Course Overview

- Regulations and Standards
- Monitoring Networks
- Station Siting
- Instrumentation
- Documentation
- Data Handling
- Quality Assurance
- References and Resources
EPA Responsibilities Under CAA

- National Ambient Air Quality Standards (NAAQS)
  - Identification
  - Attainment
- Toxic air pollutants
  - Identification
  - Control
- Acid Rain
- Pollution Index
- PSD
Monitoring

- Attainment
- Progress Toward Attainment
- Pollution Trends
- Emergency Control Procedures
- Database.

Regulations

- U.S. EPA
  - 40 CFR 50 – NAAQS
  - 40 CFR 53 – Methods
  - 40 CFR 58 – Monitoring criteria
  - 40 CFR 51.24 – PSD

- State and Local Regs
Monitoring Networks

- SLAMS -- State and Local Air Monitoring Station
- NAMS -- National Air Monitoring Station
- PAMS -- Photochemical Assessment Monitoring Station
- NCore—National Core Multipollutant Network

- PSD -- Prevention of Significant Deterioration
- SPM -- Special Purpose Monitoring
- IMPROVE -- Interagency Monitoring of Protected Visual Environments
  Acid Rain Network
Photochemical Assessment Monitoring (PAMS) Network

PAMS Network Design

1. Maximum Ozone Site
2. Mal Emission Sites
3. Extreme Downwind Site
4. Central Business District
5. Urbanized Fringe
6. Primary Afternoon Wind
7. Upwind Site
8. Secondary Morning Wind
9. Primary Morning Wind
Ambient Air Monitoring

NCore Network

National Core (NCore) Multipollutant Network

NCore pollutants

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM2.5 speciation</td>
<td>Organic and elemental carbon, major ions and trace metals (24 hour average; every 3rd day); IMPROVE or CSN</td>
</tr>
<tr>
<td>PM2.5 FPM mass</td>
<td>24 hr. average at least every 3rd day</td>
</tr>
<tr>
<td>continuous PM2.5 mass</td>
<td>1 hour reporting interval; FEM or pre-FEM monitors</td>
</tr>
<tr>
<td>PM(10-2.5) mass</td>
<td>Filter-based or continuous</td>
</tr>
<tr>
<td>ozone (O3)</td>
<td>all gases through continuous monitors</td>
</tr>
<tr>
<td>carbon monoxide (CO)</td>
<td>capable of trace levels (low ppm and below) where needed</td>
</tr>
<tr>
<td>sulfur dioxide (SO2)</td>
<td>capable of trace levels (low ppb and below) where needed</td>
</tr>
<tr>
<td>nitrogen oxide (NO)</td>
<td>capable of trace levels (low ppb and below) where needed</td>
</tr>
<tr>
<td>total reactive nitrogen (NOy)</td>
<td>capable of trace levels (low ppb and below) where needed</td>
</tr>
<tr>
<td>surface meteorology</td>
<td>wind speed and direction (reported as &quot;Resultant&quot;), temperature, RH</td>
</tr>
</tbody>
</table>
Ambient Air Monitoring

