Nothing Compares
NORTH CAROLINA

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Department of Environmental Quality

Lori Cherry, Division of Air Quality,
Ambient Monitoring Section

Monitoring for Sulfur Dioxide Using New Sensor Technology ~ A Pilot

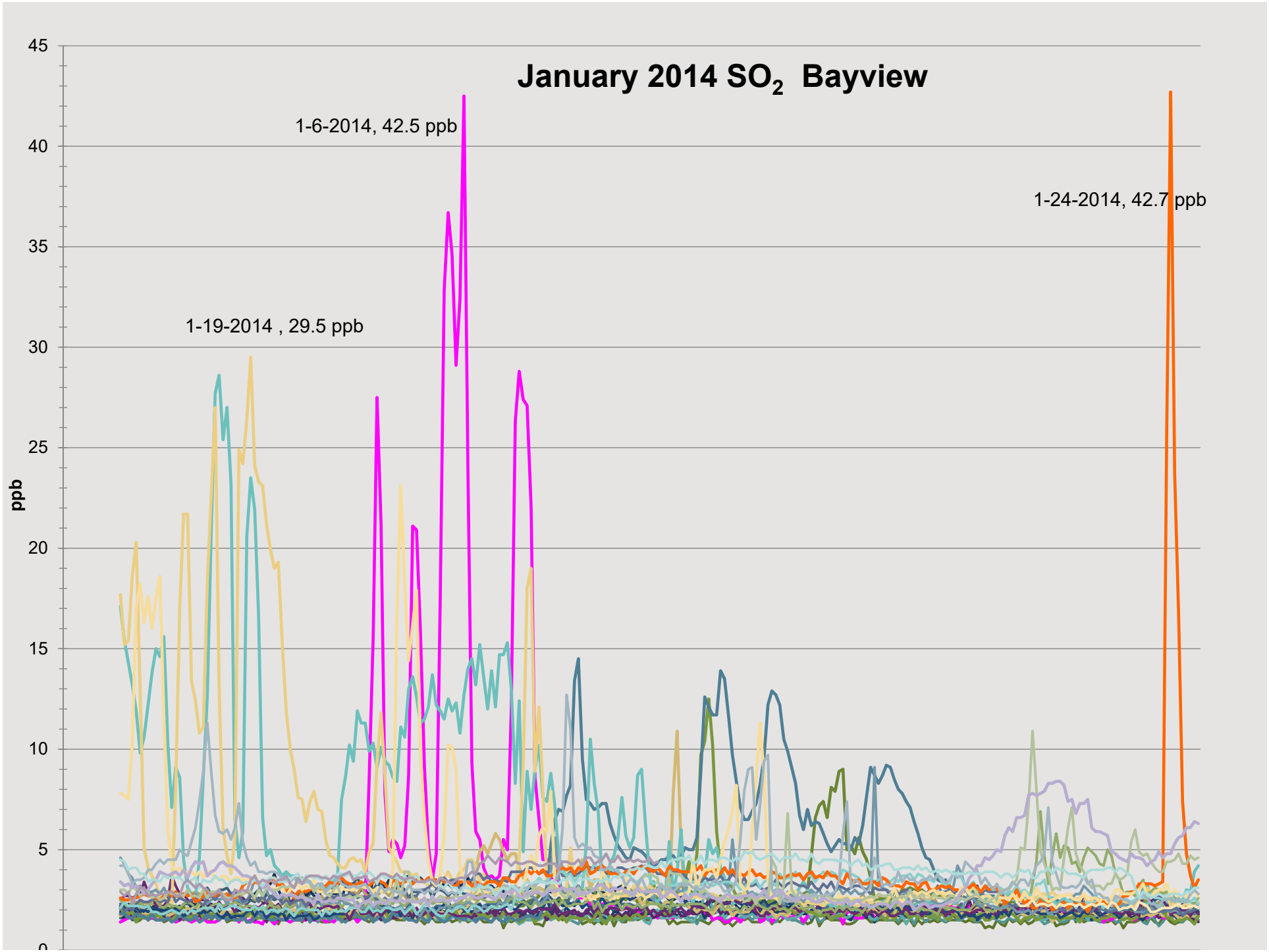
- Why did we test sensor technologies?
- New Generation Air Monitors
- Equipment and experimental design thoughts
- How did they perform? A look at some data.
- Some conclusions and final remarks

Why did we test sensor technology?

