Air Quality Management (AQM)

- Clean Air Act (History, Objectives, NAAQS)
- Non-attainment regions
The Clean Air Act, which was last amended in 1990, requires EPA to set National Ambient Air Quality Standards for pollutants considered harmful to public health and the environment. The Clean Air Act established two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

The EPA Office of Air Quality Planning and Standards (OAQPS) has set National Ambient Air Quality Standards for six principal pollutants, which are called "criteria" pollutants. Units of measure for the standards are parts per million (ppm) by volume, milligrams per cubic meter of air (mg/m3), and micrograms per cubic meter of air (µg/m3).

See: http://www.epa.gov/air/criteria.html
Clean Air Act (CAA) Goals

Protecting and promoting **human health & public welfare** by:

- Mitigating potentially harmful human and ecosystem exposure to six criteria pollutants: CO, NO₂, SO₂, O₃, PM(2.5, 10), and lead (Pb).
- Limiting the sources of and risks from exposure to HAPs (air toxics).
- Protecting and improving visibility impairment in wilderness areas and national parks.
- Reducing the emissions of species that cause acid rain, specifically SO₂ and NOx.
- Curbing the use of chemicals that have the potential to deplete the stratospheric O₃ layer.
The Air Pollutants of Concern in AQM

- Carbon monoxide (CO)
- Sulfur dioxide (SO$_2$)
- Nitrogen dioxide (NO$_2$)
- Particulate matter (PM)
- Ozone (O$_3$)
- Lead (Pb)
- Air toxics (solvents, fuels, metals, etc.)
- Haze (visibility)

“criteria” pollutants
EPA must describe the characteristics and potential health and welfare effects of these pollutants
# Federal AQM Legislation *History*

<table>
<thead>
<tr>
<th>Date</th>
<th>Legislation</th>
<th>Authorization</th>
</tr>
</thead>
<tbody>
<tr>
<td>1955</td>
<td>Air Pollution Control Act</td>
<td>Provided funds to local and state agencies for research and training</td>
</tr>
<tr>
<td>1959</td>
<td>Air Pollution Control Act Extension</td>
<td>Extended the 1955 act</td>
</tr>
<tr>
<td>1960</td>
<td>Motor Vehicle Exhaust Study</td>
<td>Authorized the Public Health Service (PHS) to study automotive emissions and health</td>
</tr>
<tr>
<td>1962</td>
<td>Air Pollution Control Act Extension</td>
<td>Extended 1955 act and required PHS to include auto emissions in their program</td>
</tr>
</tbody>
</table>
| 1963 | Clean Air Act | Research at the federal level  
Aid to states for training  
Federal authority to abate interstate pollution  
Matching grants to local/state agencies for air pollution control |
| 1965 | Motor Vehicle Air Pollution Control Act | National standards for auto emissions  
Coordinated pollution control between United States, Canada, and Mexico  
Research into SO$_2$ and auto emissions |
| 1967 | Air Quality Act | Air Quality Control Regions (AQCRs)  
Air Quality Criteria  
Control Technology Documents  
State Implementation Plans (SIPs)  
Separate automotive emission standards for California |

President Nixon (1970) created the Environmental Protection Agency (EPA) by Executive Order
## History: CAA’s First NAAQS

<table>
<thead>
<tr>
<th>Date</th>
<th>Legislation</th>
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</table>
| 1970 | Clean Air Act Amendments | National Ambient Air Quality Standards (NAAQS)  
SIPs to achieve NAAQS by 1975  
New Source Performance Standards (NSPS)  
National Emission Standards for Hazardous Air Pollutants (NESHAP)  
Aircraft emission standards to be developed by EPA  
Automotive emission standards for hydrocarbons and CO for 1975 models and for NO<sub>x</sub> for 1976 models  
States allowed to adopt air quality standards more stringent than federal standards  
Motor Vehicle Emissions Inspection and Maintenance (I/M) Program  
Citizen allowed to sue for air pollution violations |
| 1977 | Clean Air Act Amendments | Geographic regions (classes I, II, III) to preserve air quality  
EPA-sanctioned emission offsets and emission banking within nonattainmet regions  
State permits that require prevention of significant deterioration (PSD) studies  
Lowest-achievable emission rate (LAER) in nonattainment regions  
Delayed auto emission standards set in 1970 Clean Air Act Amendments  
Section 169A declared a national goal of preventing andremedying visibility impairment due to anthropogenic pollution in mandatory Class I areas |
1990 CAA Amendments

**Title I: Non-attainment regions**
Non-attainment regions for O$_3$ are ranked in terms of pollution severity; deadlines to achieve NAAQS. New and amended NAAQS must be attained in 5 years (possible 5-yr extension).

