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Puget Sound Clean Air Agency

Working together for clean air

Seattle Near-road Air Toxics Study
Intro to Criteria Pollutants and PMF and AERMOD Results

Phil Swartzendruber

NW-AIRQUEST Annual Meeting

June 2018

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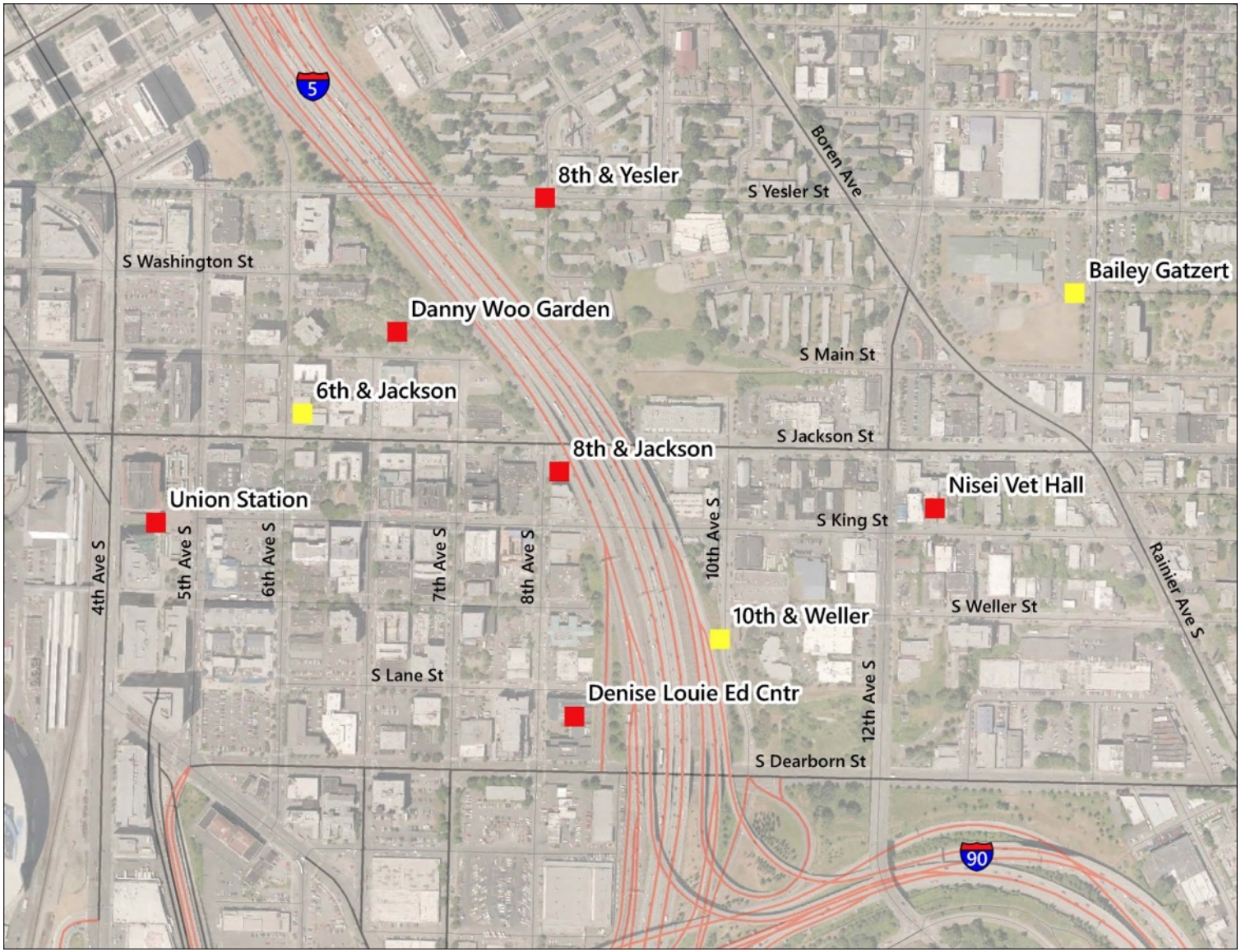
Fixed site data collection locations



AERMOD and PMF modeling scientific questions…

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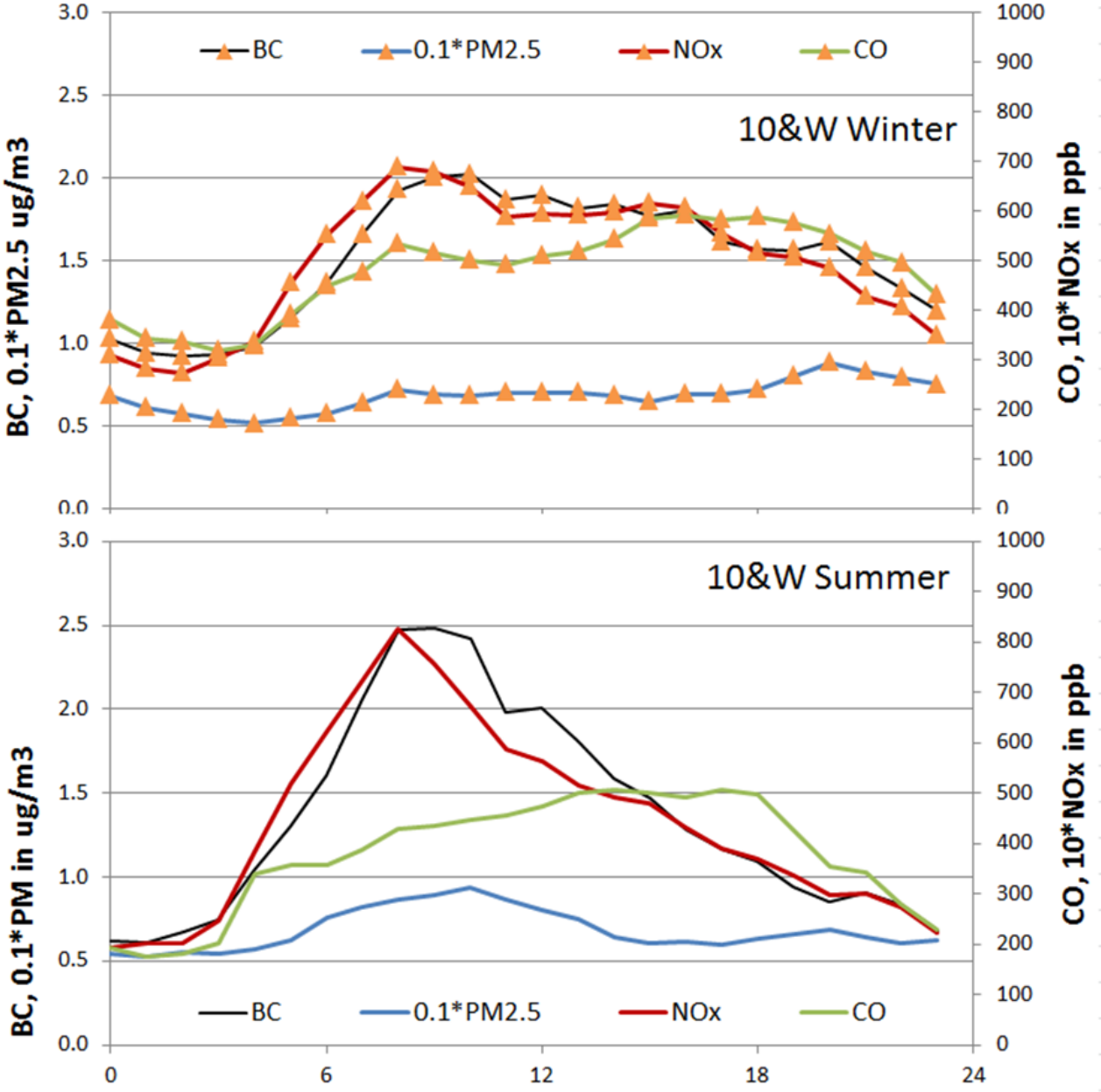
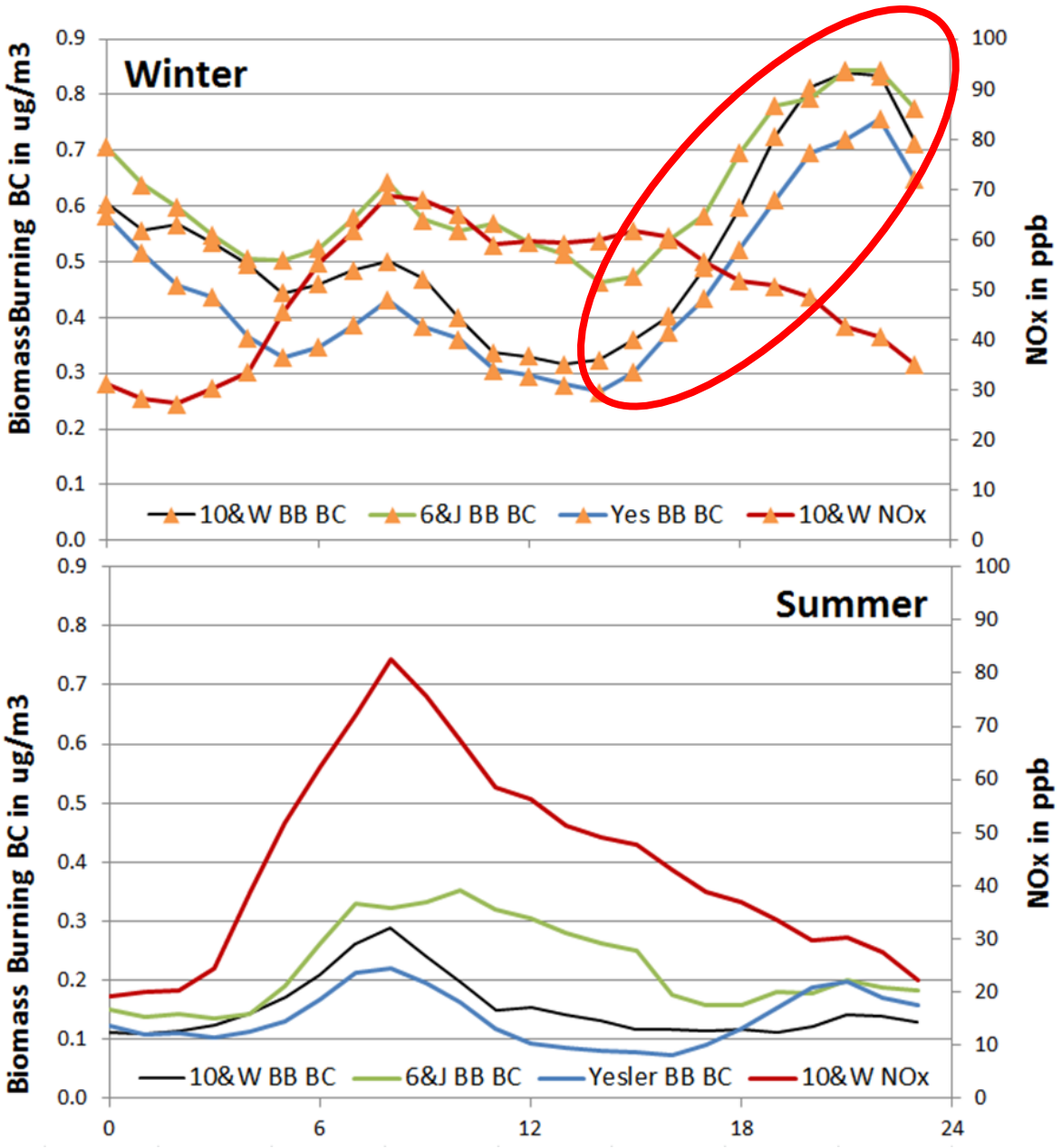
- How much pollution do vehicles on I-5 and I-90, and restaurants contribute to the study area?
- How well can the observations be explained by a simple (2 or 3 source) model?
- Can we quantify diesel fine PM?
- How well does the simple dispersion capture the spatial distribution?



