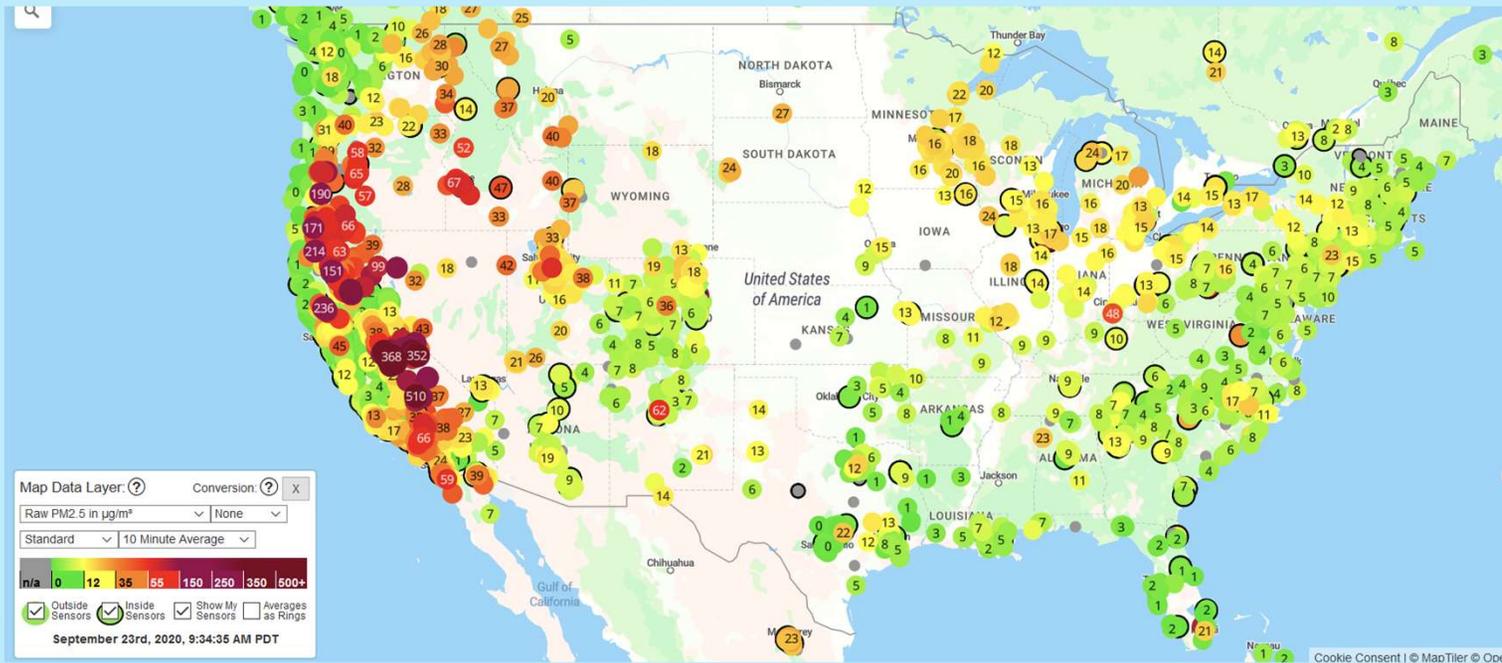


# Purple air corrections for different aerosol types

Colleen Miller and Dan Jaffe

University of Washington Bothell School of STEM

PNW Airquest Meeting, October 1, 2020



Purple air map showing operating sensors in the United States on 23 Sept. 2020



UNIVERSITY of WASHINGTON

# Purple Air (PA) Sensors



Indoor purple air sensor

- Based on Plantower PMS5003, laser scattering.
- Conversion of scattering to PM mass makes many assumptions about aerosol size distribution and composition.
- Off the shelf units appears to be precise, but not accurate.
- Empirical corrections for PM<sub>2.5</sub> have been developed LRAPA, U.Utah and EPA. The LRAPA and EPA calibration equations give similar results. Utah eqn gives higher values.
- EPA recently began to integrate PA data into Airnow.



# Project Goals

- Does the response factor for purple air sensors change depending on different pollution types?
- What is the validity of the EPA correction equation across different aerosol types?
- How important is humidity in the correction equation?

