

# Performance validation of new high precision CH<sub>4</sub> and CO<sub>2</sub> analyzers based on optical feedback cavity enhanced absorption spectroscopy

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## Introduction

Global CO<sub>2</sub> and CH<sub>4</sub> monitoring requires instruments that must meet the stringent requirements for:

- ☐ Accuracy, precision and stability
- ☐ Low power consumption, field portability, and limited maintenance

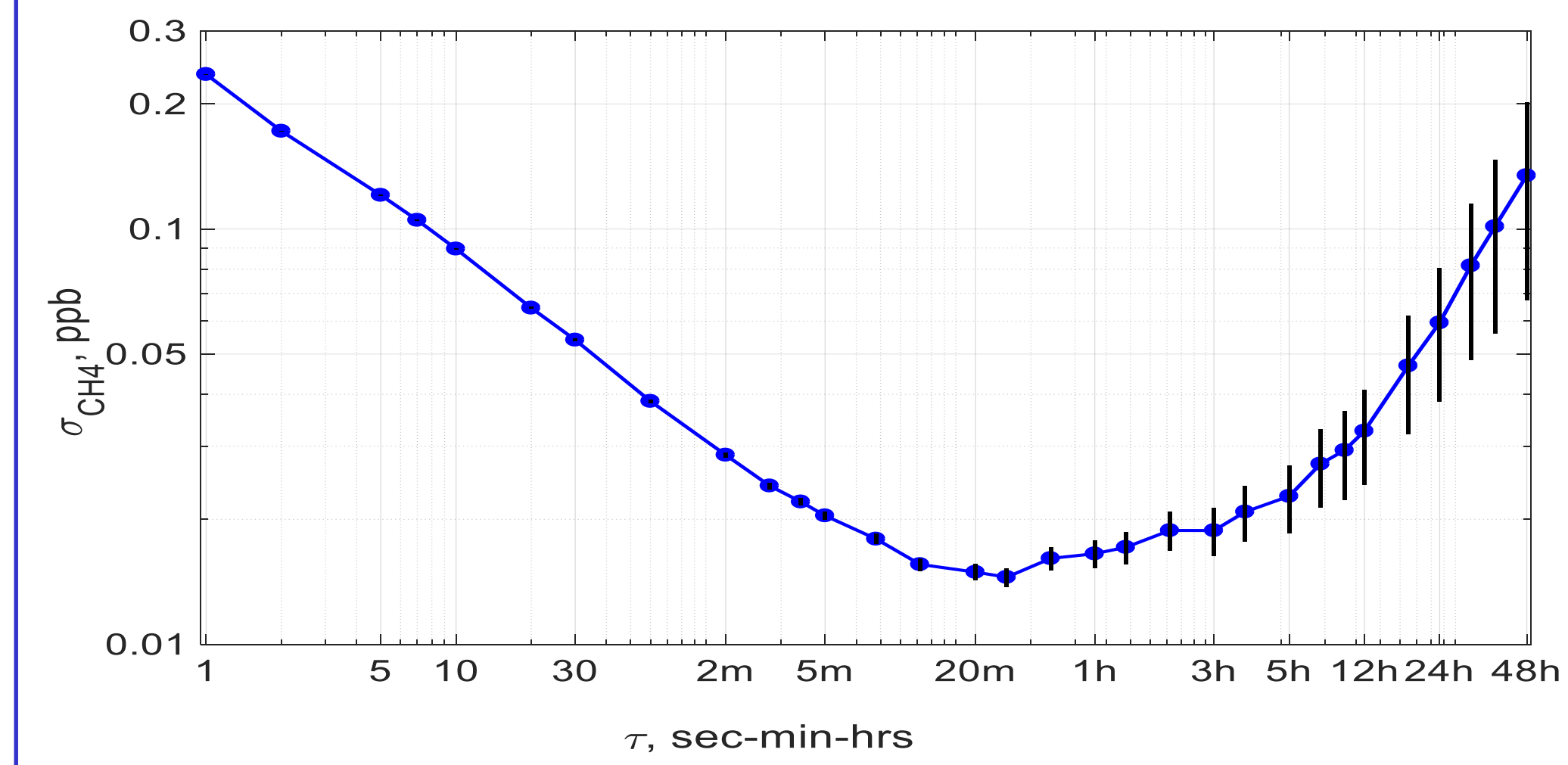
Two new field portable analyzers were designed to address these requirements:

- ☐ LI-7810 (CH<sub>4</sub>/H<sub>2</sub>O/CO<sub>2</sub>)
- ☐ LI-7815 (CO<sub>2</sub>/H<sub>2</sub>O).

