



Update on the Urbanova Air Quality Research in the Spokane University District

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What is Urbanova?



Rethinking Cities

- Cities across the globe are growing. Today, 50 percent of the population lives in cities.
- To meet their needs, cities are using **technology** to enhance their livability, workability, and sustainability.
- Urbanova is one of the innovators in this movement towards ***smart cities***.
- Urbanova is a living laboratory for the future design of cities. Located in Spokane, Washington, Urbanova harnesses data to gain insights, empower people and solve urban challenges in new ways.





Founding Partners

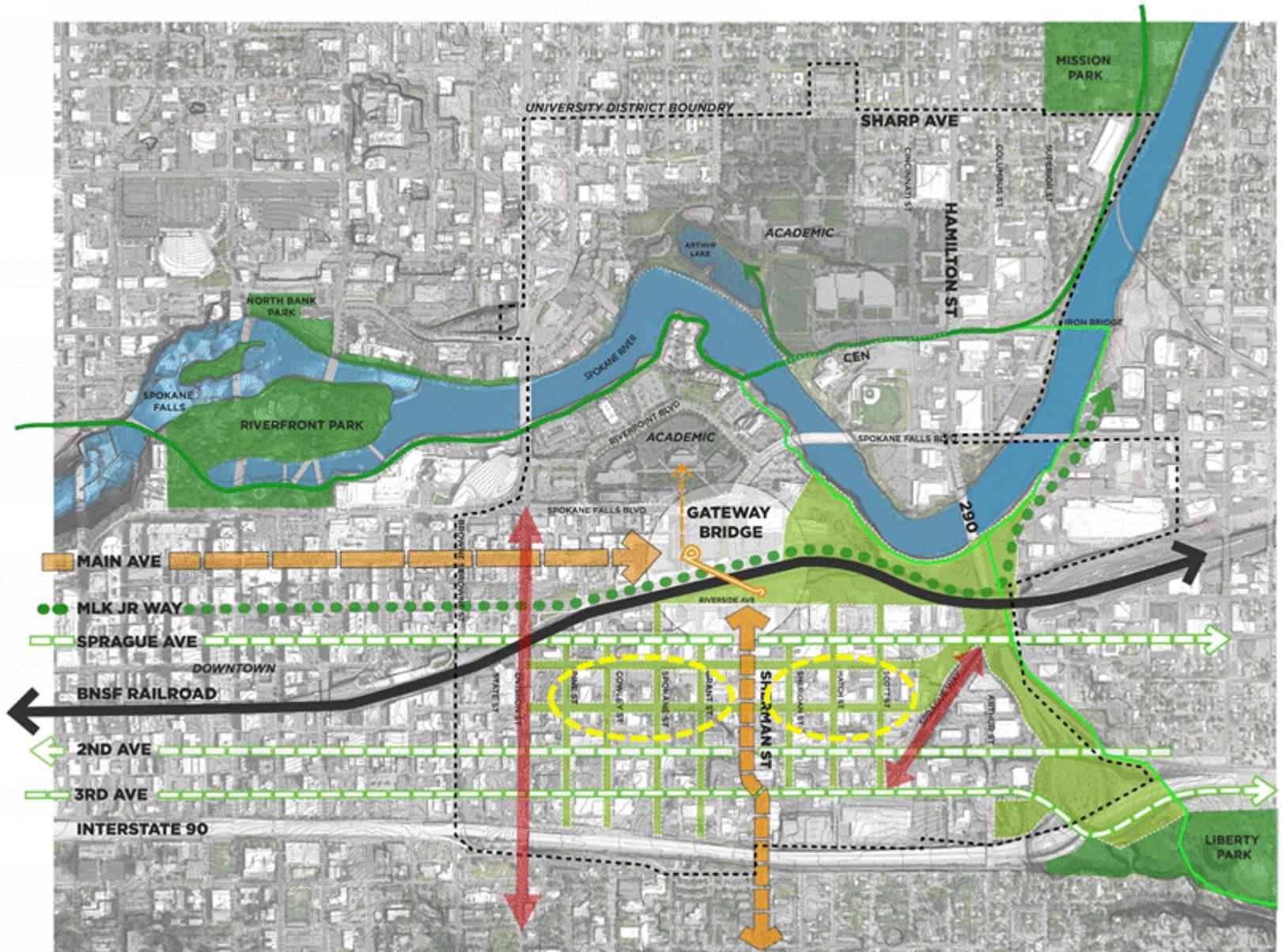


Spokane University District



- Near central downtown Spokane
- Mix of university, commercial and residential neighborhoods
- Cut through by the Spokane River
- Bisected by I-90 E-W freeway, major N-S surface arterials, and E-W railroads

Major Development Plans: Gateway bridge, new retail/housing centers, MKL Way extension



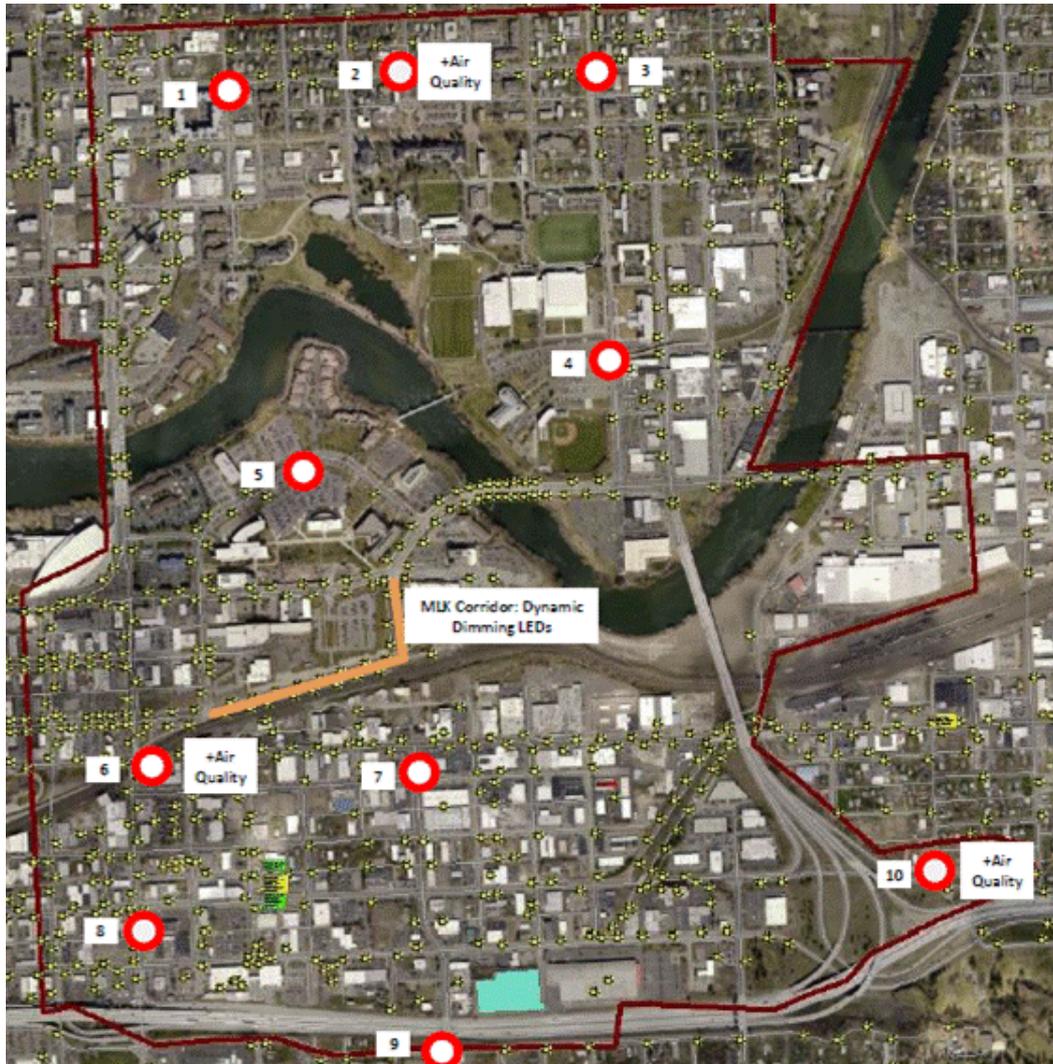


Timeline of LAR's Involvement

- Urbanova Smart and Connected Streetlights
 - 18 March 2017 – June 2018
- LAR Reference Site
 - Dec 2017 – Current
- LAR Rooftop Sensors
 - 6 new units; October 2018 - ...
 - Testing at WSU, then the Reference Site
- LAR Mobile Sensors
 - Deploy in Fall/Winter 2018-2019 on new LAR van
 - Wintertime stagnation
 - WSU buses and Spokane City buses