To address these, we will look at the PA response compared to regulatory data for typical urban, smoke, and dust aerosol events



# Overall Method

## ➤ Cases identified as having outside PA data near regulatory sites during pollution events

- Typical urban events: hourly PM 2.5 measurements exceeded  $30 \mu\text{g m}^{-3}$  at regulatory sites during non-wildfire season without smoke presence
- Smoke events: hourly PM 2.5 measurements exceeded  $30 \mu\text{g m}^{-3}$  at regulatory sites during wildfire season and in the presence of smoke (confirmed by HMS Fire and Smoke Product).
- Dust events: hourly PM 2.5 measurements exceeded  $30 \mu\text{g m}^{-3}$  at regulatory sites during known dust events. Dust events also confirmed as having very high  $\text{PM}_{10}/\text{PM}_{2.5}$  ratio (in progress).
- Average distance between PA and regulatory monitor is 7 km (range 0-16 km)

## ➤ Purple Air Data

- Average of A and B channels
- Use raw PA data with  $C_f = 1$

## ➤ Performed linear regression analysis on hourly data with and without EPA correction

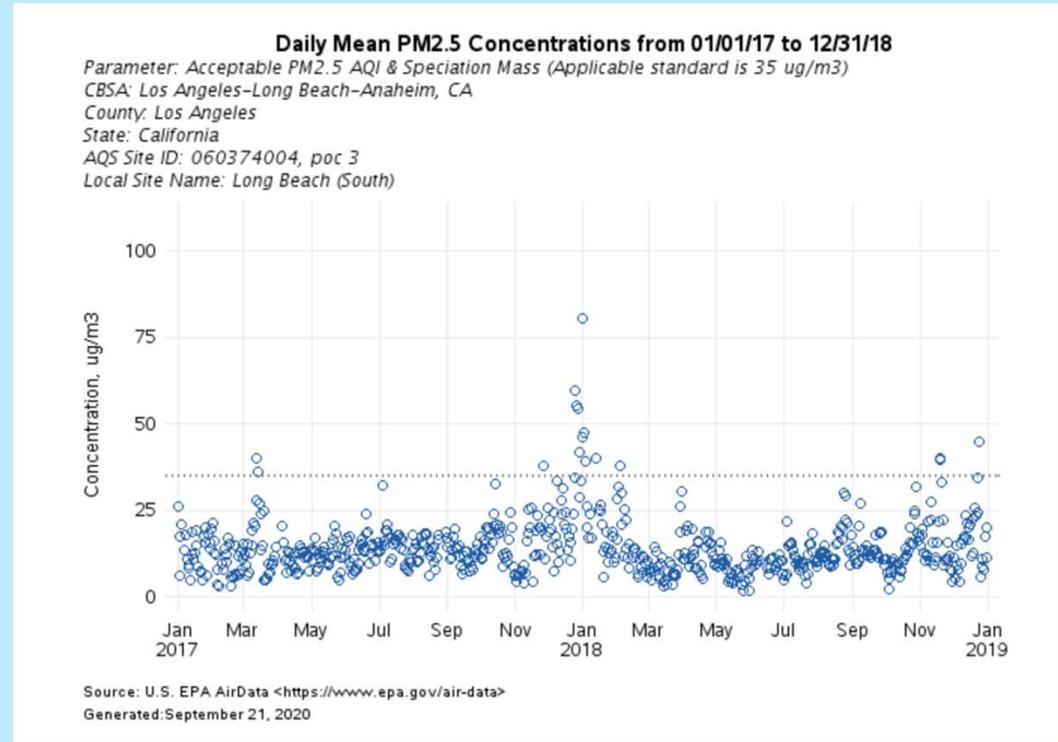
- $R^2$  criteria – results must be higher than 0.7 to be included.

## ➤ EPA national PA correction: $\text{PM}_{2.5} \text{ corrected} = 0.52 * [\text{PA\_cf1}(\text{avgAB})] - 0.085 * \text{RH} + 5.71$



# Methods: Typical Urban Events

- Analyzed winter-time PM<sub>2.5</sub> concentrations for select nonattainment cities.
- Most are in winter so may have a significant residential wood combustion component.
- 16 cases lasting between 24 and 96 hours
  - 7 in San Francisco, CA
  - 6 in Los Angeles, CA
  - 3 in Salt Lake City, UT

