Mobile ObserVations of Ultrafine Particles (MOV-UP)

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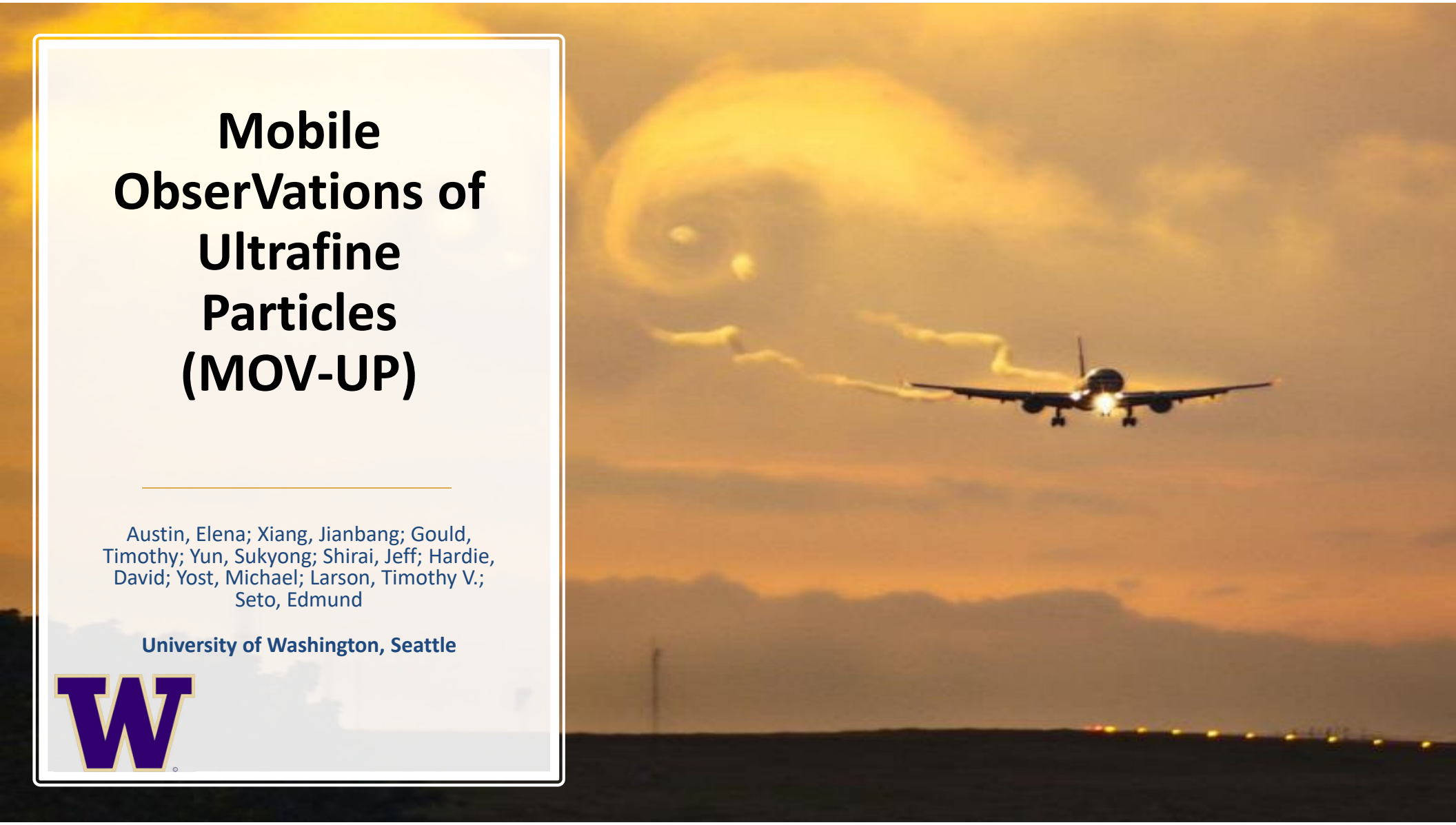
University of Washington, Seattle



Outline

Study aims and overview

Methods

Results from fixed monitoring

Results from mobile monitoring

Conclusions and next steps

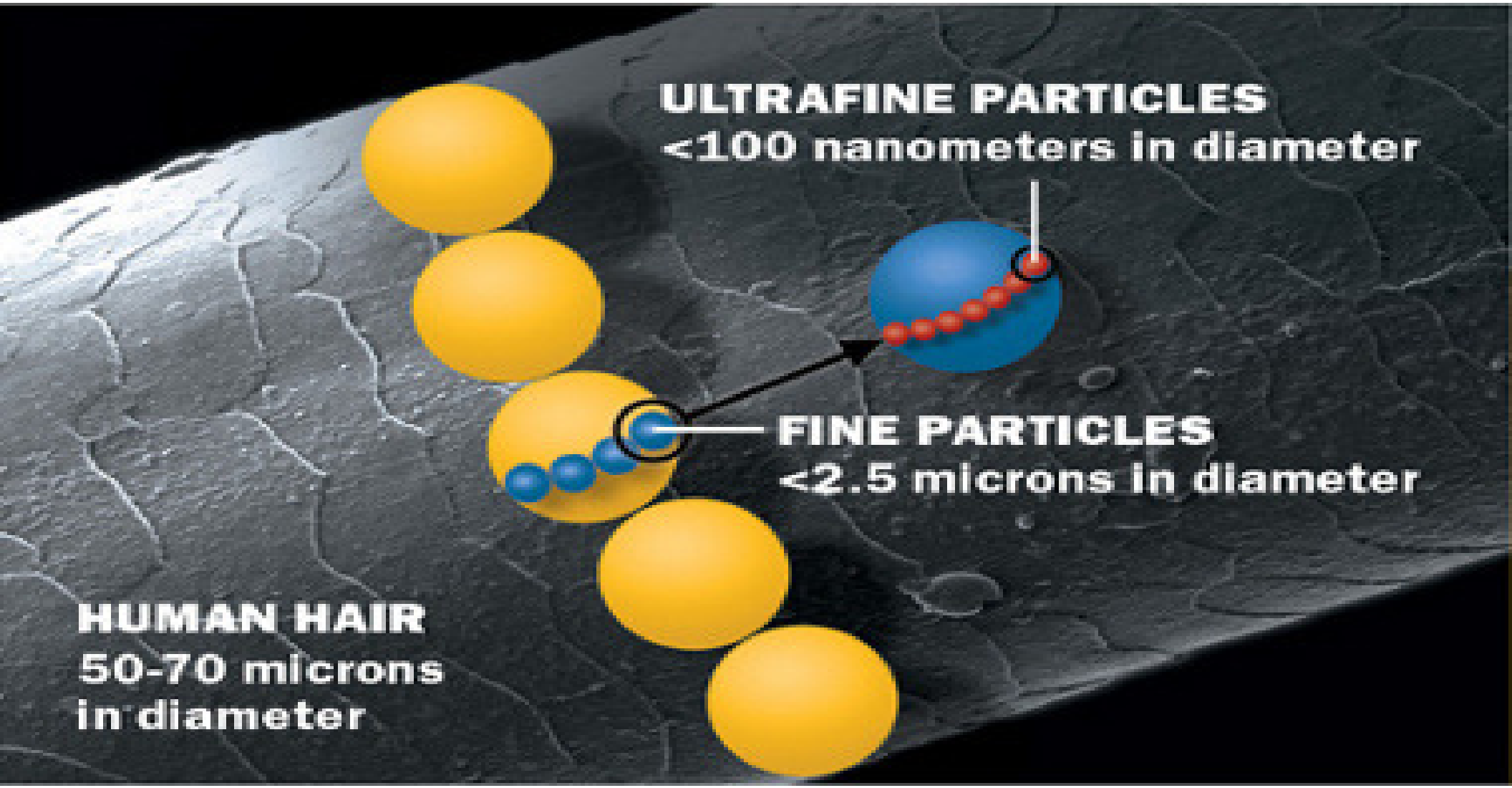
Study Objectives

- Study the implications of air traffic at Sea-Tac
- Assess the concentrations of ultrafine particulate matter (UFP) in areas surrounding and directly impacted by air traffic
- ***Distinguish between and compare concentrations of aircraft-related and other sources of UFP***
- Coordinate with local governments, and share results and solicit feedback from community

