Assessment of BluBird 2.0 Methane Concentration Estimates Versus Known Calibration Gas Concentrations

Earthview Corp. (proprietary)
J. Maslanik

Version 1: 10 Sept. 2023
Modified: 10 Oct. 2023

Test objectives: Document sensitivity of the BluBird 2.0 system (hardware, firmware, and cloud-based algorithm processing) to variations in methane concentrations. Assess accuracy of sensor-to-concentration conversion algorithm "MO" under controlled conditions.

Summary of Results:

In this test setting using zero-air and methane calibration gas mixtures at known concentrations over a range from zero to 900 ppm, the BluBird 2.0 measurements showed high correlation with the actual concentrations and good overall accuracy. Average error was 9% over a concentration range from 0-20 ppm, and 16% over a range from 0-900 ppm. Results were consistent over the testing period.

Test procedure:

Test unit: Standard BluBird 2.0 (ID#: test-node-1-JHQ), operated at a 15-second sampling interval.

Test mode: Calibration gas (PortaGas™) injected into Kynar 18 inch x 18 inch gas sampling bag (Cole-Parmer™) via an 0.6 liter/min flow regulator passing through Nafion tubing. (Nafion tubing was used to add humidity to the gas mixtures from the near-zero humidity of the calibration gases). Mixtures of different amounts of air zero calibration gas and calibration gas of known (20 ppm or 1000 ppm) CH4 concentration were used to create different concentration ranges in the Kynar bag. The mixtures were achieved by varying the amount of time that zero air and 20 ppm or 1000 ppm methane were injected into the bag. Measurements obtained when exposed to 100% zero-air calibration gas defined the zero-air background sensor values. Gas mixture conditions reported for the BluBird sensor chamber via the sensor-chamber internal sensors varied from 30 to 35 deg. C temperature and 22 to 28% relative humidity. Testing was conducted indoors. Testing was done over a 17-day period, with each individual testing sequence lasting about 4 hours.

Sensor-to-Methane-Concentration algorithms: The conversion algorithms used to convert the raw BluBird sensor data to methane concentrations are standard algorithms in the Earthview algorithm library and were developed independent of the testing data used here. This experiment uses algorithm "MO", which is designed to be applied to natural gas+air mixtures where the gas is nearly 100% methane. These algorithms make use of the ratio of sensor

resistances exposed to fresh air (Rs) and air with presence of the test gas (Ro). For these tests, the Rs value was taken as the resistance when exposed to the air zero calibration gas.

Testing apparatus uncertainties: Some error in the accuracy of the achieved ("actual") CH4 concentrations in the Kynar bag is expected due to small uncertainties in the timing of flow for the zero-air and calibration-gas canisters.

Data files analyzed:

"gas_test_analysis"
"tests_cal_gas_incremental_CH4_increase_100-900_2sept23"
"tests_cal_gas_1_20ppm_4sept23"

Results:

The observed relationships between estimated and test CH4 concentrations are summarized below.

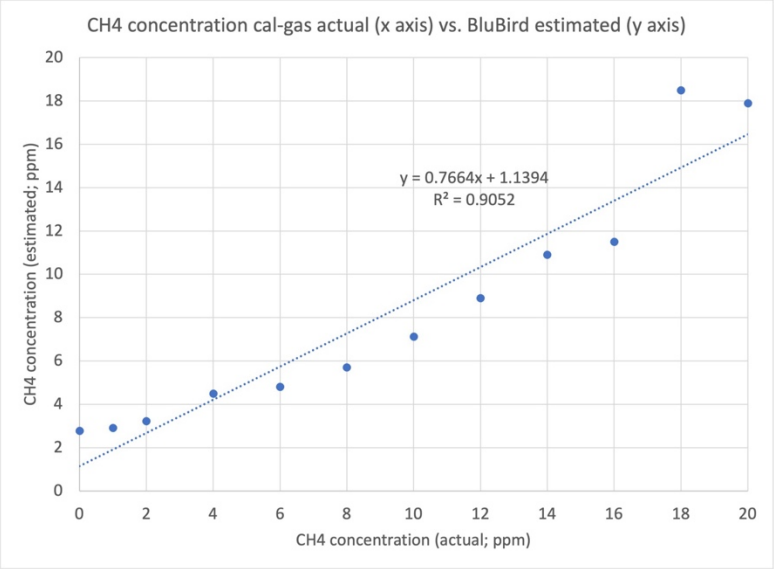

Figure 1. Comparison over a range of 0 to 20 ppm CH4.