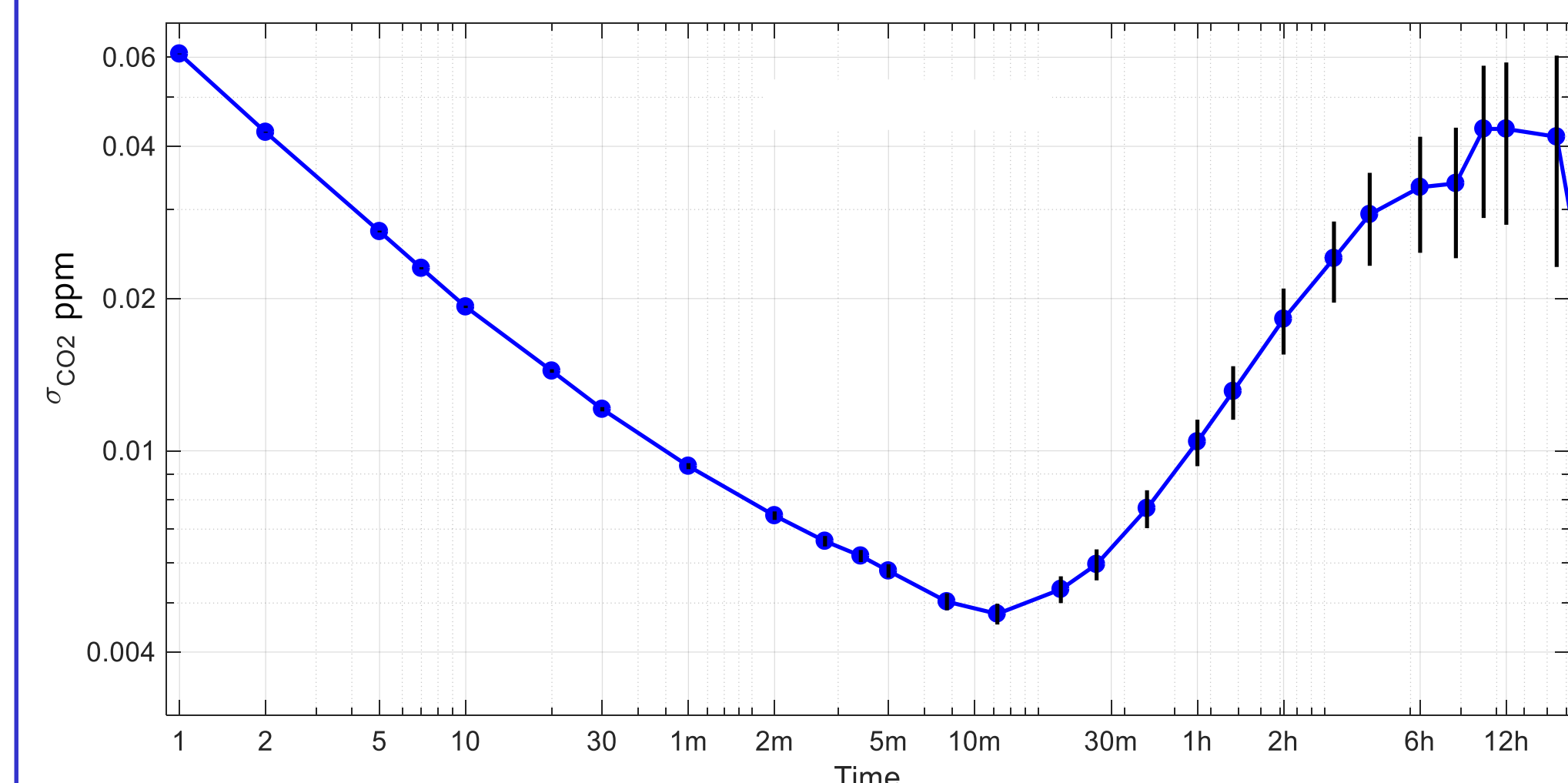
We report on the performance validation of the initial alpha prototypes.



