EPA United States Environmental Protection Agency

Use of Air Sensors for Short Duration and High Concentration Emissions

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Background

- Determine emission factors from open combustion sources – estimate downwind concentrations, risk assessments
- Plume concentration varies rapidly: dilution, change in wind direction
- Unmanned aircraft systems (UAS) can quickly change directions both horizontally and vertically

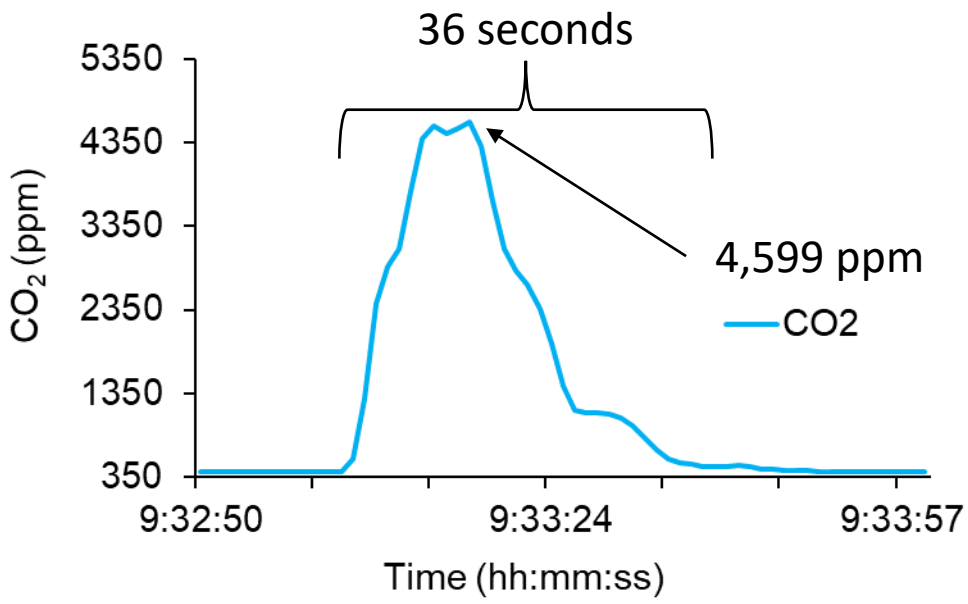
Photo by Jesse Juchtzer

Plume Concentration

Concentration Range – source dependent

- PM: 0 - 150 mg/m^3
- CO: 0 - 500 ppm
- CO_2: 400 - 10,000 ppm

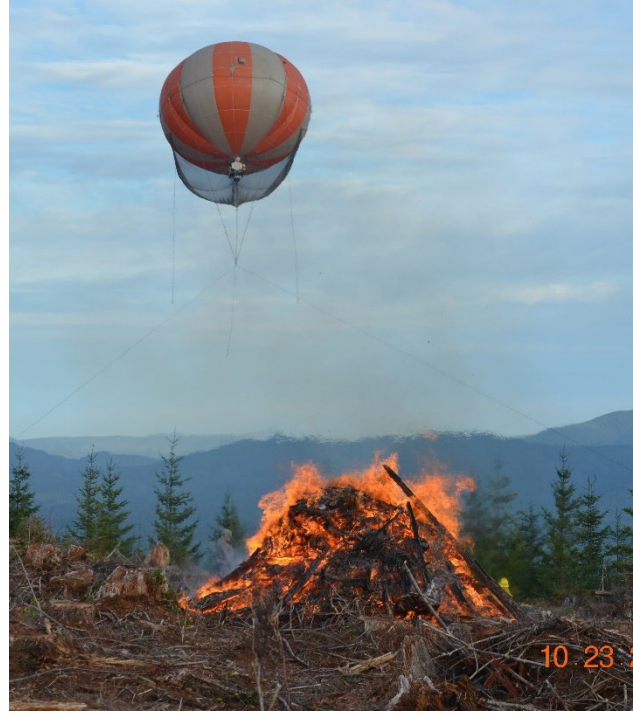
Open Burning of Military Ordnance

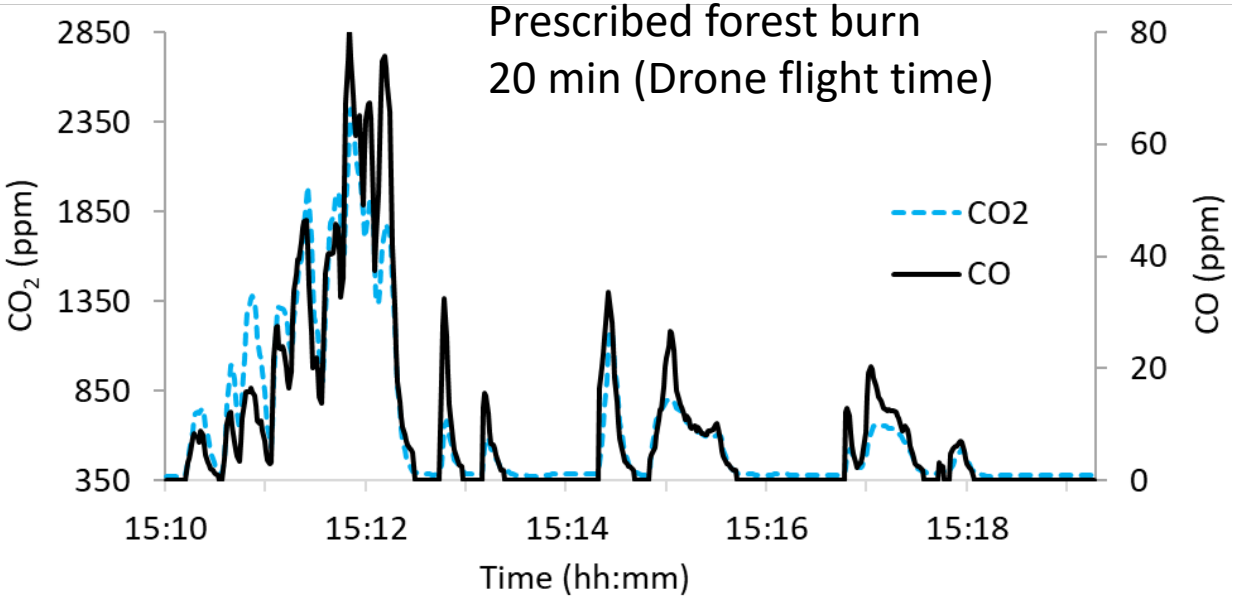


