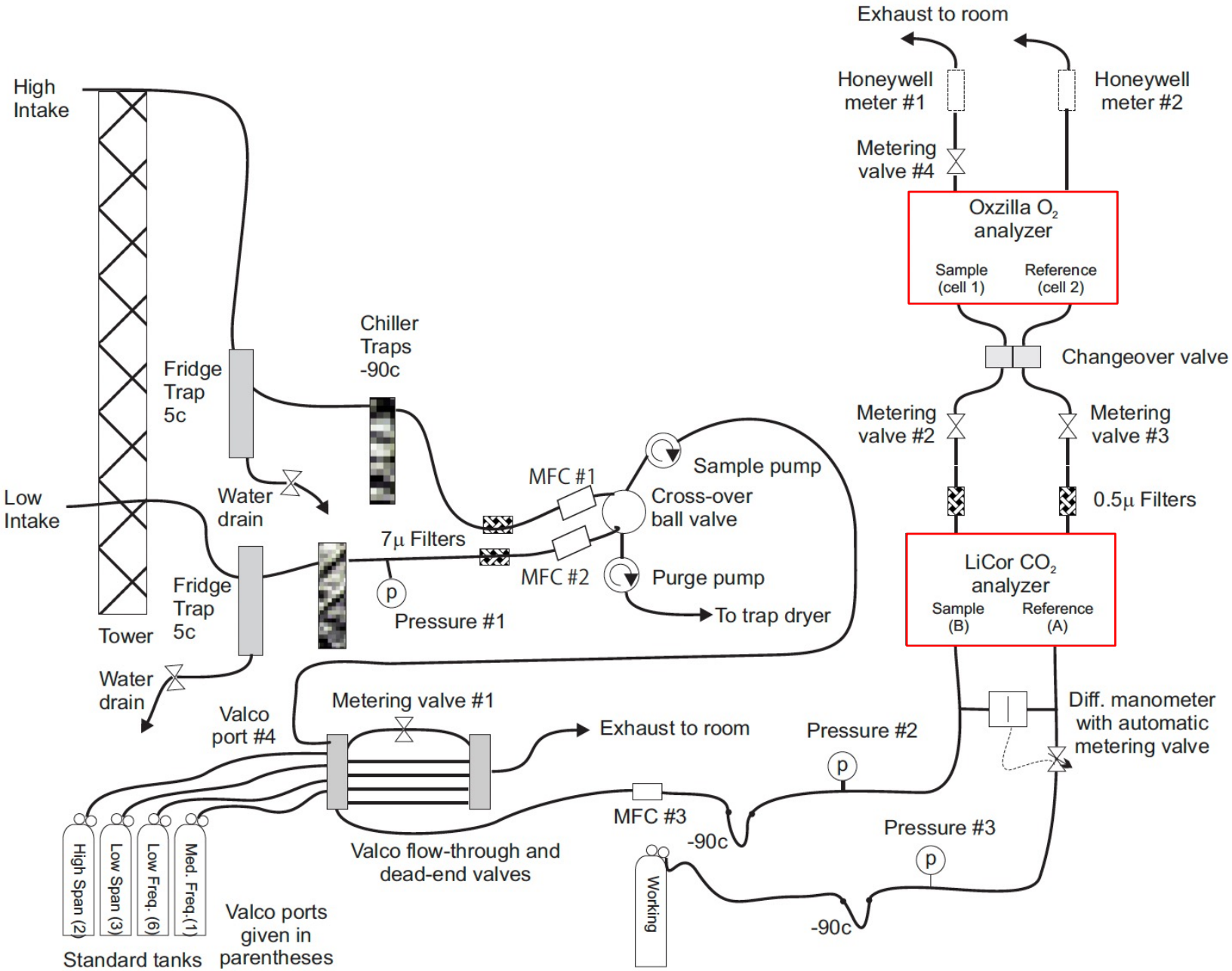
Bowdoin

Improving the Precision of the Bowdoin/Harvard Forest Dataset *ex post facto*

Eden Salzig and Mark Battle

WAO4

Harvard Forest
&
“The Shack”


Exhaust to room
Honeywell meter #1
Honeywell meter #2
Metering valve #4
Oxzilla O_2 analyzer
Sample (cell 1)
Reference (cell 2)
Changeover valve
Metering valve #2
Metering valve #3
0.5μ Filters
LiCor CO_2 analyzer
Sample (B)
Reference (A)
Diff. manometer with automatic metering valve
High Intake
Low Intake
Tower
Fridge Trap 5c
Water drain
Chiller Traps -90c
MFC #1
MFC #2
7μ Filters
Sample pump
Cross-over ball valve
Purge pump
To trap dryer
Pressure #1
Fridge Trap 5c
Water drain
Valco port #4
Metering valve #1
Exhaust to room
Pressure #2
MFC #3
-90c
Pressure #3
Valco flow-through and dead-end valves
Working
-90c
High Span (2)
Low Span (3)
Low Freq. (6)
Med. Freq.(1)
Standard tanks
Valco ports given in parentheses

Why revisit published data and compare it to recent data?

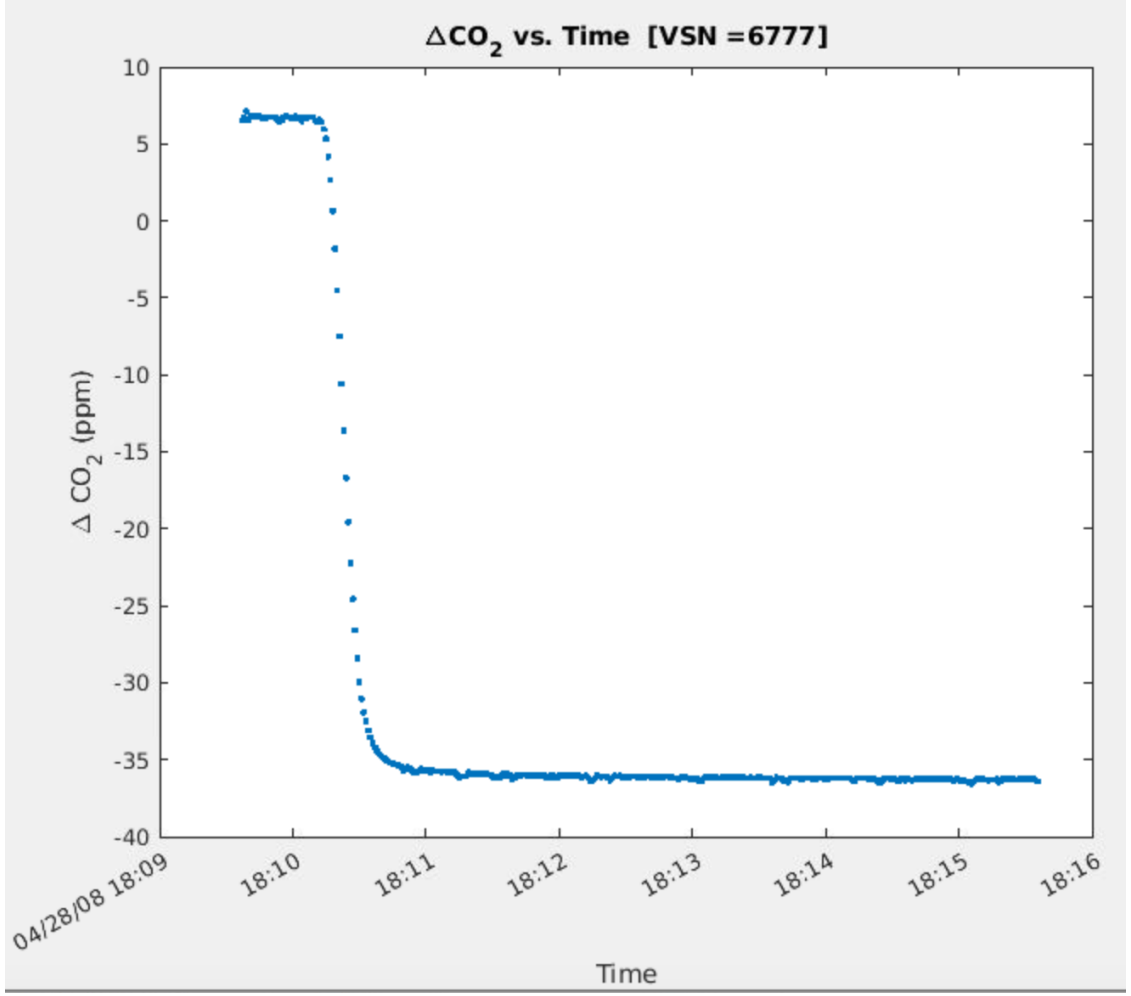
Investigate anomalies

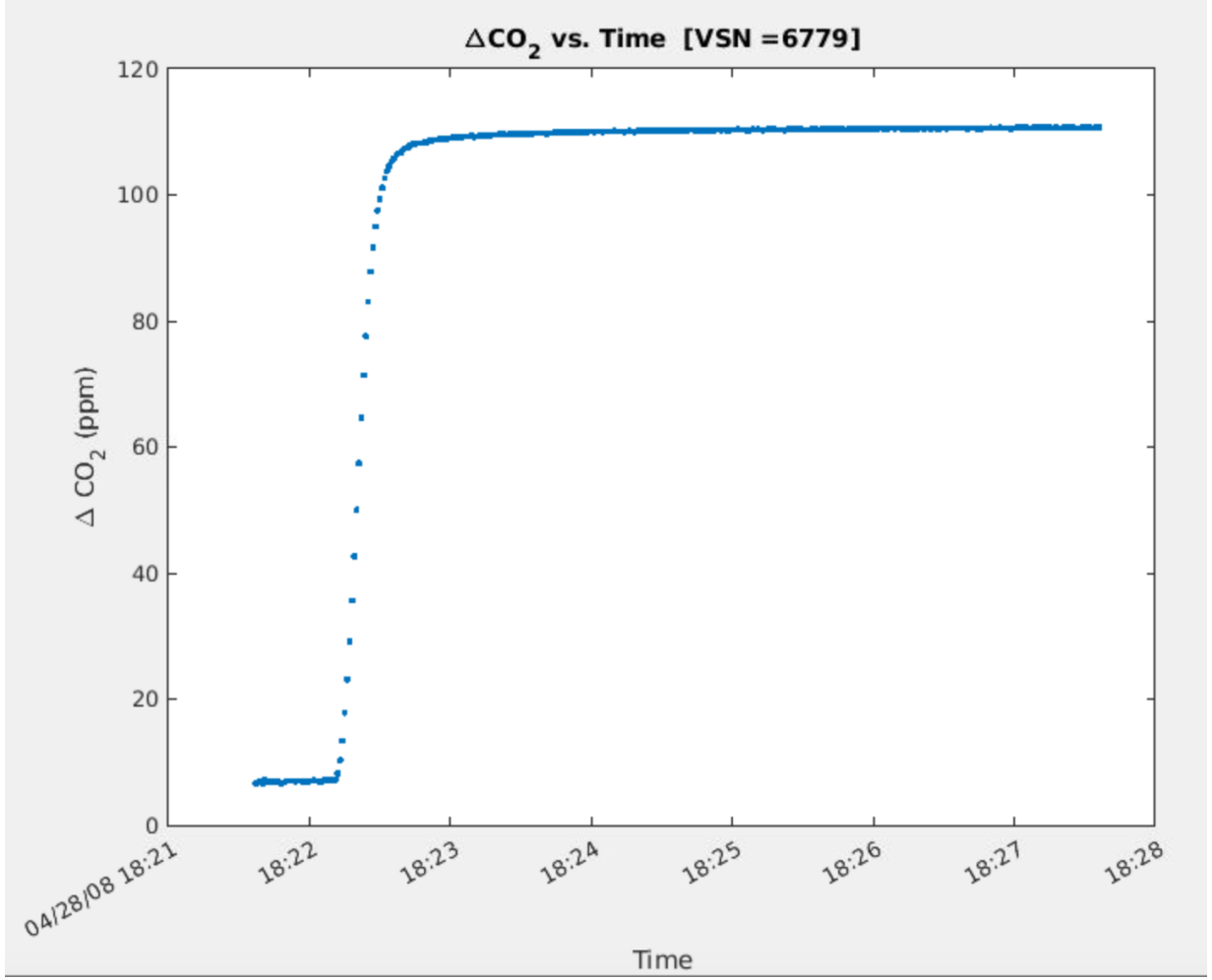
Refine data quality

Improve protocols going forward

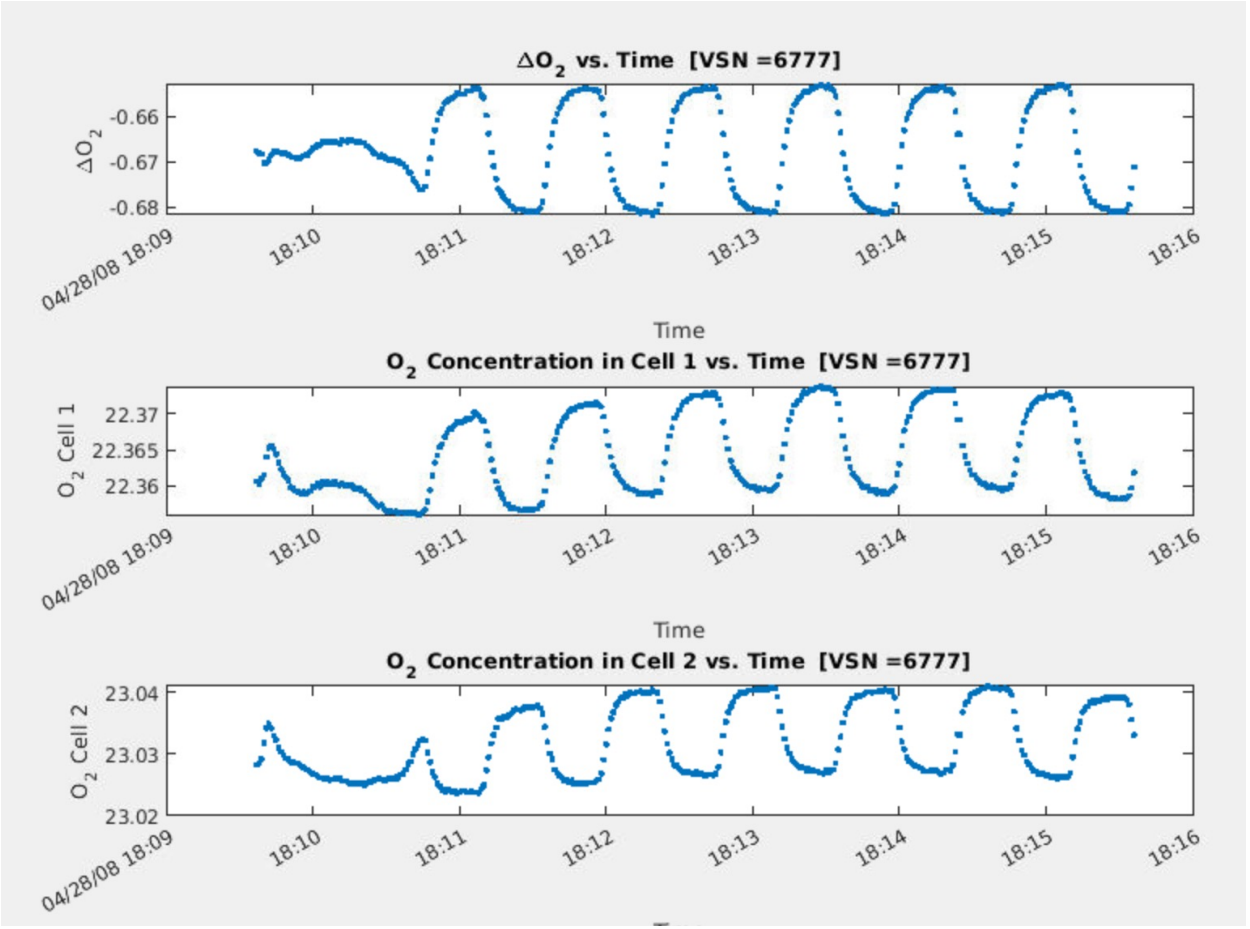
Why are calibration runs important?