Recent MOV-UP Presentations

- FAA Aviation Emissions Characterization Roadmap Meeting (May 24, 2019)
- Airport Impact Study Meeting, Seatac City Hall (May 20, 2019)
- Federal Way City Council, Land Use & Transportation Meeting (Apr 1, 2019)
- Seattle King County Board of Health (Feb 21, 2019)
- Highline Forum (Jan 23, 2019)

- Study Advisory Board Meeting (Aug 15, 2018)
- NW-AIRPACT (June 12, 2018)
- Highline Forum (Mar 28, 2018)
- Study Advisory Board Meeting (Jan 5, 2018)


ULTRAFINE PARTICLES
<100 nanometers in diameter
FINE PARTICLES
<2.5 microns in diameter
HUMAN HAIR
50-70 microns
in diameter

Ultrafine Particles (UFPs)

Ultrafine Particles unregulated but potentially important

Health Effects more uncertain compared to $PM_{2.5}$,but a growing body of evidence

Diesel Engines emit ultrafine particles resulting in elevated levels near major roadways (within 200 meters downwind)

Jet aircraft directly emit “ultra-ultra fine” particles (< 30 nanometers)

Health Effects Studies of Ultrafine Particles

- WA Department of Health currently conducting a detailed literature review of the health effects associated with ultrafine particles.
- The current UW MOV-UP project is not a study of health effects. It is air quality measurement and source characterization study.

- One study that explicitly considered exposures to aircraft-related ultrafine PM

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Short-term effects of airport-associated ultrafine particle exposure on lung function and inflammation in adults with asthma

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- Randomized crossover study of 22 non-smoking adults with mild to moderate asthma
- 2-hr scripted, mild walking activity both inside and outside of the high LAX UFP impact zone (avg. difference ~30,000 /cc)
- Mean particle size at LAX impact zone was 29 nm
- *"We found significant increases in markers of systemic inflammation associated with 'Airport UFPs' and 'Traffic' exposure*

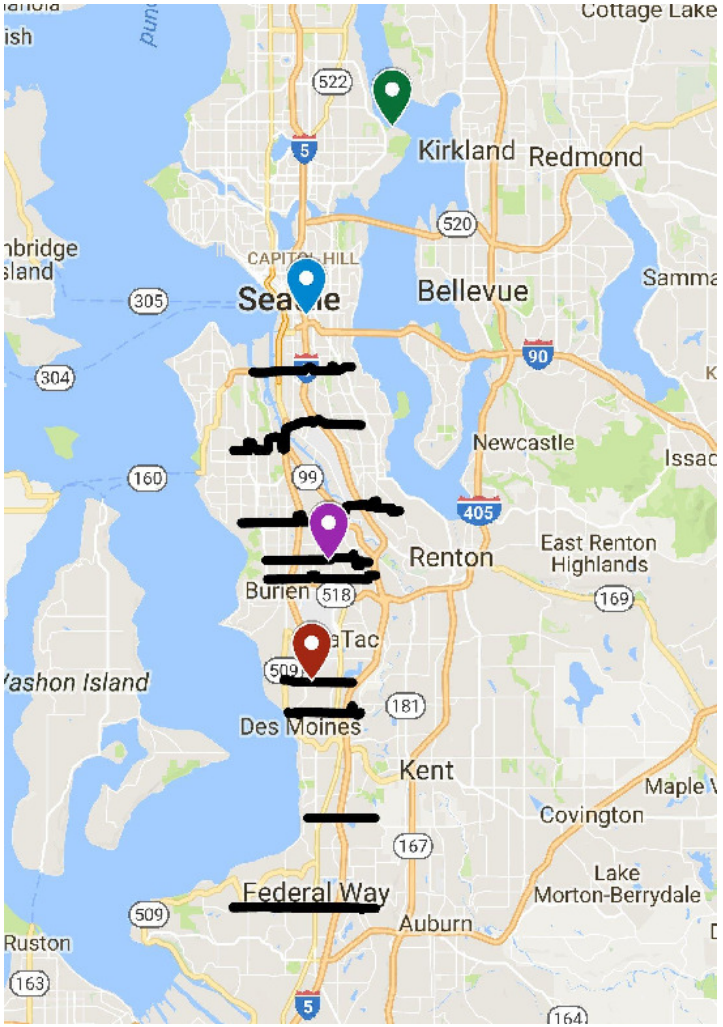
Mobile Monitoring Platform

Parameter	Instrument
Mobile and Fixed sampling:	
Particle number concentration (35 nm – 1 µm)	P-Trak 8525, w/ diffusion screens
Particle number concentration (20 nm – 1 µm)	P-Trak 8525
Particle number concentration (10 nm – 1 µm)	Condensation Particle Counter 3007
Black Carbon PM	Micro-Aethalometer AE51
CO2	LI-850 Gas Analyzer
Temperature & Humidity	Hobo T, RH datalogger
Position & Time tracking	GPS Receiver DG-500
Fixed Location sampling:	
Particle size distribution, 13 bins	NanoScan 3910

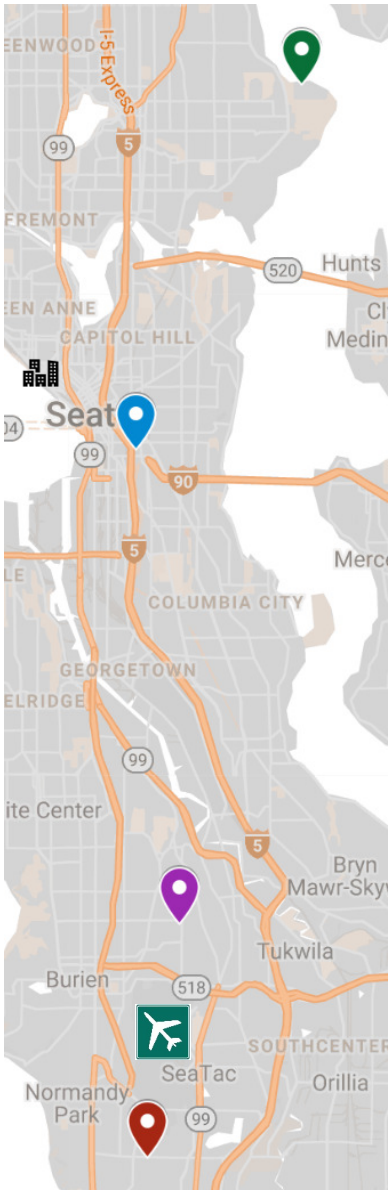
Study Region: Mobile Transects and Fixed Monitoring Site Locations

Fixed Sites

- SeaTac Community Center
- Maywood School Building
- Near Roadway Site
- Background



Fixed Monitoring Results



Fixed Monitoring Sites

	SeaTac Center N of Runway	Maywood S of Runway	10th & Weller Near Road	Sand Point Background
Spring 2018	-	10	8	23
Summer 2018	11	22	-	12
Autumn 2018	7	7	-	-
Winter 2018-19	17	15	-	-