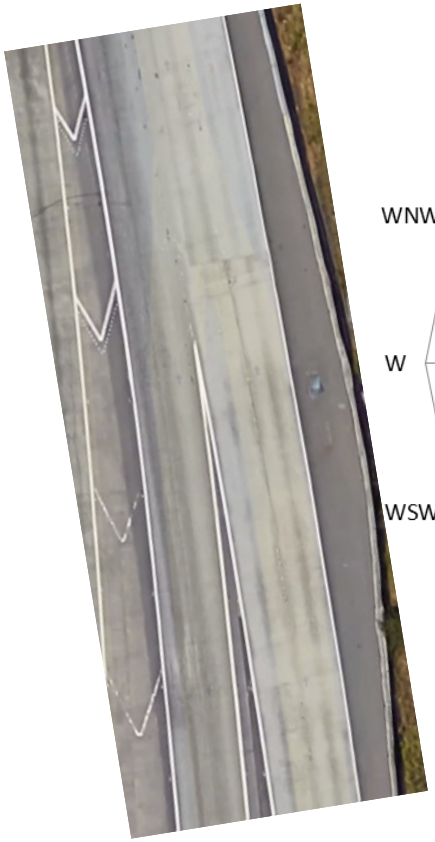
- **Diurnal average at 10th and Weller**
- **Same scale**
- **NOx and BC strongly correlated**
- **CO moderately correlated**
- **Trucks have lower CO:BC than cars**

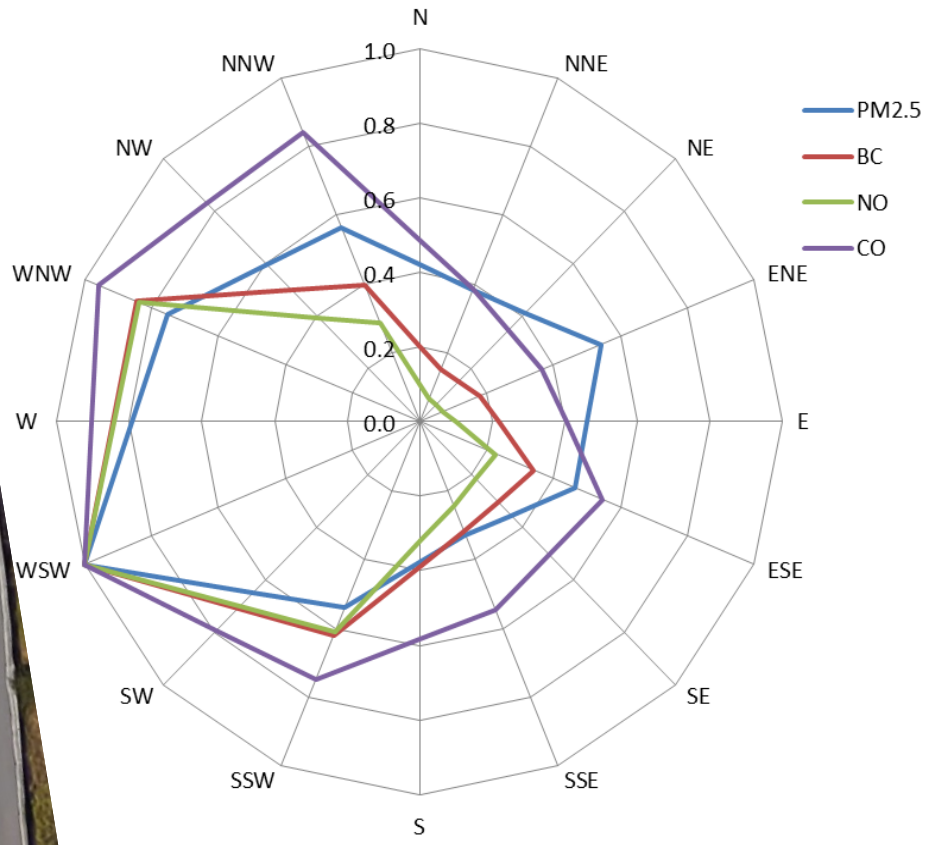


- Diurnal average at 10&W and two fixed sites
- Same scale
- Biomass burning black carbon BB BC
- Measure is aethelometer UV-BC

