Long-term Evaluation of Low-Cost PM and Gaseous Sensors in Middle Tennessee

Michelle Oakes, Ph.D.

Tennessee Dept of Environment and Conservation
Division of Air Pollution Control

National Ambient Air Monitoring Conference, August, 24, 2022`

What are Low-Cost Air Sensors?

www.purpleair.com

Main Features of Sensors

- Inexpensive
- Portable
- Easy to Use
- Data Accessibility

www.aqmesh.com

https://www.clarity.io/

https://airqualityegg.com/home

https://www.amphenol-sensors.com/

Overview of TDEC's Sensor Study

Multi-year evaluation of gaseous and particulate sensors against regulatory (FEM/FRM) monitors

4 Middle Tennessee Monitoring Sites

3 urban sites

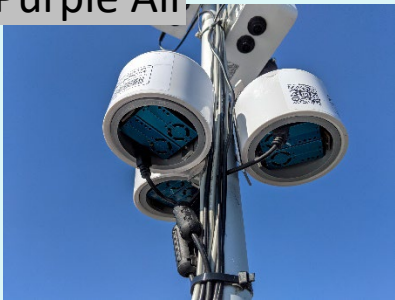**1 background sites**

Near-Road Site

Sensors Evaluation Criteria

- Intercomparison with Regulatory Monitors

- Sensor Degradation

- Performance during Special Air Quality Events (dust storms, wildfires, etc)
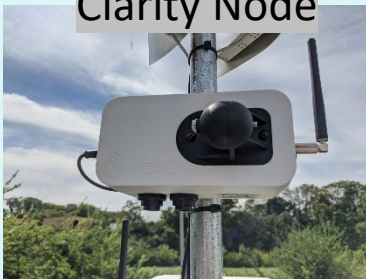
Sensors Evaluated in the Study

