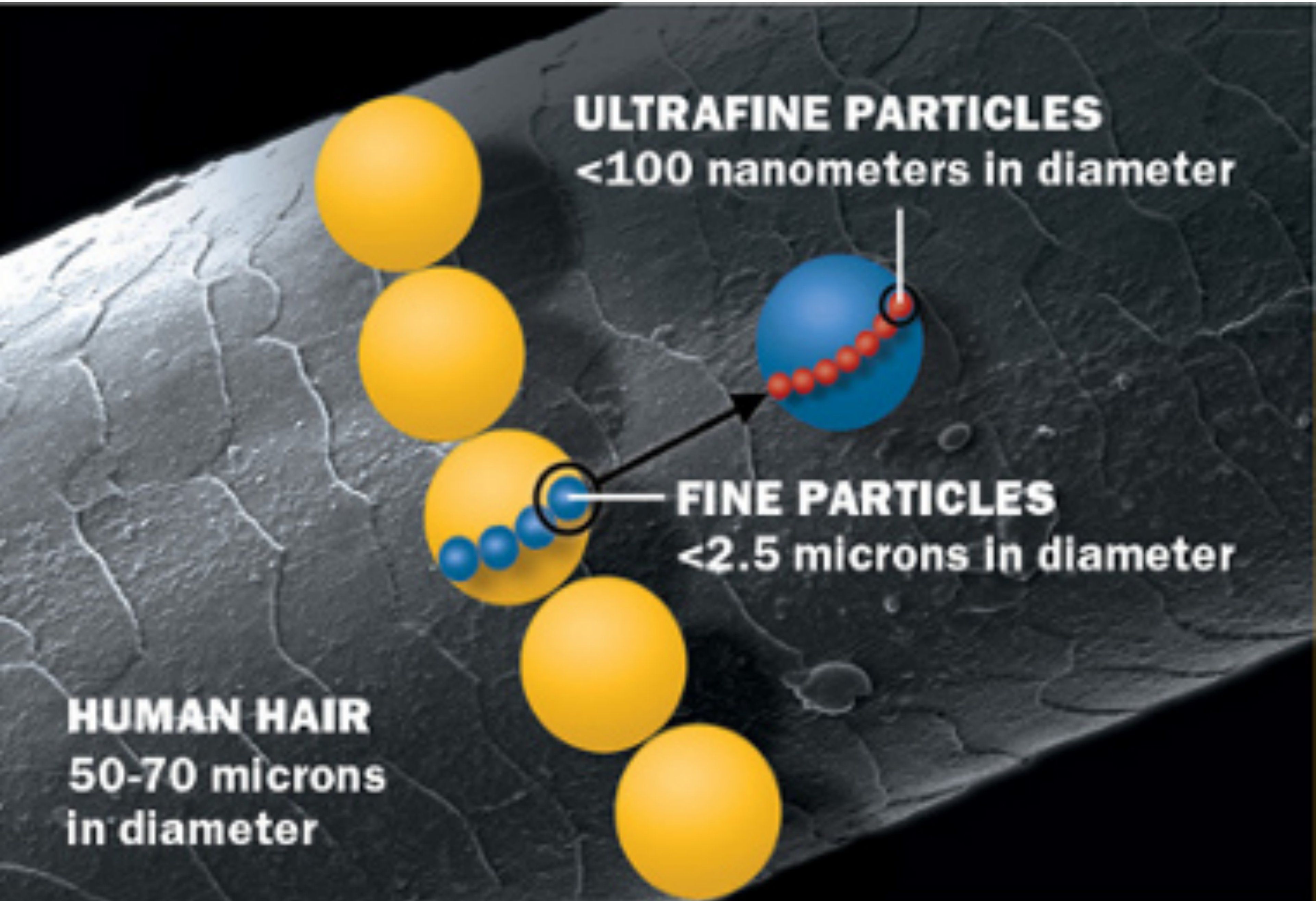
Ambient Ultrafine Particles Near Sea-Tac Airport

