# Mobile ObserVations of Ultrafine Particles (MOV-UP)

**Aviation Noise & Emissions Symposium 2020**

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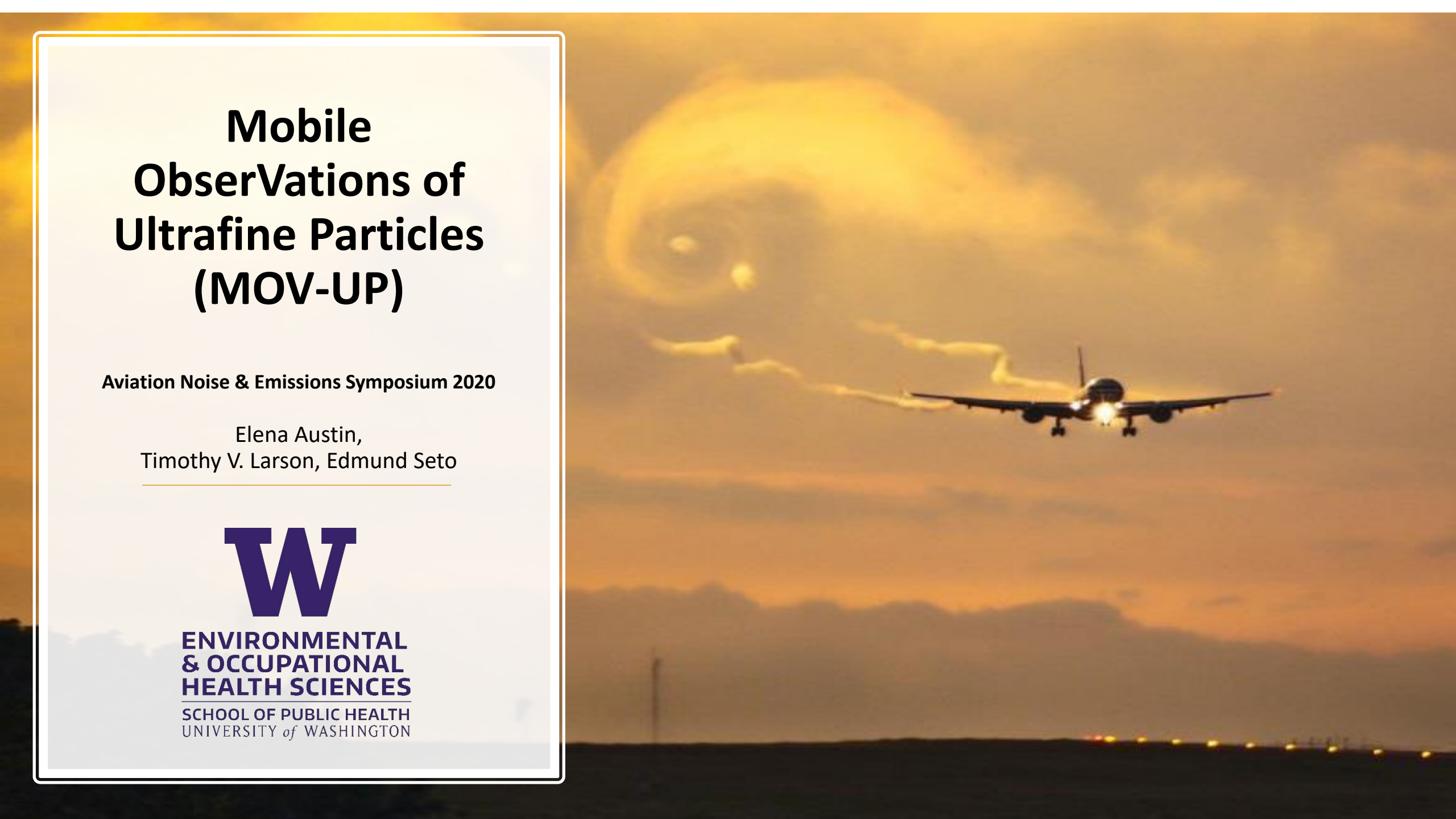
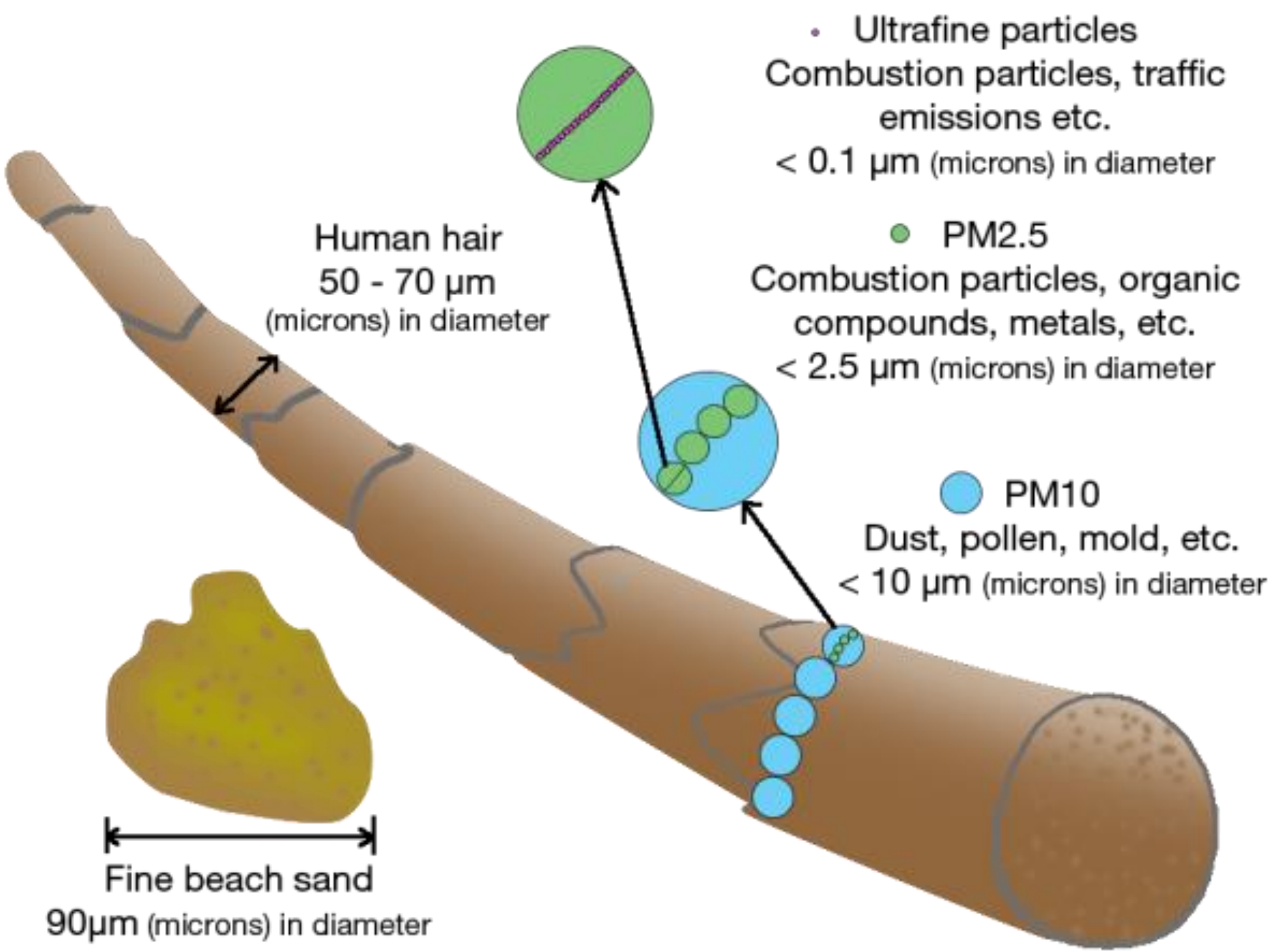



