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Puget Sound Clean Air Agency

Working together for clean air

PSCAA: Air Sensors

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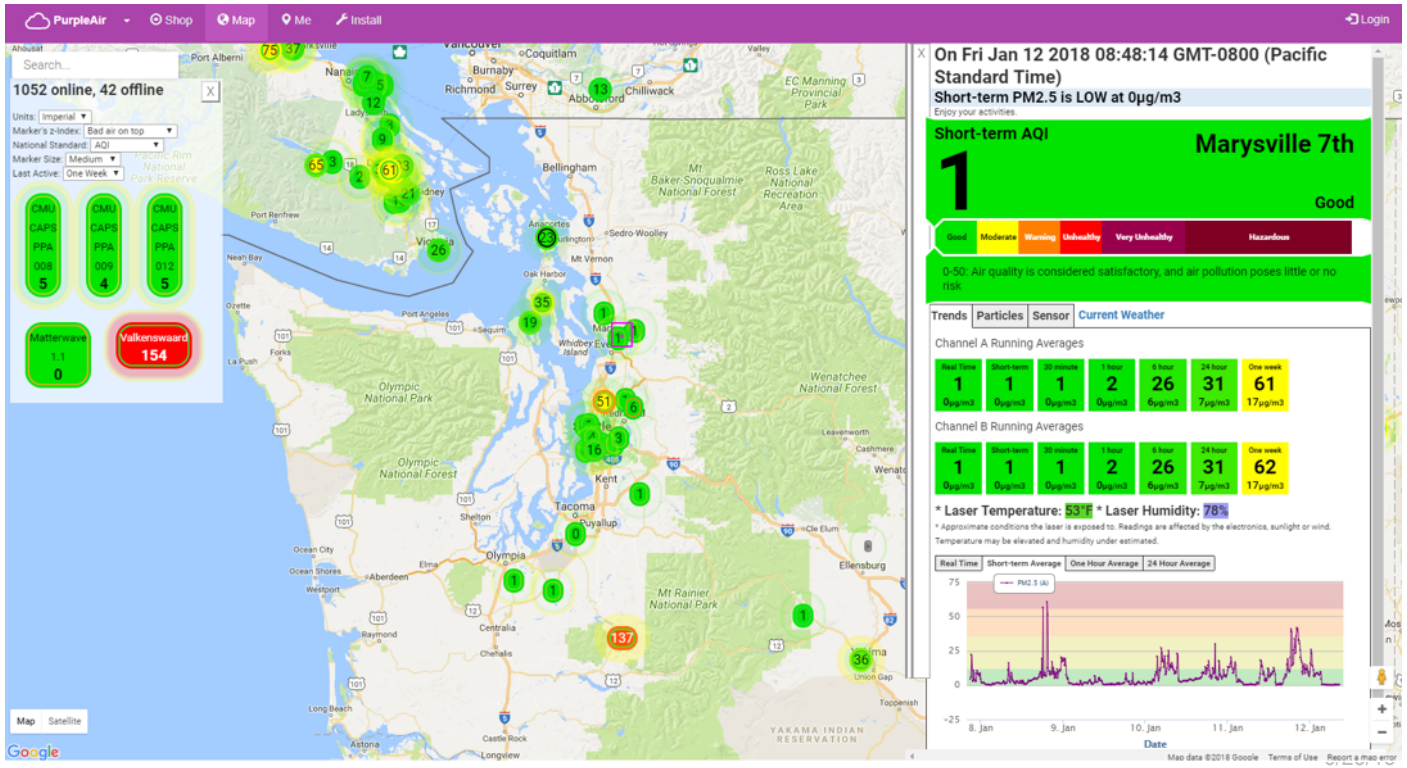
Overview

1. Purple Air collocation
2. Purple Air as a low-cost monitoring tool for network use
3. Lending library and community reporter project

Purple Air Experiment

- 3 Sites (Marysville, Duwamish, Tacoma South L)
- Data from 12/6/17 to 4/4/18



Comparison to Nephelometer and FEM TEOM

- TEOM ~ Purple Air + RH + Temp
- Hour / day time scale (averaged over 3 sites)
- CF=1

	PA to TEOM	PA to Neph	Neph to TEOM
Correlation	0.91 / 0.96	0.94 / 0.98	0.95 / 0.98
Slope	0.52 / 0.52	0.48 / 0.49	1.08* / 1.05
Intercept	2.01 / 0.79	4.14 / 2.50	-2.35* / -0.36

- Purple air reads ~1.8 times higher
- Purple air correlation with TEOM is close to the correlation between the neph and TEOM

*Neph has already been calibrated to Partisol

Performance Criteria

EPA Air Sensor Toolbox: Suggested Performance Goals for Air Sensors

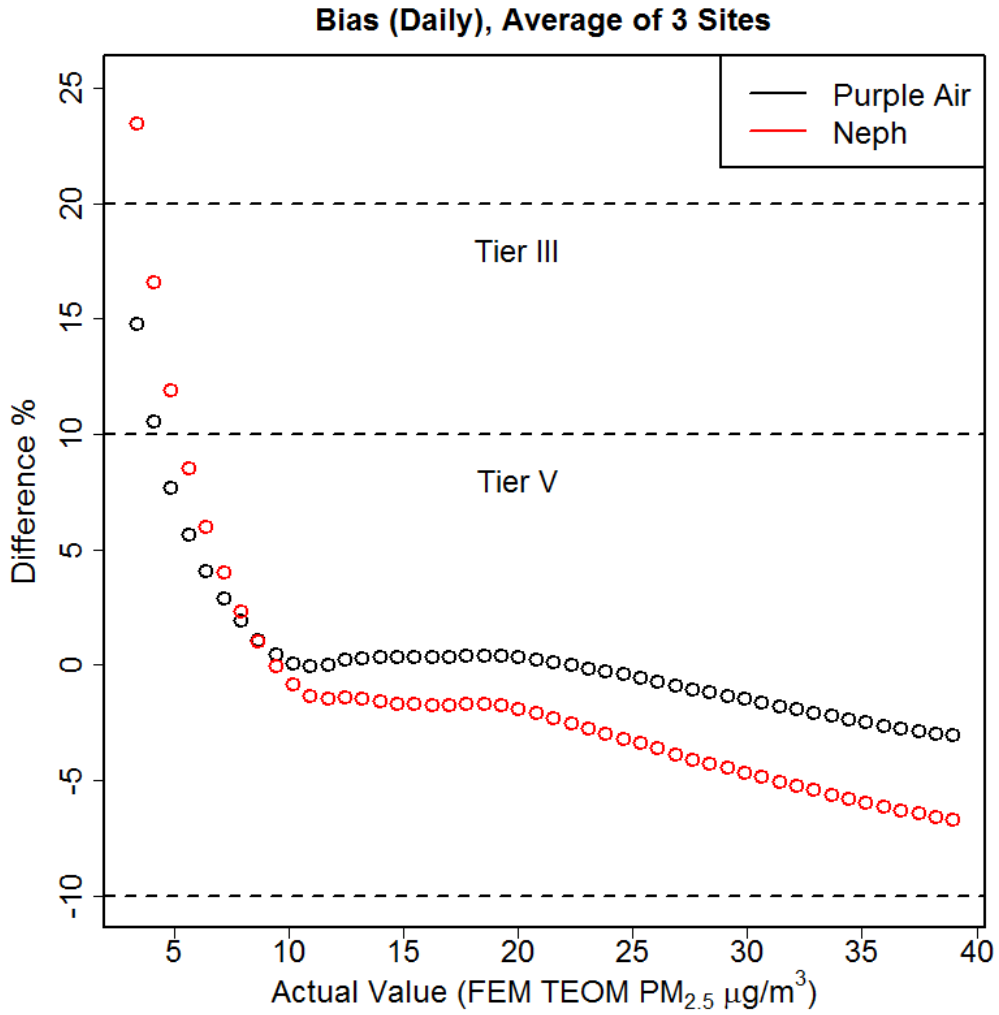
Tier	Name	Precision/Bias %	Data Completeness %
I	Educational	50	50
II	Hotspot identification	30	75
IV	Personal monitoring	30	80
III	Supplemental monitoring*	20	75
V	Regulatory monitoring	10	75