PM2.5 Sensors

Purple Air

AQ Egg

Clarity Node

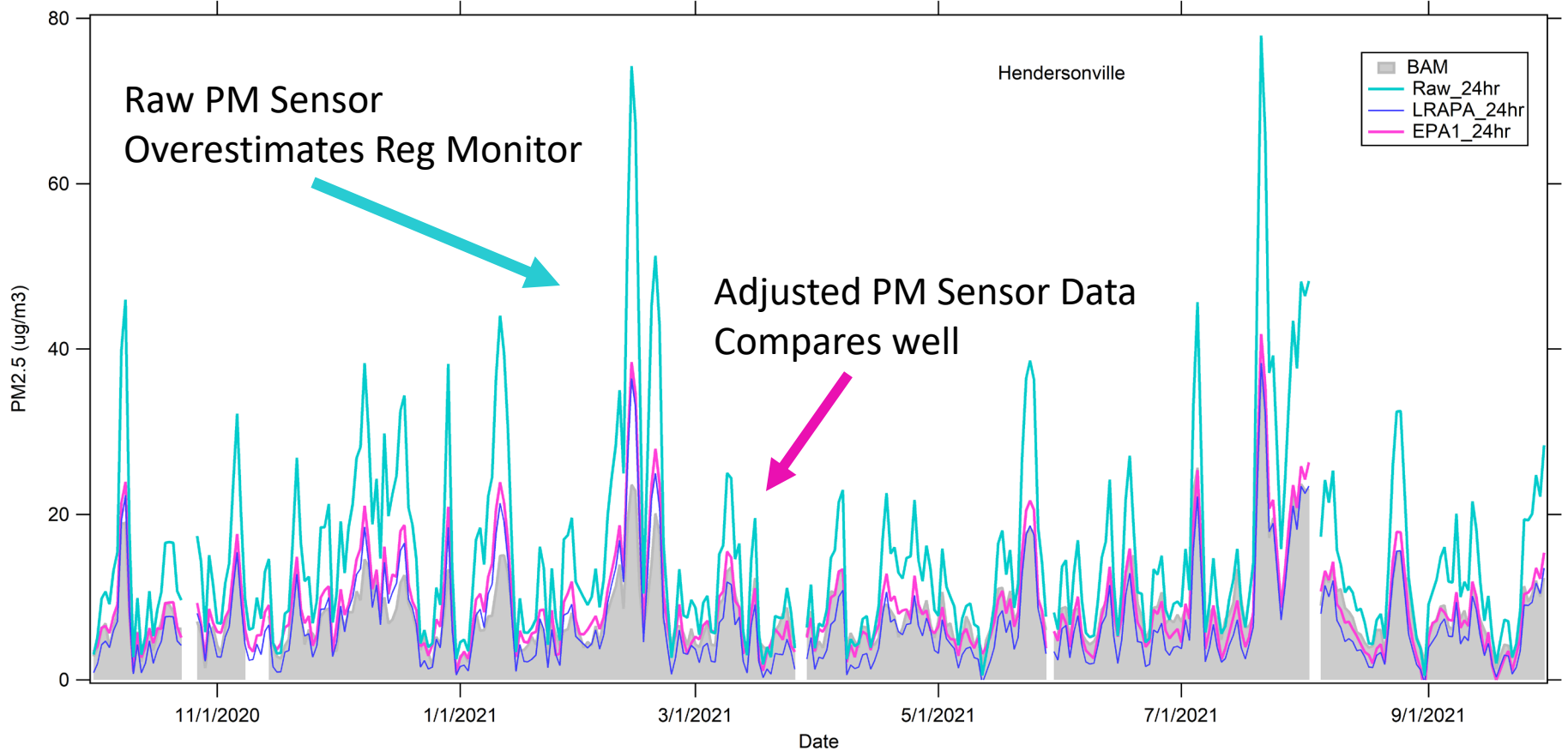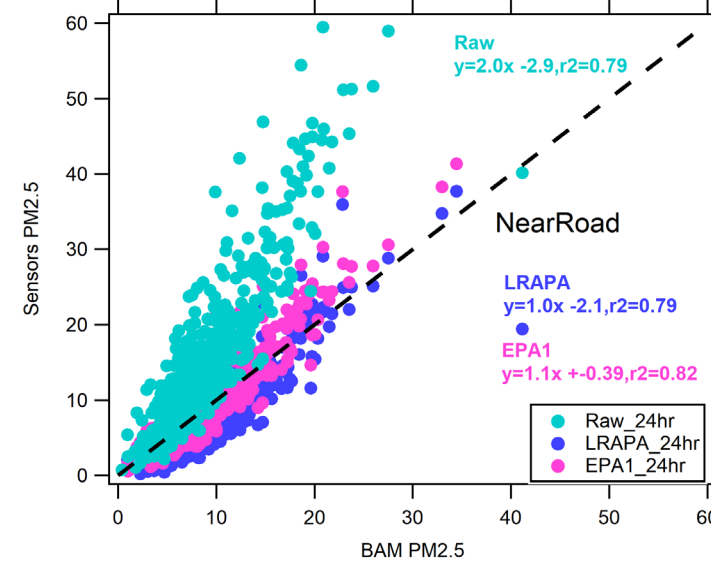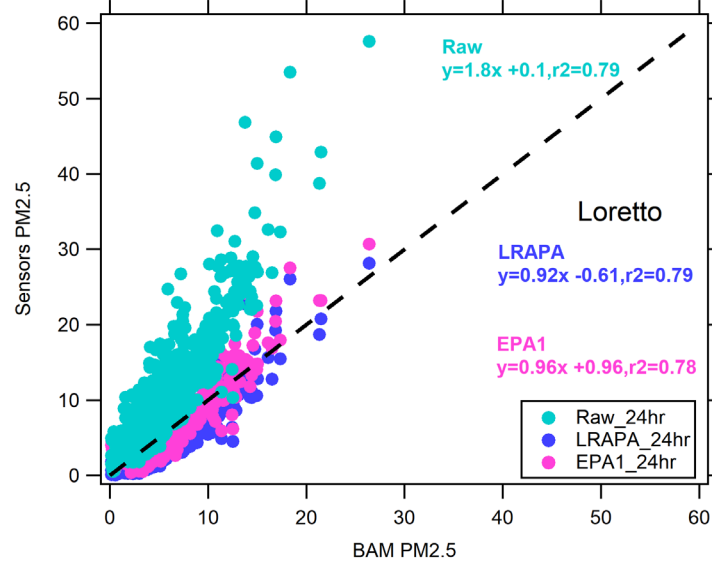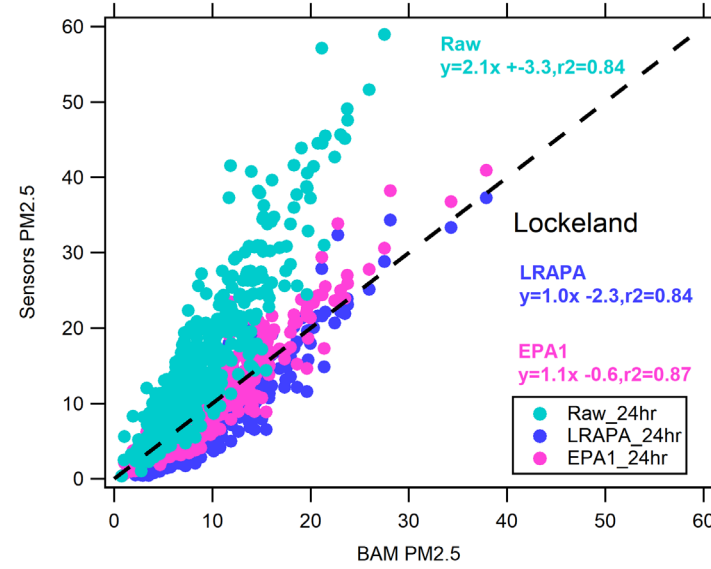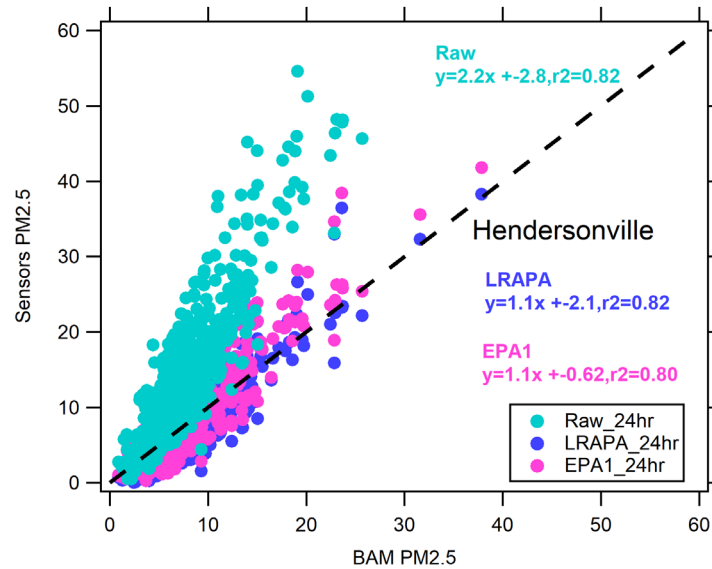## Gaseous Sensors