Ultrafine particles
Combustion particles, traffic emissions etc.
< 0.1 µm (microns) in diameter
PM2.5
Combustion particles, organic compounds, metals, etc.
< 2.5 µm (microns) in diameter
PM10
Dust, pollen, mold, etc.
< 10 µm (microns) in diameter
Human hair
50 - 70 µm
(microns) in diameter
Fine beach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

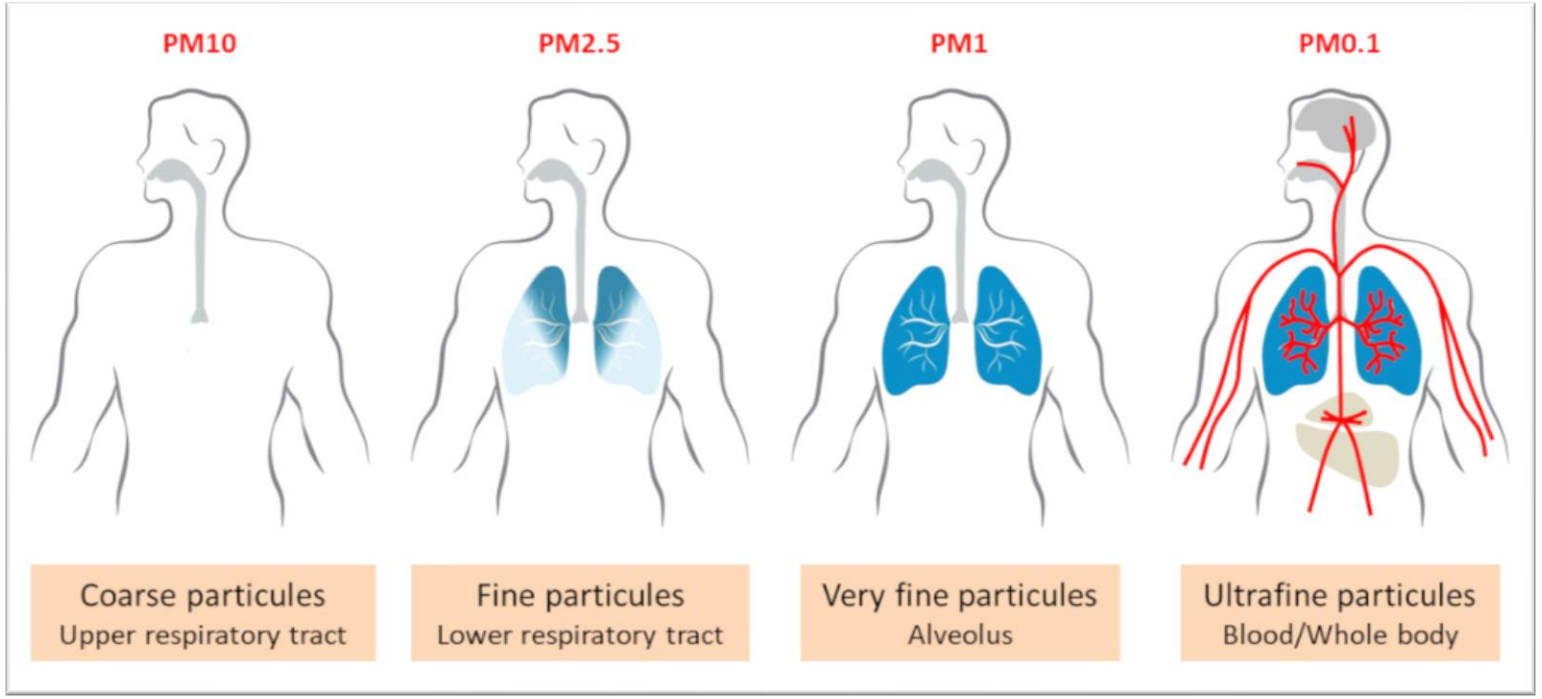
# A selection of cities with published studies of airport UFP impacts

| Distance from airport to monitoring site | | |
|---|---|---|
| < 1km | 1 to 10 km | > 10 km |
| Tianjin, China | London, England | Los Angeles, CA |
| Rome, Italy | Los Angeles, CA | Amsterdam, NL |
| Venice, Italy | Norwich, England | Atlanta, GA |
| Taipei, Taiwan | Boston, MA | New York, NY* |
| Oakland, CA | Warwick, RI | |
| Santa Monica, CA | | |

*La Guardia

# Important characteristic of Ultrafine Particles

- They have a larger 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.
- They are measured differently than $PM_{2.5}$ (count for UFP vs mass for $PM_{2.5}$)



# Ultrafine Particles (UFPs)

Ultrafine Particles unregulated but potentially important

Health Effects more uncertain compared to $PM_{2.5}$ , but there is 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)

Approaches to reduce noise do not necessarily address UFP

# MOV-UP Study

# 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: Community, government and academic representation. Their role was to provide feedback on the study design, methods and findings.