* "Supplemental monitoring might have value in potentially providing additional air quality data to **complement existing monitors**. To be useful in providing such complementary data, it must be of sufficient quality to ensure that the additional information is helping to **"fill in" monitoring gaps rather than making the situation less understood."**

Link: https://www.epa.gov/air-sensor-toolbox/how-use-air-sensors-air-sensor-guidebook

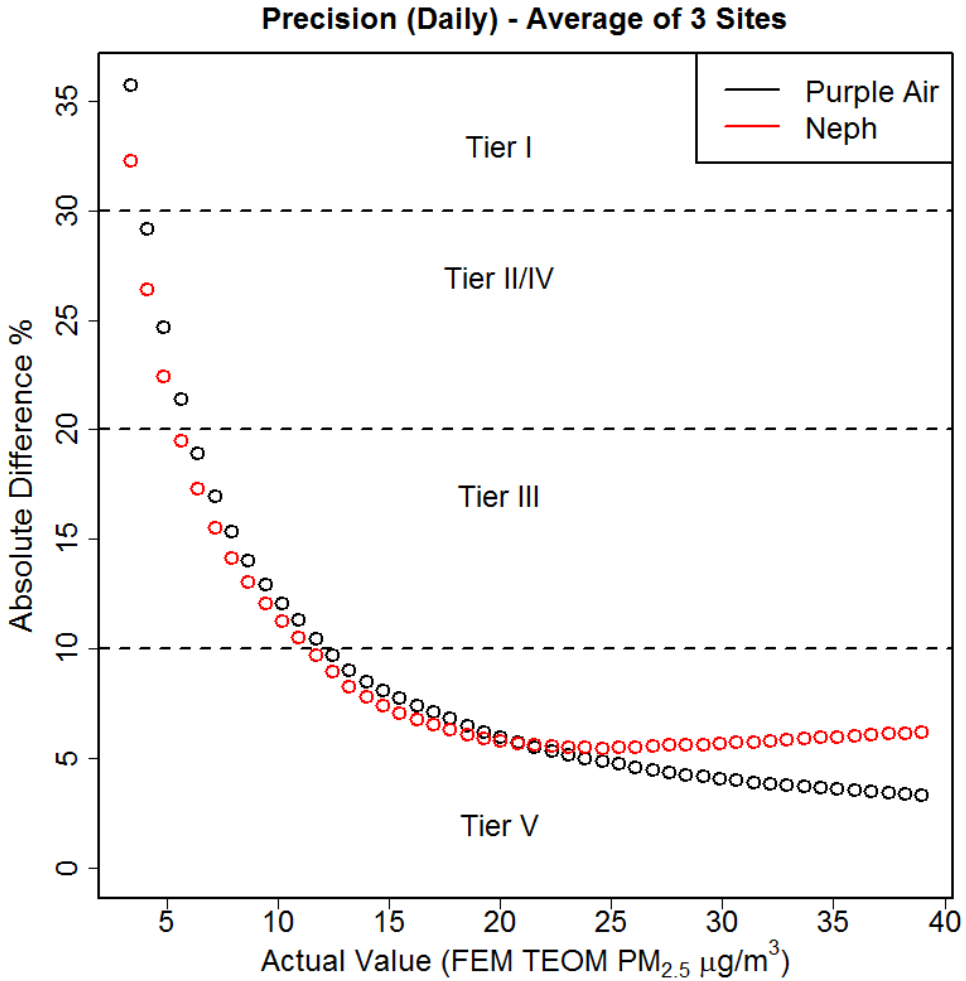
Bias

- 100 * (Purple Air – TEOM)/TEOM
- X-axis starts at 3 ug/m^3
- Calibrated Purple Air and neph read higher than TEOM at low concentrations and lower at high concentrations
- Meets Tier III criteria from ~4 ug/m^3 to max measured and Tier V criteria from ~6 ug/m^3 to max measured



