Mobile ObserVations of Ultrafine Particles (MOV-UP)

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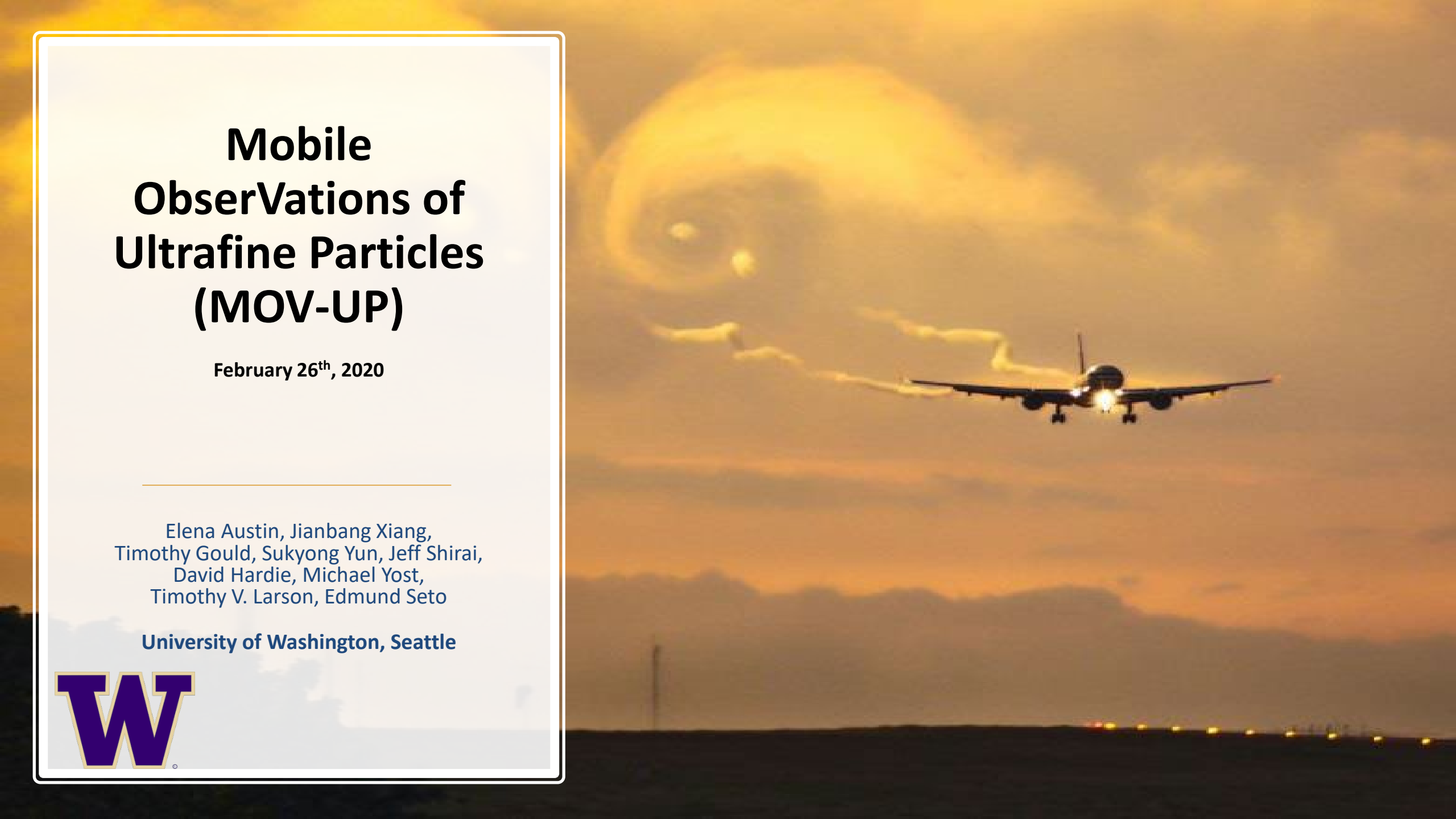


Study Objectives

- 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

Community Engagement

Funding for the MOV-UP study was provided to the University of Washington by a proviso in the state budget.