Frequent communication with community

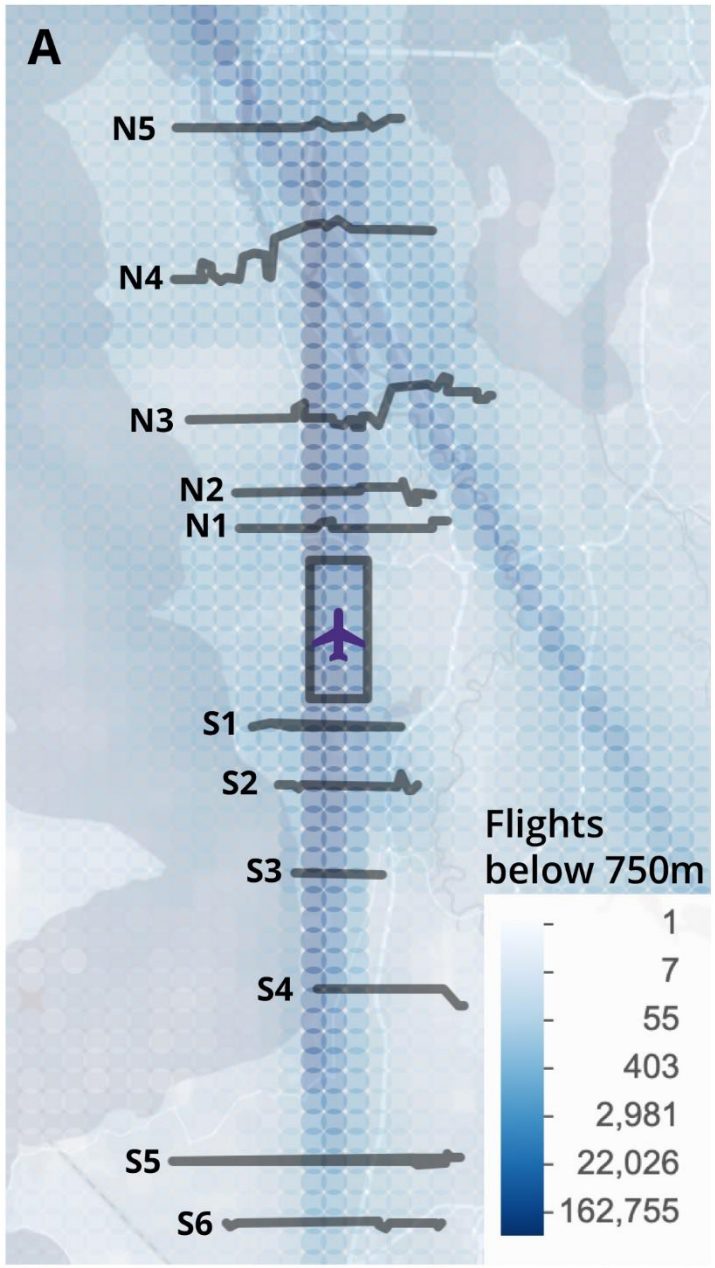
-presentations

-forums

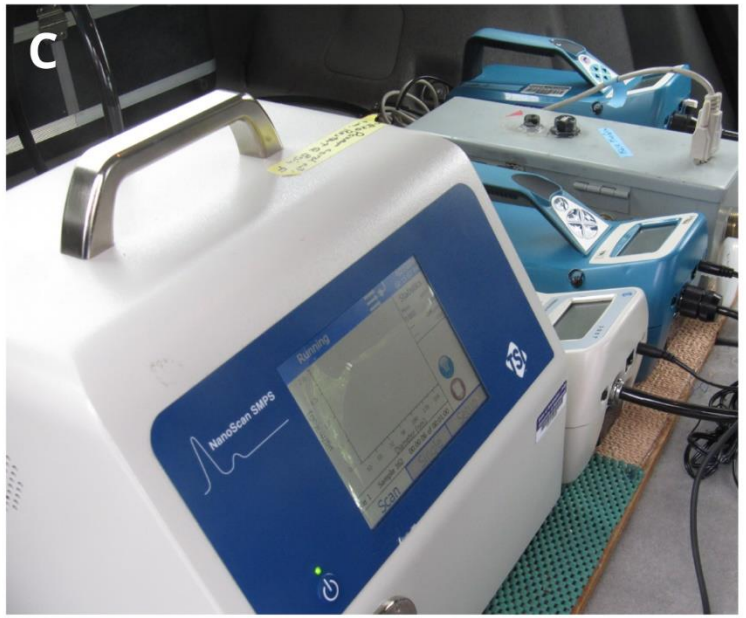
-media coverage

# Study Region: Mobile Transects and Fixed Monitoring Site Locations

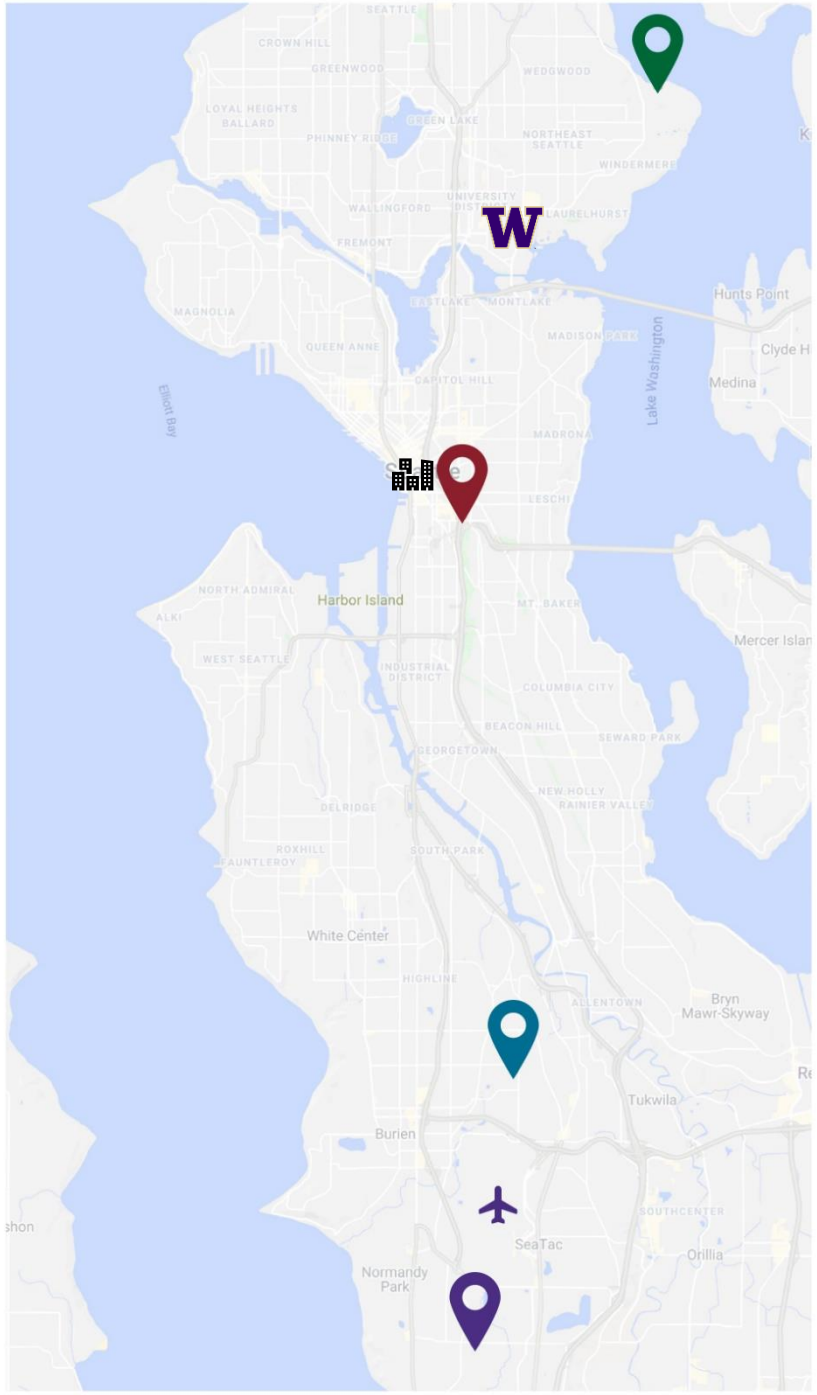
SEATAC (2018)
- ❖8th busiest U.S. airport
- ❖> 49.8 million passengers
- ❖>432,315 metric tons of air cargo



