



Update on our ongoing ultrafine monitoring

October 2024

Monitoring Team

Couple acronyms & facts to start

- UFP -> Ultrafine particles (size less than 100 nm or 0.1 microns) with negligible mass
- PNC -> Particle number concentration (particle # per unit volume)
- > 80% of the PNC is accounted for by UFPs
- SMPS -> Scanning Mobility Particle Size Spectrometer
- **Not** a criteria pollutant and **not** regulated under current air quality standards, no reference methodology nor SOP
- Some recommendations are been made mainly from academics on best practices + efforts toward standardization
- WHO recommends monitoring and shares general good practice statement

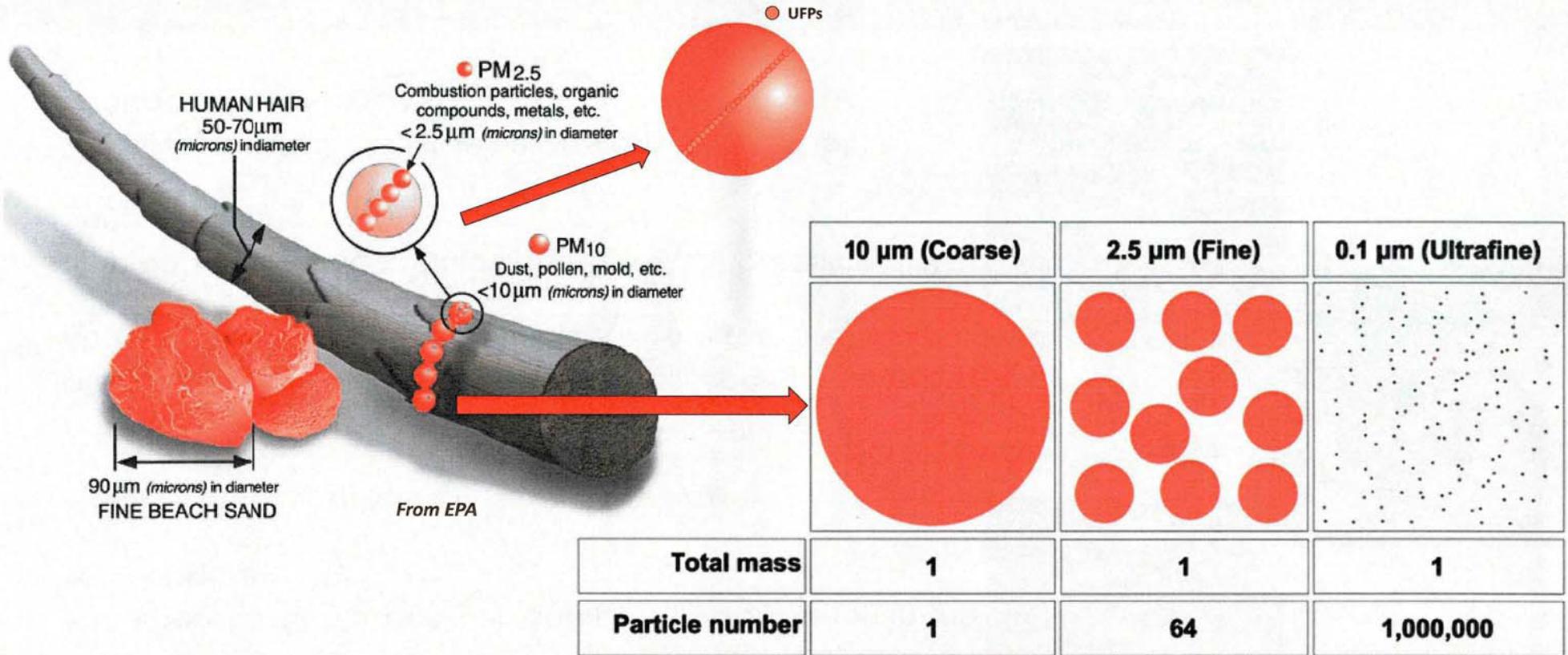
Box 4.2 Good practice statement – UFP

The GDG decided to formulate the following four good practice statements on UFP to guide national and regional authorities and research towards measures to reduce ambient ultrafine particle concentrations.

1. Quantify ambient UFP in terms of particle number concentration (PNC) for a size range with a lower limit of ≤ 10 nm and no restriction on the upper limit.
2. Expand the common air quality monitoring strategy by integration of UFP monitoring into existing air quality monitoring. Include size-segregated real-time PNC measurements at selected air monitoring stations in addition to, and simultaneously with, other airborne pollutants and characteristics of PM.
3. Distinguish between low and high PNC to guide decisions on the priorities of UFP source emission control. Low PNC can be considered < 1000 particles/cm³ (24-hour mean). High PNC can be considered $> 10\,000$ particles/cm³ (24-hour mean) or $20\,000$ particles/cm³ (1-hour).
4. Utilize emerging science and technology to advance approaches to the assessment of exposure to UFP for application in epidemiological studies and UFP management.

From WHO 2021

How small are UFPs?



<https://www.nature.com/articles/s12276-020-0405-1>

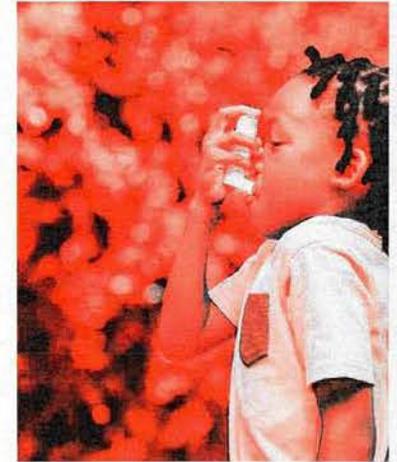
Source of UFPs

- From combustion processes and particle formation in the atmosphere
- Major source for urban air is from road traffic
- primary UFP emitted by traffic are drastically reduced after rush hours, very fast dilution rates, decreasing concentrations within 10 s of meters from the site
- Shipping and aviation also contribute to increasing UFP concentrations
- Biomass burning, industries emissions, residential heating (similar to PM sources)



UFP health impacts

- Smaller size allow them to reach deeper parts of the respiratory system
- Lead to respiratory and cardiovascular diseases
- Fraction of UFPs could reach circulatory system and any organ in the body
- Evidence that UFP might reach the brain through olfactory nerve and affect central nervous system