Current NATTS monitors

Criteria Pollutants
## Ambient Air Monitoring

### CURRENT NAAQS

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Primary/Secondary</th>
<th>Averaging Time</th>
<th>Level</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>primary</td>
<td>8 hours</td>
<td>9 ppm</td>
<td>Not to be exceeded more than once per year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 hour</td>
<td>35 ppm</td>
<td></td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>primary and secondary</td>
<td>Rolling 3 month average</td>
<td>0.15 µg/m³</td>
<td>Not to be exceeded</td>
</tr>
<tr>
<td>Nitrogen Dioxide (NO₂)</td>
<td>primary</td>
<td>1 hour</td>
<td>100 ppb</td>
<td>98th percentile of 1-hour daily maximum concentration, averaged over 3 years</td>
</tr>
<tr>
<td></td>
<td>primary and secondary</td>
<td>1 year</td>
<td>53 ppb</td>
<td>Annual Mean</td>
</tr>
<tr>
<td>Ozone (O₃)</td>
<td>primary and secondary</td>
<td>8 hours</td>
<td>0.070 ppm</td>
<td>Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years</td>
</tr>
<tr>
<td>Particle Pollution (PM)</td>
<td>primary</td>
<td>1 year</td>
<td>12.0 µg/m³</td>
<td>Annual mean, averaged over 3 years</td>
</tr>
<tr>
<td></td>
<td>primary and secondary</td>
<td>1 year</td>
<td>15.0 µg/m³</td>
<td>Annual mean, averaged over 3 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24 hours</td>
<td>35 µg/m³</td>
<td>98th percentile, averaged over 3 years</td>
</tr>
<tr>
<td></td>
<td>primary and secondary</td>
<td>24 hours</td>
<td>150 µg/m³</td>
<td>Not to be exceeded more than once per year on average over 3 years</td>
</tr>
<tr>
<td>Sulfur Dioxide (SO₂)</td>
<td>primary</td>
<td>1 hour</td>
<td>75 ppb</td>
<td>99th percentile of 1-hour daily maximum concentrations, averaged over 3 years</td>
</tr>
<tr>
<td></td>
<td>secondary</td>
<td>3 hours</td>
<td>0.5 ppm</td>
<td>Not to be exceeded more than once per year</td>
</tr>
</tbody>
</table>

---

### Carbon Monoxide (CO) Standards – Table of Historical CO NAAQS

<table>
<thead>
<tr>
<th>Final Rule/Decision</th>
<th>Primary/Secondary</th>
<th>Indicator</th>
<th>Averaging Time</th>
<th>Level</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971</td>
<td>Primary and Secondary</td>
<td>CO</td>
<td>1-hour period</td>
<td>35 ppm</td>
<td>Maximum, not to be exceeded more than once in a year</td>
</tr>
<tr>
<td>1971</td>
<td>Primary and Secondary</td>
<td>CO</td>
<td>8-hour period</td>
<td>9 ppm</td>
<td>Maximum, not to be exceeded more than once in a year</td>
</tr>
<tr>
<td>1985</td>
<td>Secondary</td>
<td></td>
<td></td>
<td></td>
<td>Primary standards retained, without revision; secondary standards revoked.</td>
</tr>
<tr>
<td>1994</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Primary standards retained, without revision.</td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Primary standards retained, without revision.</td>
</tr>
</tbody>
</table>
### Ambient Air Monitoring

**Current CO monitors**

**Nitrogen Dioxide (NO2) Standards—Table of Historical NO2 NAAQS**

<table>
<thead>
<tr>
<th>Final Rule/Decision</th>
<th>Primary/Secondary</th>
<th>Indicator</th>
<th>Averaging Time</th>
<th>Level</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971</td>
<td>Primary and Secondary</td>
<td>NO$_2$</td>
<td>Annual</td>
<td>53 ppb</td>
<td>Annual arithmetic average</td>
</tr>
<tr>
<td>1985</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>Primary</td>
<td>NO$_2$</td>
<td>1-hour</td>
<td>100 ppb</td>
<td>98th percentile, averaged over 3 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Ambient Air Monitoring

Current NO\textsubscript{2} monitors

Oxides of Sulfur (SO\textsubscript{2}) Standards–Table of Historical SO\textsubscript{2} NAAQS