Smart and Connected Streetlights and Initial Air Quality Sensor Array

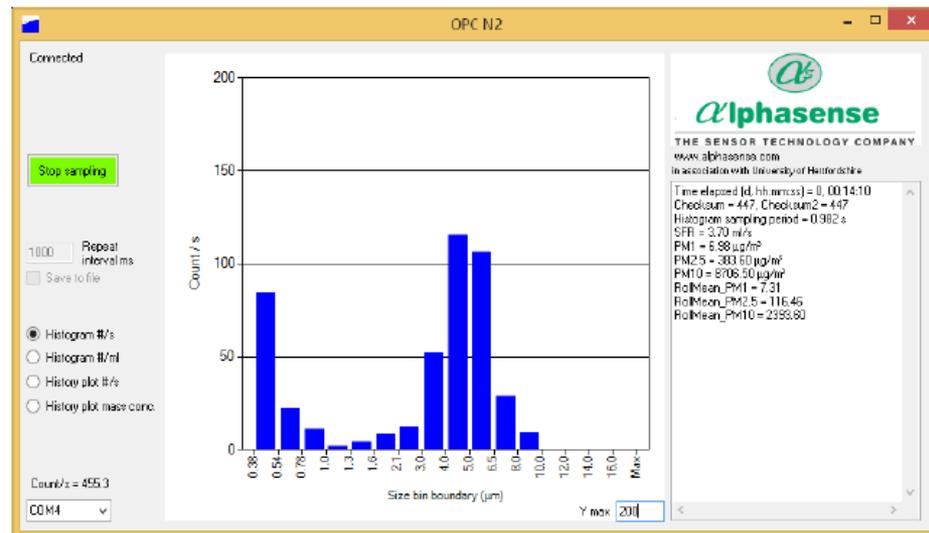
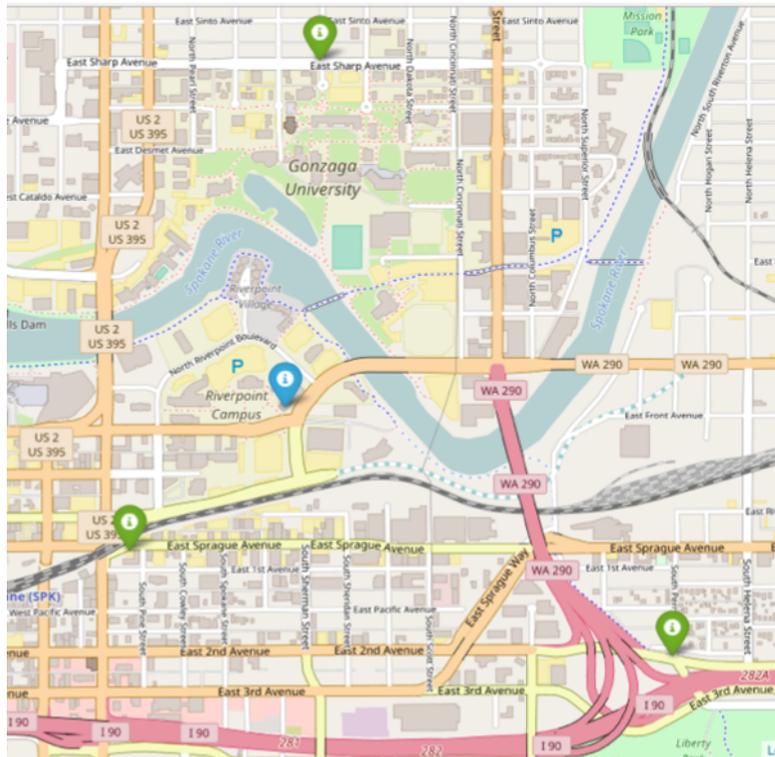


- 10 lights initially
- 100 lights eventually
- Smart lights includes dimming, pedestrian movement, & air quality
- Sensor packages connected via Itron smart network connections
 - Real-time data access



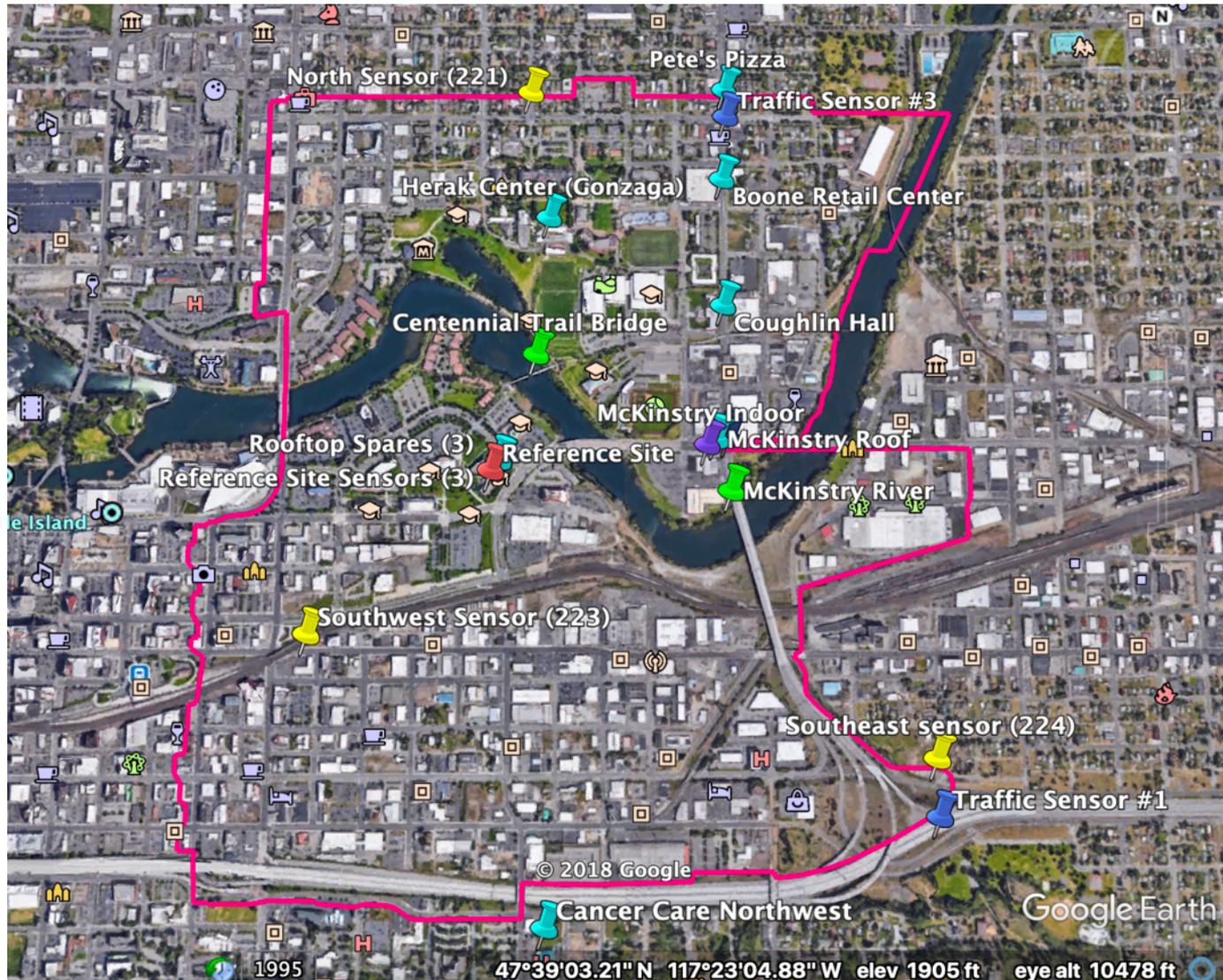
Initial Air Quality Sensor Array

- Objective: Explore new sensor technology for Smart City developments
- Approach: deploy ~ 10 small packages on smart streetlights and city rooftops
- Initial package design: Pi Raspberry computer and data acquisition, cell phone modem
 - CO₂ Alphasense K-30
 - PM Alphasense OPC-N2, 16 size channels
 - T, RH



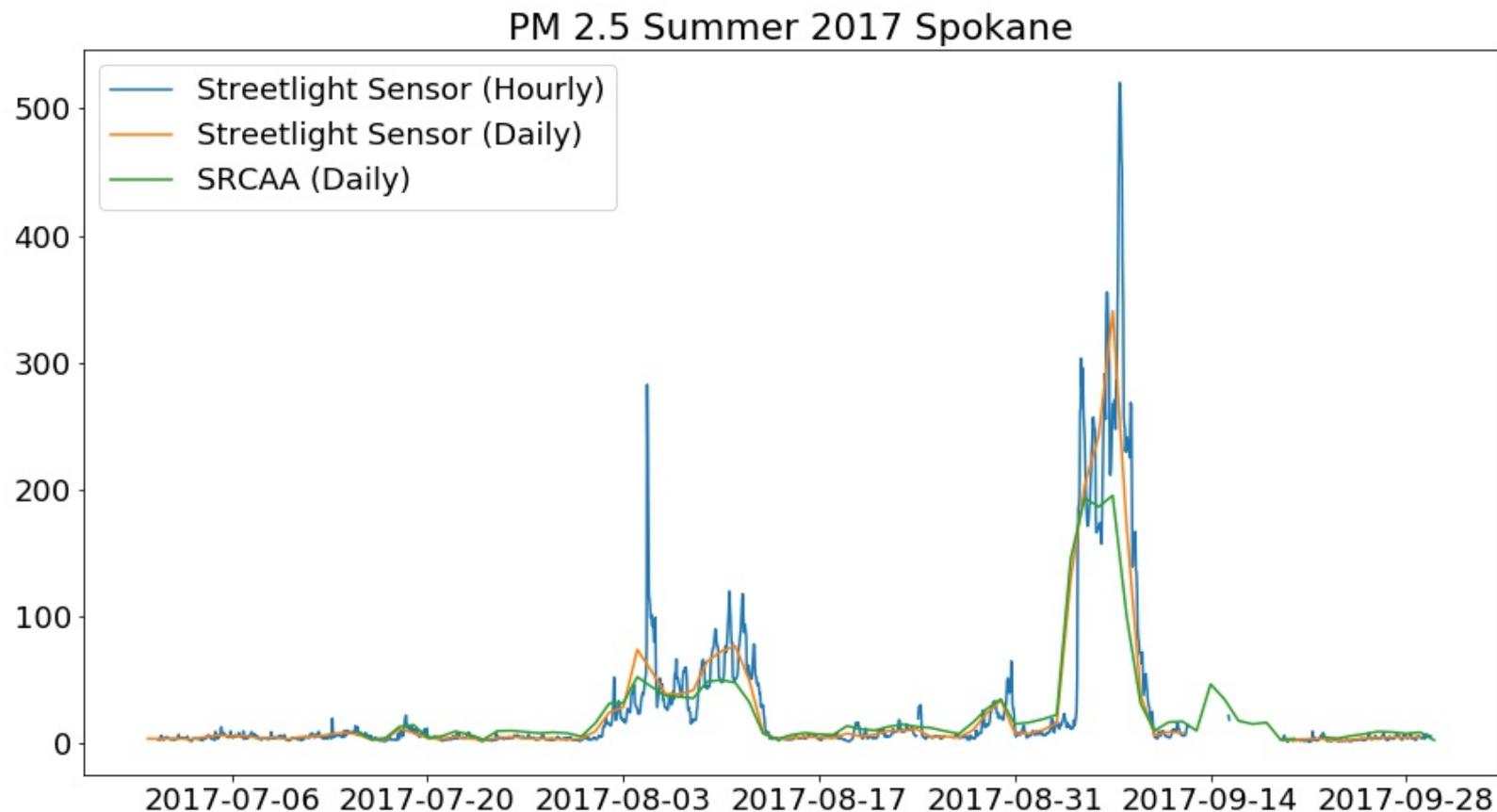
Initial Air Quality Sensor Array

- Plan is to deploy 6 new rooftop sensors in the next few months, along with traffic sensors.