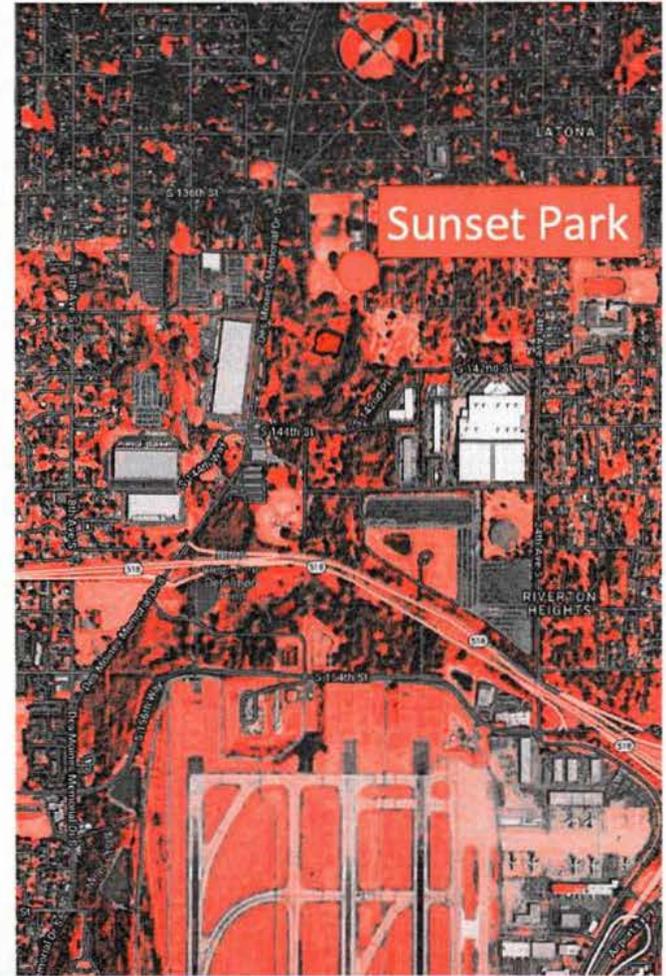
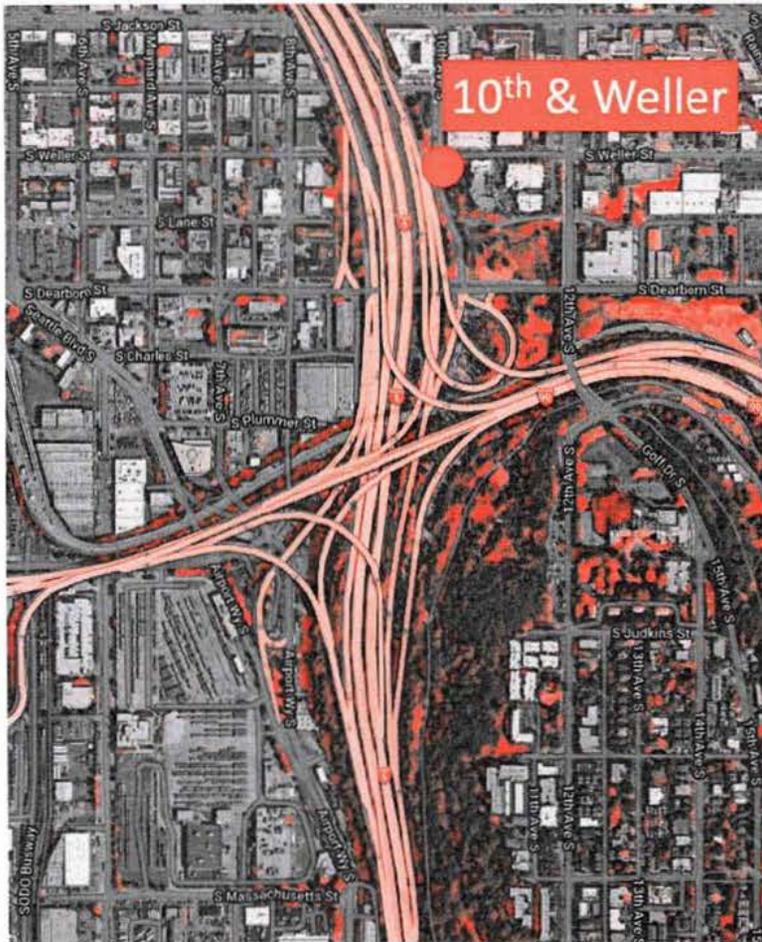
➔ Lots of ongoing research, UFPs have the potential to be harmful but their role in specific illnesses and epidemiology is not well known

UFP monitoring at the Agency

- Funding Source: WA state legislative proviso (including funds for instrumentation and staff time)
- \$370k for two sites: near-road at 10th and Weller (Ecology's site) and North SeaTac once the site will be setup
- No official SOP but best practices shared by academics to provide guidance (ASCENT network & UW)
- More UFP work being done with the TREE trailer (handheld sensors and instrumentation in the trailer)