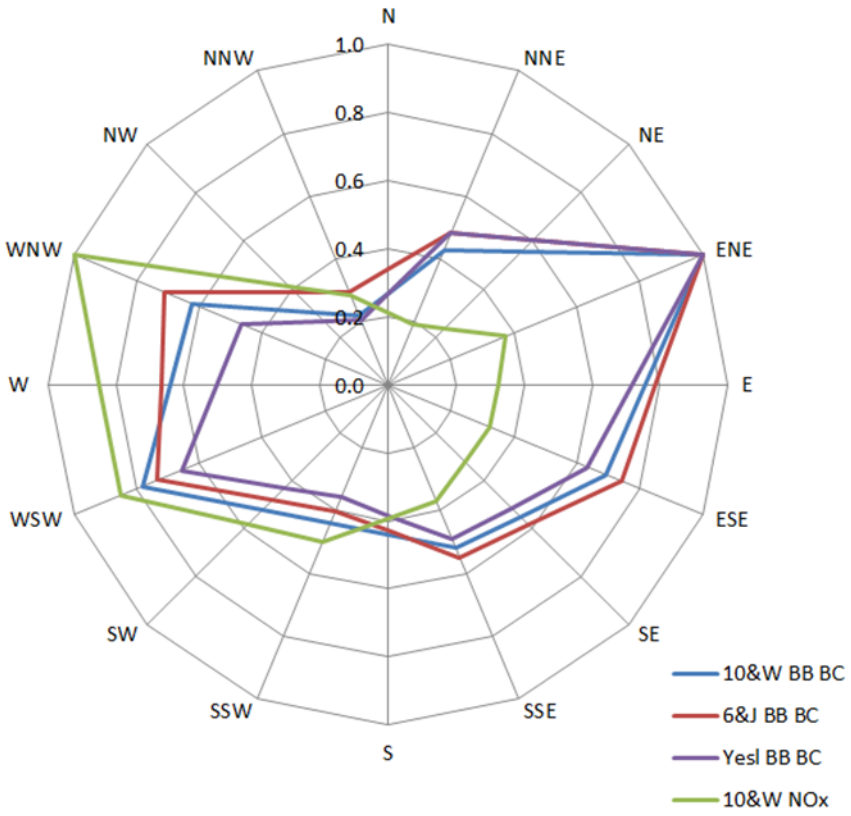
Pollution rose of biomass burning black carbon at 10th & W and temporary sites

- NO and BC strong directionality
- PM2.5 and CO are weaker



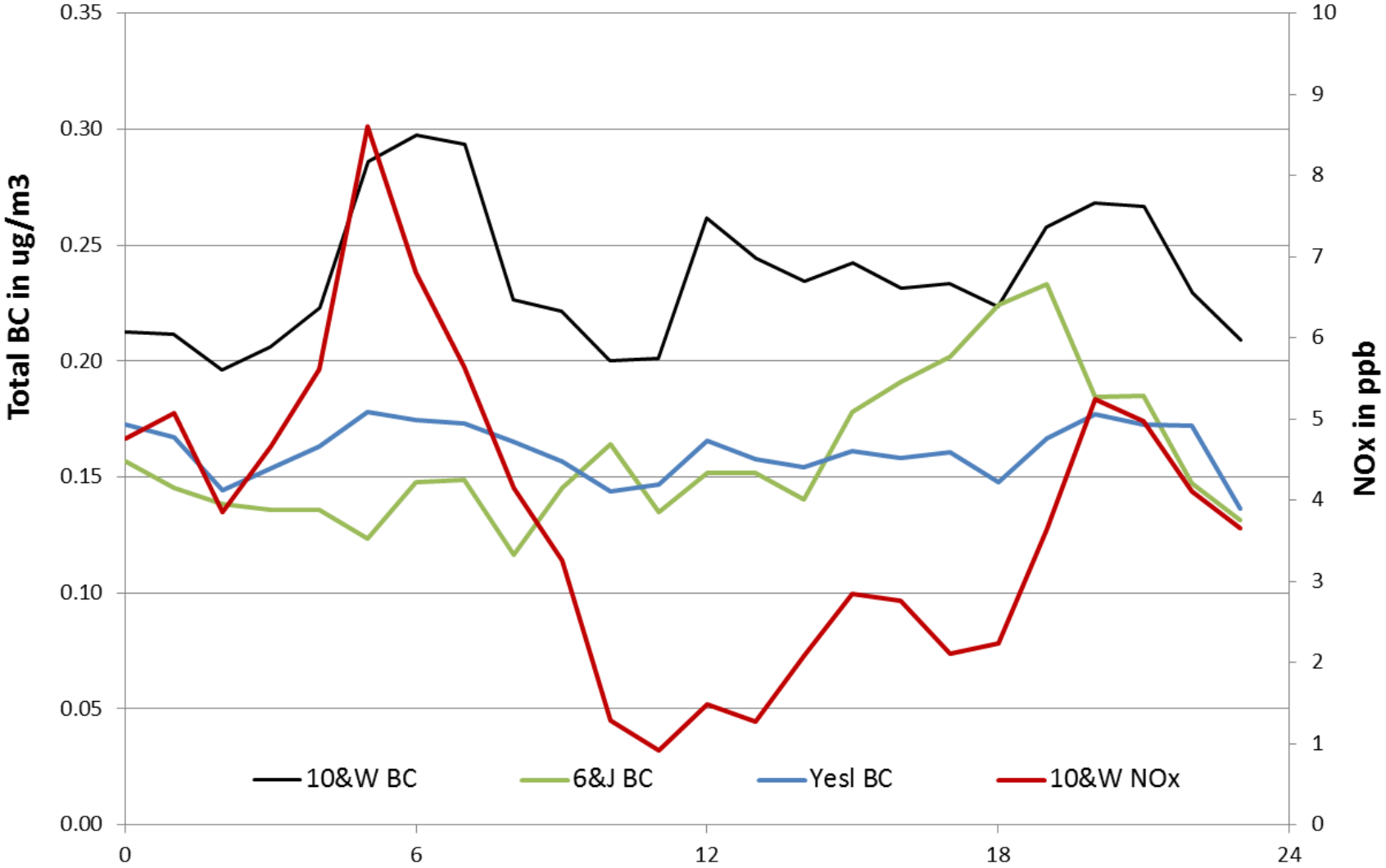


Winter pollution rose of biomass burning black carbon at 10th & Weller



- Biomass burning black carbon (BB BC) good marker for wood burning
- Also has NOx for context

2016-17 Chinatown-ID diurnal difference in pollutants due to August 2017 wildfires: BC and NOx