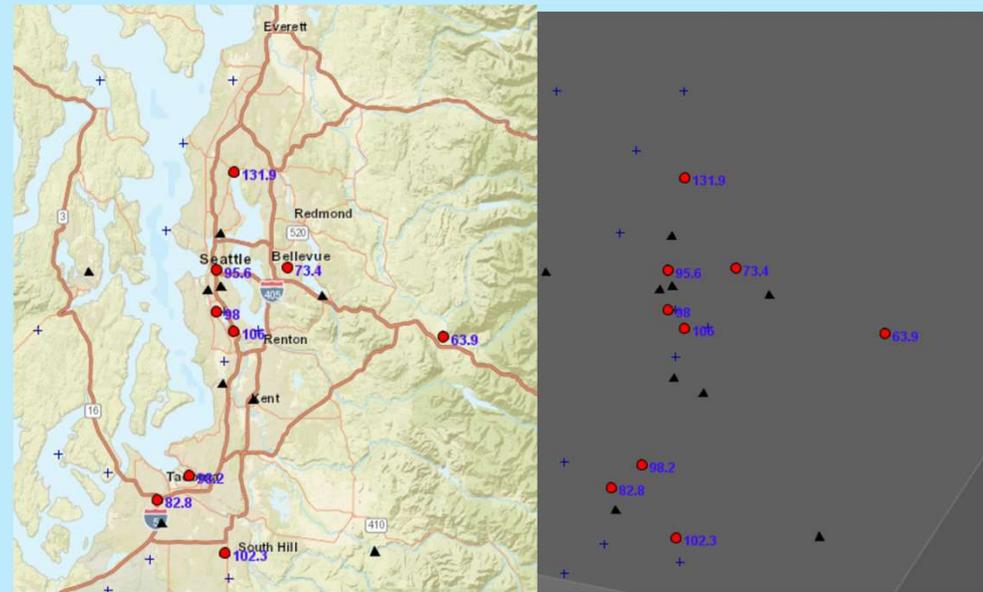


**Daily mean PM<sub>2.5</sub> concentration in Los Angeles, CA.**



# Methods: Smoke Events

- Events determined using [airnowtech.com](http://airnowtech.com) to locate fires and smoke plumes
  - Looking for smoke events exceeding  $30 \mu\text{g m}^{-3}$
- 21 cases lasting between 5 and 25 days
  - 3 in Seattle, WA
  - 6 in Portland, OR
  - 2 in Eugene, OR
  - 1 in Medford, OR
  - 2 in Chico, CA
  - 1 in Boise ID
  - 6 Fairbanks, AK



**Puget Sound with and without smoke overlay for 22 Aug 2018 from [airnowtech.com](http://airnowtech.com) used in determining smoke events.**

# Methods: Dust Events

- Analyzed data from the 2019 Phoenix AZ dust storm and the Saharan dust cloud that occurred this June
- 8 cases lasting between 24 and 46 hours
  - 2 in Phoenix, AZ
  - 2 in Denton, TX
  - 2 in Birmingham, AL
  - 1 in Wichita, KS
  - 1 in Tulsa, OK



# Results: Typical Urban Case Compared with EPA Correction

Figure 5: PA (AQMD\_NASA\_17) vs Reg (AQS: 60370016) Los Angeles, CA 31 Dec 2017 - 3 Jan 2018