Study Advisory Group

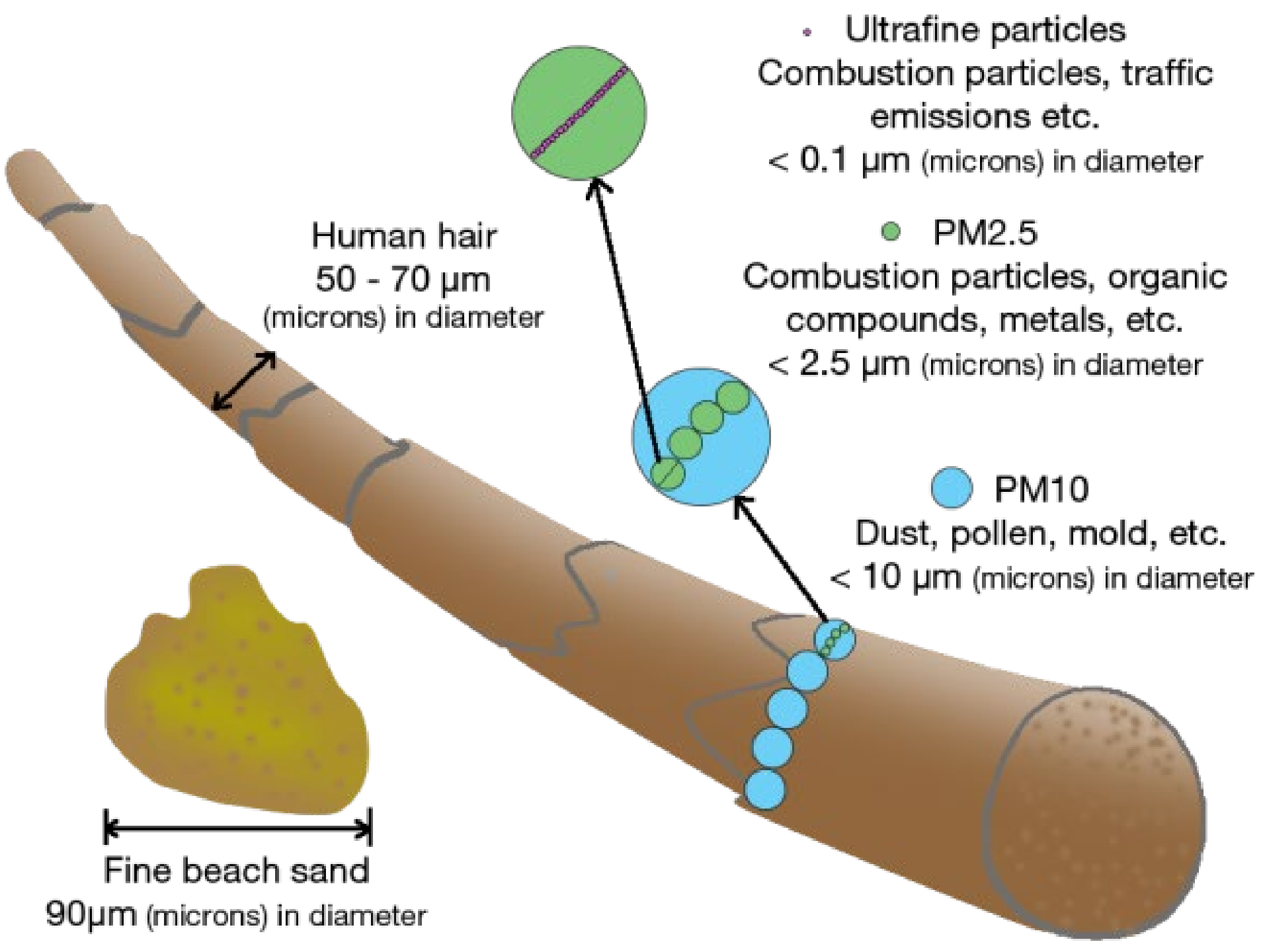
*3 meetings to date

Ongoing communication with community

*6 meetings to date

e.g., Highline Forum, Federal Way City Council, Seattle/King Board of Health, Airport Impacts Meeting

Media Coverage


Ultrafine particles
Combustion particles, traffic emissions etc.
< 0.1 µm (microns) in diameter
PM2.5
Combustion particles, organic compounds, metals, etc.
< 2.5 µm (microns) in diameter
PM10
Dust, pollen, mold, etc.
< 10 µm (microns) in diameter
Human hair
50 - 70 µm
(microns) in diameter
Fine beach sand
90µm (microns) in diameter

Important characteristic of Ultrafine Particles

- They have a large amount of surface area, relative to their size.
- They are small enough to enter the bloodstream, cross the placenta, and cross the blood-brain barrier.

- Because they are small, they have very little mass.
- Typically, they are measured differently than $PM_{2.5}$, which includes larger particles, and therefore has appreciable mass that can be weighed.

Ultrafine Particles (UFPs)

Ultrafine Particles unregulated but potentially important

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

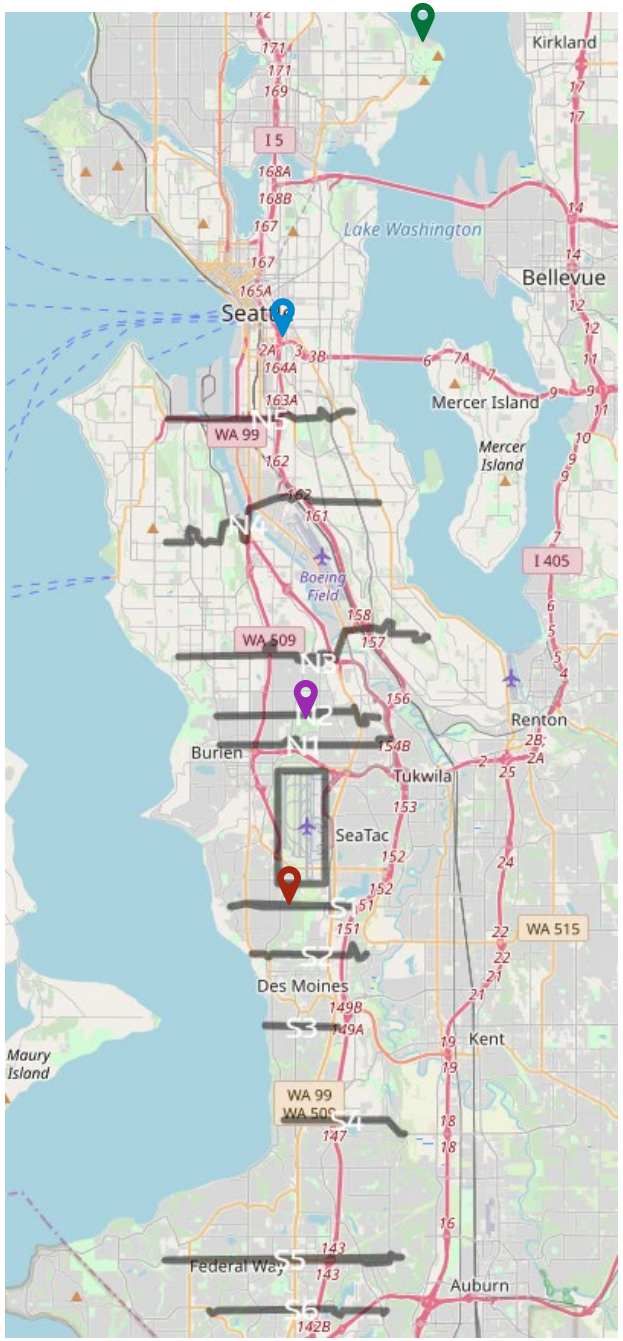
Diesel Engines emit ultrafine particles resulting in elevated levels near major roadways (within 200 meters downwind)

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

Study Region: Mobile Transects and Fixed Monitoring Site Locations

Fixed Sites

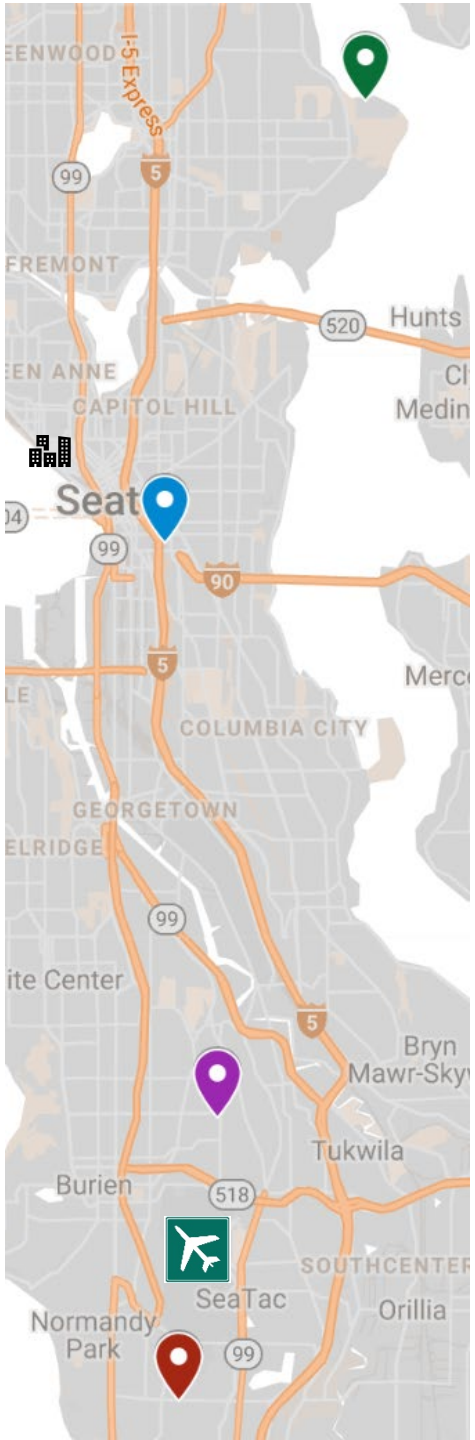
- SeaTac Community Center
- Maywood School Building
- Near Roadway Site
- Background