Fixed Sites

- SeaTac Community Center
- Maywood School Building
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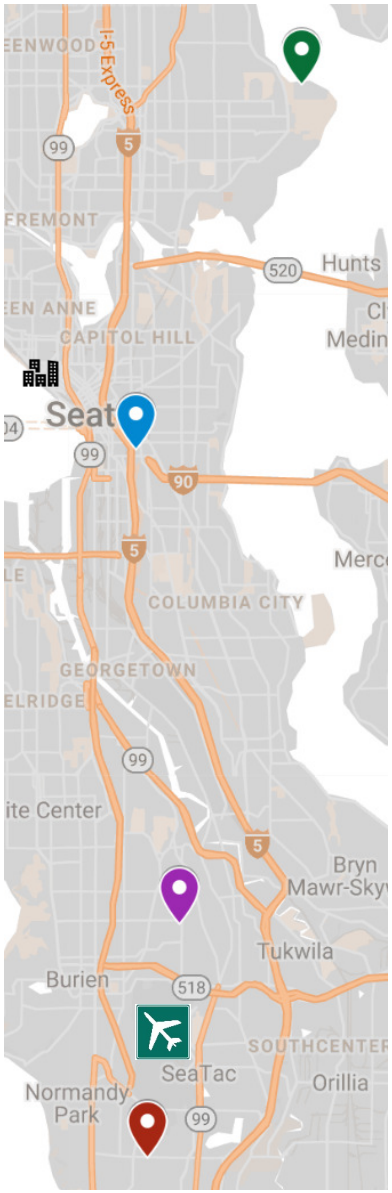
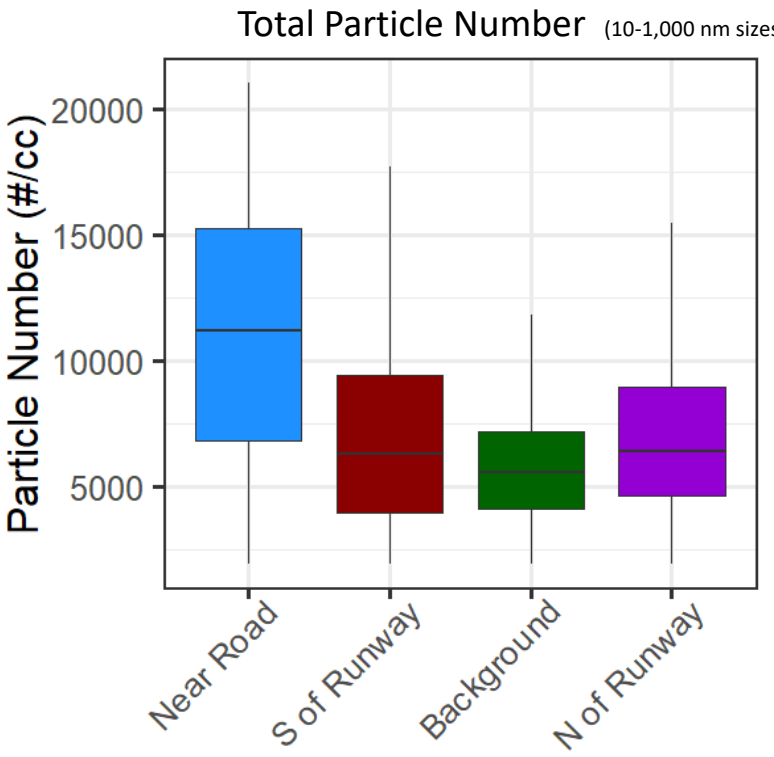
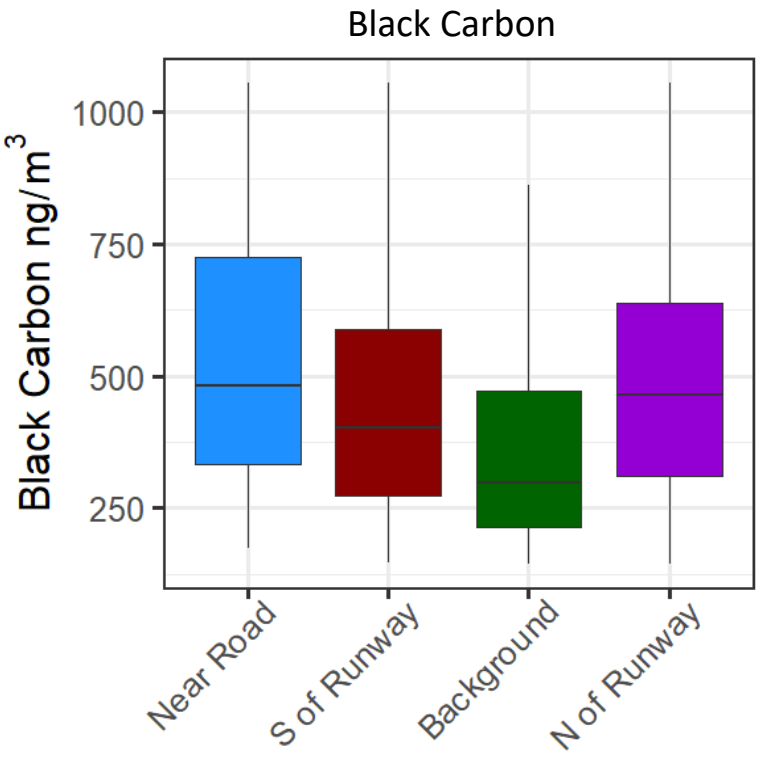
- Background

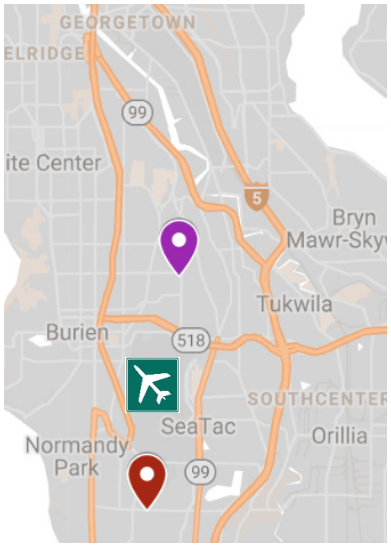


Traffic Related Pollutants

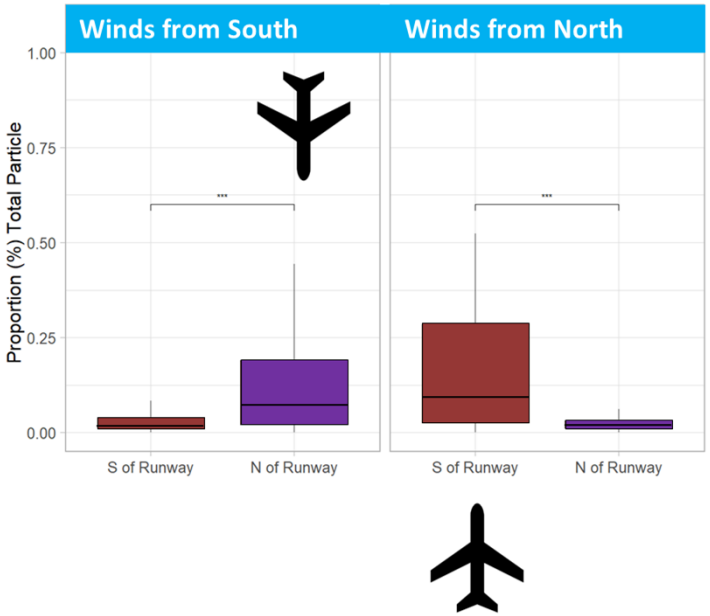




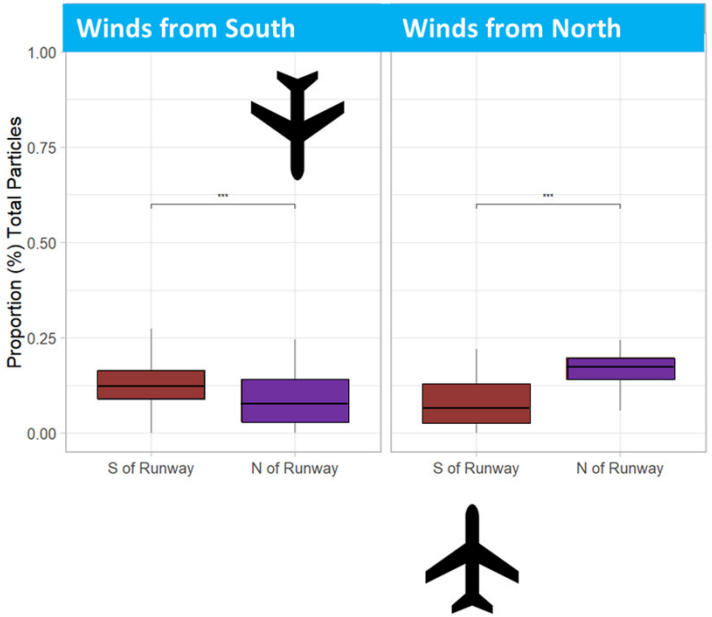
Smaller Sized Particles Near SeaTac Associated with Jet Landings