## Precision

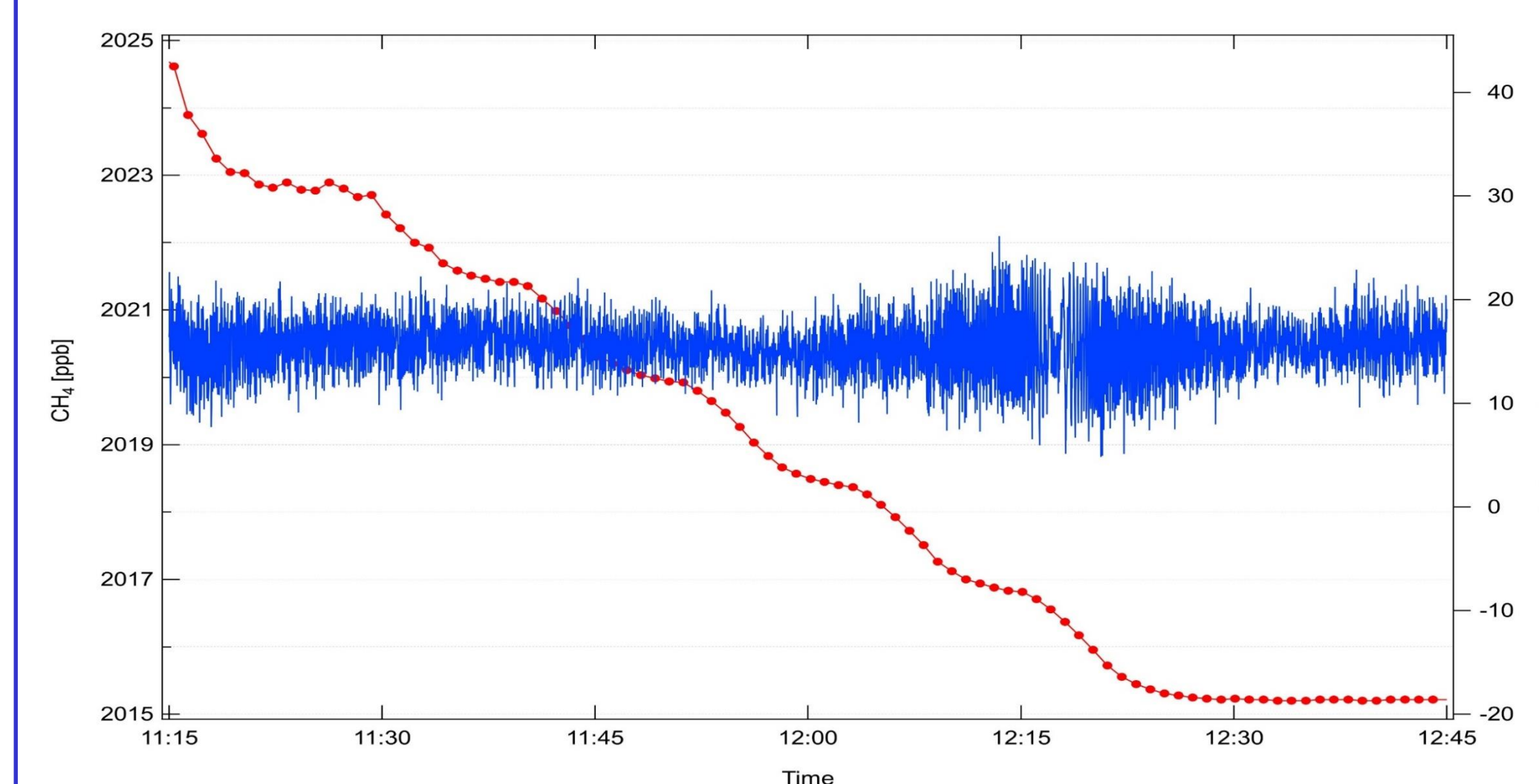


Allan deviation plot for LI-7810 prototype.



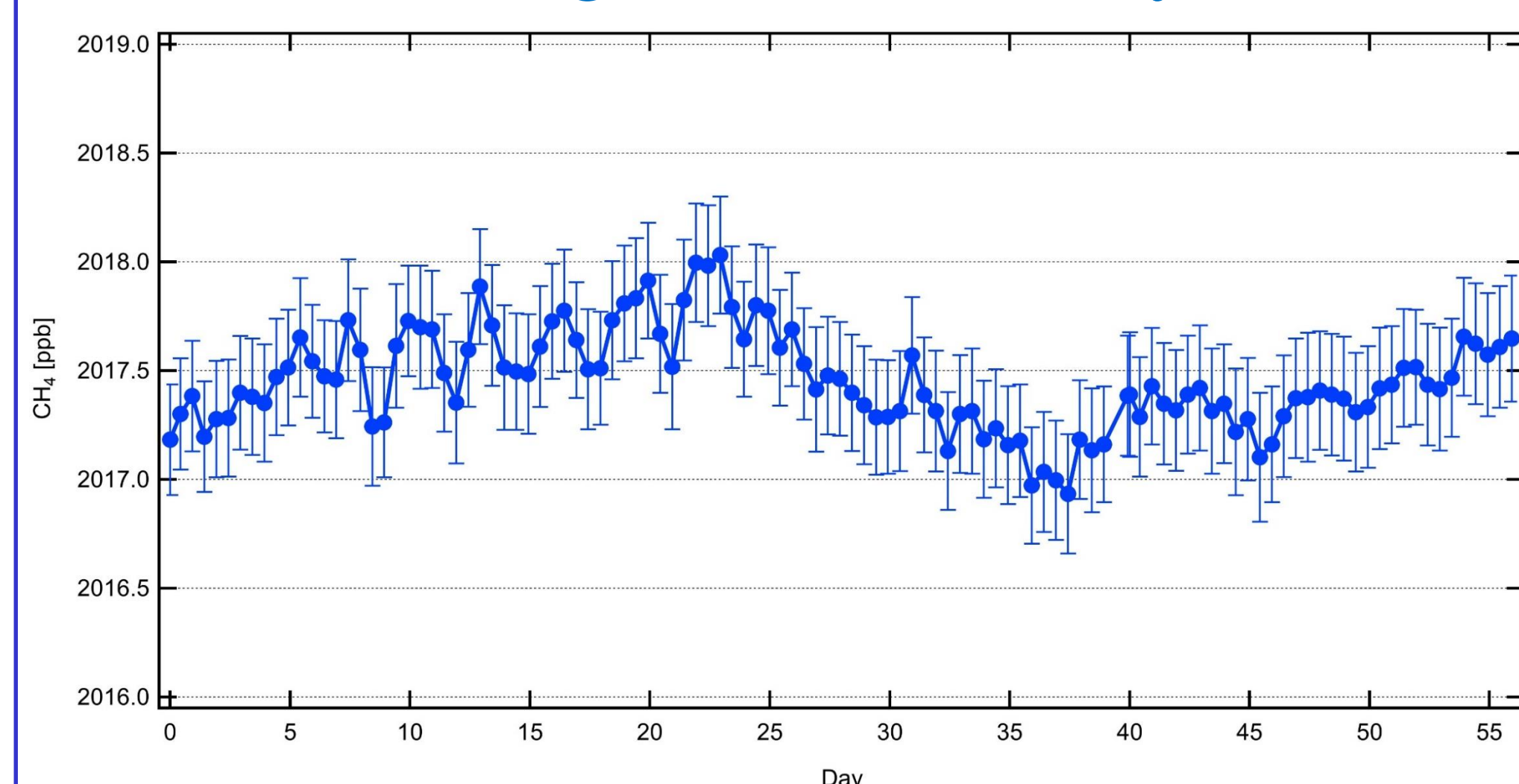
Allan deviation plot for LI-7815 prototype.