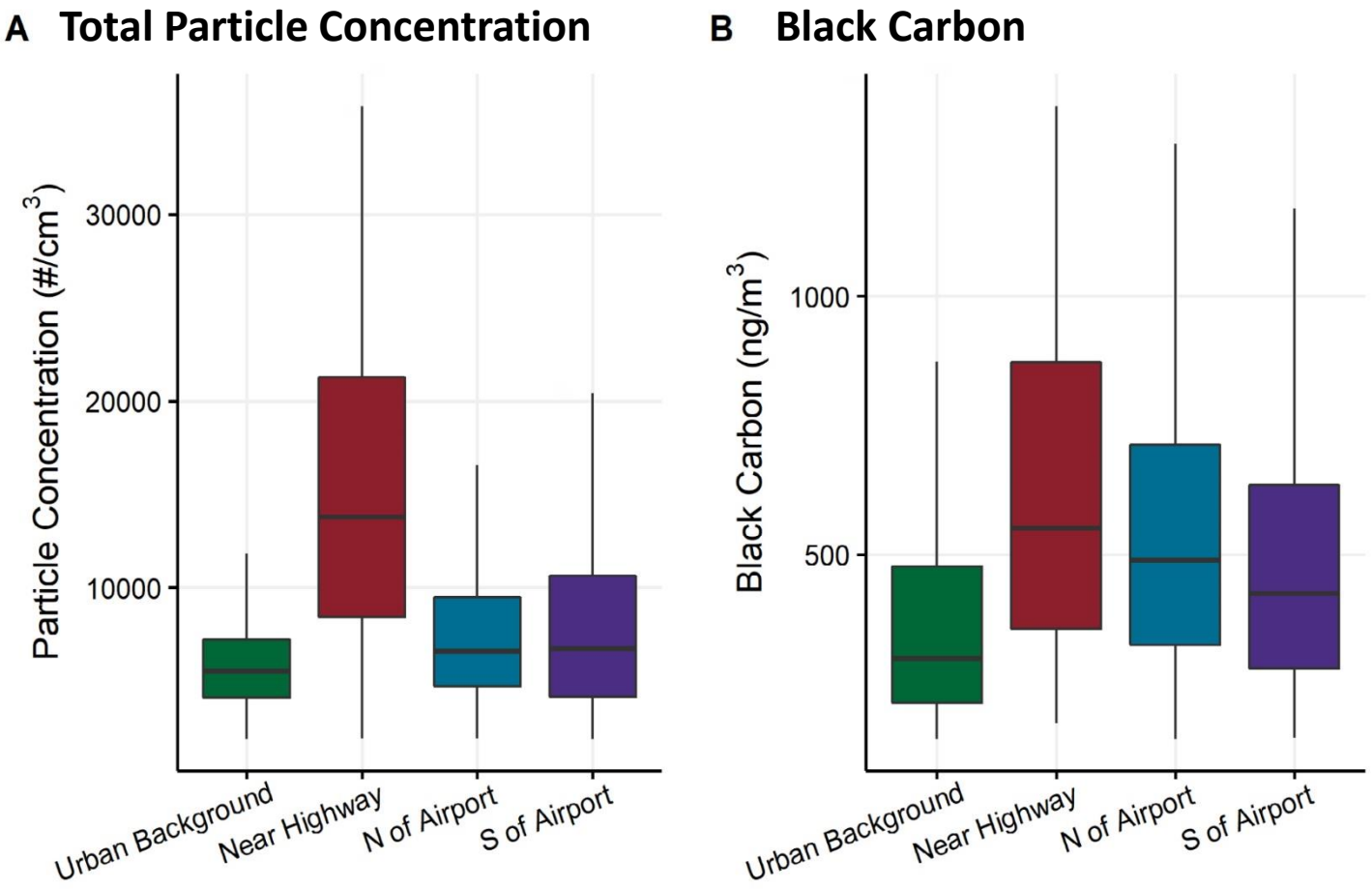




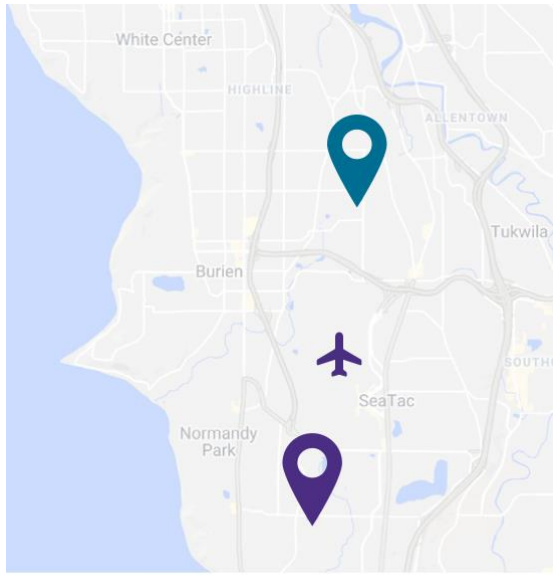
# Fixed Site Monitoring

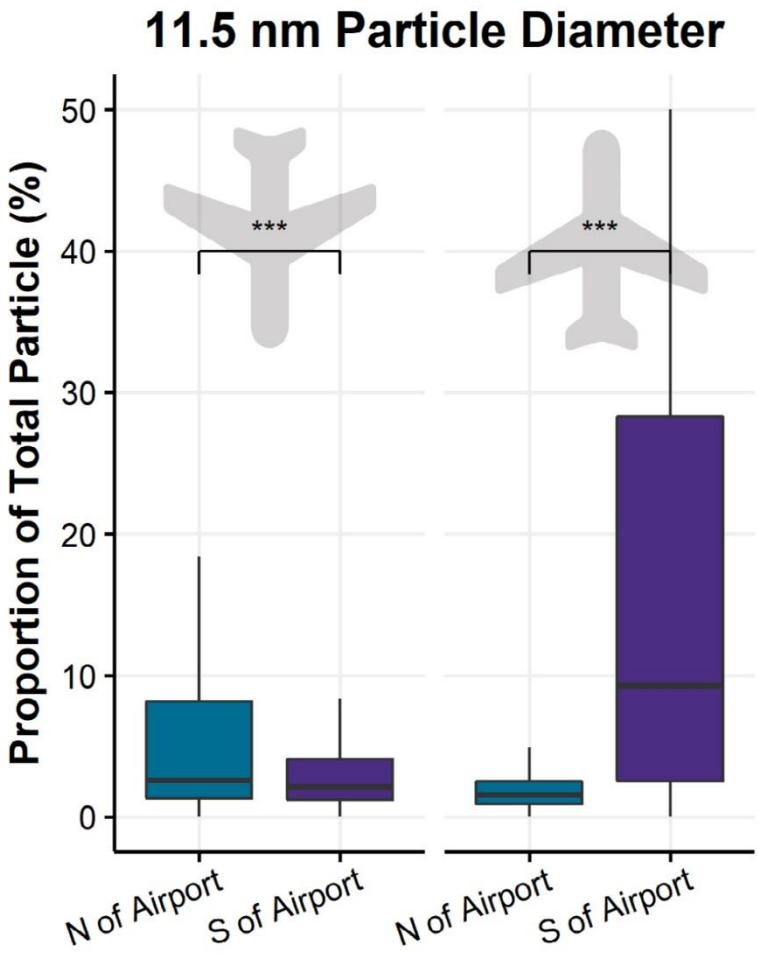


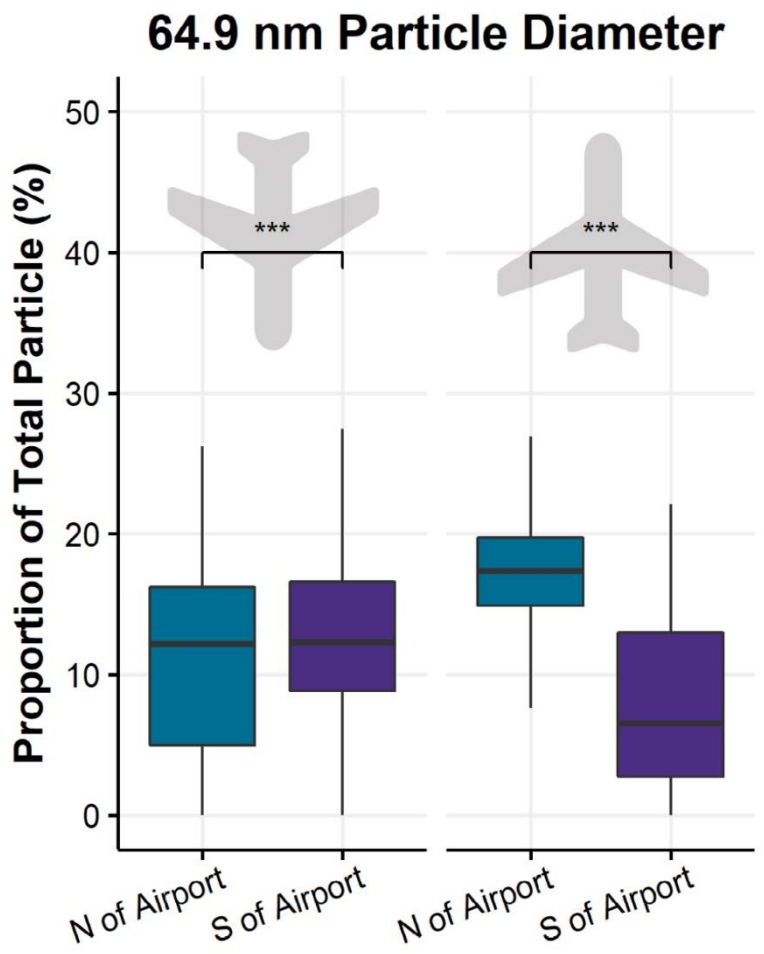

# Fixed Monitoring Results: Traffic Related Pollutants



# Smaller Sized Particles Near SeaTac Associated with Jet Landings



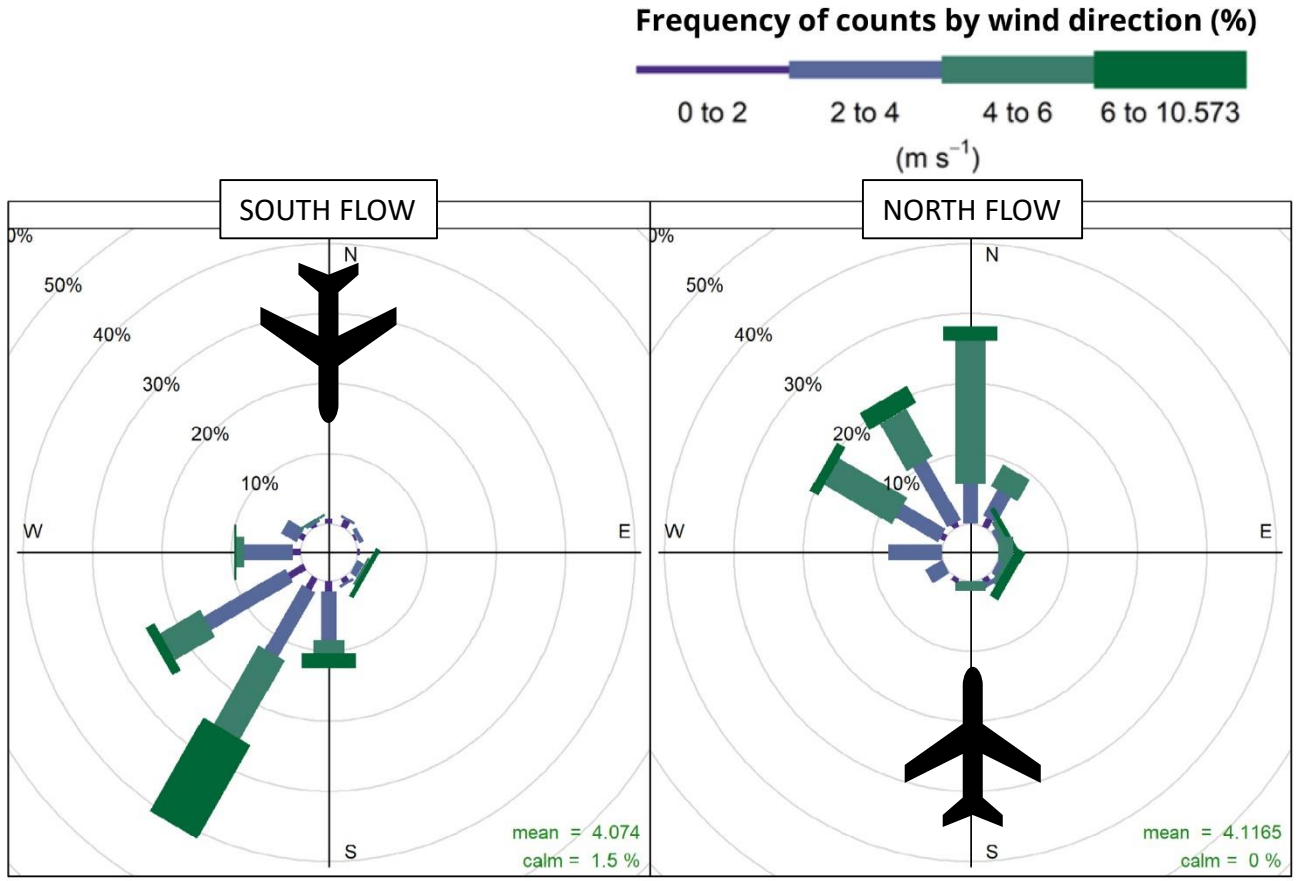



