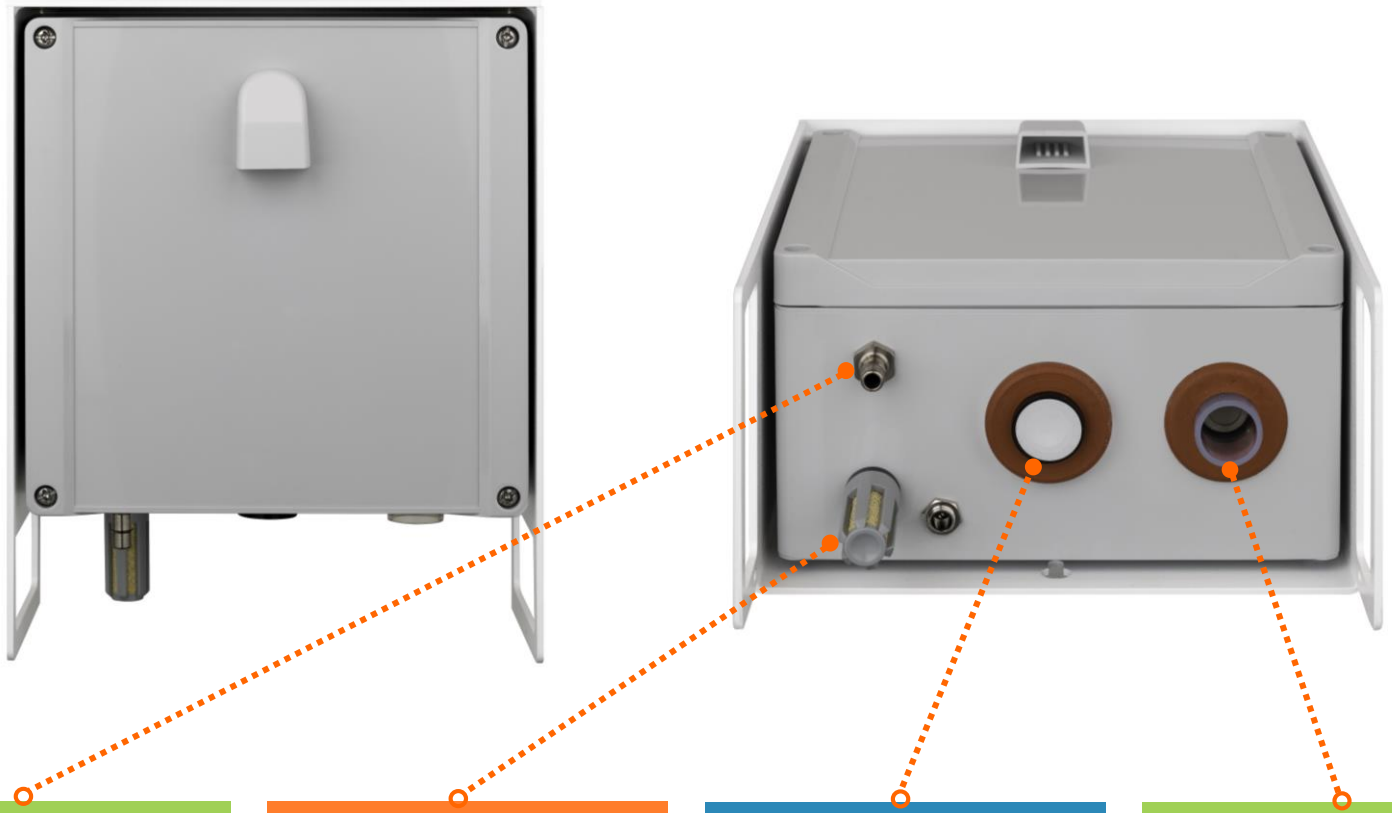
Low-cost air quality sensor network deployment and data analysis

Kyle A. Alberti[1,2], Geoff Henshaw[1], Hamesh Patel[2], Brandon Feenstra[3],
Berj Der Boghossian[3], Vasileios Papapostolou[3], Lita Lee[1,2], Jonathan Taylor[1], David E. Williams[2]

1. Aeroqual Ltd, Auckland, NZ
2. University of Auckland, Auckland, NZ
3. South Coast Air Quality Management District, Diamond Bar, CA, USA