Timothy Larson, Edmund Seto, Elena Austin, Timothy Gould, Michael Yost

University of Washington, Seattle

Presentation to the Federal Way Transportation & Planning Commission

April 1, 2019

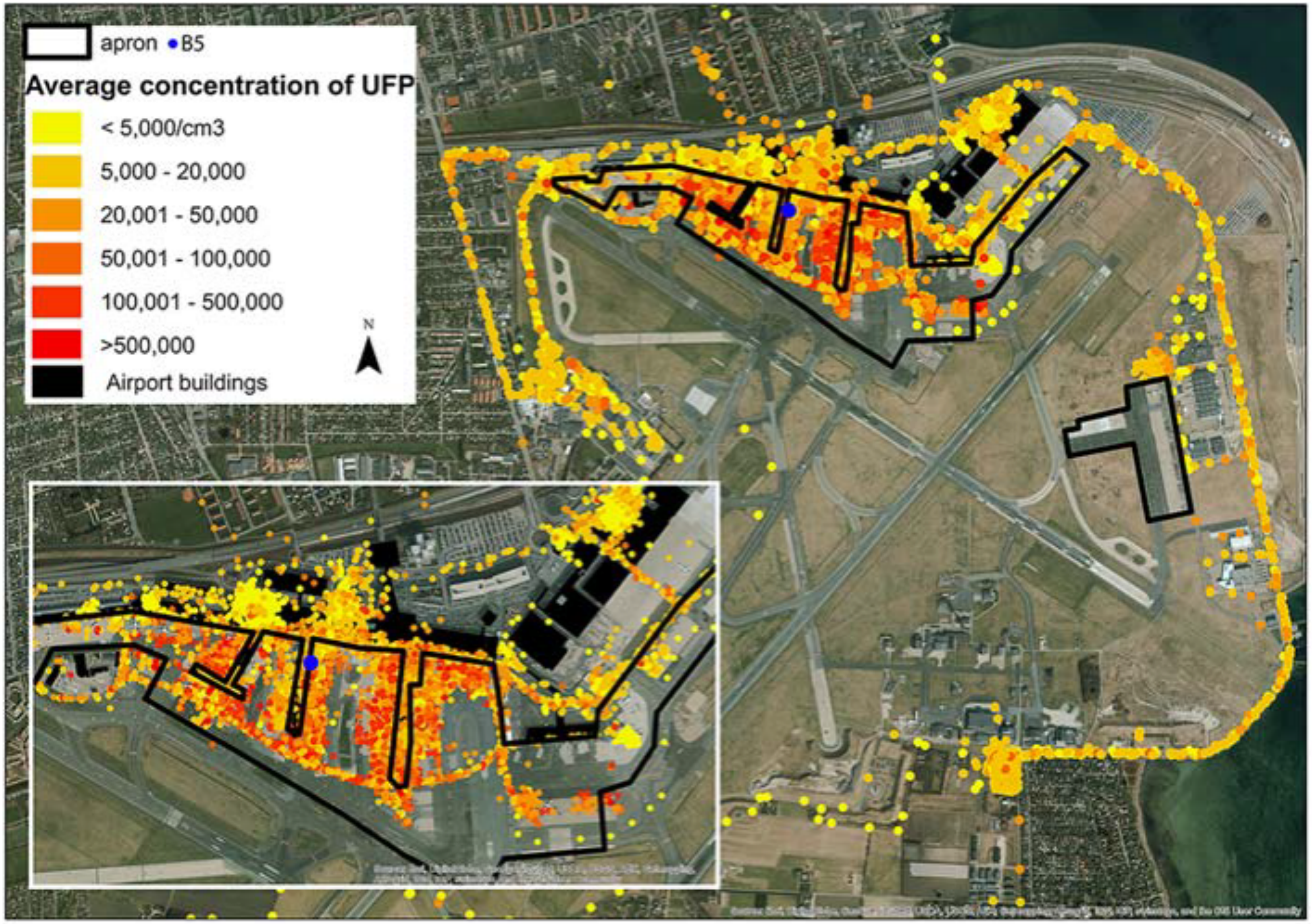

ULTRAFINE PARTICLES
<100 nanometers in diameter
FINE PARTICLES
<2.5 microns in diameter
HUMAN HAIR
50-70 microns
in diameter

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 emissions emit “ultra-ultra fine” particles (< 30 nanometers)

Occupational exposures to UFP are known to be high in some settings.

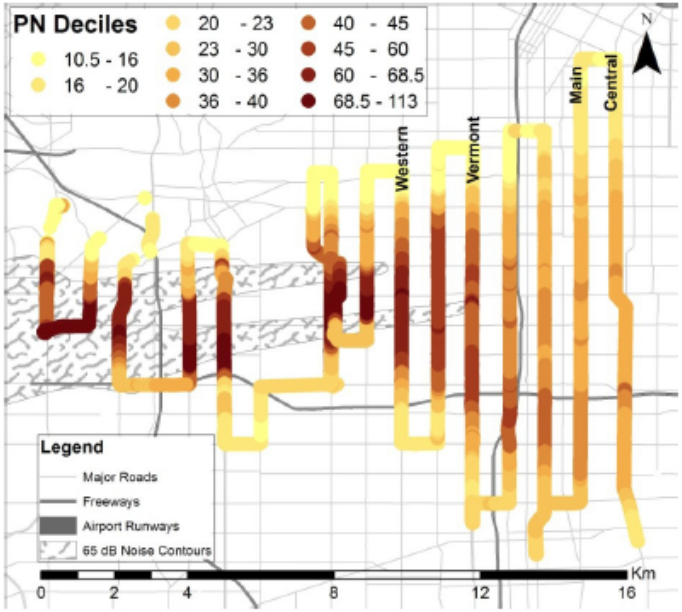
A map of personal exposure concentrations for workers at the Copenhagen airport in Autumn of 2012 is shown at right.



Moller et al (2014) PLoS ONE 9(9): e106671, doi:10.137/journal.pone.006671

“Ultra-Ultrafine” Particles

10³/cc



Particle size between ~10 and 30 nm diameter are still present at high concentrations at ground level at 16 km downwind

Hudda et al, ES&T 2014; Hudda and Fruin, ES&T 2016

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

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journal homepage: www.elsevier.com/locate/envint

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*

UFP Monitoring Instruments

Increasing Reliability & Cost

DiSC mini

- Electrostatic
- 10 nm – 300 nm
- Average size & total count
- 1 second readings

Condensation Particle Counter

- Alcohol-based CPC
- > 7nm total count
- No Sizing
- 1 second readings

Nanoscan

- Alcohol-based CPC
- Electrostatic Sizing
- 10nm – 300 nm
- 16 size bins
- 1-minute readings

Scanning Mobility Particle Sizer

- Water-based CPC
- Electrostatic Sizing
- 2nm – 1000 nm
- >100 size bins
- 15 second readings

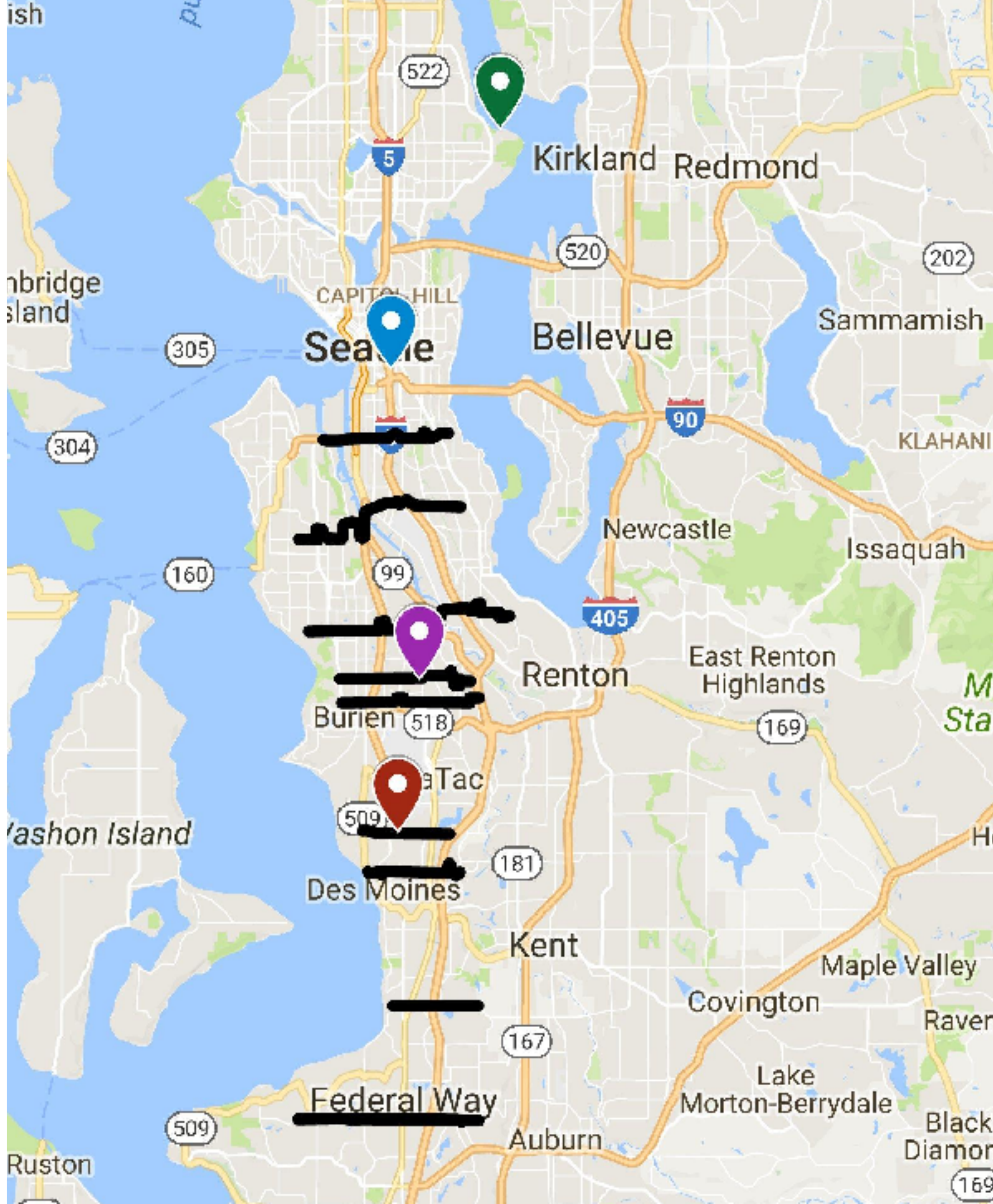
MOV-UP Study

Mobile ObserVations of Ultrafine Particles (MOV-UP) Study

Instruments used in mobile and fixed location sampling

Parameter	Instrument
Particle number concentration (10 nm – 1 µm)	Condensation Particle Counter 3007
Particle size distribution, 13 bins	NanoScan 3910
Black Carbon PM	Micro-Aethalometer AE51
CO_2	LI-820 Gas Analyzer
Position & Time tracking	GPS Receiver DG-500