AQ Egg (O3, SO2, NO2)

Clarity Node (NO2)

TN

PM2.5 Sensor Results (Focus on Purple Air)

Raw Purple Air Overestimates FEMs

Data Adjustments: National EPA and LRAPA Adjustments

Raw PM Sensor Overestimates Reg Monitor

Adjusted PM Sensor Data Compares well

Hendersonville
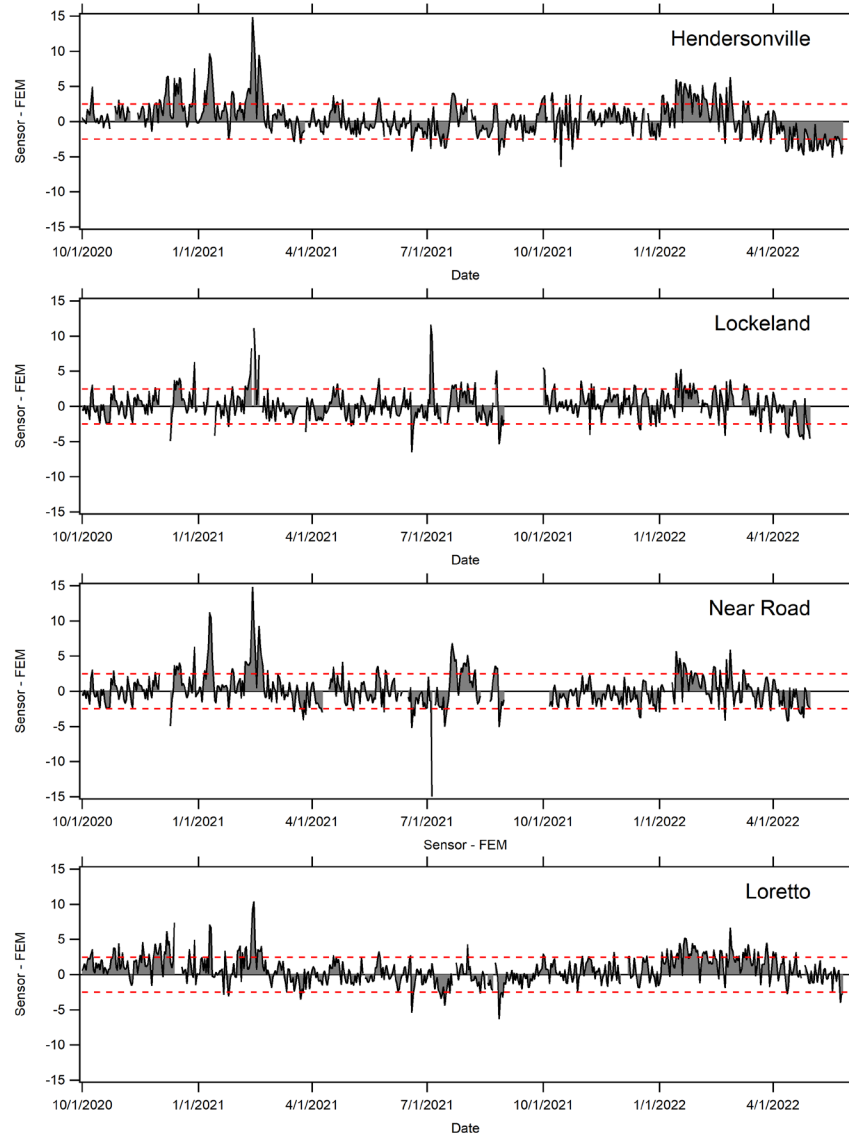
BAM
Raw_24hr
LRAPA_24hr
EPA1_24hr

PM2.5 (ug/m3)