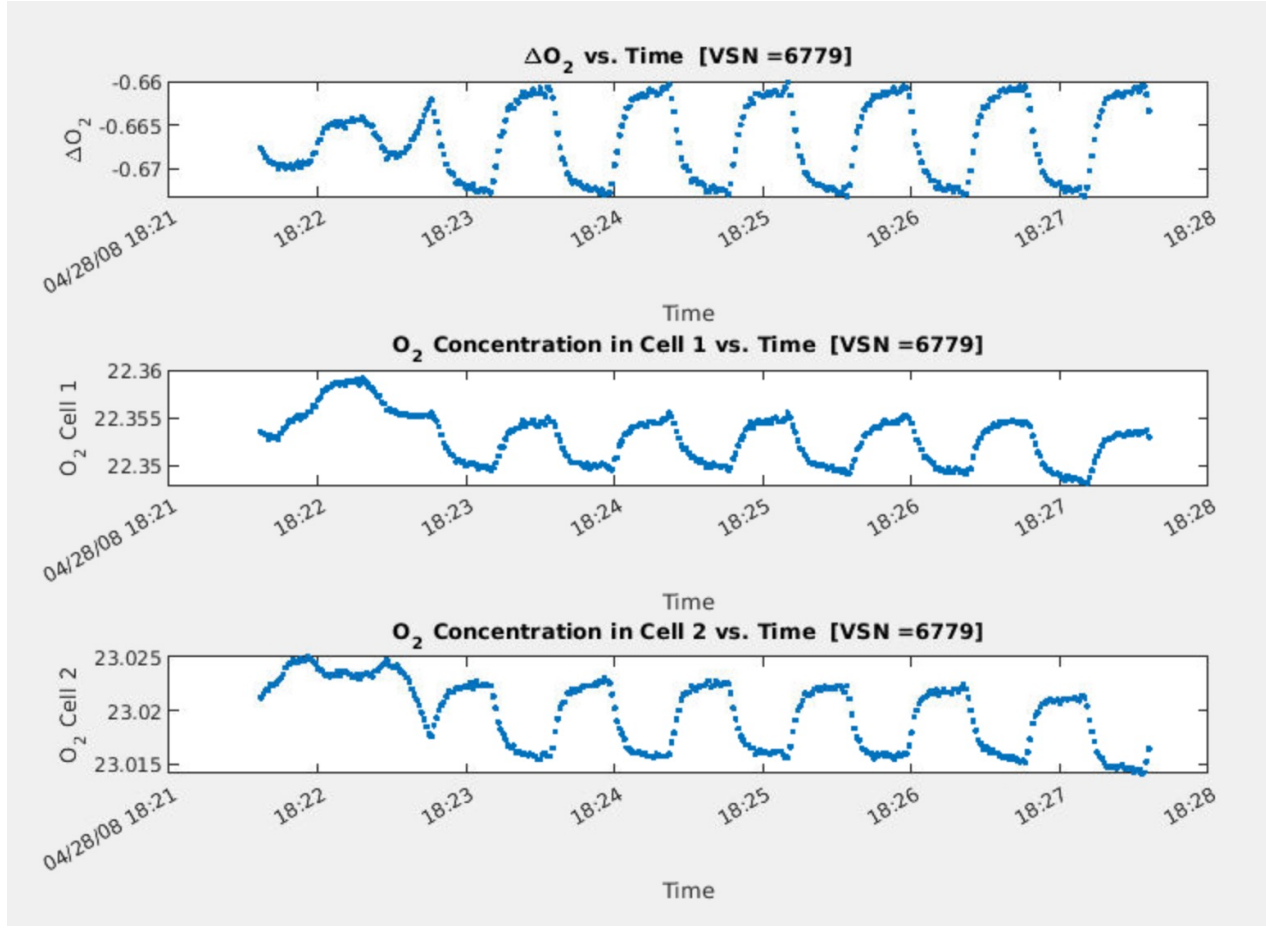
Normal Calibration Runs: CO2



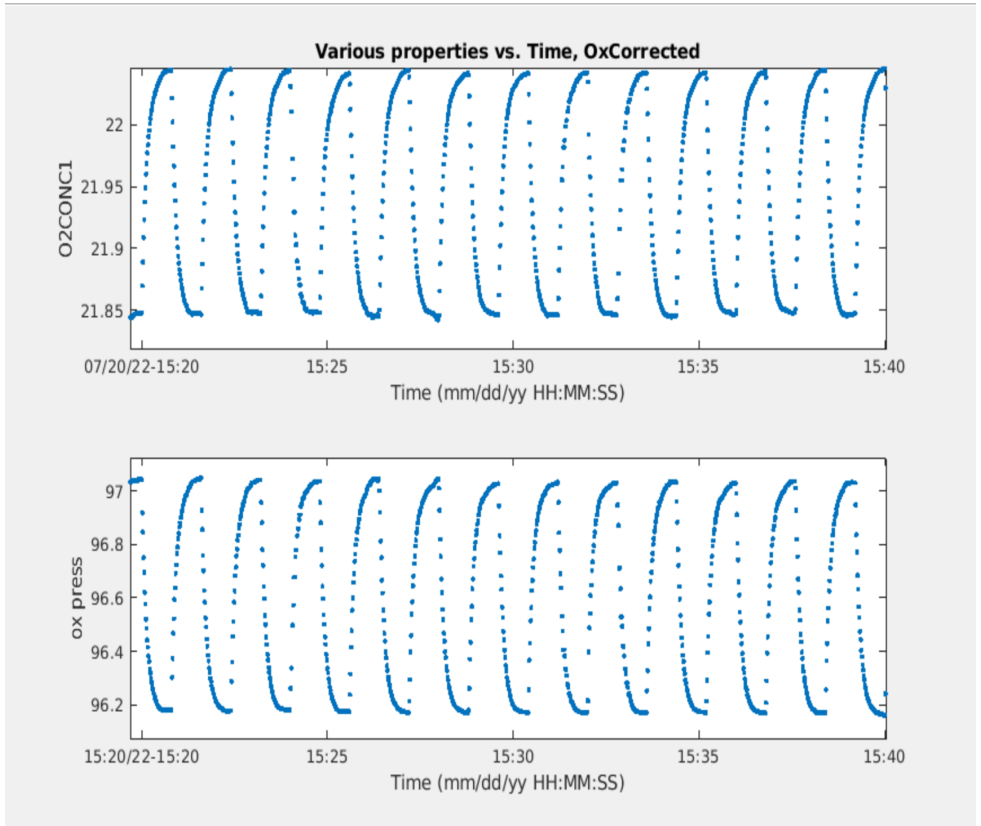


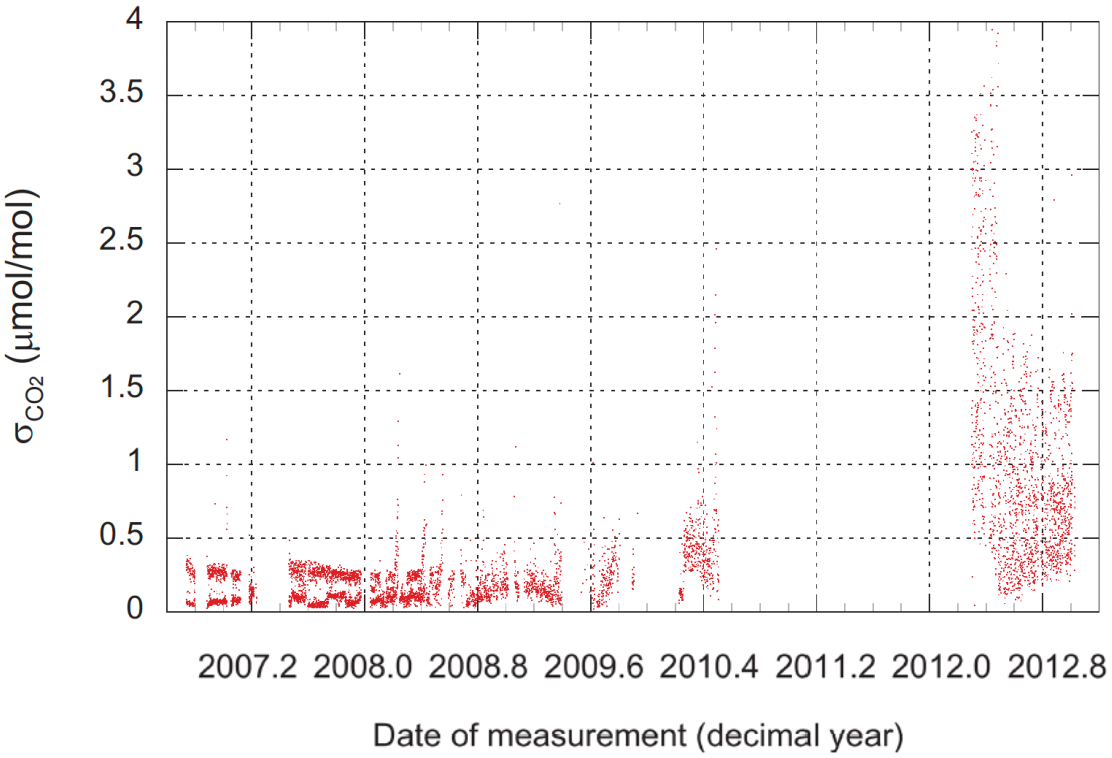
Normal Calibration Run: O2





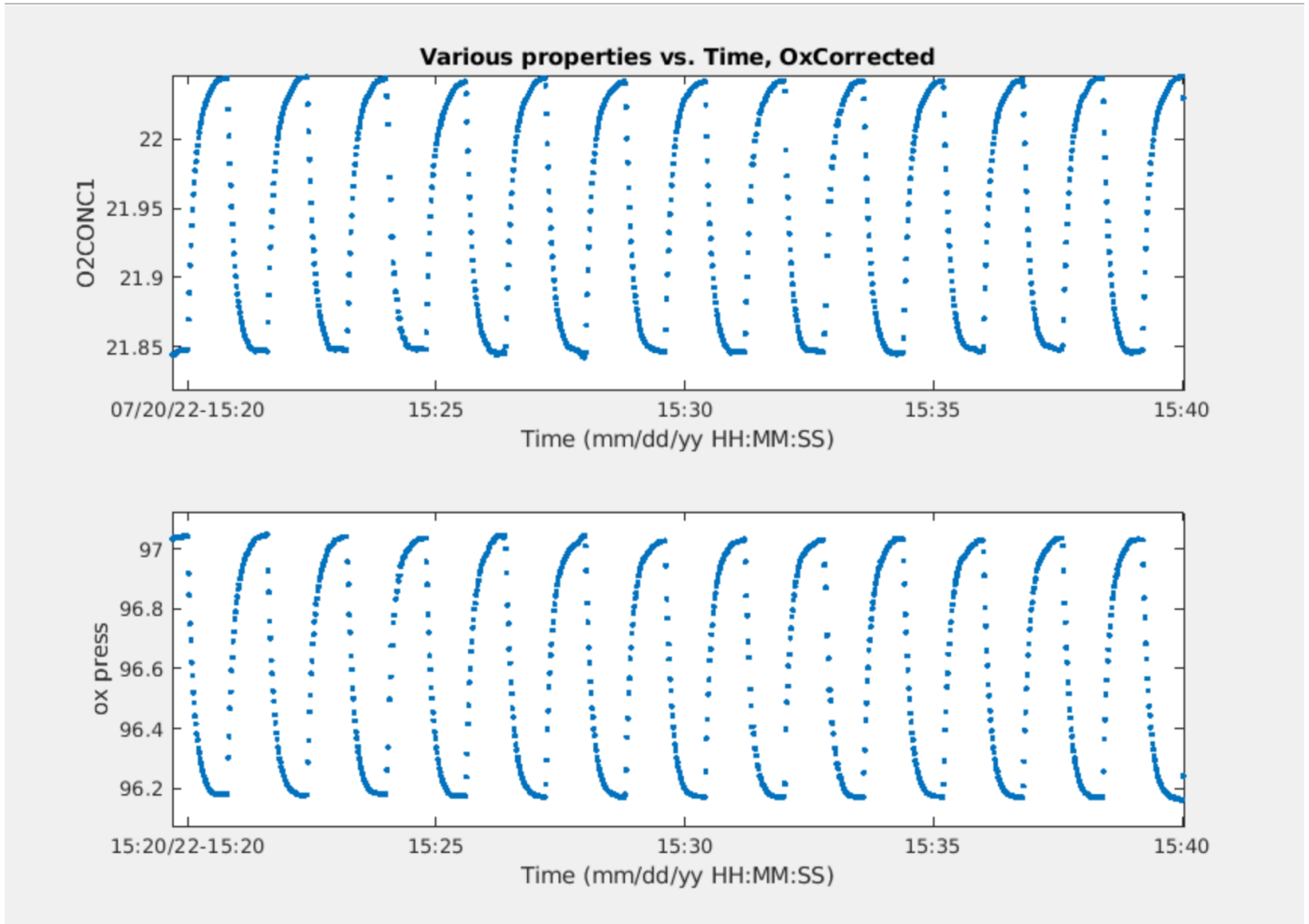
Investigating Anomalies

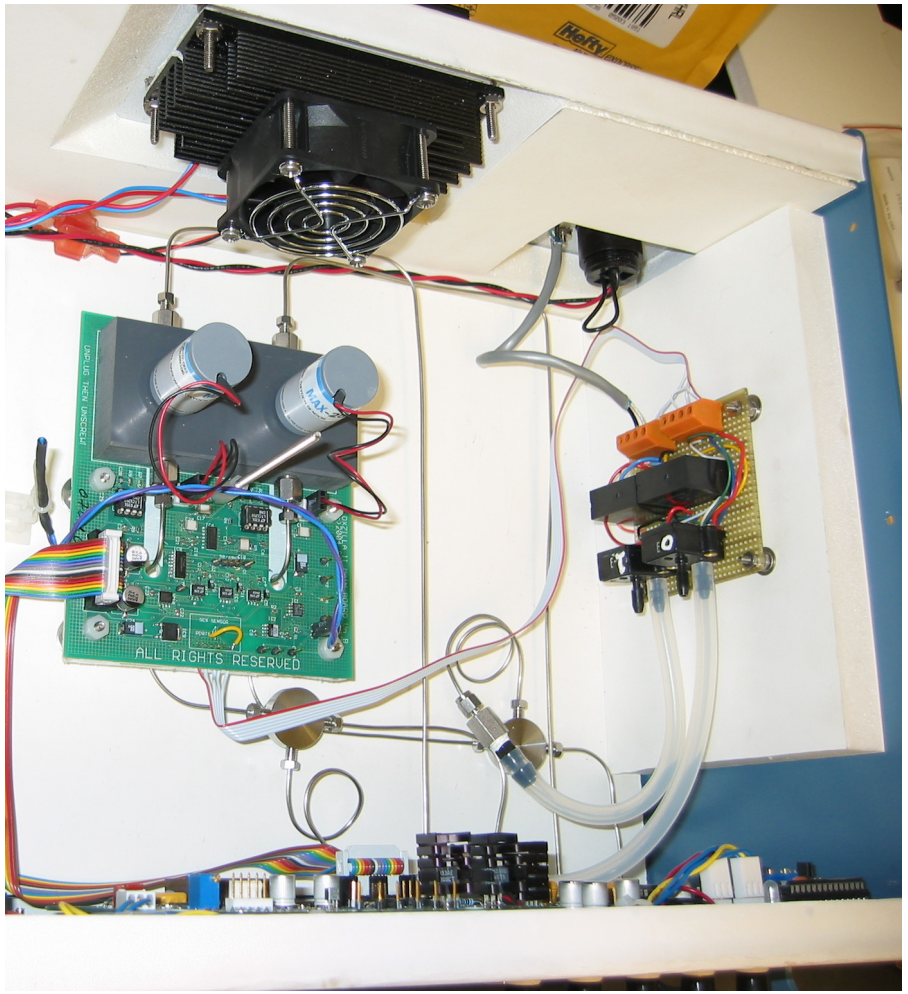




Battle et al., 2019

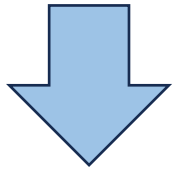
Frequency Issues





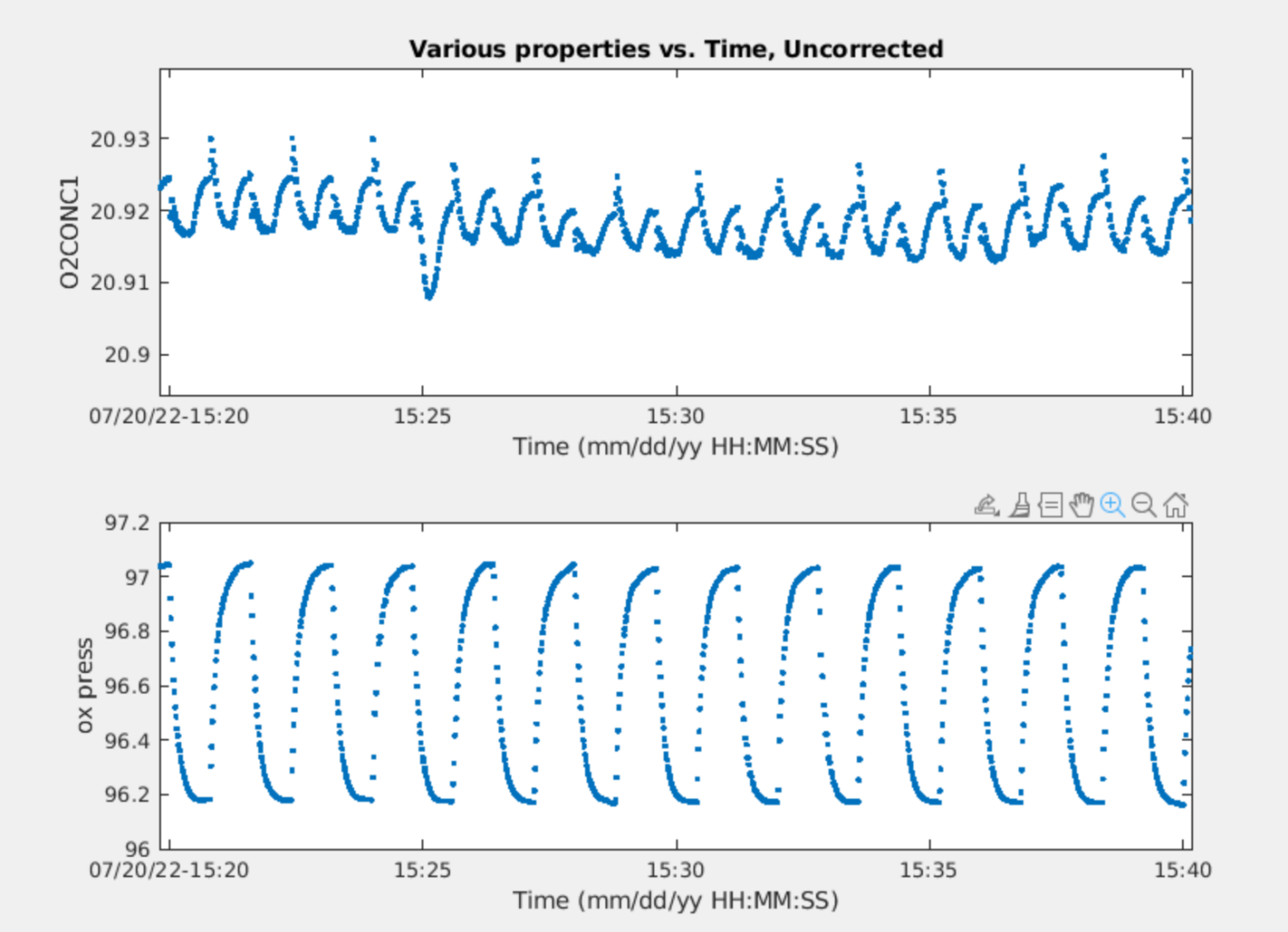
Oxzilla Pressure Compensation

$$O_{2\ compensated} = (1013\ hPa / P_{read}) * O_{2\ measured}$$

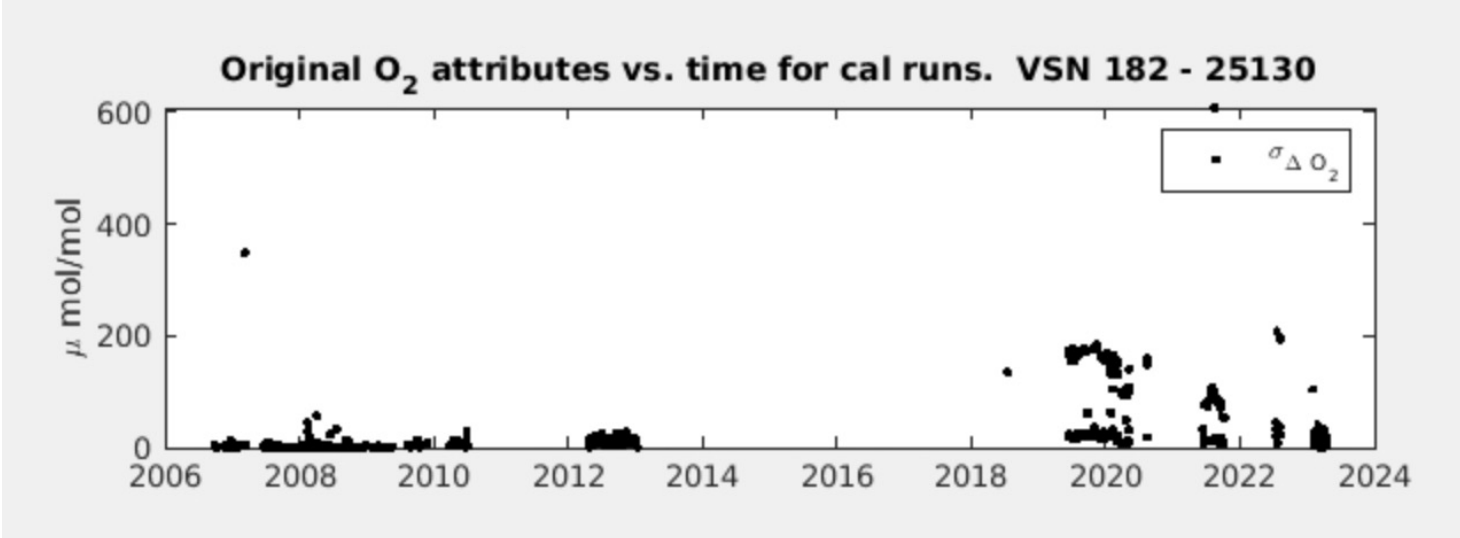


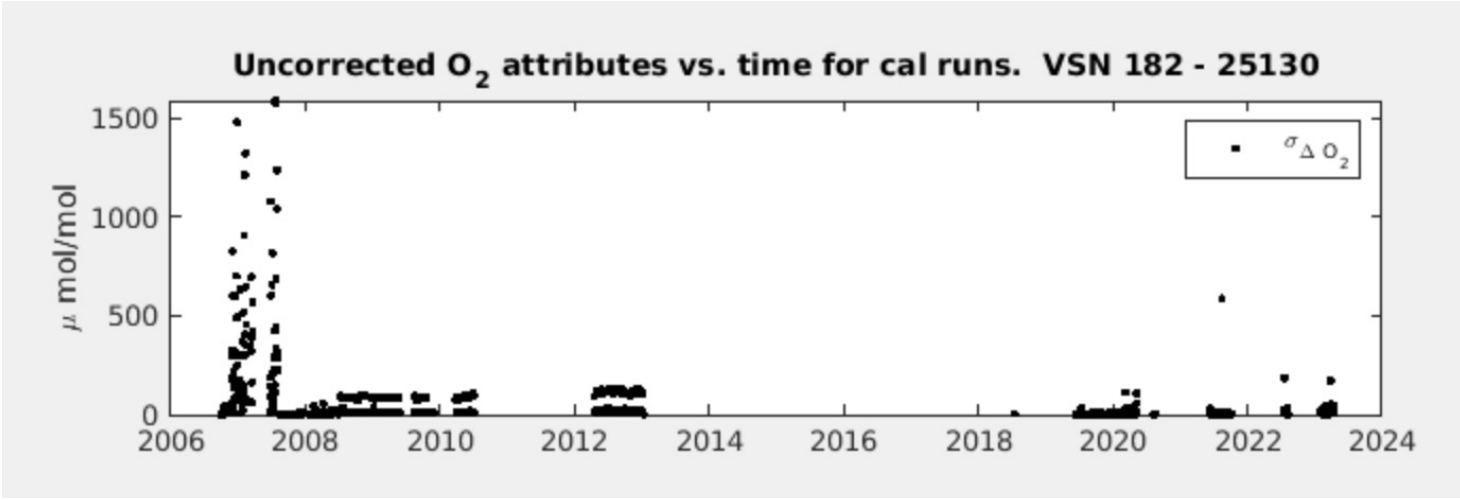