- Data Requirements Rule, May 13, 2014 proposal
- As many as 9 facilities
- Modeling ok in certain situations
- How many monitors? Really???
- Adding SO_2 sites expensive, and poses logistical challenges to meet requirements
- TAD?
- Prior experience with SO_2

New Generation Air Monitors

- Most promising options measure air quality using emerging sensor technology
- Sensors can be easily deployed in multiple locations around sources increasing spatial and temporal resolution
- Wireless transmission makes data readily available
- Most sensors available at a lower cost compared to reference monitors
- But what about:
    - Equipment and data reliability?
    - Equipment and data rigor?
    - Relatable to air quality standards?


January 2014 SO2 Bayview
1-6-2014, 42.5 ppb
1-24-2014, 42.7 ppb
1-19-2014 , 29.5 ppb
ppb
45
40
35
30
25
20
15
10
5
0

The Basic Experimental Idea – Can these sensors be used as indicators?

- Assess the viability of paired sensors to [robustly] monitor SO_2
  - In a side-by-side comparison, do the pods read the "same value" ? (+/- 15% or other value)
  - Does a pod, one or the other, read the "same value" as the SO_2 Monitor? (+/- 15% or other value)
  - Or alternatively, is there a quantifiable, consistent deviation between the pod values and the monitor values?
- Run sensors simultaneously with the SO_2 reference monitor at established source-oriented sites
- Evaluate data