Instrument Overview

Aeroqual AQY



Humidity-corrected $PM_{2.5}$

Temperature, Humidity & Dew Point

Electrochemical NO_2

Gas-sensitive Semiconductor O_3

Project Overview

Instrument Deployment

100 instruments deployed to-date in Southern California

- Distributed in 4 primary regions
  - Riverside/San Bernardino (~50)
  - Central Los Angeles (~25)
  - Imperial County (~15)
  - Catalina Island (4, 2x2 co-located)

Deployed in 4 batches

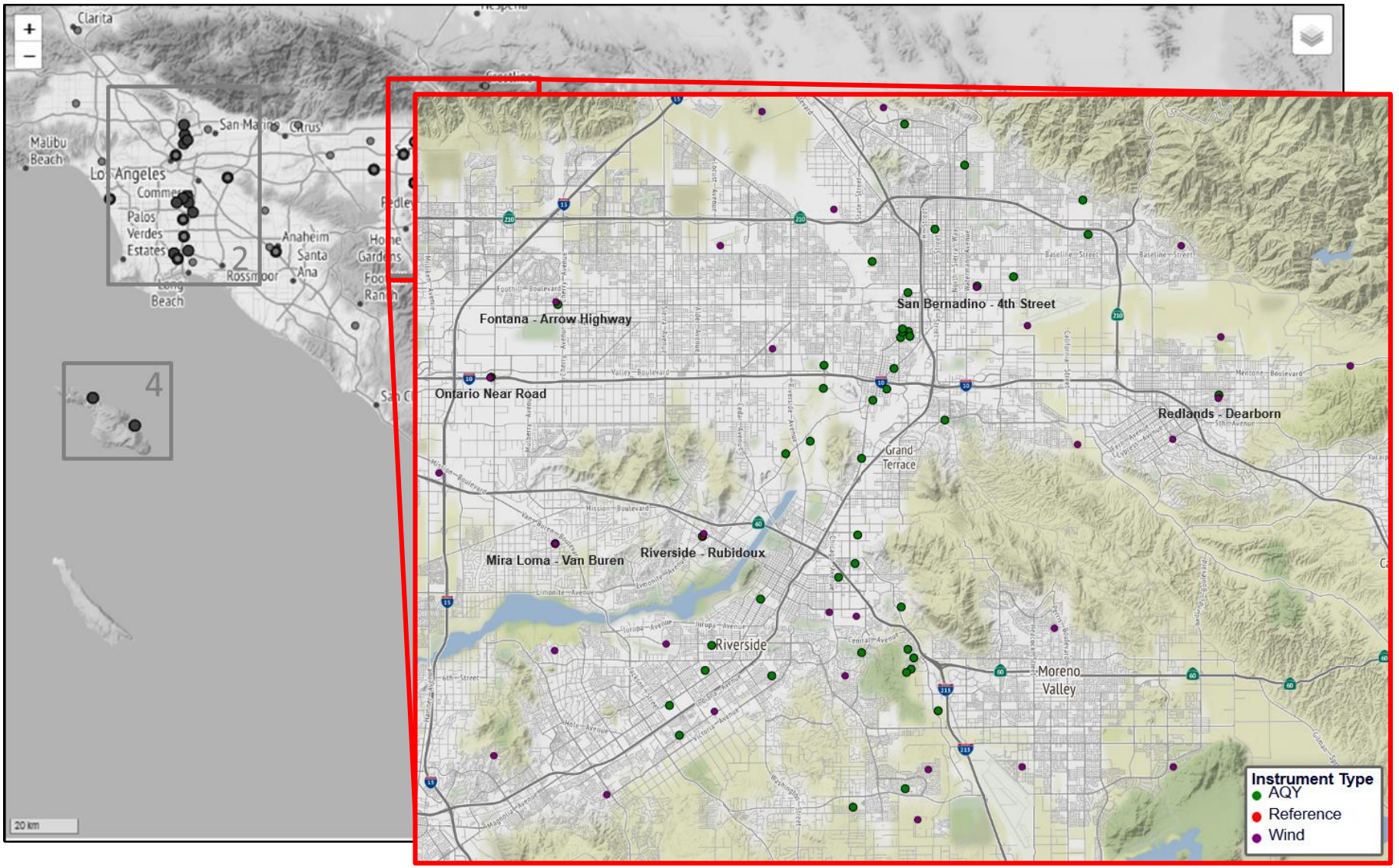
- 1st – November 2017
- 2nd – December 2017
- 3rd – February 2018
- 4th – March/April 2018