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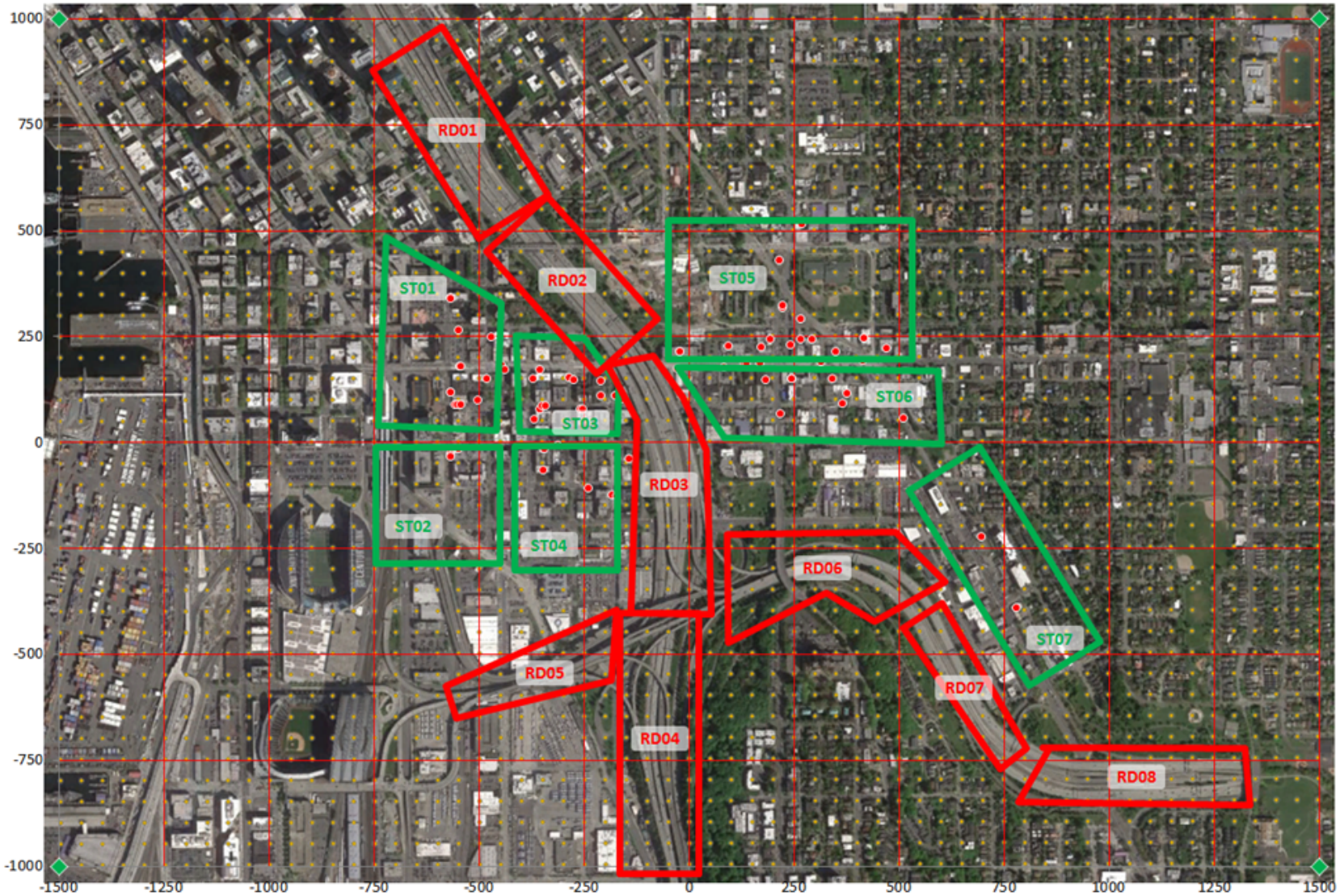
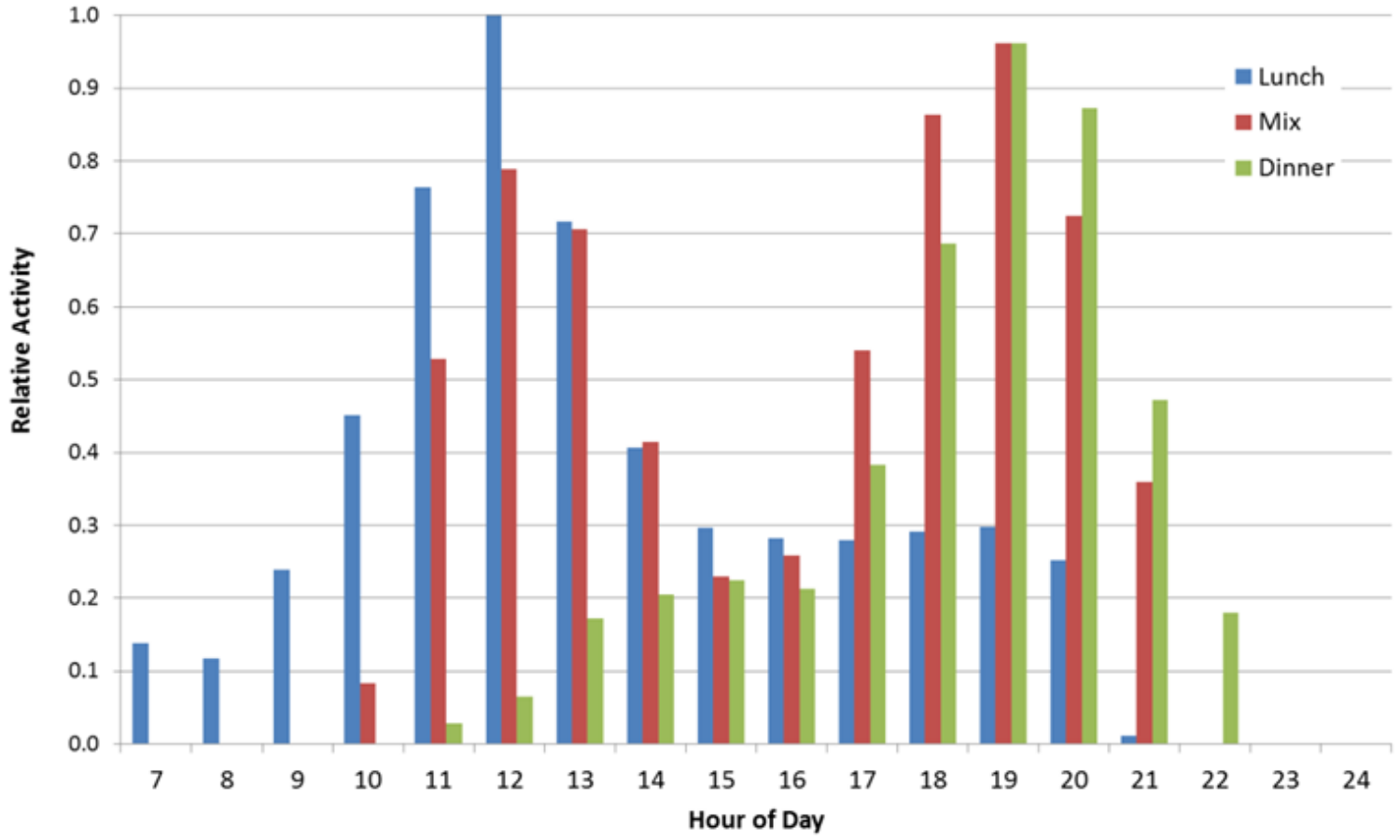
AERMOD domain in patches

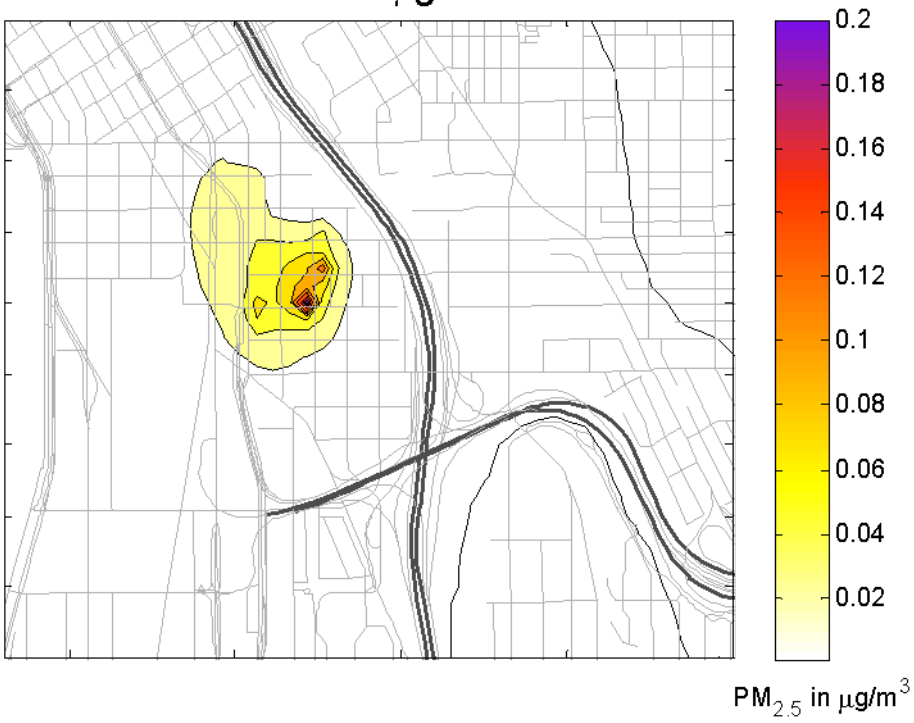


Diurnal Activity Pattern for Selected Restaurants

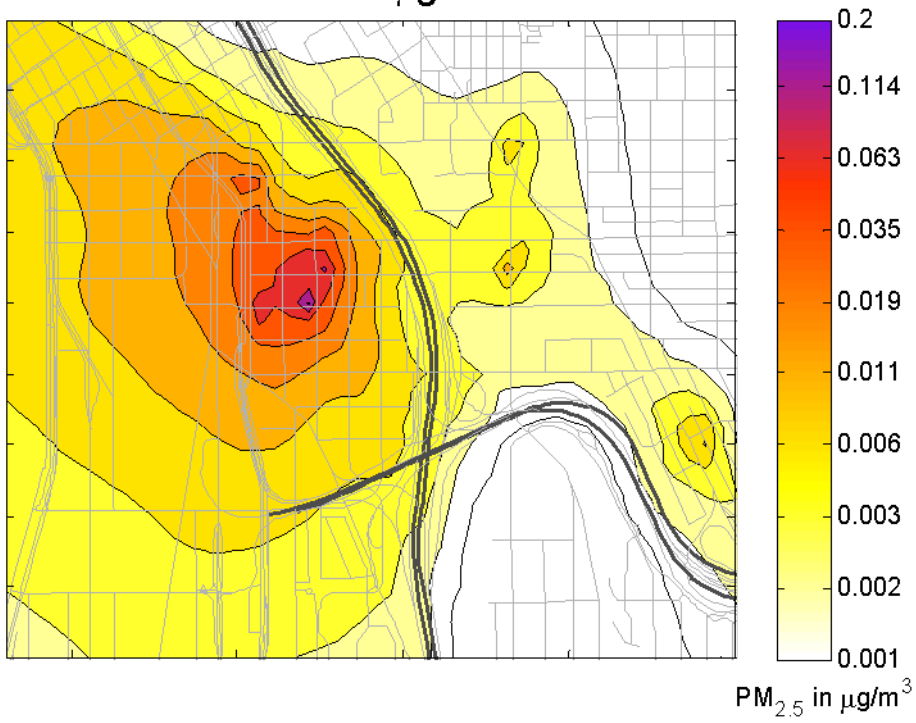


Value	Unit	Description	Author, year, Journal
6809	mg/portion	hamburger underfired charbroiler	EPA NEI, 2002
2299	mg/portion	charbroiled beef or chicken	McDonald, 2003, JAWMA
710	mg/portion	charbroiled beef or chicken	
80	mg/portion	high emission rate for grilling	Buonano, 2009, Atmos. Environ
7.2	mg/portion	low emission rate for grilling	
30.7	mg/portion	high emsssions, any food, fried or grilled	Hu, 2012, Law. Burk. Nat. Lab
16	mg/portion	low emission, any food, fried or grilled	
43.9	mg/portion	high emissions, any food, stir fried	CARB
20.7	mg/portion	low emissions, any food, stir fried	
41.3	mg/portion	high emissions, any food, stir fried	Wang, 2015, Aerosol and Air Quality Res.
20.7	mg/portion	low emissions, any food, stir fried	
		geometric mean	
2232	mg/portion	charbroiling	
26.2	mg/portion	frying or stir frying	