## Temperature Stability



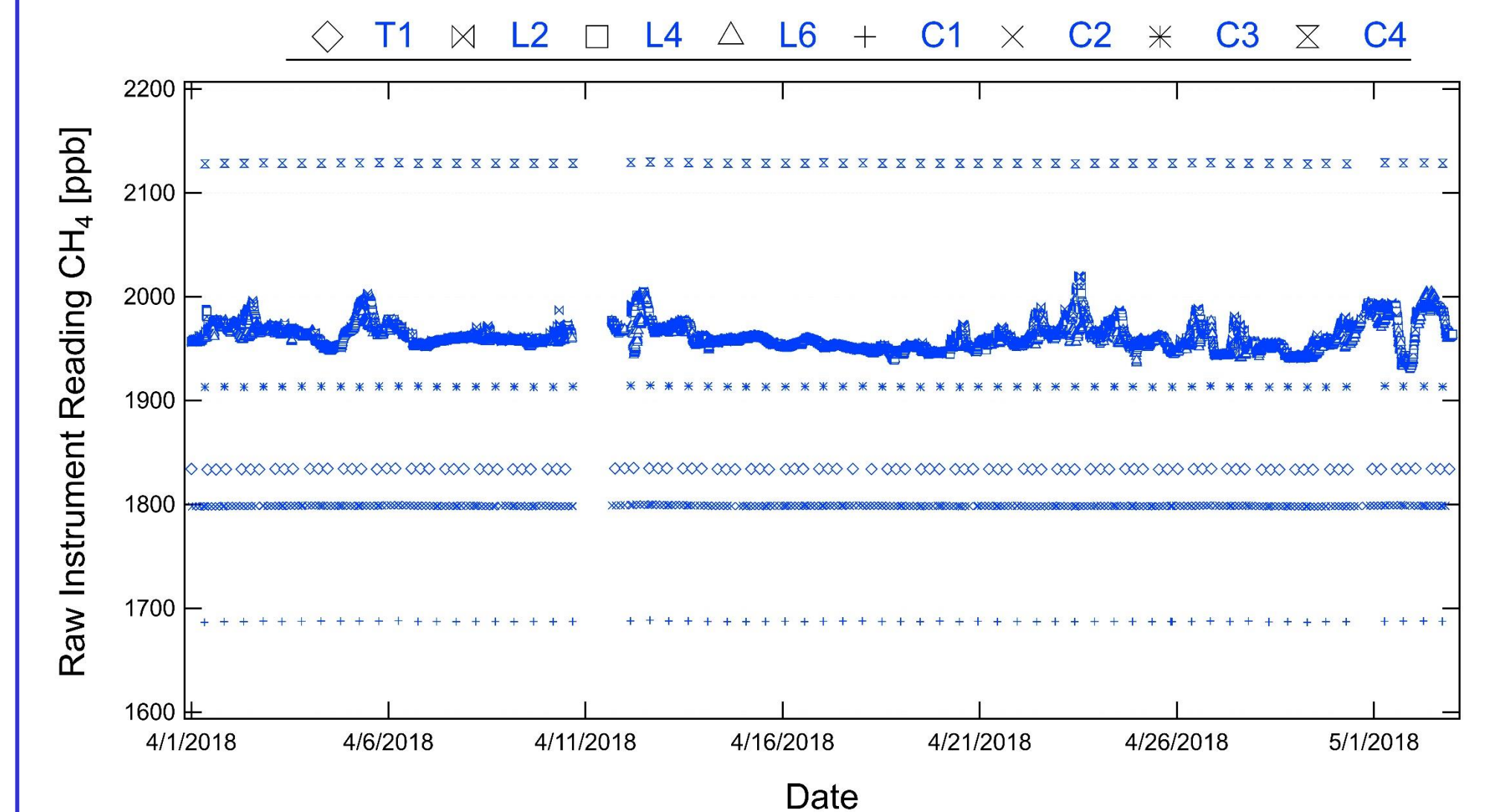
A LI-7810 prototype was placed in a test chamber connected to a gas cylinder. The chamber temperature (shown in red) was ramped down from 42 to -20 °C. The 1 Hz CH<sub>4</sub> output is shown in blue.