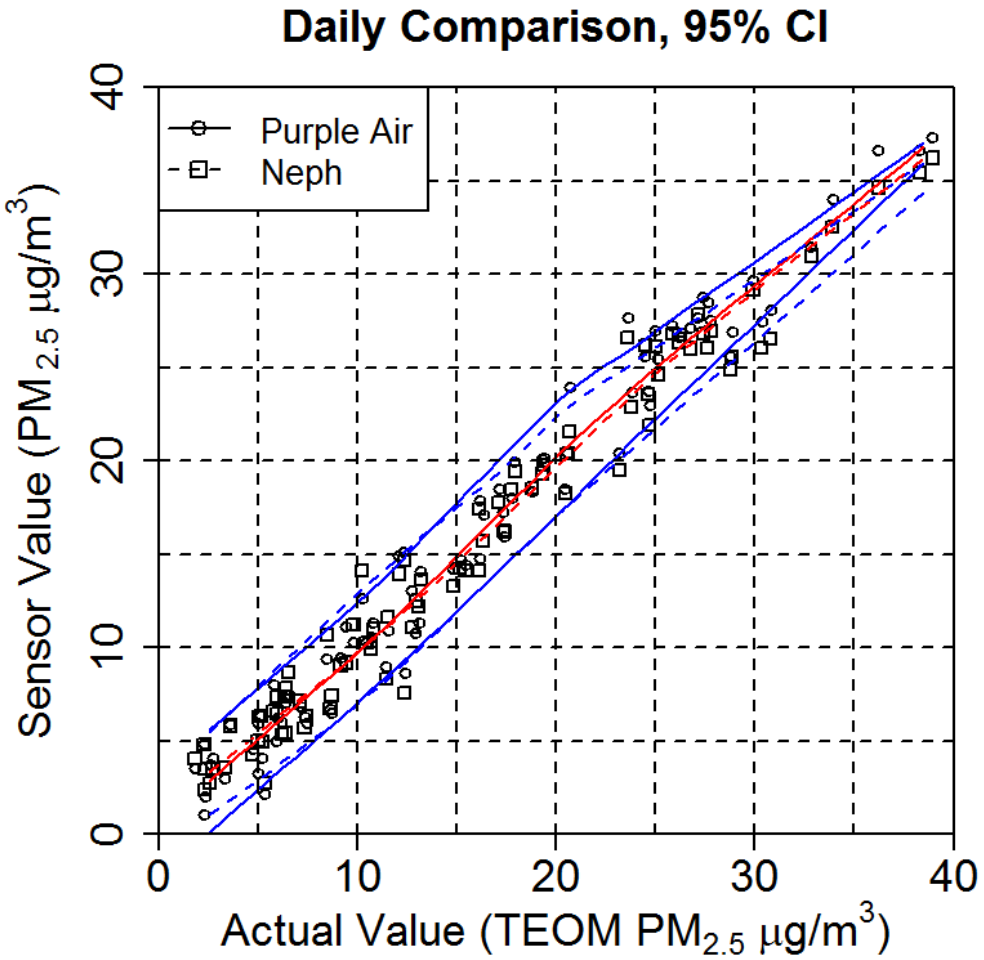
Precision

- 100 * abs(Purple Air – TEOM)/TEOM
- X-axis starts at 3 ug/m^3
- Meets Tier III criteria from ~7 ug/m^3 to max measured



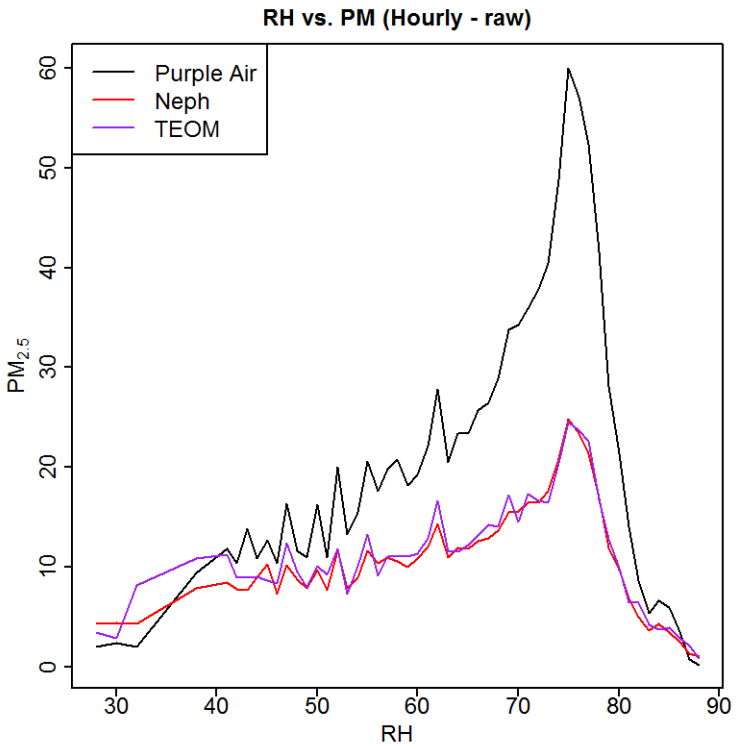
Daily Comparison with 95% Confidence Intervals

- Solid lines are Purple Air, dashed lines are the neph. Circles are PA, squares are neph
- The red lines are the mean, the blue lines are the 95% CIs
- If the TEOM says the $PM_{2.5}$ concentration is 10 µg/m^3, 95% of the time the Purple Air or Neph will report 7 to 13 µg/m^3
- If the TEOM says the $PM_{2.5}$ concentration is 30 µg/m^3, 95% of the time the Purple Air or Neph will report 27 to 31 µg/m^3