Two sites



Air Quality Programs - UFP

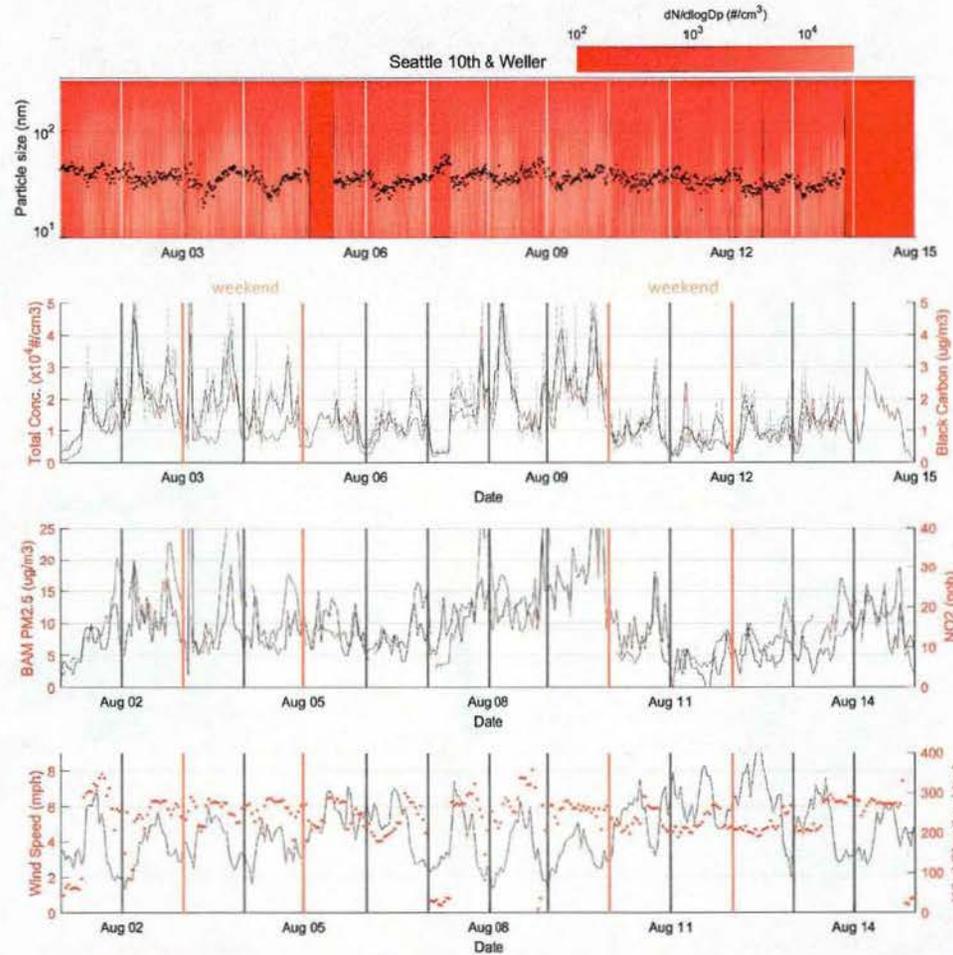
October 2024



Initial data

Example: 2 weeks of monitoring at 10th and Weller in August:

- Particle growth/ageing during the day
- Total counts and black carbon follow each other well
- Does not correlate so much with PM_{2.5} concentrations
- Sensitive to weather patterns (Aug 3-5 vs Aug 10-12)



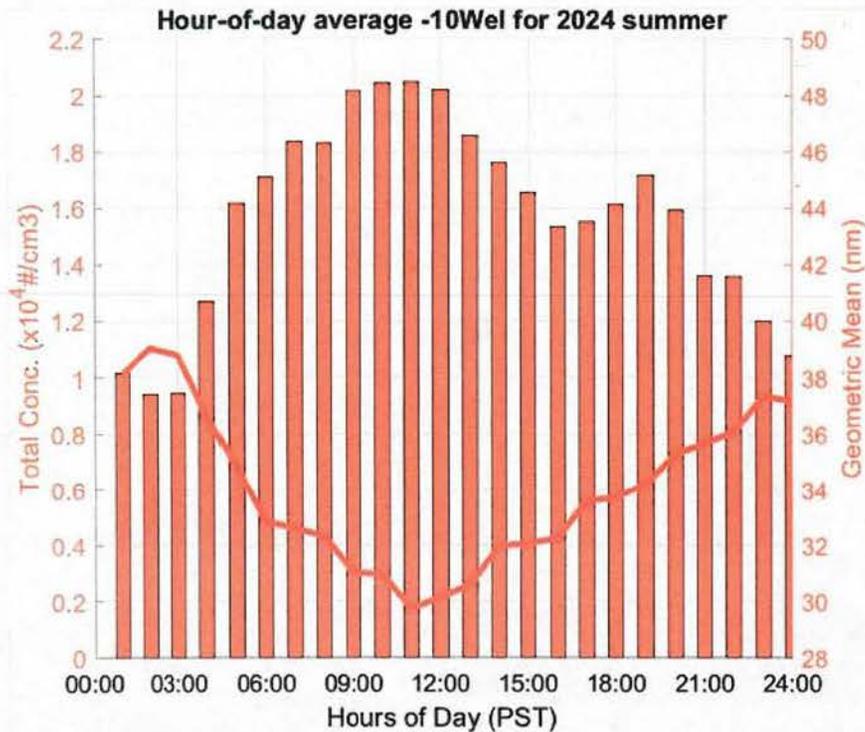
Size distribution
(log scale)

Total UFP

PM_{2.5}

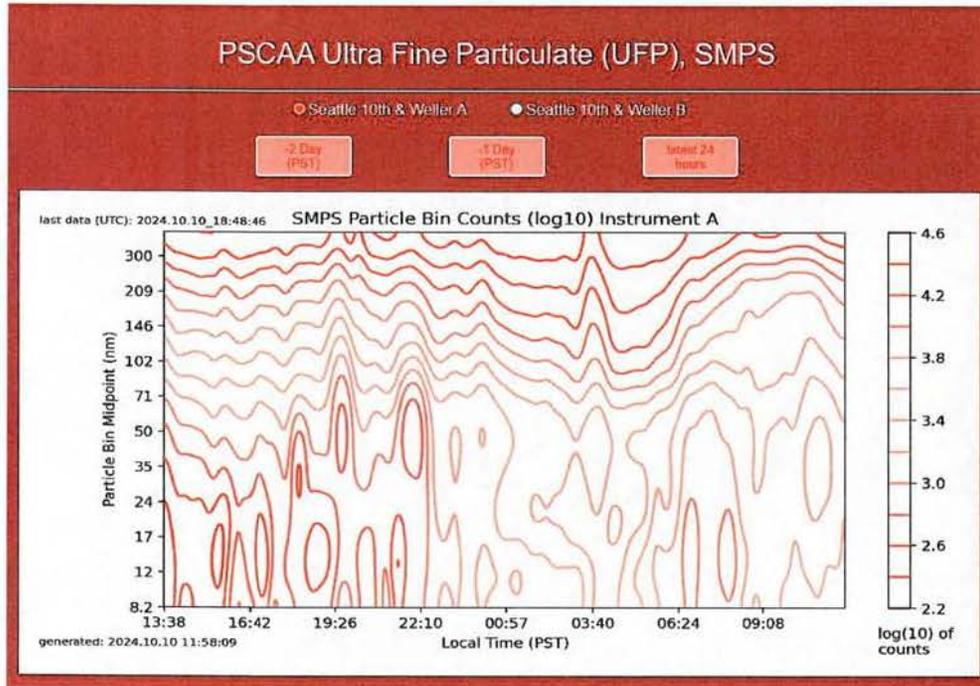
Wind speed
&

Initial data

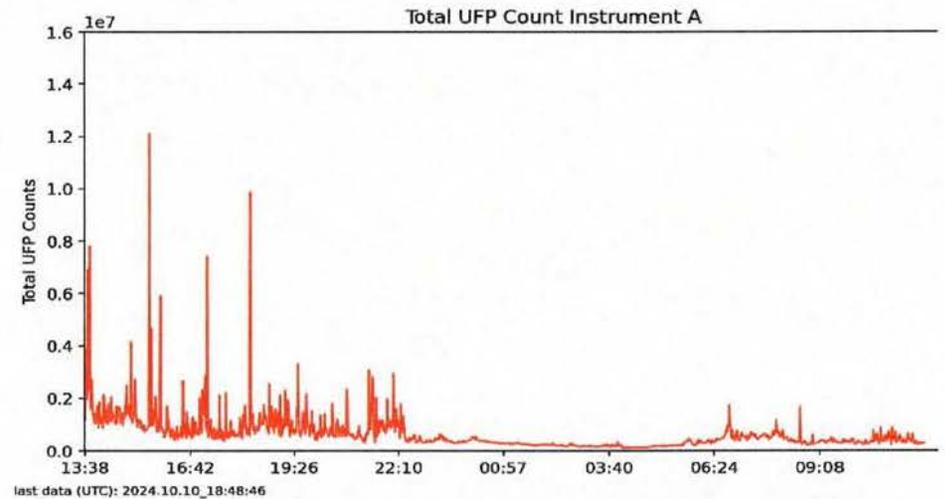


- Increase in particle size by mid day
- Highest total concentration in the morning coinciding with rush hours

Real-time data



Thank you, Phil and PAF!