Co-locations:

- O_3 reference: 15 sites
- NO_2 reference: 15 sites
- $PM_{2.5}$ reference: 3 sites

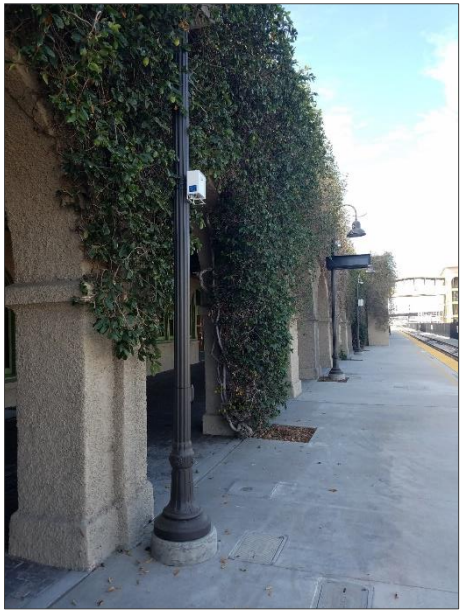
Instrument Locations

Southern California Network



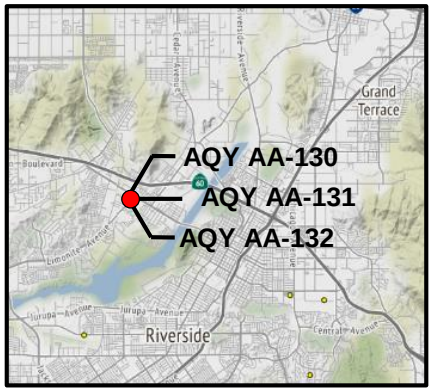
Site Photos

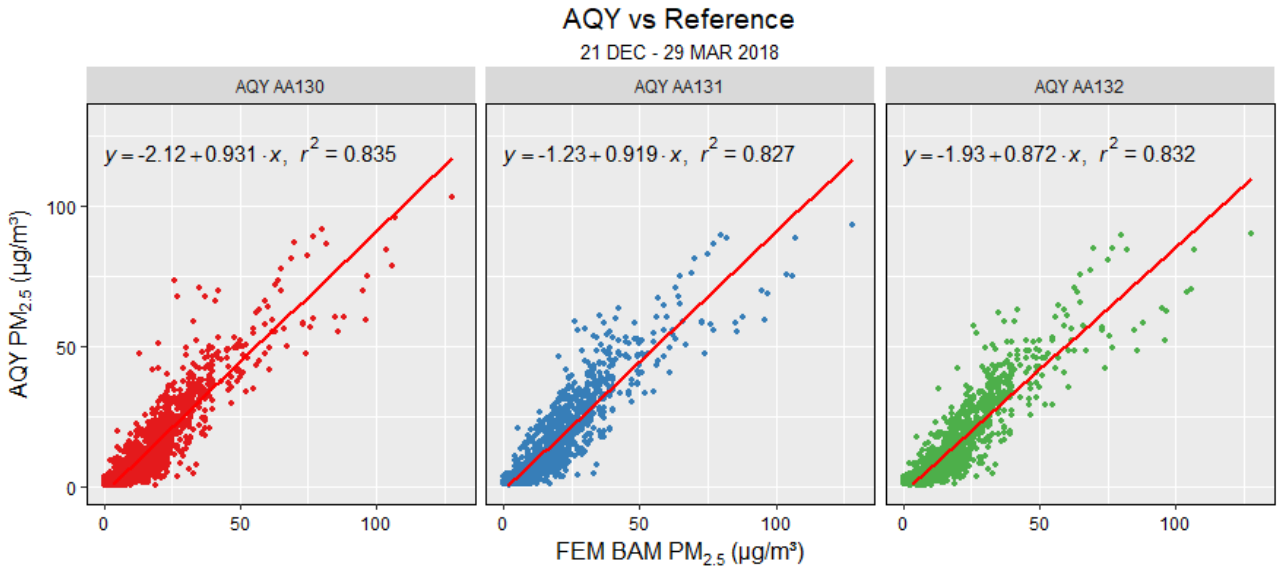



Short Term Instrument Performance – $PM_{2.5}$

- Three instruments co-located at the same reference site
- Hourly-averaged data over a period of 3 months