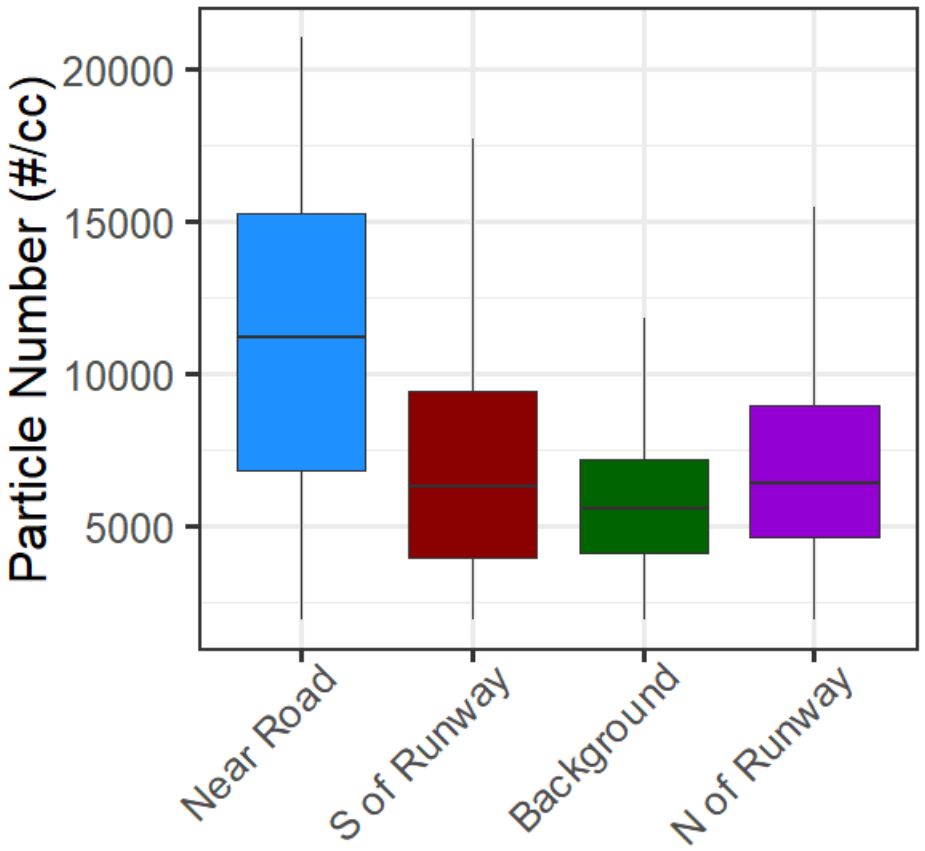
Mobile Monitoring Platform

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

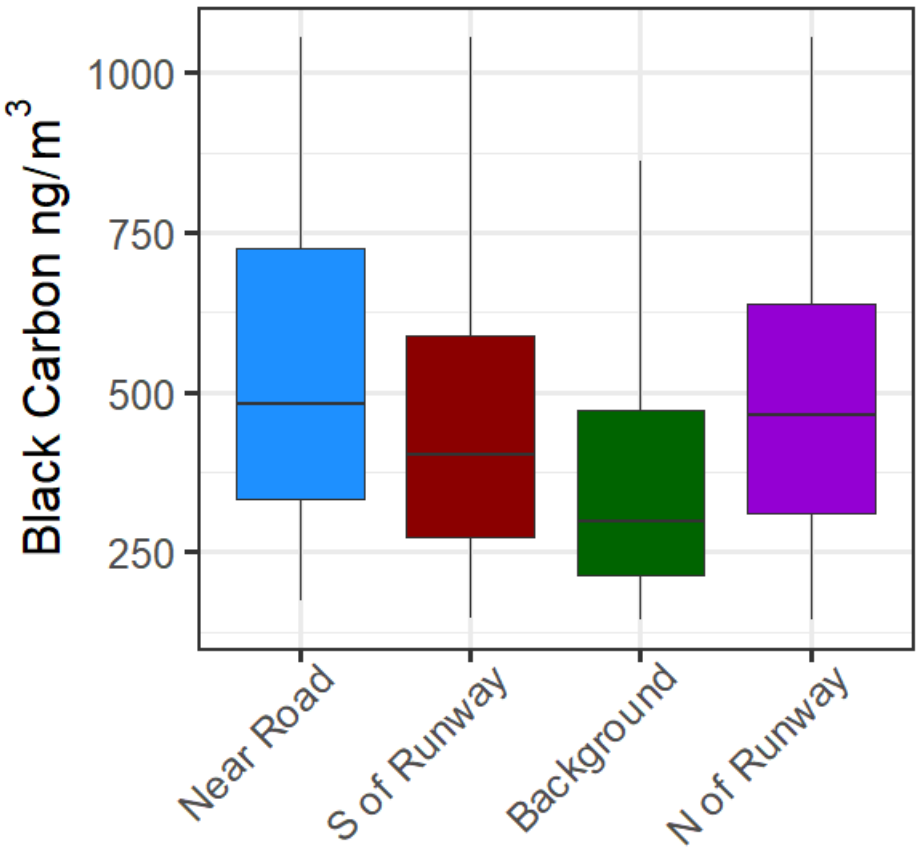
Fixed Monitoring Results



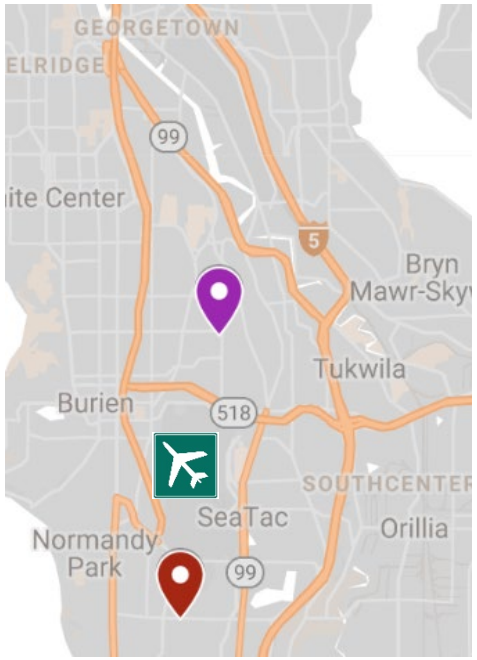
Fixed Site Monitoring Results



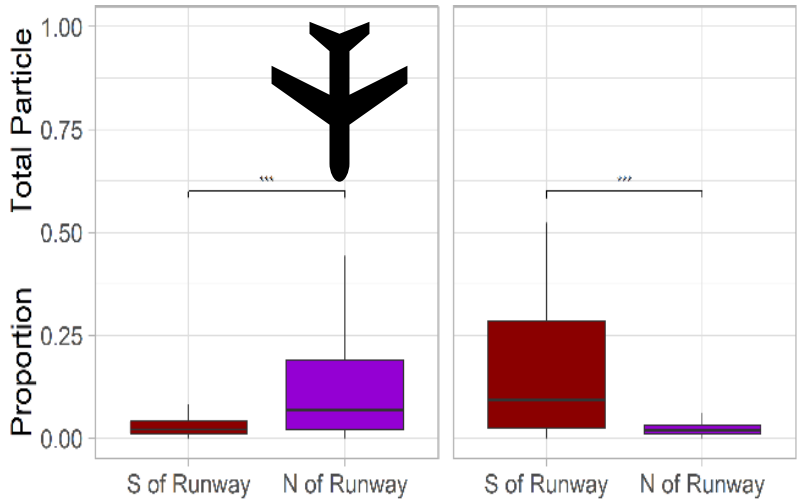
Black Carbon



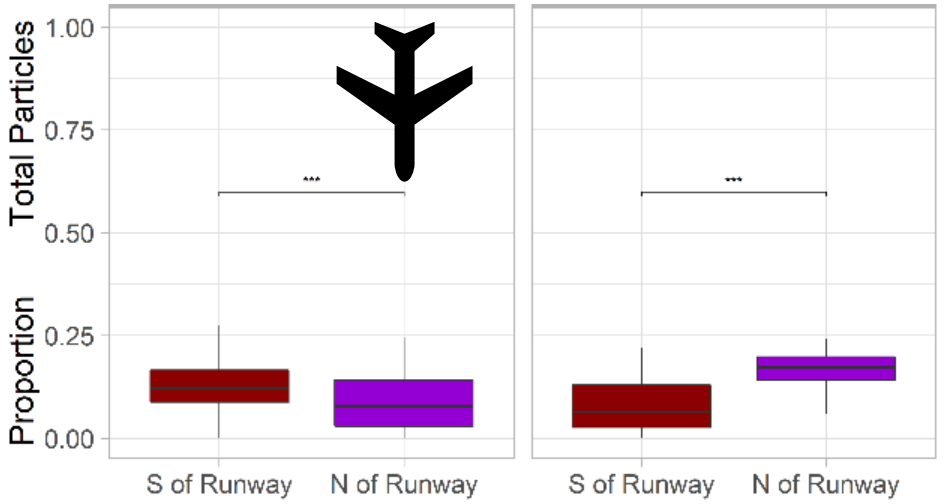