$$O_{2\ measured} = (P_{read} / 1013\ hPa) * O_{2\ compensated}$$

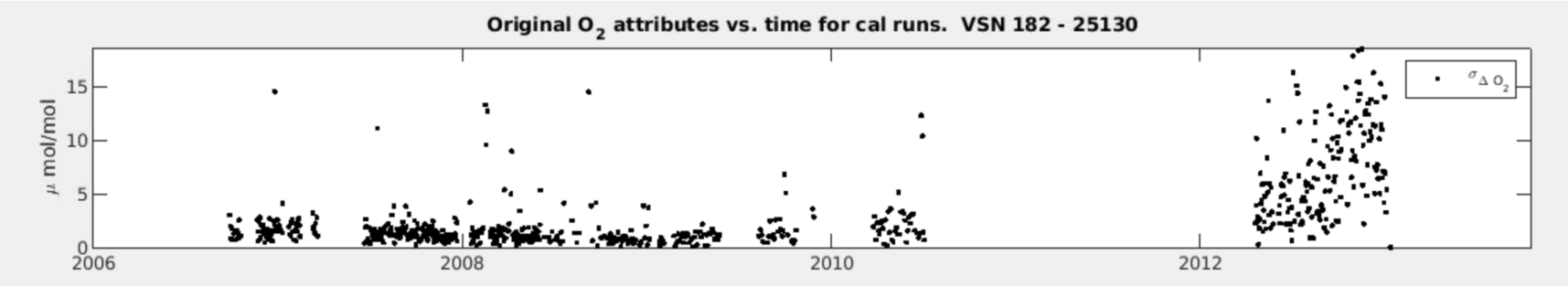
Pressure Un-compensation

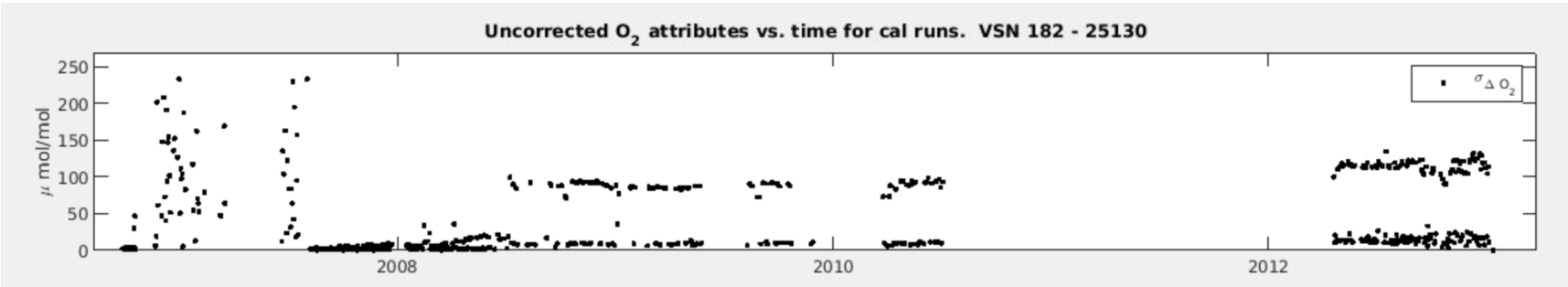


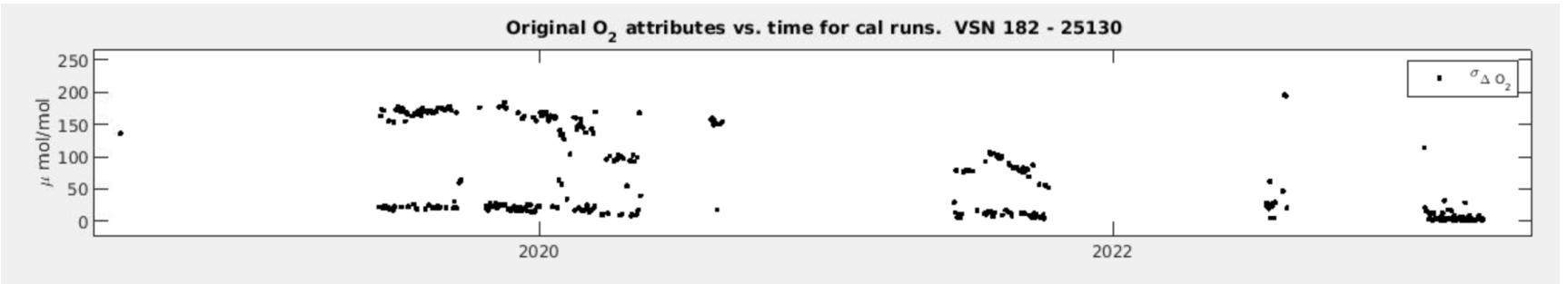
When should we undo compensations?

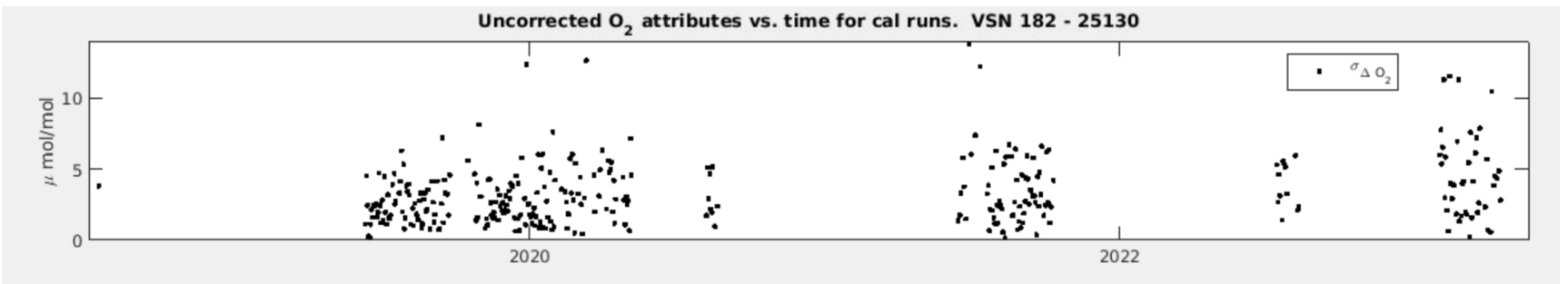




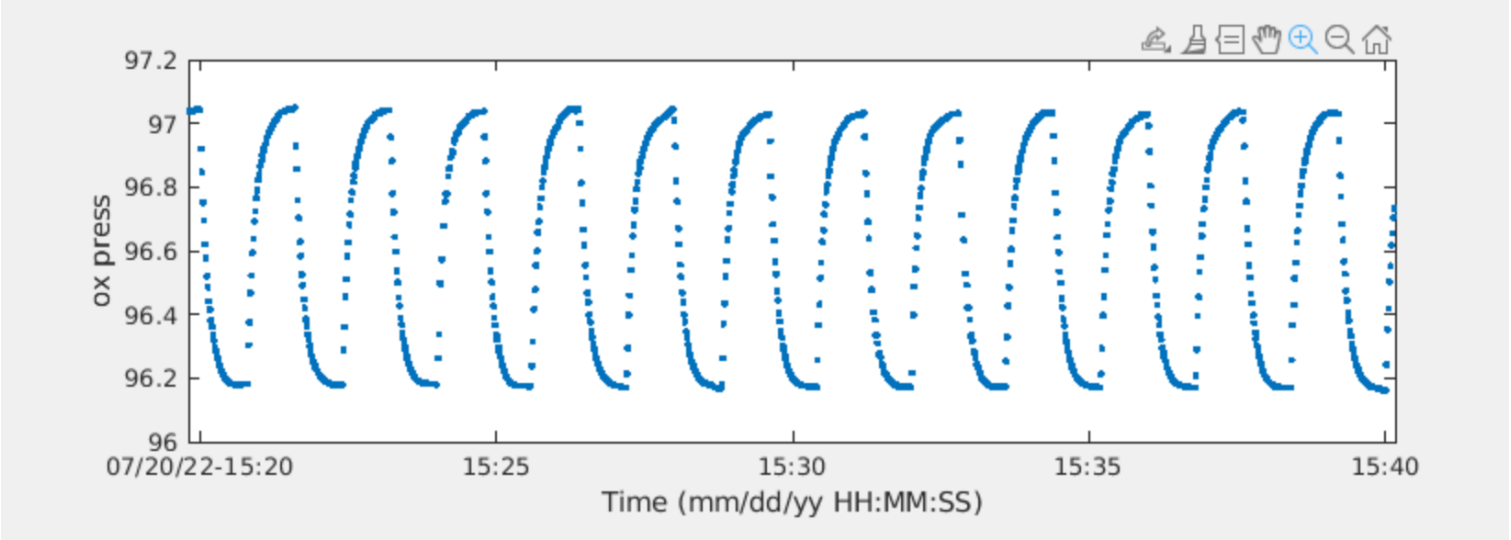

Original O_2 attributes vs. time for cal runs. VSN 182 - 25130
μ mol/mol
0
5
10
15
2006
2008
2010
2012
$\sigma_{\Delta O_2}$

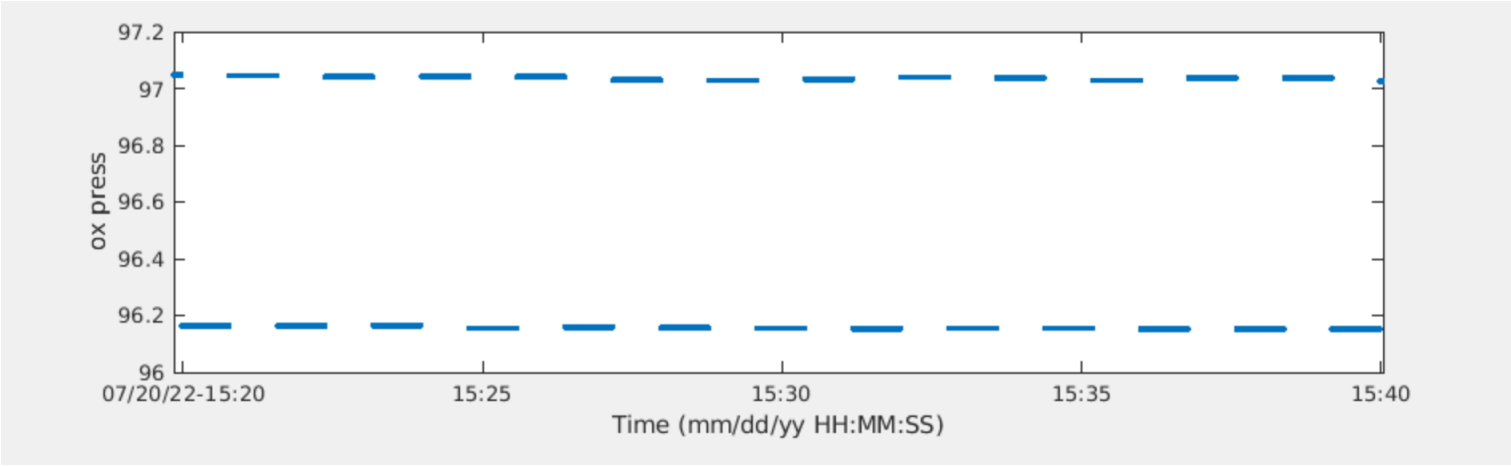

Uncorrected O_2 attributes vs. time for cal runs. VSN 182 - 25130
μ mol/mol
0
50
100
150
200
250
2008
2010
2012
$\sigma_{\Delta O_2}$