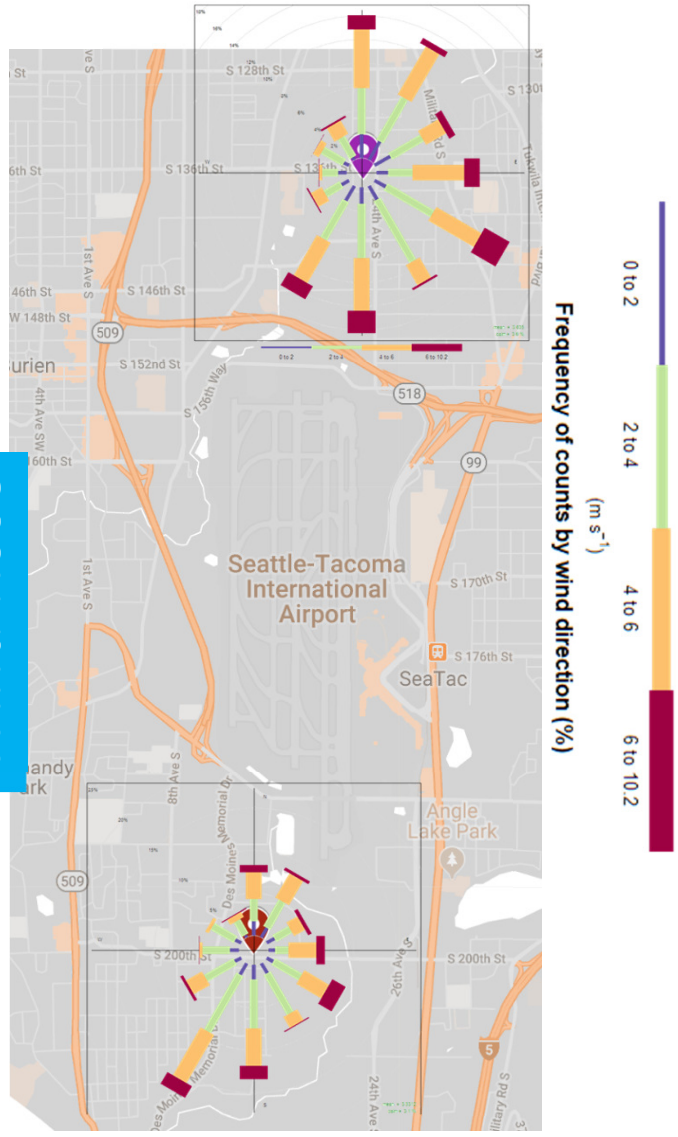
11.5 nm particles (% of UF)



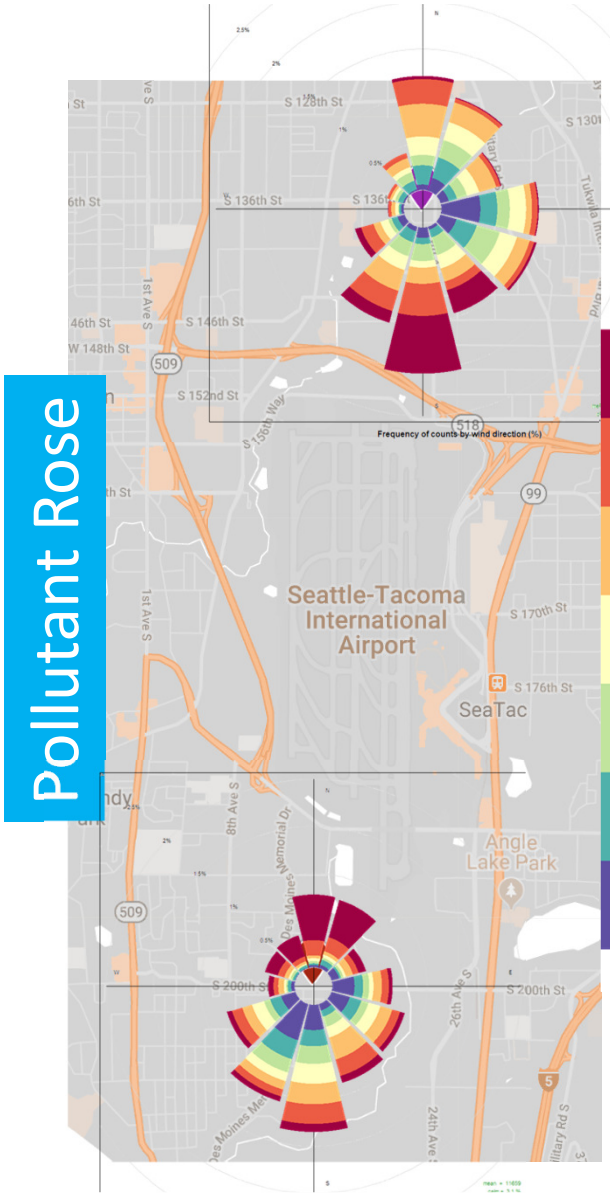
65 nm particles (% of UF)