Smaller Sized Particles Near SeaTac Associated with Jet Landings



11.5 nm particles (% of UF)



65 nm particles (% of UF)



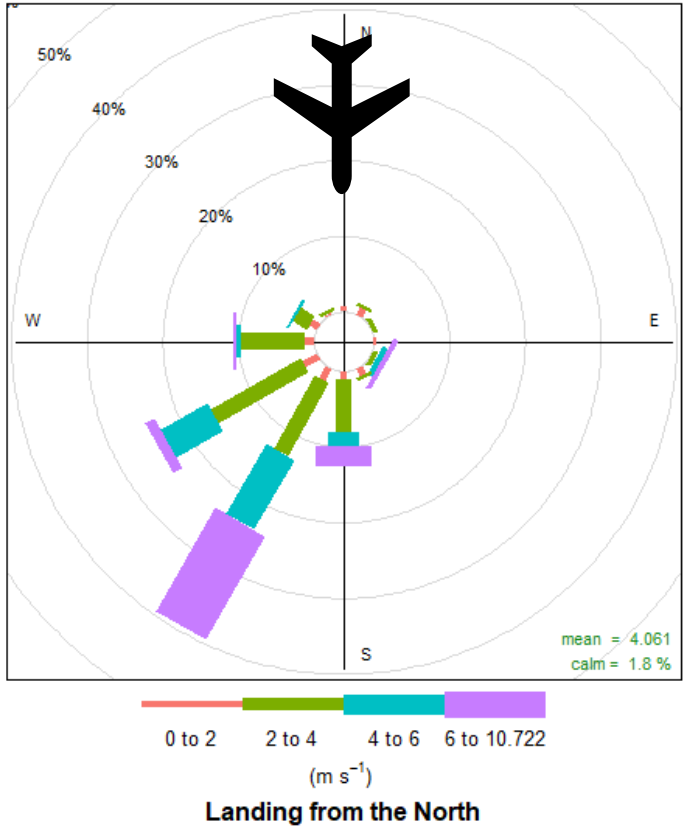
Mobile Monitoring Results

Mobile Monitoring Results: Monitoring Summary

	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%

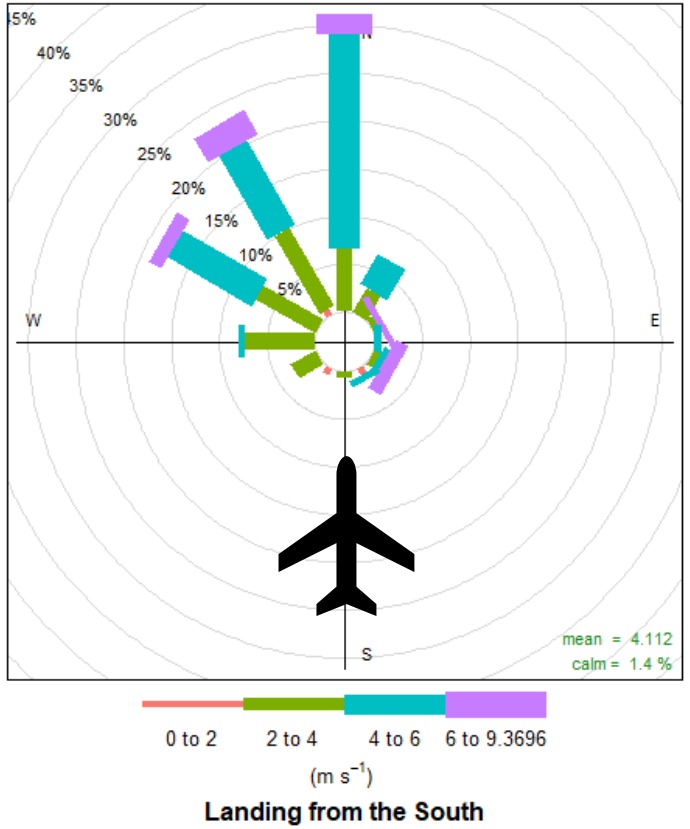
Wind roses indicate the speed and direction the wind is blowing “from”.