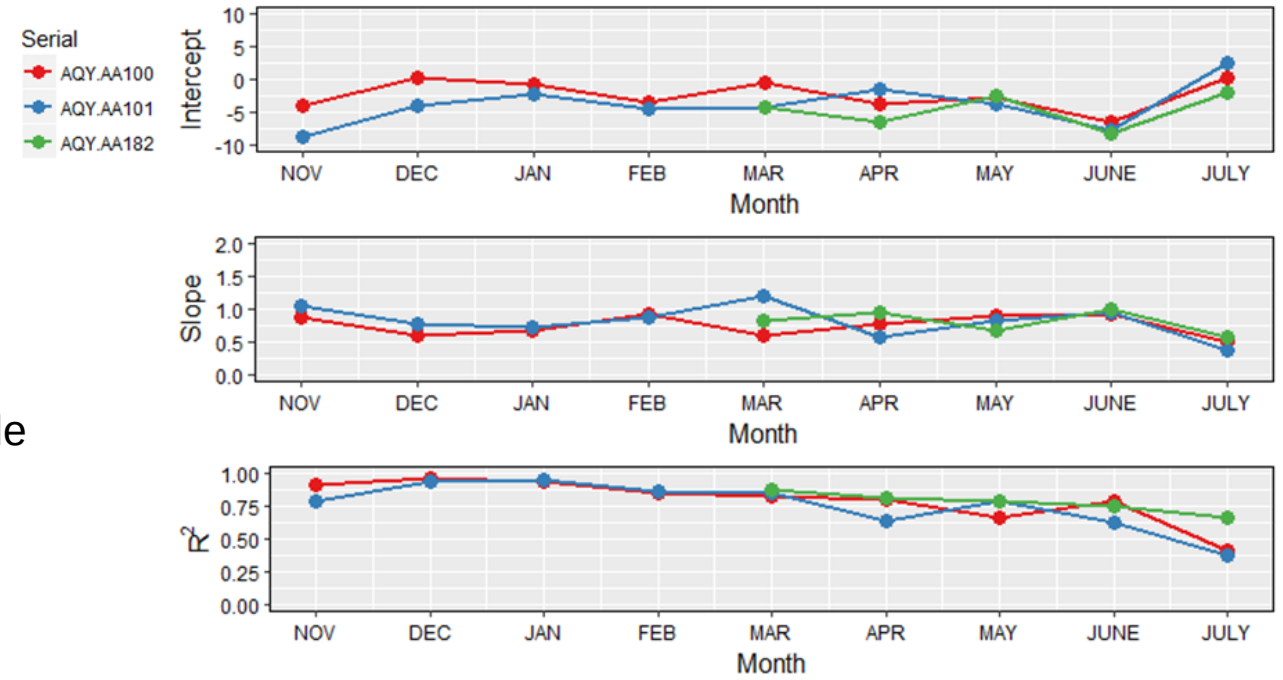


	R^2	Slope	Intercept
vs Reference	0.831	0.91	-1.76
Between Instruments	0.987	0.99	0.27

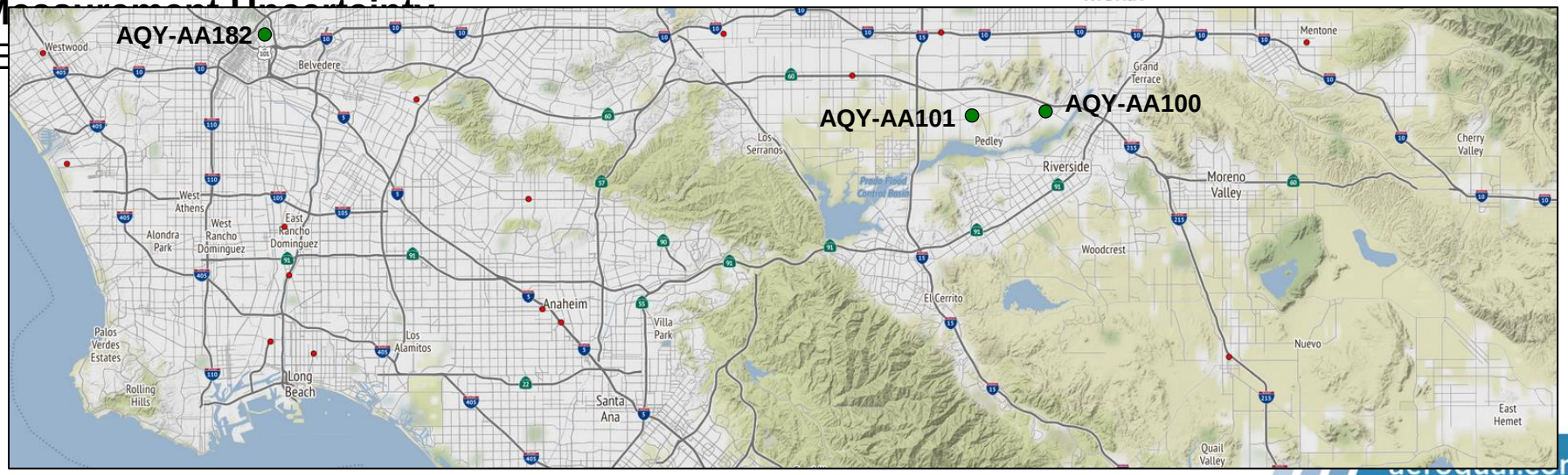
Long Term Instrument Performance - $PM_{2.5}$