<table>
<thead>
<tr>
<th>Final Rule/Decision</th>
<th>Primary/Secondary</th>
<th>Indicator</th>
<th>Averaging Time</th>
<th>Level(s)</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971</td>
<td>Primary</td>
<td>SO\textsubscript{2}</td>
<td>24-hour</td>
<td>0.14 ppm</td>
<td>Not to be exceeded more than once per year</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Annual</td>
<td>0.05 ppm</td>
<td>Annual arithmetic average</td>
</tr>
<tr>
<td>16 FR 31846</td>
<td>Secondary</td>
<td>SO\textsubscript{2}</td>
<td>3-hour</td>
<td>0.5 ppm</td>
<td>Not to be exceeded more than once per year</td>
</tr>
<tr>
<td>Apr 30, 1971</td>
<td></td>
<td></td>
<td>Annual</td>
<td>0.02 ppm</td>
<td>Annual arithmetic average</td>
</tr>
<tr>
<td>1973</td>
<td>Secondary</td>
<td>SO\textsubscript{2}</td>
<td>Secondary 3-hour</td>
<td>Standard retained, without revision; secondary annual SO\textsubscript{2} standard revoked.</td>
<td></td>
</tr>
<tr>
<td>38 FR 25670</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sept 14, 1973</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>Primary</td>
<td>SO\textsubscript{2}</td>
<td></td>
<td></td>
<td>Existing primary SO\textsubscript{2} standards retained, without revision.</td>
</tr>
<tr>
<td>61 FR 25586</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>May 22, 1996</td>
</tr>
<tr>
<td>2010</td>
<td>Primary</td>
<td>SO\textsubscript{2}</td>
<td>1-hour</td>
<td>75 ppb</td>
<td>99th percentile, averaged over 3 years</td>
</tr>
<tr>
<td>75 FR 25528</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Jun 22, 2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Primary annual and 24-hour SO\textsubscript{2} standards revoked.</td>
</tr>
</tbody>
</table>
Ambient Air Monitoring

Current SO$_2$ monitors

SO$_2$ Nonattainment areas

SO$_2$ Nonattainment Areas (2010 Standard)

Nonattainment areas are indicated by color. When only a portion of a county is shown in color, it indicates that only that part of the county is within a nonattainment area boundary.
Ambient Air Monitoring

SO₂ Nonattainment areas

<table>
<thead>
<tr>
<th>Final Rule/Decision</th>
<th>Primary/Secondary</th>
<th>Indicator</th>
<th>Averaging Time</th>
<th>Level</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978 43 FR 46246 Oct 5, 1978</td>
<td>Primary and Secondary</td>
<td>Pb–TSP (2)</td>
<td>Calendar Quarter</td>
<td>1.5 µg/m³</td>
<td>Not to be exceeded</td>
</tr>
<tr>
<td>Feb 21, 1991 – Agency released multimedia “Strategy for Reducing Lead Exposures”</td>
<td>2008 73 FR 66964 Nov 12, 2008</td>
<td>Primary and Secondary</td>
<td>Pb–TSP</td>
<td>3–month period</td>
<td>0.15 µg/m³</td>
</tr>
</tbody>
</table>
Ambient Air Monitoring

Current Lead monitors

Lead Nonattainment areas

Counties Designated Nonattainment for Lead 2008 Standard

Nonattainment Areas (2008 Standard)

The portions of a county designated nonattainment are indicated by color on this national map. The counties with nonattainment areas are outlined. The double circles indicate that there are two nonattainment areas within the same county. The State maps provide details of the smaller nonattainment areas within the county boundaries.
History of the NAAQS for Ozone, from 1971 to 2015