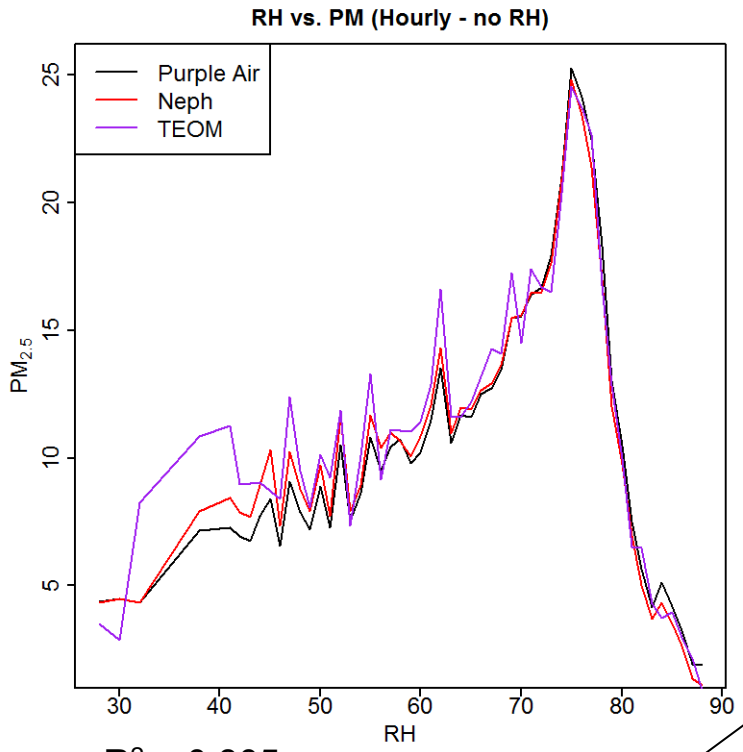


Effect of RH

Raw Purple Air

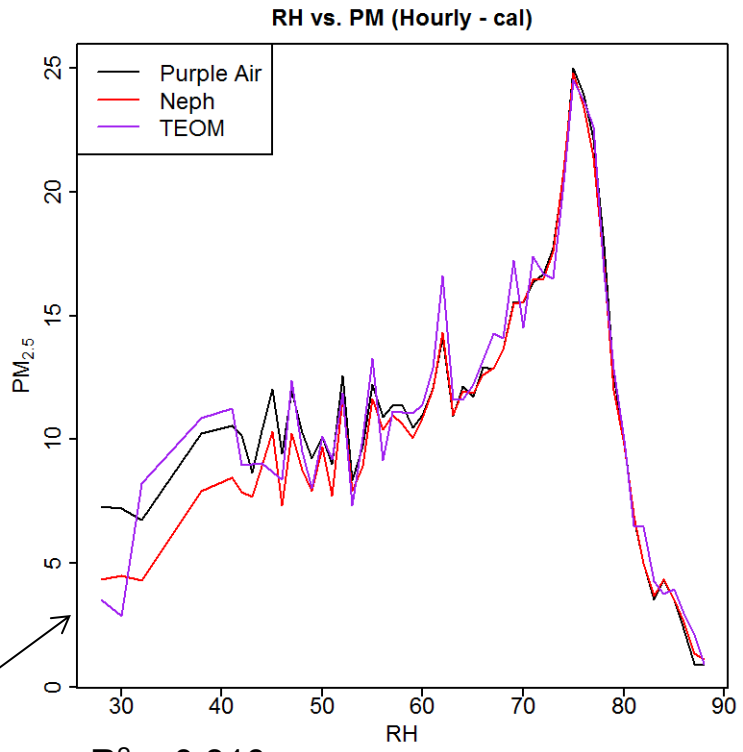


Purple Air Calibrated to TEOM
No Temp/RH



$R^2 = 0.805$

Purple Air Calibrated to TEOM
And Temp/RH



$R^2 = 0.810$

- **The addition of RH to the model helps accuracy at low-med RH (30-50%)**

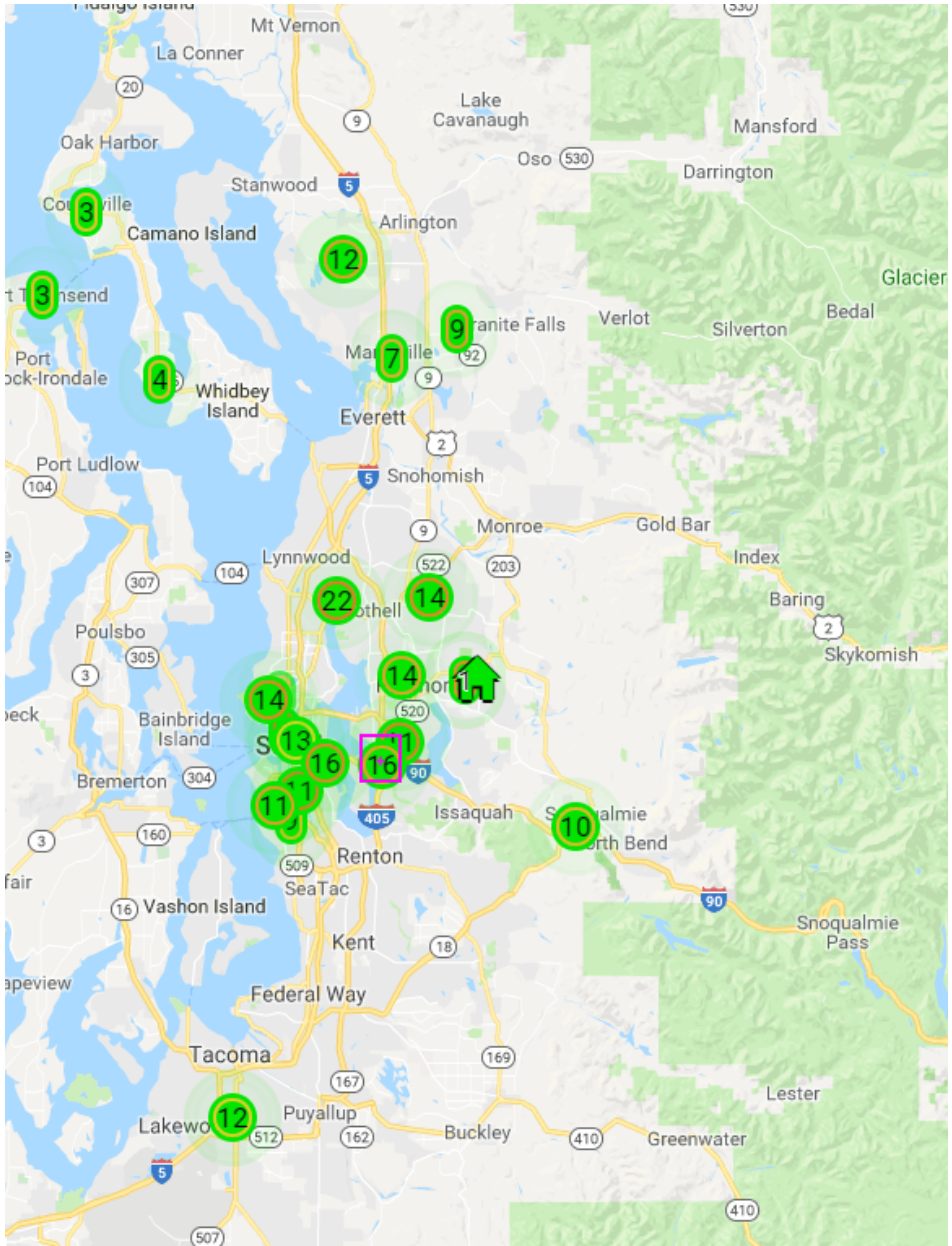
Summary

- Purple Air is very highly correlated to neph and highly correlated to TEOM
- Purple Air performs similarly to neph in terms of bias and precision
- May be useful in supplemental monitoring as well as education, exploratory analyses, and micro-scale monitoring

- Caveats
  - Upper limits? (>80 ug/m^3 hourly)
  - Reliability over time in the field
  - Limited amount of data
    - Seasonality
    - Differences by site