South-Flow Air Traffic



Landing from the North

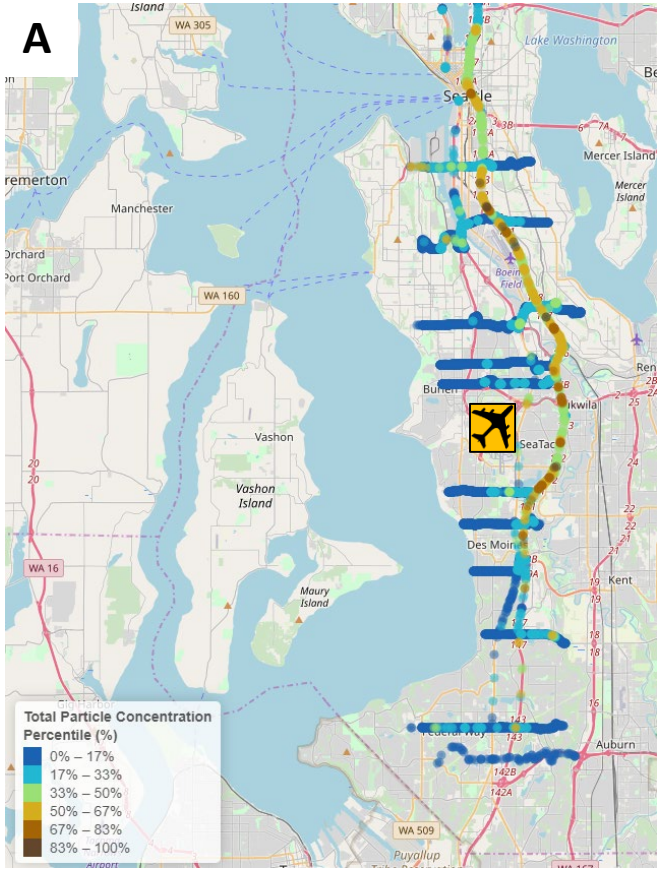
North-Flow Air Traffic



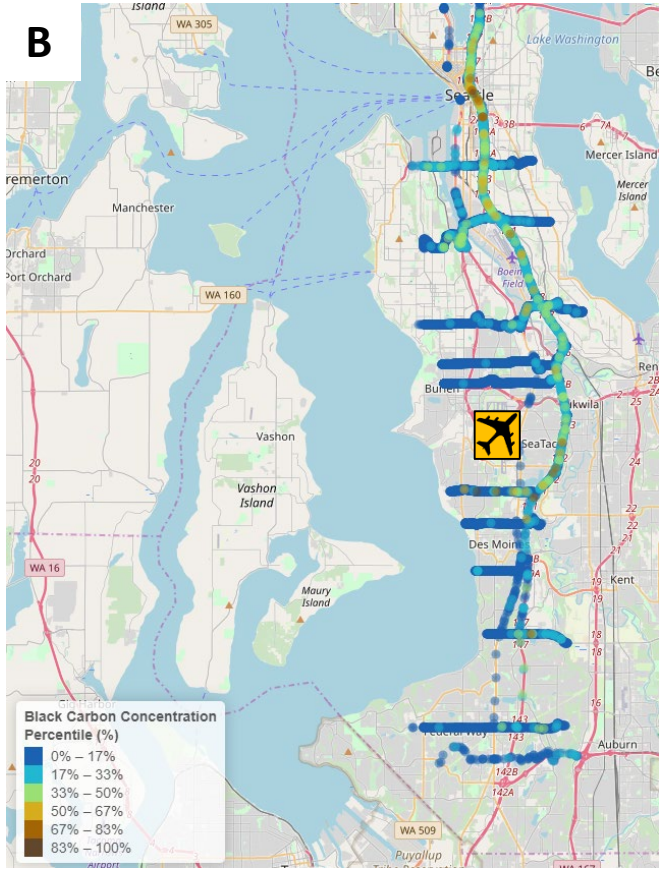
Landing from the South

Traffic Related Pollutants
Spatial Distribution

Total Particle Number*



Black Carbon



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