Study Region and Fixed Monitoring Site Locations

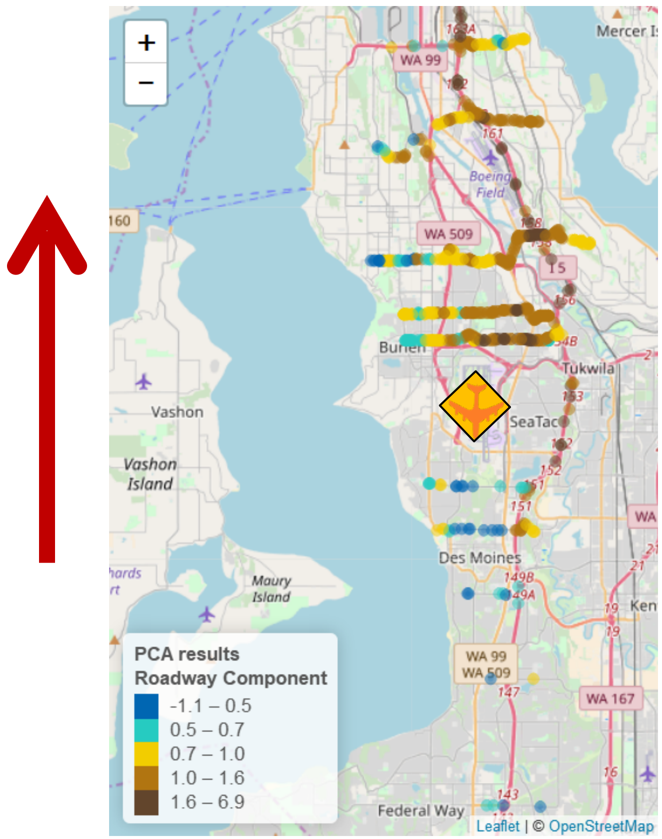


Fixed Sites

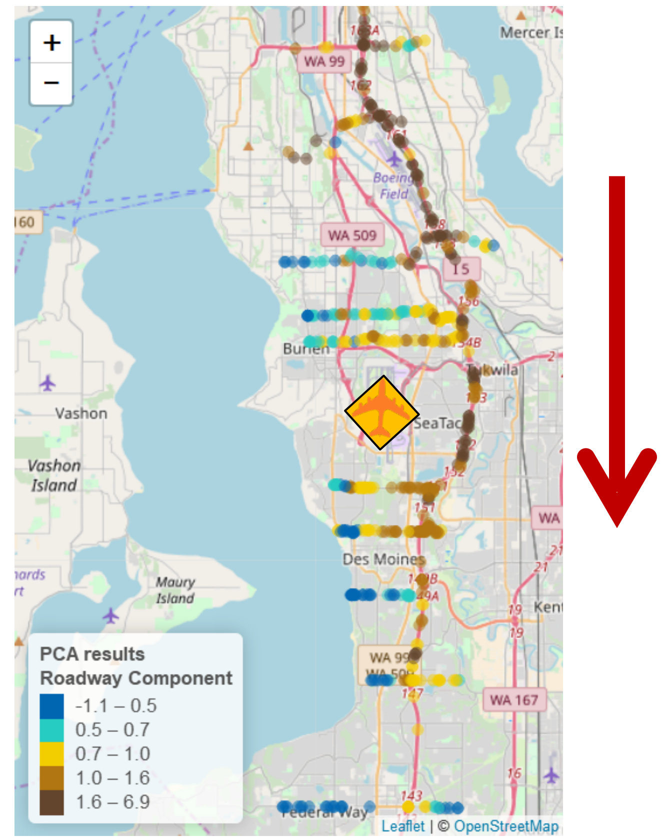
- SeaTac Community Center
- Maywood School Building
- Near Roadway Site
- Background