PA Network - Current

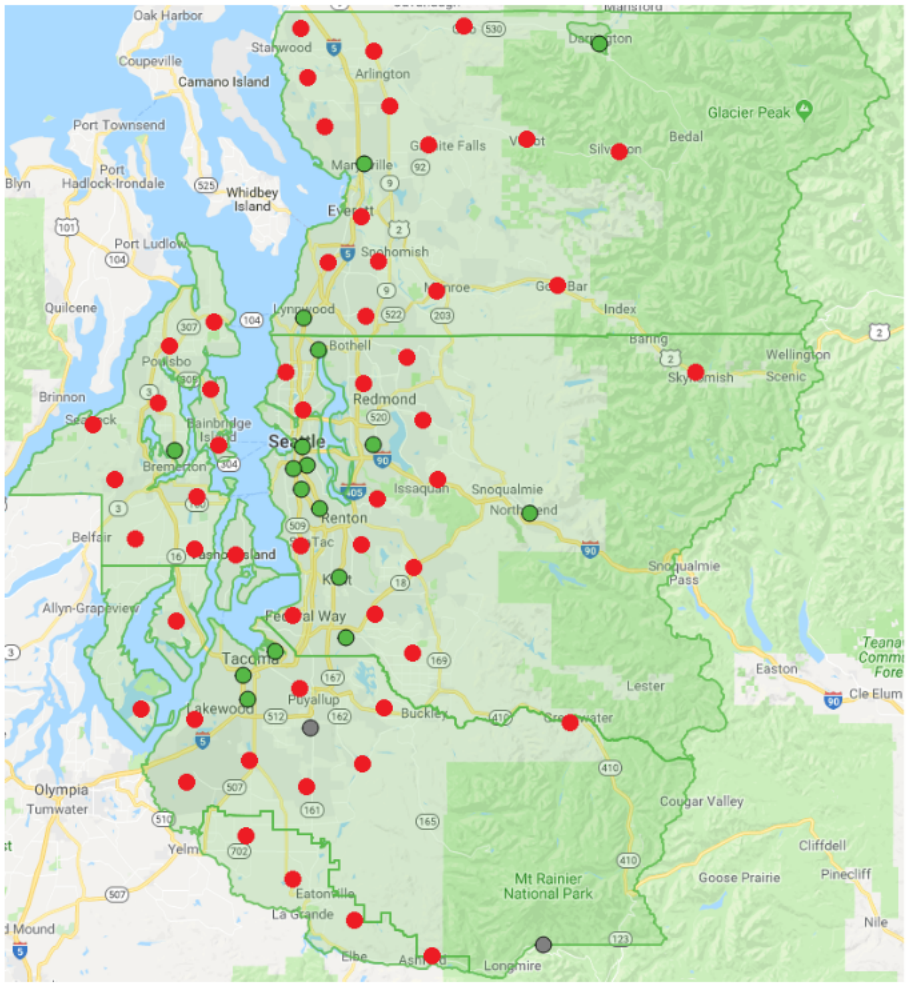
- 18 PA monitors as of 6/6/18 within our jurisdiction



PA Coverage - Future

- Based on high density PA networks (Salt Lake City, LA) a 4-mile range may be able to be covered by one monitor
  - Calibration zones defined by topography, meteorology and source characteristics
- Partnering with other groups for sites
- Or asking owners to provide information to approve their monitors so they could be used on our sensor map