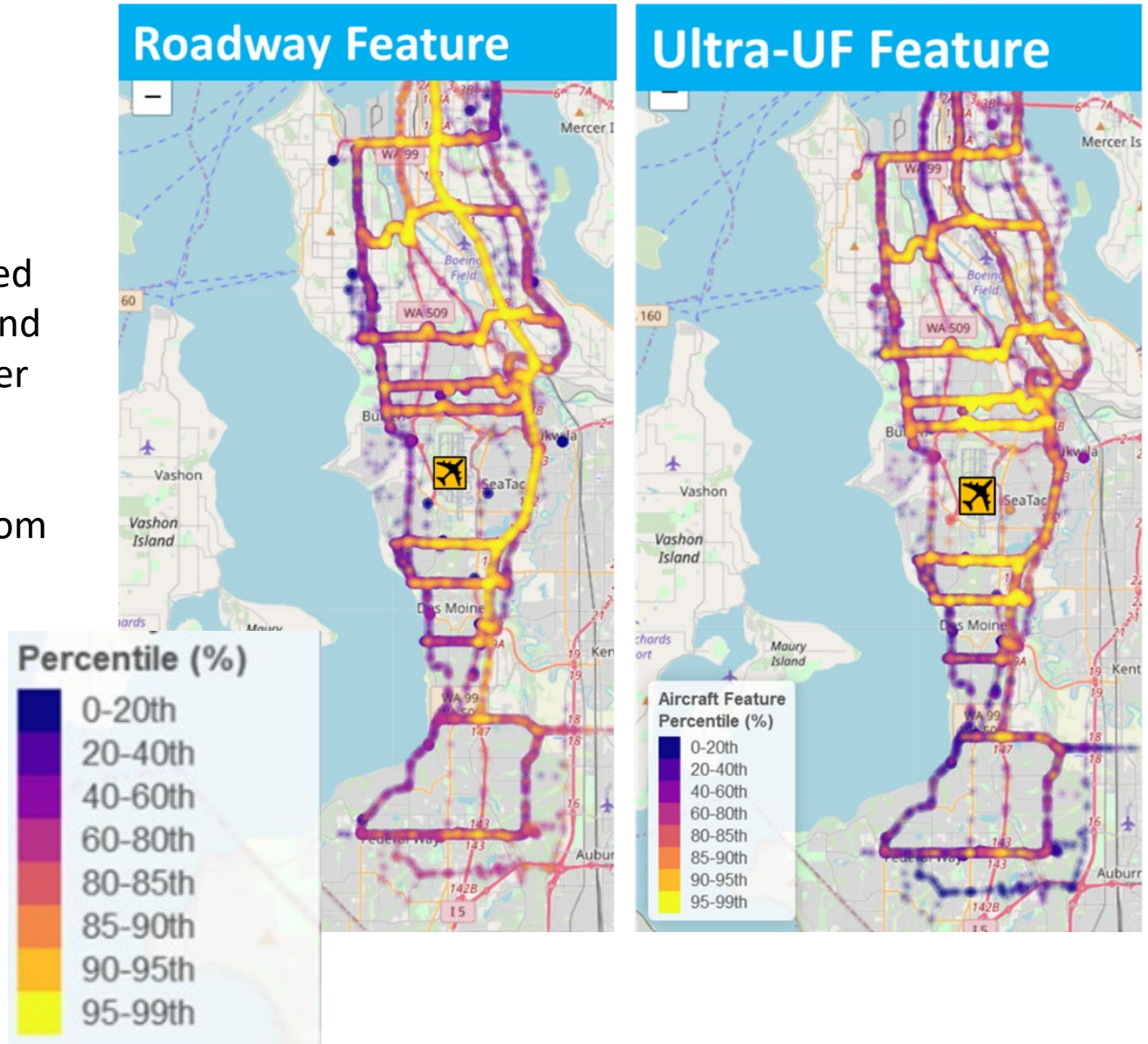
Principal Component Analysis (PCA)

- **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

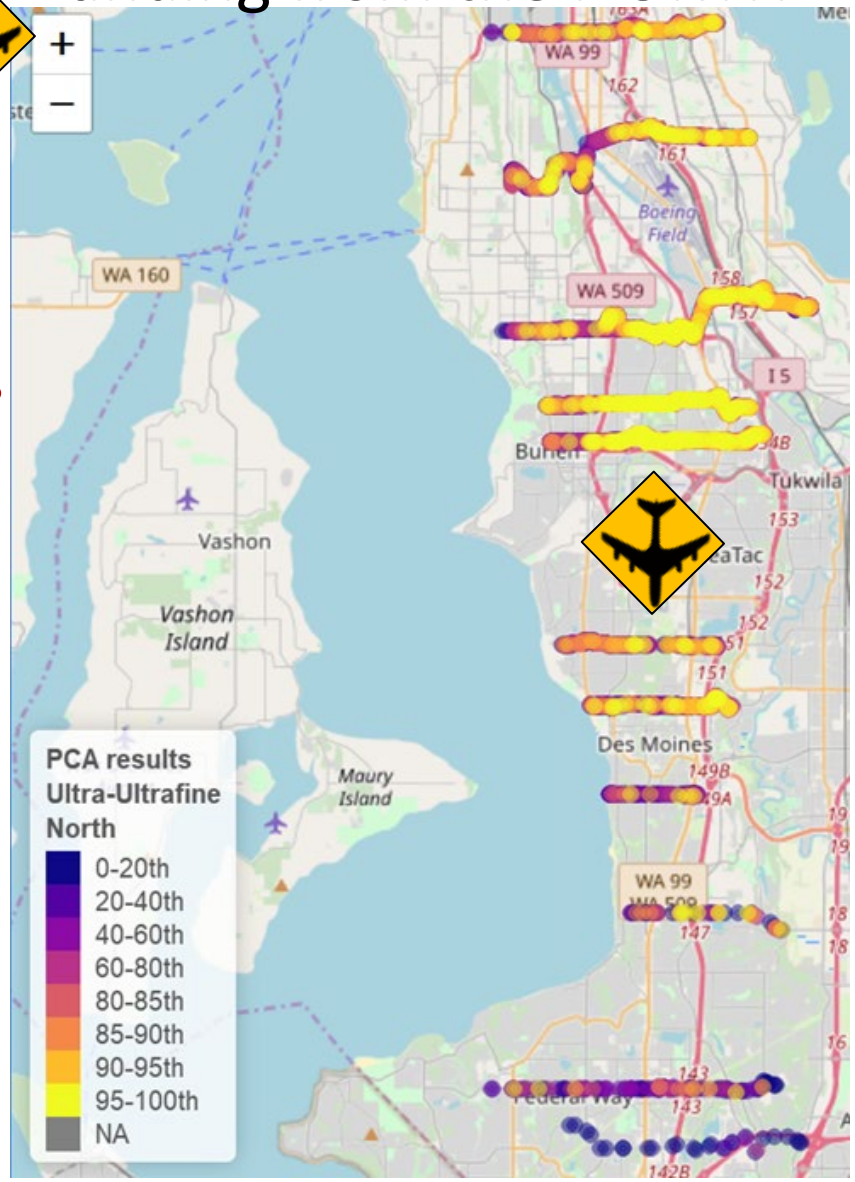
- POSITIVELY correlated with Black Carbon and Total Particle Number Concentration
- Median diameter from Nanoscan is approximately 30 nm