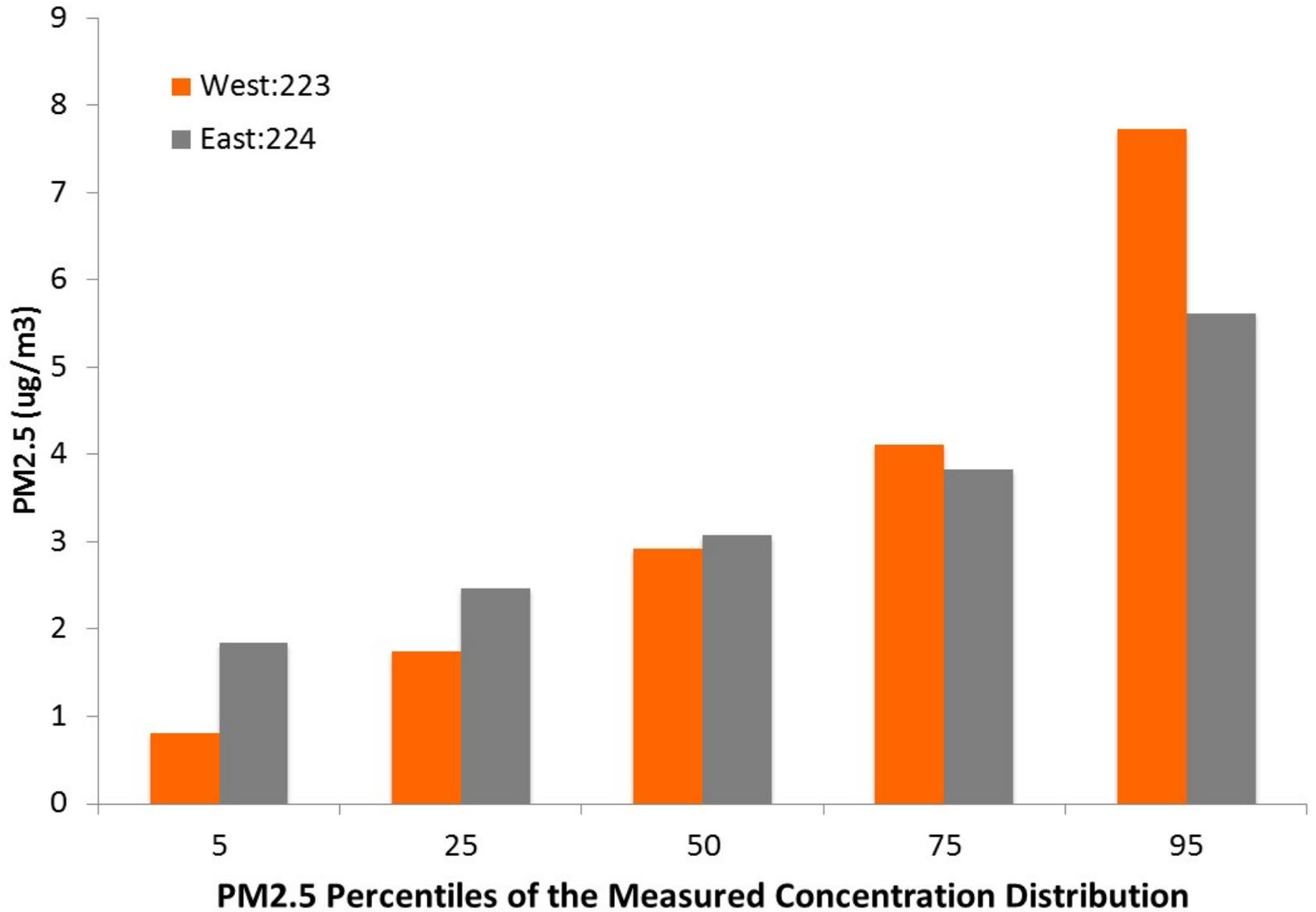


2017 Fire Season

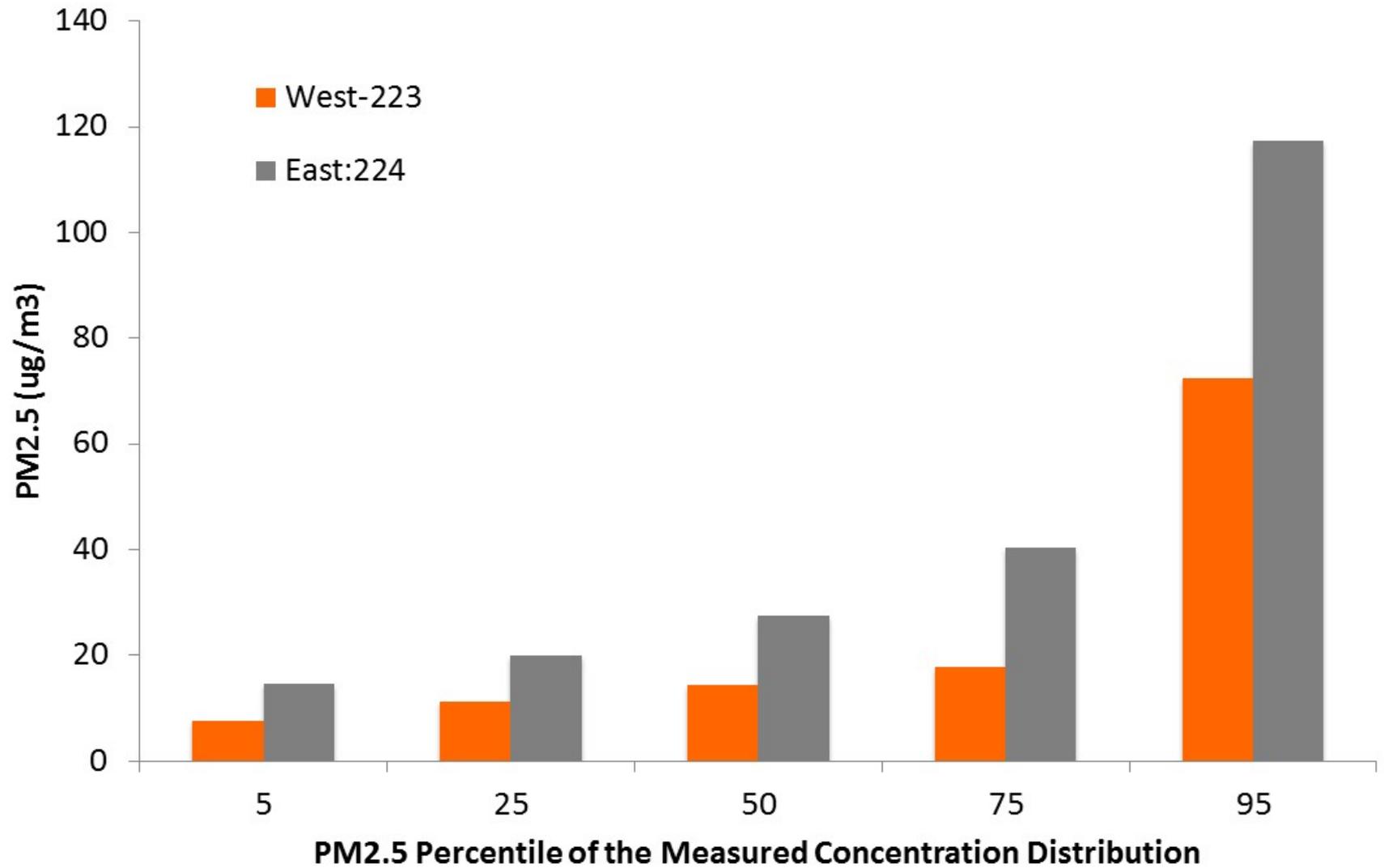


- Decent agreement between SRCAA and LAR sensor

Before Fires 7/27-7/30

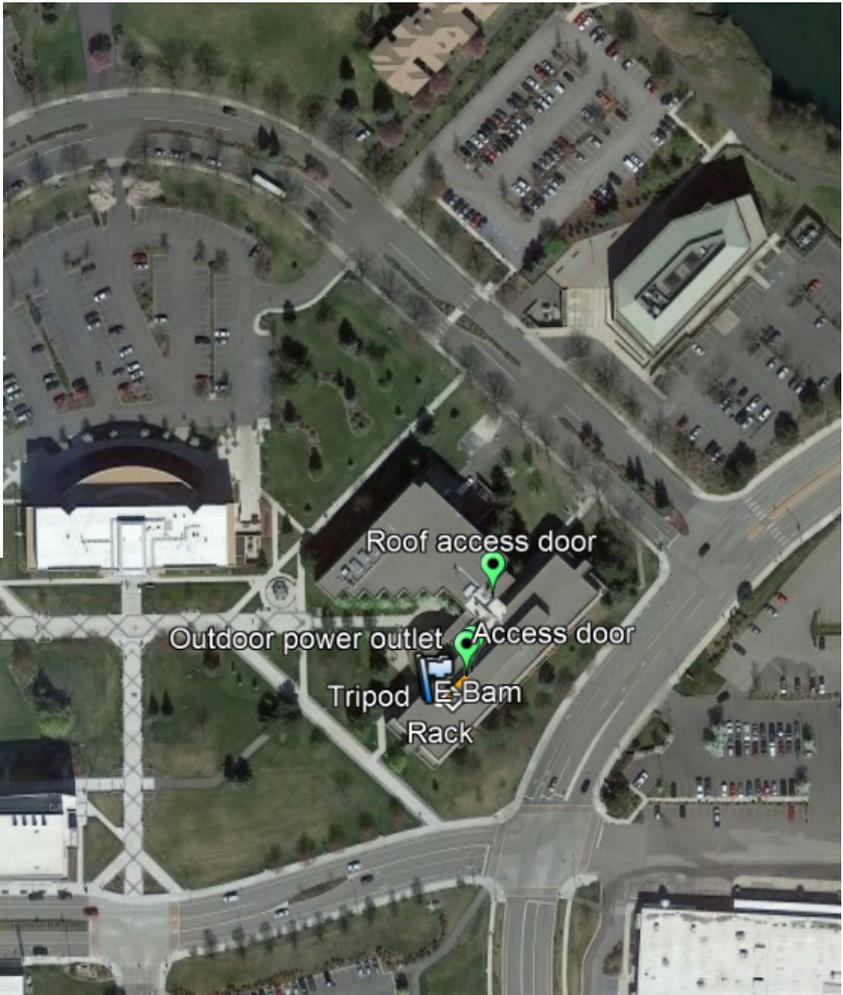
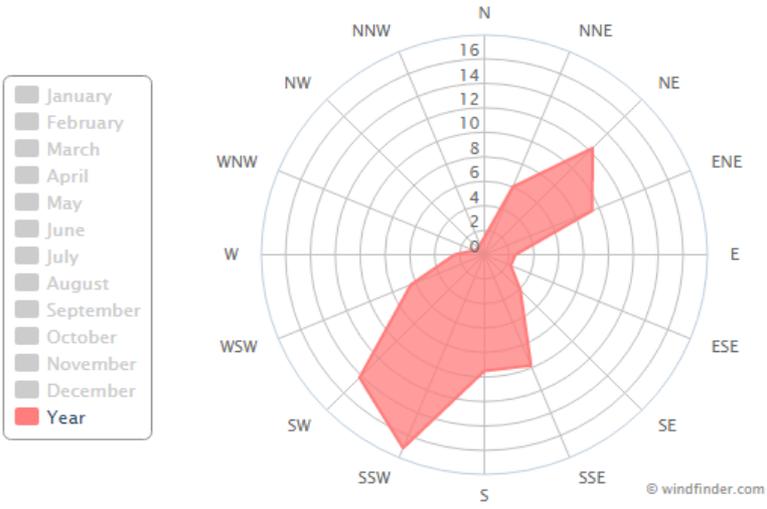


During Fires 8/02-8/05



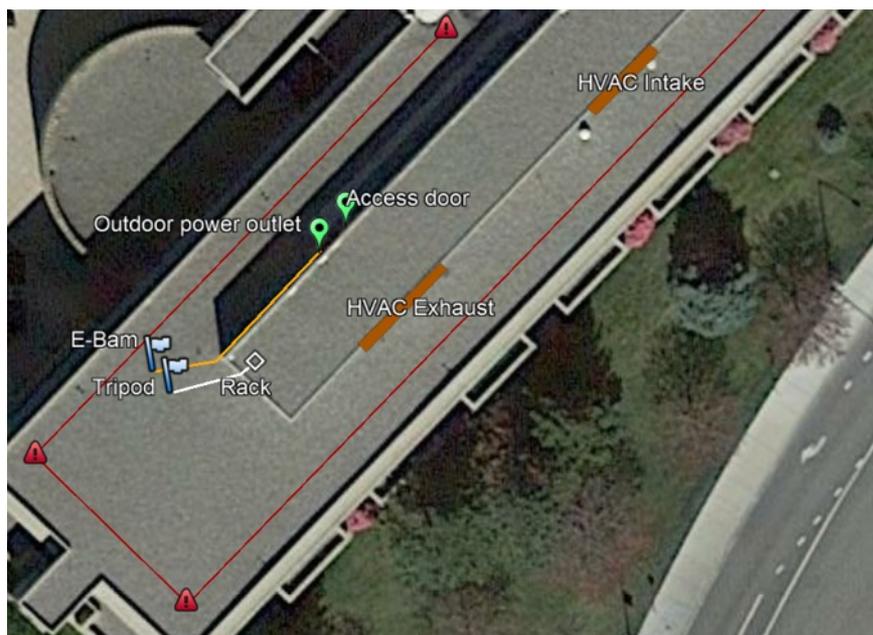
Reference Site

Wind direction distribution in (%)
Year



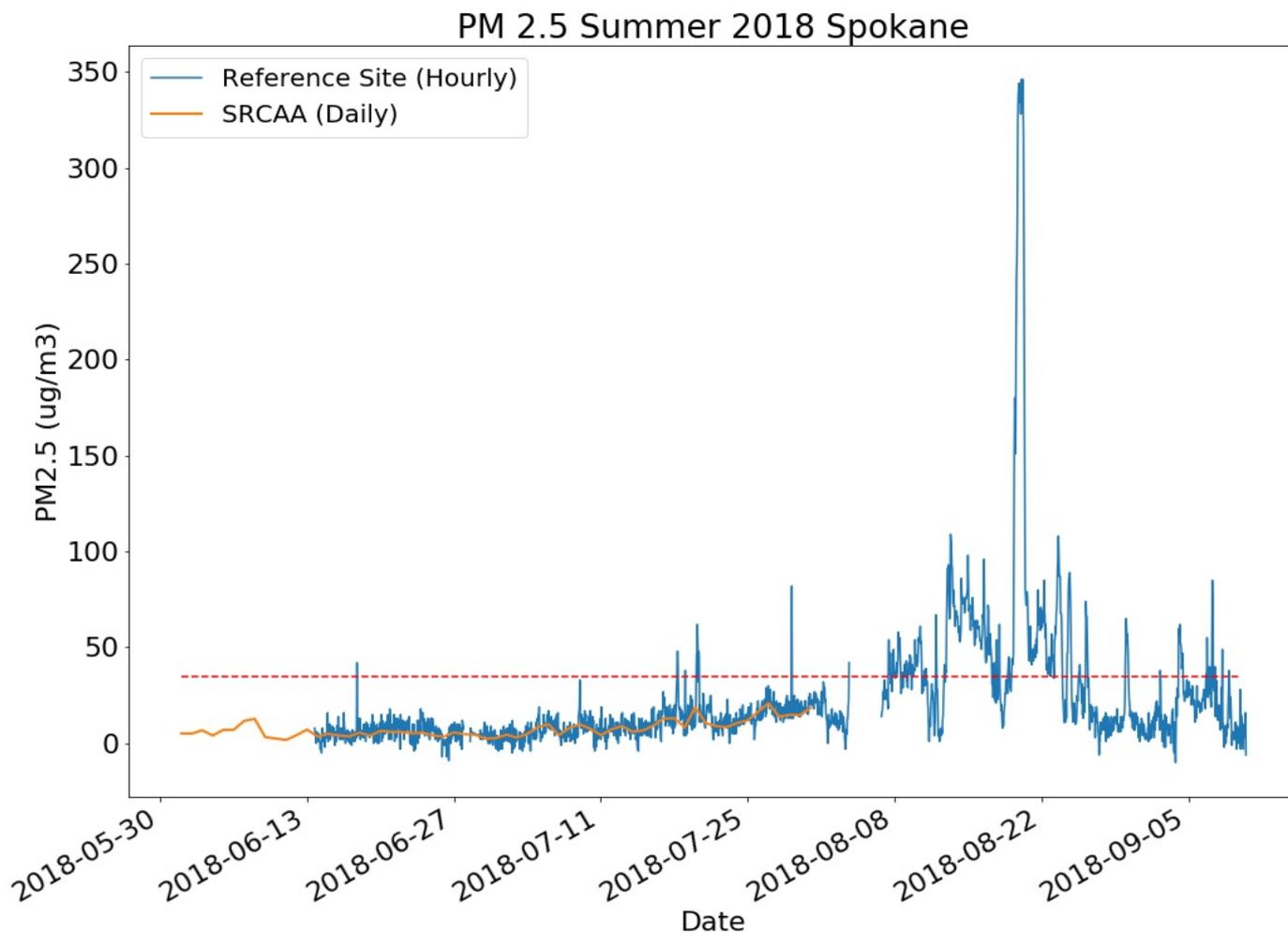
Reference Site

Location	Make/model	Metrics
inside rack	2B Tech. Model 405 nm	NO, NO ₂ , NO _x
inside rack	2B Tech. Model 205	O ₃
inside rack	Licor LI-840A	CO ₂ , H ₂ O
inside rack	<i>tentative</i> TECO Model 48	CO
inside rack	<i>tentative</i> TECO Model 43B	SO ₂
roof tripod	Gill Instruments MaxiMet 600	T, P, RH, WS, WD, DP, precip
roof tripod	Met One E-Bam Plus	PM _{2.5}
roof tripod	in-house AQ sensor node (qty 3)	T, P, RH, CO ₂ , PM _{1/2.5/10} <i>tentative</i> O ₃ , CO, NO
roof tripod	<i>tentative</i> Kipp & Zonen CNR1	4-channel component radiation
roof tripod	<i>tentative</i> Licor LI-190SB	photosynthetically active radiation





2018 Fire Season



- Good agreement between SRCCA and LAR sensor

Social Media Analysis



Collaboration with WSU Colleges of Medicine and Nursing

- Working with colleagues to devise a medical-based approach for analyzing social media to determine public response to wildfires.
- We've looked at both Google Trends and Twitter.