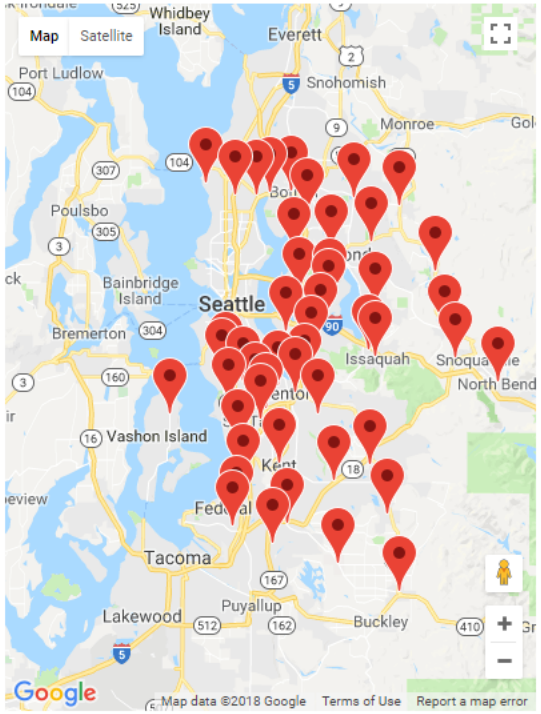
4-mi coverage



55 sites

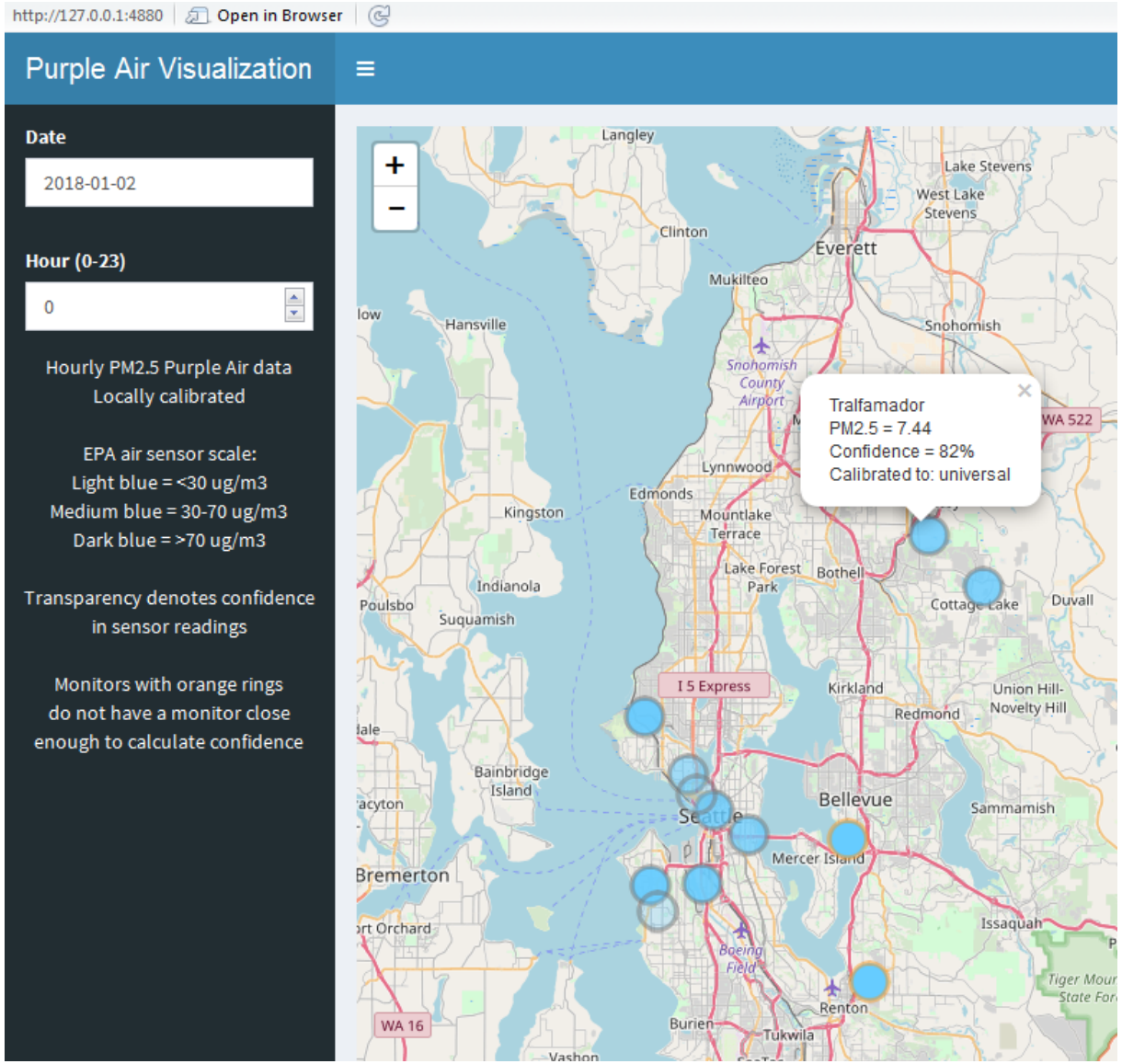
+10 collocations

King County Library Locations



PA Adjustment Website

- **Website showing calibrated sensor data**
  - **Calibrated to nearest site if close, otherwise calibrated to the average within a window**
- **Confidence ratings**
  - **Intra- and inter-monitor**
- **EPA sensor scale**



Lending Library

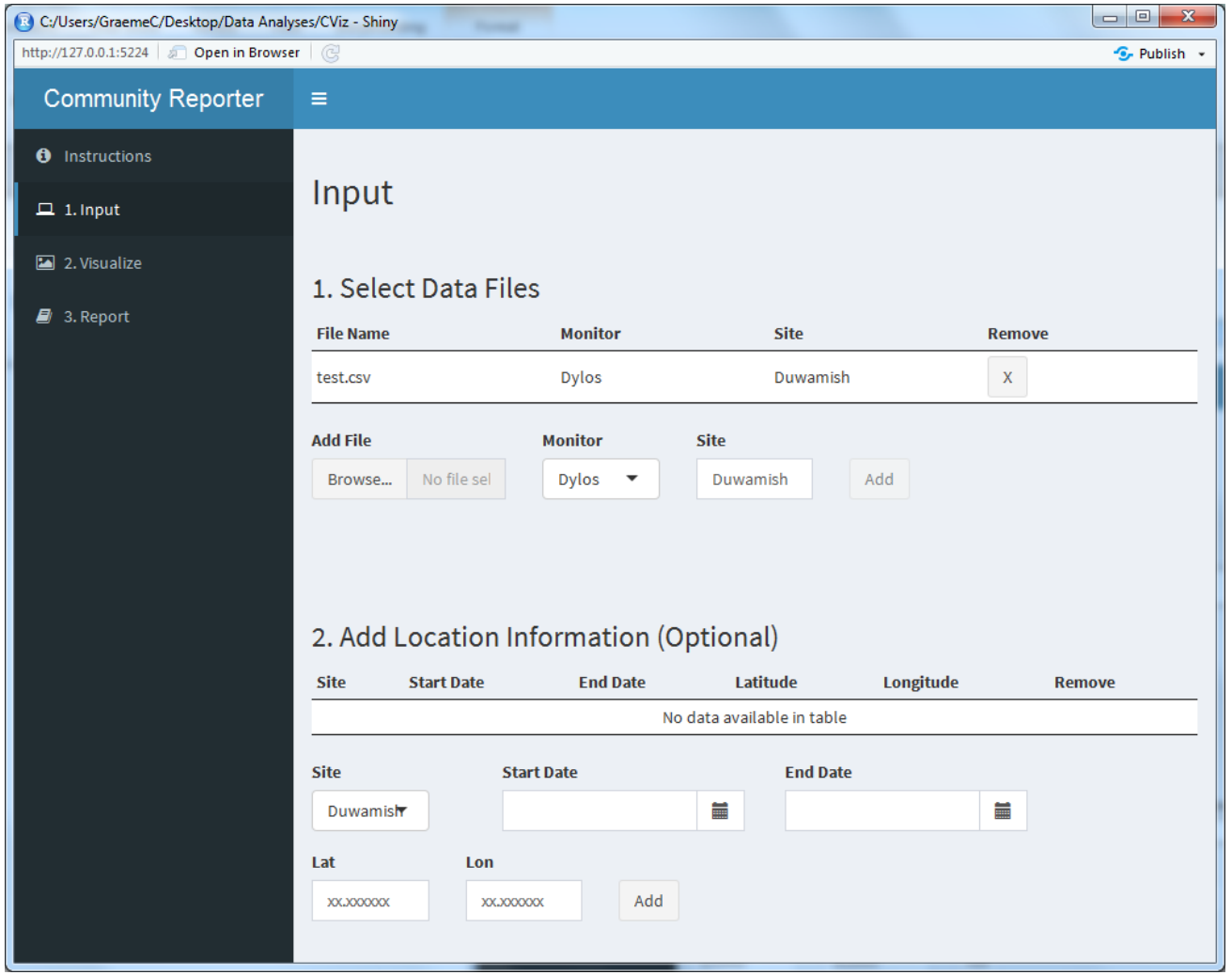
- Loan out monitors to community groups and individuals
  - 10x Dylos, Air Beams, Purple Air
- Questionnaire to collect information about monitor use
- Guidance for monitor operation and how to analyze data
  - Appropriate guidance for people of all technical skill levels

Community Reporter

- A tool to help citizen scientists create useful reports from monitoring data
- Gets over the barrier of having to manipulated “messy” data
- Requires a moderate level of technical skill