Plume Duration

Duration – source dependent

- Open detonation - 20 seconds
- Prescribed forest burns - all day event



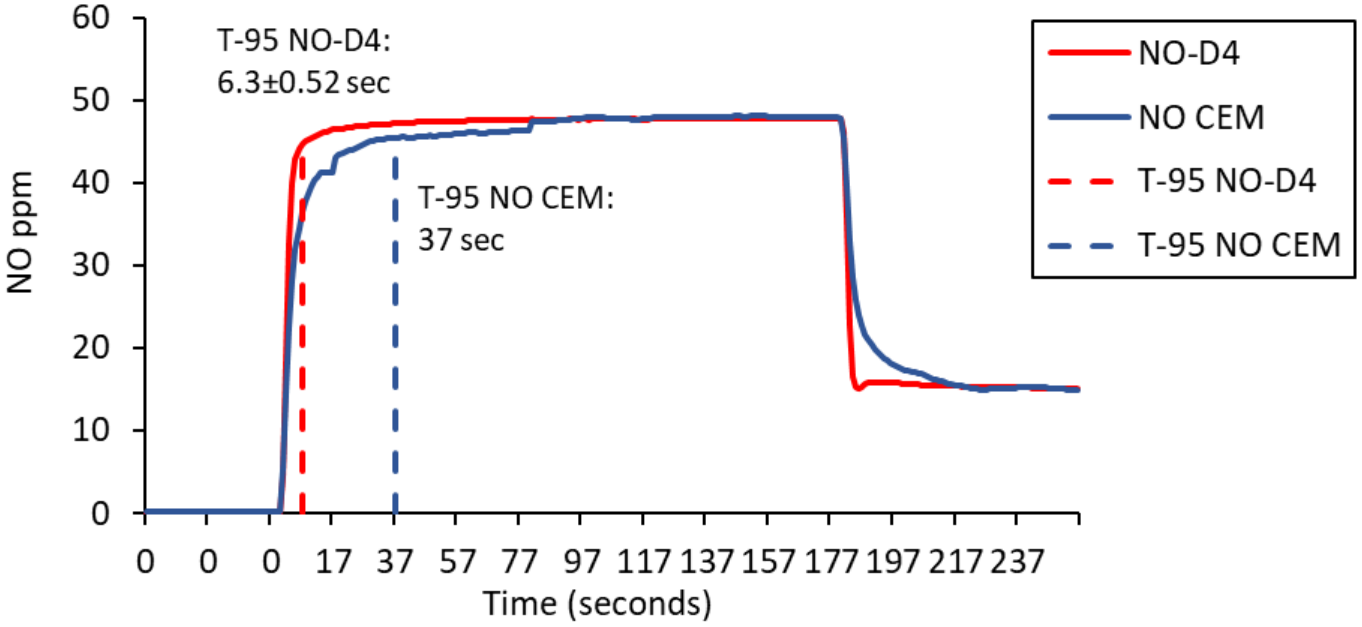


Sensor Requirements

- Fast response time
- Low noise level
- Low drift (8-12-hour period)
- Precision and Accuracy
- Low interference to CO and other gases

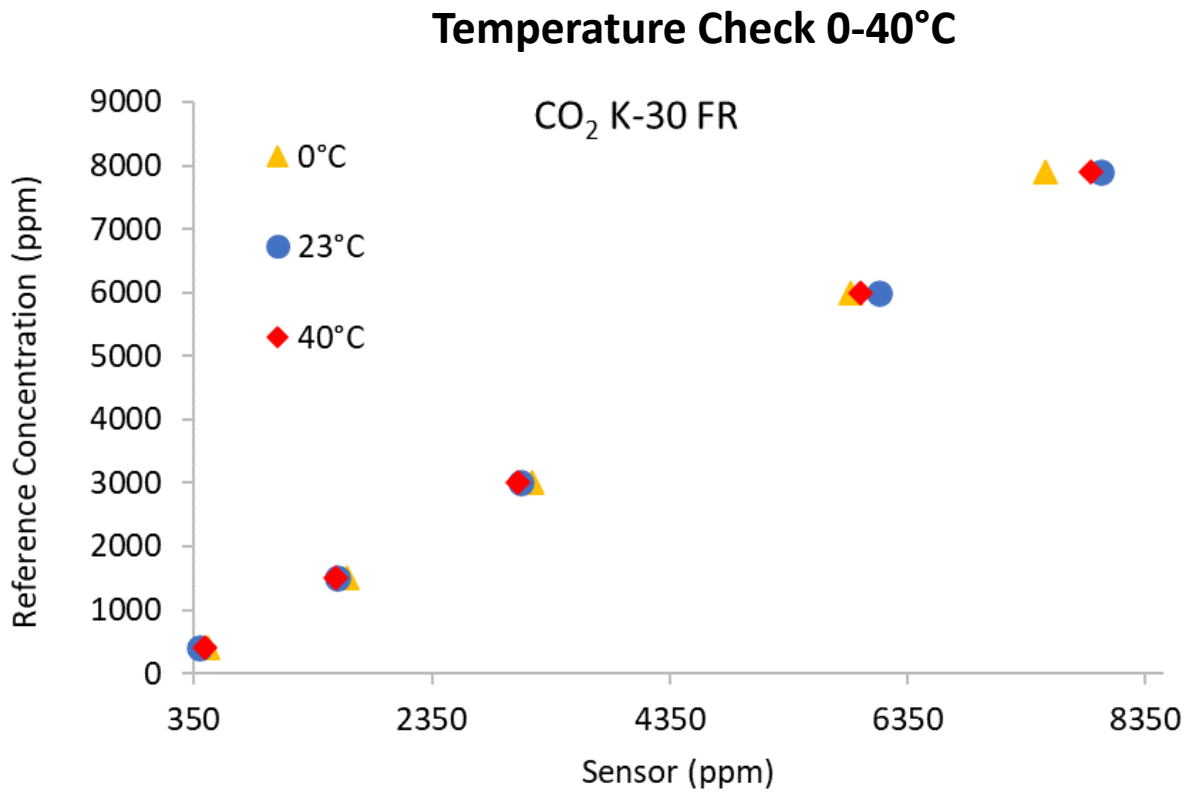
Sensor Testing (I)