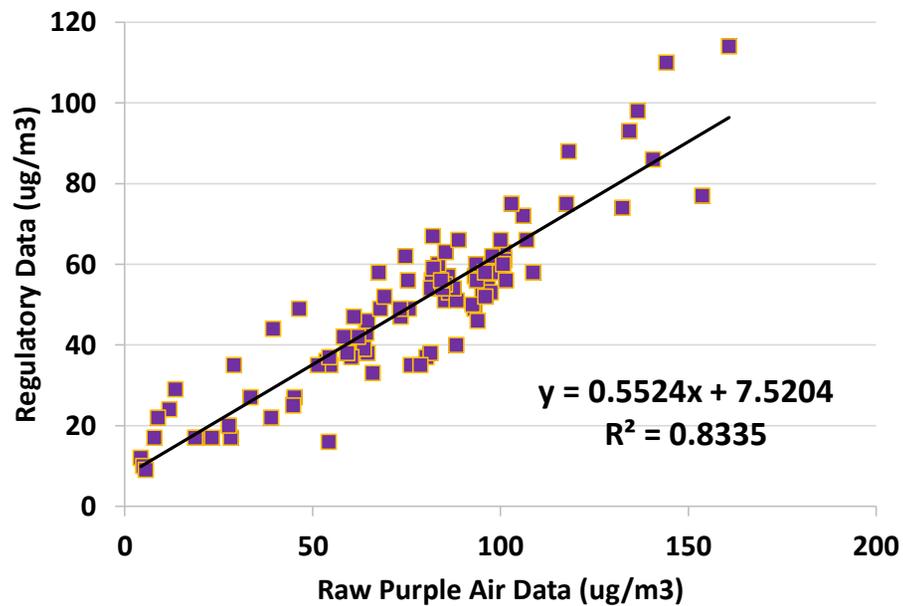
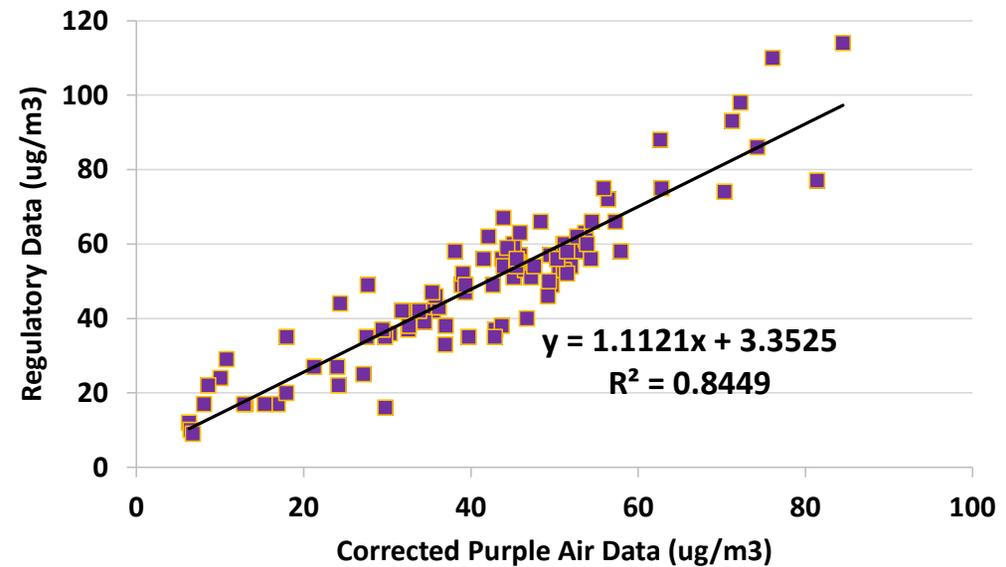


Figure 6: EPA Corrected PA (AQMD\_NASA\_17) vs Reg (AQS: 60370016) Los Angeles, CA 31 Dec 2017 - 3 Jan 2018