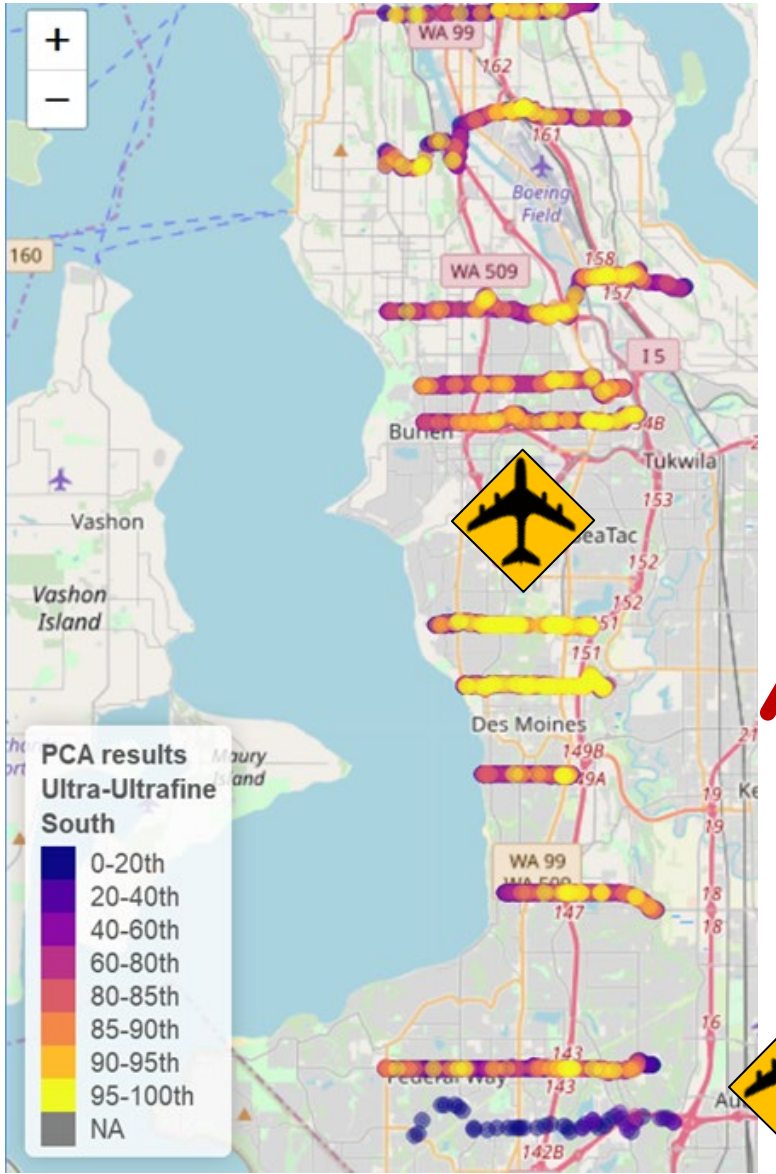
- POSITIVELY correlated with ultra-UF particles
- NEGATIVELY correlated with Black Carbon
- Median diameter from Nanoscan is approximately 15 nm