- Response time (t_{95})
- Detection limit: lowest signal above zero
- Noise: short duration deviation of the sensor's signal
- Calibration curve: relation between sensor signal and true value
- Drift: concentration change with time
- Concentration accuracy and precision
- Reproducibility: multiple sensors



Sensor Testing (II)

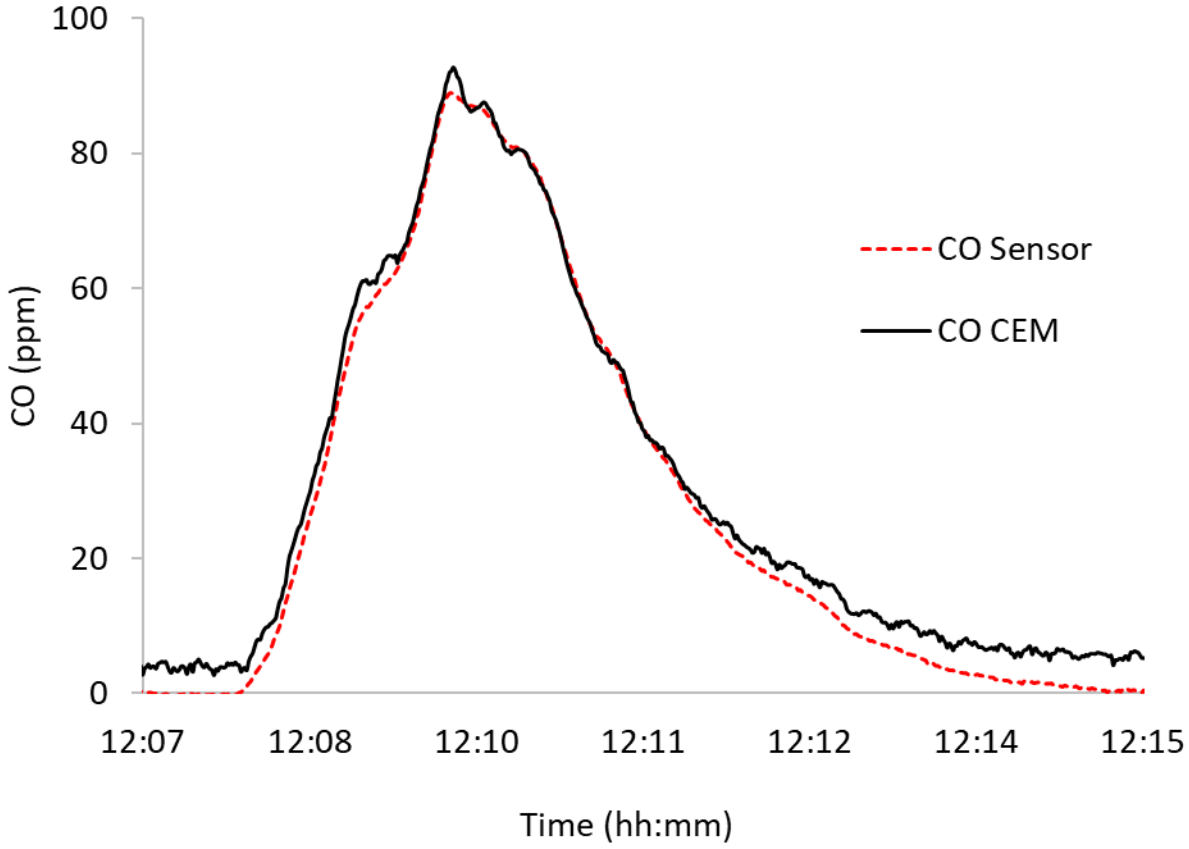
- Environmental conditions: temperature, humidity
- Interference: signal caused by substance other than measured



Sensor Testing (III)