**Title II: Mobile sources**
Gasoline reformulation to lower toxic and VOC by 1997. Reduction in NOx (60%) and HC (40%)

**Title III: Toxics**
Emissions of 189 HAPs controlled.

**Title IV: Acid rain (Electricity Generation Facilities)**
NOx: cut emissions by 2.0 x 106 tons/yr; SO$_2$: reduce to 9.2 x 106 / 8.9 x 106 tons/yr (US total) by 2000 / 10.
Phase I (beginning 1995): 110 large power plants; Phase II (beginning 2000): remaining units
Policy: market-based “cap and trade” rather than “command and control”. If a utility reduces SO2 emissions below their emissions “allowance”, the utility can sell their extra “allowance” to another utility.

**Title V: Permits**
New and existing major sources must secure permits, duration ≤ 5 yr.
Fees to sustain state air pollution control agencies.

**Title VI: Stratospheric ozone**
Phase out chlorofluorocarbons, halons, and carbon tetrachloride by 2000; CH3CCl3 / HCFCs by 2002 / 30

**Title VII: Enforcement**
Larger penalties.
## NAAQS Effective January 2003

<table>
<thead>
<tr>
<th>Primary Standard (Health-Based)</th>
<th>Secondary Std (Welfare-Based)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td><strong>Level</strong></td>
</tr>
<tr>
<td><strong>PM10</strong></td>
<td><strong>Level</strong></td>
</tr>
<tr>
<td>Annual arithmetic mean</td>
<td><strong>50 µg/m3</strong></td>
</tr>
<tr>
<td>24-hr avg not to be exceeded</td>
<td><strong>150 µg/m3</strong></td>
</tr>
<tr>
<td>more than 1/yr on avg over 3yr</td>
<td></td>
</tr>
<tr>
<td><strong>PM2.5</strong></td>
<td><strong>Level</strong></td>
</tr>
<tr>
<td>Spatial and annual</td>
<td><strong>15 µg/m3</strong></td>
</tr>
<tr>
<td>arithmetic mean in area</td>
<td></td>
</tr>
<tr>
<td>98th percentile of 24-hr avg</td>
<td><strong>65 µg/m3</strong></td>
</tr>
<tr>
<td><strong>O3</strong></td>
<td><strong>Level</strong></td>
</tr>
<tr>
<td>Maximum daily 1-hr avg to be</td>
<td><strong>0.12 ppm</strong></td>
</tr>
<tr>
<td>exceeded no more than 1/yr</td>
<td></td>
</tr>
<tr>
<td>averaged over 3 consec years</td>
<td></td>
</tr>
<tr>
<td>3-yr avg of the annual fourth</td>
<td><strong>0.08 ppm</strong></td>
</tr>
<tr>
<td>highest daily 8-hr average</td>
<td></td>
</tr>
<tr>
<td><strong>NO2</strong></td>
<td><strong>Level</strong></td>
</tr>
<tr>
<td>Annual arithmetic mean</td>
<td><strong>0.053 ppm</strong></td>
</tr>
<tr>
<td><strong>SO2</strong></td>
<td><strong>Level</strong></td>
</tr>
<tr>
<td>Annual arithmetic mean</td>
<td><strong>0.03 ppm</strong></td>
</tr>
<tr>
<td>24-hr average</td>
<td><strong>0.14 ppm</strong></td>
</tr>
<tr>
<td><strong>CO</strong></td>
<td><strong>Level</strong></td>
</tr>
<tr>
<td>8-hr (not to be exceeded more</td>
<td><strong>9 ppm</strong></td>
</tr>
<tr>
<td>than once per year)</td>
<td></td>
</tr>
<tr>
<td>1-hr (not to be exceeded more</td>
<td><strong>35 ppm</strong></td>
</tr>
<tr>
<td>than once per year)</td>
<td></td>
</tr>
<tr>
<td><strong>Lead</strong></td>
<td><strong>Level</strong></td>
</tr>
<tr>
<td>Maximum quarterly average</td>
<td><strong>1.5 µg/m3</strong></td>
</tr>
</tbody>
</table>

http://www.epa.gov/air/criteria.html
Four Topics of Concern for AQM

1. Elevated concentrations of ground-level ozone.

2. Elevated concentrations of fine particulate matter.

3. Emissions of air toxics and bio-accumulators (cause cancer, birth defects etc...).

4. Emissions of greenhouse gases and global climate change.

Acute Effects

Well Known

Chronic Effects

Less Well Known
Why Control Aerosols

• Visibility
  – Small particles scatter light

• Health
  – 10 μg/m³ increase in PM$_{2.5}$ $\Rightarrow$ 4%, 6%, and 8% increased risk in all-cause, cardiopulmonary, and lung cancer mortality (Pope et al., 2002)