# Mobile Monitoring

# Mobile Monitoring Results: Monitoring Summary

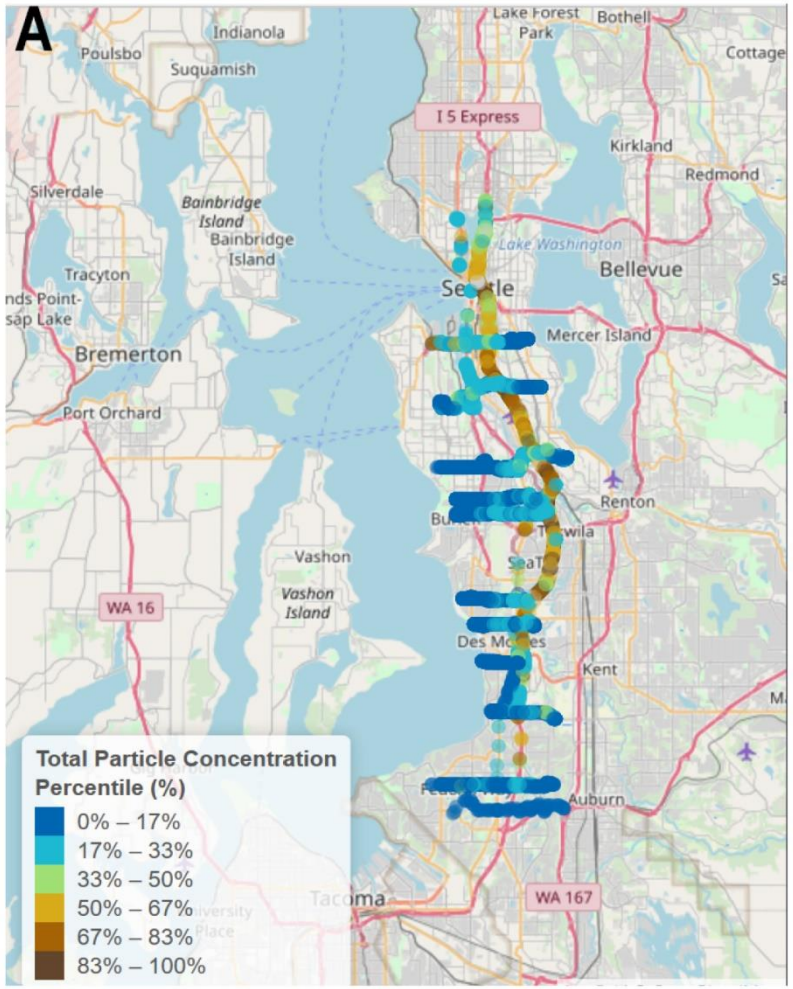
| | Sampling Day | Second Car (%) | Start Hour | End Hour | Temp (F) | RH | South Flow Operation |
|---|---|---|---|---|---|---|---|
| Winter | 21 days | 62% | 14:00 | 16:30 | 51F | 62% | 59% |
| Spring | 14 days | 71% | 11:00 | 16:30 | 65F | 50% | 52% |
| Summer | 16 days | 81% | 11:00 | 17:00 | 73F | 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”.