Title: A conceptual approach to identifying search terms addressing public health responses to wildfire related air pollution

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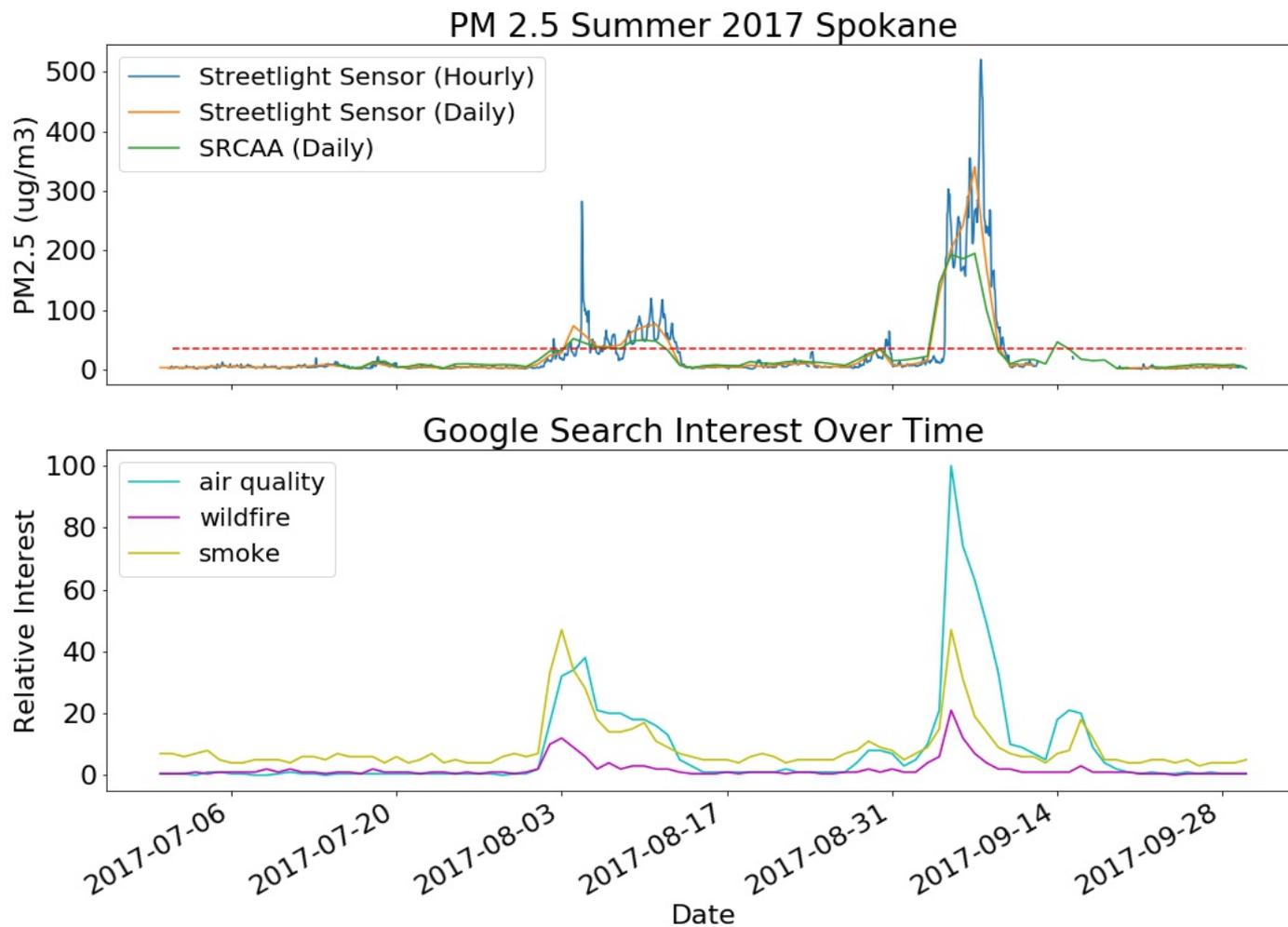
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2017 Fire Season



- Google Search shows good correlation with poor air quality events.

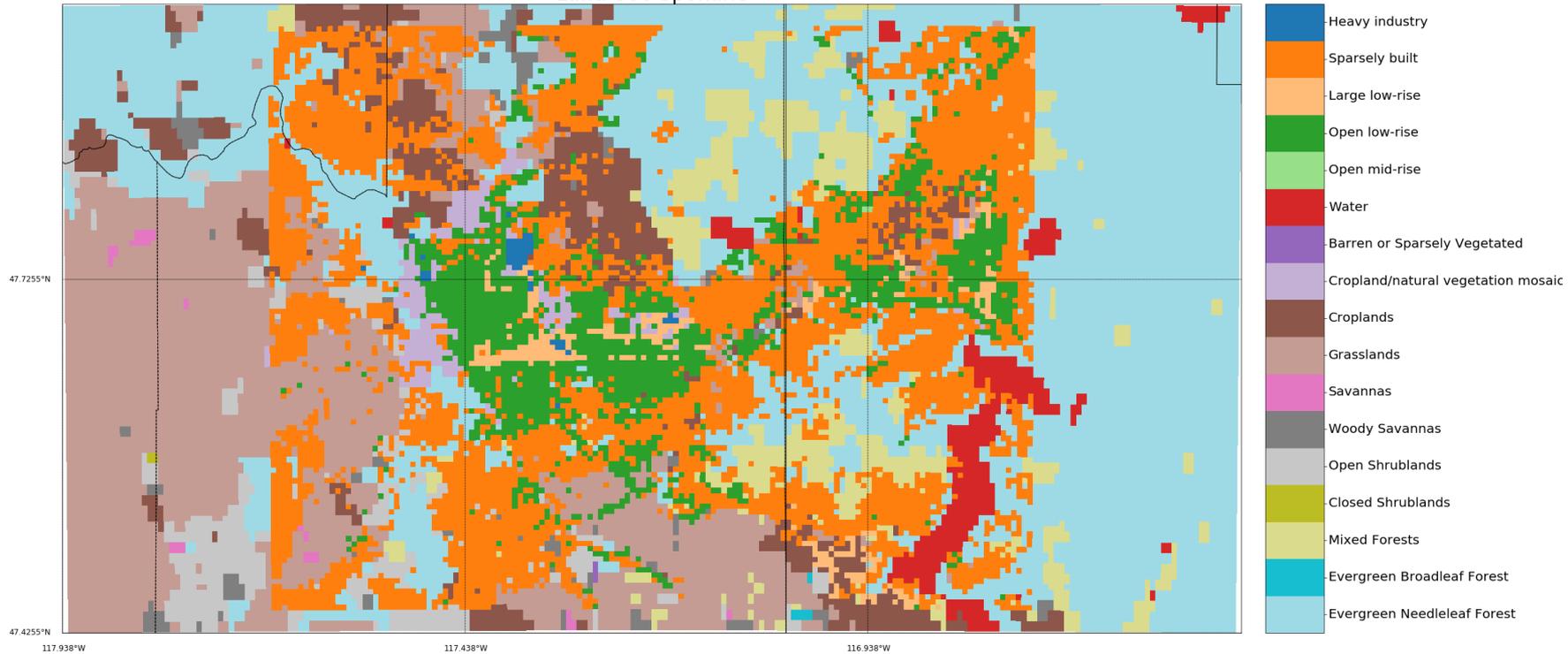
Modeling

Urban Climate and Air Quality Modeling

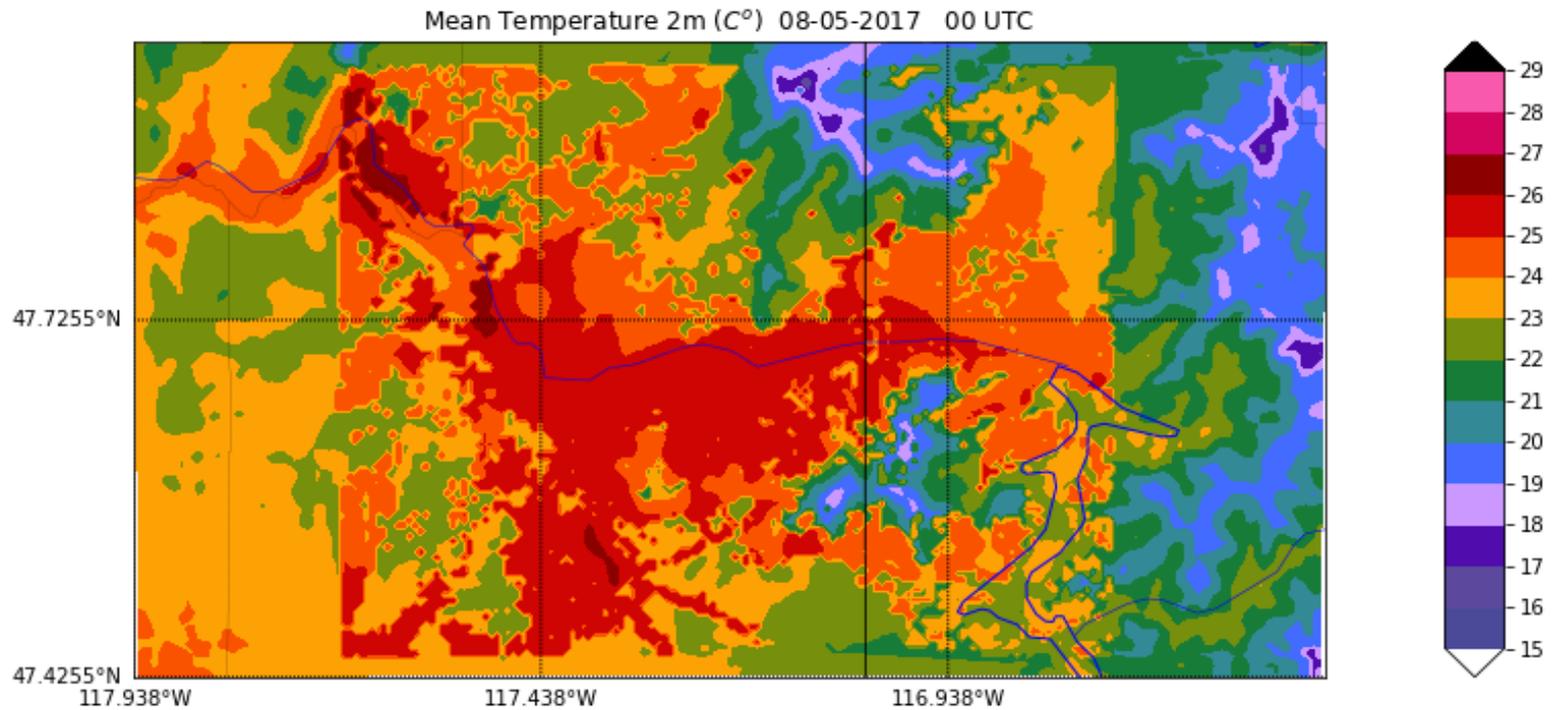
- **AIRPACT**
 - 1.33 km grids
 - Domain centered on Spokane
 - Resolution is insufficient for micro-climate modeling
 - Use 1.33 runs to provide BCON for micro-scale modeling
- **WRF-Urban-Chem**
 - Domain= 120x120
 - Grid spacing = 500m
 - No Chemistry included yet; TBD
 - Urban parametrization: BEP
 - Land use: Urban Classes of WUDPAT data (created by Alex) combined with MODIFIED_IGBP_MODIS_NOAH. This combination rely in a total of 40 classes, which 10 of them are urban.
- **ENVI-Met** computational fluid dynamics urban model
 - CFD k-e code; grid sizes of a few meters
 - Developed in Germany beginning in 1995
 - Comprehensive treatment of urban landscapes, building surfaces, and vegetation