AERMOD annual mean from restaurants
PM2.5 in μg/m^3

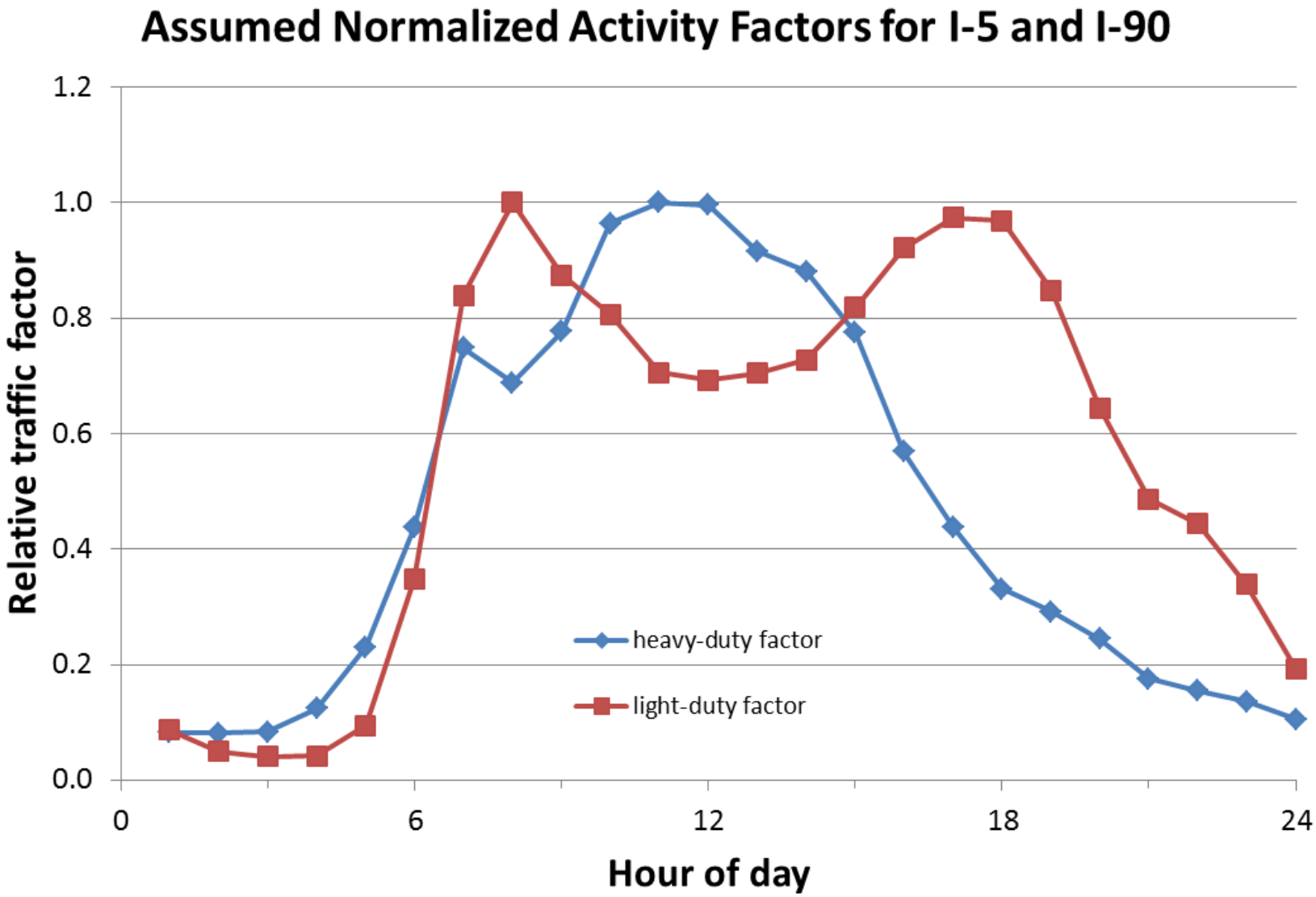


AERMOD annual mean from restaurants (log ints.)
PM2.5 in μg/m^3



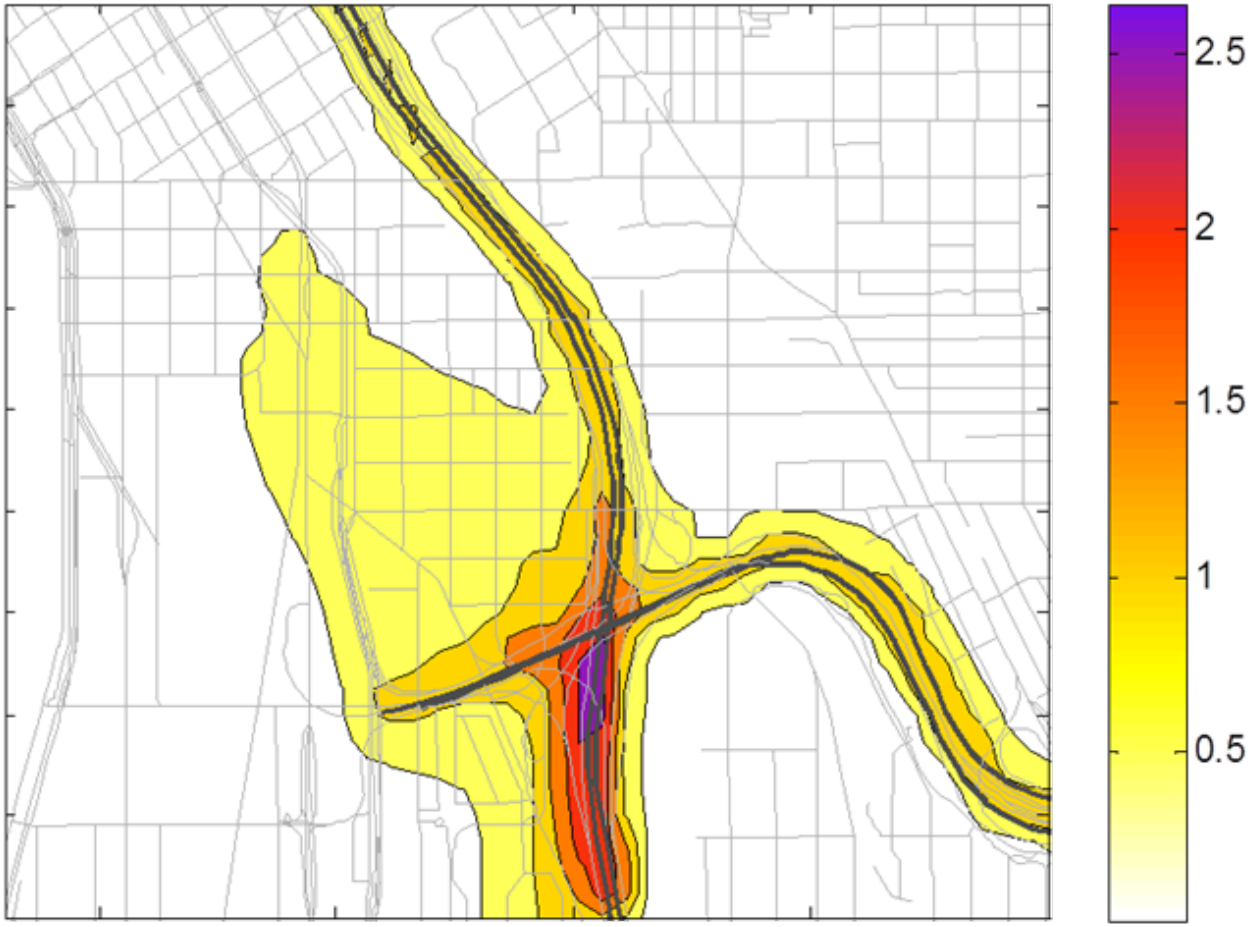
AERMOD simplified road modeling

- 8 patches
- Total traffic flows on 3 sections from WSDOT data
- From I-90 counter:
  - Hourly truck and light duty counts each day
- Cars and HD trucks have different diurnal patterns
- Use fleet average emission factors for each age of vehicle, separate factors and distributions for LD, HD
- In-use fleet is weighted average of each distribution