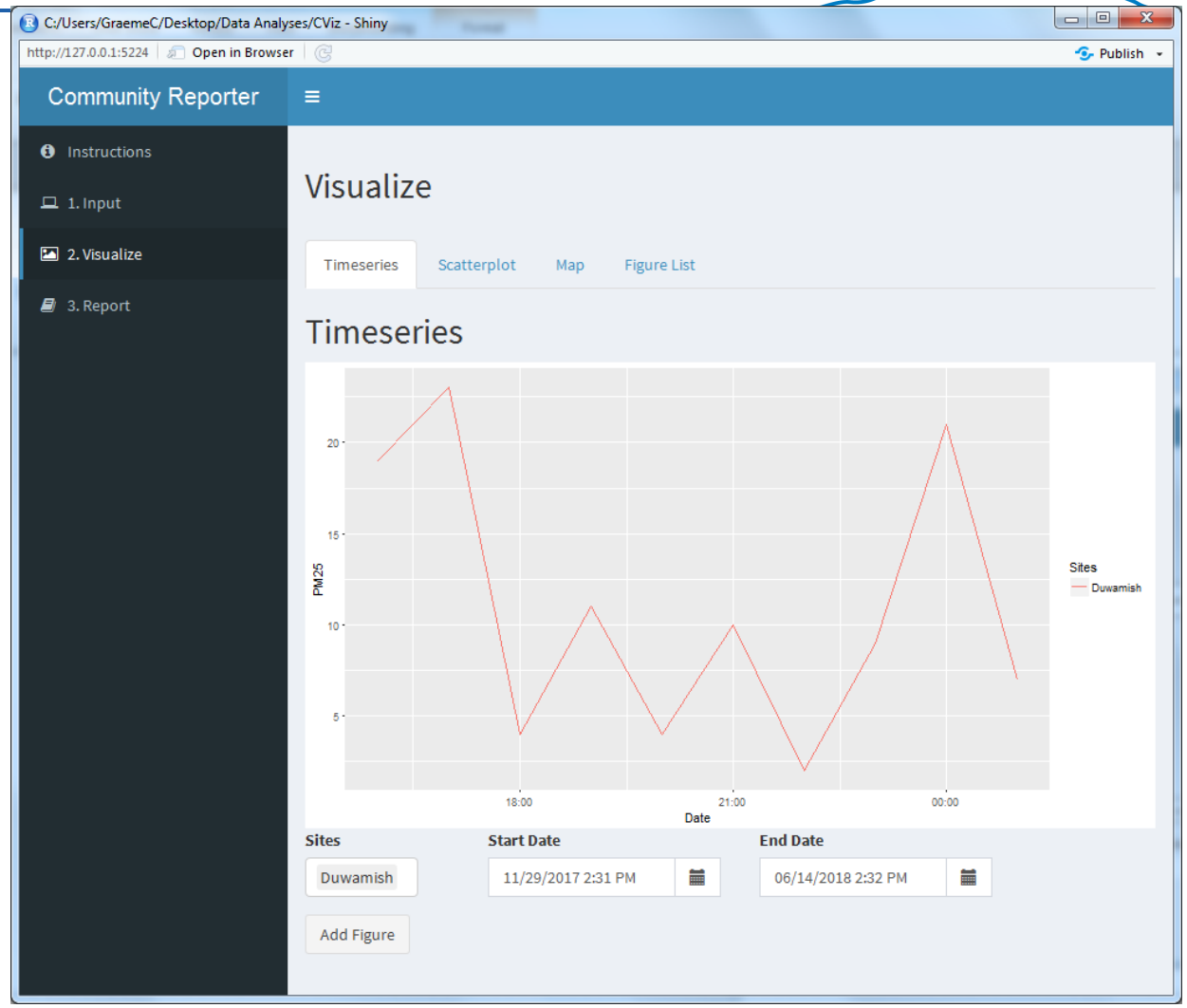
1. Input Data

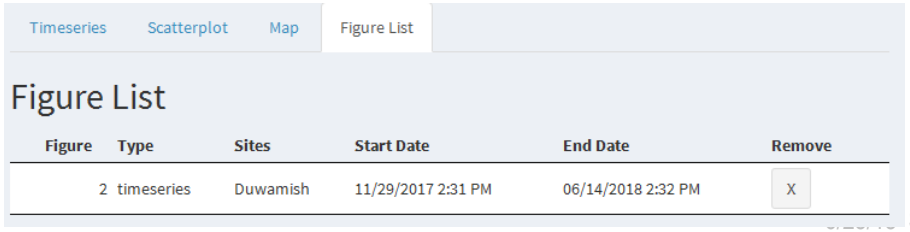
- Upload data
- Select monitor type
- Add monitor name
- Add lat, lon



2. Create Graphs

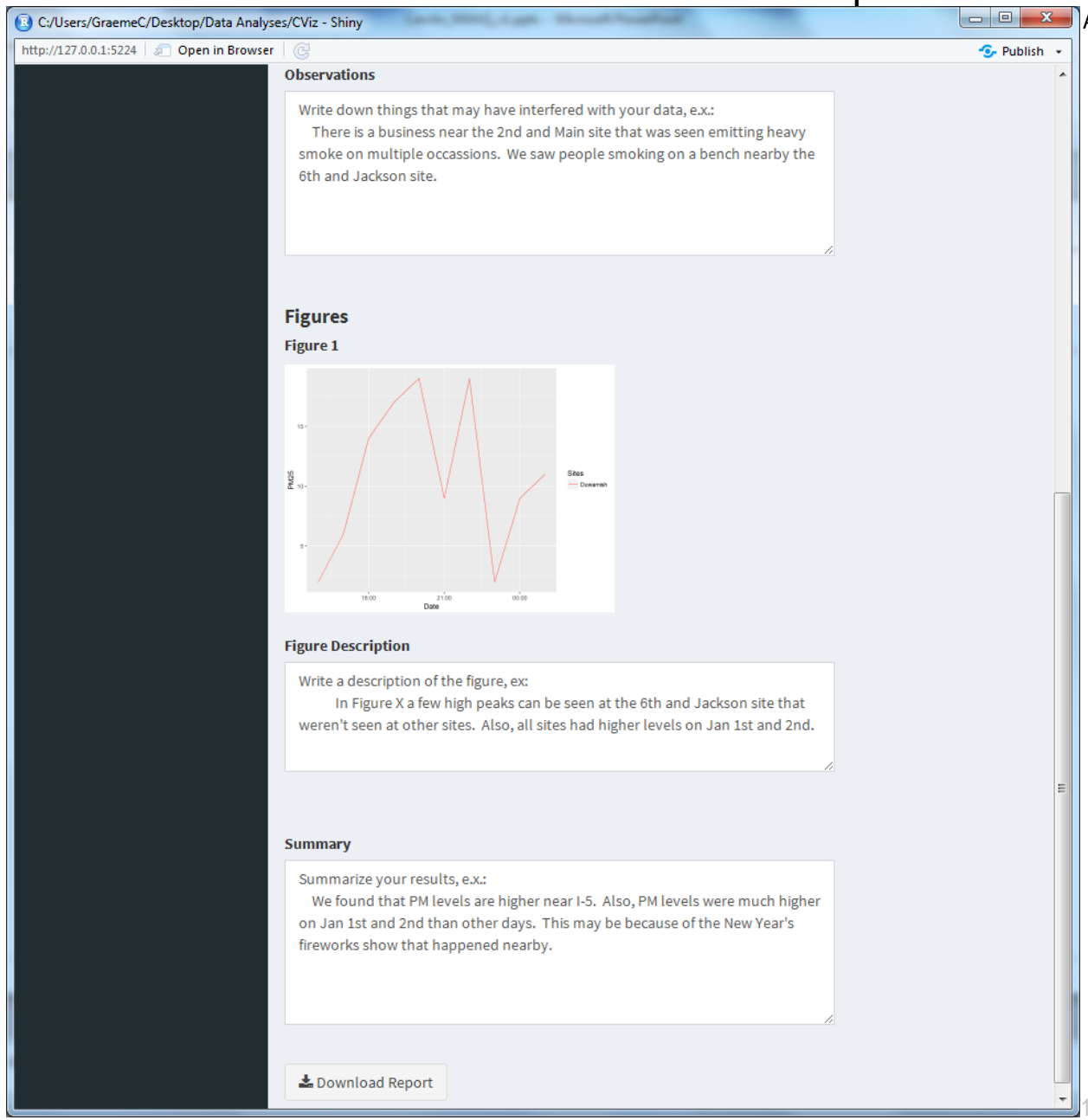
- Add timeseries, scatterplots, maps
- Could be automatically picked based on study design
  - i.e. A study looking at pollution near a source would have a map