# Results: Smoke Cases Compared with EPA Correction

Figure 7: PA (Entari) vs Reg (AQS: 530330031) Bellevue, WA  
8 Aug - 18 Aug 2017

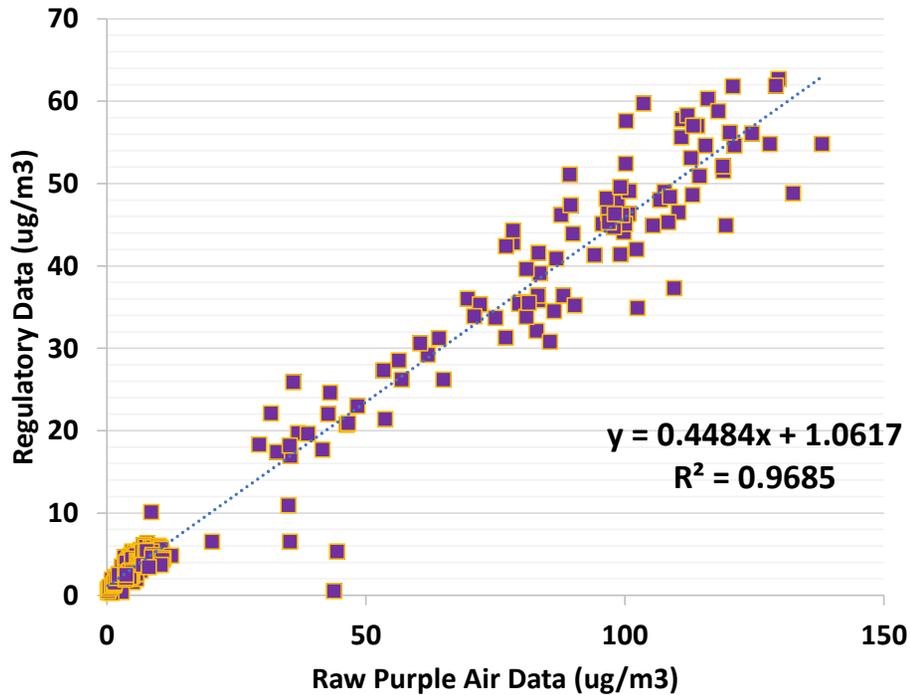
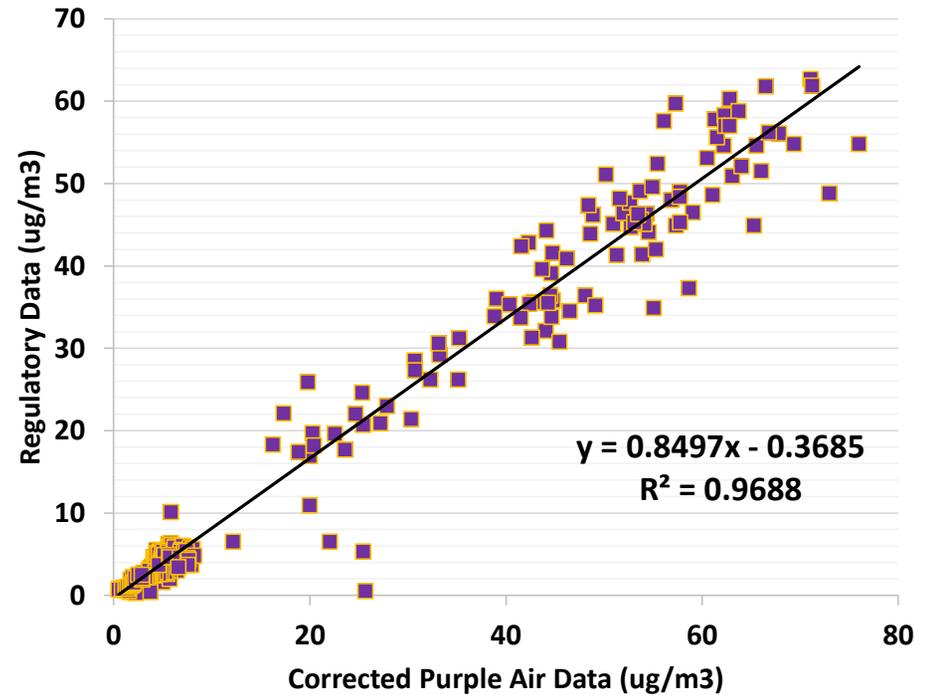


Figure 8: EPA Corrected PA (Entari) vs Reg (AQS: 530330031) Bellevue, WA  
8 Aug - 18 Aug 2017



# Results: Dust Cases Compared with EPA Correction

Figure 9: PA (Creative Montessori School) vs Reg (AQ5: 10730023) Birmingham, AL 26 Jun 2020