## Long-Term Stability

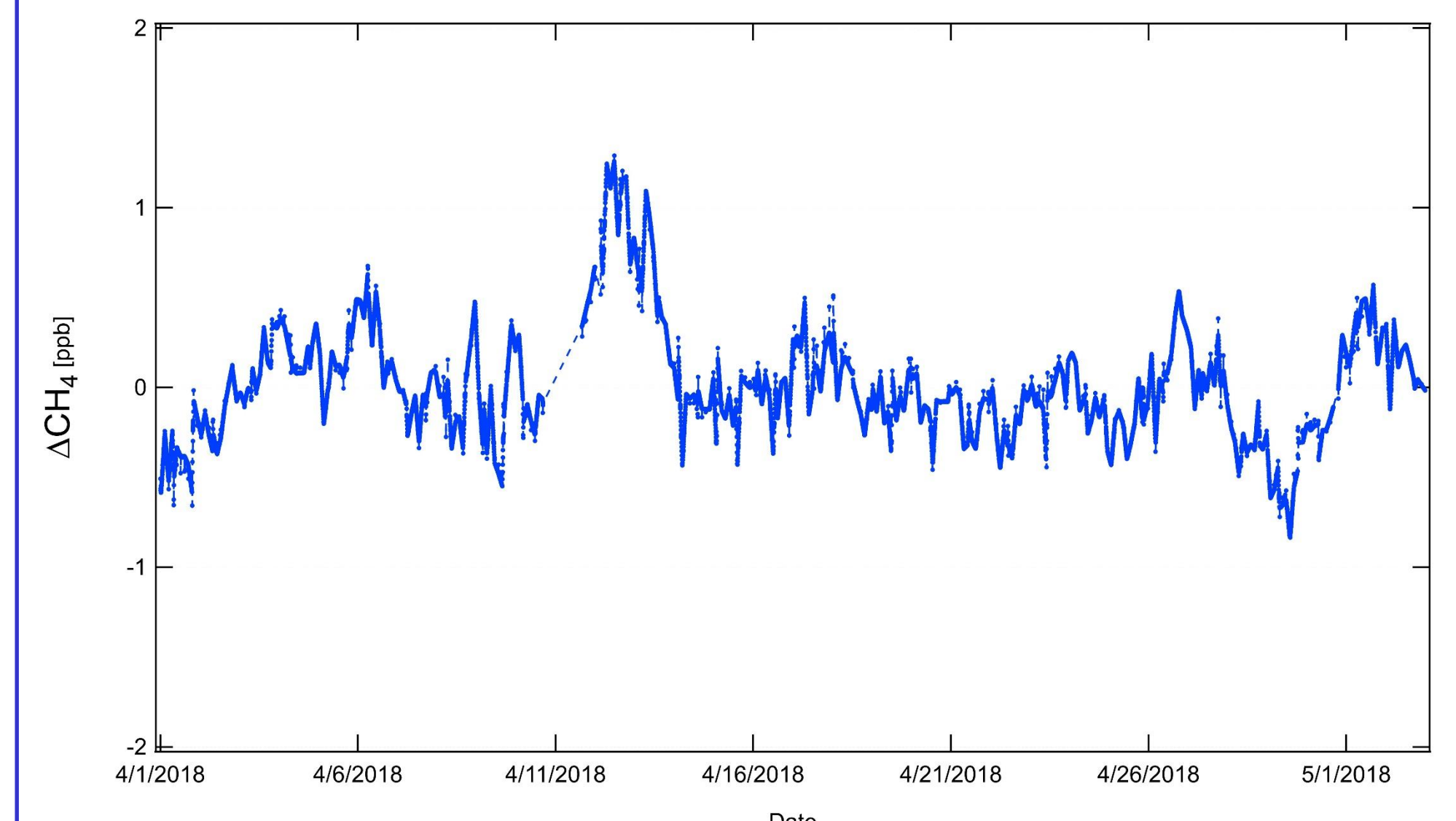


For long-term stability testing, a continuously operated LI-7810 prototype was flushed for 10 minutes with tank gas and data was recorded for the subsequent 10 minutes every 12 hours. The figure shows the mean value of the 10-minute measurements. Error bars represent a 1σ confidence interval.