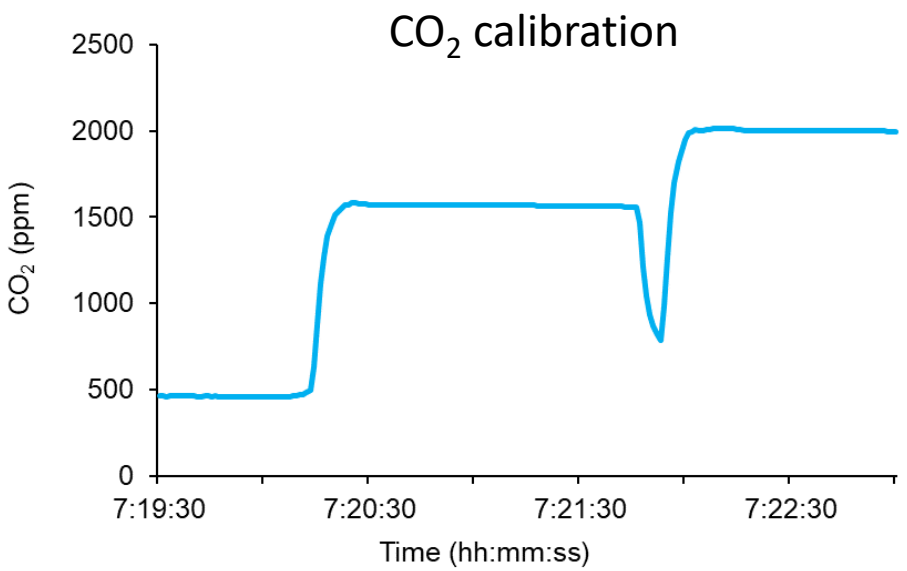
- Determine sensor performance against research-grade instrument during realistic field conditions