<http://pscaa-ultrafinepmcurtains-public.s3-website-us-west-2.amazonaws.com/>

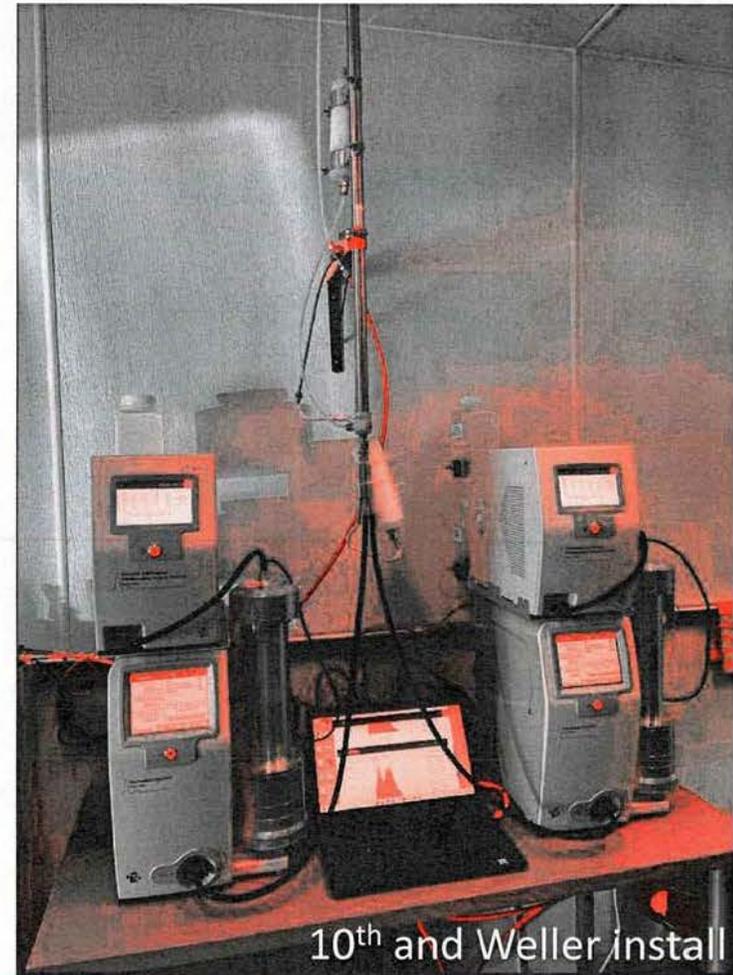
Air Quality Programs - UFP

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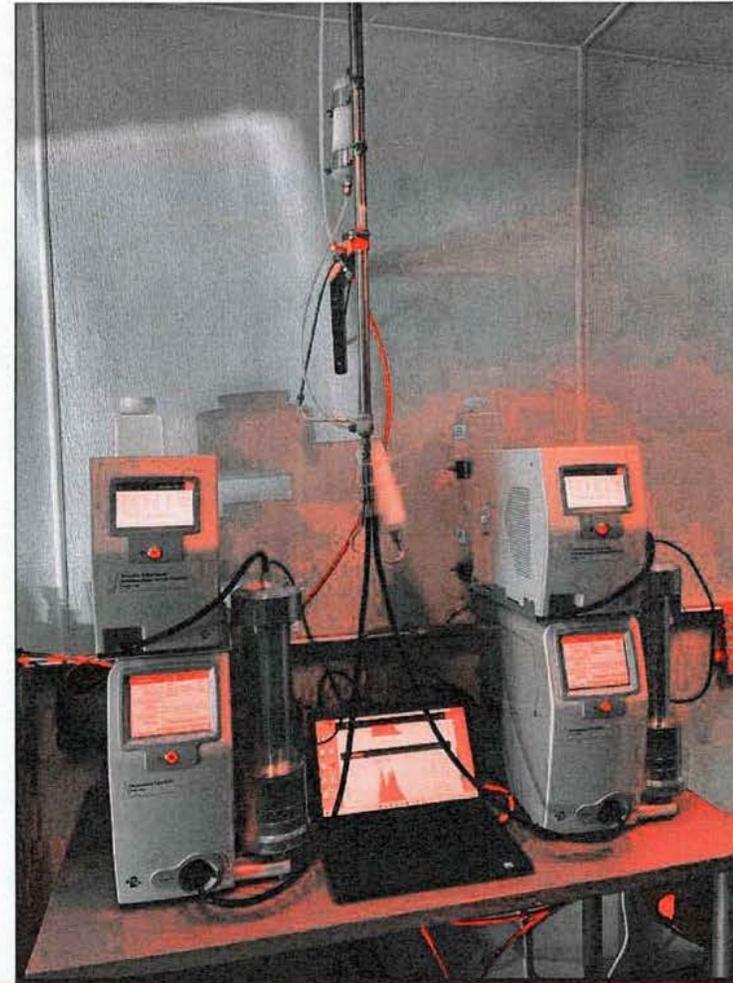
Ongoing collocation

- Since September 24, 2024
- Assess the precision of the instrumentation and repeatability
- Use different sampling rates (1min, 2.5 min, 5 min) to fine-tune data resolution