<table>
<thead>
<tr>
<th>Final Rule/Decision</th>
<th>Primary/Secondary</th>
<th>Indicator</th>
<th>Averaging Time</th>
<th>Level</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971 36 FR 8196 Apr 30, 1971</td>
<td>Primary and Secondary</td>
<td>Total photochemical oxidants</td>
<td>1 hour</td>
<td>0.08 ppm</td>
<td>Not to be exceeded more than one hour per year</td>
</tr>
<tr>
<td>1979 44 FR 8202 Feb 8, 1979</td>
<td>Primary and Secondary</td>
<td>O₉</td>
<td>1 hour</td>
<td>0.12 ppm</td>
<td>Attainment is defined when the expected number of days per calendar year, with maximum hourly average concentration greater than 0.12 ppm, is equal to or less than 1</td>
</tr>
<tr>
<td>1993 58 FR 13008 Mar 9, 1993</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>EPA decided that revisions to the standards were not warranted at the time</td>
</tr>
<tr>
<td>1997 62 FR 38856 Jul 18, 1997</td>
<td>Primary and Secondary</td>
<td>O₉</td>
<td>8 hours</td>
<td>0.08 ppm</td>
<td>Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years</td>
</tr>
<tr>
<td>2008 73 FR 16483 Mar 27, 2008</td>
<td>Primary and Secondary</td>
<td>O₉</td>
<td>8 hours</td>
<td>0.075 ppm</td>
<td>Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years</td>
</tr>
<tr>
<td>2015 80 FR 65202 Oct 26, 2015</td>
<td>Primary and Secondary</td>
<td>O₉</td>
<td>8 hours</td>
<td>0.070 ppm</td>
<td>Annual fourth-highest daily maximum 8 hour average concentration, averaged over 3 years</td>
</tr>
</tbody>
</table>
OZONE Formation

July 2, 2002 8:00 am EDT

Ground-Level Ozone

Ground-Level Ozone in the Sacramento Region

Thursday
07-Aug-97
08:00 AM PDT

Health
Activity
Unhealthy
Marginal
Healthy
Ambient Air Monitoring

Current Ozone monitors
Ozone Nonattainment areas
(8 hour, average 4th maximum, 0.75 ppm)

8-Hour Ozone Nonattainment Areas (2015 Standard)

Nonattainment areas are indicated by color. When only a portion of a county is shown in color, it indicates that only that part of the county is within a nonattainment area boundary.
### Ambient Air Monitoring

#### Particulate Matter (PM) Standards – Table of Historical PM NAAQS

<table>
<thead>
<tr>
<th>Final Rule</th>
<th>Primary/Secondary</th>
<th>Indicator</th>
<th>Averaging Time</th>
<th>Level (µg/m³)</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971&lt;br&gt;36 FR 8186&lt;br&gt;Apr 30, 1971</td>
<td>Primary</td>
<td>TSP&lt;br&gt;(1)</td>
<td>24-hour</td>
<td>260</td>
<td>Not to be exceeded more than once per year</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>TSP</td>
<td>Annual</td>
<td>75</td>
<td>Annual Average</td>
</tr>
<tr>
<td>1987&lt;br&gt;52 FR 24634&lt;br&gt;Jul 7, 1987</td>
<td>Primary and Secondary</td>
<td>PM₁₀</td>
<td>24-hour</td>
<td>150</td>
<td>Not to be exceeded more than once per year on average over a 3-year period</td>
</tr>
<tr>
<td></td>
<td>Annual</td>
<td>PM₁₀</td>
<td>Annual Arithmetic mean, averaged over 3 years</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>1997&lt;br&gt;62 FR 39022&lt;br&gt;Jul 16, 1997</td>
<td>Primary and Secondary</td>
<td>PM₁₀</td>
<td>24-hour</td>
<td>65</td>
<td>98th percentile, averaged over 3 years</td>
</tr>
<tr>
<td></td>
<td>Annual</td>
<td>PM₁₀</td>
<td>Annual Arithmetic mean, averaged over 3 years</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>2006&lt;br&gt;71 FR 61144&lt;br&gt;Oct 17, 2006</td>
<td>Primary and Secondary</td>
<td>PM₁₀</td>
<td>24-hour</td>
<td>150</td>
<td>Not to be exceeded more than once per year on average over a 3-year period</td>
</tr>
<tr>
<td></td>
<td>Annual</td>
<td>PM₁₀</td>
<td>Annual Arithmetic mean, averaged over 3 years</td>
<td>15.0</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>Primary</td>
<td>PM₁₀</td>
<td>Annual</td>
<td>12.0</td>
<td>Annual Arithmetic mean, averaged over 3 years</td>
</tr>
<tr>
<td>Secondary</td>
<td>Annual</td>
<td>PM₁₀</td>
<td>Annual</td>
<td>15.0</td>
<td>Annual Arithmetic mean, averaged over 3 years</td>
</tr>
<tr>
<td>Primary and Secondary</td>
<td>24-hour</td>
<td>PM₁₀</td>
<td>98th percentile, averaged over 3 years</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Primary and Secondary</td>
<td>24-hour</td>
<td>PM₁₀</td>
<td>Not to be exceeded more than once per year on average over a 3-year period</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