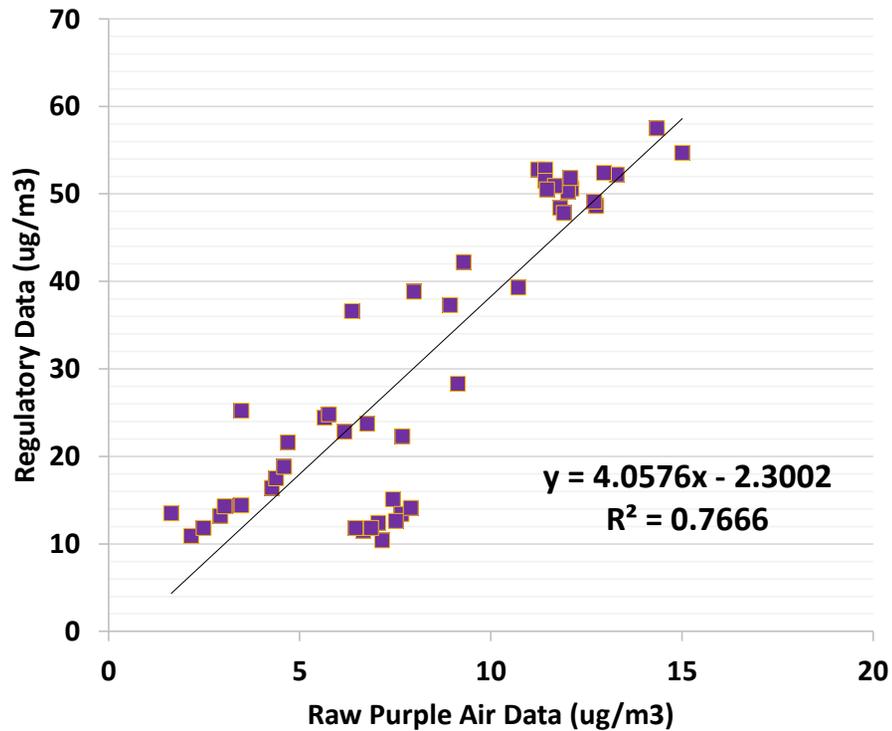
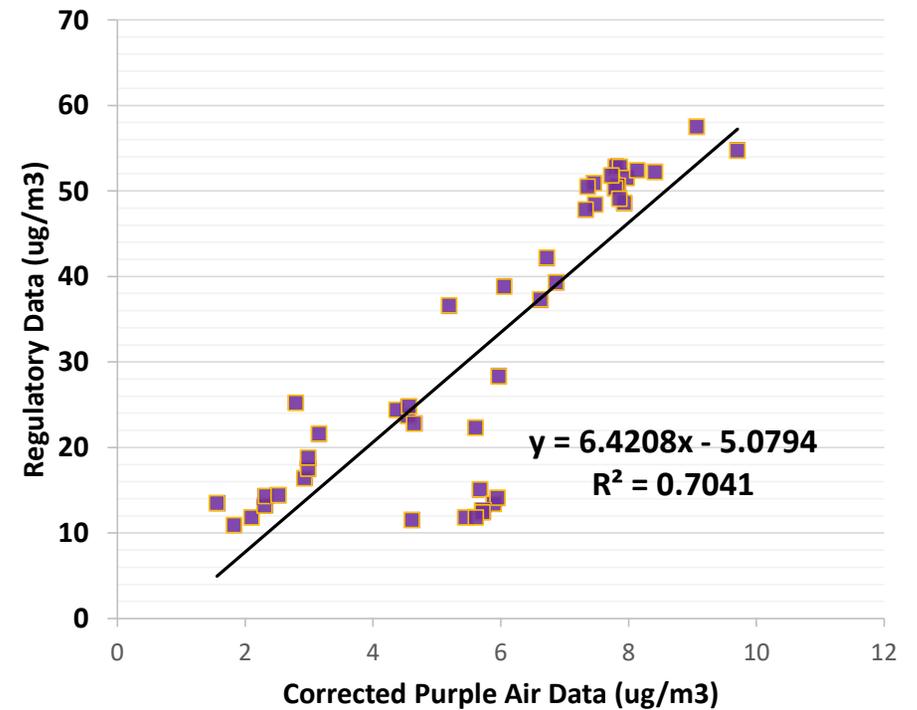


Figure 10: Corrected PA (Creative Montessori School) vs Reg (AQ5: 10730023) Birmingham, AL 26 Jun 2020



# Results and Summary

Table 1: Report Table for Average Slopes and R2 for Raw and Corrected PA Data

	Avg Slope PA vs Reg Data	Avg R <sup>2</sup> PA vs Reg Data	Avg Slope PA w/EPA Correction	Avg R <sup>2</sup> PA w/ EPA Correction
Typical Urban Events (16 cases)	0.5172	0.7822	1.009	0.7841
Smoke Events (21 cases)	0.4984	0.8699	0.9528	0.8633
Dust Events (8 cases)	4.461	0.7902	7.922	0.7534

1) Raw PA data overestimates typical urban and smoke pollution and underestimates dust pollution.

2) EPA correction equation does a very good job on typical urban and smoke events.

3) EPA correction equation does a poor job when applied to dust events.

4) R2 for individual events is similar whether looking at raw data or using EPA correction equation. This suggests that for elevated PM events, there is not any evidence that humidity improves the relationship.