Next steps

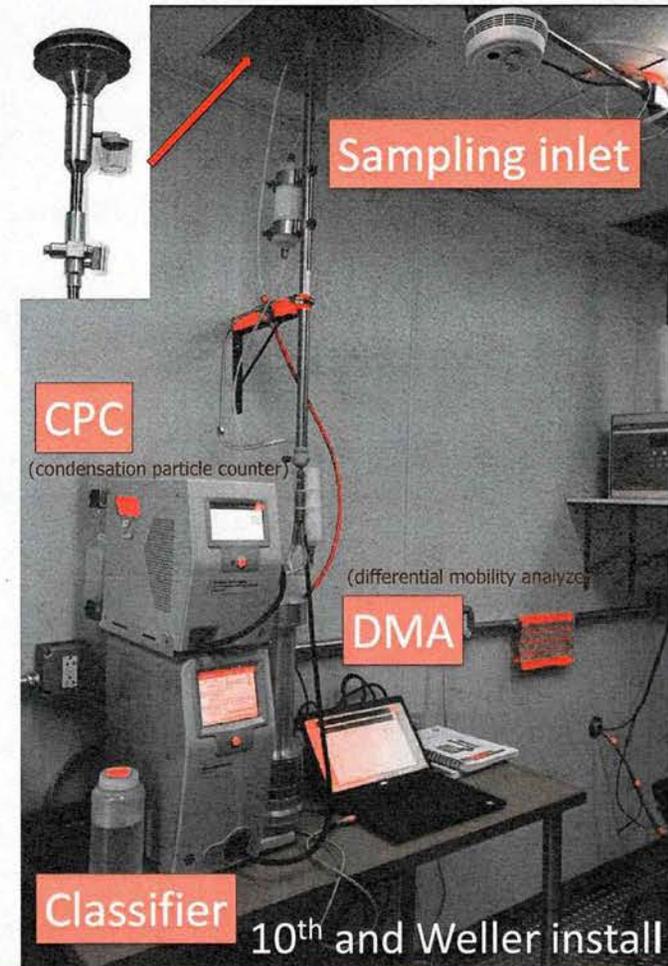
- Relocate the 2nd SMPS at SeaTac site
- Analyze collected data (in partnership with UW)
- Keep up with routine maintenance + write an SOP
- Make sampling protocol + data accessible to community we serve
- Inform public about our findings



Measurement Theory

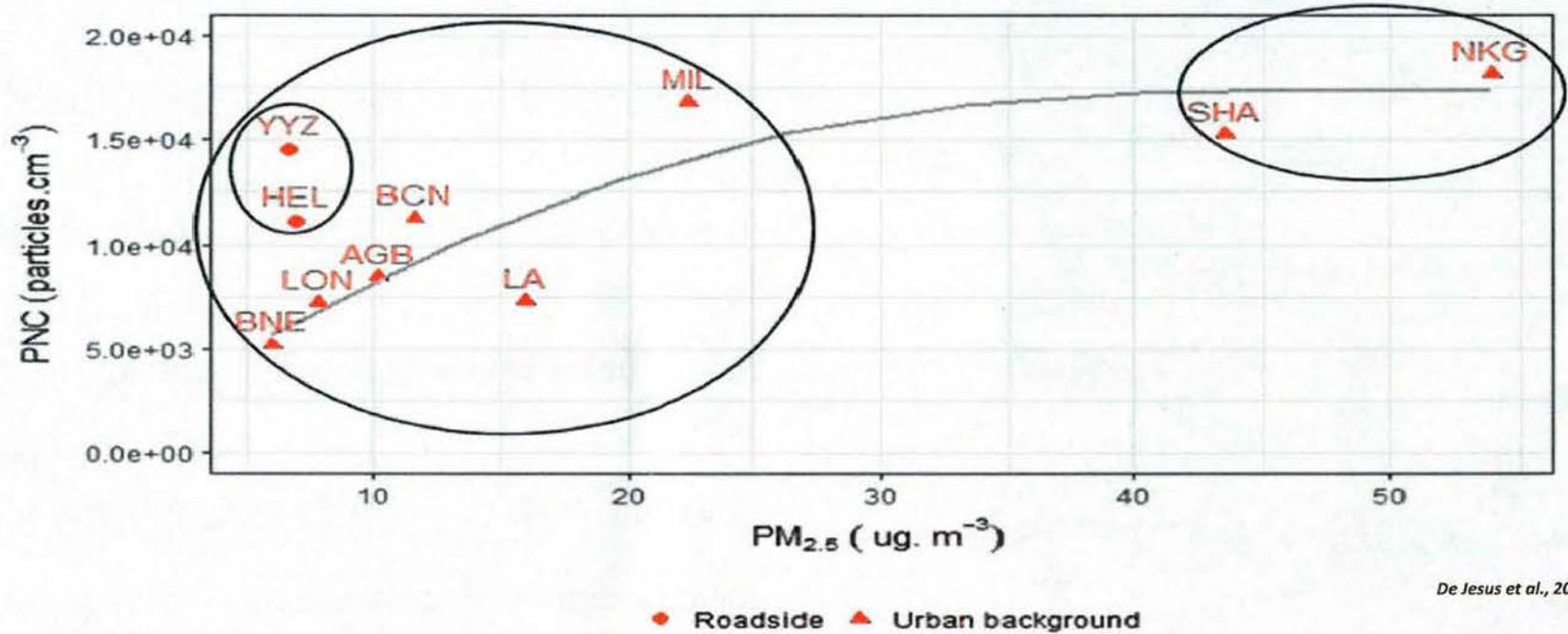
1. Particles less than 2.5 microns enter the sampling inlet
2. Flow is split into two flows (drying and sampling) and enters classifier
3. Neutralizer (in classifier) creates a known electrical charge distribution on the particles
4. In the DMA, charged particles are separated in sizes by applying an electrical field
5. As the flow of particles leaves the DMA, it is being counted in the CPC