## Field Validation

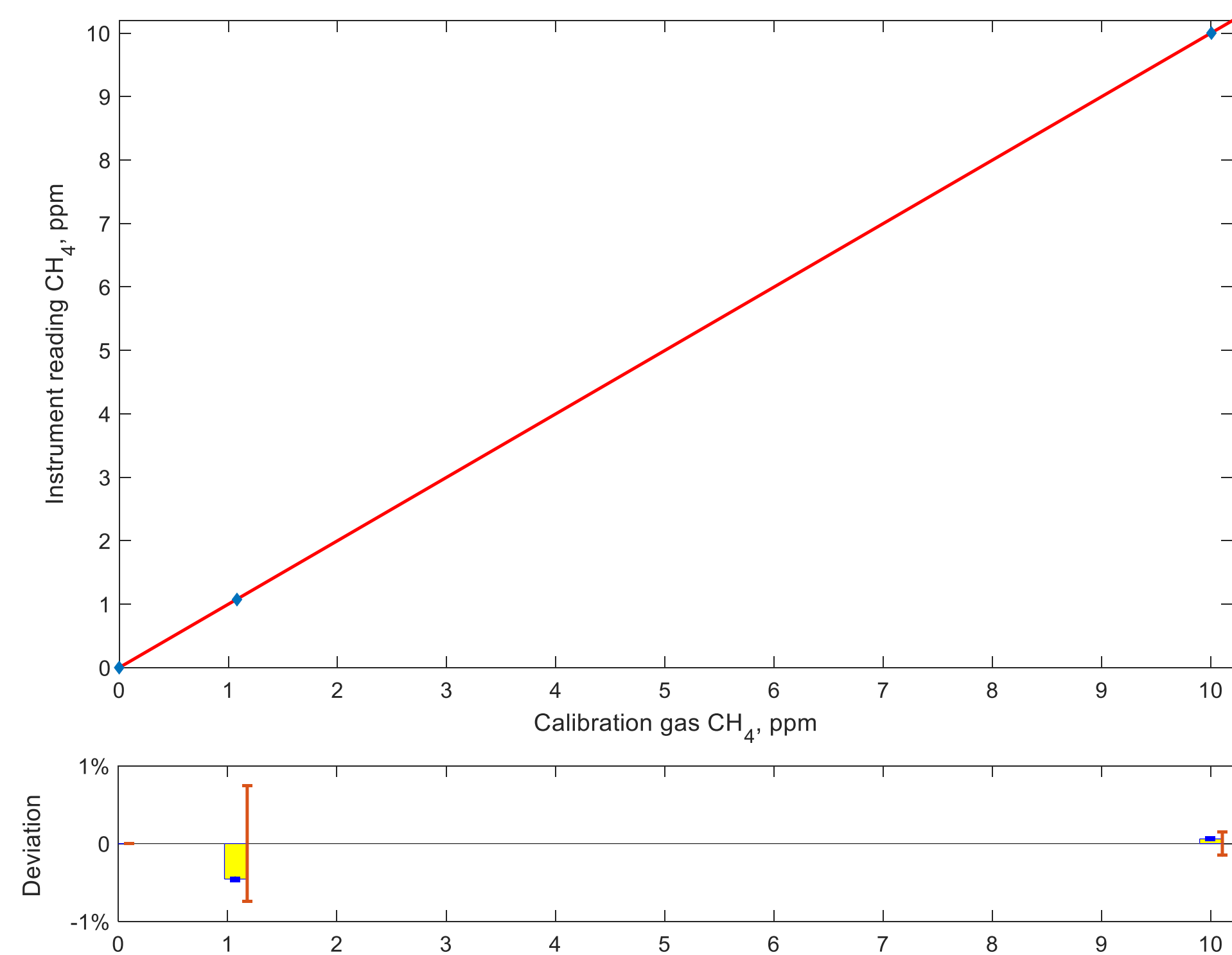


A LI-7810 prototype was installed at the NOAA LEF site in Wisconsin. 30 second averaged instrument readings are shown for the month of April. Legend indicates the code for different measurement levels (L2, L4 and L6) and reference concentrations (C1, C2, C4, C4, and T1)