“Roadway” Feature

Wind from the SOUTH



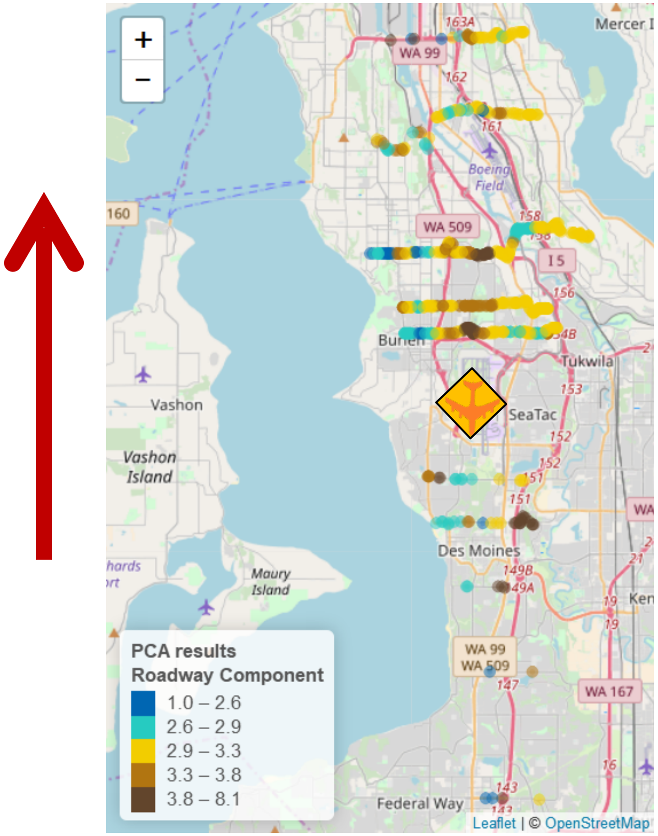
Wind from the NORTH



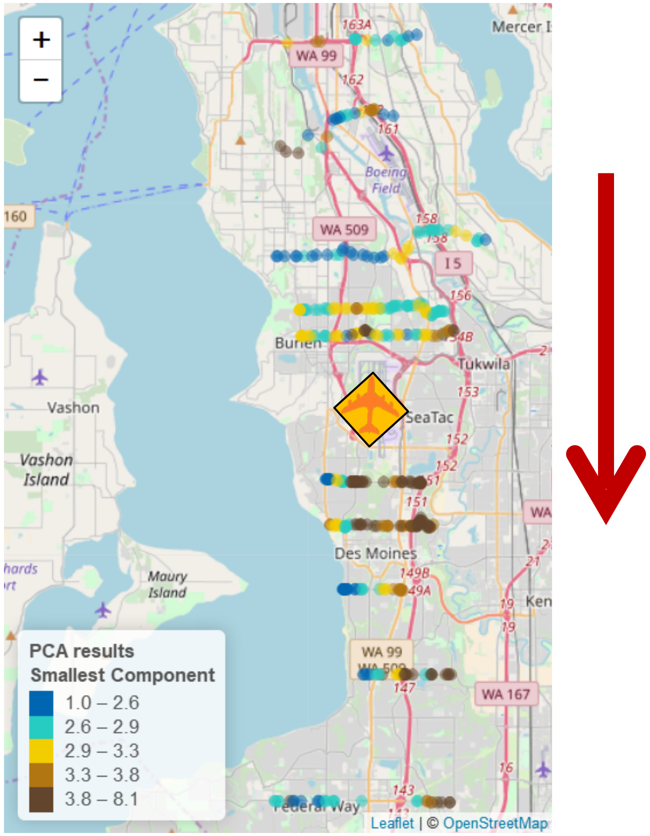
Winter – Spring Data

"Ultra-UFP" Feature

Wind from the SOUTH



Wind from the NORTH

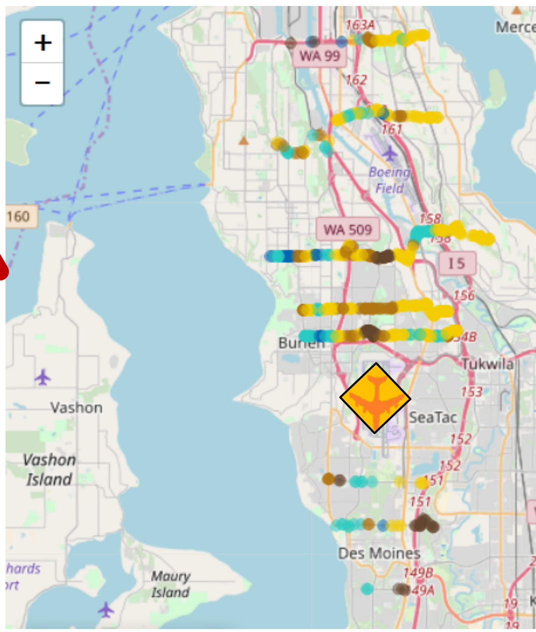


Winter – Spring Data

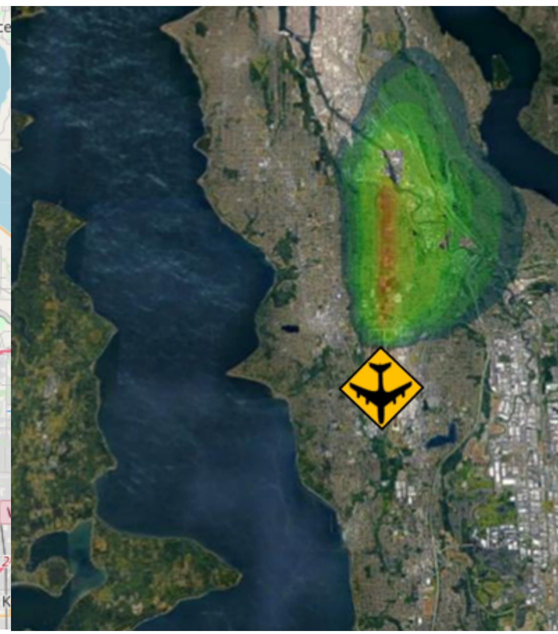
“Ultra-UF” Feature

Winds from the SOUTH

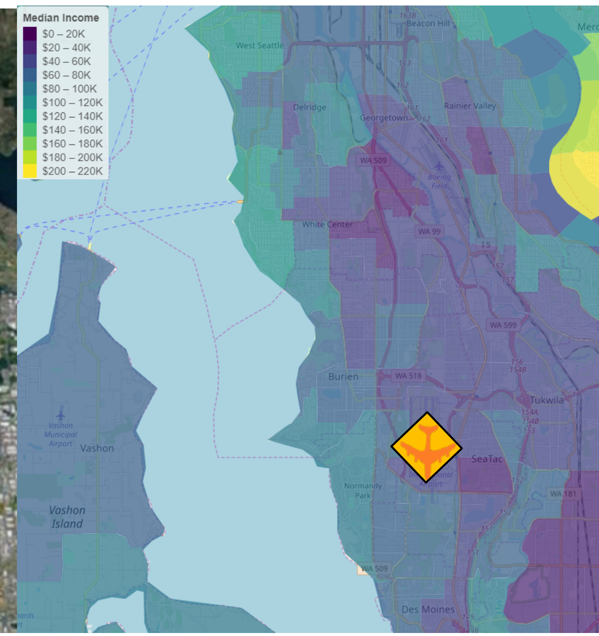
Observed*



Predicted*



Median Income



*Average of all hours during daytime sampling periods

**Average over all hours on all sampling days

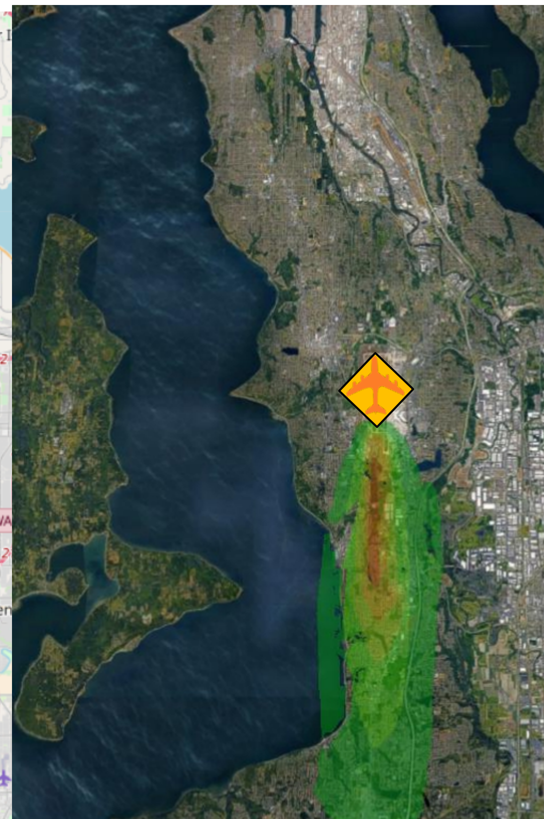
“Ultra-UF” Feature

Winds from the NORTH

Observed *

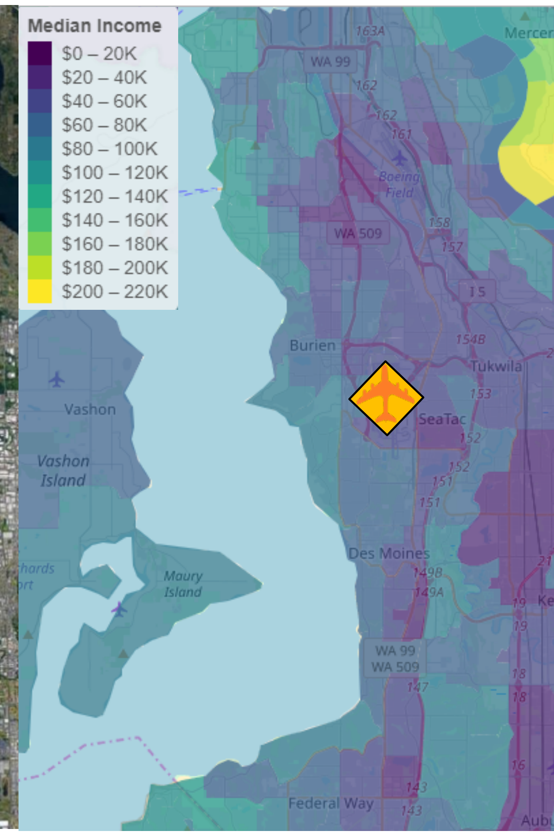
*Average of all hours during daytime sampling periods