WRF-Urban-Chem for Spokane area

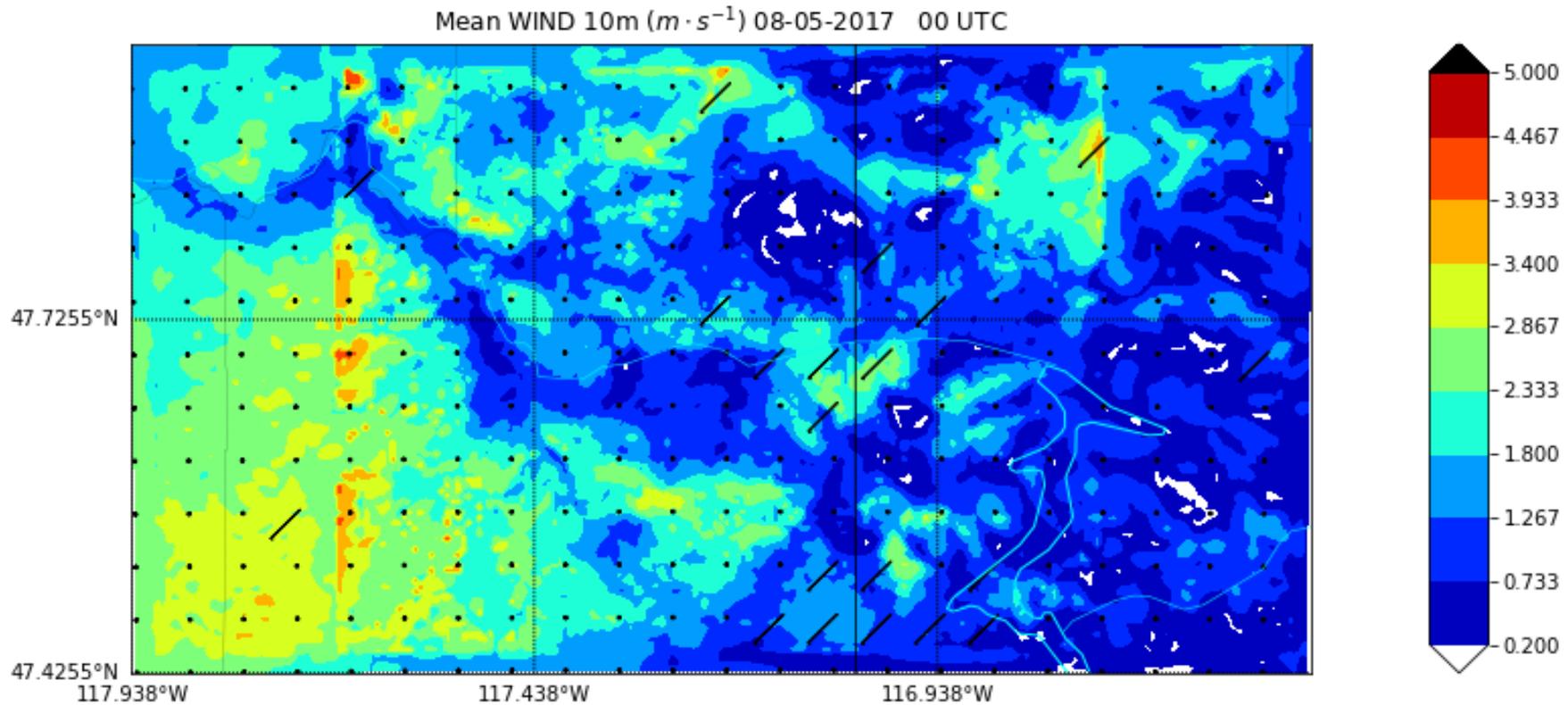
Land Use Spokane



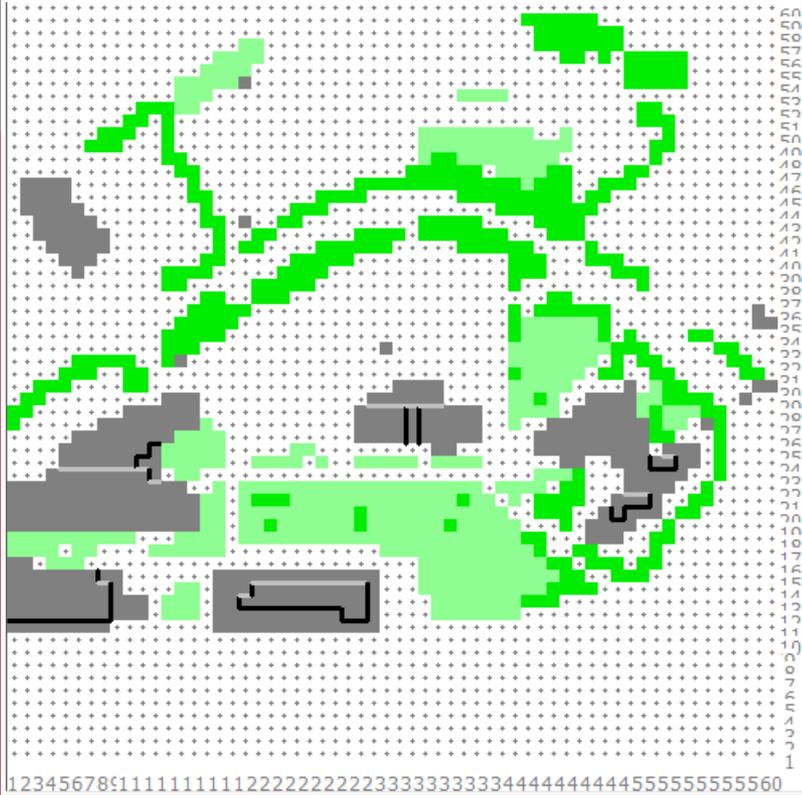
WRF-Urban-Chem for Spokane area



WRF-Urban-Chem for Spokane area

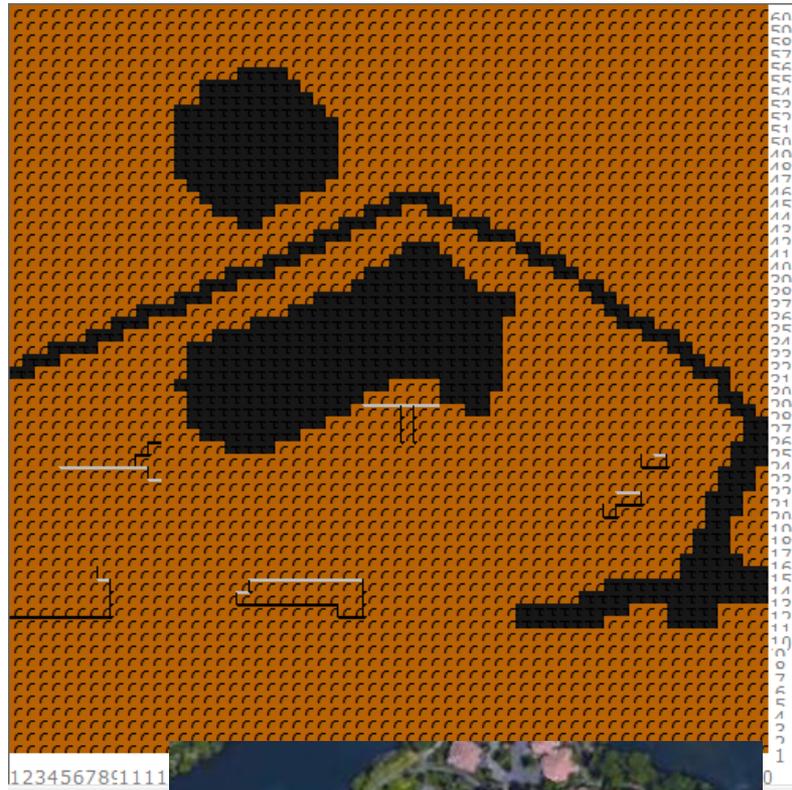


Buildings and vegetation



Surfaces

ENVI-Met



Jill Peery, WSU 2017 REU student

Start date	23/6/2017
Start time	7:00am
Total run time (hrs)	4 hrs
Output intervals for receptors and buildings (min)	30.00
Output interval for all other files (min)	60.00
Wind speed at 10m (m/s)	4
Wind direction (degrees from North)	90
Roughness length at measurement site	0.01
Initial temperature of atmosphere (°C)	21.00
Specific humidity at 25000m (g/kg)	7.0
Relative humidity in 2m (5)	50