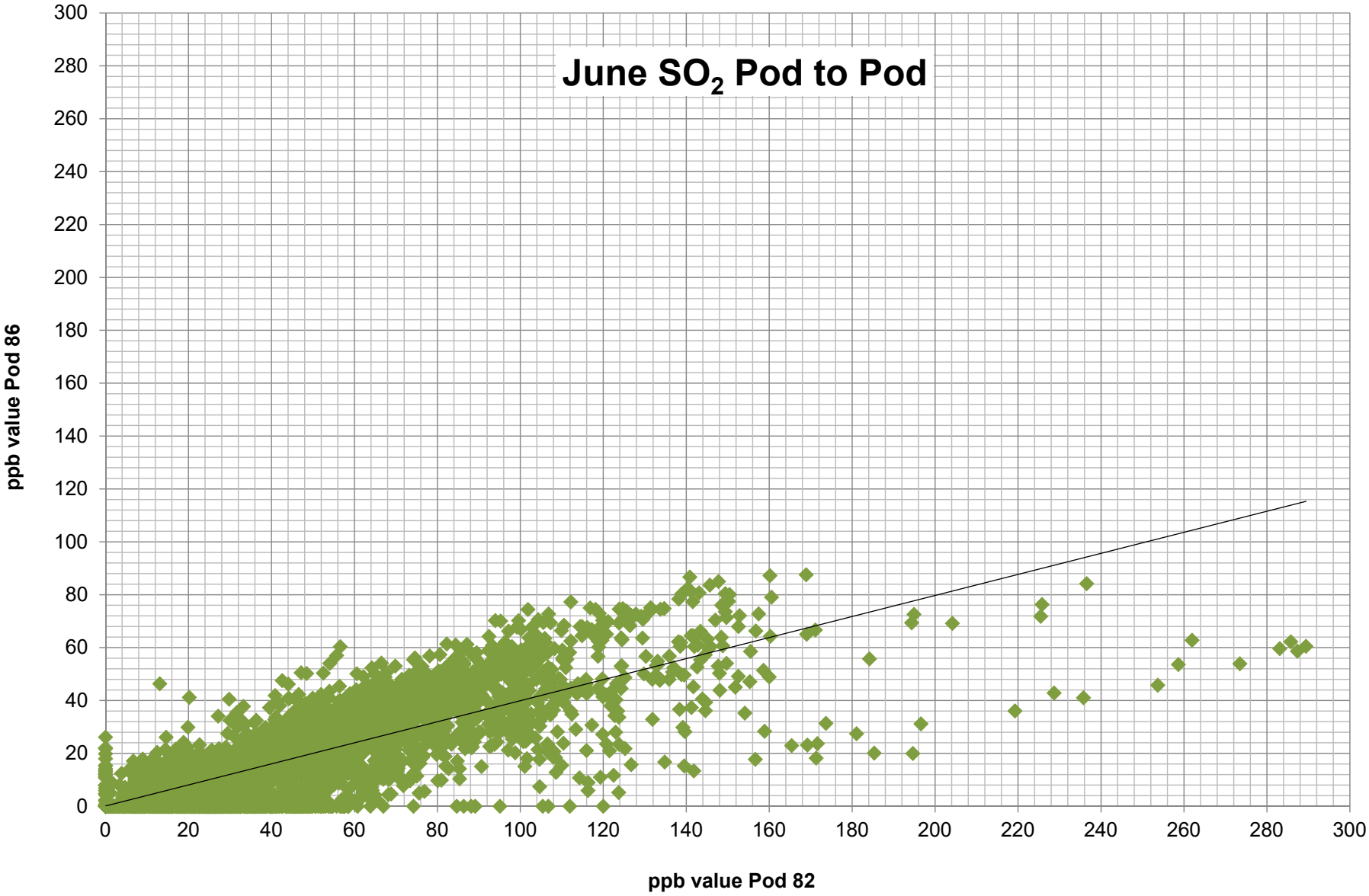
Equipment Selected

- AQMesh

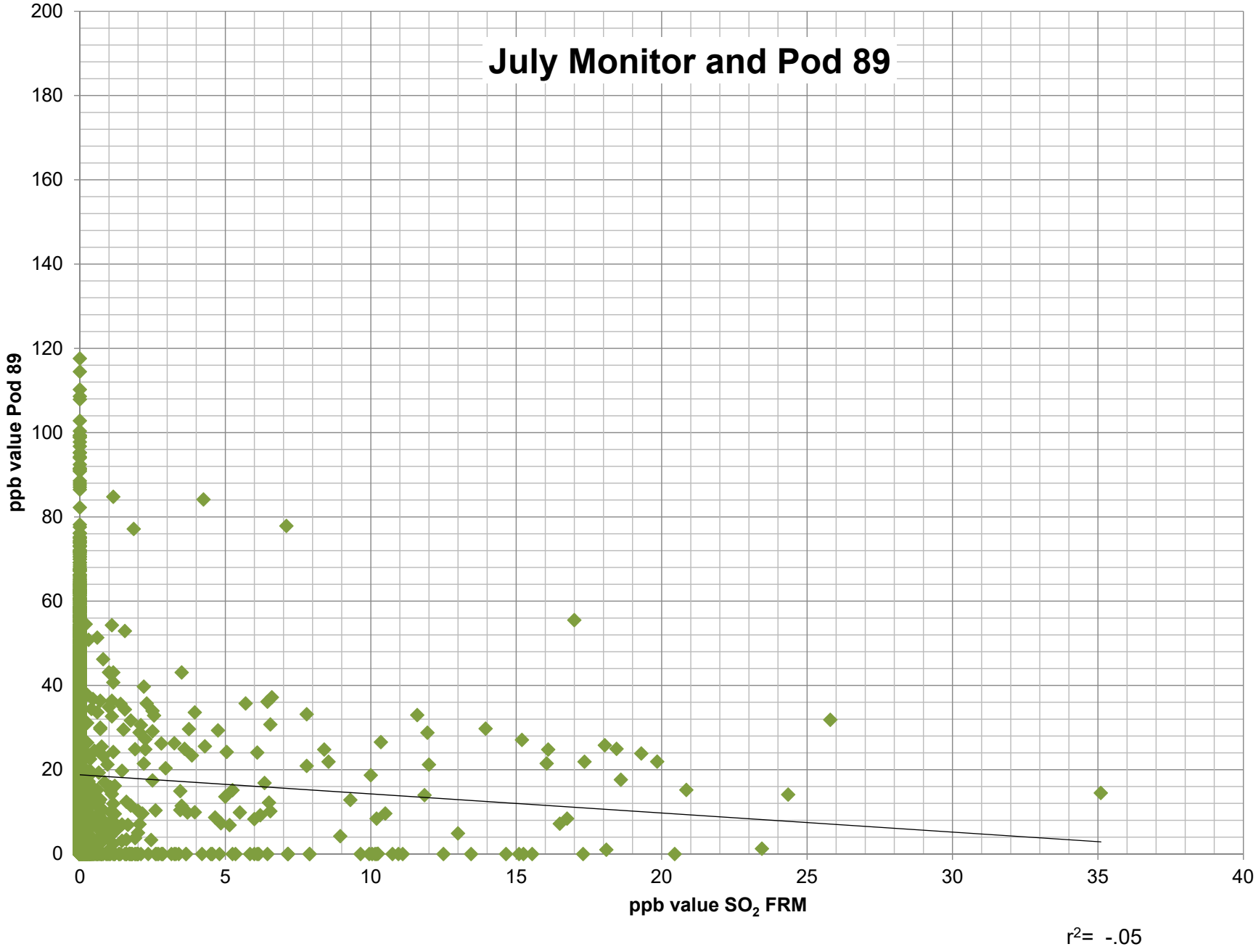
"The Pod"