Laboratory test: CO sensor comparison



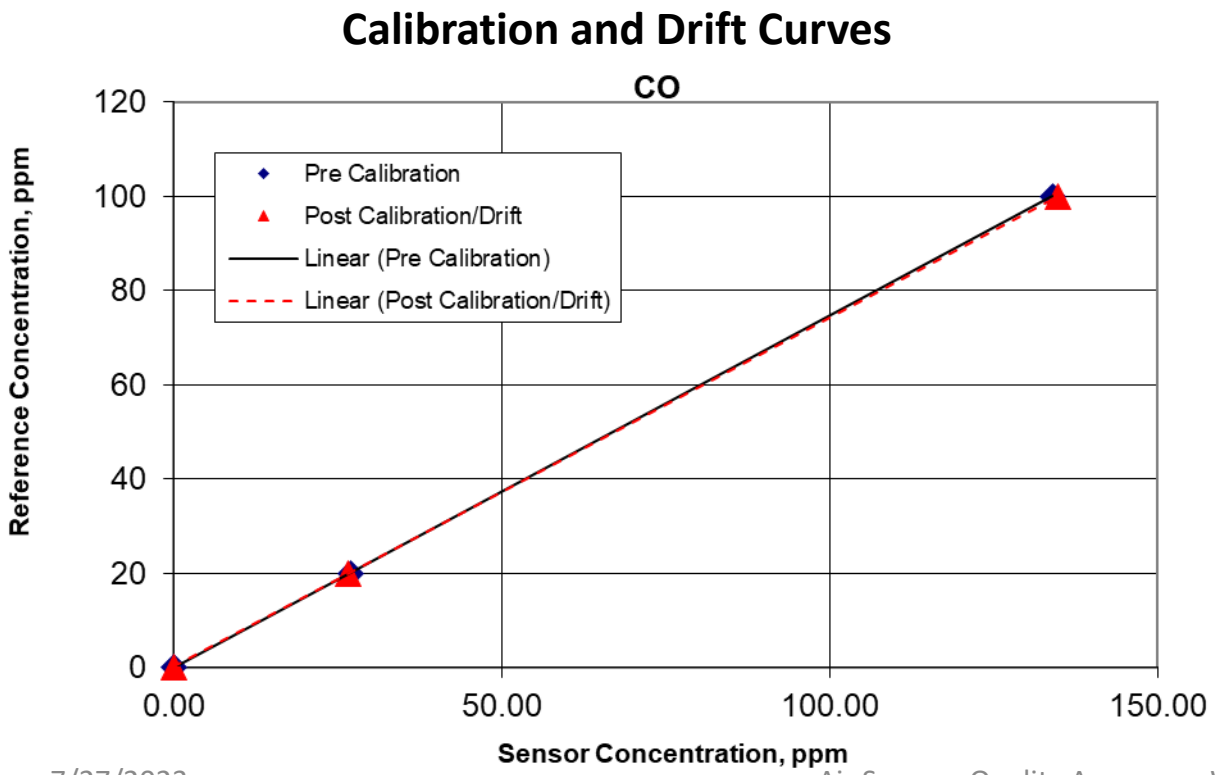
In-Field Calibration Measurements

- Reference gas: 3-point calibration
- Sensor stability: lack of variability in the sensor's signal
- Linearity check: change in sensor's signal with tested reference gas
- Calibration verification - midpoint check: reference gas vs calibration curve



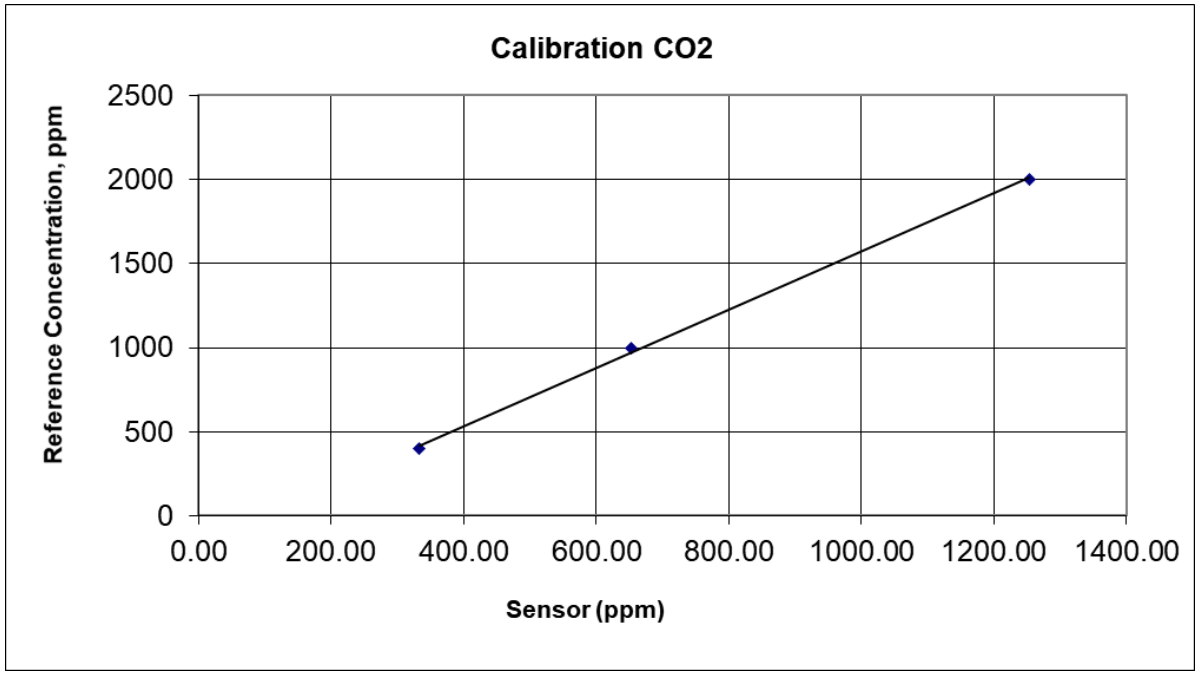
In-Field Drift Measurements

- Same day drift
- Repeat of the calibration procedure
- Drift: ≤ 5% of initial calibration value



Environmental Impacts

Pressure
High Altitude Calibration NDIR: cal gas 400 ppm = 330 ppm sensor
NDIR = Non-dispersive infrared



Literature

OTM-48

NOx Sampling using UAS

Sensor System

Emission Factors from Grassland

OTM = Other Test Method