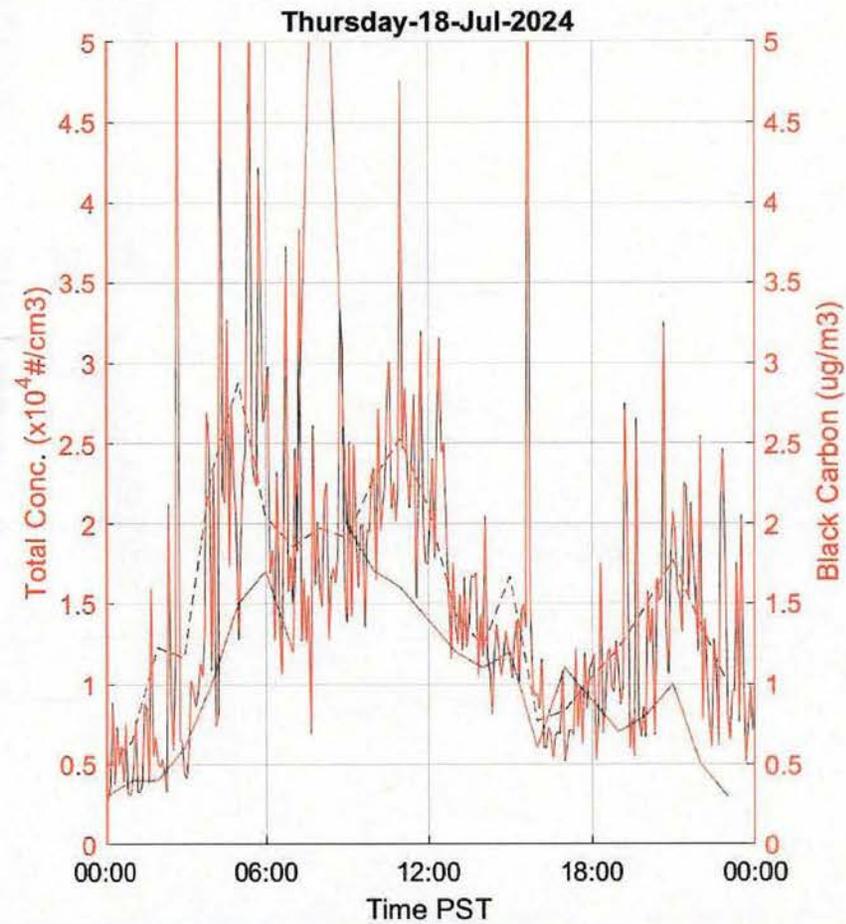
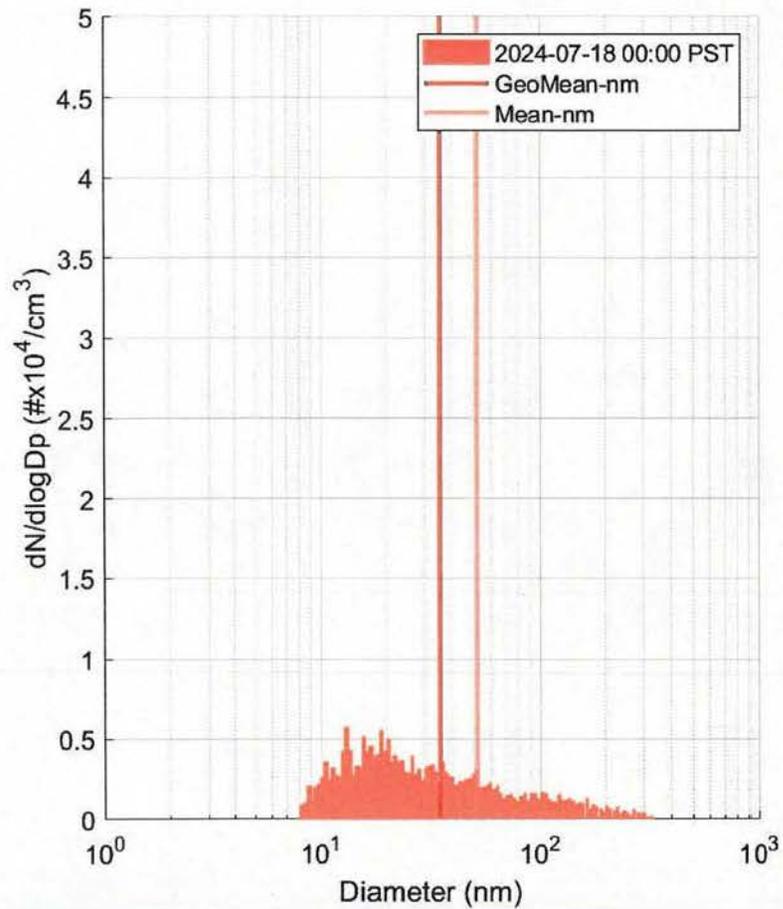
Particle diameters range from 5-15 nm (low end) to 400 to 1000 nm (upper end)



PM2.5 vs PNC

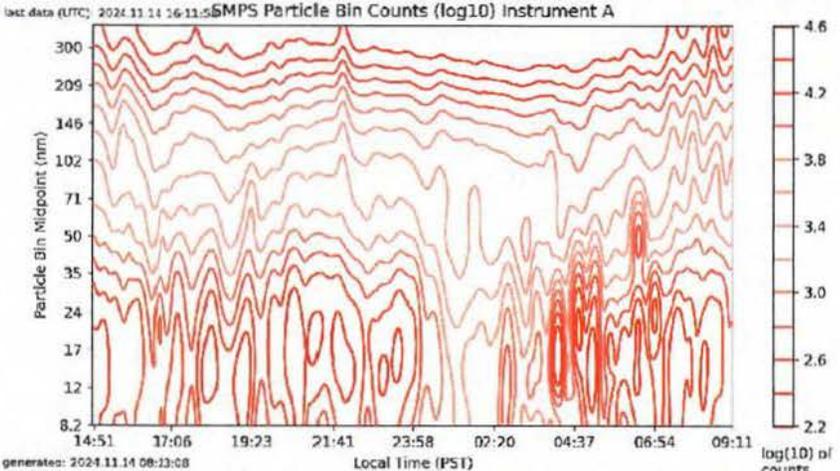
- Not a linear relationship based on yearly averages from several sites worldwide



