Mobile ObserVations of Ultrafine Particles (MOV-UP) Advisory
January 23, 2019
Highline Forum

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Outline

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

• 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
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’ (IL-6) and ‘Traffic’ (sTNFrII) exposure and a significant decrease in FEV1 associated with measured PM and BC and modeled ‘Traffic’ exposure. The robust IL-6 effects we found with the ‘Airport UFPs’ source, which would have been masked by considering PN alone…”
MOVUP
Monitoring Locations

Mobile Monitoring Transects + Stationary Sites

4 stationary sites
## Data collection as of 2018

<table>
<thead>
<tr>
<th>Season</th>
<th>Mobile monitoring</th>
<th>Airport fixed sites</th>
<th>Near highway fixed sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter 2018</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring 2018</td>
<td>14</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Summer 2018</td>
<td>16</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Autumn 2018</td>
<td>12</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td><strong>Total finished</strong></td>
<td><strong>58</strong></td>
<td><strong>32</strong></td>
<td><strong>8</strong></td>
</tr>
</tbody>
</table>

- Mobile monitoring typically occurs between 12 PM and 5 PM
- Typically monitoring consists of 2 concurrent cars (N and S of the airport)
- Another round of Mobile and Fixed site monitor was recently completed in January 2019.
# Fixed Site Monitoring Status

## Background Site

<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>
<td></td>
</tr>
<tr>
<td>SeaTac Community Center</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOAA- Sand Point</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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>
MOV-UP Study
Mobile Observations of Ultrafine Particles (MOV-UP) Study
Area-weighted number concentration equivalent to ~ half the freeways in LA!

10^3/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)

![Wind Rose Diagram]

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>
</tr>
</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>
</tr>
<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>
<td>South</td>
<td>N</td>
</tr>
<tr>
<td>14-Feb-18</td>
<td>42</td>
<td>South</td>
<td>N then S</td>
</tr>
<tr>
<td>15-Feb-18</td>
<td>43</td>
<td>South-west</td>
<td>N</td>
</tr>
<tr>
<td>16-Feb-18</td>
<td>46</td>
<td>South</td>
<td>N</td>
</tr>
<tr>
<td>7-Mar-18</td>
<td>48</td>
<td>West</td>
<td>S</td>
</tr>
<tr>
<td>8-Mar-18</td>
<td>50</td>
<td>South</td>
<td>N</td>
</tr>
<tr>
<td>9-Mar-18</td>
<td>49</td>
<td>South-west</td>
<td>N</td>
</tr>
<tr>
<td>12-Mar-18</td>
<td>71</td>
<td>East</td>
<td>S then N</td>
</tr>
<tr>
<td>13-Mar-18</td>
<td>51</td>
<td>South-west</td>
<td>N</td>
</tr>
<tr>
<td>14-Mar-18</td>
<td>50</td>
<td>South-west</td>
<td>N</td>
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<tr>
<td>15-Mar-18</td>
<td>54</td>
<td>West</td>
<td>S</td>
</tr>
<tr>
<td>16-Mar-18</td>
<td>54</td>
<td>South-west</td>
<td>S</td>
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<tr>
<td>18-Apr-18</td>
<td>55</td>
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<td>19-Apr-18</td>
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<td>24-Apr-18</td>
<td>74</td>
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<td>S</td>
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<td>25-Apr-18</td>
<td>69</td>
<td>North-west</td>
<td>S</td>
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<tr>
<td>26-Apr-18</td>
<td>76</td>
<td>North-west</td>
<td>S</td>
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<tr>
<td>27-Apr-18</td>
<td>55</td>
<td>South-west</td>
<td>N</td>
</tr>
</tbody>
</table>
Measurements
Primary Roadway (I-5) vs Transect
Winter - Spring Data

[Box plots showing Black Carbon (ug/m³) and CO2 Concentration (ppm) for Primary and Transect for I-5]
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

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/\(\text{kgC}_{\text{Fuel}}\)

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

Winter – Spring Data
Fuel-Based Emission of UF particles
(Particles/kgC\textsubscript{Fuel})

Preliminary Fixed Site
Small Particles (~15.4 nm)

Maywood (S of airport)
Submitted NIH Proposal in Nov 2018 for Further Study

Develop a “Selective Ultrafine Particle Respirator” (SUPR)

Selectively filters out the smallest ultrafine particles so that we can use it in controlled experiments to measure short-term health effects.

We should find out about the status of this proposal by summer 2019.
Next Steps

- Repeat analyses on full data set
- Analyze fixed site data
- Estimate daily Emission Rates for roadways and airport
- Report by December 2019
QUESTIONS