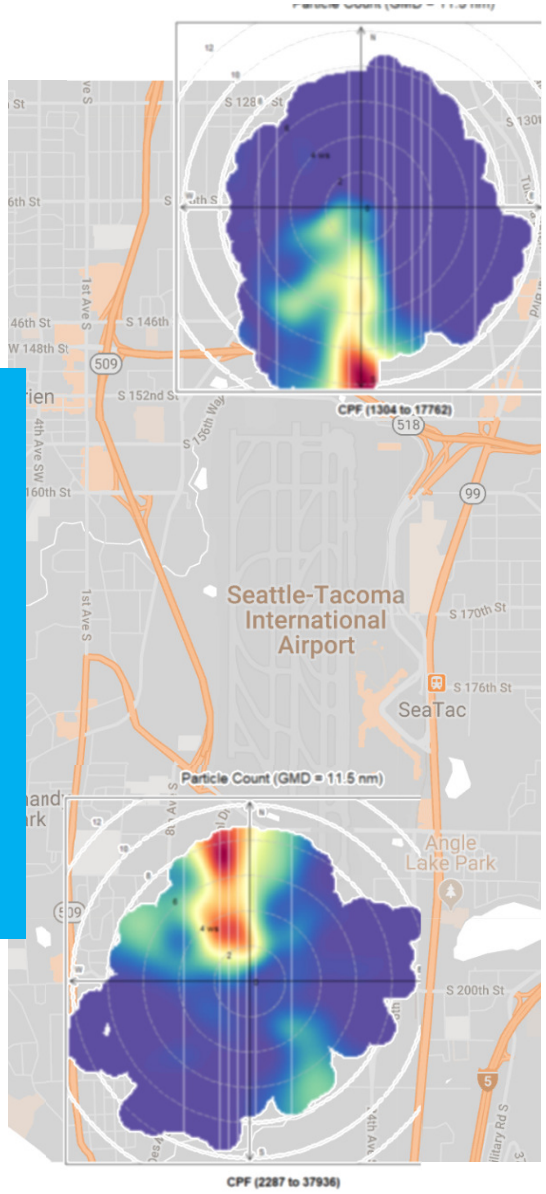
Wind Rose



Pollutant Rose

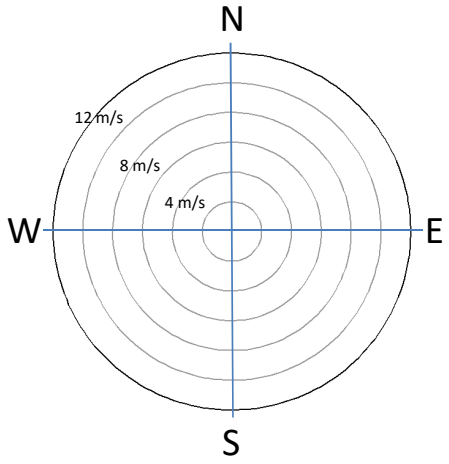


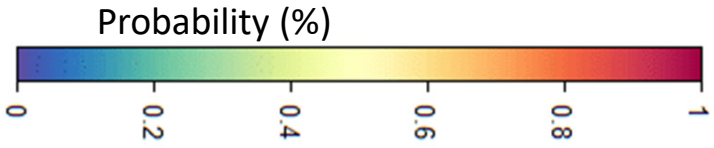
11.5 nm Diameter



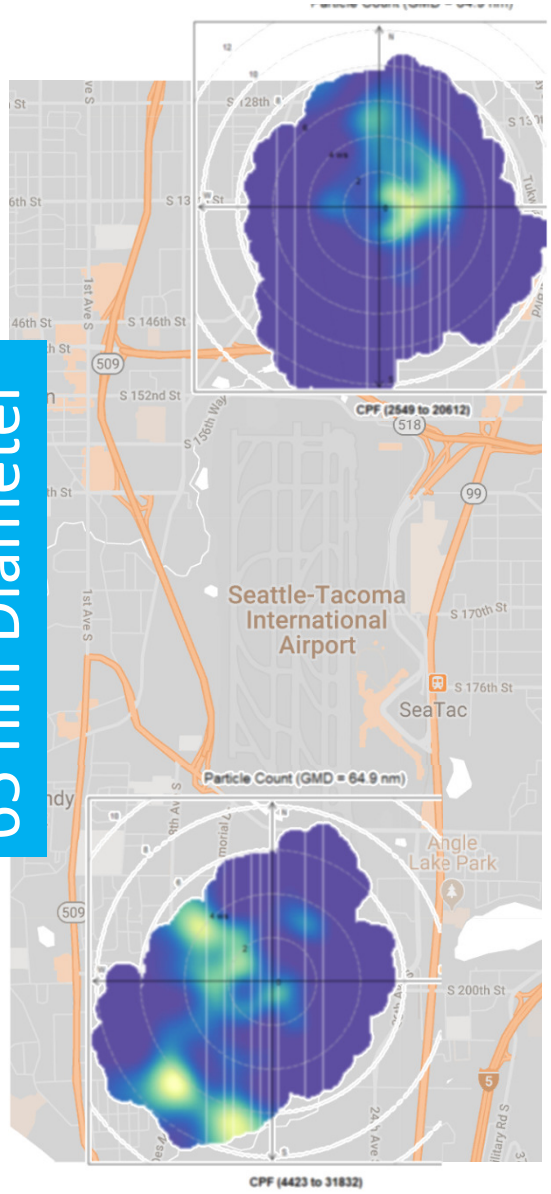
Conditional Probability Plot

These plots show the probability that a given *wind direction* and *wind speed* is associated with a high concentration of a) 11.5 nm particles and b) 65 nm particles





65 nm Diameter



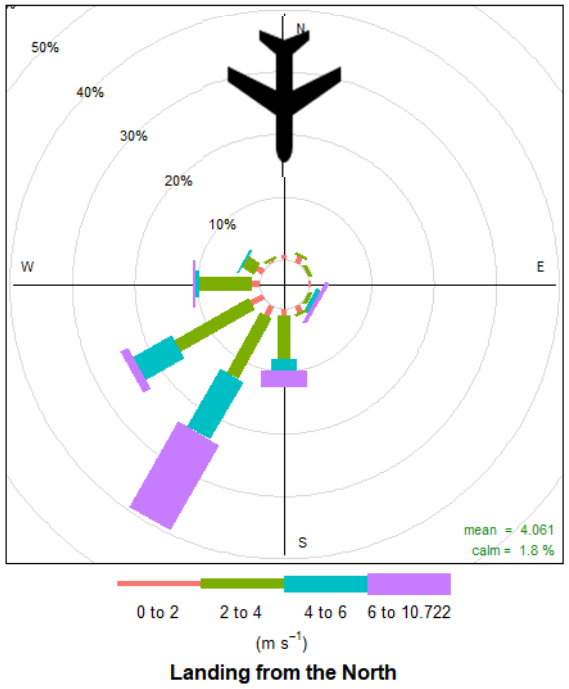
Mobile Monitoring Results

Mobile Monitoring

	Sampling Day	Second Car (%)	Start Hour	End Hour	Temp (F)	RH	South Flow Operation
Winter	21 days	62%	14:00	16:30	51F	62%	59%
Spring	14 days	71%	11:00	16:30	65F	50%	52%
Summer	16 days	81%	11:00	17:00	73F	47%	75%
Fall	12 days	83%	11:00	17:00	54F	78%	91%

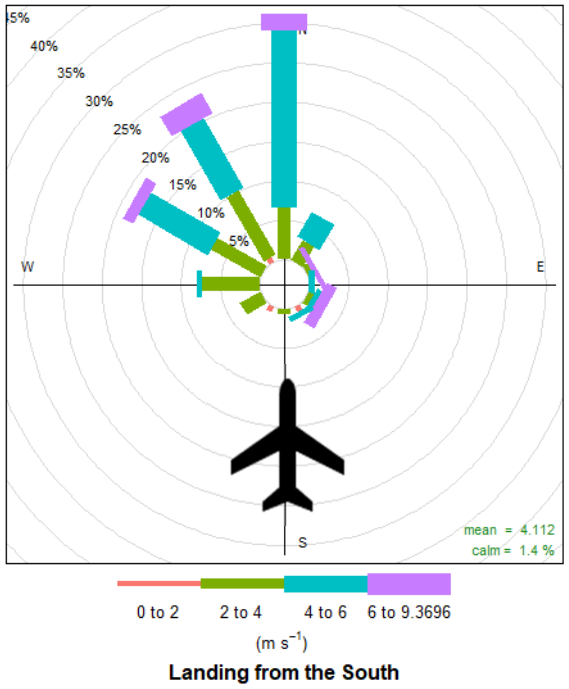
Wind roses indicate the speed and direction the wind is blowing “from”.

South-Flow Air Traffic



Landing from the North

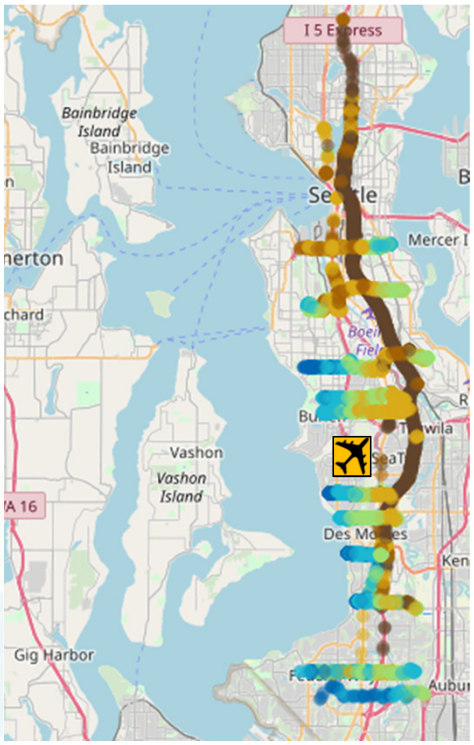
North-Flow Air Traffic



Landing from the South

Traffic Related Pollutants
Spatial Distribution

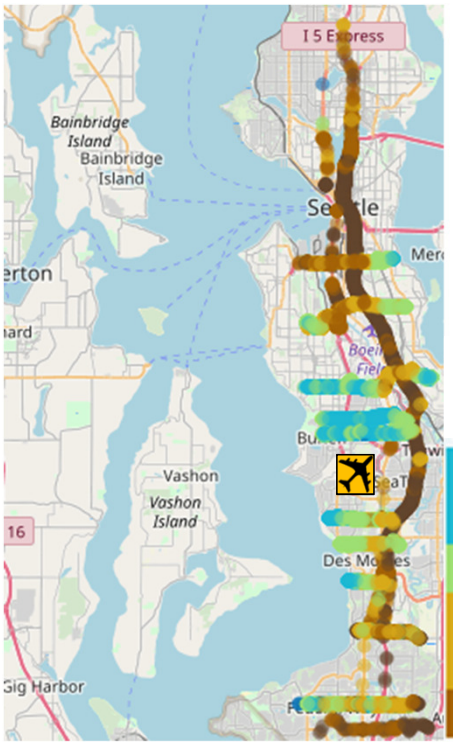
Total Particle Number*



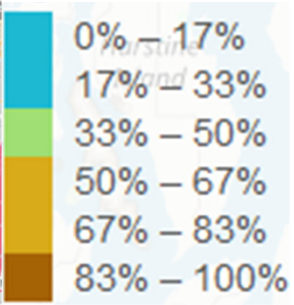
Total Particle Concentration
Percentile (%)