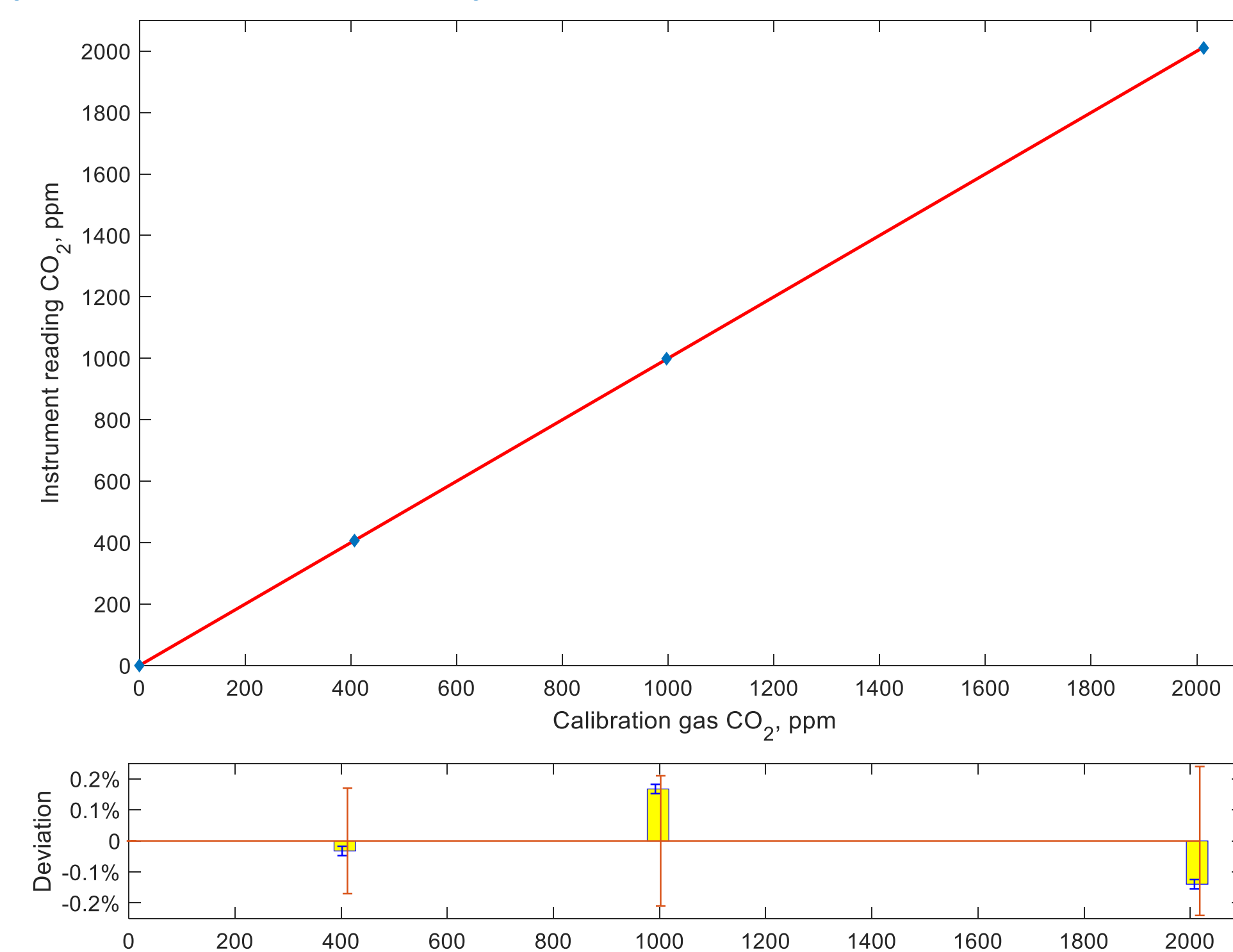


Difference between daily calibrated (adjusted) instrument readings vs single linear adjustment (for entire deployment).