Linear Correlation

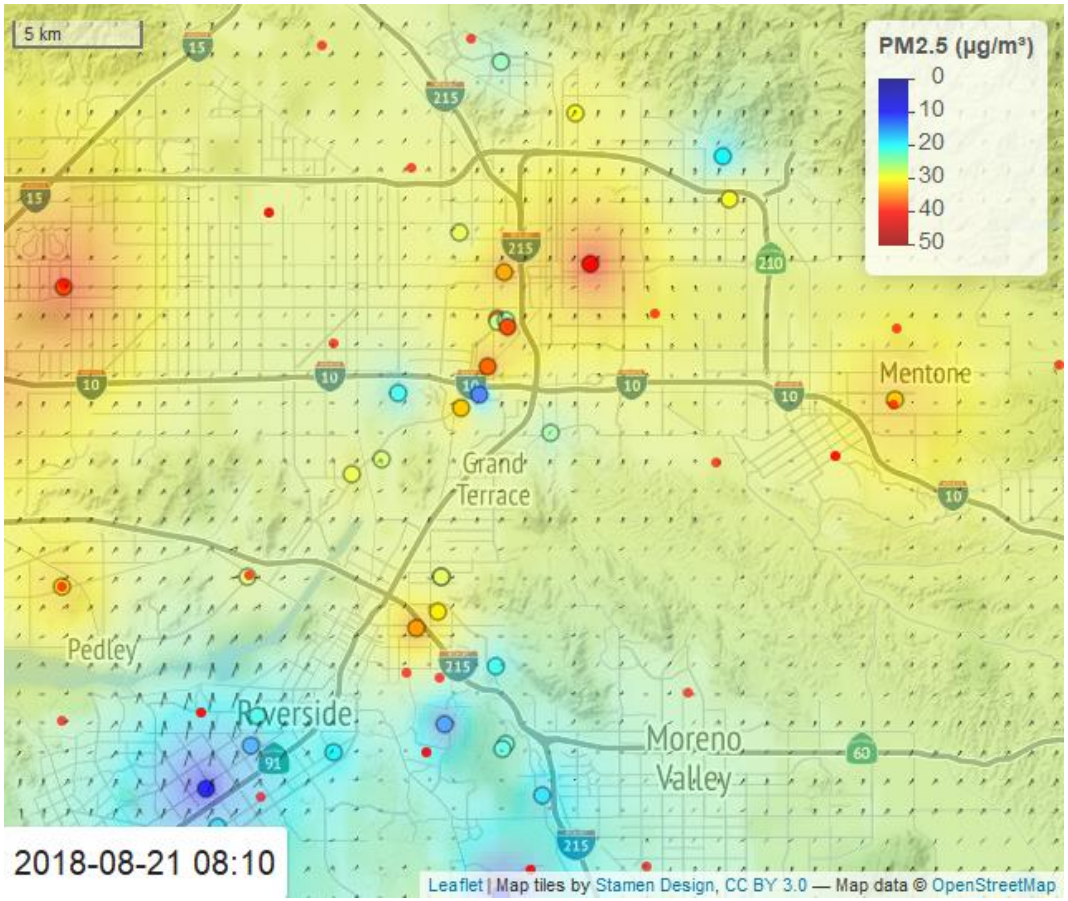
- 24h-averaged data, statistics calculated by month
- PM sensors not site calibrated
- Slope and intercept stable over time
- Good R^2 for 5-6 months