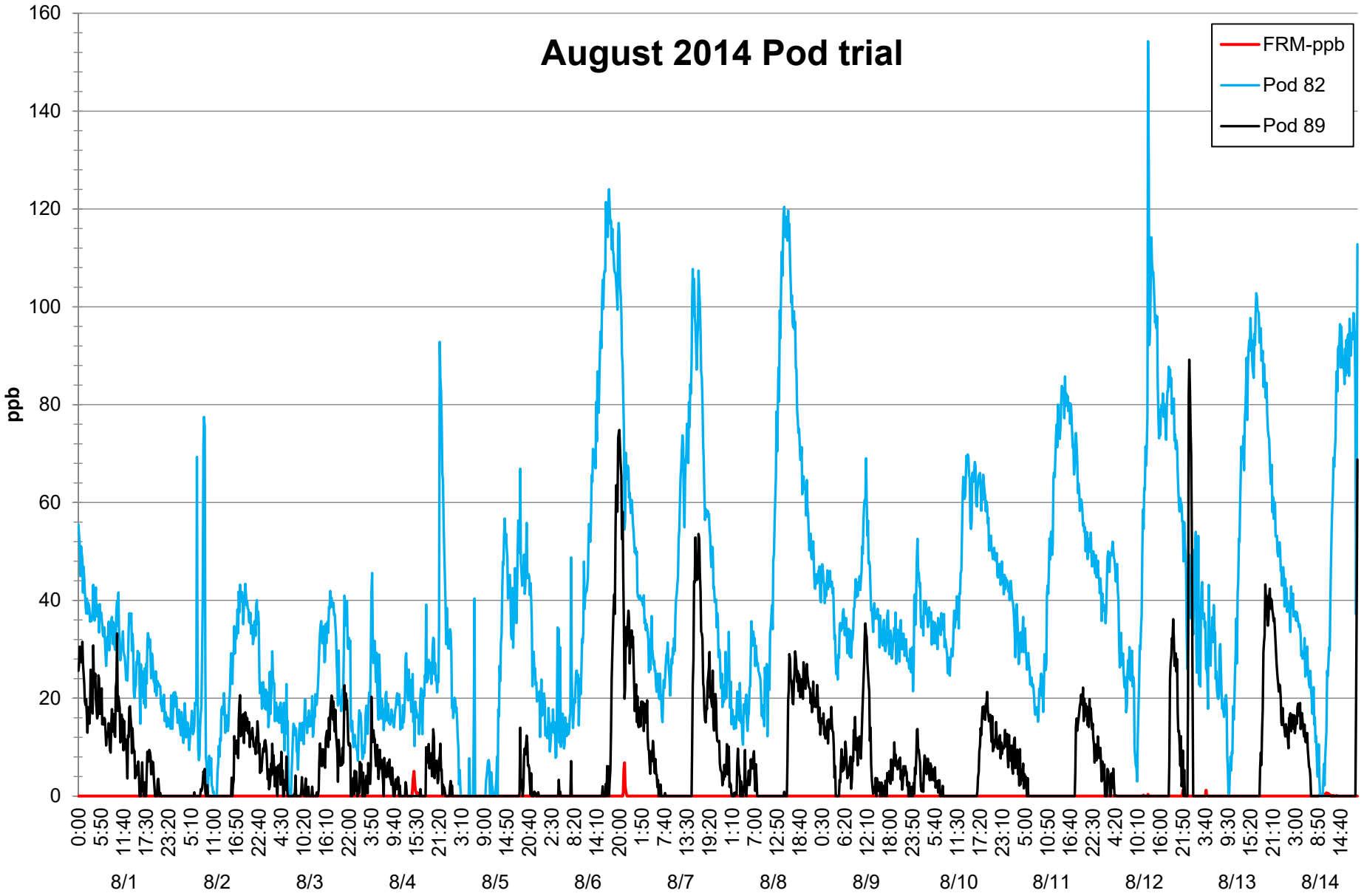
Pod also equipped with sensors for CO, O_3, NO, NO_2, temp, RH, atmospheric pressure

Set-up


June SO_2 Pod to Pod
ppb value Pod 86
ppb value Pod 82
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300

$r^2 = .78$


July Monitor and Pod 89
ppb value Pod 89
ppb value SO2 FRM
0
20
40
60
80
100
120
140
160
180
200
0
5
10
15
20
25
30
35
40
r2= -.05