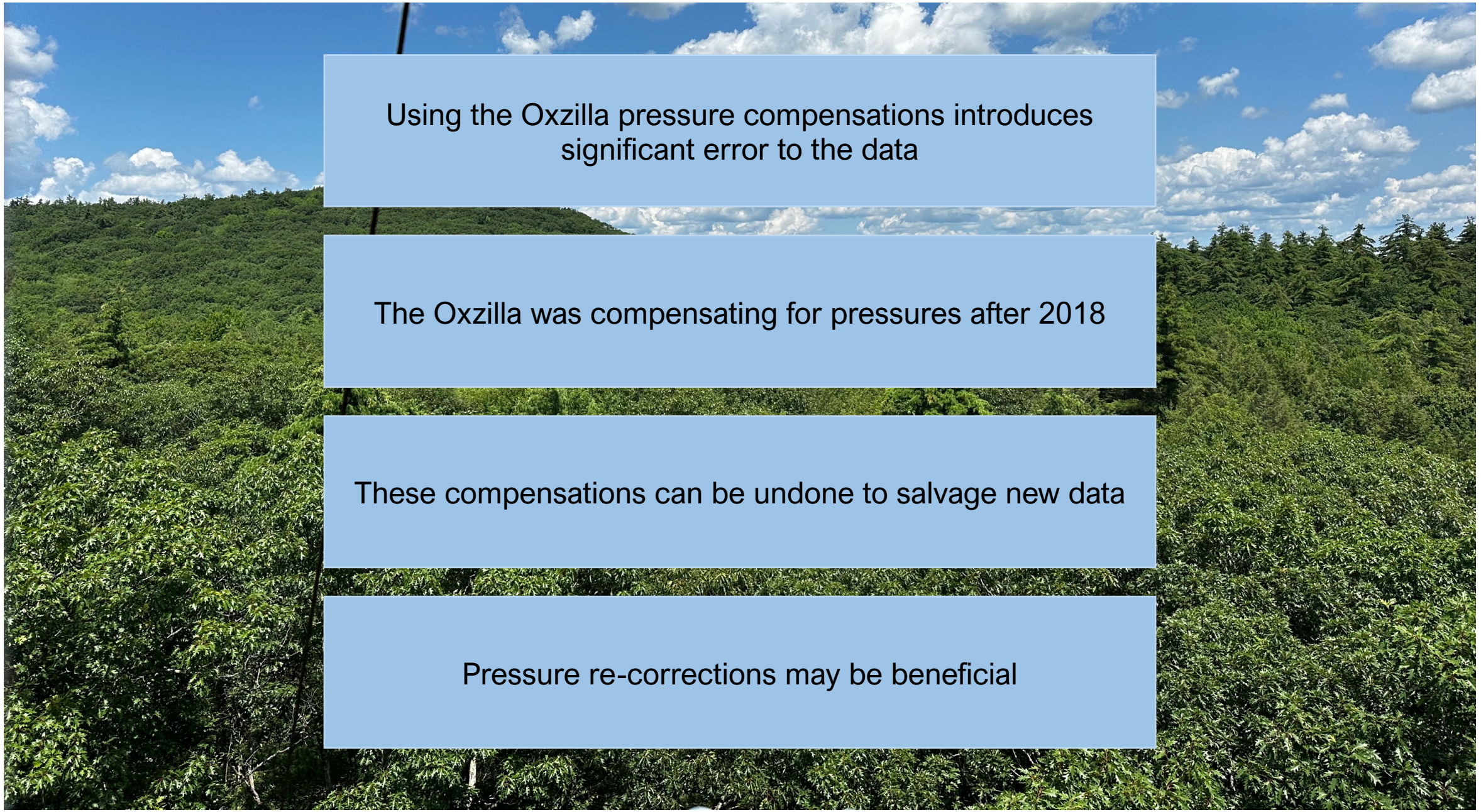

Original O_2 attributes vs. time for cal runs. VSN 182 - 25130
μ mol/mol
0
50
100
150
200
250
2020
2022
$\sigma_{\Delta O_2}$


Uncorrected O_2 attributes vs. time for cal runs. VSN 182 - 25130
μ mol/mol
0
5
10
2020
2022
$\sigma_{\Delta O_2}$

Pressure Corrections







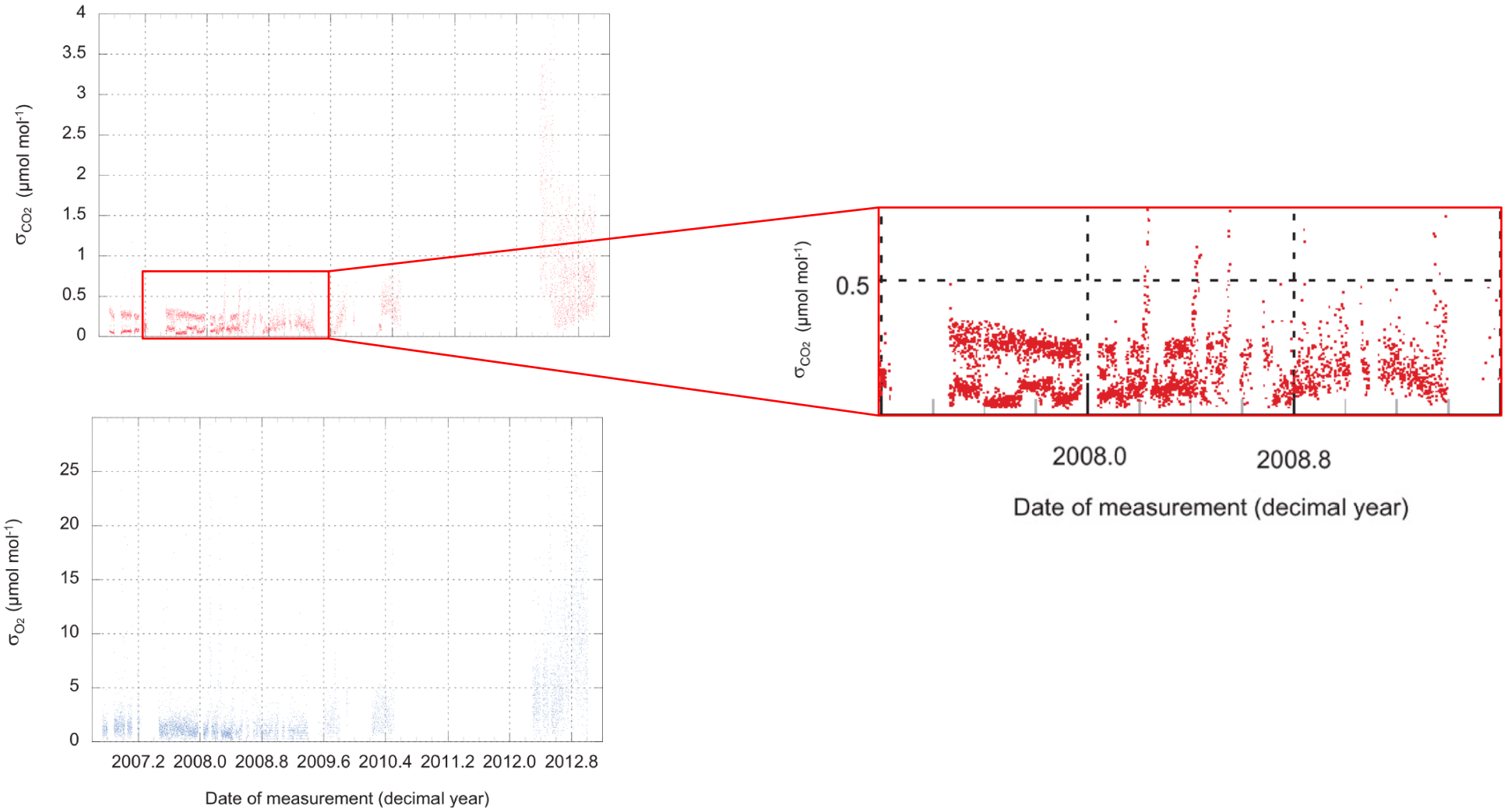
Using the Oxzilla pressure compensations introduces significant error to the data

The Oxzilla was compensating for pressures after 2018

These compensations can be undone to salvage new data

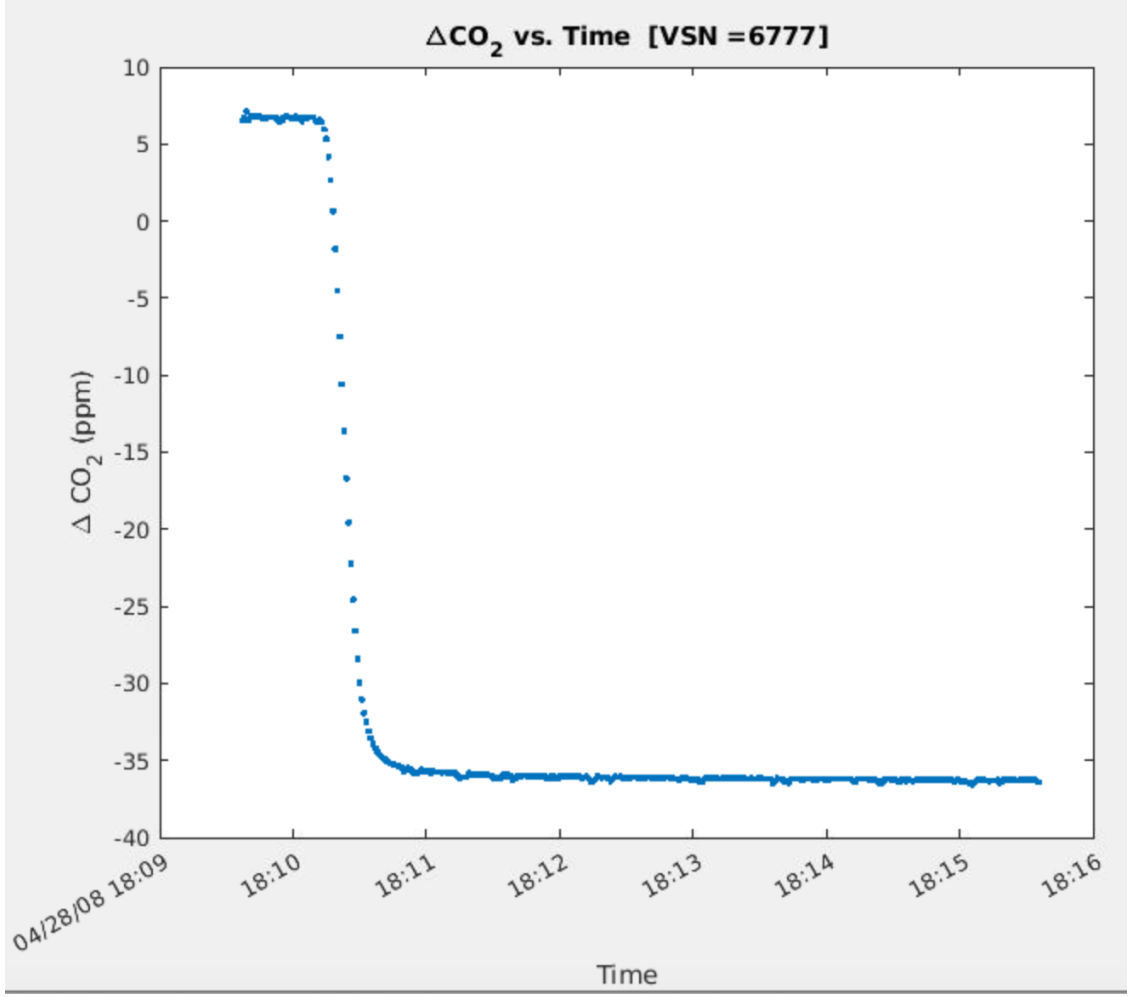
Pressure re-corrections may be beneficial