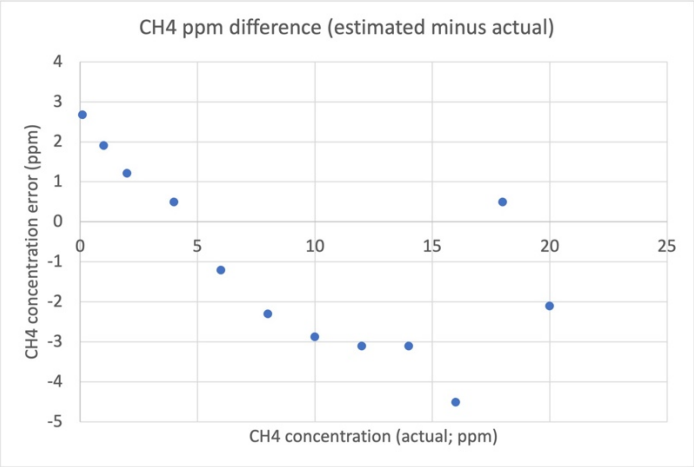

Figure 2. Absolute errors (BluBird estimated minus actual).

Average absolute error (estimated minus actual) over the range 0 to 20 ppm is -1.8 ppm. Average percent error is 9%, excluding the zero-ppm concentration point.

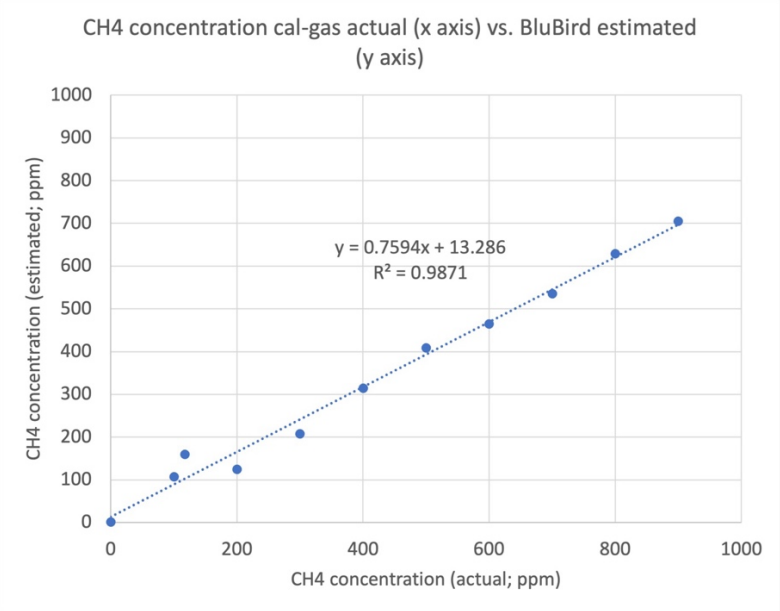

Figure 3. Comparison over a range of 0 to 900 ppm CH4.

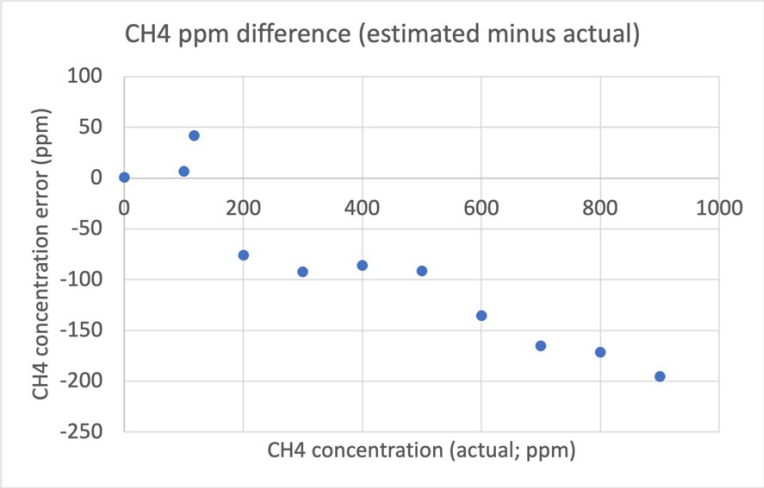

Figure 2. Absolute errors (BluBird estimated minus actual).

Average absolute error (estimated minus actual) over the range 0 to 900 ppm is -87.7 ppm. Average percent error is 16%, excluding the zero-ppm concentration point. Concentrations are underestimated for concentrations above about 100 ppm.

Summary:

In this test setting using zero-air and methane calibration gas mixtures at known concentrations over a range from zero to 900 ppm, the BluBird 2.0 measurements showed high correlation with the actual concentrations and good overall accuracy. Average error was 9% over a concentration range from 0-20 ppm, and 16% over a range from 0-900 ppm. Results were consistent over the testing period.