Assumed Normalized Activity Factors for I-5 and I-90
Relative traffic factor
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
6
12
18
24
Hour of day
heavy-duty factor
light-duty factor

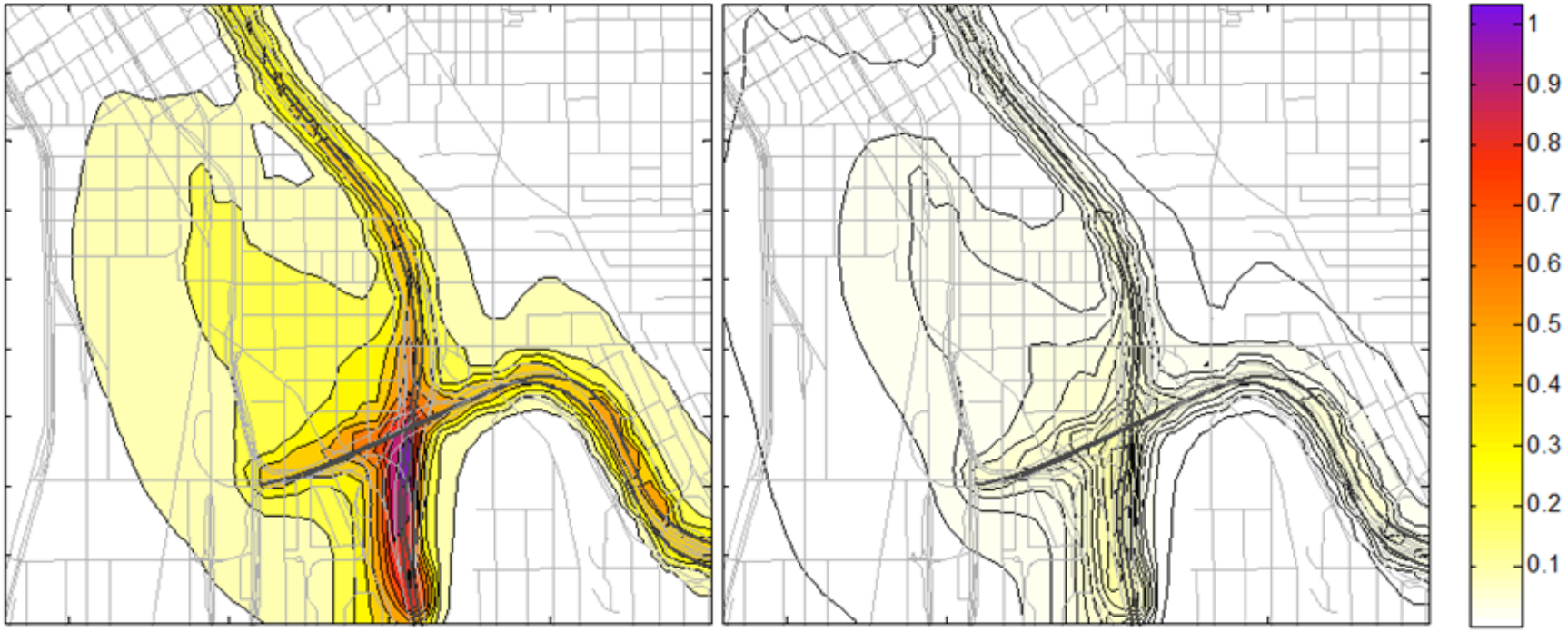
AERMOD Modeled annual mean from cars&trucks

PM2.5 in μg/m^3 (*0.8|0.75 = CO|NOx in ppb)



AERMOD Modeled annual mean from trucks
BC in μg/m^3 (*0.8|0.75 = CO|NOx in ppb)

AERMOD Modeled annual mean from cars
BC in μg/m^3 (*0.8|0.75 = CO|NOx in ppb)



PMF overview

- 61 dates with 80 analytes/ parameters, n ~ 4800
- Explored 5-11 factors
- By 7-8 factors, ambiguity becomes significant and gets a lot of swaps
- 5 factors seemed to mix some major markers
- 6 factors was fairly robust with no swaps, but still some BS-DISP swaps
- Allowed EC2 to be pulled down and UV-BC to pulled up with little dQ robust

PMF factor interpretation

- Woodsmoke is clear from temporal factor, benzo-PAHs, and UV-BC
- Summer factor was robust across all # of factors
- Summer has strong diesel/industrial components: EC2, sulfate ion; also has temporal factor with greater winds from west (Port & Duwamish)
- Smoldering episodes had a majority of OC1, but were isolated to a few short, strong episodes

PMF factor interpretation 2

- Diesel: strong EC1 and EC2, good NO and BC, good portion of metals: zinc, iron, titanium, antimony
- Aged urban: background like, halogenated compounds, no EC2 and OC1, little EC1 and OC2-4, also a big chunk of CO and aldehydes
- Industrial metals: largest factor having arsenic, cadmium, lead, small amounts of others
- Puzzles-questions: smoldering episodes, unclear what this is, events-processes or