Date

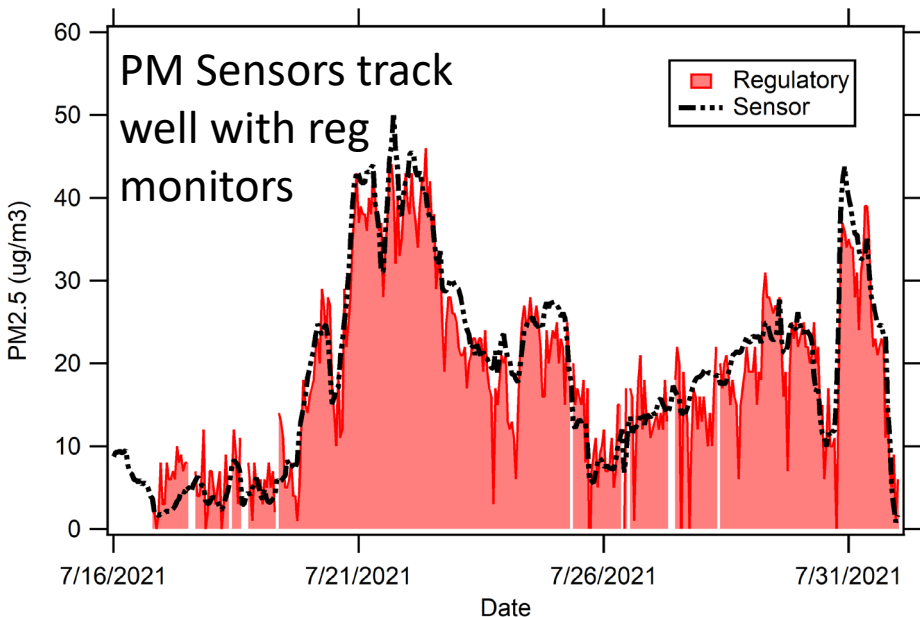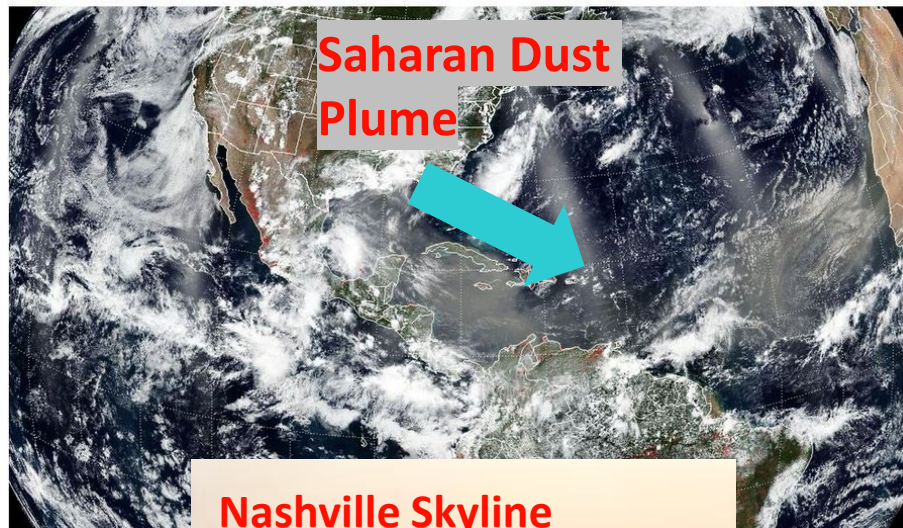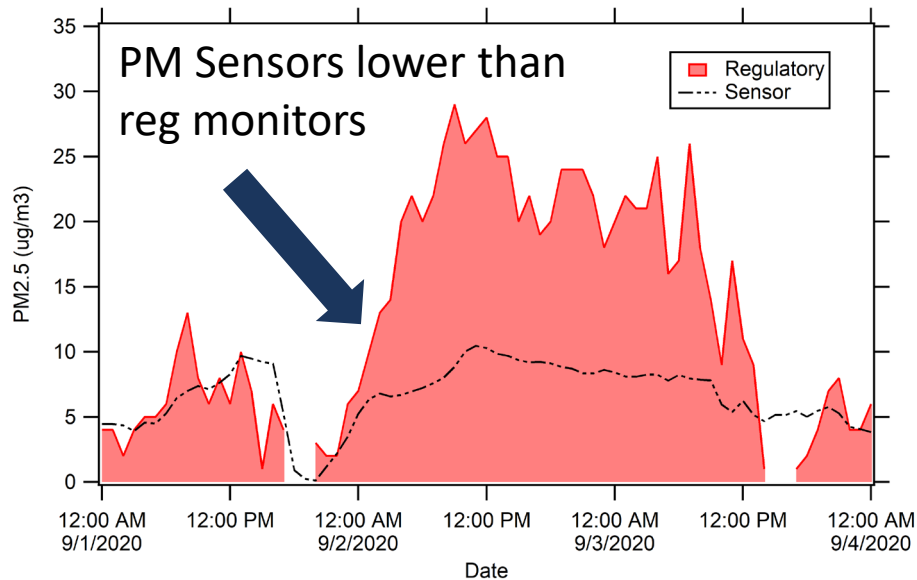# With Appropriate Adjustments, Purple Airs Compare Well with FEMs (near 1 to 1)

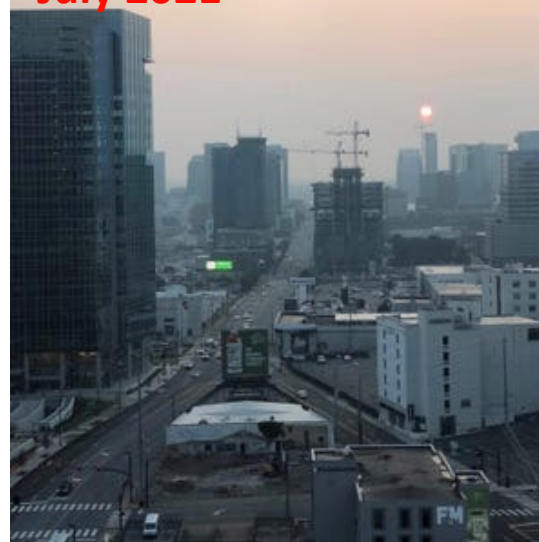# No Significant Sensor Degradation

Sensors performed well during 1.75 years of sampling with minimal maintenance.