---

#### Current PM 10 and 2.5 monitors

- Map showing current PM monitors across the United States.
Ambient Air Monitoring

PM-10 Nonattainment areas

Counts Designated Nonattainment for PM-10

Classification
- Serious
- Moderate

Classification colors are shown for whole counties and denote the highest area classification that the county is in.

PM-2.5 Nonattainment areas

Counts Designated Nonattainment for PM-2.5 (1997, 2006, and/or 2012 Standards)

Nonattainment areas are indicated by color. When only a portion of a county is shown in color, it indicates that only that part of the county is within a nonattainment area boundary.
PM-2.5 Nonattainment areas
For standards of different years

PM-2.5 Nonattainment Areas (2012 Standard)

Nonattainment areas are indicated by color. When only a portion of a county is shown in color, it indicates that only that part of the county is within a nonattainment area boundary.

Counties Designated “Nonattainment” for Ozone Air Act’s National Ambient Air Quality Standards (NAAQS) *

* The National Ambient Air Quality Standards (NAAQS) are health standards for Carbon Monoxide, Lead (1975 and 2008), Nitrogen Dioxide, Sulfur Oxide (2008), Particulate Matter (PM-10 and PM-2.5 (1997, 2008 and 2012), and Sulfur Dioxide (1971 and 2010)

** Included in the counts are counties designated for NAAQS and revised NAAQS pollutants. Revised 1-hour (1976) and 8-hour Ozone (1997) are excluded. Partial counties, those with part of the county designated nonattainment and part attainment, are shown as full counties on the map.
Ambient Air Monitoring

Counts Designated "Nonattainment" or "Maintenance" for Clean Air Act's National Ambient Air Quality Standards (NAAQS) *

Legend **

- County Designated Nonattainment or Maintenance for 8 NAAQS Pollutants
- County Designated Nonattainment or Maintenance for 6 NAAQS Pollutants
- County Designated Nonattainment or Maintenance for 4 NAAQS Pollutants
- County Designated Nonattainment or Maintenance for 2 NAAQS Pollutants
- County Designated Nonattainment or Maintenance for 1 NAAQS Pollutants

* The National Ambient Air Quality Standards (NAAQS) are health standards for Carbon Monoxide, Lead (1975 and 2009), Nitrogen Dioxide, 8-hour Ozone (2008), Particulate Matter (PM-10 and PM-2.5) (1997, 2006 and 2012), and Sulfur Dioxide (1971 and 1978).

** Included in the counts are counties designated for NAAQS and revised NAAQS pollutants. Excluded: 1-hour (1975) and 8-hour Ozone (1987). Partial counties, those with part of the county designated nonattainment and part attainment, are shown as full counties on the map.

Siting Criteria
Network Design Considerations

- Concentration Expected
- Representative Concentrations
- Significant Sources or Source Categories

Network Design Considerations

- Background Concentrations
- Regional Transport
- Welfare–Related Impacts for Rural Areas
Scales of Monitoring

- Micro
- Middle
- Neighborhood

Micro Scale Site

Up to 100 m
Ambient Air Monitoring

**Middle Scale Site**

- 100 m to 0.5 km

**Neighbor-scale Site**

- 0.5 km to 4 km
Additional Scales of Monitoring

- Urban
- Regional
- National and Global
Ambient Air Monitoring

Regional Scale Site

10s km to 100s km

National and Global Scale Site

100s to 1,000s km

(On the Scale of a Nation or the World as a Whole)
Monitoring Objectives & Scale

<table>
<thead>
<tr>
<th>Highest concentration</th>
<th>Micro, middle, neighborhood (sometimes urban)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source impact</td>
<td>Micro, middle, neighborhood</td>
</tr>
<tr>
<td>Population</td>
<td>Neighborhood, urban</td>
</tr>
<tr>
<td>General / Background</td>
<td>Neighborhood, regional, global</td>
</tr>
</tbody>
</table>