Predicted **



**Average over all hours on all sampling days

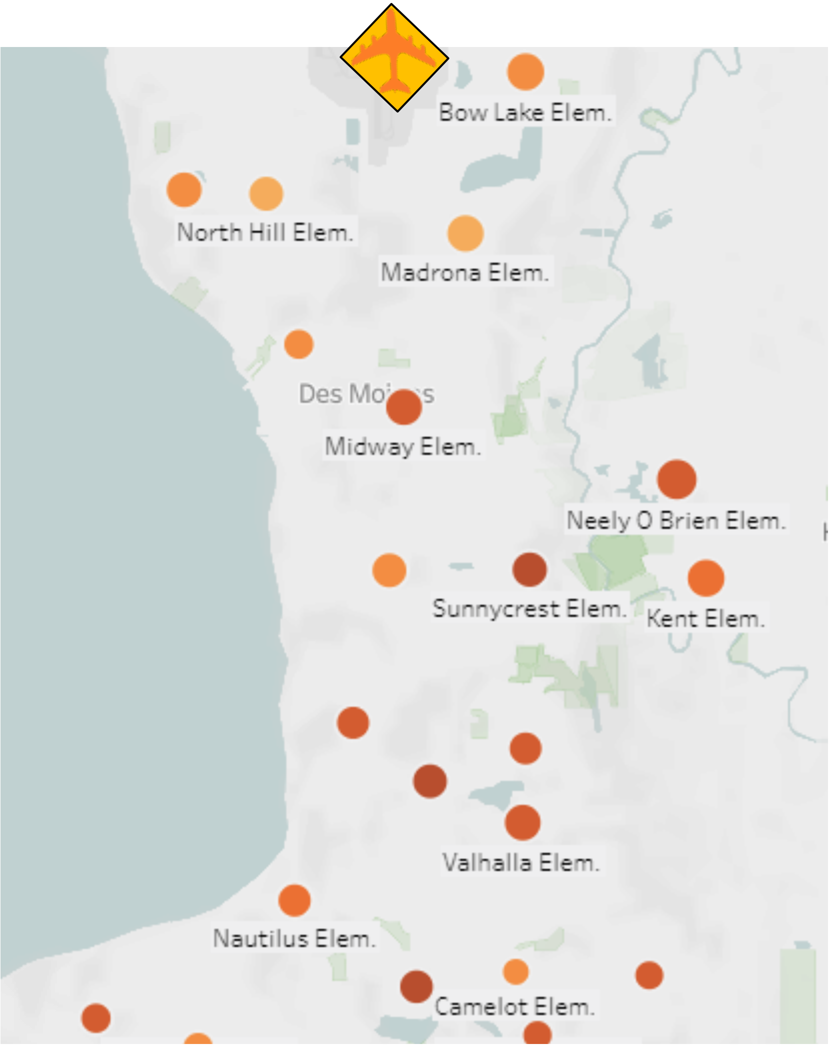
Median Income



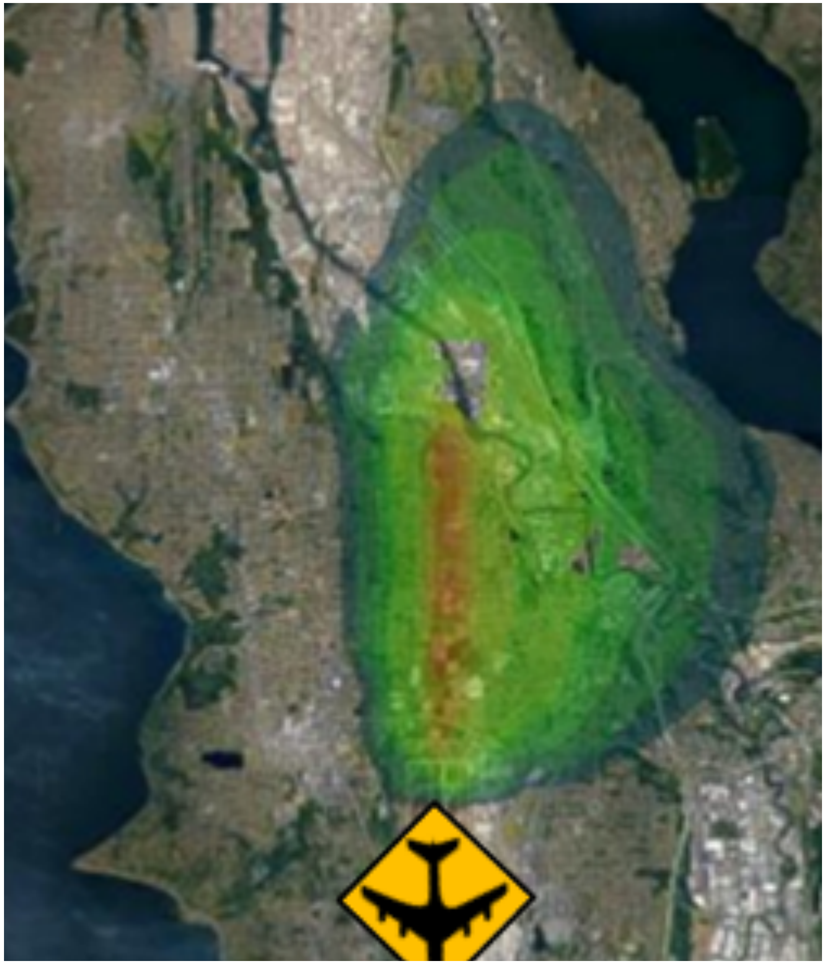
Monitoring Locations: Schools

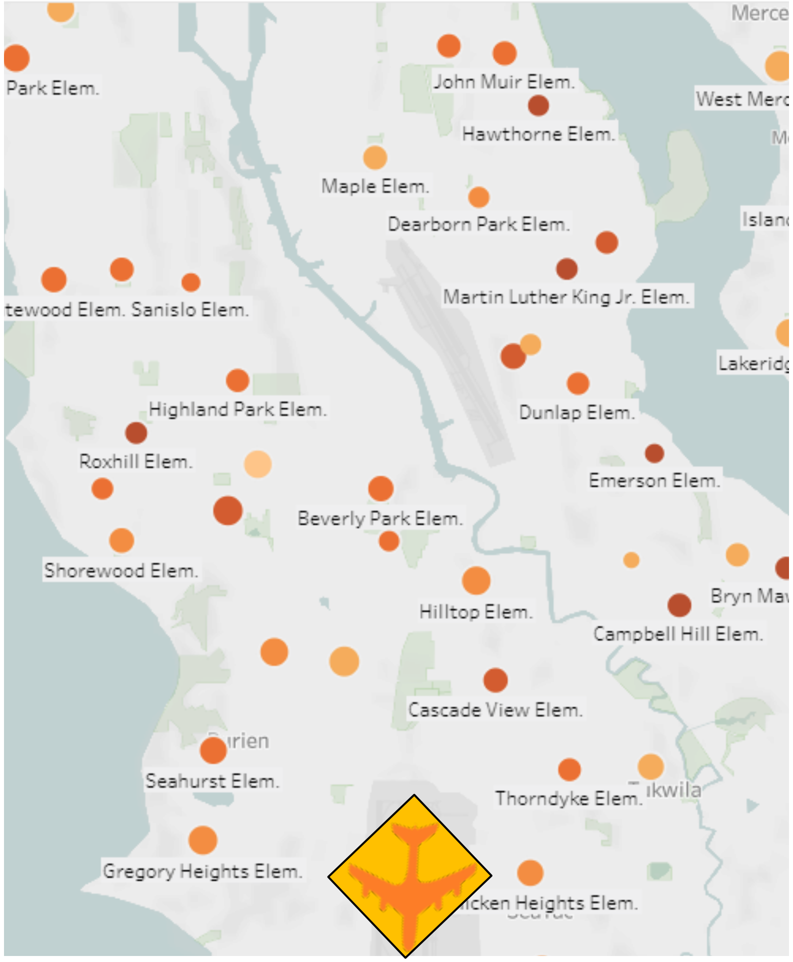
- Scientifically Relevant (in or out of plume?)
- Relevant to Communities
- Long-term Availability
- Adequate infrastructure
  - Power
  - Space
  - Security
  - Ease of access for operating instruments

Monitoring Locations: Schools



Monitoring Locations: Schools





Summary

- Ultrafine Particles (UFPs) are observed near busy roadways and also up to ~10-15 km downwind of SeaTac Airport
- Additional monitoring is needed to support health impact studies near the airport