A Tale of Two Populations

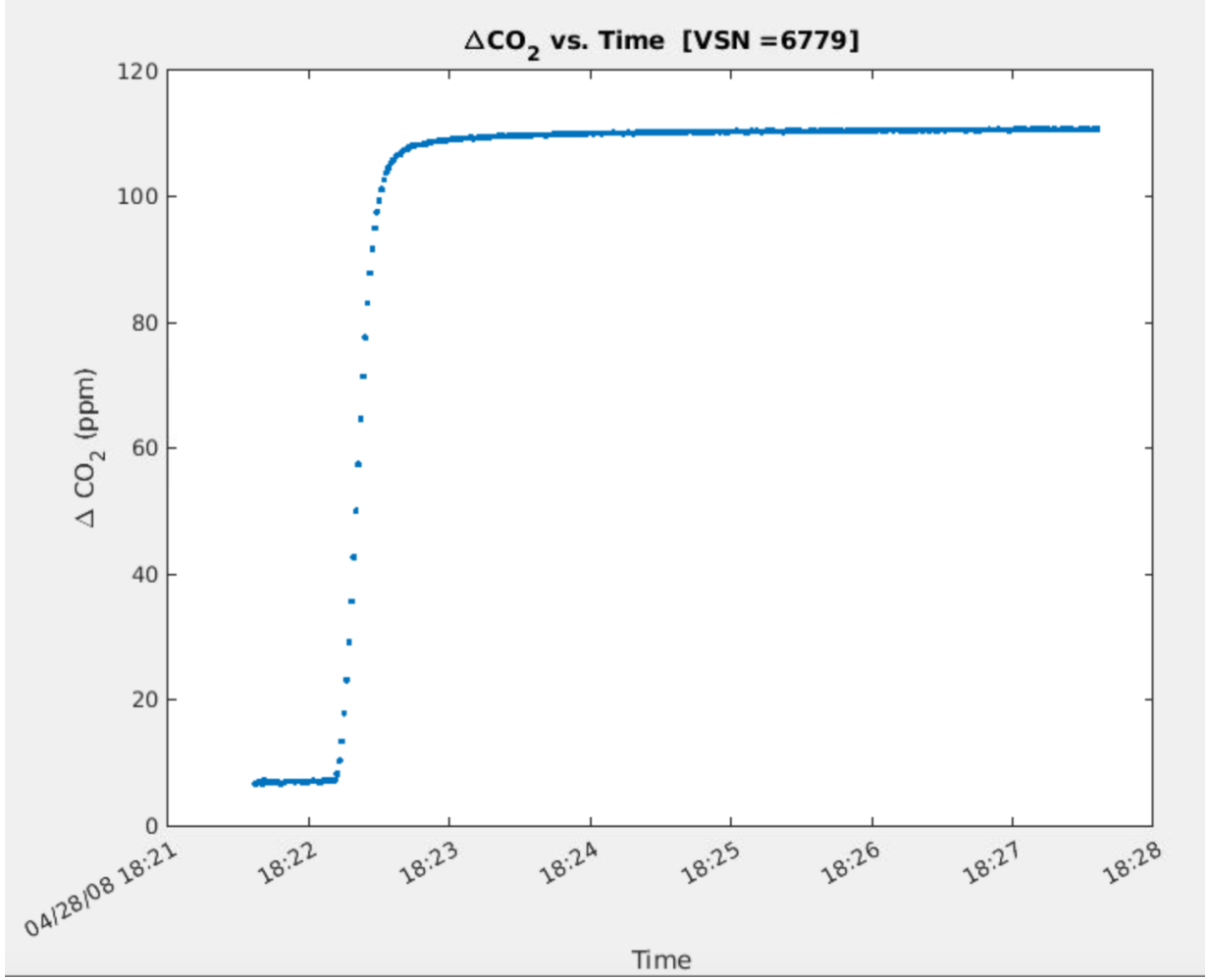


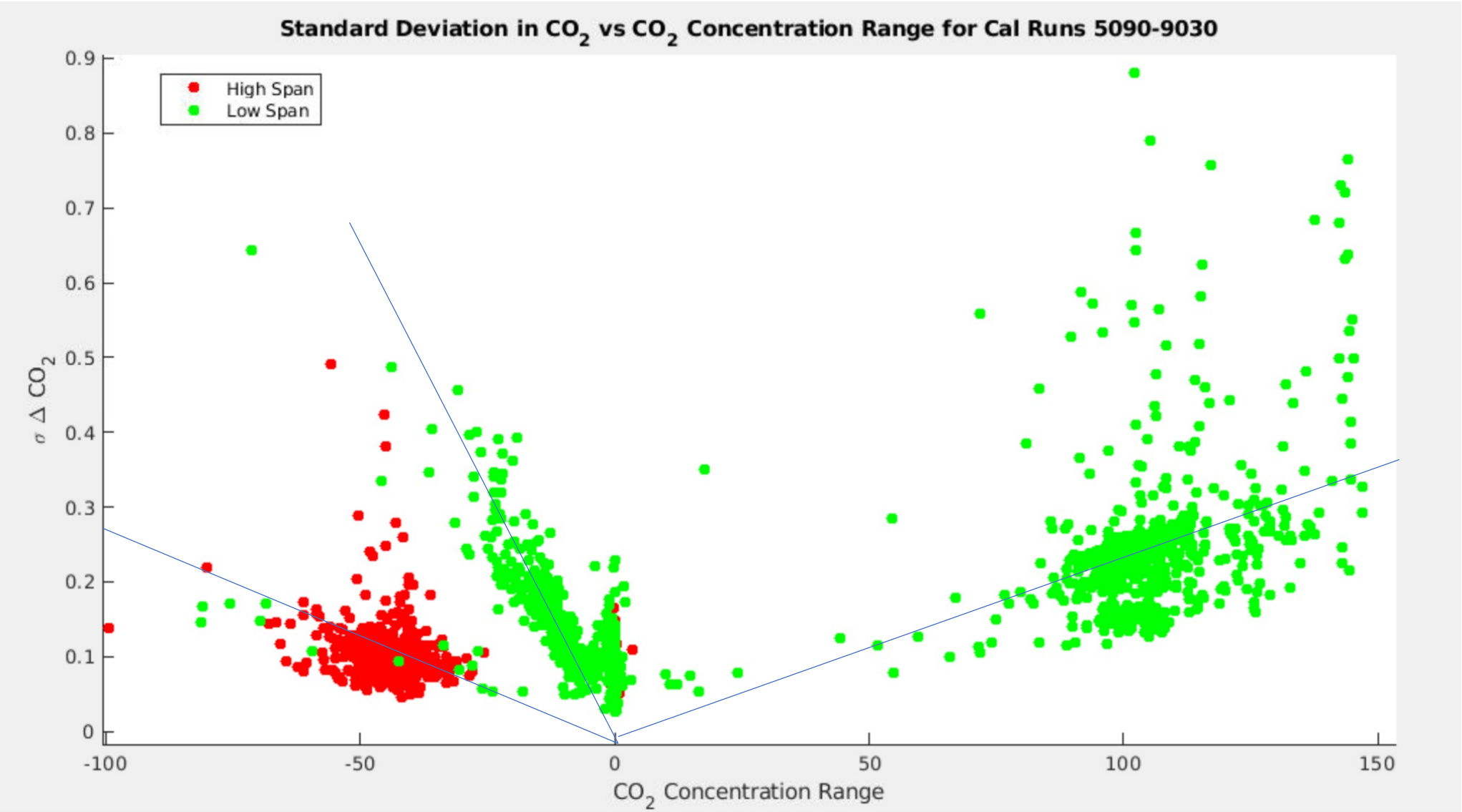
Battle et al., 2019

High Span: ~50 ppm change

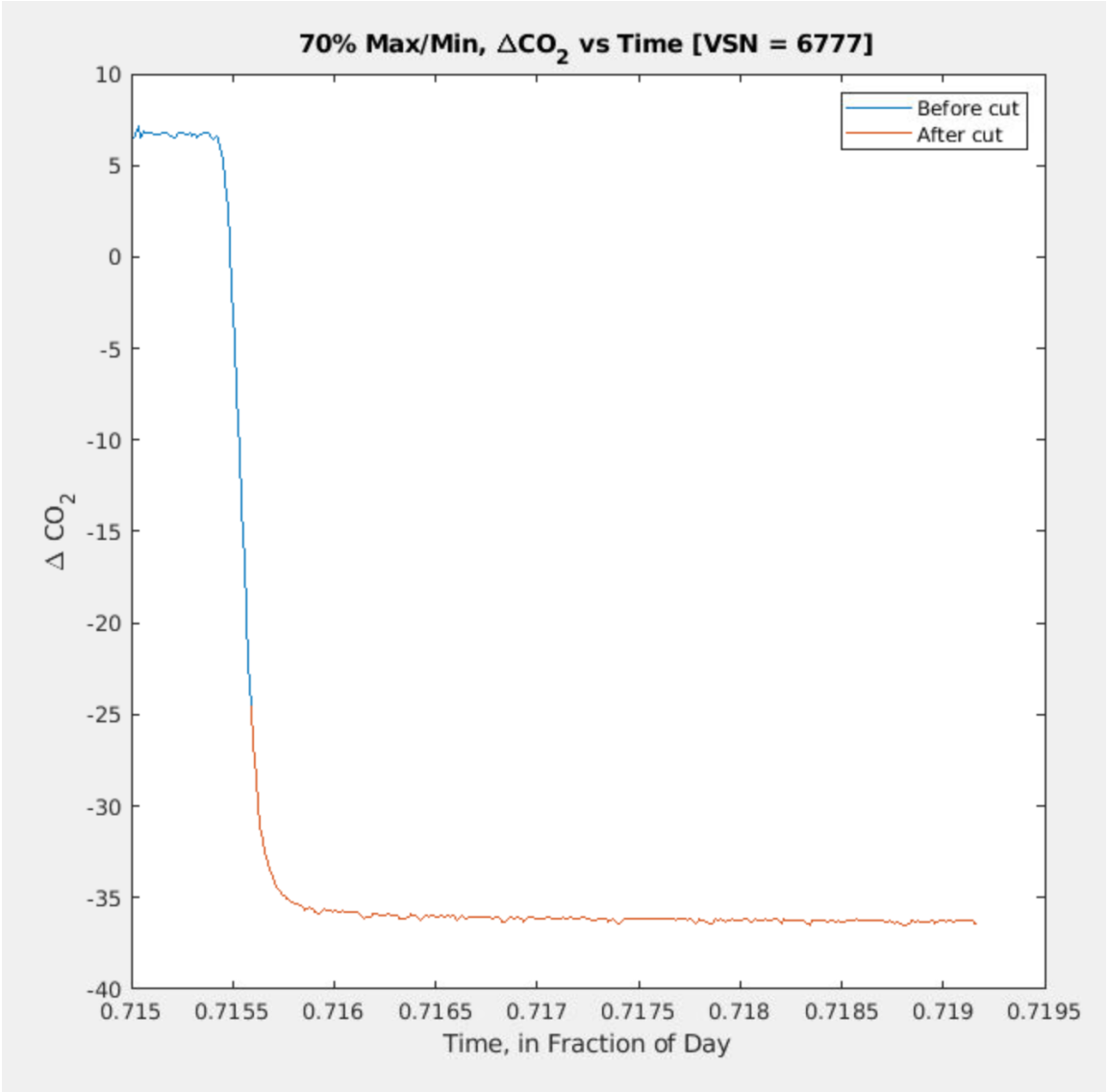


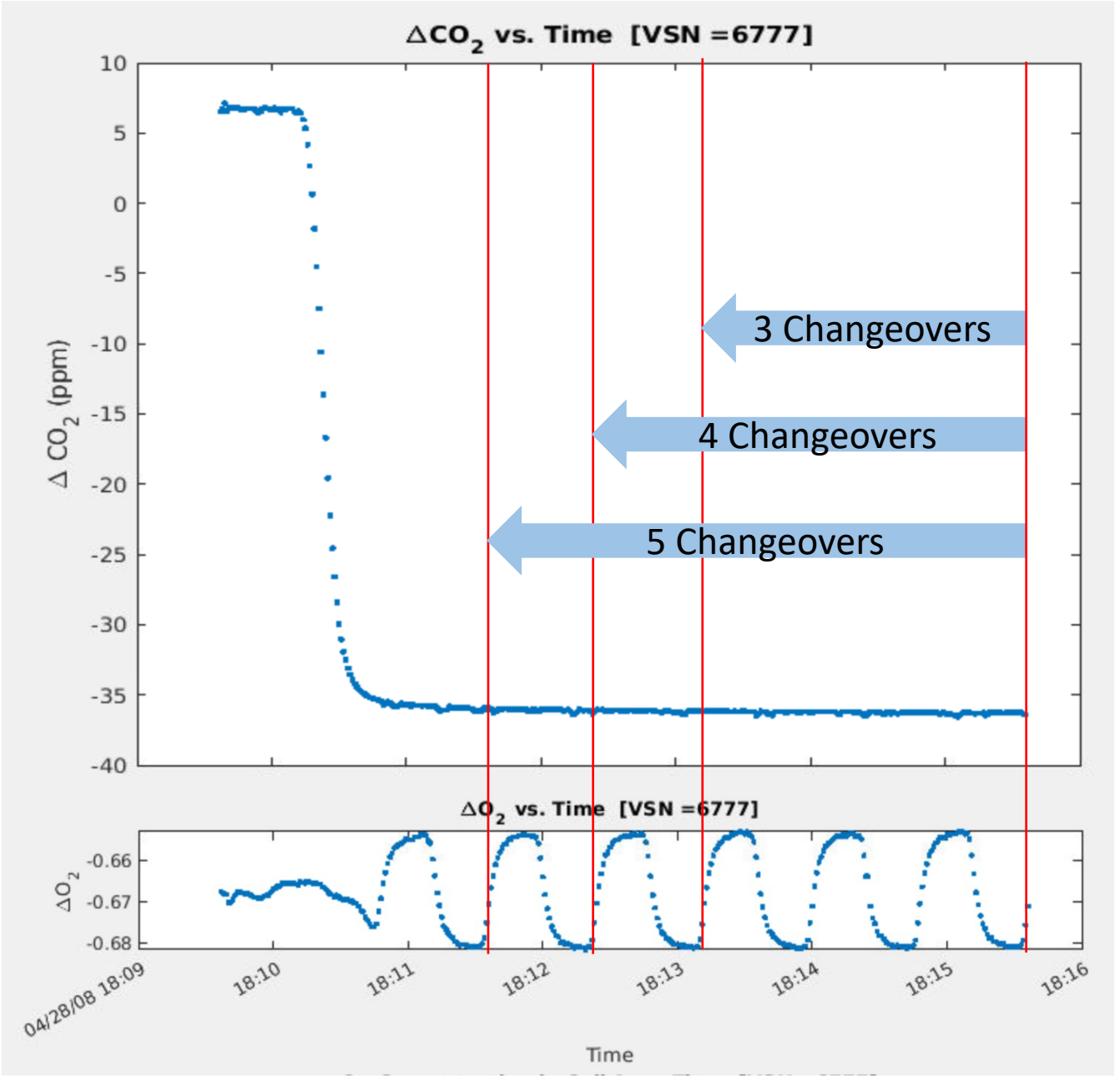
High Span: ~100 ppm change



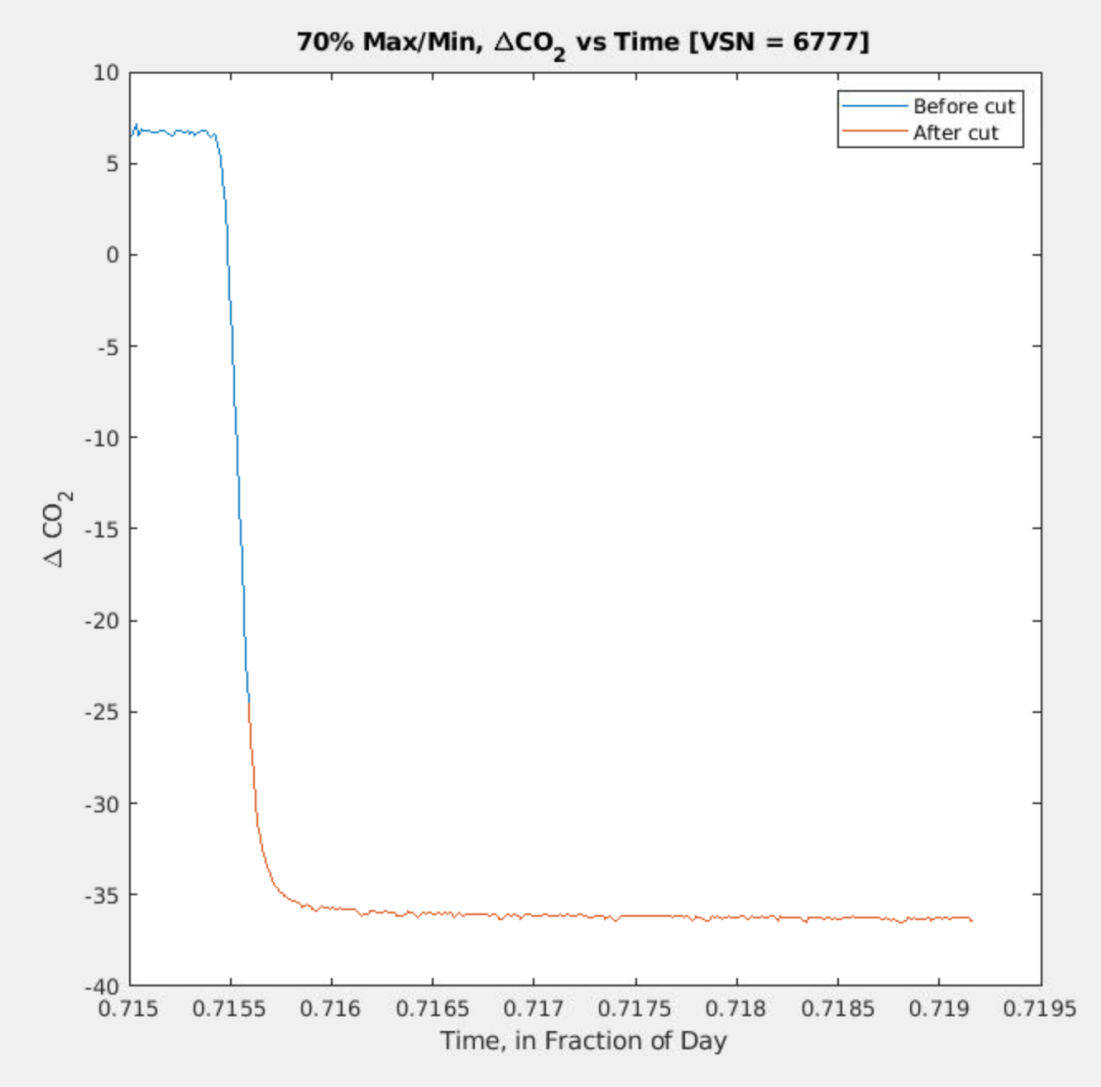

Standard Deviation in CO_2 vs CO_2 Concentration Range for Cal Runs 5090-9030
High Span
Low Span
$\sigma \Delta CO_2$
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
-100
-50
0
50
100
150
CO_2 Concentration Range

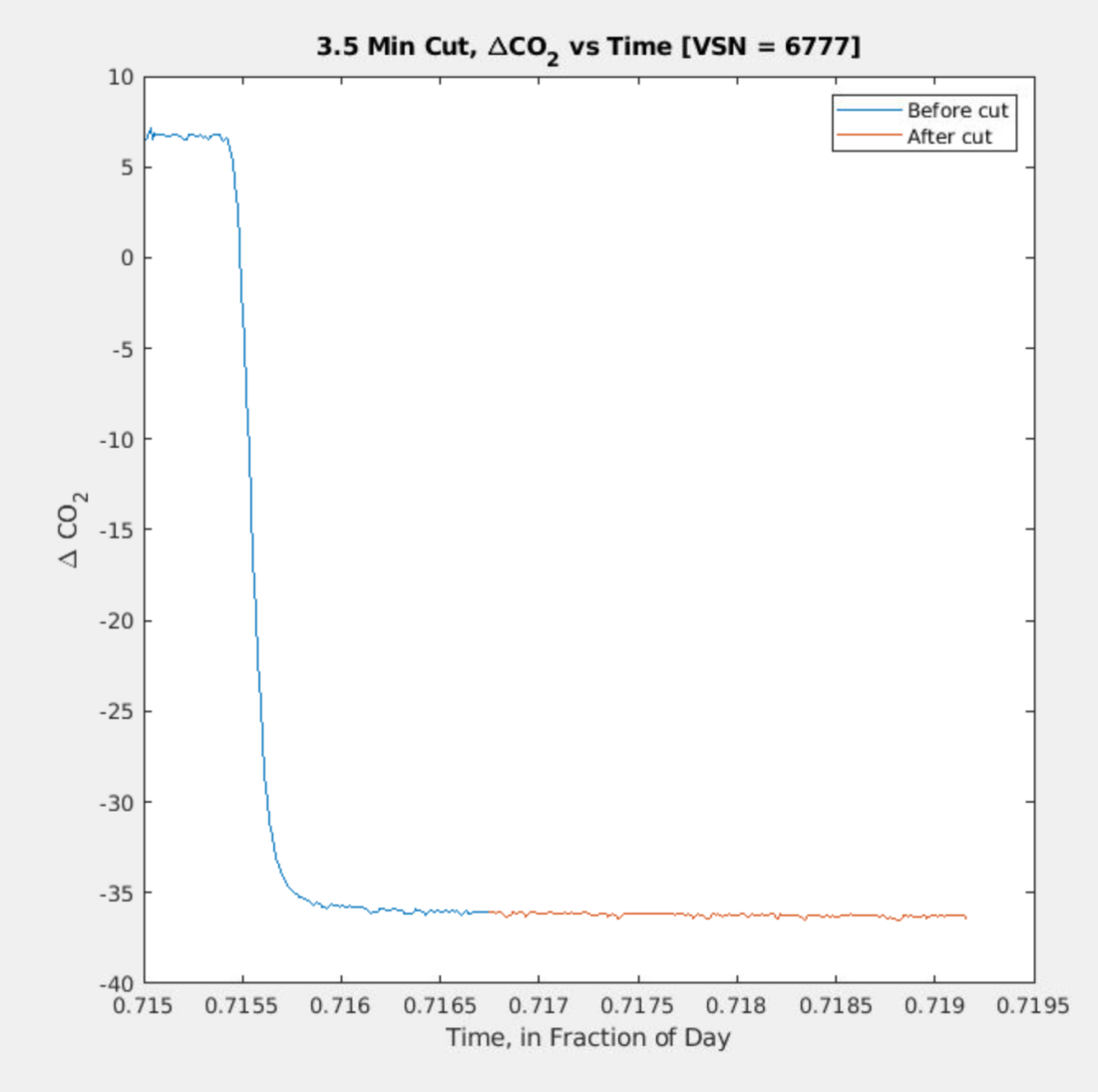
How do we find a value for CO_2?