## Calibration Accuracy and Linearity

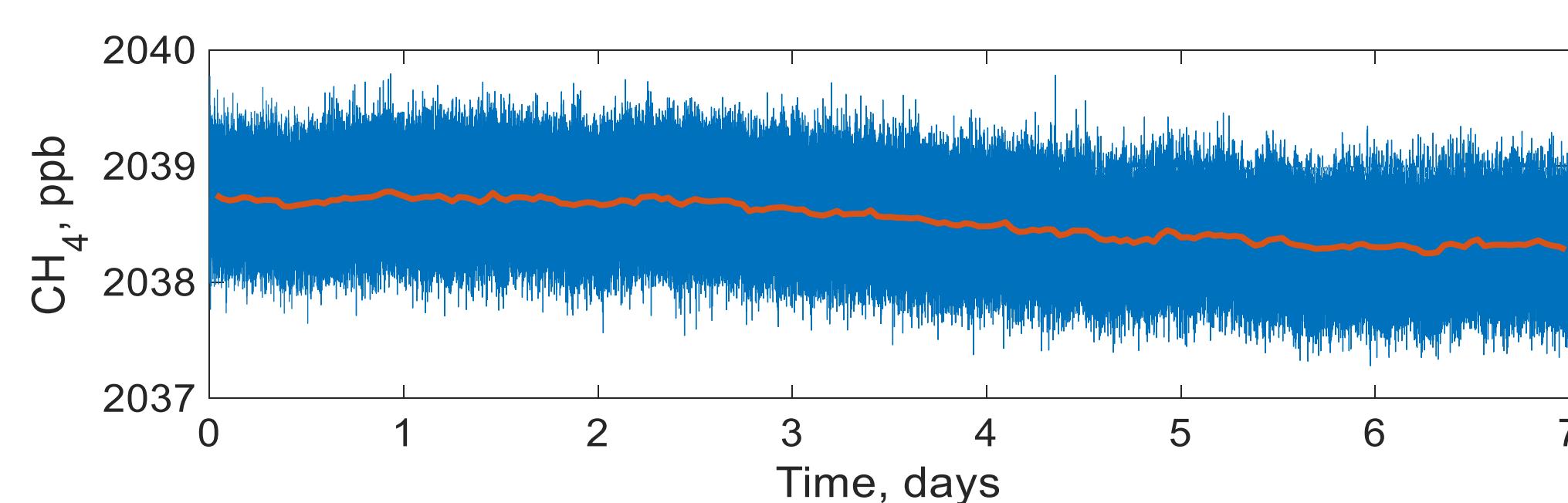


LI-7810 prototype linearity was checked using NIST reference standards. The yellow bar is the measured deviation, the red bar is the uncertainty in the reference standard and the blue bar is instrument noise (1σ, at 1 second averaging).

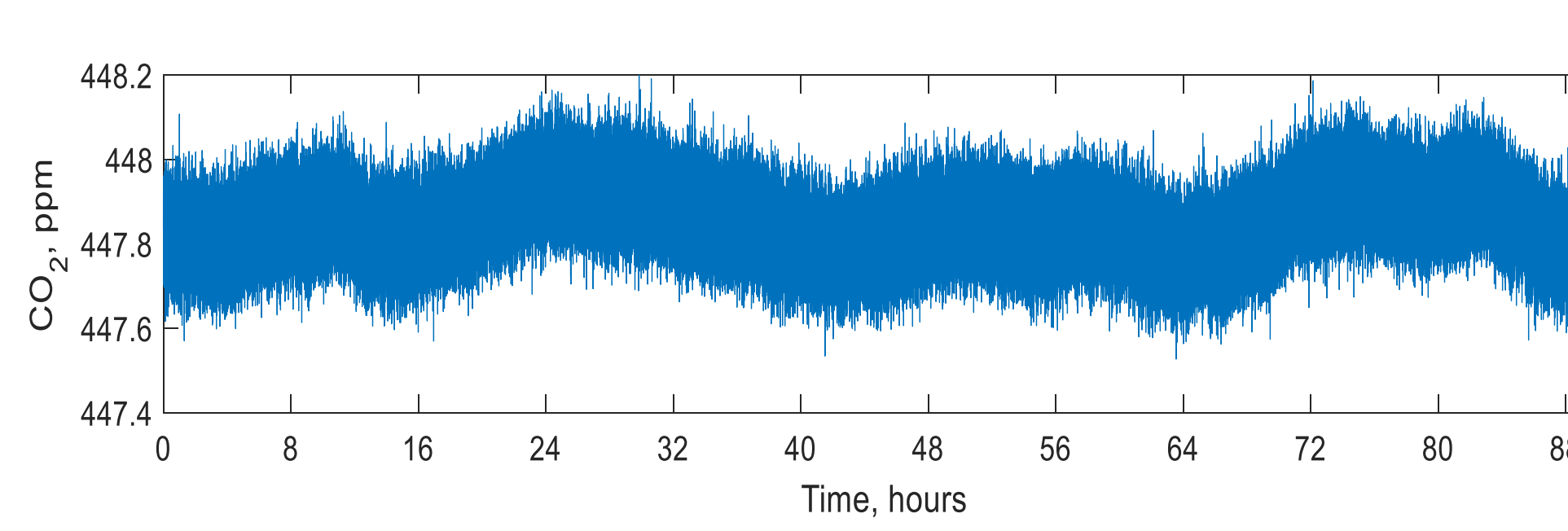


LI-7815 prototype linearity was checked using transfer standards. The yellow bar is the measured deviation, the red bar is the uncertainty in the standard used and the blue bar is instrument noise (1σ, at 1 second averaging).

## Short-Term Stability



LI-7810 short-term stability was tested by measuring the same gas cylinder continuously for 7 days. The data shown in blue is 1 Hz instrument output. The 50 minute averages are shown in red.



LI-7815 short-term stability was tested by measuring the same gas cylinder continuously for several hours. The data shown is 1 Hz instrument output.

## Acknowledgments

We would like to acknowledge Arlyn Andrews and Jonathan Kofler for their help with field validation, including data analysis.

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