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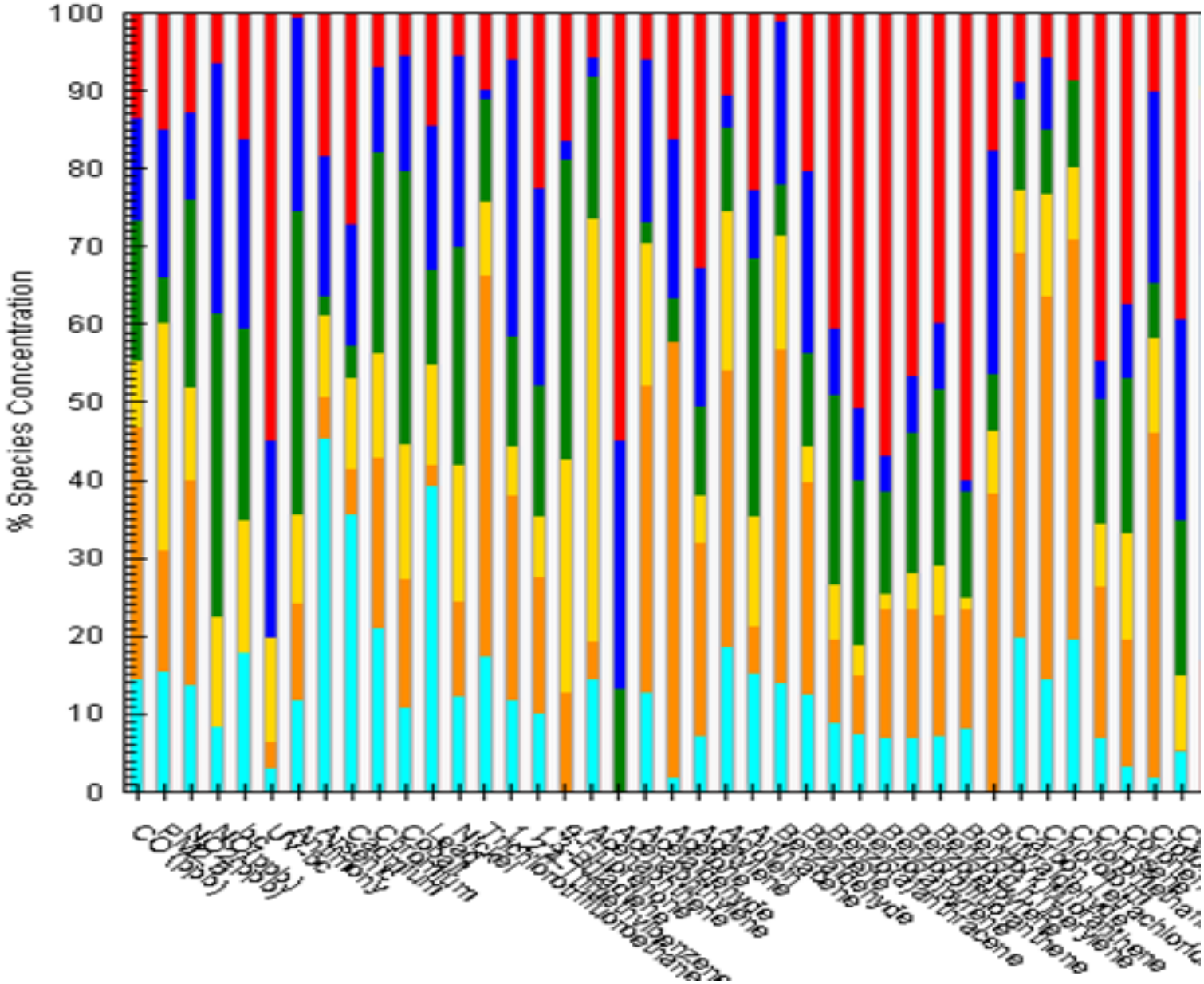
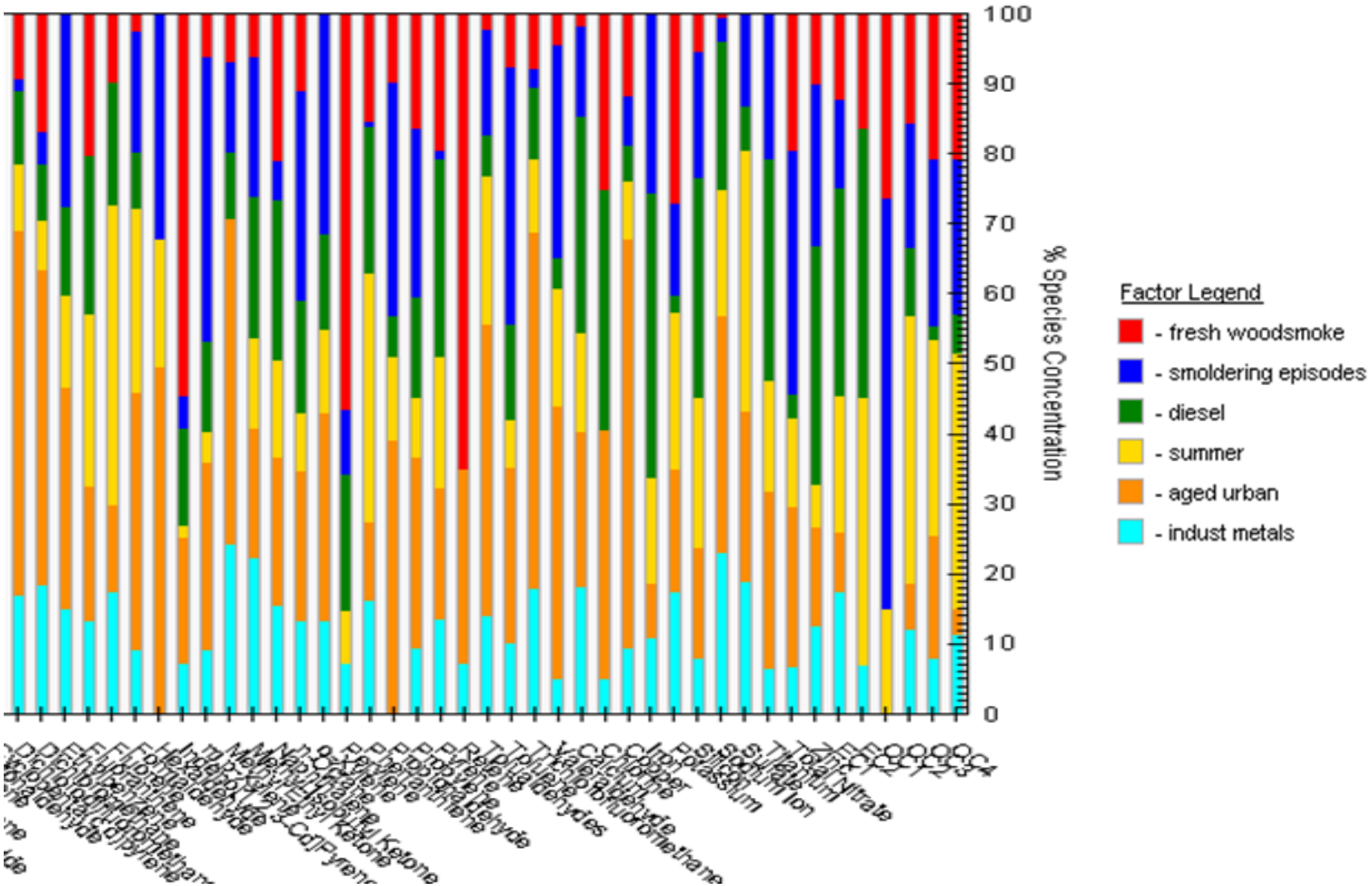
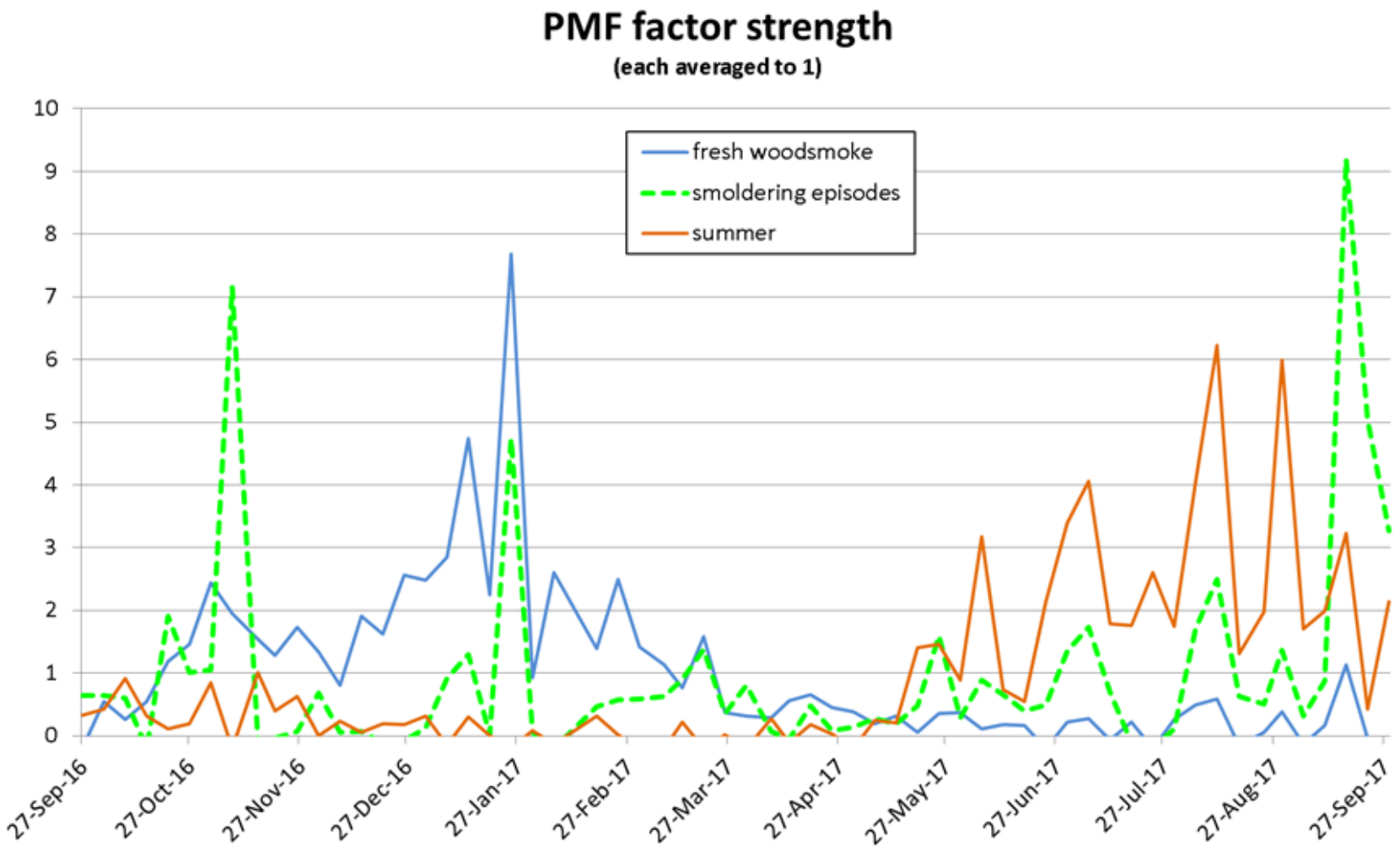
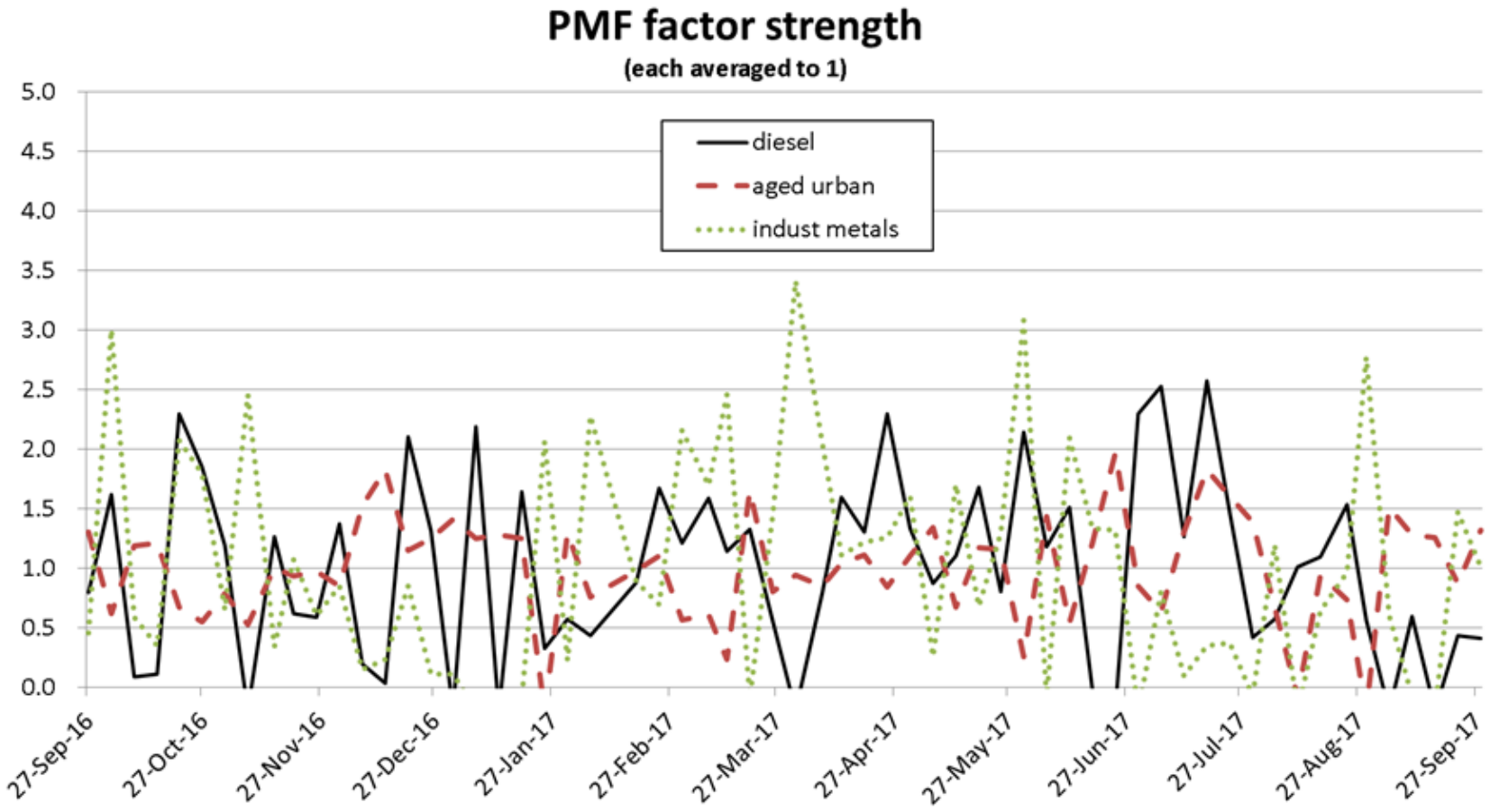
Constrained Fa