M
(E
-
-
-



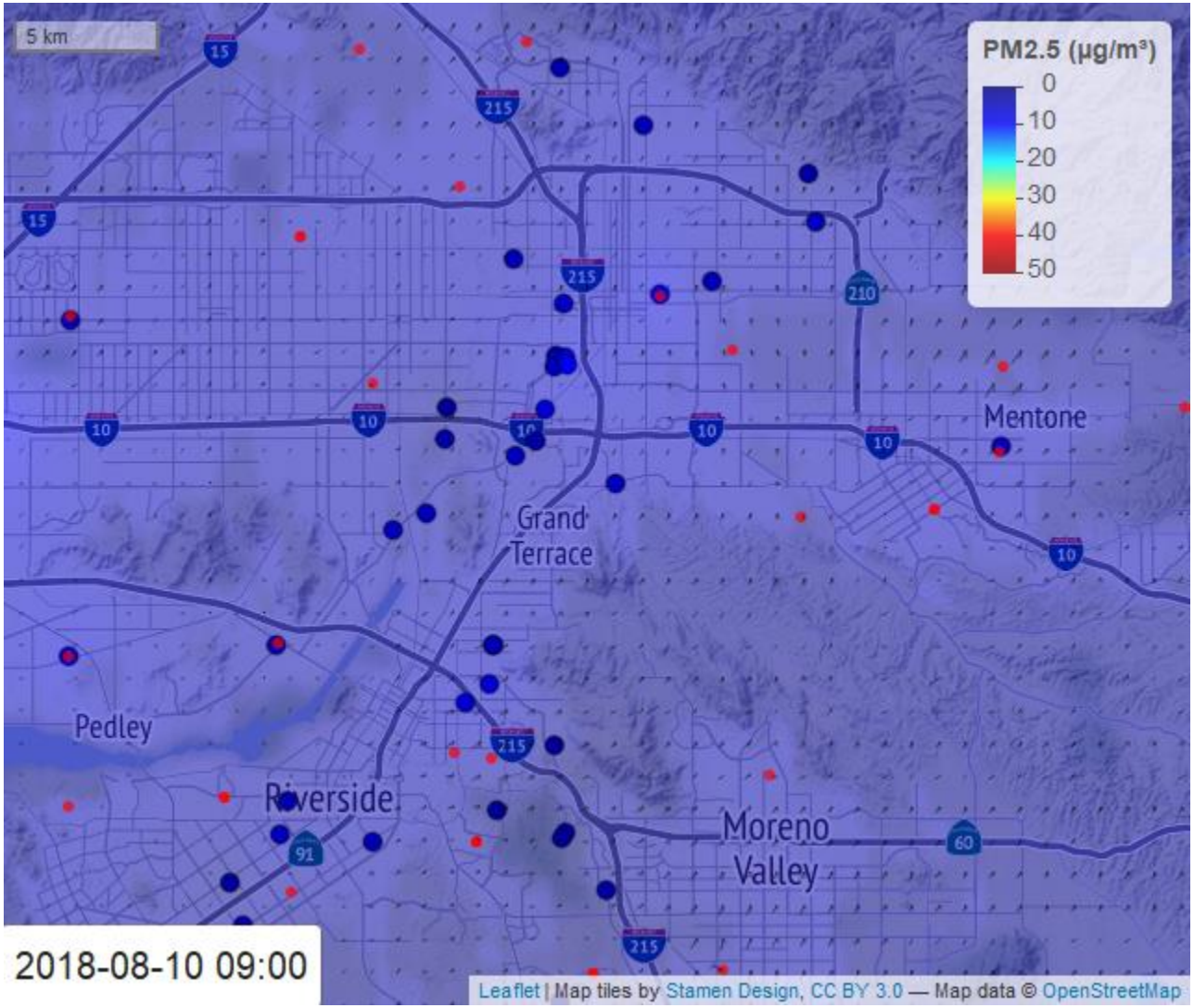
Network Visualization



Network Data:

- AQY data pushed to cloud server in real-time
- Heatmap generated using inverse-distance weighted interpolation
  (via R – gstat, raster, Leaflet)
- Wind data downloaded via MesoWest API
  (https://mesowest.utah.edu/, https://synopticlabs.org/api/mesonet)
- Wind data interpolated as indicative indication of conditions