August 2014 Pod trial
FRM-ppb
Pod 82
Pod 89
ppb
160
140
120
100
80
60
40
20
0
0:00
5:50
11:40
17:30
23:20
5:10
11:00
16:50
22:40
4:30
10:20
16:10
22:00
3:50
9:40
15:30
21:20
3:10
9:00
14:50
20:40
2:30
8:20
14:10
20:00
1:50
7:40
13:30
19:20
1:10
7:00
12:50
18:40
0:30
6:20
12:10
18:00
23:50
5:40
11:30
17:20
23:10
5:00
10:50
16:40
22:30
4:20
10:10
16:00
21:50
3:40
9:30
15:20
21:10
3:00
8:50
14:40
8/1
8/2
8/3
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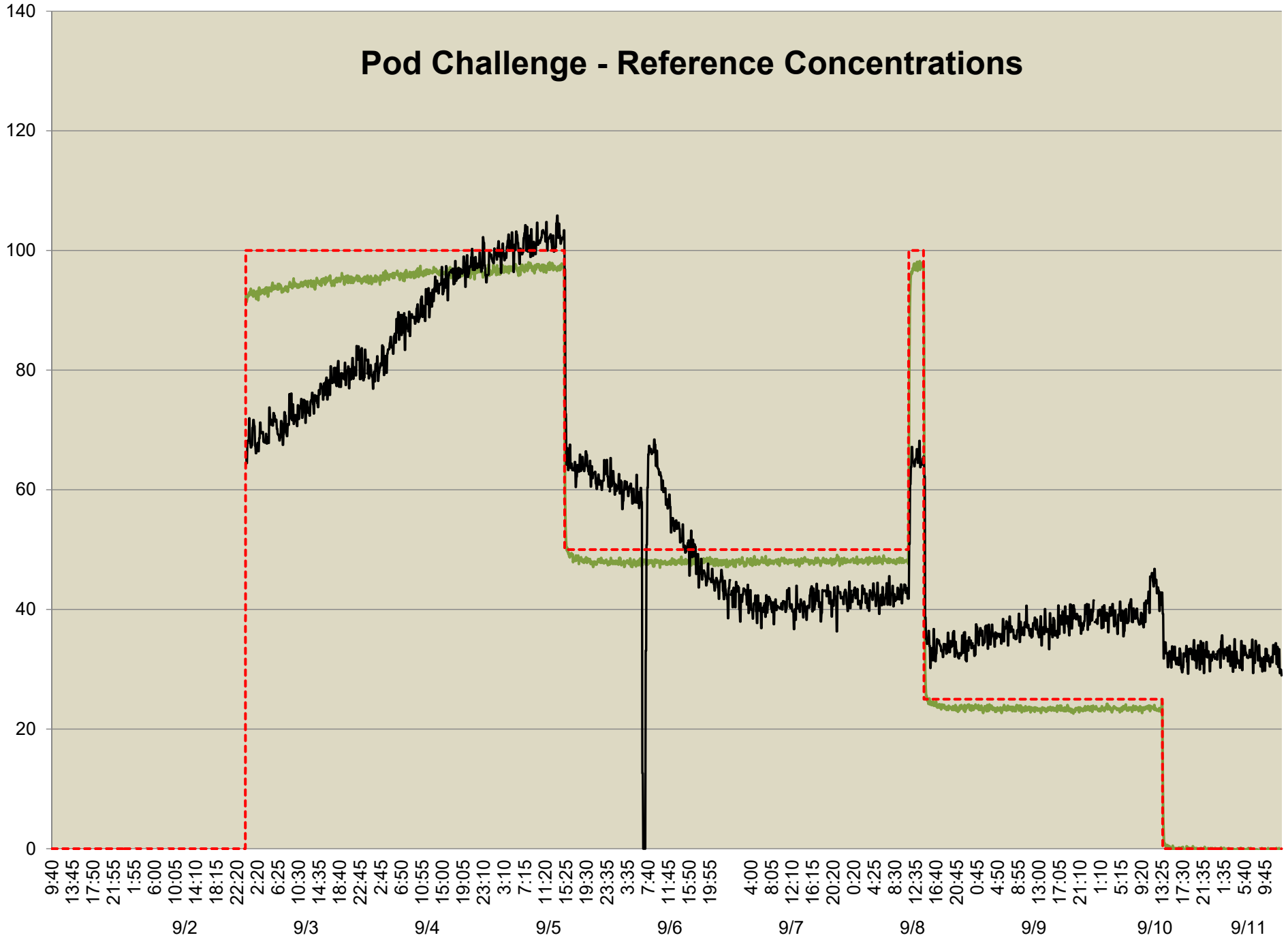
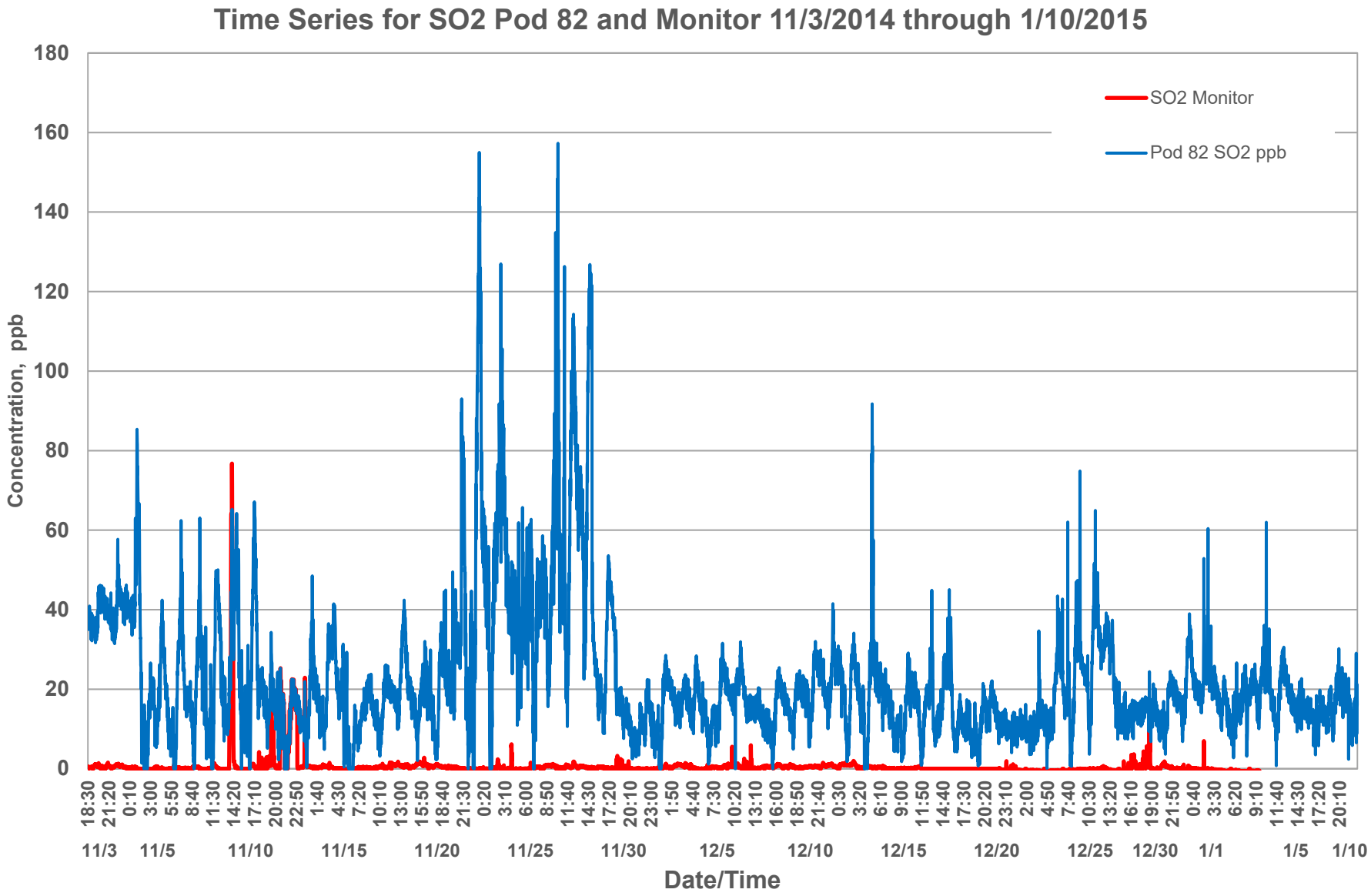
8/14