- Predictions from a standard atmospheric dispersion model can help to design a UPF monitoring network near the airport
- Public schools are good candidates for UFP monitoring sites

Questions?

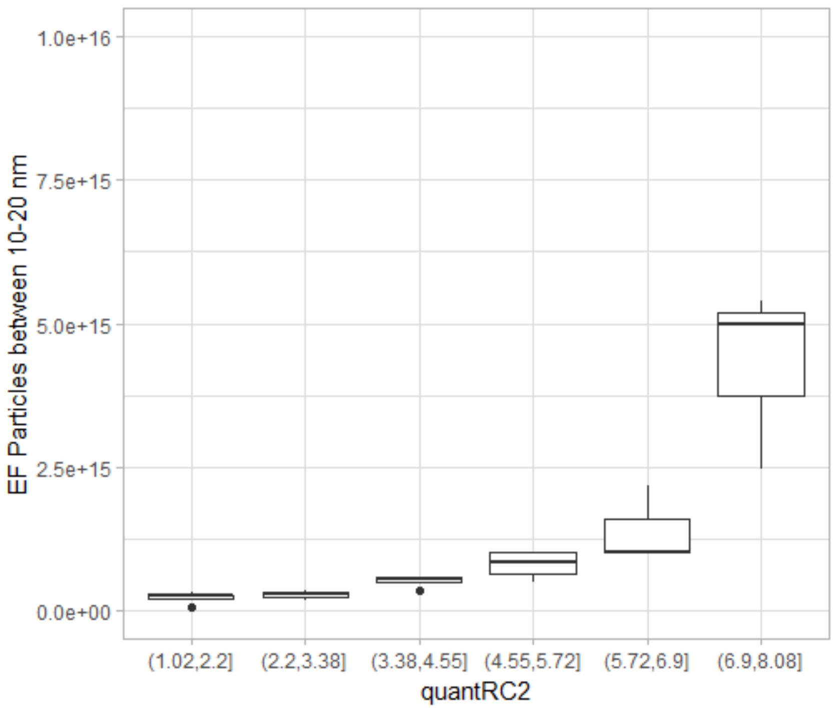
Supplemental Slides
(if questions arise)

New Beacon Hill Study

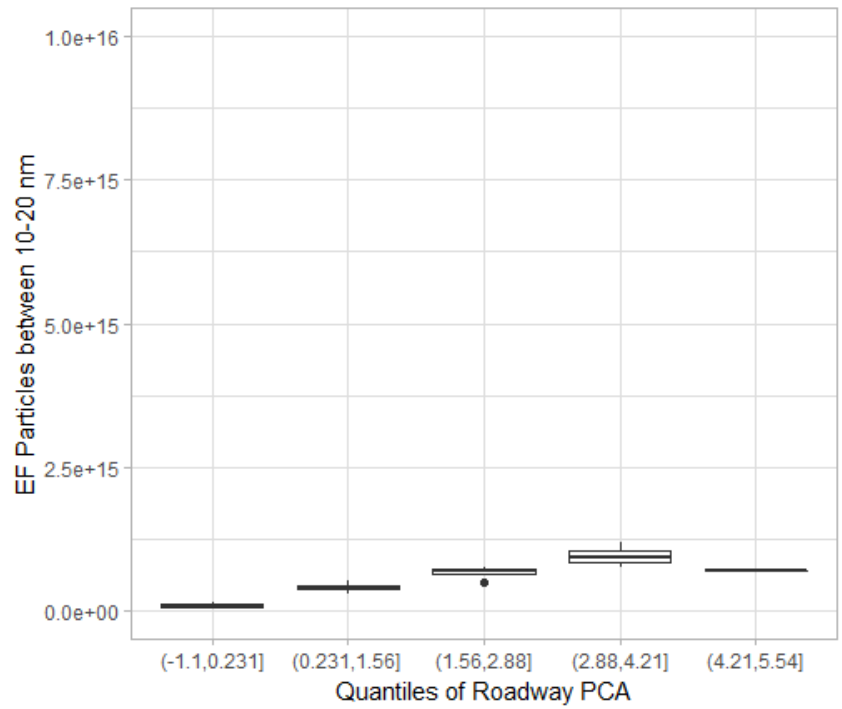
- Select at least one site in Beacon Hill for simultaneous ultrafine particle (UFP) and noise sampling.
- Set up an “anchor site” for comparison that we know is impacted by aircraft UFP and noise.
- Run both sites simultaneously so that we can make comparisons for different flight characteristics (traffic, time of day, etc.)