Sensor Performance Impacted during Some Special Events

PM Sensors lower than reg monitors

Saharan Dust Plume

PM Sensors track well with reg monitors
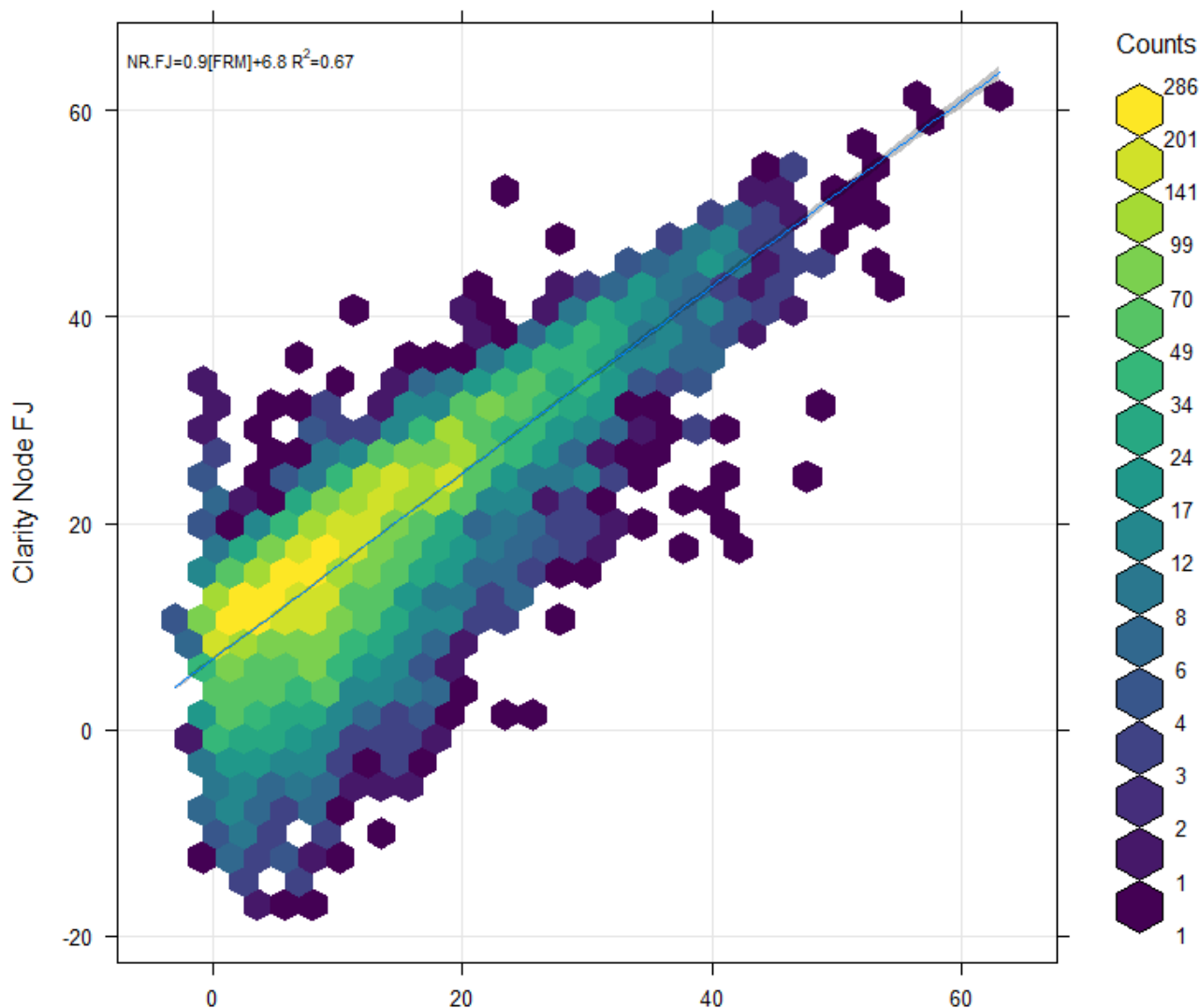
Nashville Skyline Impacted by Wildfires July 2021