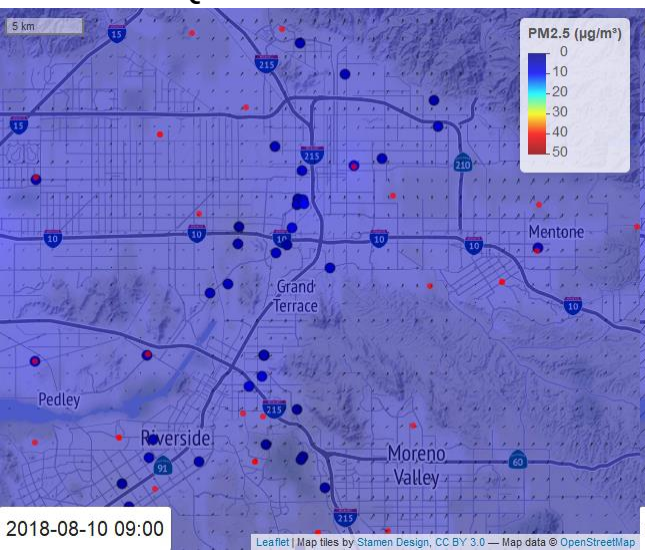
Event Detection



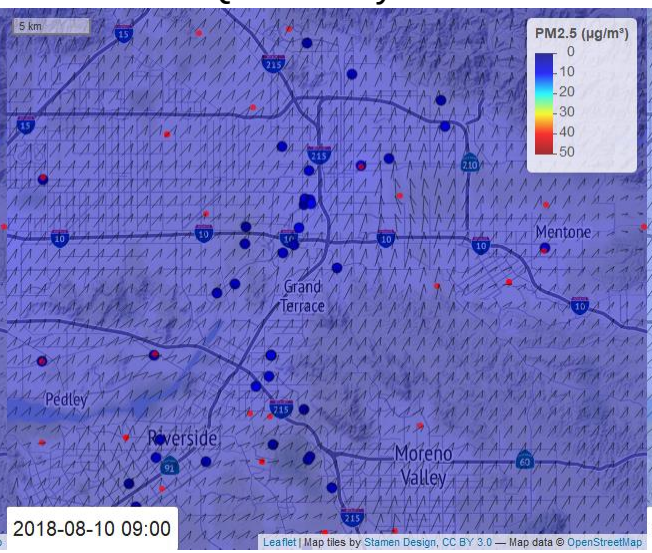
10-minute data averaging

High Spatial and Temporal Resolution

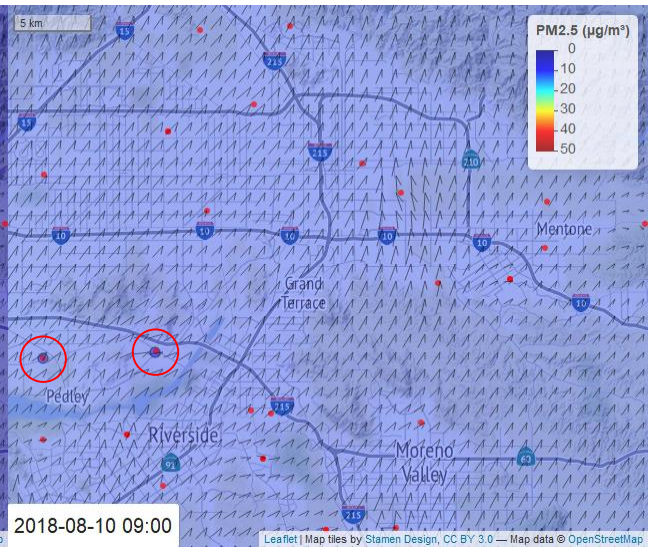
AQY 10-minute data



AQY - hourly data



Reference - hourly



- Higher time resolution provides more information about the event
- Higher density detects more isolated events

What Next?

With a large deployed network - developing methods:

- How do we remotely validate data from an instrument?
- How do we remotely calibrate the network?
- How do we analyse data from a network like this?

Acknowledgements

Aeroqual Ltd

- Dr. Geoff Henshaw
- Dr. Lita Lee
- Dr. Elaine Miles
- Jonathan Taylor

University of Auckland

- Prof. David Williams
- Hamesh Patel
- Dr. Georgia Miskell

South Coast Air Quality Management District

- Brandon Feenstra
- Berj Der Boghossian
- Dr. Vasileios Papapostolou
- Dr. Andrea Polidori