Emission Factors
Particles/$[CO2]_{mass}$

Quantiles of PCA (Ultra-UF)



Quantiles of PCA (Roadway)



Winter – Spring Data

Recent Studies Suggesting Acute Health Effects in Susceptible Populations

TOXICOLOGICAL SCIENCES 140(1), 61–72 2014
doi: 10.1093/toxsci/kfu063
Advance Access publication April 9, 2014

Controlled Exposure of Humans with Metabolic Syndrome to Concentrated Ultrafine Ambient Particulate Matter Causes Cardiovascular Effects

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Controlled Exposures to Concentrated Ambient Particles

Peters *et al. Particle and Fibre Toxicology* (2015) 12:7
DOI 10.1186/s12989-015-0083-7

PARTICLE AND FIBRE TOXICOLOGY

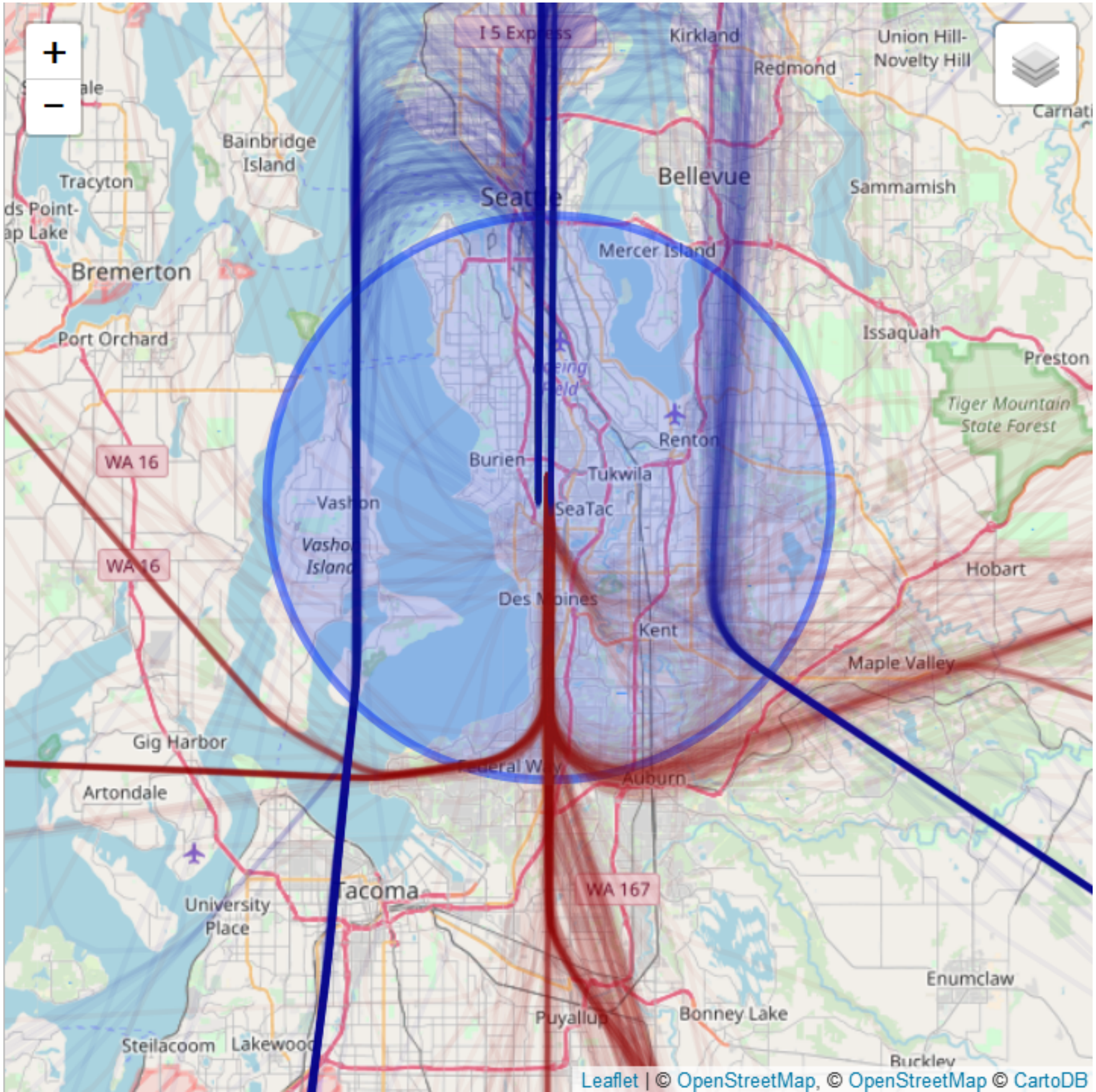
RESEARCH Open Access

Elevated particle number concentrations induce immediate changes in heart rate variability: a panel study in individuals with impaired glucose metabolism or diabetes

Annette Peters[1,2*], Regina Hampel[1], Josef Cyrys[1,3], Susanne Breitner[1], Uta Geruschkat[1], Ute Kraus[1], Wojciech Zareba[4] and Alexandra Schneider[1]