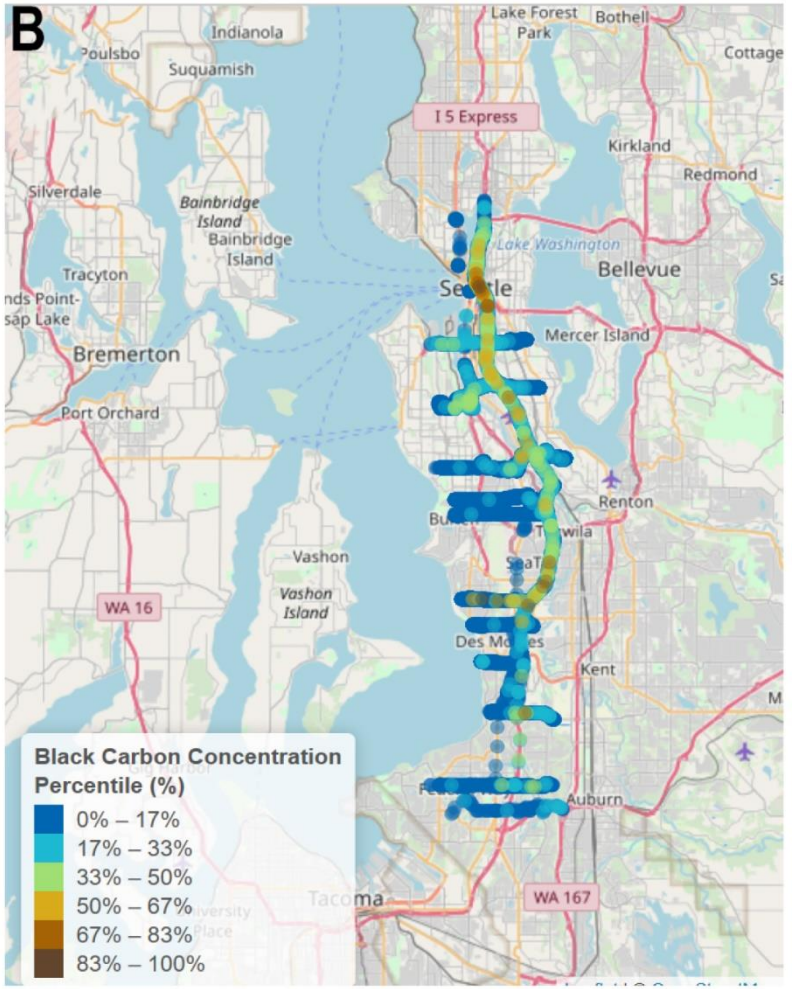


# Traffic Related Pollutants
# Spatial Distribution

## Total Particle Number*




## Black Carbon




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

# Distinguish Sources

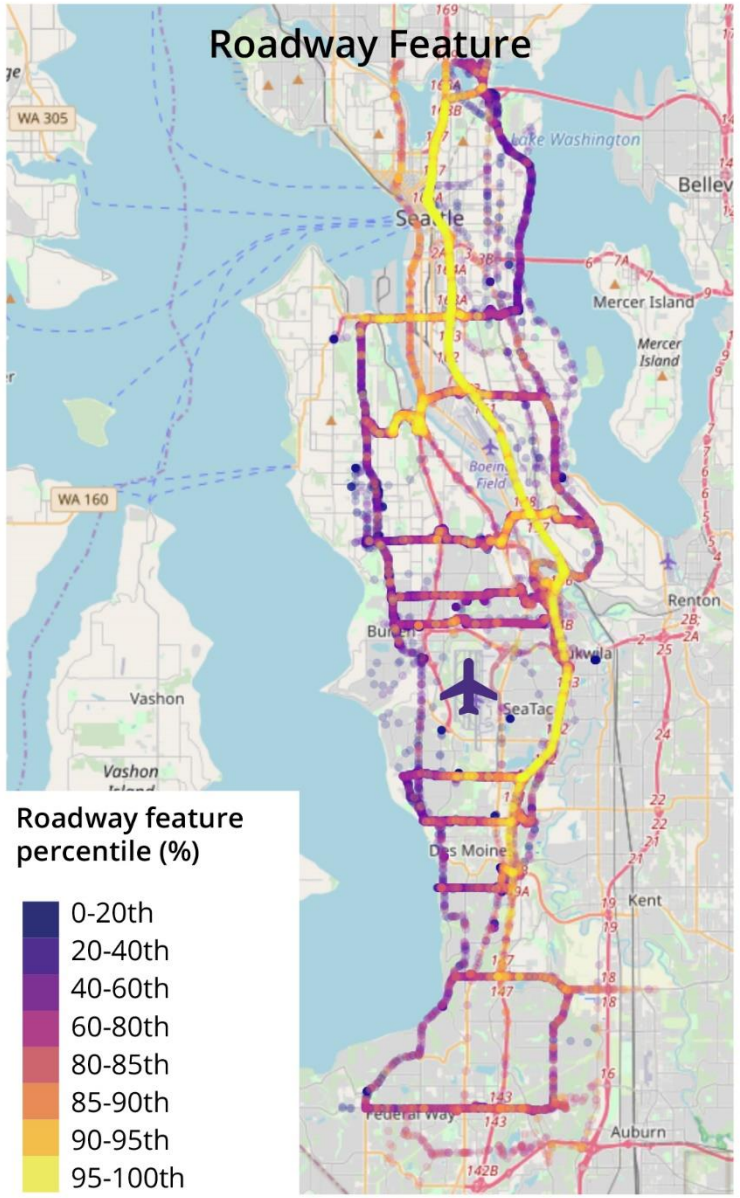
- **Goal**: Combining particle size and other pollutant characteristics collected from mobile monitoring to characterize the source of pollutant