Pod Challenge - Reference Concentrations
140
120
100
80
60
40
20
0
9:40
13:45
17:50
21:55
1:55
6:00
10:05
14:10
18:15
22:20
2:20
6:25
10:30
14:35
18:40
22:45
2:45
6:50
10:55
15:00
19:05
23:10
3:10
7:15
11:20
15:25
19:30
23:35
3:35
7:40
11:45
15:50
19:55
4:00
8:05
12:10
16:15
20:20
0:20
4:25
8:30
12:35
16:40
20:45
0:45
4:50
8:55
13:00
17:05
21:10
1:10
5:15
9:20
13:25
17:30
21:35
1:35
5:40
9:45
9/2
9/3
9/4
9/5
9/6
9/7
9/8
9/9
9/10
9/11


Time Series for SO2 Pod 82 and Monitor 11/3/2014 through 1/10/2015
SO2 Monitor
Pod 82 SO2 ppb
Concentration, ppb
180
160
140
120
100
80
60
40
20
0
18:30 21:20 0:10 3:00 5:50 8:40 11:30 14:20 17:10 20:00 22:50 1:40 4:30 7:20 10:10 13:00 15:50 18:40 21:30 0:20 3:10 6:00 8:50 11:40 14:30 17:20 20:10 23:00 1:50 4:40 7:30 10:20 13:10 16:00 18:50 21:40 0:30 3:20 6:10 9:00 11:50 14:40 17:30 20:20 23:10 2:00 4:50 7:40 10:30 13:20 16:10 19:00 21:50 0:40 3:30 6:20 9:10 11:40 14:30 17:20 20:10
11/3 11/5 11/10 11/15 11/20 11/25 11/30 12/5 12/10 12/15 12/20 12/25 12/30 1/1 1/5 1/10
Date/Time