Network Design Considerations

- **Priority area** (zone of highest pollution conc.)
- **Air Transport**
- **Evaluation**
Network Design Considerations

- Population Areas
- Future development
- Full Representation

Number of Stations – PM$_{10}$

<table>
<thead>
<tr>
<th>Population</th>
<th>6 - 10</th>
<th>4 - 8</th>
<th>2 - 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 1,000,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500,000 - 1,000,000</td>
<td>4 - 8</td>
<td>2 - 4</td>
<td>1 - 2</td>
</tr>
<tr>
<td>250,000 - 500,000</td>
<td>3 - 4</td>
<td>1 - 2</td>
<td>0 - 1</td>
</tr>
<tr>
<td>100,000 - 250,000</td>
<td>1 - 2</td>
<td>0 - 1</td>
<td>0</td>
</tr>
</tbody>
</table>
Station Siting Considerations

- Available sites
- Start-up costs
  - Equipment
  - Facility improvements
- Operation costs
  - Equipment operation and maintenance
  - Station costs (lease payments, heating, etc.)
  - Expendables (calibration gases, chart paper, etc.)
  - Personnel

Station Siting Considerations

- Types of Pollutants
- Topography
- Air flow
Station Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Ground Level)</td>
<td>Heavy pollutant concentration, high potential for pollutant buildup</td>
</tr>
<tr>
<td>B (Ground Level)</td>
<td>Heavy pollutant concentration, minimal potential for buildup</td>
</tr>
<tr>
<td>C (Ground Level)</td>
<td>Moderate pollution concentration</td>
</tr>
<tr>
<td>D (Ground Level)</td>
<td>Low pollutant concentration</td>
</tr>
<tr>
<td>E (Air Mass)</td>
<td>Sampler probe that is between 6–45m (20–150 ft) above ground</td>
</tr>
<tr>
<td>F (Source-Oriented)</td>
<td>Sampler that is adjacent to a point source</td>
</tr>
</tbody>
</table>

Site Information

- Local Sources
  - Flues & Vents by Inlet
  - Non-Vehicular/Local Industry
  - Traffic
- Dominant Influence Category
  - Industrial
  - Residential
  - Commercial
  - Vehicular
  - Urbanization
  - Near Urban
  - Agricultural
  - Recreational Area
Local Sources Near Monitoring Stations

Site Information

- Data Acquisition Objective
- Station Type
- Spatial Scale
- Instrumentation
- Sampling System
- Influential Pollutant Sources
- Topography
- Atmospheric Exposure
Site Information

- Obstacles
  - Description
  - Distance
  - Height above inlet
  - Walls
  - Air flow arc
- Trees
  - As obstacles
  - As interferants

Obstacle Effects

1 height

5 to 10 heights
Location of Monitors

- C = Core site
- S = SLAMS site
- p = Special Purpose Monitor

Measurement Process
Ambient Air Monitoring

Air Pollutant Measurement Process

- Separate pollutant from air
- Determine pollutant quantity and air volume
- Calculate pollution concentration by dividing pollutant quantity by air volume
- Analyze data

Types of Monitoring

- Automated analytical methods
  - Point analyzers
  - Open path analyzers
- Time averaged samplers
  - Manual methods
  - Filter (ex. PM$_{10}$) samples
**Ambient Air Monitoring**

**Electromagnetic Spectrum**

- Gamma rays
- X rays
- UV
- IR
- Microwave
- FM Radio waves
- AM Radio waves
- Long radio waves