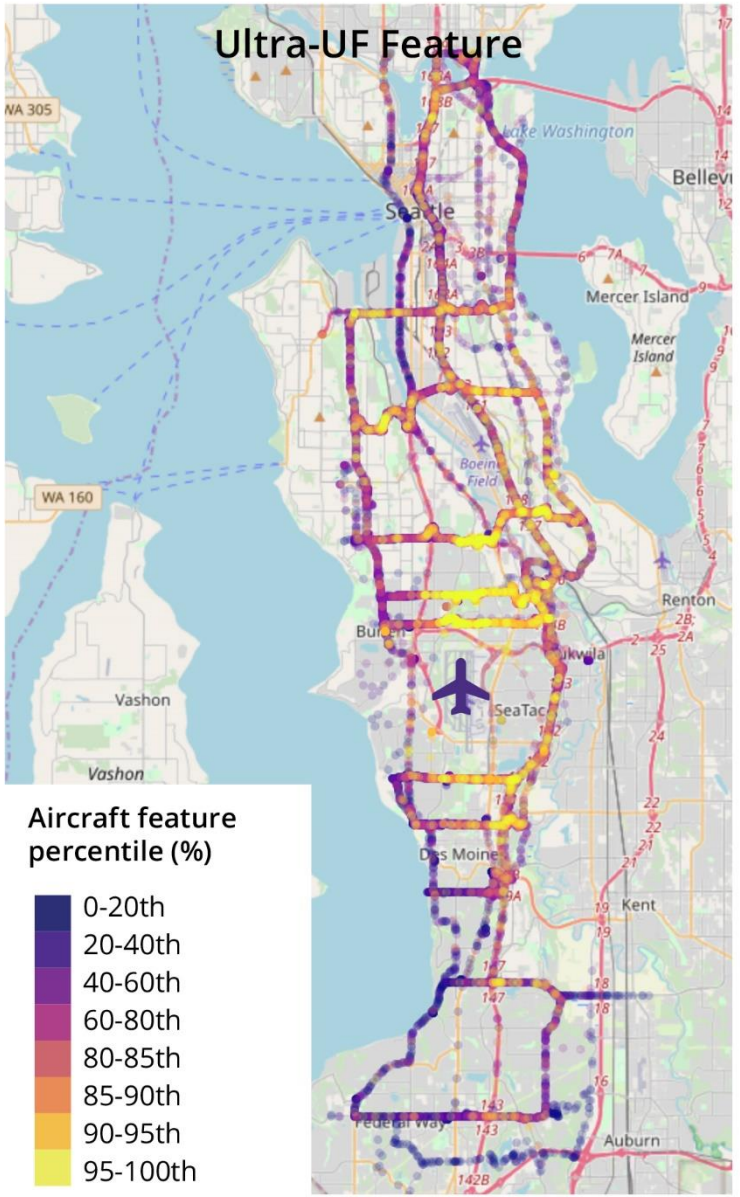
- **Method**: Perform a Principal Component Analysis (PCA) with varimax-rotation to identify features or “fingerprints” that reflect pollutant source.

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

# Pollutant Features

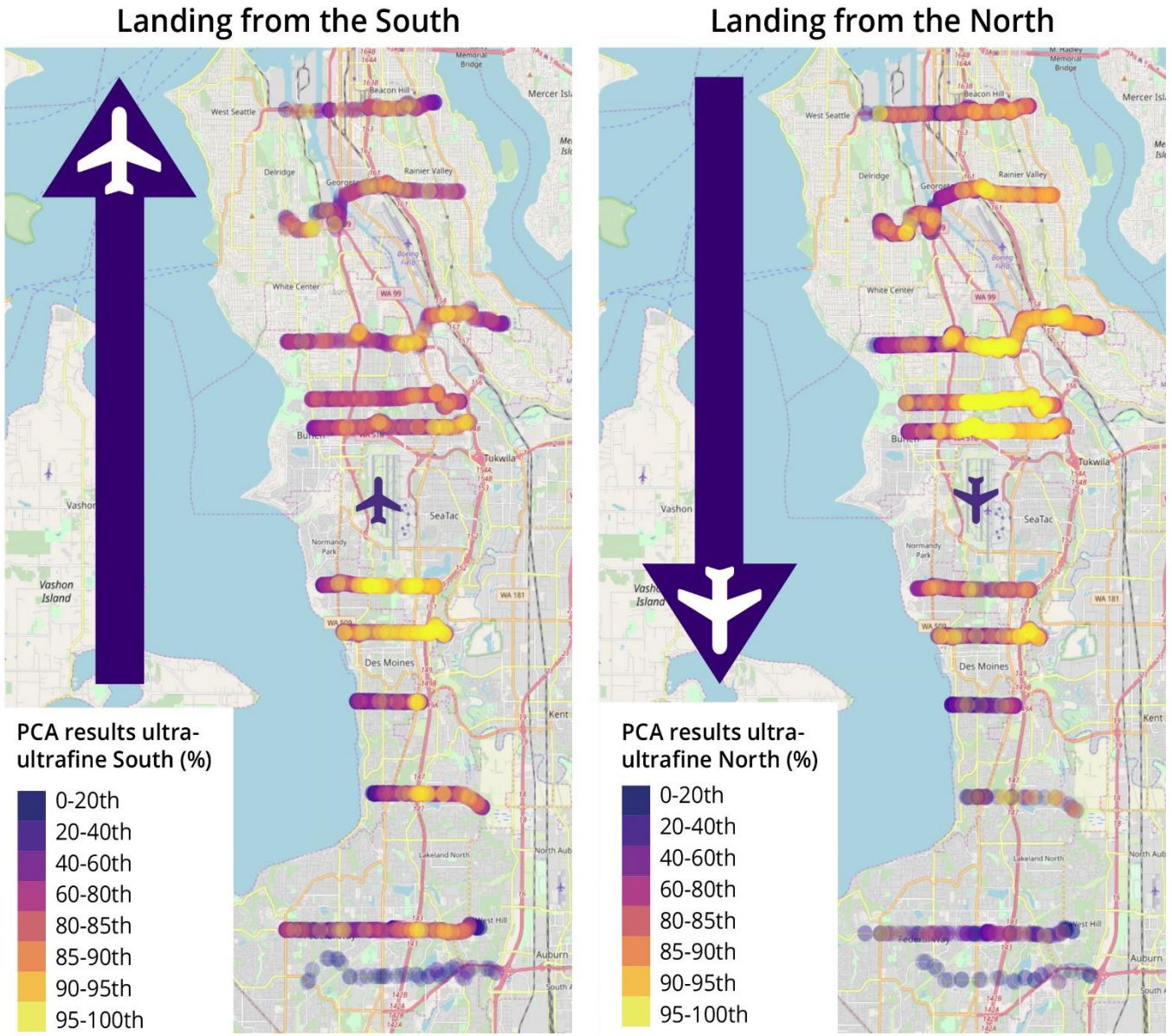
- POSITIVELY correlated with Black Carbon and Total Particle Number Concentration
- Median diameter from Nanoscan is approximately 30-40 nm