Gaseous Sensor Results
Clarity Node and AQ Eggs
**Kudos to Kyle Spangle

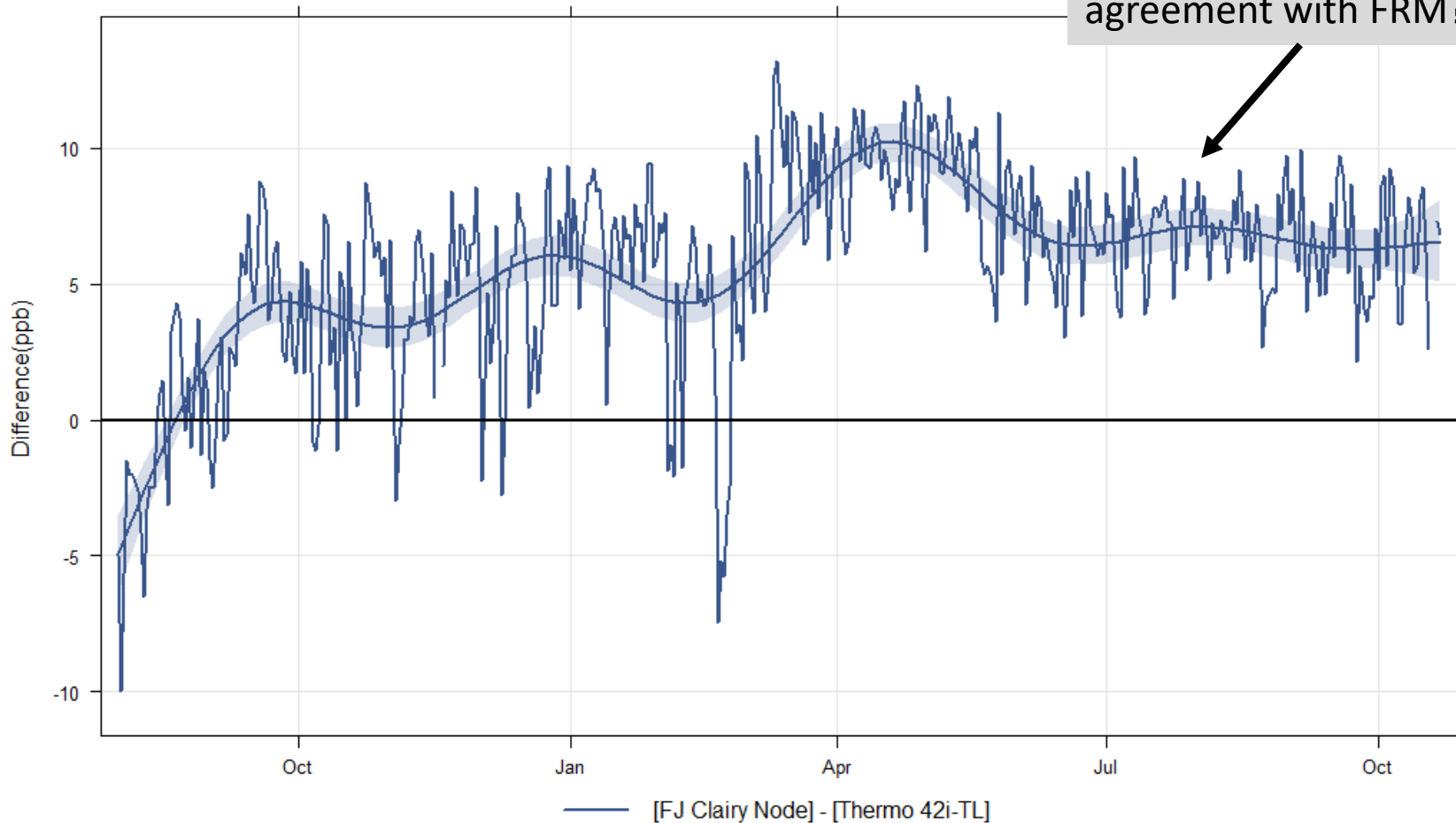# Clarity Node NO2 Compared well with the FRM, but some bias exists, especially at lower end

Clairty Node FJ & Regulatory Monitor Comparison
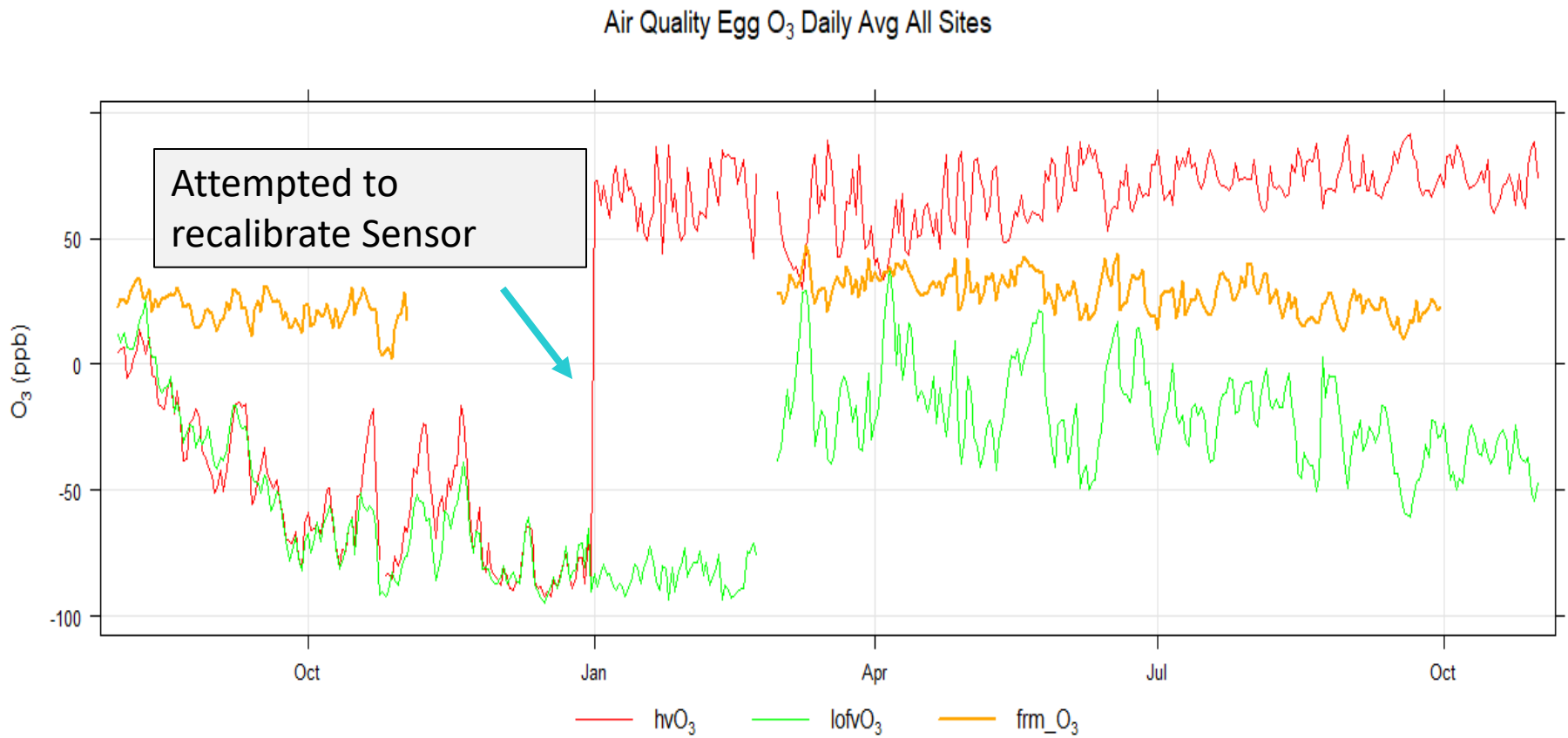
Sensor Drift towards End of Study

