppm, 25 °C
H_2O: 0.100-60 ppT	≈20 ppm@ 5 s	1.5 %@ 0.5-60 ppT, 25 °C

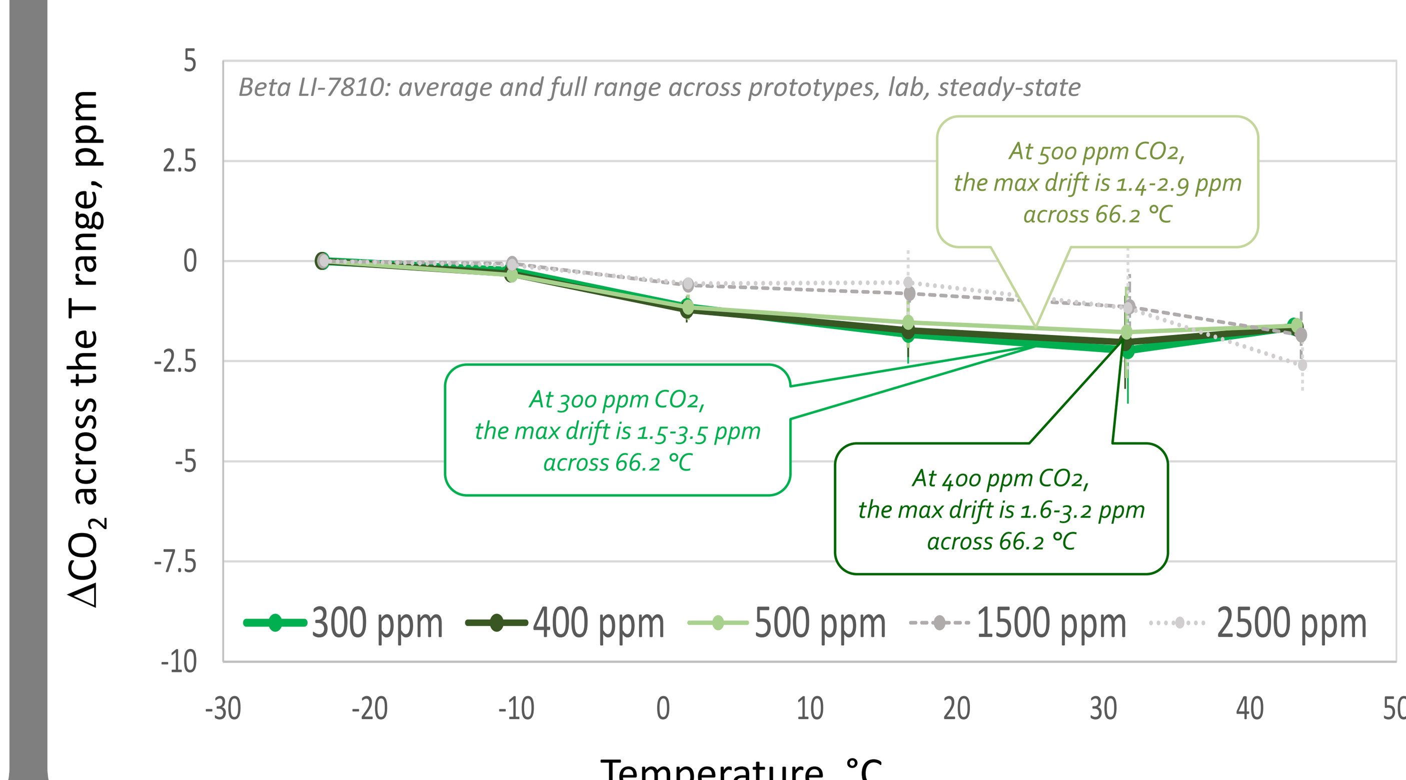
CO_2 Allan Deviation



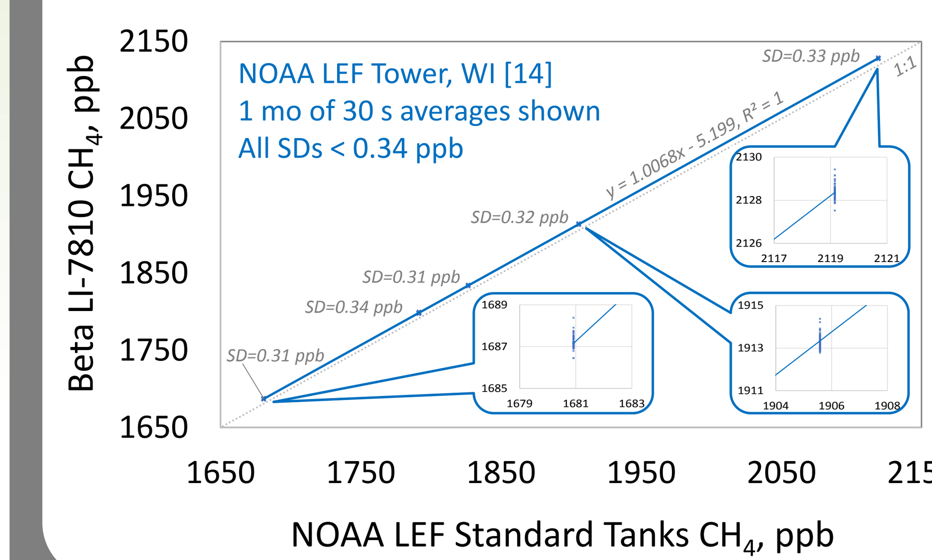
CO_2 Stability at Constant Temperature



CO_2 Stability Across Wide Temperature Range



FIELD VALIDATION



KEY APPLICATIONS

- Approaches relying on very high precision concentrations, often used by WMO-GAW groups: Inverse Flux Methods, Lagrangian Modeling, Mass Balance, Fence-Line, *etc.*
- Chamber fluxes of both CO2 and CH4 from the same gas analyzer
- Micromet methods relying on slow well-resolved concentrations, such as Disjunct Eddy Covariance, Eddy Accumulation, Aerodynamic, Resistance, Integrated Horizontal Flux, Control Volume, Bowen Ratio, *etc.*
- Distributed sensors techniques being currently developed for Megacities/ Green Cities projects
- Mobile flux monitoring and concentration mapping
- Eddy Covariance method from towers taller than about 10 m when long intake tubes are deployed

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