Temperature

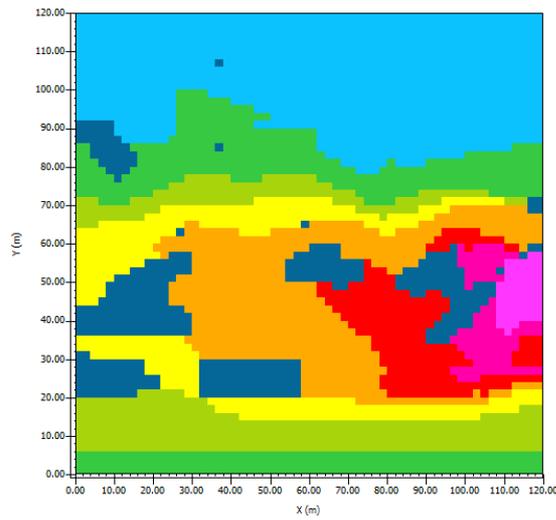
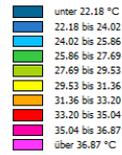


Abbildung 1: Simulation Test1
09:00:01 23.06.2017
xy Schnitt bei h=0 (z=0.2000 m)

Air Temperature



Mini: 20.35 °C
Max: 38.71 °C



Wind Speed

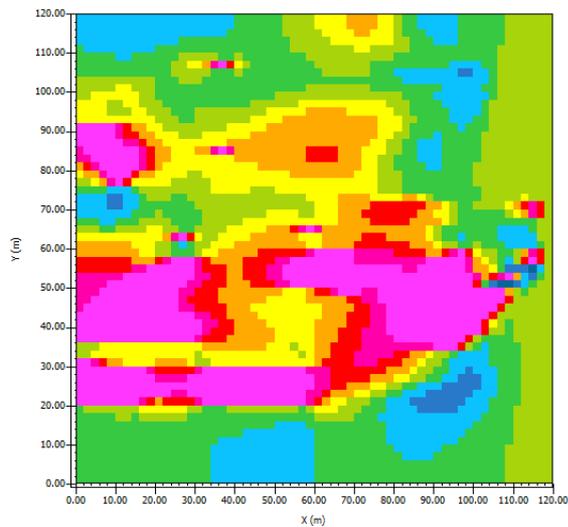
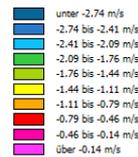


Abbildung 1: Simulation Test1
09:00:01 23.06.2017
xy Schnitt bei h=0 (z=0.2000 m)

Flow u



Mini: -3.06 m/s
Max: 0.19 m/s

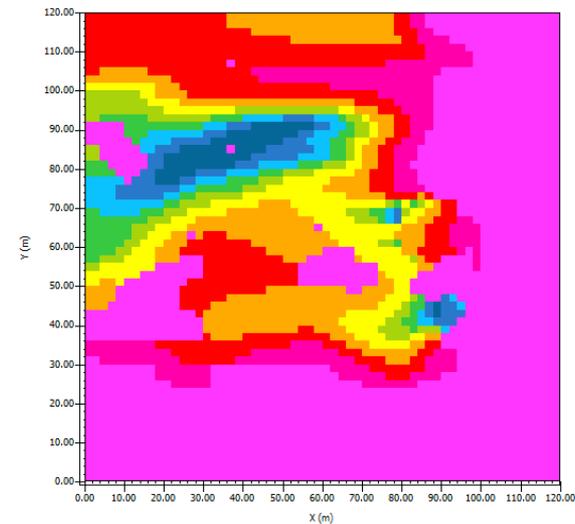


Abbildung 1: Simulation Test1
09:00:01 23.06.2017
xy Schnitt bei h=0 (z=0.2000 m)

CO2



Mini: 625.47 mg/m3
Max: 637.65 mg/m3



CO2

Looking forward

- Deploy additional sensors on rooftops and other locations throughout the university district
- Reference site has been established
 - Fitted with research grade instruments
 - Co-located with sensor packages for calibration and validation
 - Available for additional intensive measurement campaigns
- Mobile sampling along university district roadways
 - Sensor packages on city buses
 - New WSU instrumented van
 - Backpack bicycle or pedestrian monitoring
- Develop and apply urban modeling framework
 - AIRPACT at 1.33 km
 - WRF-Urban-Chem
 - ENVI-Met at high resolution
 - Large Eddy Simulation (WRF-LES)
- Continue to integrated with health, social science, and other physical science and engineering faculty



Questions?