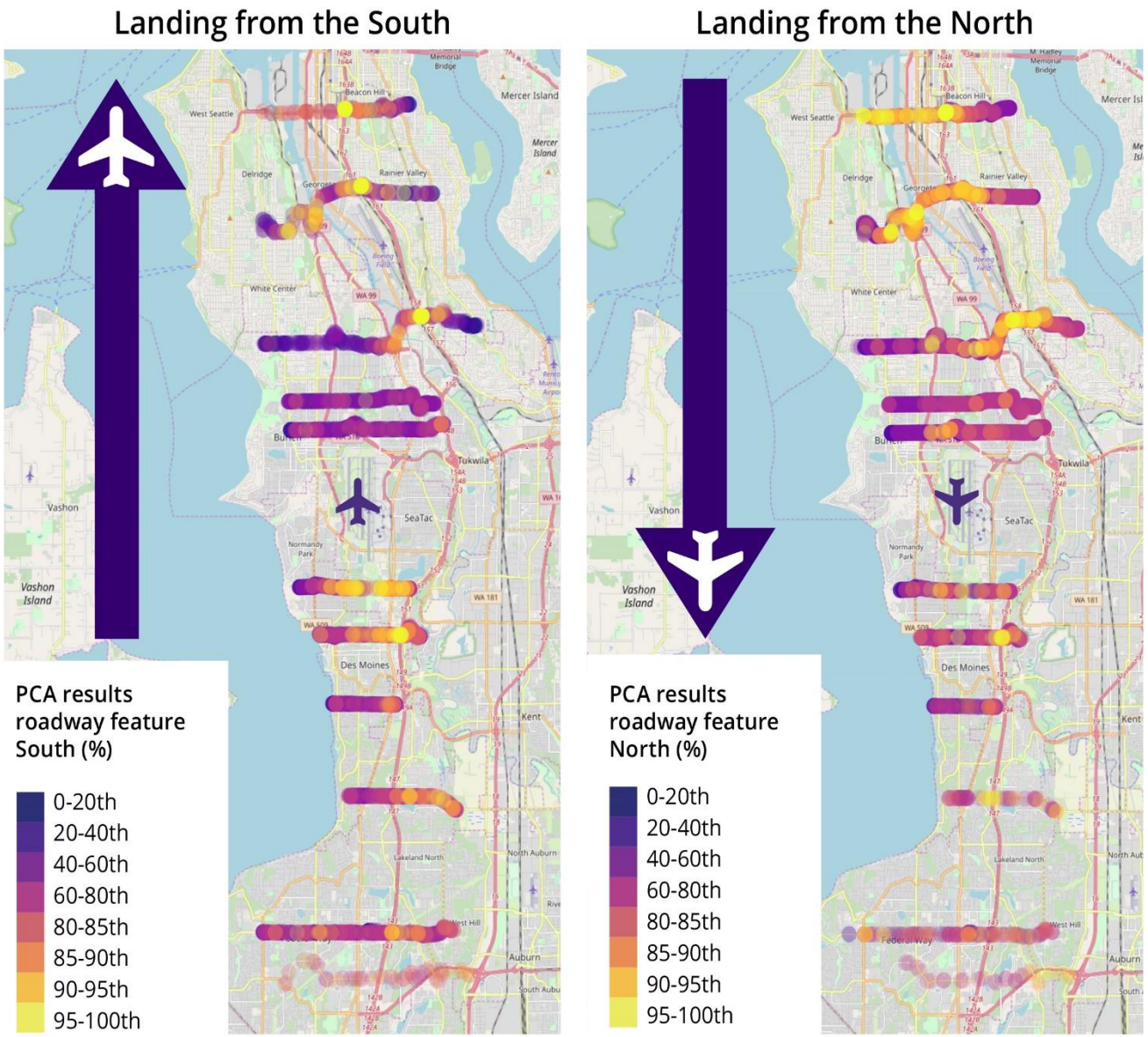




- POSITIVELY correlated with ultra-UF particles
- NEGATIVELY correlated with Black Carbon
- Median diameter from Nanoscan is approximately 15 nm

# “Ultra-UFP” tracks landing direction



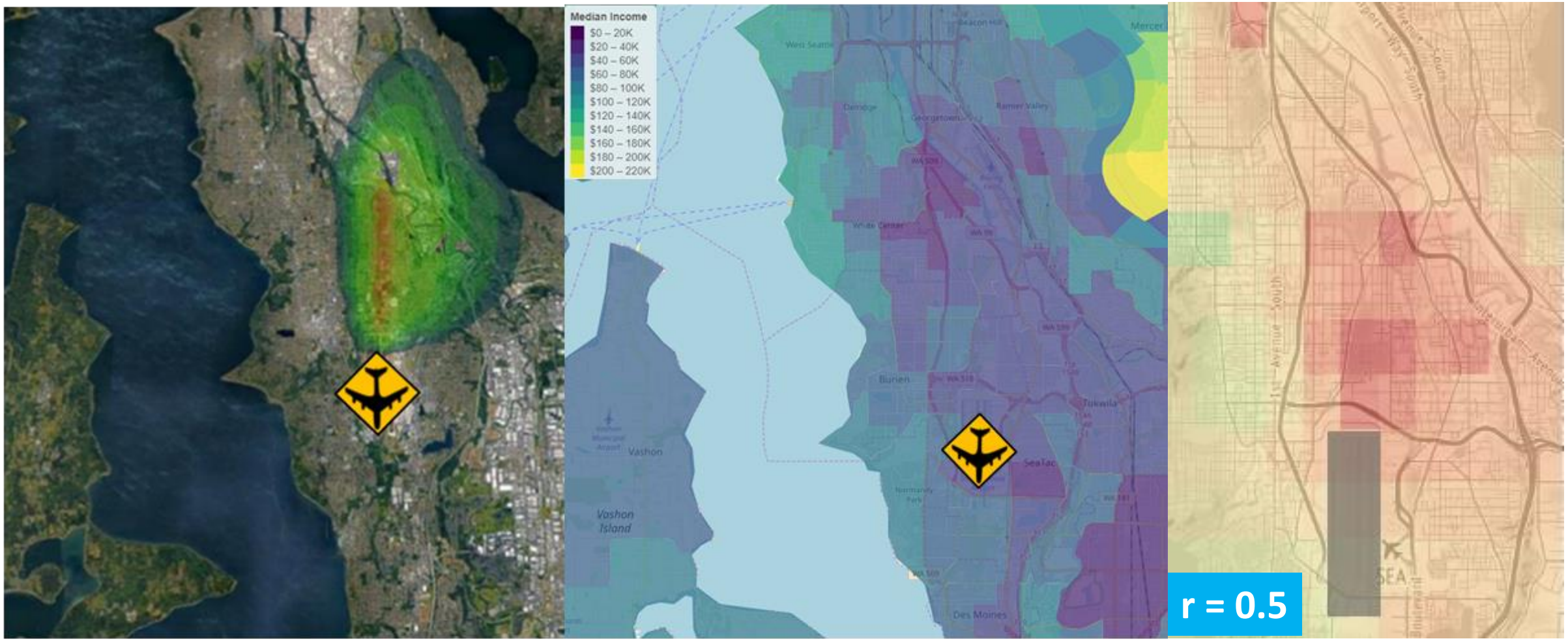
# “Roadway” is invariant to landing direction



# Predicted*

# Median Income

# Aircraft Feature




**Average over all hours on all sampling days

# 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 2018. Important uncertainties emerge in trying to predict distributions for past or future years.

# Acknowledgements


- Study Team - Elena Austin, Jianbang Xiang, Timothy Gould, Sukyong Yun, Jeffry Shirai, David Hardie, Michael Yost, Timothy V Larson, Edmund Seto
- Study Advisory Committee
- Funder: WA State



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