Visible Range

- 400 nm
- 700 nm

**Beer–Lambert Law**

- Absorption of light related to:
  - Absorption coefficient dependencies
    - Wavelength of light
    - Properties of the pollutant molecule
  - Number of molecules in light path
    - Concentration
    - Path length
Analytical Techniques

- Infrared Methods
  - Differential Absorption
  - Gas Filter Correlation
  - Fourier Transform Infrared
- Ultraviolet Methods
  - Differential Absorption
  - Second Derivative Spectroscopy
- Visible Light – Opacity Measurement
  - Scattering & Absorption
**Analytical Techniques**

- **Luminescence Methods**
  - Fluorescence
  - Chemiluminescence
  - Flame Photometry
- **Electroanalytical Methods**
  - Polarography
  - Electrocatalytic
  - Paramagnetism
  - Conductivity

**Site Information**

- **Site Description**
  - Ground Cover
  - Height of Inlet
  - Type of Samplers
  - Spacing Between Samplers
  - Inlet Boom Description and Orientation
  - Meteorological Instrument Tower Description
  - Meteorological Instrument Radiation Shield
Site Information

- Probe Information
  - Probe Material
  - Probe Dimensions
  - Manifold Description
  - Manifold Dimensions
  - Tubing Material
  - Tubing Dimensions
  - Residence Time
    - Probe, Manifold, Tubing, Total

Gas Inlet
Non-Dispersive IR Analyzer

Sample in

Light source

Bandpass filter

Sample out

Reference cell

Detector

NOx & CO Analyzer
Let’s Discuss GFC CO Analyzer

Gas Filter Correlation Analyzer
Ambient Air Monitoring

Looking Inside a GFC CO Analyzer

Chemiluminescence NO$_x$ Analyzer

- NO$_2$ to NO converter
- Sample in
- $O_2$ generator
- $O_2$ source
- NO + $O_2$
- Reaction chamber
- Bandpass filter
- Photomultiplier tube
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Thermo Environmental Chemiluminescence NOx Analyzer

A Typical NOx Analyzer

Rosemount Analytical
Ambient Air Monitoring

Chemiluminescence NOx Analyzer

Non-Dispersive UV Analyzer

- Photomultiplier tube
- Measurement filter
- Reference filter
- Electronics
- Sample in
- Sample out
- UV lamp
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Fluorescence SO₂ Analyzer

A Typical CO & O₂ Analyzer
Calibrations and Zero Air

Calibration is the process of establishing the relationship between the output of a measurement process and a known input.

- Pure (zero) air generators
- Certified cylinder gases
- Dilution calibration systems
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Calibration Gases

EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards
Particulate Properties

- Collected Mass
- Inertial Properties
- Particle Size
- Optical Density
  - Haze and Opacity in the Air
  - Density of Collected Deposit

Measures of Particulate Matter in the Atmosphere

Total Suspended Particles

- PM$_{10}$
- PM$_{2.5}$
- Aerosols
Particulate

- Total Suspended Particulate (TSP) Samplers
  - Lead
- PM10 and/or PM2.5 samplers
  - Size Selective Inlet
  - BAM
  - TEOM
- Visibility Samplers
  - Nephelometer
  - Optical Test Tape Sampler
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PM$_{10}$ - Size Selective Inlet (SSI)

Buffer Chamber
Air Flow
Acceleration Nozzle
Impaction Chamber
Acceleration Nozzle
Impaction Chamber
Vent Tubes
Filter Cassette
Filter
Filter Support Screen
Motor Inlet

Inside SSI Head
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SSI Filter Area

PM2.5 Sampler
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PM_{10} Size Selective Inlet

- Screen
- Ambient Air Flow
- Deflector Cone
- Upper Plenum
- Acceleration Jet
- Middle Plenum: Particles ≥ 10 \text{um}
- Lower Plenum: Particles < 10 \text{um}
- Vent Jet
- Flow to Virtual Impactor
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Virtual Impactor

