Uncertainty Analysis and Optimization of Gas Filling Procedures for Reliable Carbon Dioxide Measurements

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Introduction

- NEON collects carbon dioxide measurements as part of the environmental data provided to the public
- Cylinders are created with given carbon dioxide concentrations to calibrate and validate the carbon dioxide sensors
- Uncertainty is inherent to this process
- Uncertainty needs to be understood to apply it to the calibration or validation





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Conclusions

CO2 Uncertainty (A	ll Uncertainties given in ppm)	Type of Assessment	n/Deg of Freedom	Uncertainty	•	Nos
Truth	Picarro Calibration	В	95	0.11		peri
Repeatability	Assay Repeatability	А	26	0.109		
Reproducibilty	Assay Reproducibility	Α	26	0.060	•	Con
Repeatability	Cylinder Repeatability	Α	800	0.209973		mag
Combined	Calibration Combined Uncertainty	eff	101	0.17		
Expanded	Calibration Expanded Uncertainty	k	1.98	0.33	•	Zero
δ Uncertainty (Al	l Uncertainties given in ‰)	Type of Assessment	n/Deg of Freedom	Uncertainty		delt
<mark>δ Uncertainty (Al</mark> Truth	I Uncertainties given in ‰) Picarro Calibration	Type of Assessment B	n/Deg of Freedom 23	Uncertainty 0.15	•	delt Tim
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Veek parison	Morning Ambient	Morning Zero Air	Morning CO2 spike	Afternoon Ambient	Afternoon CO2 spike	Afternoon Zero Air		using Student T
and 2								
and 3								distribution
and 4							•	Comparing each
and 5								week to the
and 6								others
and 3								
and 4							•	Shift cylinder
and 5								positions in
and 6								fixture after week
and 4								Δ
and 5								
and 6							•	No statistical
and 5								difference
and 6								between any of
and 6	Net							the weeks
gend:	Different	Different						
Delta - S	Student T S	Statistic Co	omparing 2	Means (95%	o Confidence)	•	Hypothesis test
Delta - S Veek Iparison	Student T S Morning Ambient	Statistic Co Morning Zero Air	omparing 2 Morning CO2 spike	Means (95% Afternoon Ambient	Afternoon CO2 spike) Afternoon Zero Air	•	Hypothesis test using Student T
Delta - S Veek iparison and 2	Student T S Morning Ambient	Statistic Co Morning Zero Air	omparing 2 Morning CO2 spike	Means (95% Afternoon Ambient	Afternoon CO2 spike) Afternoon Zero Air	•	Hypothesis test using Student T distribution
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- ignificant drift occurring within a 6 week
- bined uncertainties small relative to nitude of data being collected
- Air spiking does not appear to affect the value, only CO₂ spiking
- of day for filling does not seem to affect the ount of drift occurring in the cylinders
- tinued sampling will monitor for drift over and depletion of cylinders.