Measurements

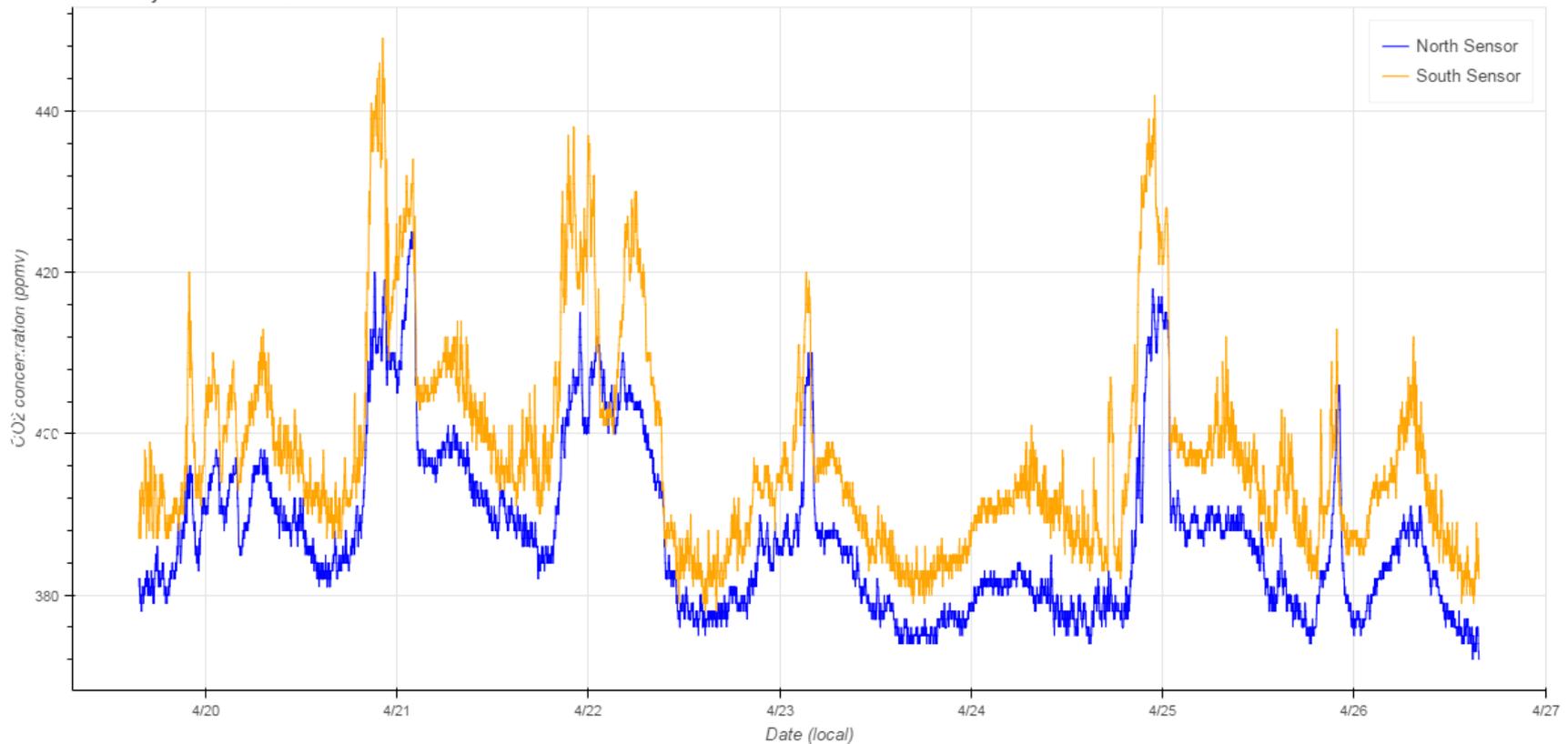
CO₂ Concentrations April 20-27, 2017



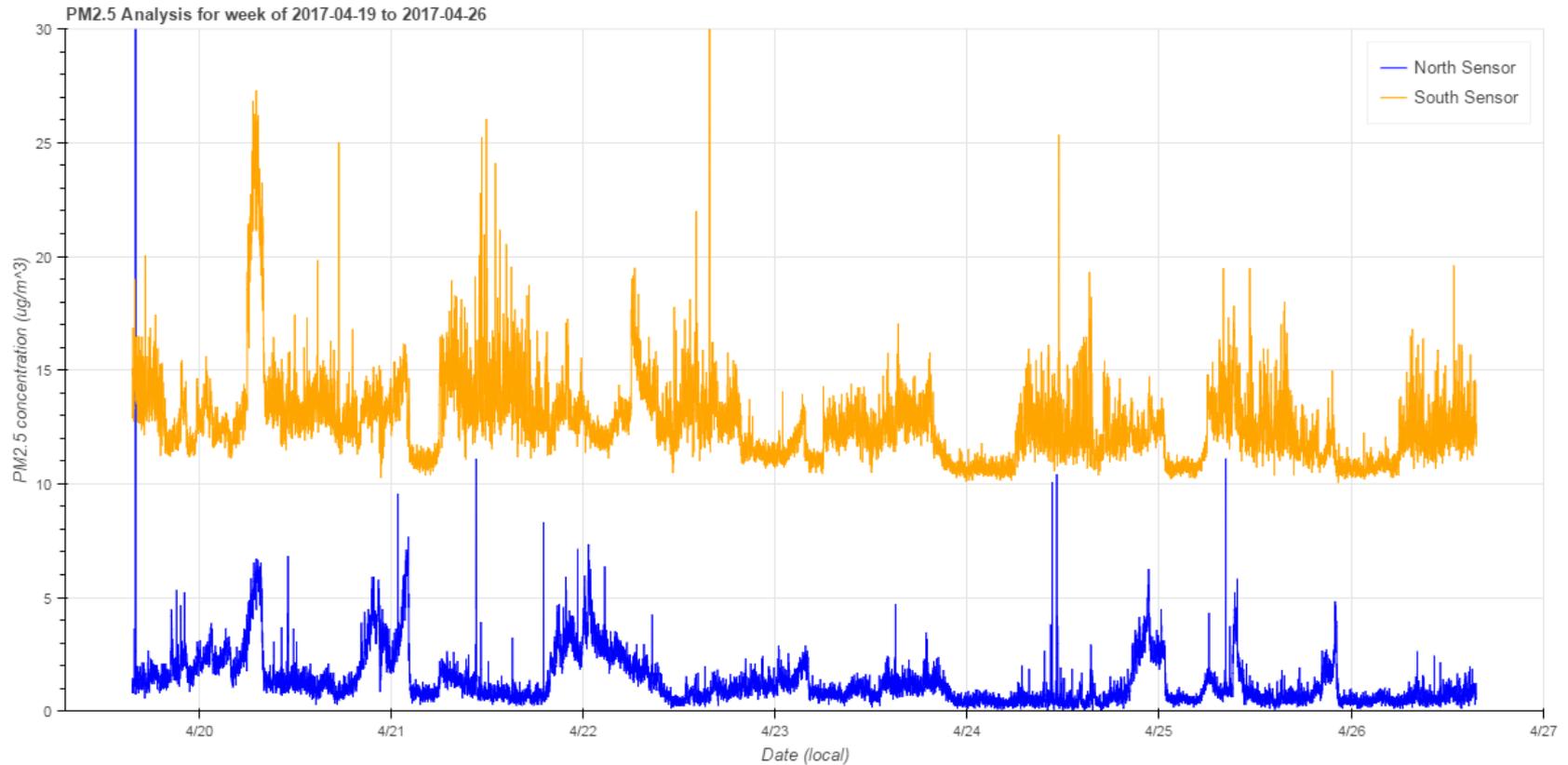
WASHINGTON STATE
UNIVERSITY



CO₂ Analysis for week of 2017-04-19 to 2017-04-26



PM2.5 Concentrations April 20-27, 2017

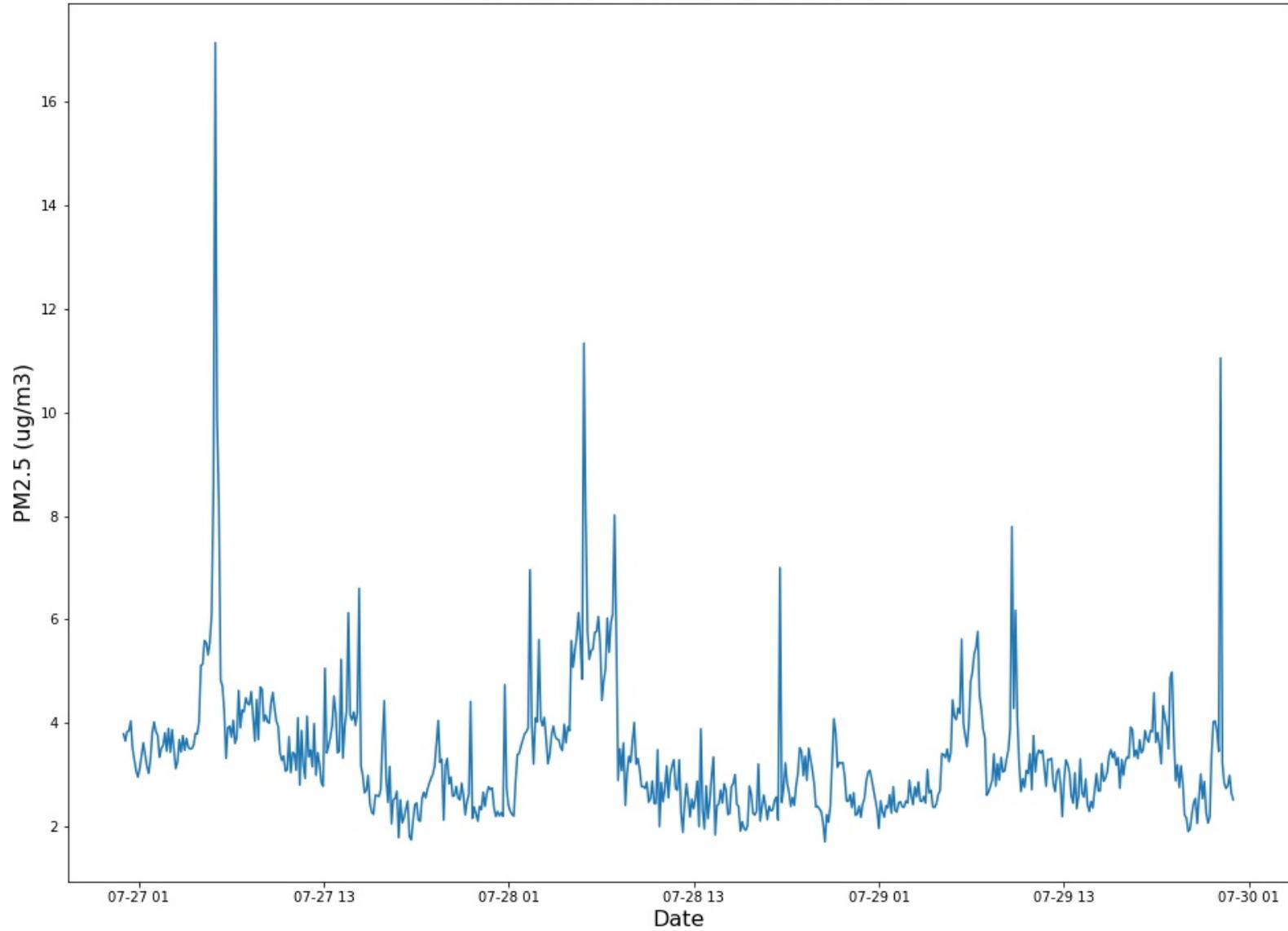


<http://sila.paccar.wsu.edu/~vonw/urbanova/AQnetMap.html>

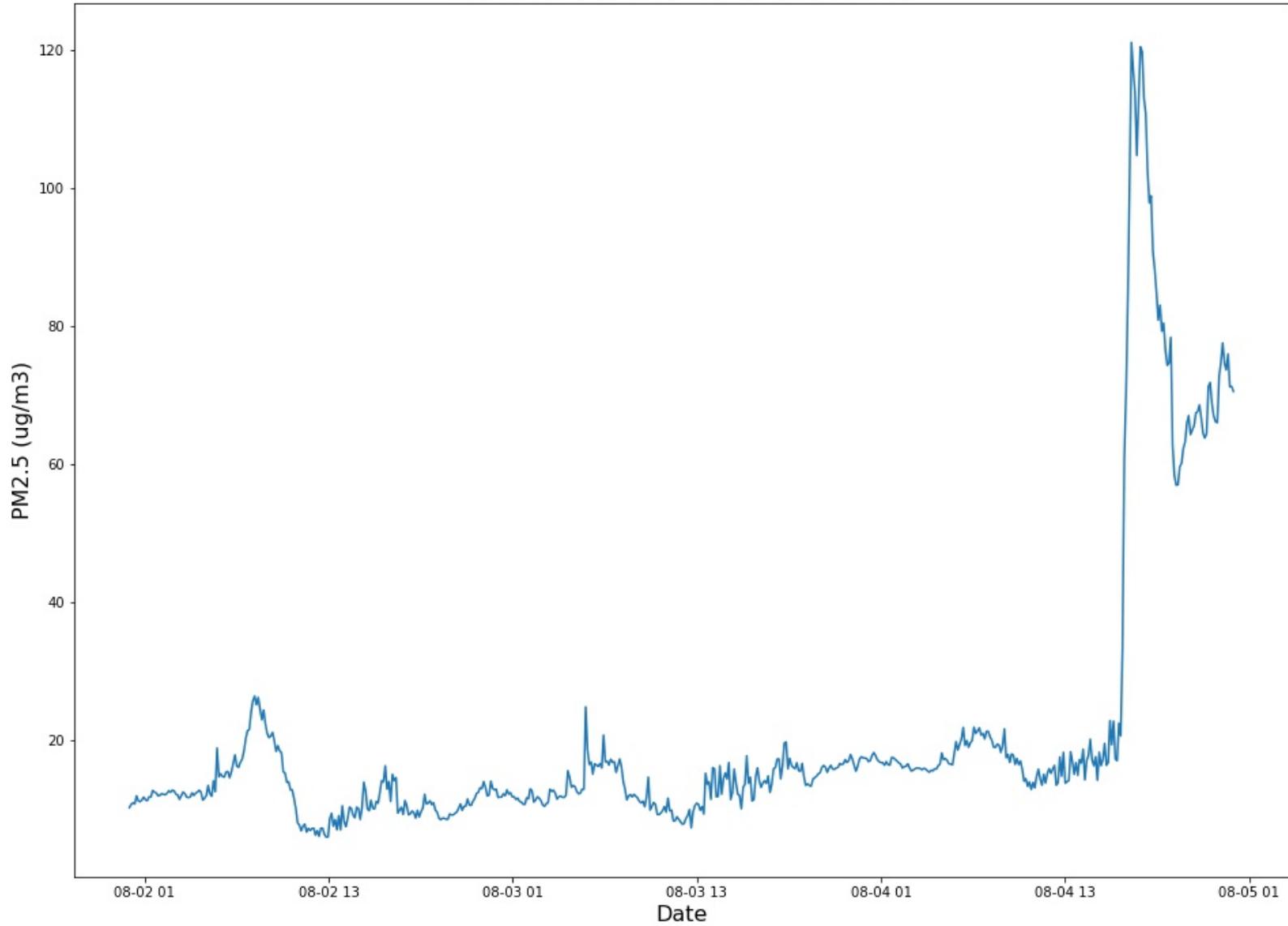
<http://sila.paccar.wsu.edu/~vonw/urbanova/weekly/>

http://sila.paccar.wsu.edu/~vonw/urbanova/weekly/UrbanovaWeekly_PM2.5_2017-05-22_2017-05-29.html

PM 2.5 Before Fires 7/27-7/30, East Sensor



PM 2.5 During Fires 8/02-8/05, West Sensor



PM 2.5 During Fires 8/02-8/05, East Sensor