actor Fingerprints




PMF factor strength
(each averaged to 1)
fresh woodsmoke
smoldering episodes
summer
10
9
8
7
6
5
4
3
2
1
0
27-Sep-16
27-Oct-16
27-Nov-16
27-Dec-16
27-Jan-17
27-Feb-17
27-Mar-17
27-Apr-17
27-May-17
27-Jun-17
27-Jul-17
27-Aug-17
27-Sep-17


PMF factor strength
(each averaged to 1)
diesel
aged urban
indust metals
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
27-Sep-16
27-Oct-16
27-Nov-16
27-Dec-16
27-Jan-17
27-Feb-17
27-Mar-17
27-Apr-17
27-May-17
27-Jun-17
27-Jul-17
27-Aug-17
27-Sep-17

Summary

- Diurnal pattern suggests ~1.7 ug/m3 of PM2.5
  - EFs suggest I-5/I-90 emitted PM2.5 is about 80% diesel
  - So, roughly 1.4 ug/m3 of diesel PM2.5
- AERMOD suggests 0.4-1.3 ug/m3 of diesel PM from I-5 and I-90
- PMF suggests 0.9-1.3 ug/m3 of diesel PM, but signs of diesel in other factors (industrial metals, episodes), possibly up to 2.0 ug/m3?
- So possibly up to an additional 0.1-1.0 ug/m3 of diesel PM2.5 from outside the study area

Questions

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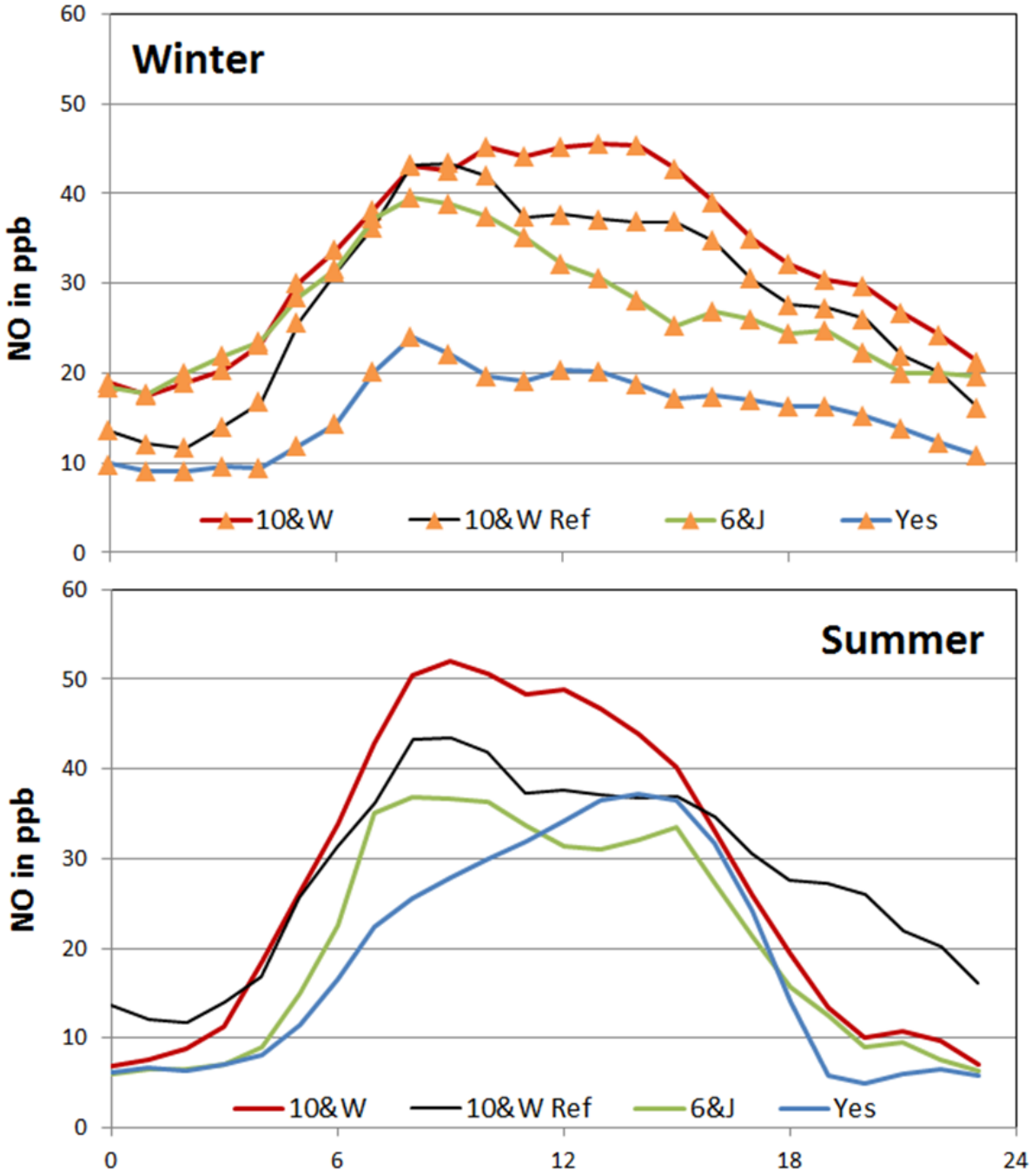
- **Phil Swartzendruber**
- **Phils@pscleanair.org**
- **206-689-4085**

extra



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