Ambient Aerosol Size Distributions And Number Concentrations Measured At Pittsburgh (PAQS)
Authors

Charles Stanier
University of Iowa
Chemical and Biochemical Engineering
charles-stanier@uiowa.edu

Andrey Khlystov
Duke University
Civil and Environmental Engineering
andrey@duke.edu

Spyros Pandis
University of Patras, Greece
Carnegie Mellon University
Chemical Engineering
spyros@andrew.cmu.edu
Abstract

- 12 months of aerosol size distributions from 3 nm – 560 nm, measured using Scanning Mobility Particle Sizers (SMPS) are presented + 7 months of Aerosol Particle Sizer (APS) Data
- The measurements were made at the main sampling site of the Pittsburgh Air Quality Study from July 2001 – June 2002.
- Measurements at the main site were made continuously under both low and ambient relative humidity.
- The average Pittsburgh number concentration (3-500 nm) is 22,000 cm\(^{-3}\) with an average mode size of 40 nm.
- Strong diurnal patterns in number concentrations.
- New particle formation from homogeneous nucleation is significant on 30-50% of study days and over a wide area (at least a hundred kilometers).
- Rural number concentrations are a factor of 2-3 lower (on average) than the urban values due to urban ultrafine sources.

Organization of This Poster

- **Sampling System**
  - Panels 5-7

- **Results - Monthly and Diurnal Summaries**
  - Panels 8-12

- **Ultrafine Sources**
  - Panels 13-15

- **Rural vs. Urban Size Distributions; Pittsburgh vs. Other Cities**
  - Panels 16-19
Pittsburgh Air Quality Study (PAQS)

- 2 Year Collaborative Study
  - 17 Participating Groups
  - Funded by
    - Environmental Protection Agency
    - Department of Energy

- Main goals
  - Characterize Pittsburgh aerosols
    - Sources
    - Atmospheric Processes
    - Instruments

- Measurements
  - Meteorology
  - Atmospheric gases
  - Aerosol parameters
    - Particle size distribution, ambient relative humidity
    - Particle size distribution, dried

Presented in this work
Schenley Park Sampling Site

Pittsburgh Air Quality Study – Schenley Park Station

Particle Size Sampling Instruments

View Toward Downtown
Experimental Technique

**Sampling Locations**

- **Pittsburgh (Urban Site) Jul ’01 - Jun ‘02**
  - 3-80 nm by TSI 3936N25 Scanning Mobility Particle Sizer (SMPS)
  - 15-680 nm by TSI 3936L10 Scanning Mobility Particle Sizer (SMPS)
  - 0.53 – 10 µm by TSI 3320 & 3321 Aerodynamic Particle Sizer (APS)

- **Florence (Rural Site) 2/24/02 - 3/28/02**
  - 12-280 nm by TSI 3936 Scanning Mobility Particle Sizer (SMPS)
Example Results

Pittsburgh, Aug 10, 2001

- 192 distributions per day
Results

- Average and Variation of Distributions
- Important Sources of Particles (Traffic, Nucleation)
- Upwind (Rural) vs. Urban Concentrations
- Diurnal Profiles
- Comparison to Other Studies

- **Number and mass inversely correlated**

**Pittsburgh, PA 2001-2002**

![Graph showing aerosol mass and number distribution.](image-url)
24 hr Average Number Distributions:
Schenley Park (Pittsburgh Urban)

- Average number distribution has minimal seasonal pattern
- Variation at sizes < 50 nm due to changes in nucleation frequency
Dry vs. Ambient Monthly Levels

Dried to < 25% RH

Ambient RH

Note change of scale for aerosol volume
Diurnal Profiles (Urban Site)

1. Midday peak in average diurnal pattern
2. Early morning minimum in 2-30 nm particles
3. Decrease in accumulation mode from boundary layer ventilation
4. Peak in 3-10 nm particles from midmorning nucleation
5. Gradual increase in accumulation mode following nucleation as particles grow
6. Weekday early morning traffic
Traffic as a Particle Source

Hourly Averaged Number Distributions
Schenley Park (Urban Pittsburgh)

15 nm Mode for Auto Traffic Easily Distinguishable
Traffic as a Particle Source

Particle Count, 10-20 nm (cm$^{-3}$)

Time of Day (EST)

$15 \text{ nm Mode for Auto Traffic Easily Distinguishable}$
Nucleation as a Particle Source

Pittsburgh, August 11, 2002

- New Particles Apparent at 9 AM in smallest size channels
- Number concentration increase by 10X in 1 hour
Site-to-Site Comparison

- Often strong qualitative similarity over large distances
Rural vs. Urban Pittsburgh

- Rural concentrations lower, especially below 50 nm
Diurnal Differences, Urban and Rural Sites

- ~200% increase from rural to urban sample in 15-50 nm bin
- rural / urban difference less apparent for larger particles
- 15-30 nm bin increase shows AM rush hour pattern
- 50-250 nm particles slightly elevated at night in urban inversion
## Comparison to Other Studies

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<th>Location</th>
<th>Number Concentration</th>
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Acknowledgements

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- US Department of Energy National Energy Technology Laboratory Contract DE-FC26-01NT41017

Related Presentations

- Poster 12-PD16 Particle Density And Shape Factors Estimated From Merging Aerodynamic And Mobility Size Distributions
- Talk 15-C2 (Thursday 11:00) Mass Balance Closure and the Federal Reference Method For PM-2.5 in Pittsburgh, Pennsylvania
- Talk 19-C2 (Friday 10:20) Aerosol Water Content During Pittsburgh Air Quality Study: Observations And Model Comparison