“Ultra-UFP” tracks landing direction

Landing from the NORTH

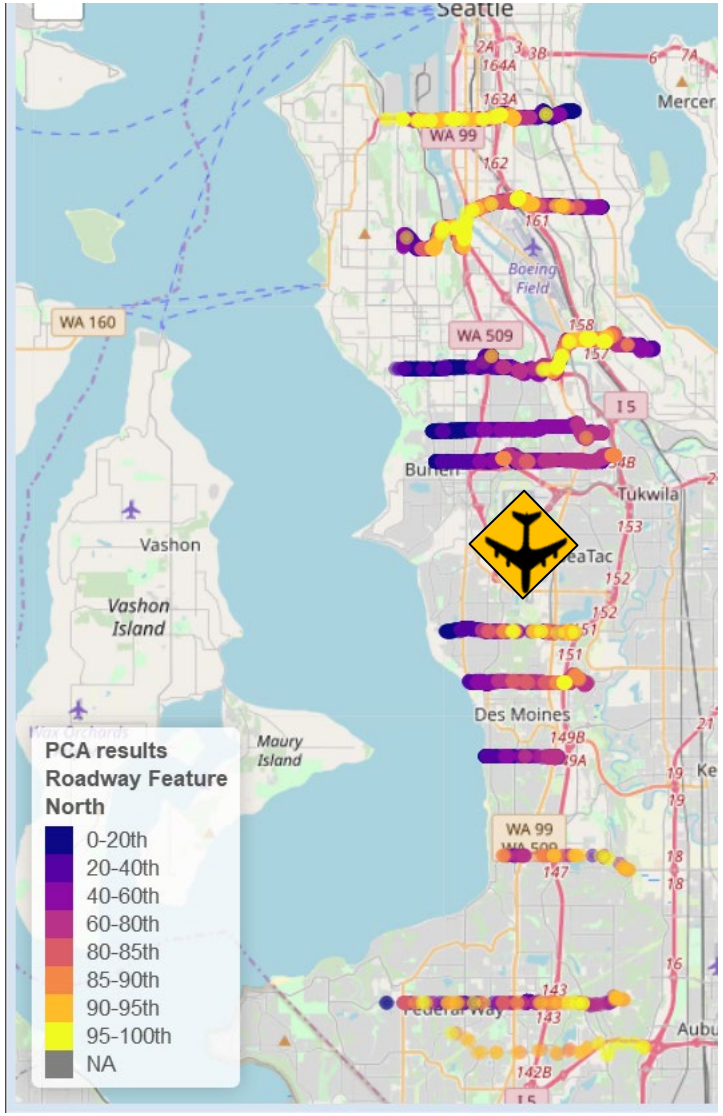


Landing from the SOUTH

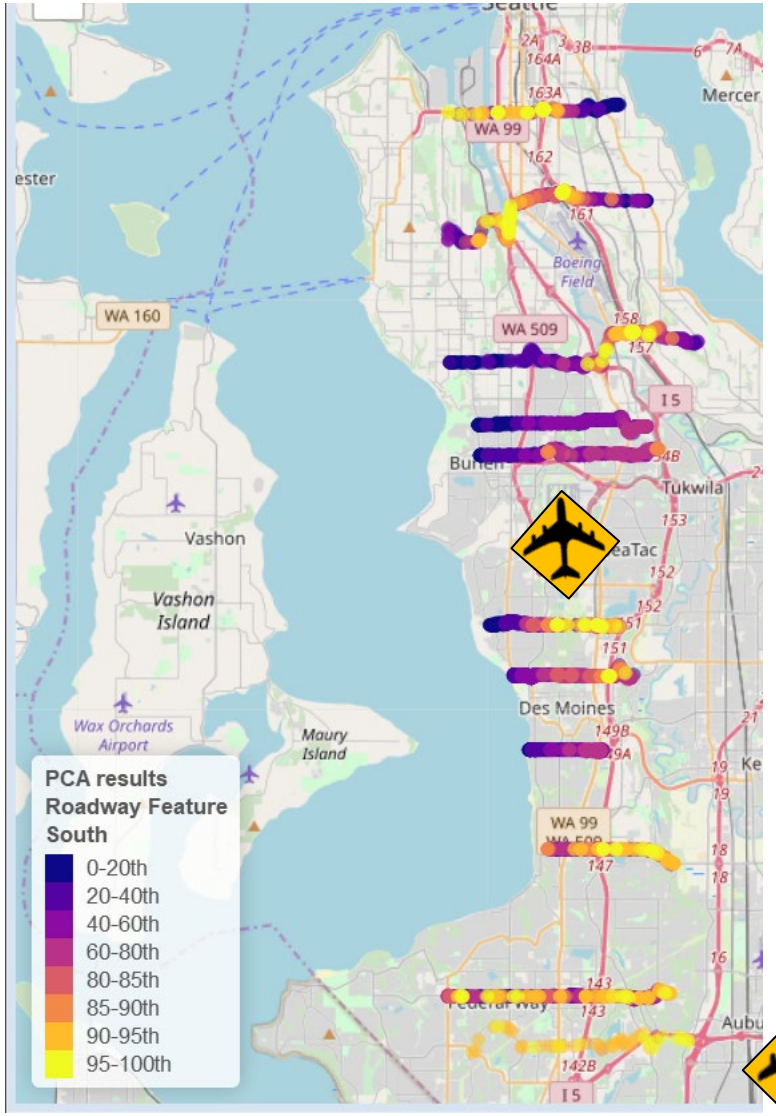


“Roadway” is invariant to landing direction

Landing from the NORTH

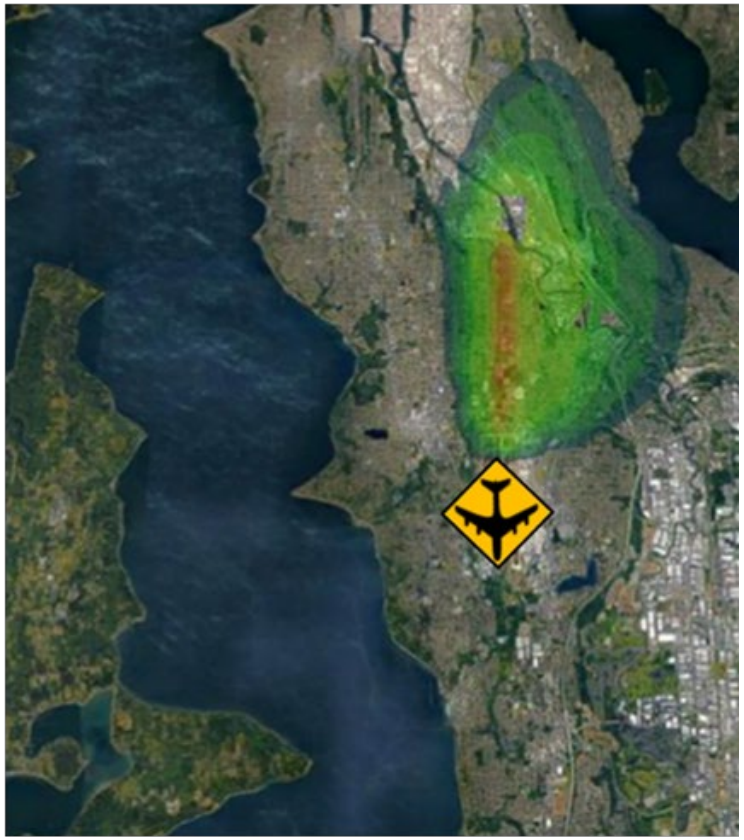


Landing from the SOUTH



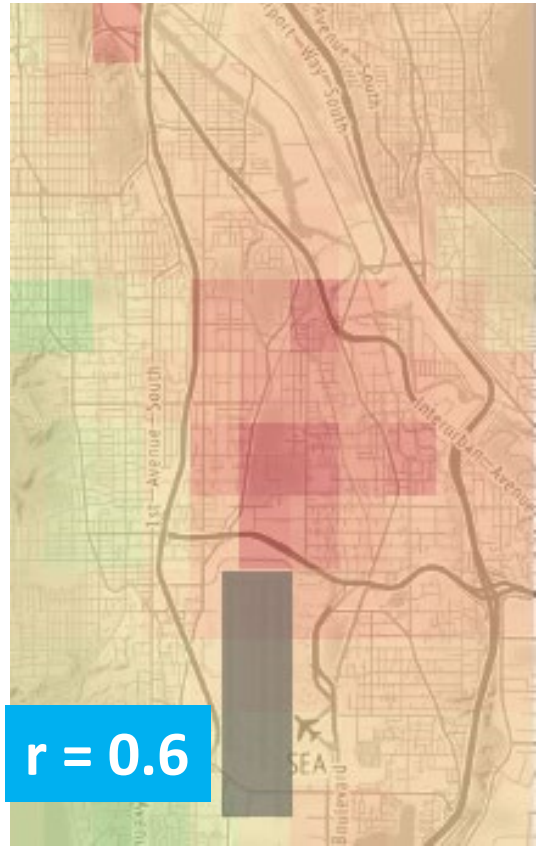
AERMOD Model of "Ultra-UFP" concentrations during landings from the North

Predicted*



**Average over all hours on all sampling days

Predicted vs Measured



Summary

- Ultrafine particles (UFP) are emitted from both traffic and aircraft sources.
- Total concentration of UFP (10 - 1000 nm) did not distinguish roadway and aircraft features.
- The spatial impact of traffic and aircraft UFP emissions can be separated 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.
- Fixed site monitoring confirms that aircraft landing activity is associated with a large fraction of particles between 10-20 nm.
- Mobile derived Fuel Based Emissions Factor (# Ultra UF/kg_{Fuel}) may lead to future air quality modeling scenarios (Findings in the Project Report).

MOV-UP Project Website

https://deohs.washington.edu/mov-up

Uncertainties and Caveats

- In this study, there was no measured single indicator of aircraft impact.
- This study provides information on the spatial distribution of ambient air quality impacts but does not provide a precise way to assign exposure estimate to specific locations or populations.
- This study provides a representative sample of pollutant distribution over the past year. Important uncertainties emerge in trying to predict distributions for past or future years.

Knowledge Gaps

Gap # 1: What are the health effects of aircraft UFP?

- What are the chemical and laboratory-based toxicological differences of UFP from roadway traffic and aircraft sources?
- Are short-term human health responses to roadway traffic and aircraft particles different?
- Are there long-term health impacts of exposure to traffic and aircraft UFP?

Knowledge Gaps

Gap # 2: What can we do to reduce human exposures to UFP?

- How much of UFP infiltrates into indoor spaces, particularly schools, daycares, elderly facilities and medical centers where potentially vulnerable populations may be exposed?
- What are the short-term and long-term interventions that effectively reduce UFP exposures?
- Are the same interventions effective in reducing exposures to both UFP and Ultra-UFP in community settings?

Knowledge Gaps

Gap # 3: How are concentrations of UFP changing in different communities?

- Are there important daily and seasonal time trends in UFP distributions?
- Are there important spatial differences in UFP distributions?
- Can communities use information about UFP distributions to identify solutions and vulnerabilities?