Exposures Documented with Personal Monitors

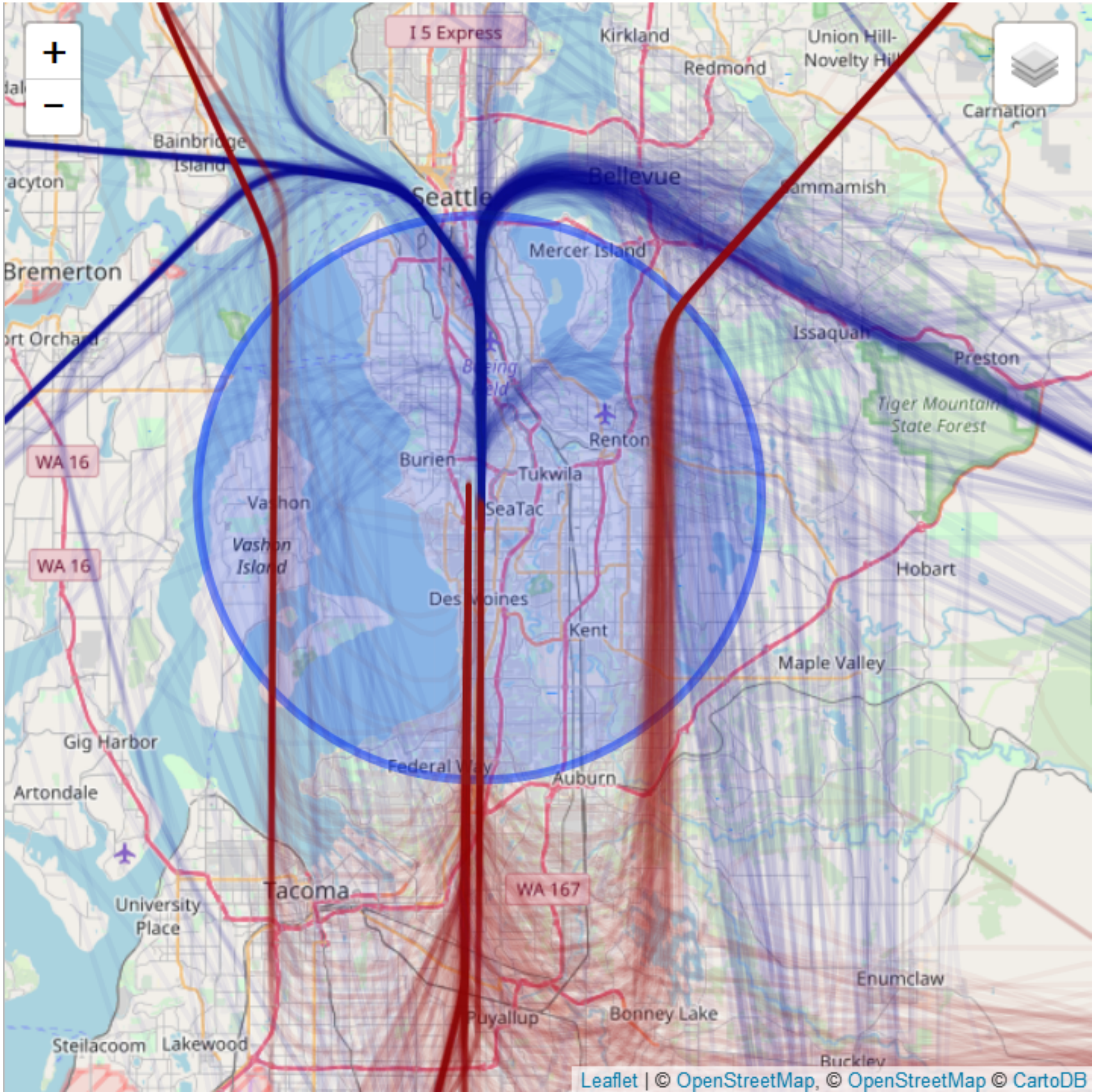
Southerly Winds



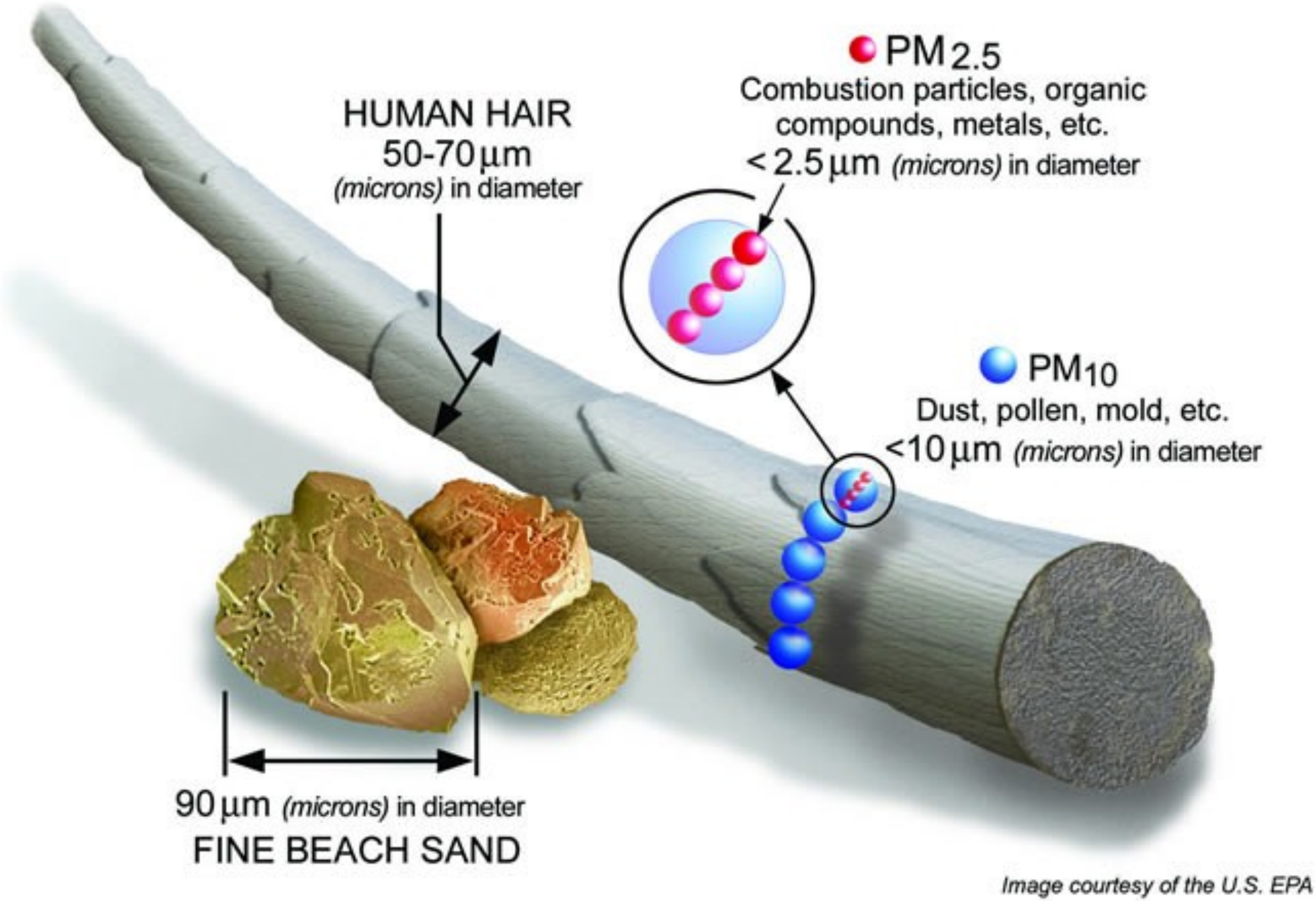
Wind (majority)

Aircraft

Northerly Winds



“Fine” Particles



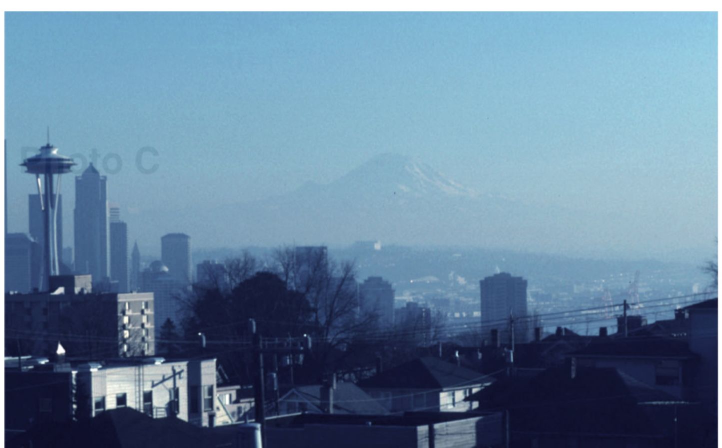
5 μg/m³

10 μg/m³

15 μg/m³

20 μg/m³

25 μg/m³



35 μg/m³