* Total Particle Number refers to particles with 10 - 1,000 nm diameter

Black Carbon

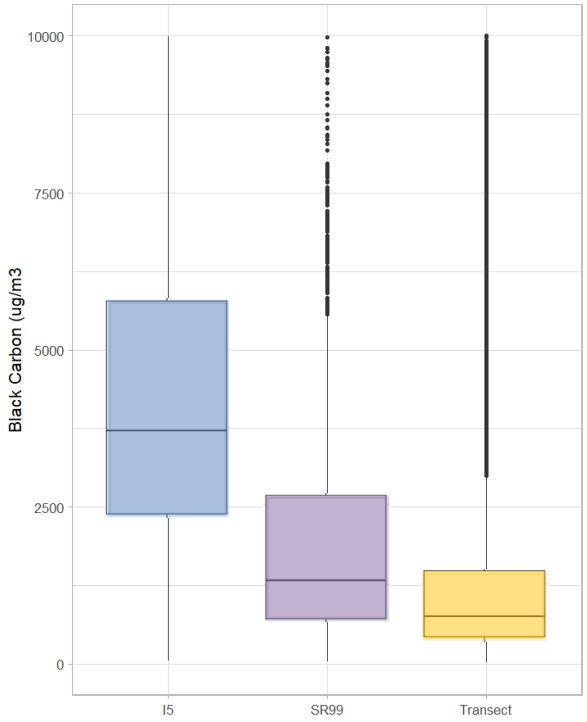


Black Carbon
Percentile (%)