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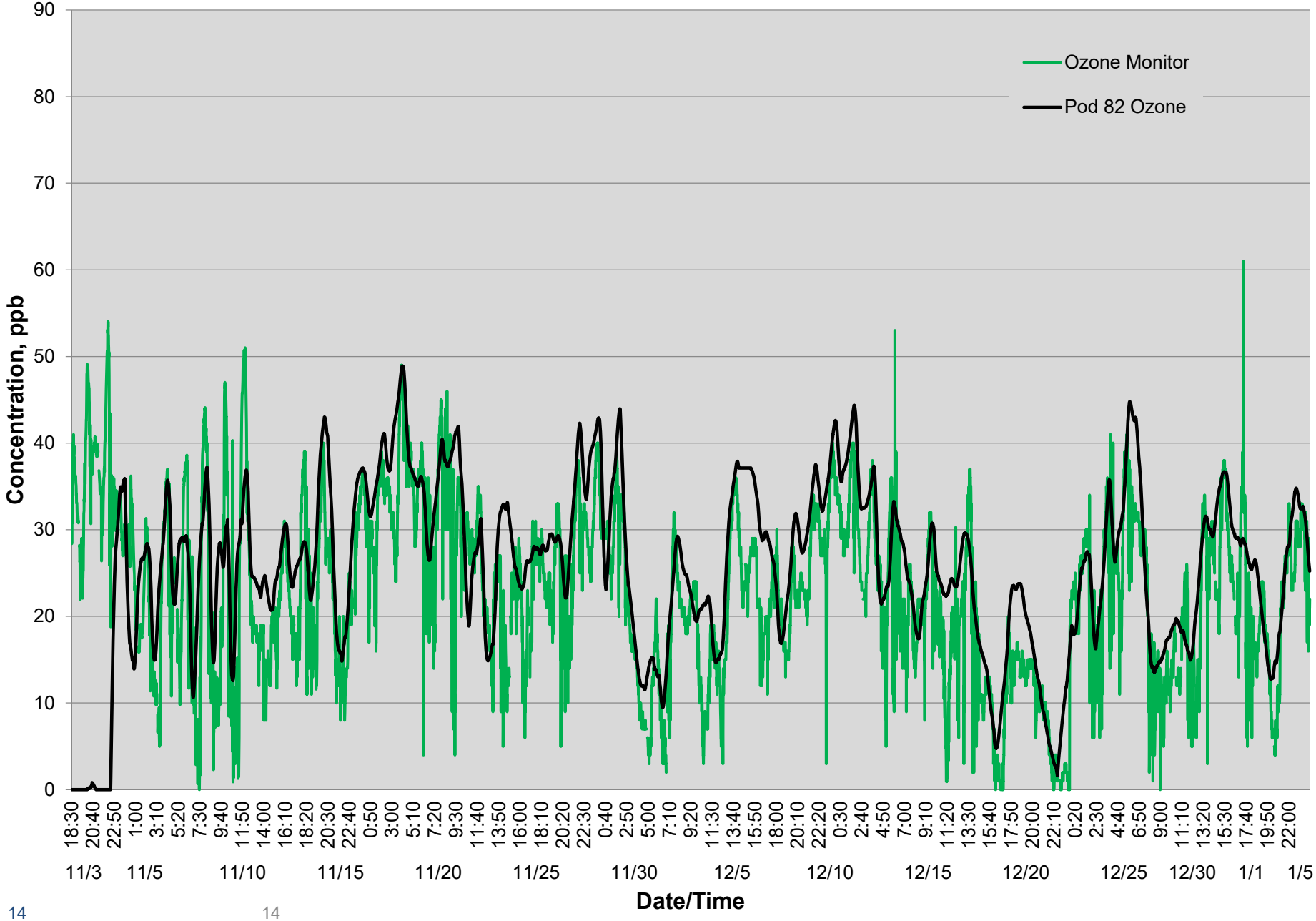
Time Series Ozone Monitor-Pod 82 11/3/2014 - 1/5/2015