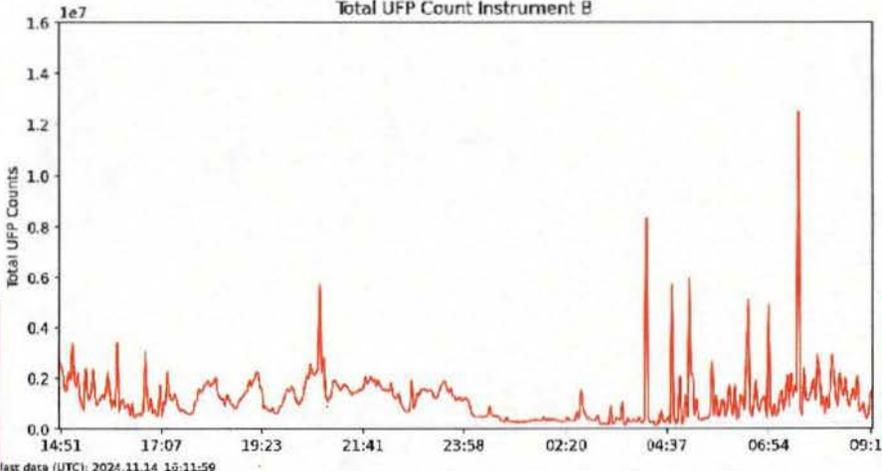
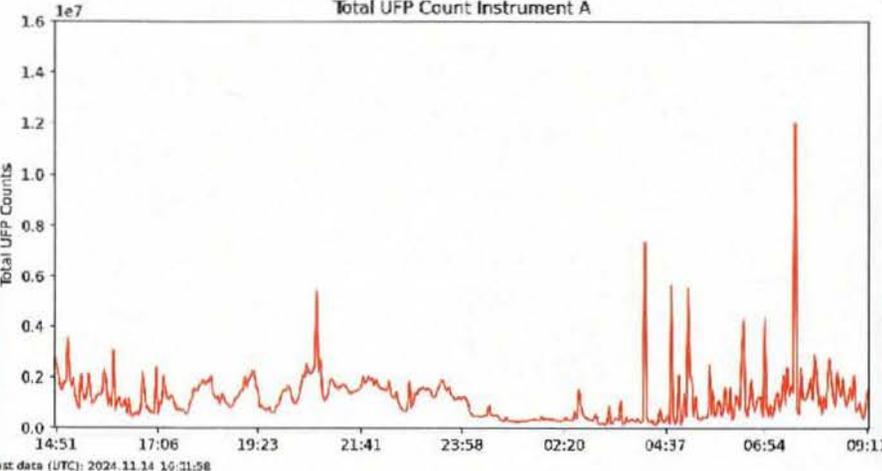
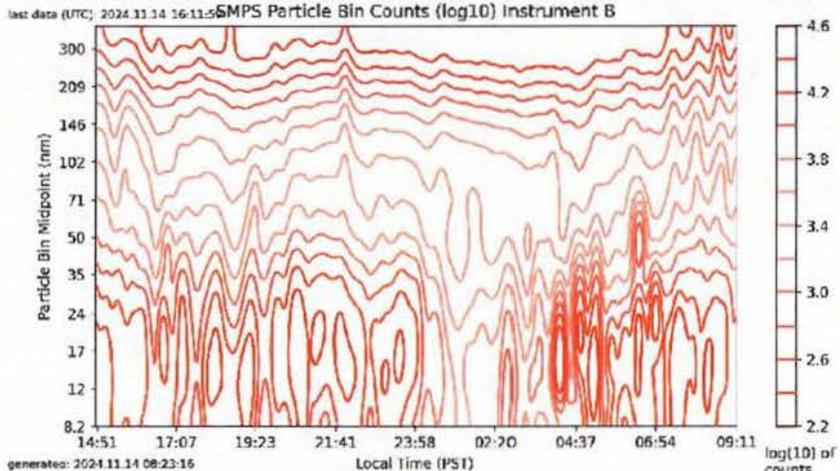


Nov 14, 2024 Precision

10th and Weller SMPS - 1

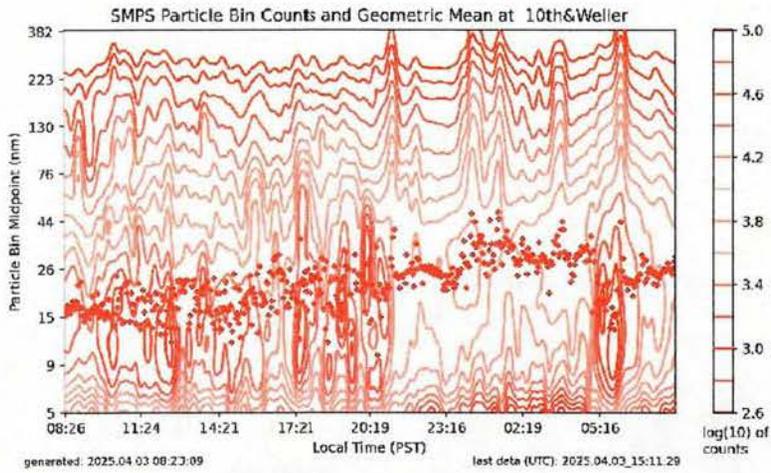


10th and Weller SMPS - 2

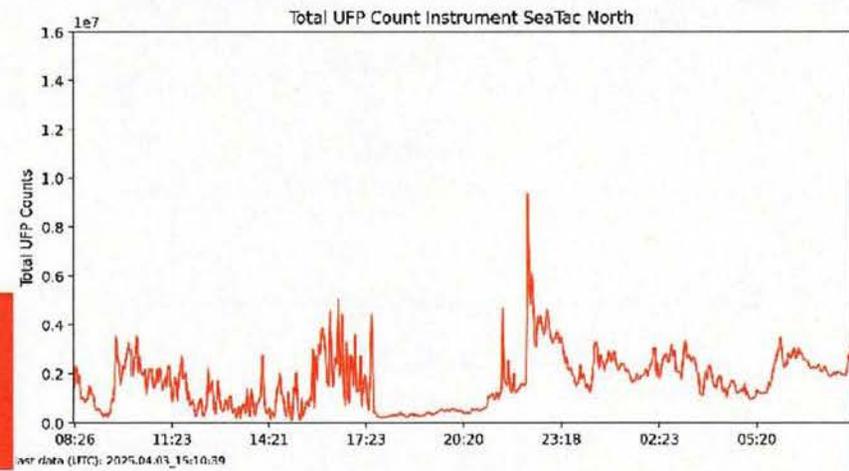
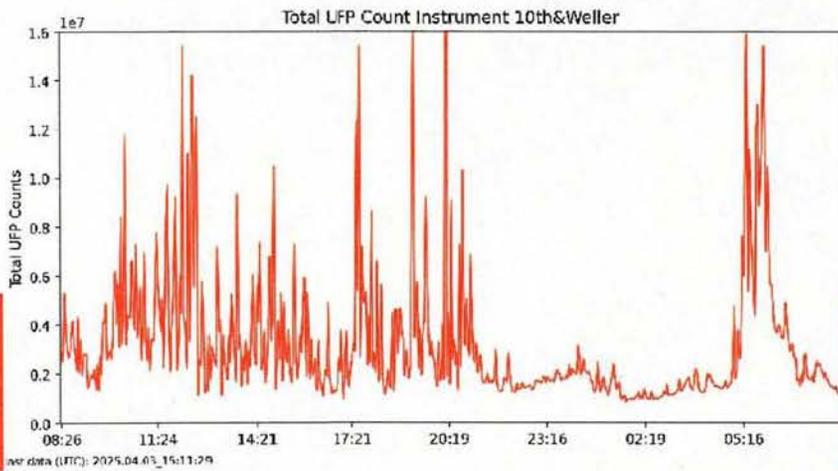
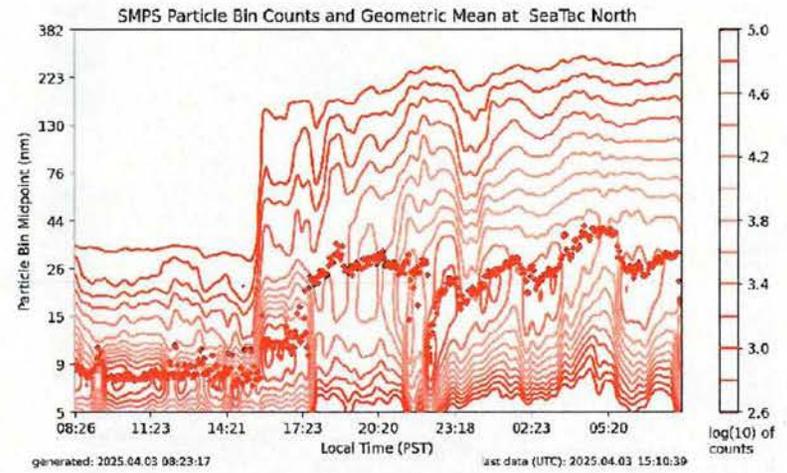


Apr 3, 2025 Weather ?