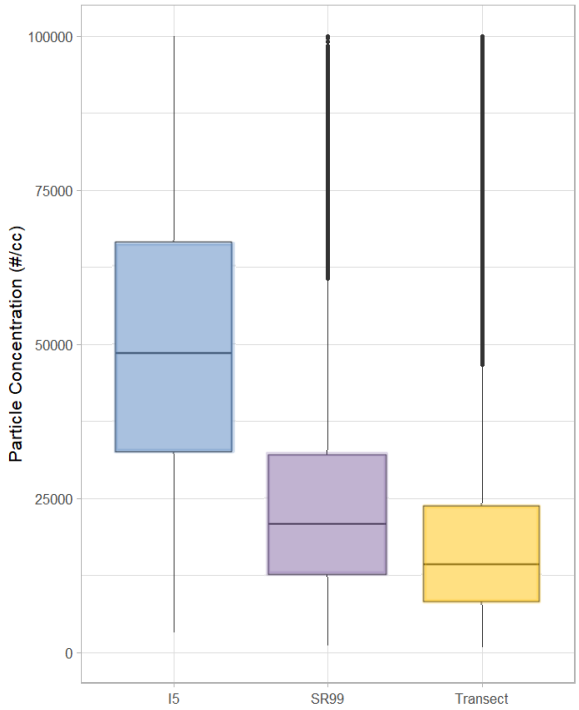


Major Roadways vs Transects

Black Carbon



Total Particle Number > 10 nm



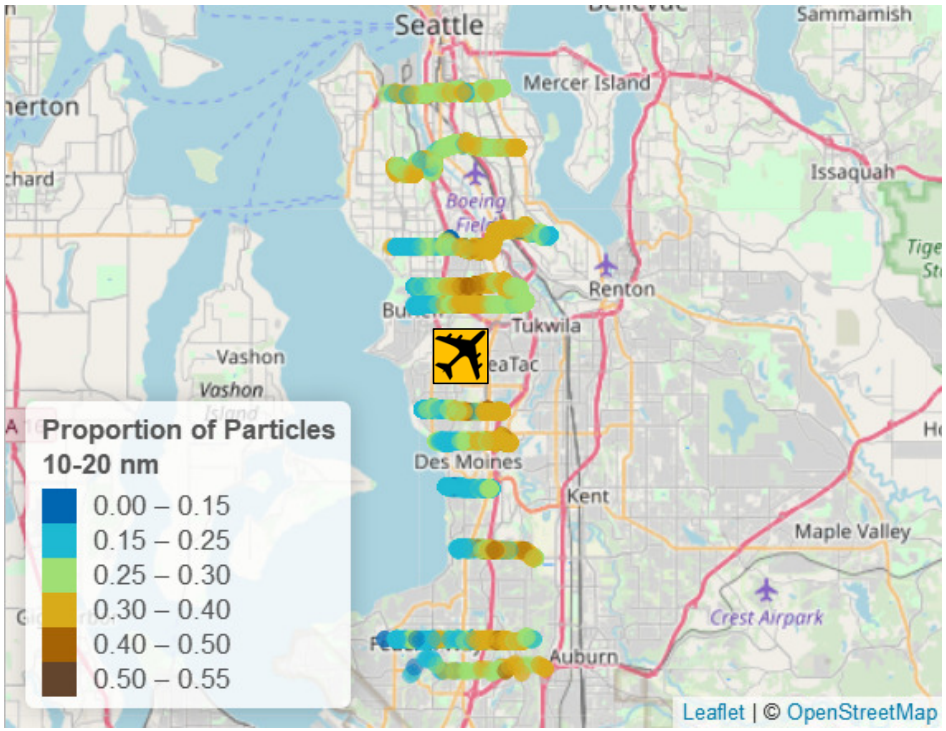
Driving on I- 5

Driving on SR99

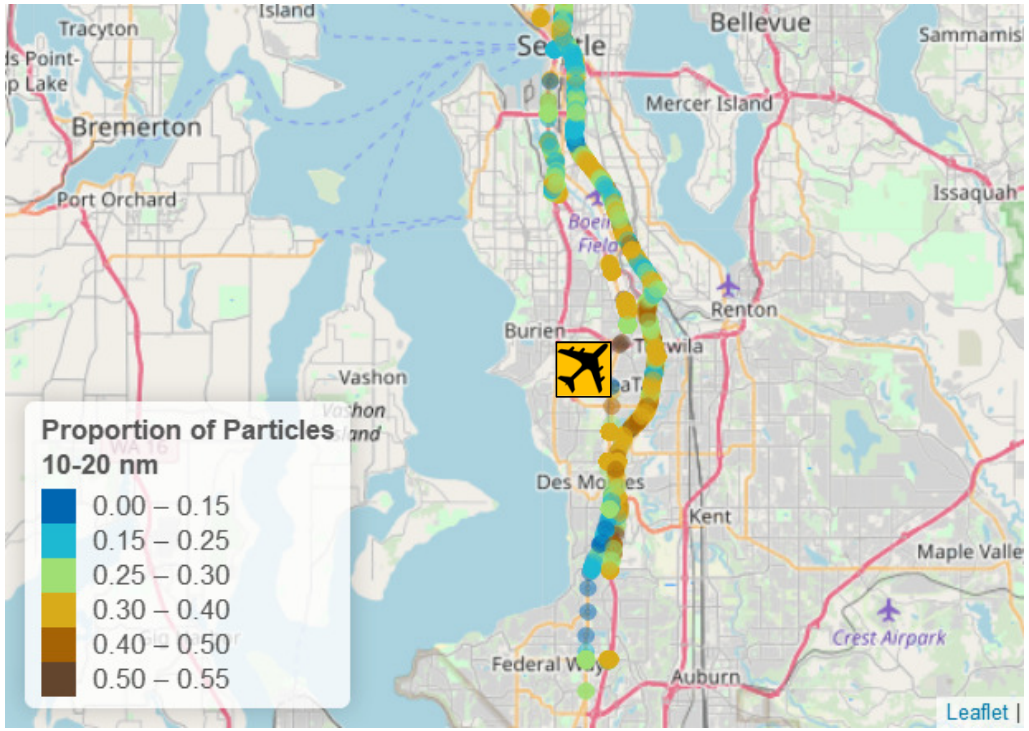
All transects

Proportion of small 10-20 nm particles enhanced near airport

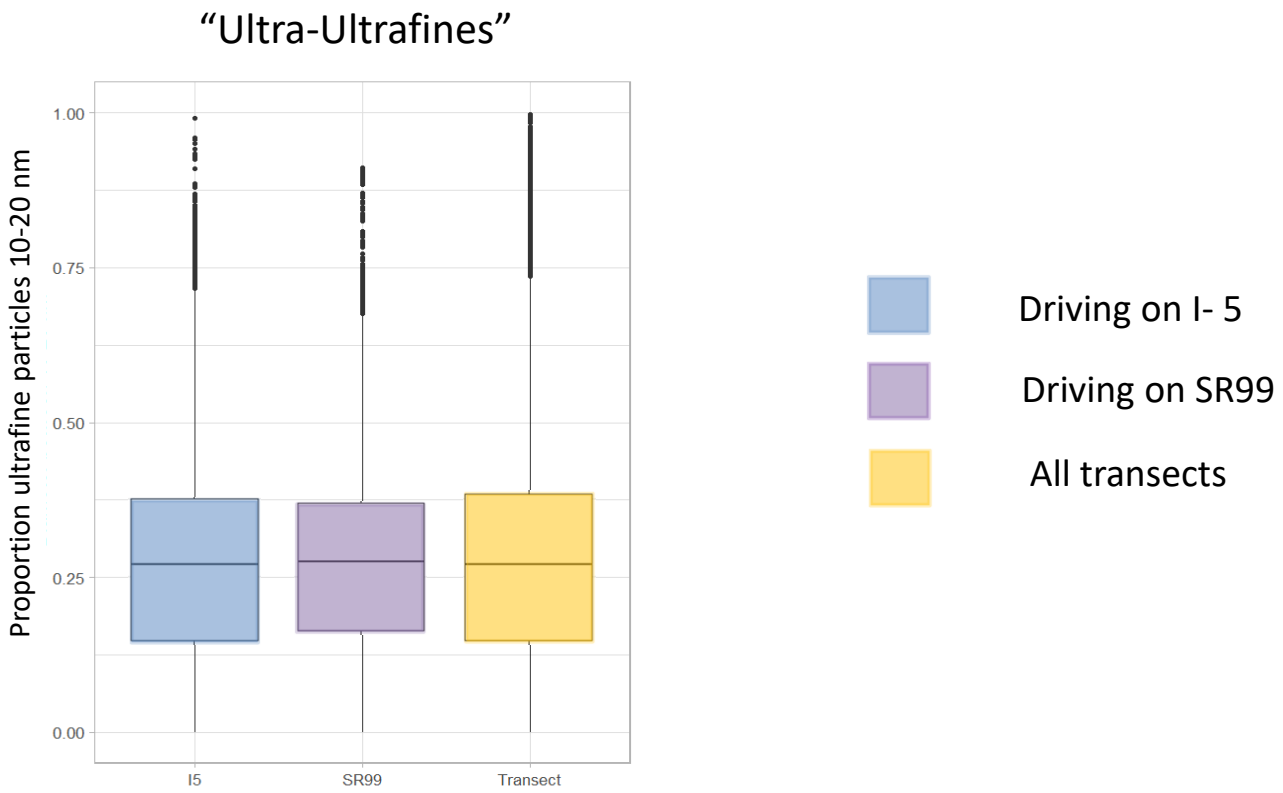
Transects



Primary Road



Proportion of small 10-20 nm particles NOT enhanced on roadways



Principal Component Analysis (PCA)

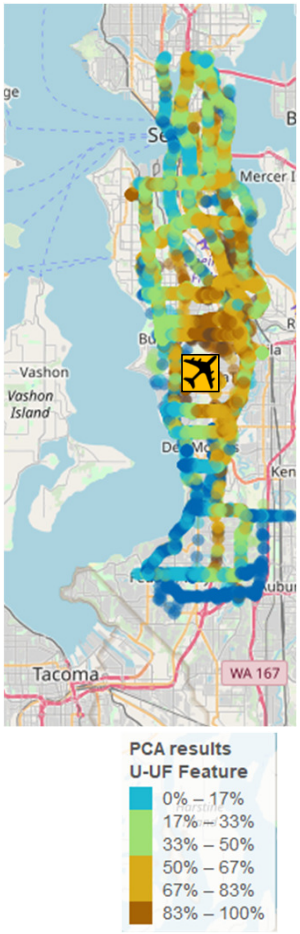
- **Goal**: Combining particle size and other pollutant characteristics collected from mobile monitoring to characterize the source of pollutant

- **Method**: Perform a PCA with varimax-rotation to identify features or “fingerprints” that reflect pollutant source.

- **Result:** We can plot the contributions from each feature on a map

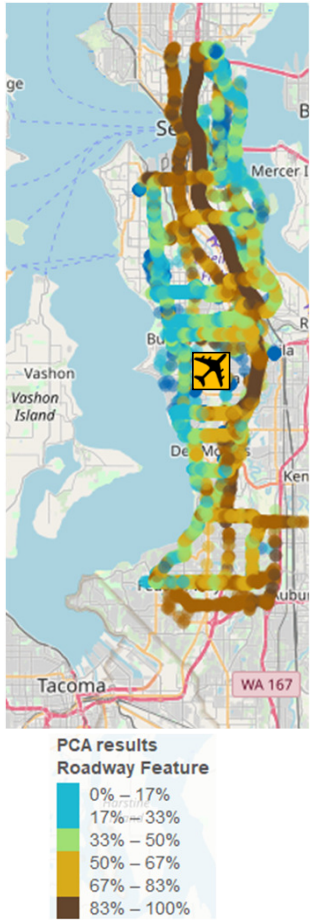
"Ultra-UF" Feature

- POSITIVELY correlated with ultra-UF particles
- NEGATIVELY correlated with Black Carbon
- Median diameter from Nanoscan is approximately 15 nm



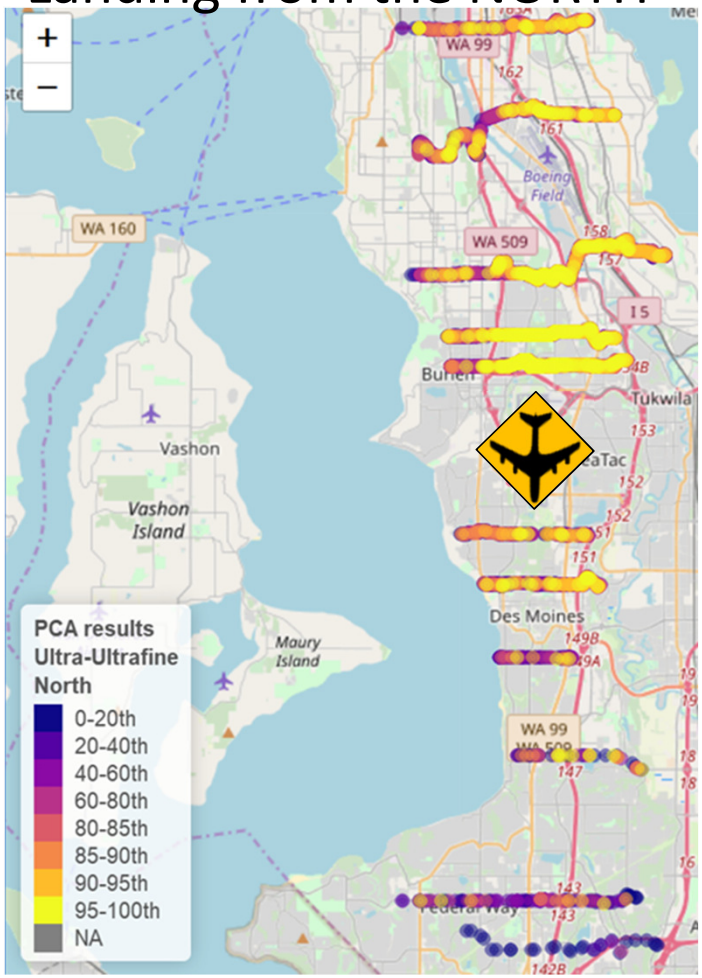
Roadway Feature

- POSITIVELY correlated with Black Carbon and Total Particle Number Concentration
- Median diameter from Nanoscan is approximately 30 nm