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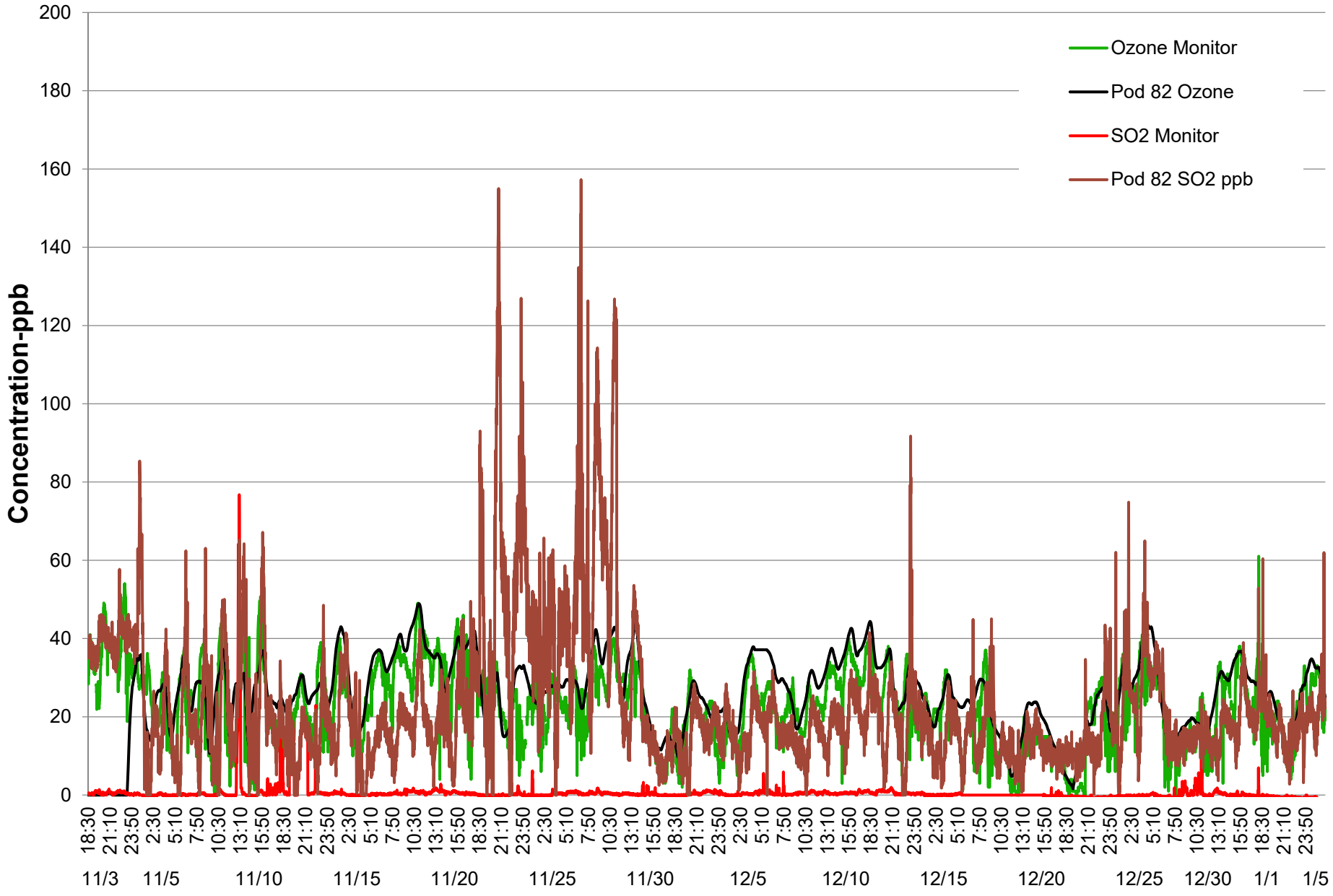
Time Series for Ozone & SO2 Monitor-to-Pod 11/3/2014-1/5/2015



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Conclusions from the Pilot Study

- Pilot was helpful in understanding possible issues with sensors
  - Be skeptical of monitoring claims without testing it
  - Be prepared for a learning curve
  - Set ground rules for use and acceptance of sensor data
- To meet Data Requirements Rule, pursuing traditional monitoring at five facilities
  - One monitor only
  - SO_2 sensor monitoring not fully developed

Conclusions from the Pilot Study

- Our anecdotal test with the ozone sensor was unexpectedly good
- Sensors are being improved upon and they will become more prevalent
- Even though SO_2 sensors are not as developed as others, there is still interest in SO_2 --another manufacturer interested in co-locating their equipment with one of the DRR sites

Final Thoughts about Understanding and Using Sensor Data

- Lots of numbers—now what?
- Currently sensors intended to support public involvement and education
- Health studies do not support linking near instantaneous data to any adverse health effects
- Sensor data is not regulatory
- EPA's sensor scale and messaging pilot based on a tiered approach; for ozone and PM
  - Planning outdoor activities