Mobile ObserVations of Ultrafine Particles (MOV-UP) Advisory
August 15th, 2018

Elena Austin, Edmund Seto, Michael Yost, Tim Larson
Outline

1. Current Monitoring Status
2. Background literature updates
3. Preliminary Data Analysis
4. Discussion
5. Questions
WA State Proviso

- 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
- Produce study report by December 1, 2019
MOVUP Monitoring Locations

Mobile Monitoring Transects + Stationary Sites

4 stationary sites
Mobile Monitoring Status

- Winter 2018
  - 16 days of monitoring
- Spring 2018
  - 14 days of monitoring
- Summer 2018
  - 10 days of monitoring (ongoing)

- Mobile monitoring typically occurs between 12 PM and 5 PM
- Typically monitoring consists of 2 concurrent cars (N and S of the airport)
Fixed Site Monitoring Status

<table>
<thead>
<tr>
<th>Fixed Site Monitoring</th>
<th>May 4th - May 11th</th>
<th>June 4th - June 13th</th>
<th>July 13th - July 16th</th>
<th>July 27th - Aug 1st</th>
</tr>
</thead>
<tbody>
<tr>
<td>10th &amp; Weller</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maywood</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>SeaTac Community Center</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>NOAA- Sand Point</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Background Site
## Instruments used in mobile and fixed location sampling

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

TSI, Inc. model 3007 CPC
MOV-UP Study
Mobile ObserVations of Ultrafine Particles (MOV-UP) Study
Area-weighted number concentration equivalent to ~ half the freeways in LA!

\[ 10^3/\text{cc} \]

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

Hudda et al, ES&T 2014
Local Background UFP (Hudda 2014 Method)

Wind Rose (Nov 21)

Plume Shifting

1st Drive

2nd Drive

3rd Drive (146th only)
PRELIMINARY RESULTS
<table>
<thead>
<tr>
<th>Date</th>
<th>Mean Temperature (F)</th>
<th>Predominant Wind Direction</th>
<th>Landing Direction (Field Notes)</th>
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</thead>
<tbody>
<tr>
<td>7-Feb-18</td>
<td>53</td>
<td>South-east</td>
<td>N</td>
</tr>
<tr>
<td>8-Feb-18</td>
<td>52</td>
<td>South-west</td>
<td>N</td>
</tr>
<tr>
<td>9-Feb-18</td>
<td>48</td>
<td>South-west</td>
<td>N</td>
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<tr>
<td>12-Feb-18</td>
<td>44</td>
<td>North-west</td>
<td>S</td>
</tr>
<tr>
<td>13-Feb-18</td>
<td>46</td>
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<td>N</td>
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<tr>
<td>14-Feb-18</td>
<td>42</td>
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<td>N then S</td>
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<tr>
<td>15-Feb-18</td>
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<td>7-Mar-18</td>
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<td>S</td>
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<td>South-west</td>
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<tr>
<td>12-Mar-18</td>
<td>71</td>
<td>East</td>
<td>S then N</td>
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<tr>
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<tr>
<td>16-Mar-18</td>
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<td>18-Apr-18</td>
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<tr>
<td>27-Apr-18</td>
<td>55</td>
<td>South-west</td>
<td>N</td>
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</tbody>
</table>
Measurements
Primary Roadway (I-5) vs Transect
Winter - Spring Data
Measurements

Primary Roadway (I-5) vs Transect

Winter - Spring Data

“Total” > 10 nm

Proportion of “Small” 10-20 nm
PRELIMINARY SPATIAL DISTRIBUTION OF POLLUTANTS
Black Carbon
Spatial Distribution

Winter - Spring Data
Carbon Dioxide Spatial Distribution

Winter - Spring Data
Particle Number Concentration ("Total" >10 nm) Spatial Distribution

Winter - Spring Data
Proportion of small 10-20 nm particles
Transects vs Primary Road (I-5)

Proportion of Small Particles (10-20 nm)

Winter – Spring Data
Proportion of small 10-20 nm particles
By Wind Direction

Wind from the SOUTH

Wind from the NORTH

Winter – Spring Data
How can we make better use of the multi-pollutant data we’ve collected?