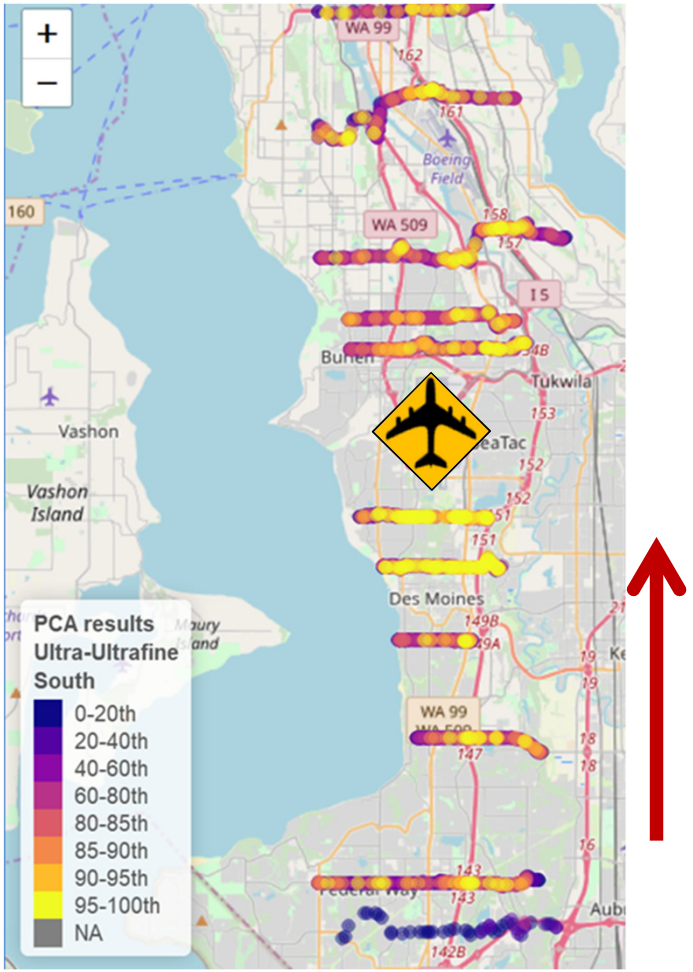


“Ultra-UFP” tracks landing direction

Landing from the NORTH

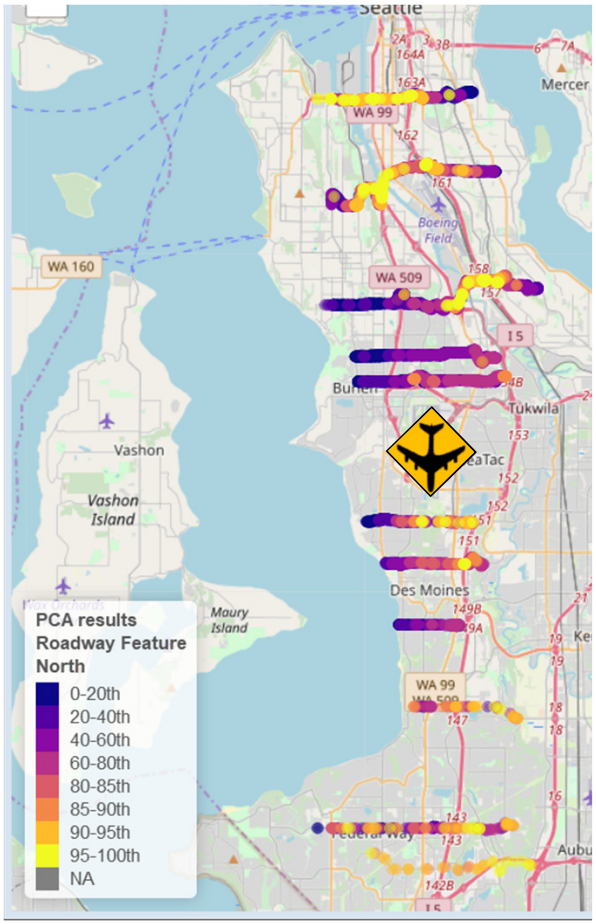


Landing from the SOUTH

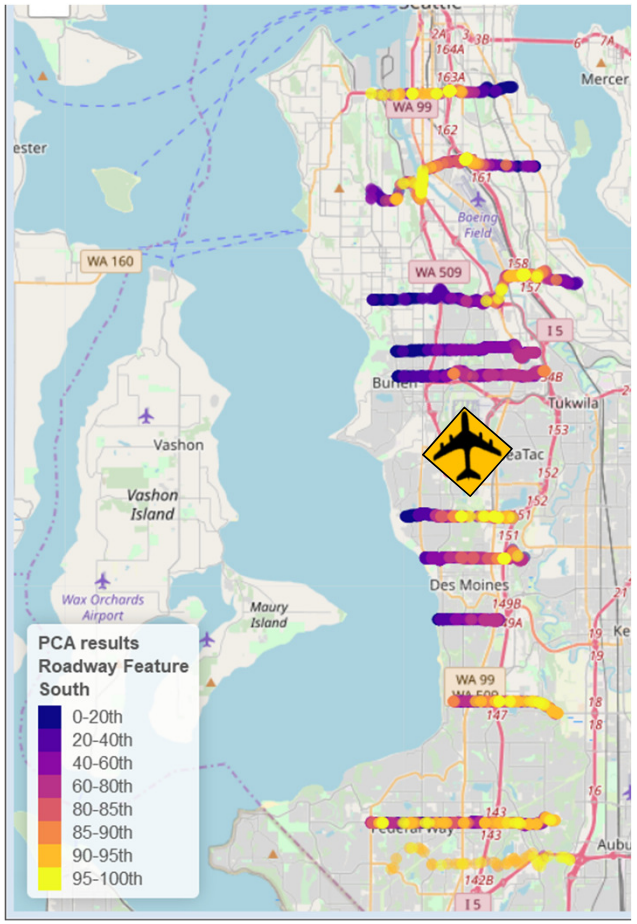


“Roadway” is invariant to landing direction

Landing from the NORTH



Landing from the SOUTH



Summary

- The impacts from traffic and aircraft UFP emissions can be separated into source-related features using a combination of mobile monitoring and standard statistical methods
- There are key differences in the particle size distribution and the black carbon concentration for roadway and aircraft features
- Findings will be presented and discussed with Study Advisory Board this summer
- Final results by December 2019

MOV-UP Project Website
https://deohs.washington.edu/mov-up

New Beacon Hill Study for City of Seattle (Start date 5/15/19)

- Select “community” sites in Beacon Hill for ultrafine particle (UFP) and noise sampling.
- Operate one community site for up to several weeks before moving to the next one
- Sample at up to five community sites
- Set up an “anchor site” that we know is impacted by aircraft UFP and noise.
- Run both the community and the anchor site simultaneously so that we can make comparisons for different flight characteristics (traffic, time of day, etc.)

Request from Mayor's Office & City Council Federal Way (May 2019)

- Asks UW MOV-UP Research Team to conduct a new study that would expand monitoring in three ways:

1. Vertical measurements of UFP (e.g., by using drones)
2. Design a network of UFP monitors that would include important sites for the community such as parks, schools, and social justice impact areas
3. Include a site not affected by air traffic for comparison of UFP levels.

- We do not currently have funding for this work.