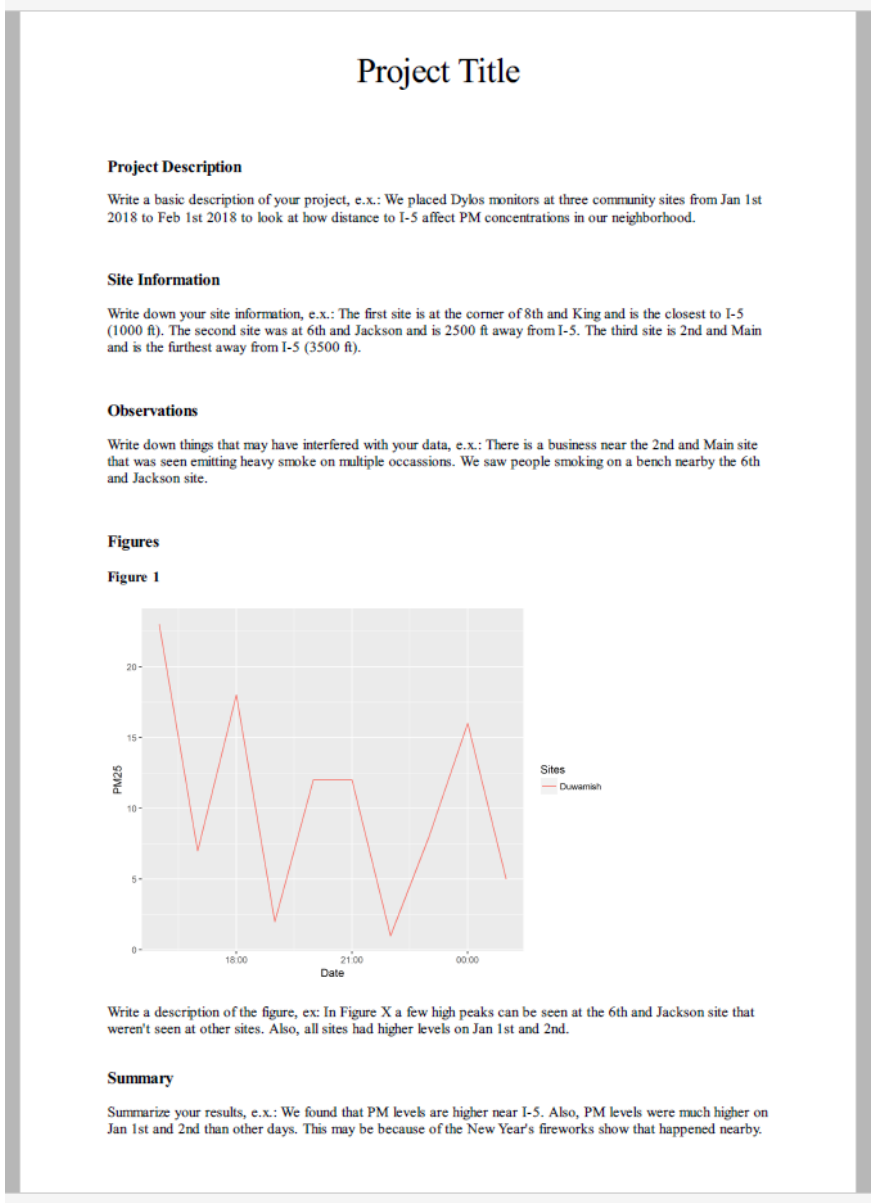
3. Report

- Add text describing what was done and explaining the figures
- Click Download to get a pdf



Community Reporter - Report

- **Pdf report**



Project Title

Project Description

Write a basic description of your project, e.x.: We placed Dylos monitors at three community sites from Jan 1st 2018 to Feb 1st 2018 to look at how distance to I-5 affect PM concentrations in our neighborhood.

Site Information

Write down your site information, e.x.: The first site is at the corner of 8th and King and is the closest to I-5 (1000 ft). The second site was at 6th and Jackson and is 2500 ft away from I-5. The third site is 2nd and Main and is the furthest away from I-5 (3500 ft).

Observations

Write down things that may have interfered with your data, e.x.: There is a business near the 2nd and Main site that was seen emitting heavy smoke on multiple occassions. We saw people smoking on a bench nearby the 6th and Jackson site.

Figures

Figure 1

Write a description of the figure, ex: In Figure X a few high peaks can be seen at the 6th and Jackson site that weren't seen at other sites. Also, all sites had higher levels on Jan 1st and 2nd.

Summary

Summarize your results, e.x.: We found that PM levels are higher near I-5. Also, PM levels were much higher on Jan 1st and 2nd than other days. This may be because of the New Year's fireworks show that happened nearby.

Summary

- Purple Air (plantower) is very precise and, once calibrated, quite accurate
- Can potentially be used for supplemental monitoring in a low-cost monitoring network
- Proper data display is key
- Sensors can also be loaned out on a small/short-term project basis
- Tools are being developed to help citizen scientists participate in the analysis and discussion of air quality data