Principal Component Analysis (PCA)

Data reduction technique that allows for capturing the variance in the data in a smaller set of variables.

The goal is to summarize the correlations among the observed variables with a smaller set of linear combinations.
Principal Component Analysis (PCA)

- **Hypothesis**: Using particle size distribution measures collected during mobile monitoring we can identify correlations that correspond to roadway and Ultra-Ultrafine features.

- **Method**: Perform a PCA with varimax-rotation. Varimax rotation searches for a rotation (i.e., a linear combination) of the original factors such that the variance of the loadings is maximized.
## Preliminary PCA Results

### Winter – Spring Data

<table>
<thead>
<tr>
<th>Classification</th>
<th>Variance Accounted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadway</td>
<td>38%</td>
</tr>
<tr>
<td>Ultra UF</td>
<td>34%</td>
</tr>
</tbody>
</table>

### Data Represented

#### Roadway (Variance Accounted 38%)

- [PN 10-20 nm] / [PN 20-36 nm]
- [PN 10-36 nm]
- % PN (10-20 nm)
- % PN (20-36 nm)
- [PN >20 nm]
- [PN >10 nm]
- [BC]/[PN >10 nm]
- [PN >10 nm]/[PN\_background >10 nm]

#### Ultra UF (Variance Accounted 34%)

- [PN 10-20 nm] / [PN 20-36 nm]
- [PN 10-36 nm]
- % PN (10-20 nm)
- % PN (20-36 nm)
- [PN >20 nm]
- [PN >10 nm]
- [BC]/[PN >10 nm]
- [PN >10 nm]/[PN\_background >10 nm]
PCA Results
“Roadway” Feature

On Transect

On I-5

Winter – Spring Data
PCA
“Roadway” Feature

Wind from the SOUTH

Wind from the NORTH

Winter – Spring Data
PCA Results

“Ultra-UF” Feature

Transects

I-5

Winter – Spring Data
PCA
“Ultra-UF” Feature

Wind from the SOUTH

Wind from the NORTH

Winter – Spring Data
Fuel-Based Emission Factors (EF)  
# Particles/kg\text{Fuel} 

Quantiles of PCA (Ultra-UF)  
Quantiles of PCA (Roadway) 

Winter – Spring Data
Preliminary Fixed Site
Small Particles (~15.4 nm)
Next Steps

- Continue mobile and stationary sampling to end of year
- Repeat analyses on full data set
- Analyze fixed site data
- Estimate daily Emission Rates for roadways and airport
- Report by December 2019

- Poll Advisory Board for input on priorities for other potential next steps
QUESTIONS
Interactive Feedback Session
Assess the impact of time-of-day on the near-airport ultrafine PM monitoring data?

When poll is active, respond at PollEv.com/jeffryhshira287 or Text JEFFRYHSHIRA287 to 22333 once to join

(1) No priority
(2) Low priority
(3) Medium priority
(4) High priority
(5) Urgent
Assess the impact of meteorological conditions on ultrafine PM levels?

When poll is active, respond at PollEv.com/jeffryhshira287 or Text JEFFRYHSHIRA287 to 22333 once to join

(1) No priority
(2) Low priority
(3) Medium priority
(4) High priority
(5) Urgent
Obtain flight data and relate flight traffic to ultrafine PM measurements?

When poll is active, respond at PollEv.com/jeffryhshira287 or Text JEFFRYHSHIRA287 to 22333 once to join

(1) No priority
(2) Low priority
(3) Medium priority
(4) High priority
(5) Urgent
Since aviation fuel potentially contains more sulfur than roadway diesel – thereby making it a potentially useful tracer for aircraft emissions – should SO2 measurements be incorporated into our study of ultrafine PM measurements?

When poll is active, respond at PollEv.com/jeffryhshira287 or Text JEFFRYHSHIRA287 to 22333 once to join

(1) No priority
(2) Low priority
(3) Medium priority
(4) High priority
(5) Urgent