From Inlet

Inlet Drift Tube

Virtual Impactor Nozzle

Virtual Impactor Receiver Tube

Fine Particles <2.5 um

Coarse Particles >2.5 um

PM 10 to 2.5 Coarse Particle Filter

Coarse Filter Cassette 1.67 LPM

To Control Module

PM 2.5 to 0 Fine Particle Filter

Fine Filter Cassette 15.03 LPM

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PM$_{10}$ - TEOM

- Sampling Head
- Heated Air Inlet
- Flow Splitter
- Sample Tube
- TEOM Sensor Unit
- Mass Transducer
- TEOM Control Unit
- Main Flow Controller
- Auxiliary Flow Controller
- Bypass Flow Line
- TEOM Filter
- Air Tubes
- Bypass Fine Particle Filter Assembly
- Inline Filters
- Vacuum Pump
- Flow
- To Flow Controller
- Flow Controller
- Microprocessor
- Electronic Feedback System
- Filter Cartridge
- Tapered Element
- HEPA Filter
- Cartridge
- Flow

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Meteorological Instruments

- Wind speed
- Wind direction
- Atmospheric pressure
- Temperature
- Relative humidity, dew pt
- Solar radiation
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Data Handling

- Data loggers
  - Strip charts
  - Computers
  - Temporary data storage
  - On-line data retrieval
Data Acquisition System

Site Survey Data

- Quality Assurance Procedures and Plans
- Cleaning Schedule
- Calibrations
- Station Temperature Control
- In-Line Filters
**Documentation**

- **Instrument Log**
  - Stays with Instrument
  - Documents Acceptance Tests
  - Documents Routine Maintenance
  - Documents Repairs
  - Documents Calibrations
  - Other Instrument Specific Information
    - i.e. Location, History, etc.

- **Station Log**
  - Stays at Station
  - Documents Conditions that may Influence Data
    - Nearby Construction
    - Changes in Traffic Patterns and Flow
  - Documents Alterations of Sampling Train
    - Probe and Equipment Changes
  - Contains Completed Site Reports
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Typical Monitoring Station

Quality Assurance
Quality Assurance

- Field QA
  - Daily and Weekly Zero and Span Checks
  - Semi-Annual Multipoint Calibrations
  - External Audits
    - Agency Audits
    - EPA NPAP (National Pollutant Audit Program)
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Data Handling

- Data review and editing
  - Complete data set
  - Reviewed for accuracy
  - Reviewed for consistency

Data Processing

- Upload to AQS (formerly AIRS)
- Air Quality Data Actions
  - Data Deletion
  - Data Correction
  - Links Data to Field QA
Station Inspection

- Review Siting
- Examine Instruments
  - Condition, Zero/Spans, Calibration, Audit Results
- Examine Gases
  - Certification
- Review Logs
- Evaluate Overall Station Cleanliness and Operation

ARB Audit Van
Safety

- Compressed Gas Cylinders
- Hazardous Gases
- Electrical Hazards
- Heights
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Outdoor Air Quality Data

Monitor Values Report

This report displays criteria pollutant summary data for individual monitoring sites. Read more about what’s in this report.

1. Pollutant
   - PM2.5

2. Year
   - 2016

3. Geographic Area
   - Select a State ...
     - or ...
     - Seattle-Tacoma-Bellevue, WA
       - or ...
       - Select a County ...

4. Exceptional Events
   - Include exceptional events data
   - Exclude exceptional events data
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- Greenhouse Gases
- Real time Particulate Speciation
- Satellite Stations
- ???????

The future
Ambient Air Monitoring

The Web

- https://www.epa.gov/outdoor-air-quality-data
  Monitoring data

- http://www.airnow.gov
  ◦ AQI

- https://www.epa.gov/technical-air-pollution-resources
  ◦ NAAQS
  ◦ Air monitoring regulations and information

- https://www.epa.gov/green-book
  ◦ Non attainment Areas
Questions???