Daily Avg Difference (Sensor Minus Reference)

Sensor Drift points to positive bias in sensor, but still good agreement with FRM?

[FJ Clairy Node] - [Thermo 42i-TL]

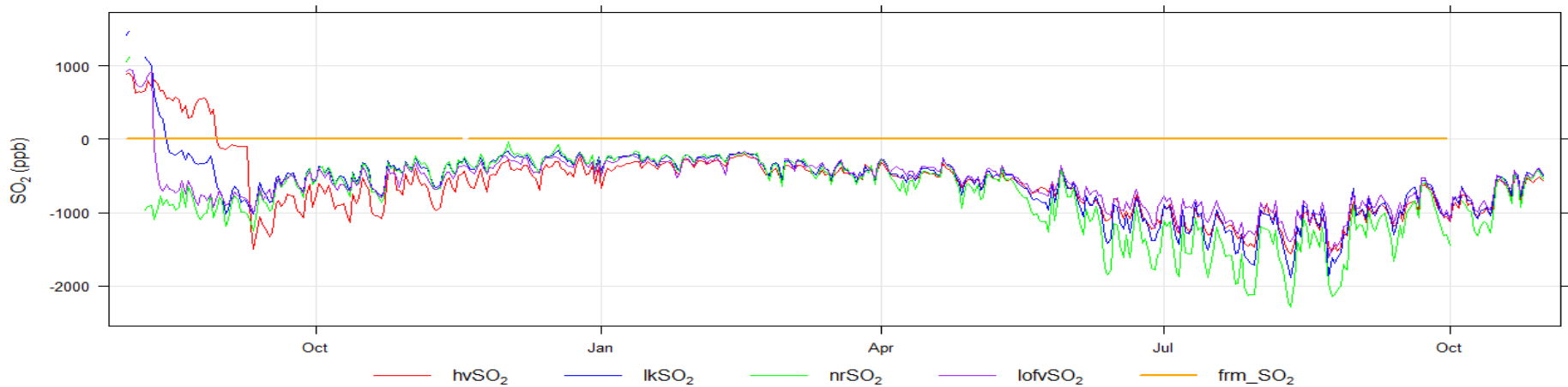# AQ Egg Showed Poor Performance "Out of the Box"

Air Quality Egg O_3 Daily Avg All Sites

Attempted to recalibrate Sensor

..as did the AQ Egg NO2 and SO2 Sensors

Air Quality Egg NO₂ Daily Avg All Sites
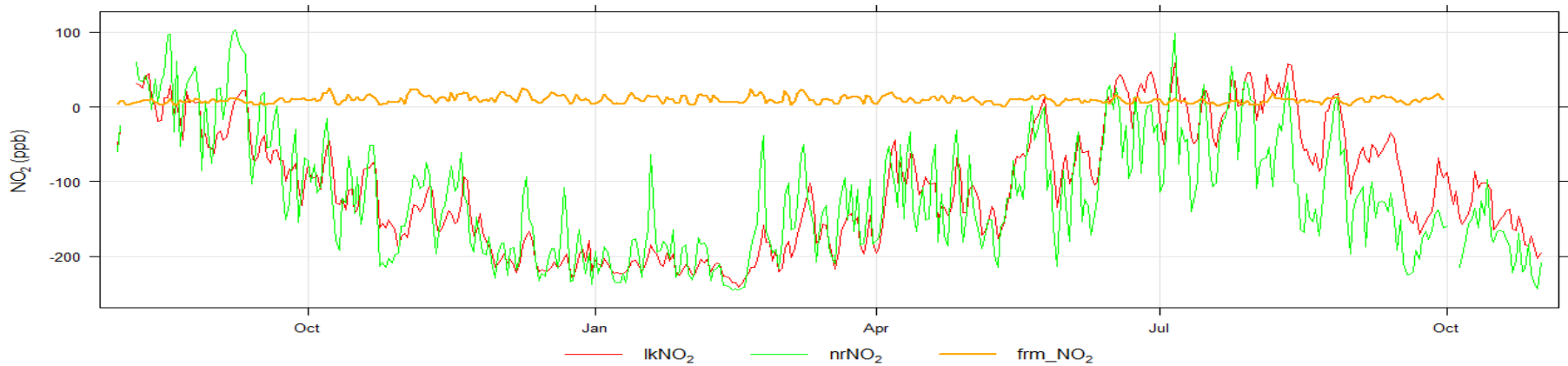
Air Quality Egg SO₂ Daily Avg All Sites

A Few Lessons Learned from our Study

- Sensors are not created equally.
  - PM sensor technology is further along than gaseous technology.