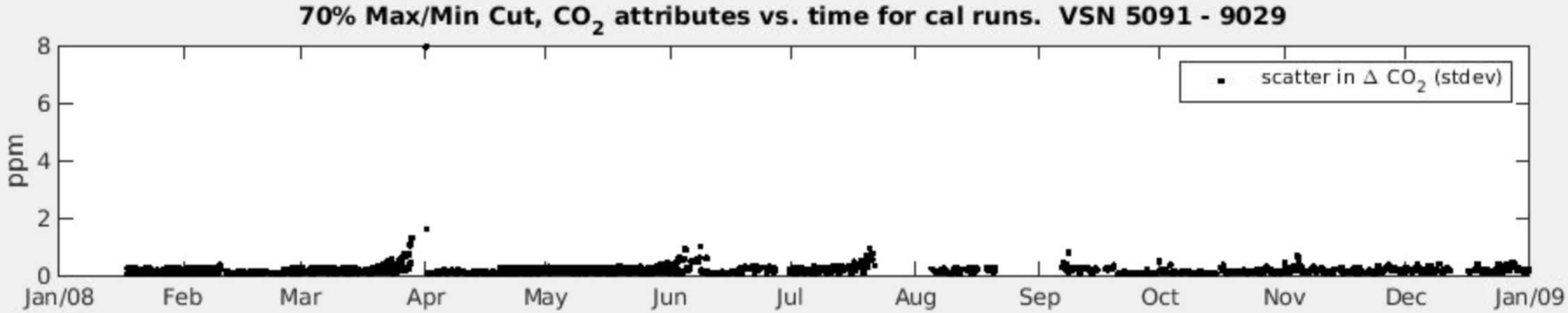


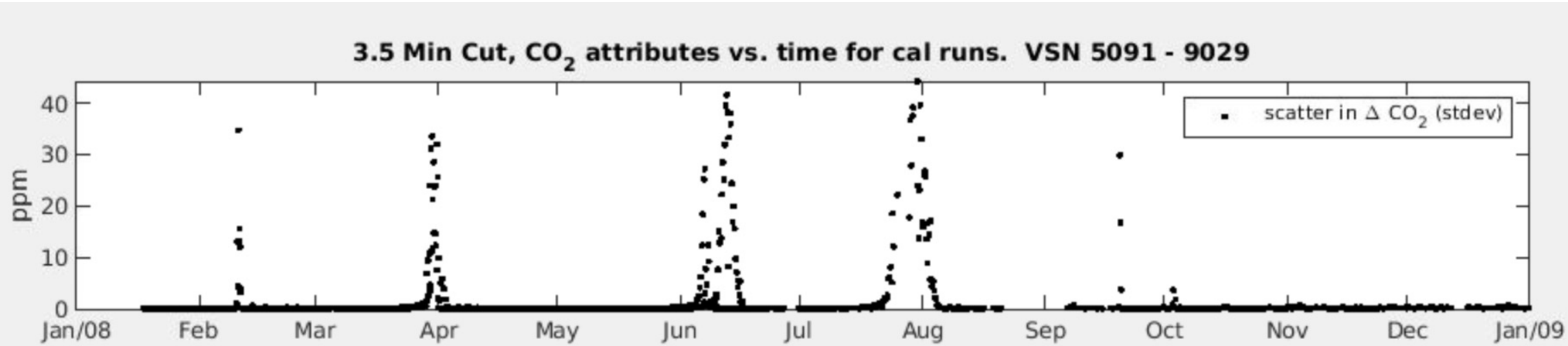


A Different Calibration Cut

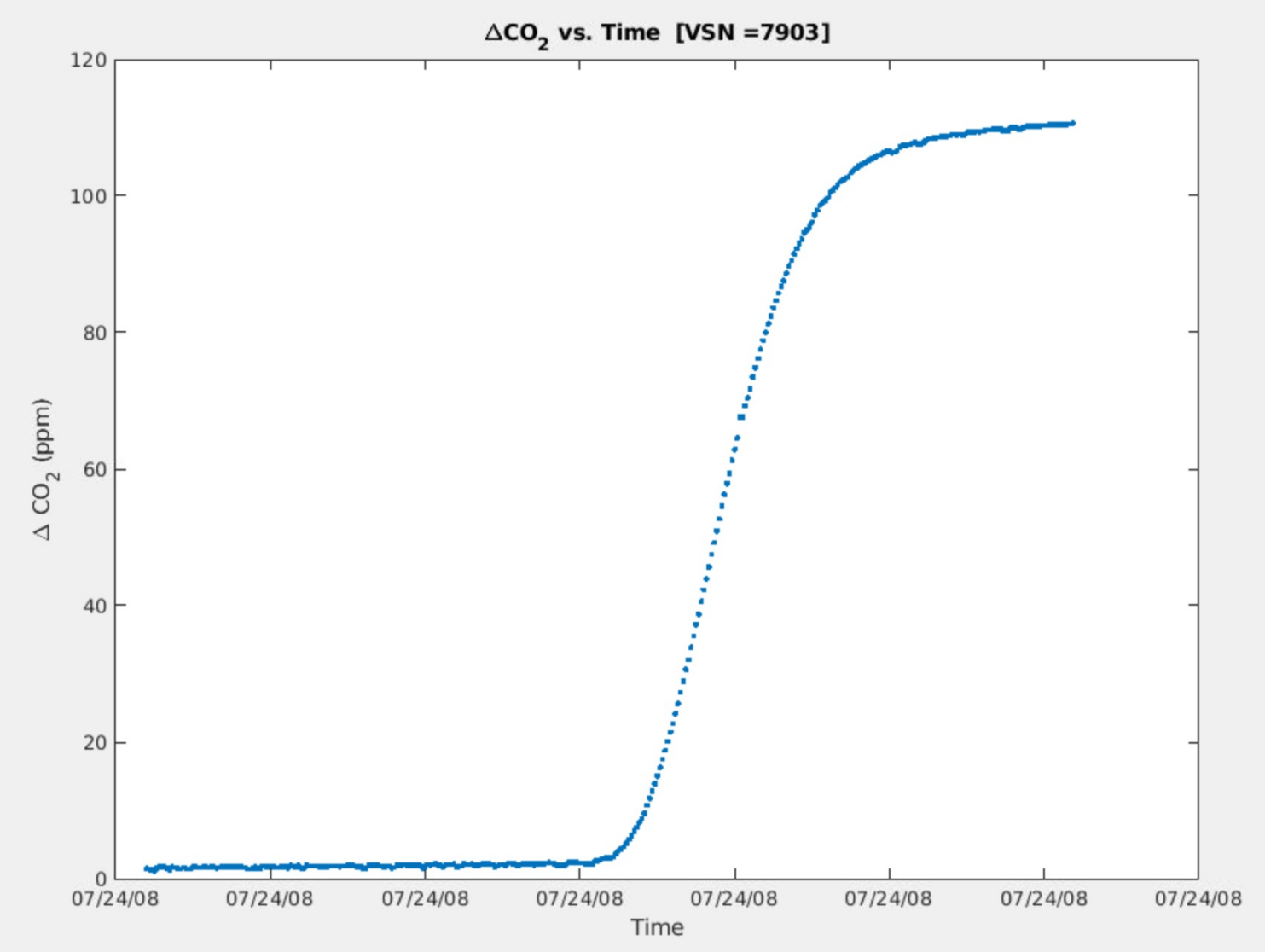


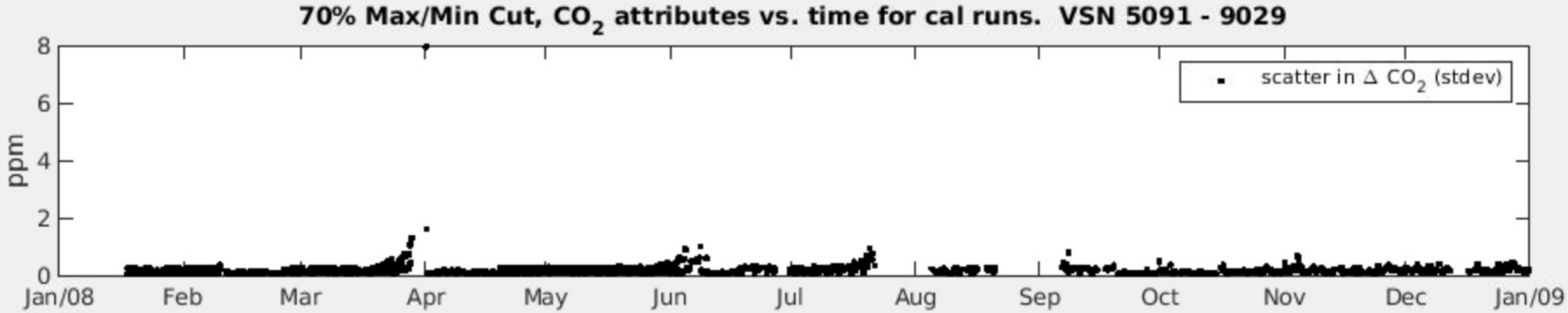


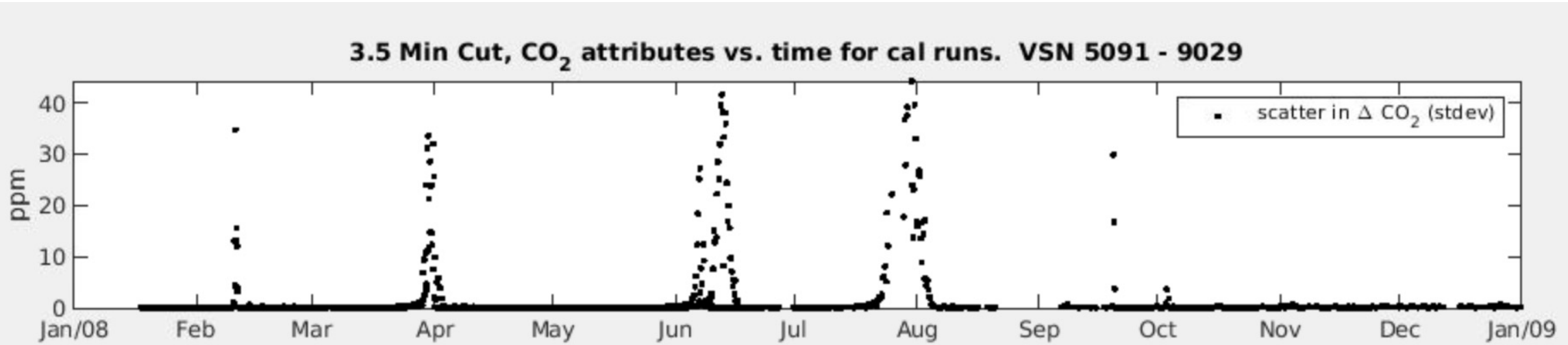

70% Max/Min Cut, CO_2 attributes vs. time for cal runs. VSN 5091 - 9029
ppm
0
2
4
6
8
Jan/08
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan/09
scatter in Δ CO_2 (stdev)

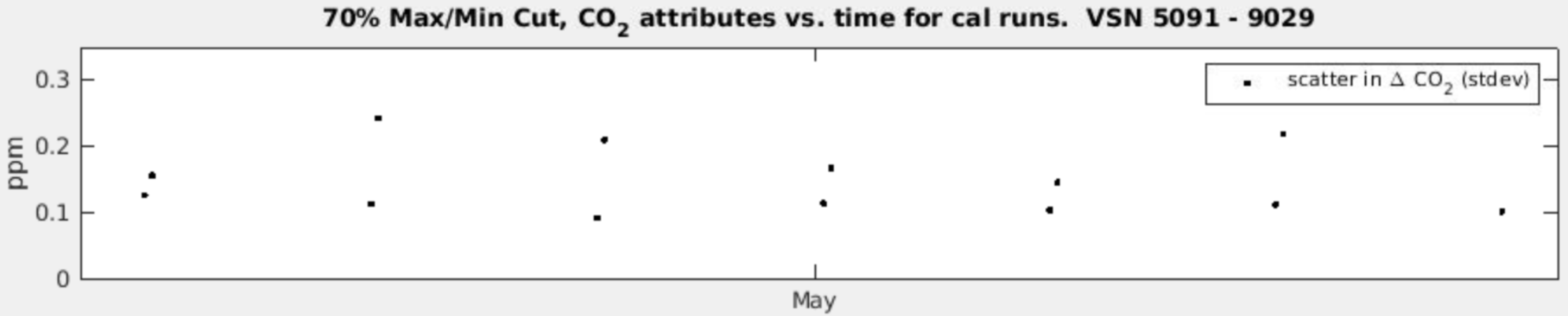

3.5 Min Cut, CO_2 attributes vs. time for cal runs. VSN 5091 - 9029
ppm
0
10
20
30
40
Jan/08
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan/09
scatter in Δ CO_2 (stdev)

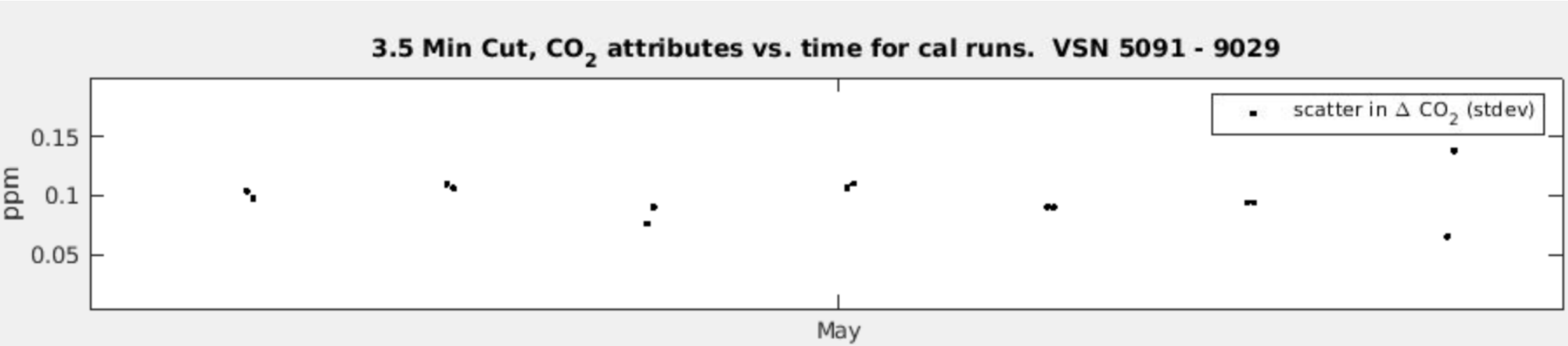
Late Transitions



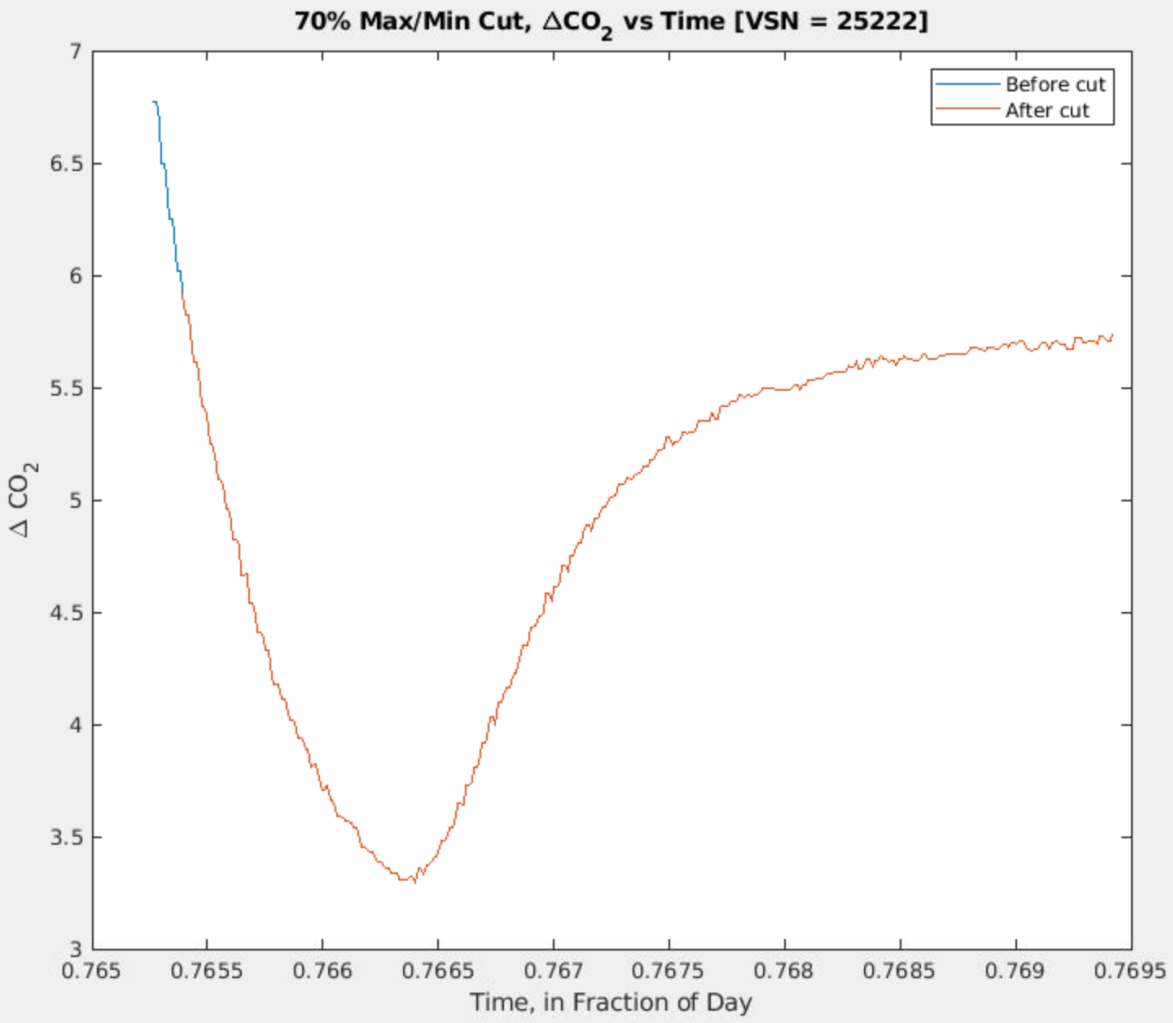

70% Max/Min Cut, CO2 attributes vs. time for cal runs. VSN 5091 - 9029
scatter in Δ CO2 (stdev)
ppm
0
2
4
6
8
Jan/08
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan/09