10th and Weller SMPS - 1

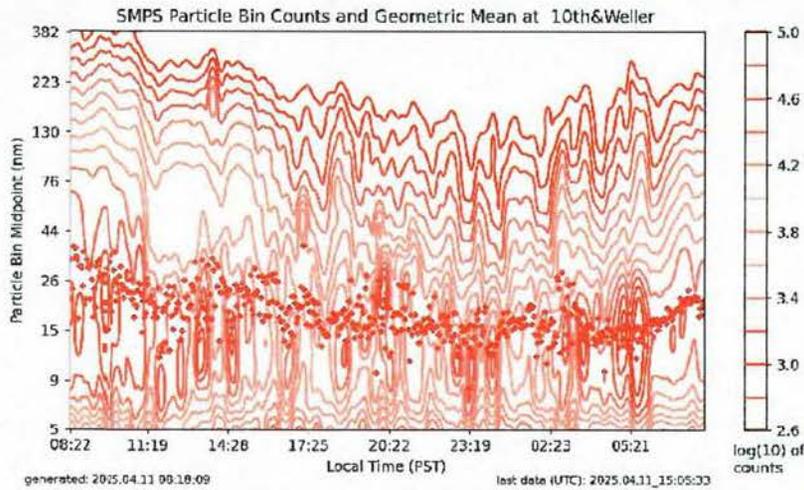


SeaTac North SMPS - 2

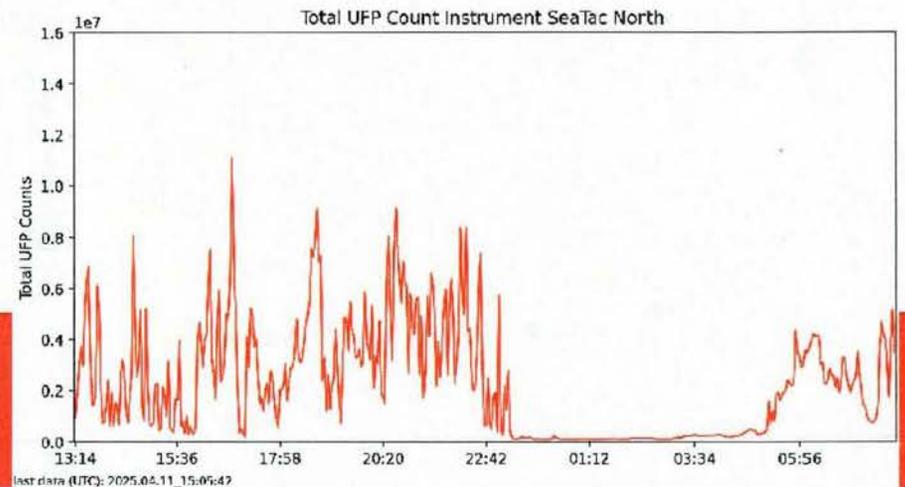
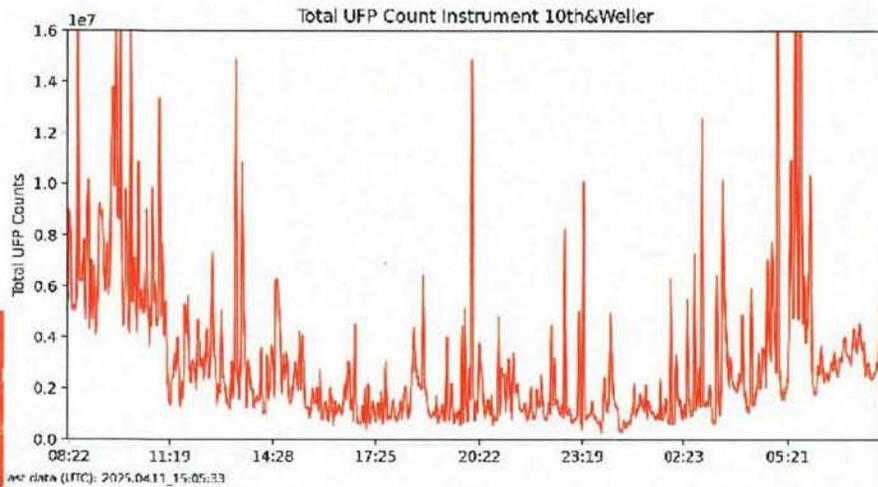
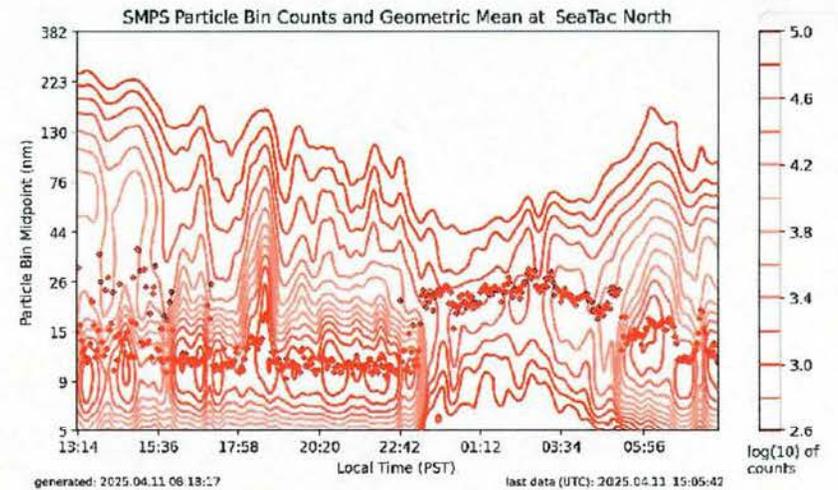


April 11, 2025

10th and Weller SMPS - 1



SeaTac North SMPS - 2



Air Q
October

Collaborations

University of Washington MOV-UP study

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

ASCENT study

Olivia Hakan from Univ of Washington, working with ORCAA –
opportunity for rural measurements