- Caution should be used when interpreting sensor data during special events (dust storms, etc).

- In our experience, sensor data interpretation requires AQ knowledge.
 - Partnering with AQ experts is recommended.

TN

What's Next?

- Determining the role of sensors in AQ Management
  - ***Not accepted for regulatory applications, but can be used to supplement regulatory data***
  - Examples of supplementary regulatory applications
    - Investigating Exceptional PM Events (Wildfires)
    - AQ Forecasting
    - Preliminary complaint response
  - Deploying PM2.5 sensors at regulatory PM and O3 sites
    - Assisting Data Validation
    - More multipollutant information
  - Testing Gaseous Sensors??

What's Next: PM Sensors Dashboard

Real-time readings for quality control

GREAT FOR DIAGNOSTICS!!
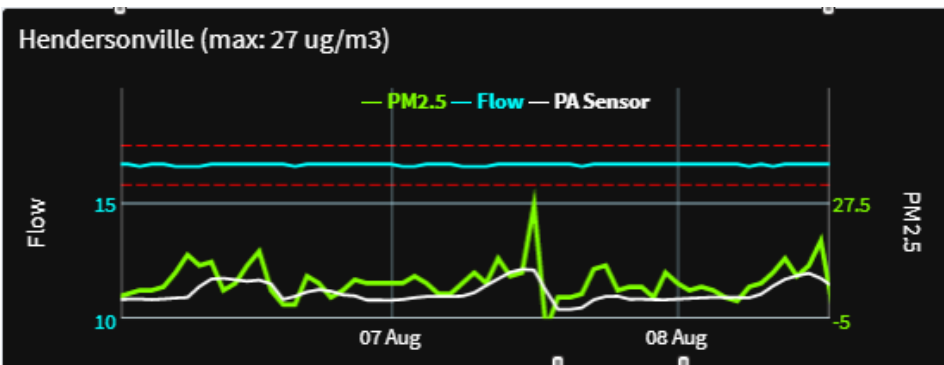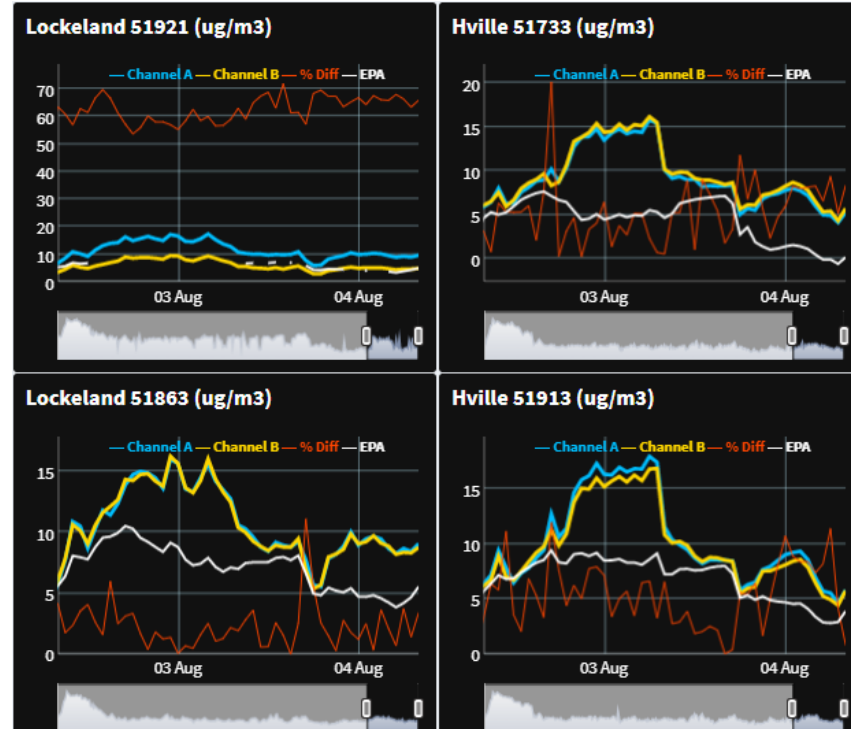
Real-time comparison with FEM

GREAT FOR VALIDATION & FORECASTING!!

Acknowledgements to the Sensors Team

Commissioner & Dep Commissioner Site Visit (March 2021)

Collaborators

APC Team (pictured left to right): Alvin Pratt, Kyle Spangle, Brad King, Michelle Oakes, Larry Yocom
Not pictured: Director Michelle Owenby

Director John Finke
Gillian Walshe-Langford
Greg Lowery
Morgan Dickie