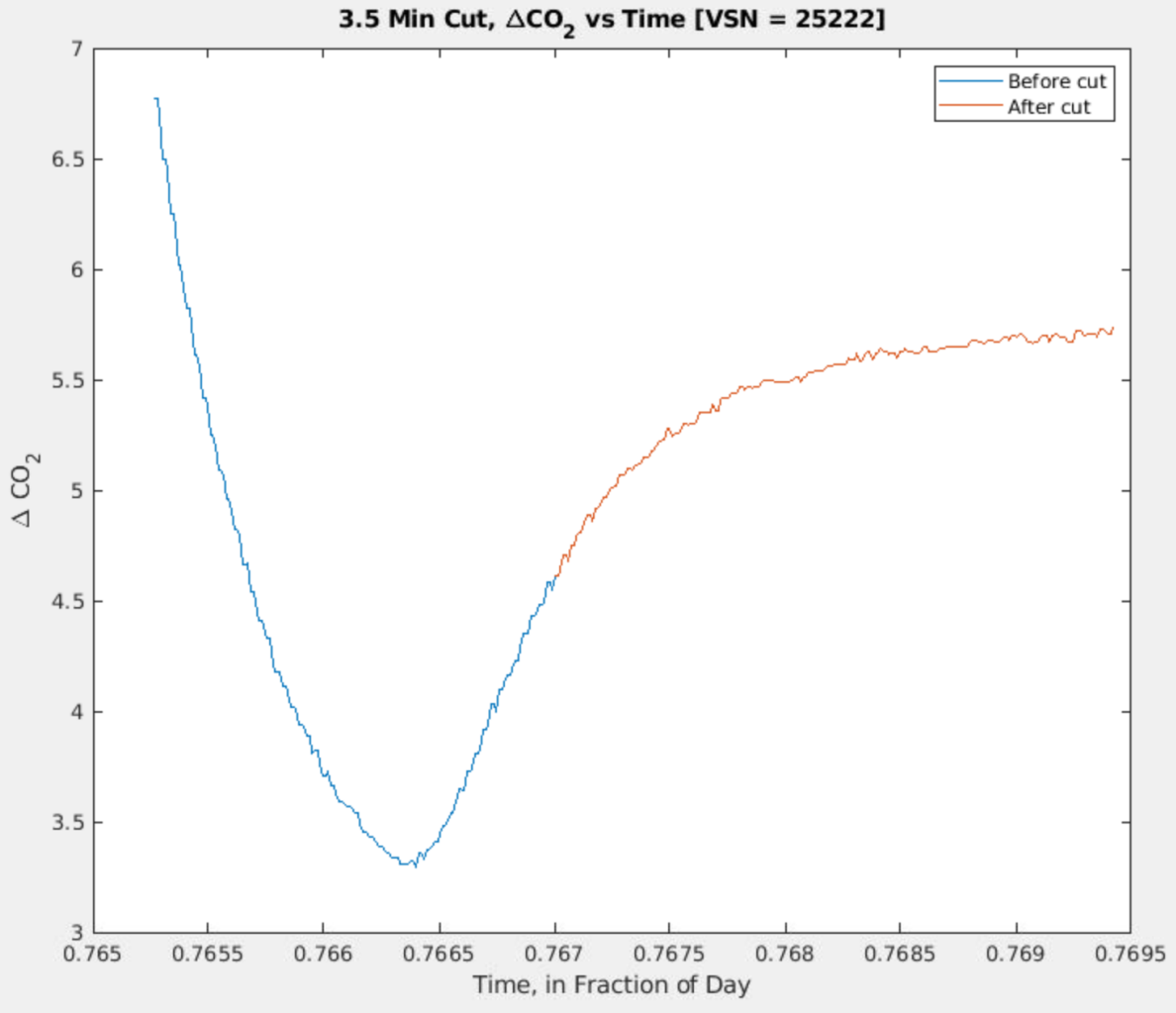

3.5 Min Cut, CO2 attributes vs. time for cal runs. VSN 5091 - 9029
scatter in Δ CO2 (stdev)
ppm
0
10
20
30
40
Jan/08
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan/09

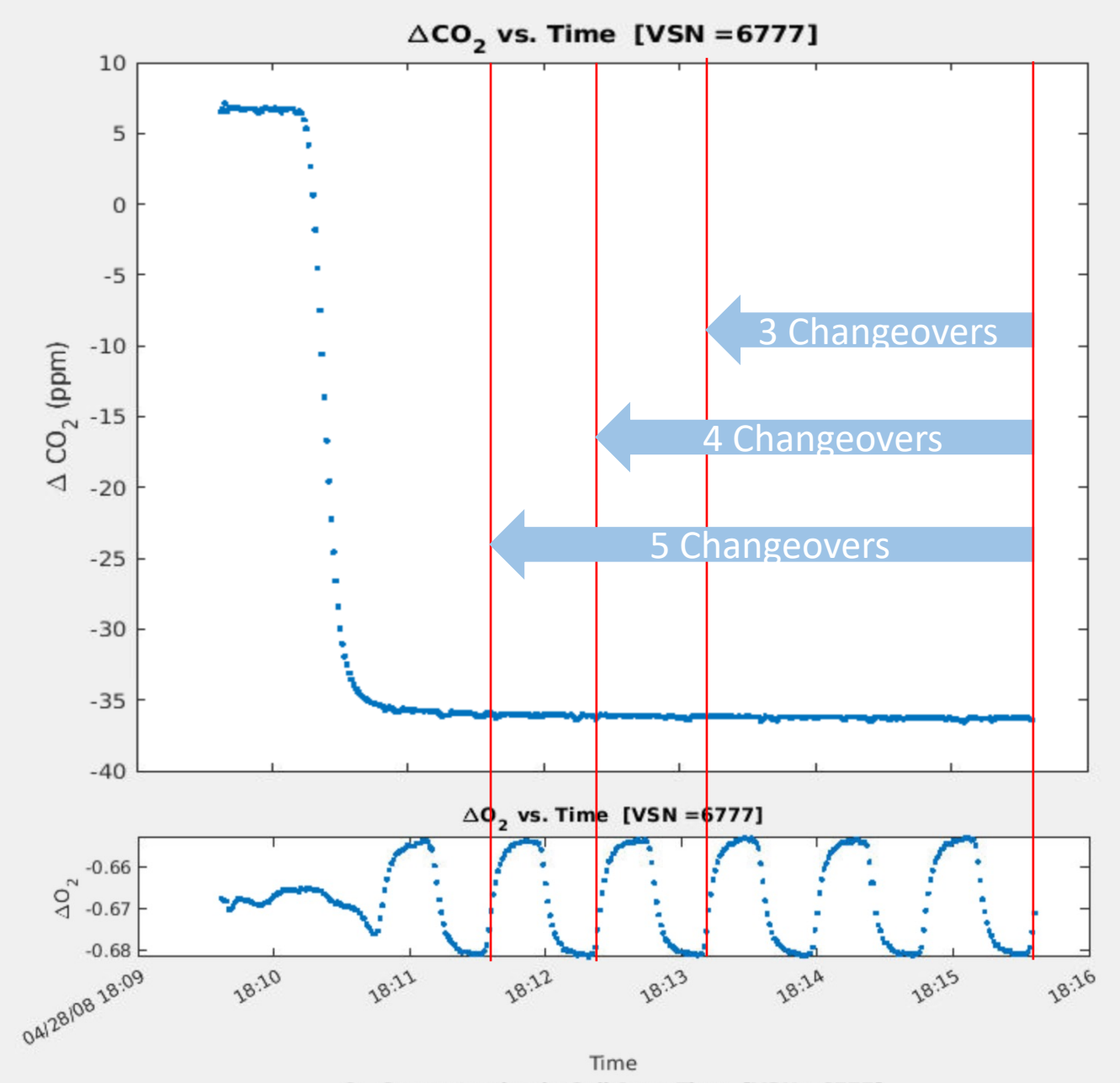

70% Max/Min Cut, CO2 attributes vs. time for cal runs. VSN 5091 - 9029
scatter in Δ CO2 (stdev)
ppm
0.3
0.2
0.1
0
May


3.5 Min Cut, CO2 attributes vs. time for cal runs. VSN 5091 - 9029
scatter in Δ CO2 (stdev)
ppm
0.15
0.1
0.05
May

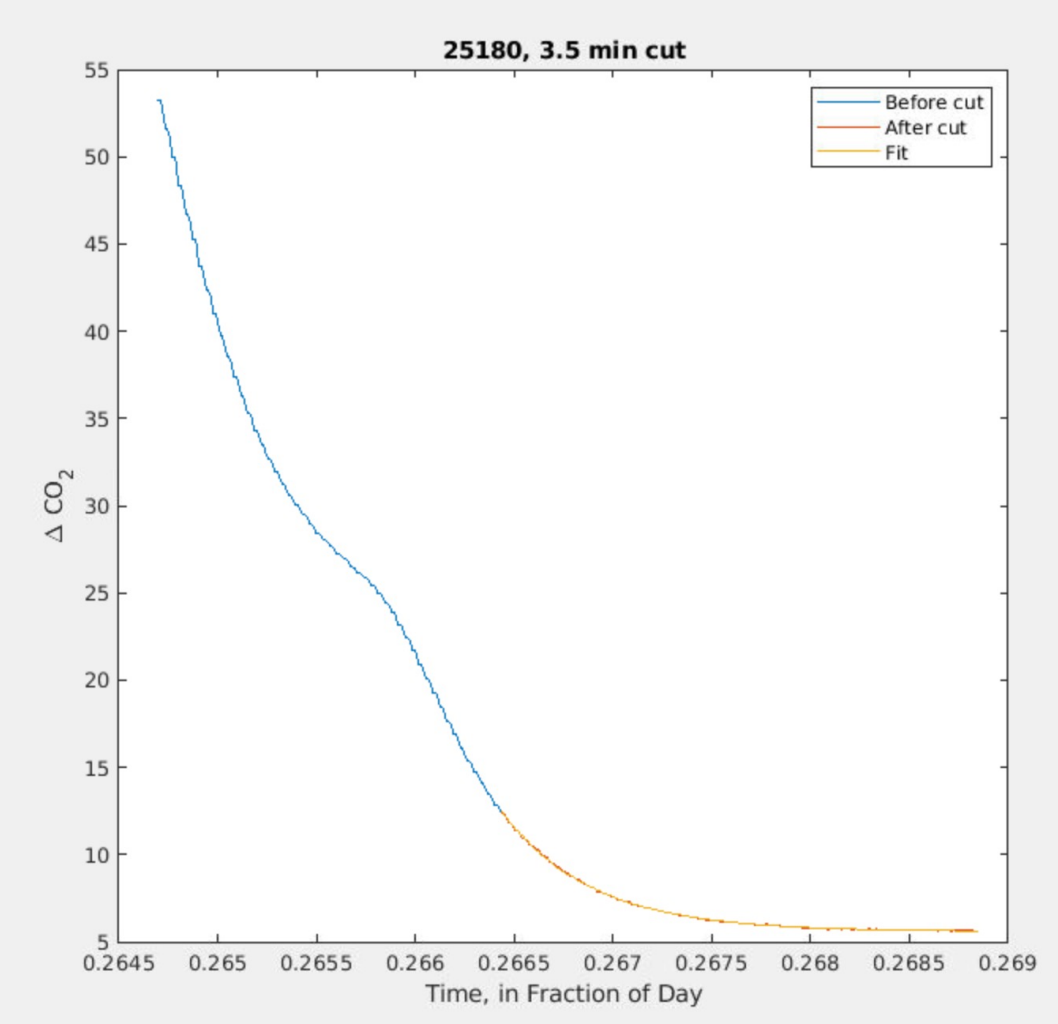
Intake Switching Issue



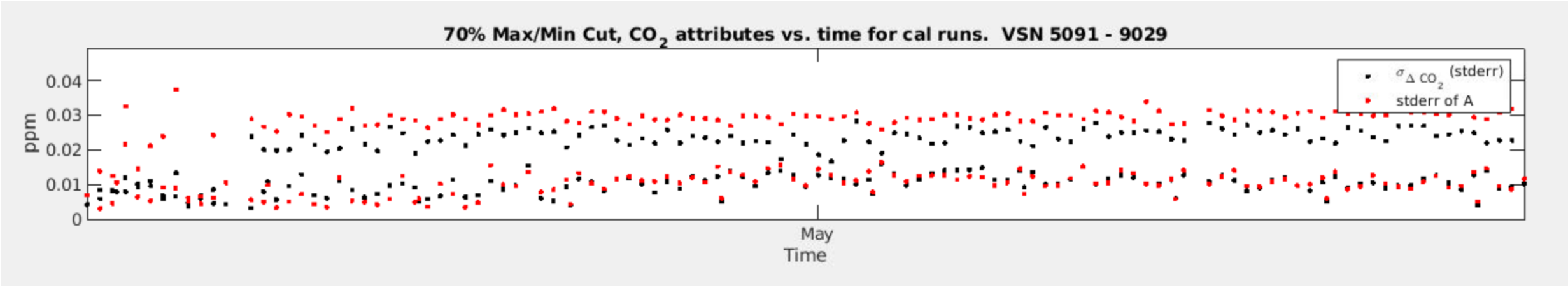


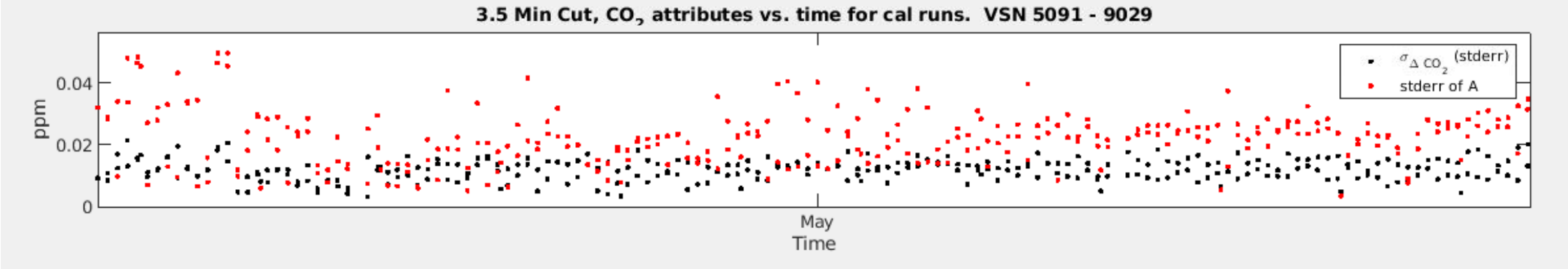


Is there a better way to find the final concentration?