• Climate
  – Impacts global cooling, heating, precipitation

• Some regions have more difficulty reaching the standard than others.
• Southeast has regionally high levels of PM
  – Anthropogenic and natural sources combined
• New health standards (NAAQS) and visibility regulations require reductions
  – Most of Georgia near or above the annual NAAQS of 15 ug/m³
    • A lot like ozone
Concern: Human Health

Asthma is a chronic lung disease that affects a person’s fundamental ability to breathe. It’s prevalence in the U.S. population is epidemic. The percentage of the population with the disease has nearly doubled since 1980. In 2000, approximately 11 million people in the U.S. experienced an asthma attack.


Note: Discontinuity between 1996 and 1997 due to change in question used to determine prevalence.
Concern: Economics

The estimated economic cost of asthma in the U.S. in 1998 was $11.3 billion. By 2002, this estimate had increased to $14.0 billion. This latter figure includes direct costs of $3.1 billion for hospital care, $2.6 billion for physicians’ services, and $3.7 billion for prescription drugs. “Direct medical costs of asthma account for approximately 1% of all health care expenditures in the United States.” The remaining $4.6 billion in costs are estimated indirect costs that include loss of productivity due to mortality, and decreases in productivity due to absences from work or school.

Asthma and the Environment: A Strategy to Protect Children; President’s Task Force on Environmental Health Risks and Safety Risks to Children; January 28, 1999; Revised May 2000.
Ozone is one of many environmental factors that can trigger asthma attacks in those that have the disease. Studies show that ERVs for treatment of asthma increase by 30 to 40% when \([O_3]\) is elevated.

Symptom: Human Health

Symptom: Ecological Health

Cotton showing chronic response to ozone on the lower leaves after exposure to rel. low concentrations (e.g. < 40 ppb), with periodic, random, intermittent episodes of rel. high ozone concentrations (e.g. > 80 ppb) throughout the plant growth season. Krupa, S.V., A.E.G. Tonneijck, and W.J. Manning. 1998. Ozone. Pp. 2-1-2-28 in Recognition of Air Pollution Injury to Vegetation: A Pictorial Atlas, 2nd Ed, R.B. Flagler, et al., eds. Pittsburgh, PA: Air & Waste Management Association.
Symptom: Buildings, Monuments & Parks
Symptom: Visibility
Exceedances of the PM2.5 NAAQS,

Monitors at which the 1999 annual average PM$_{2.5}$ concentration exceeds (yellow and red) the 15 μg/m$^3$ annual average PM$_{2.5}$ NAAQS.
129 counties have monitors that exceed NAAQA
PM-2.5 ANNUAL STANDARD (15 UG/M3)

Counties Exceeding the PM2.5 NAAQS Violations Based on 2000 - 2002 Data


Annual Average PM$_{2.5}$ in Urban Areas, 2002

Annual Average PM$_{2.5}$ in Rural Areas, 2002

Source: IMPROVE Network, 2002
Ozone: Also Regional

August 17, 2000 21:00:00
Min = 0.003 at (56, 48), Max = 0.228 at (34, 15)
Last (O₃) non-attainment designations in 1991.

More than 90% of the affected population resided in 70 metro areas.

Average Size: ~2 million (Cincinnati)
Median Size: ~1 million (Louisville)
Largest: ~20 million (New York)
Smallest: ~87,000 (Owensboro, KY)

Counties in which the 1998 2nd daily maximum 1-h [O₃] exceeds the 1-h average 120 ppb NAAQS. *EPA 2000.*

In addition to most of the original 70 metro areas, ca. 60 additional metro areas may be impacted.

Of these 60 new metro areas:
- Average Size: ~360,000 (Madison, WI)
- Median Size: ~290,000 (Macon, GA)
- Largest: ~1.3 million (San Antonio)
- Smallest: ~74,000 (Victoria, TX)