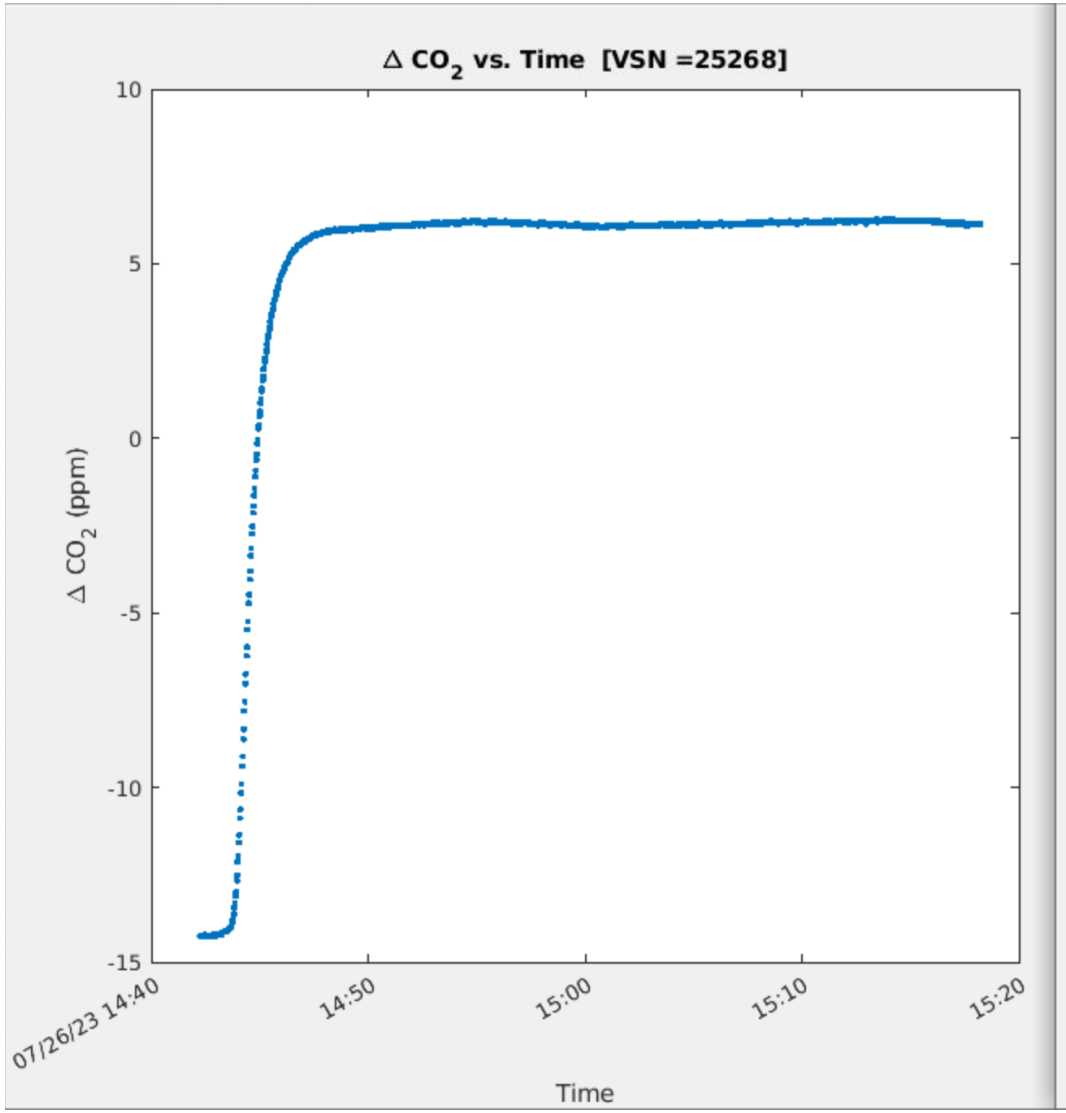


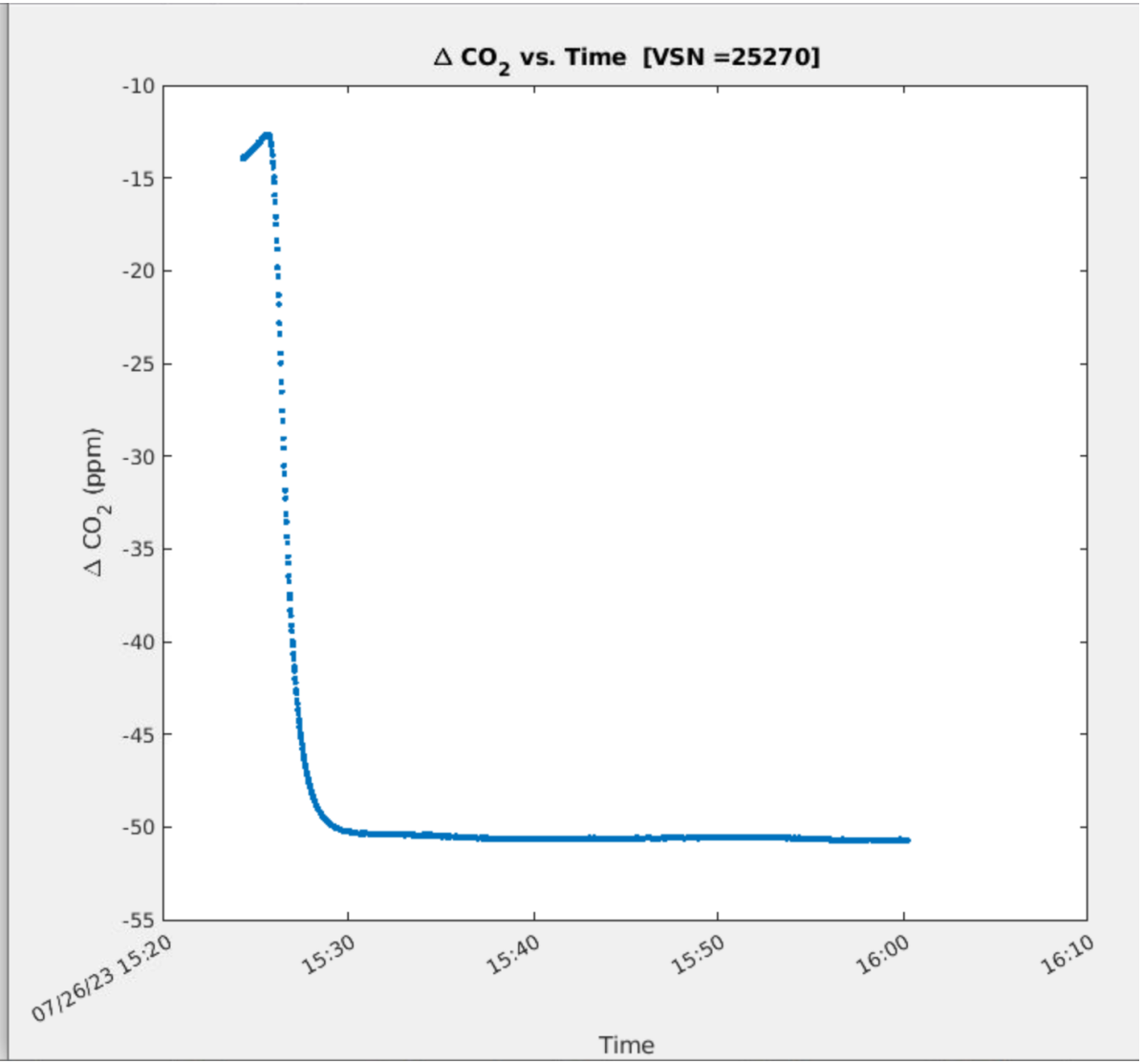
Average vs Asymptote



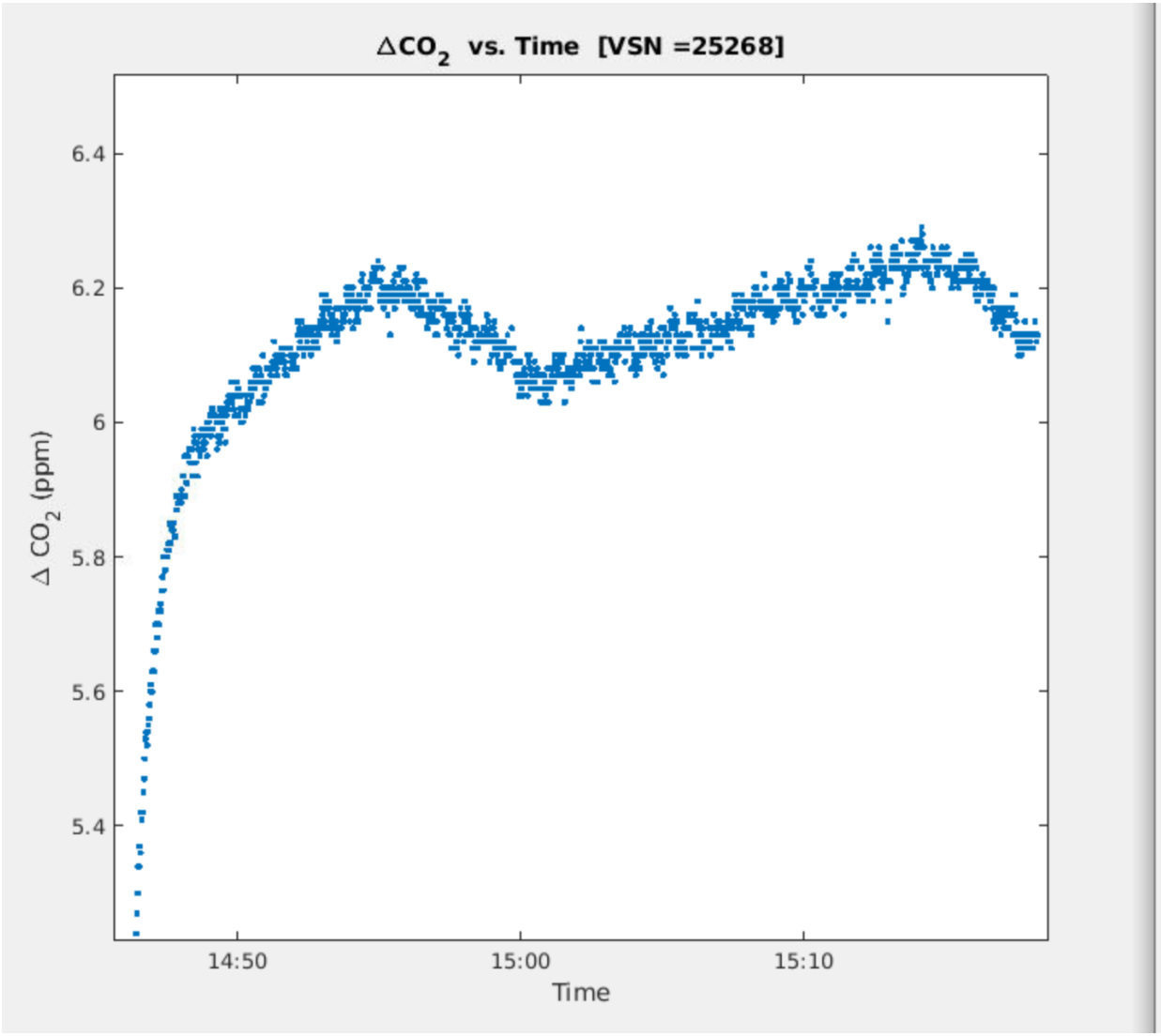


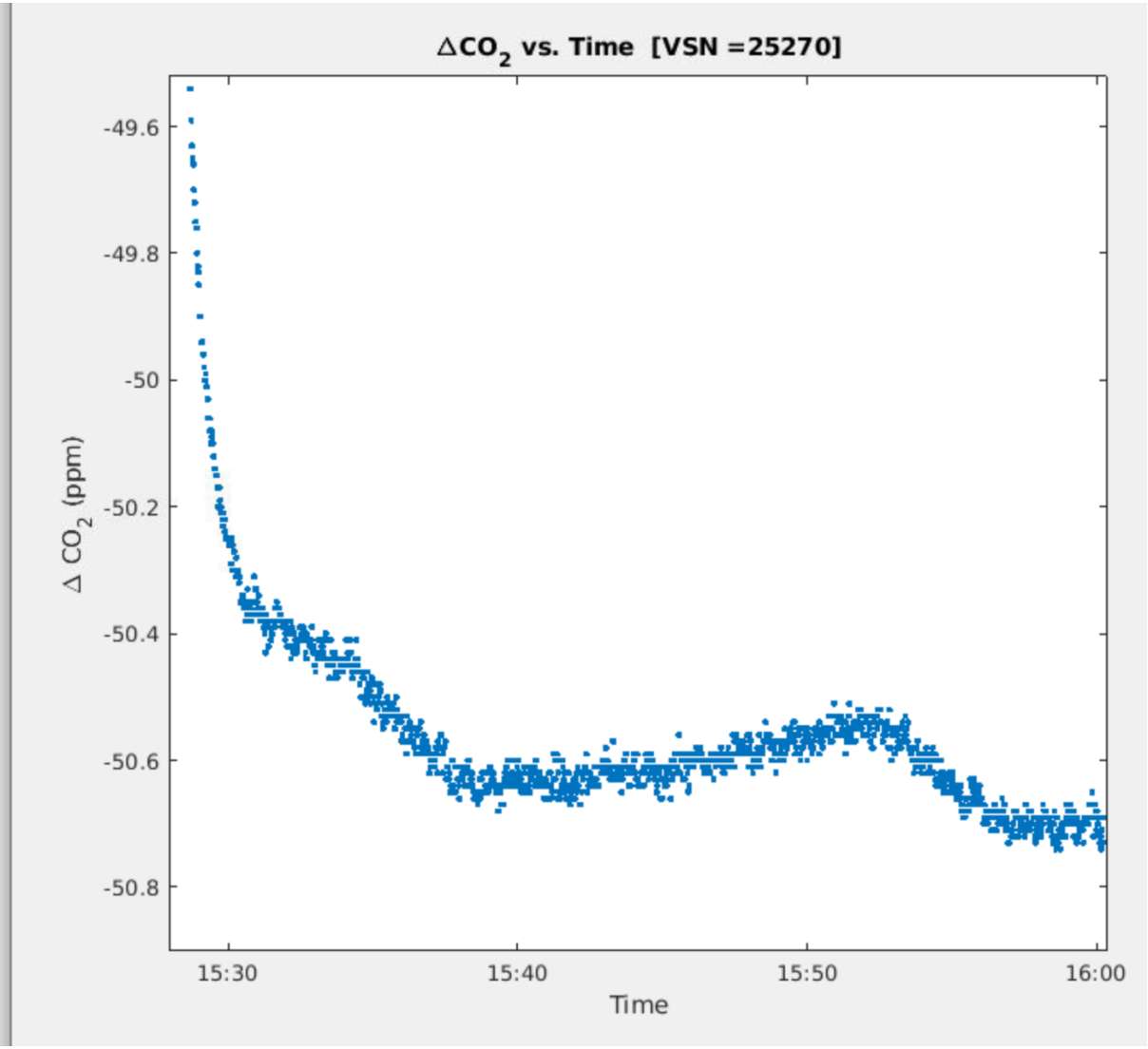
36 Minute Calibrations

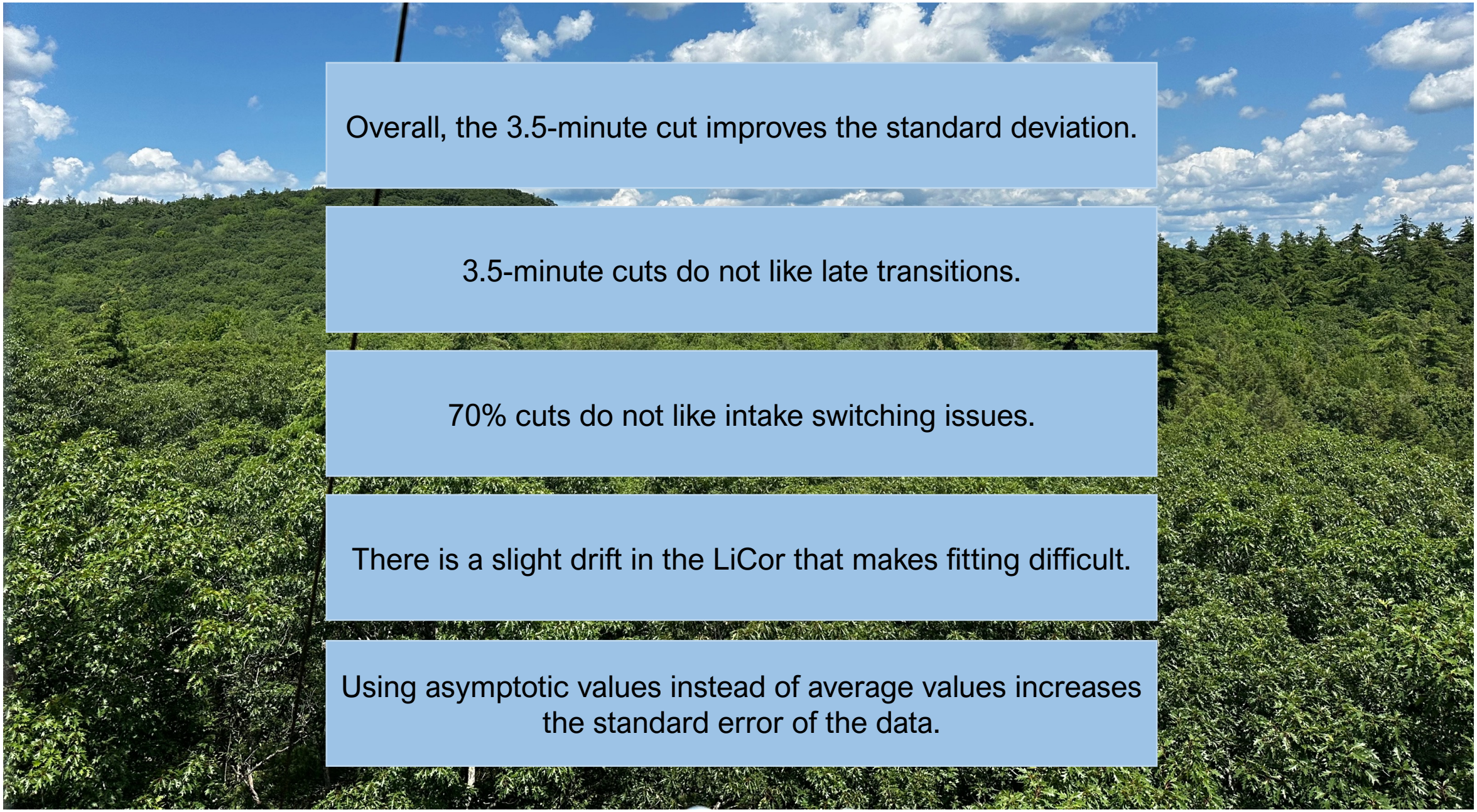




Captain, We're Drifting!







Overall, the 3.5-minute cut improves the standard deviation.

3.5-minute cuts do not like late transitions.

70% cuts do not like intake switching issues.

There is a slight drift in the LiCor that makes fitting difficult.

Using asymptotic values instead of average values increases the standard error of the data.

Overall Conclusions

Undoing the Oxzilla compensation for post-2018 data decreases the standard deviation and salvages it!

Considering a different cutoff point for calibration data may be beneficial.

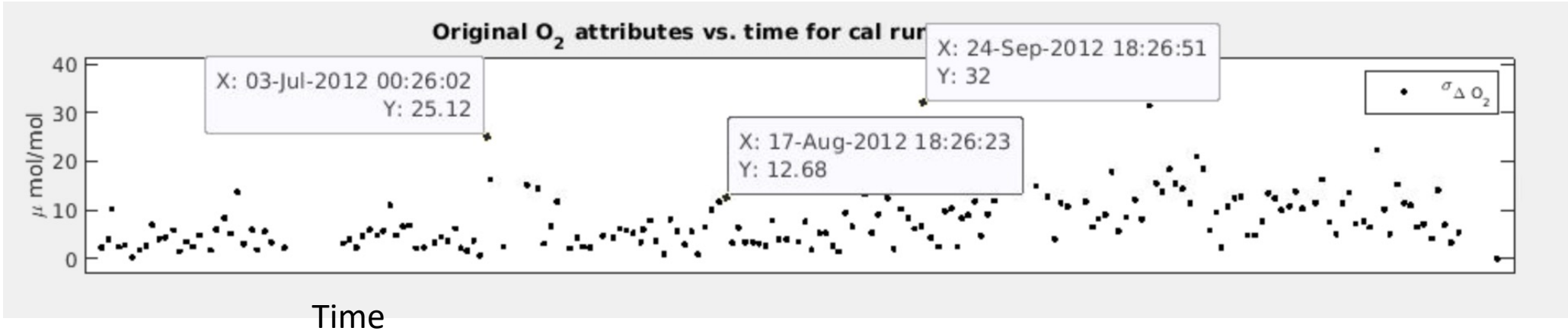
Partially due to small drifts in the LiCor, asymptotic values are not preferable to average values.

Acknowledgements

Many thanks to Mark Battle for his guidance and patience! Thanks to the WAO4 organizing committee for allowing me to speak today. Thank you to John Budney for his time in training me to climb the tower and to Mark VanScoy for helping me wrestle tanks of compressed air. Finally, thanks to the Burns Fellowship for funding my research experience this summer.

Thank you!

Pressure Corrections



Time