

Air Pollution in the Los Angeles Basin

Pollutants in L.A. Air

- Ozone
- Carbon Monoxide
- Nitrogen Oxides
- Heavy Metals
- Particulate Matter
- PAHs (polyaromatic hydrocarbons)
- Other things

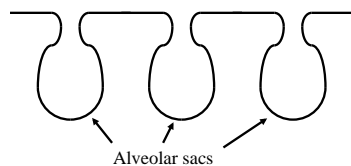
Primary Pollutants

- The following species are primary pollutants (those compounds emitted directly into the air by people, plants, and animals):
 - Hydrocarbons—transportation, industrial, and biogenic sources
 - Nitric oxide (NO)—transportation, industrial and biogenic sources. ~70% of NO emissions come from mobile sources (automobiles, trucks, buses)
 - Aerosols—dust, smoke, soot, pollen, sea spray, etc.
- Note that ozone is not a primary pollutant

Urban Smog

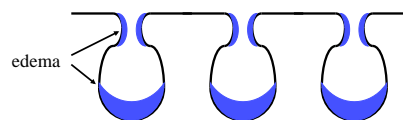
- Polluted troposphere contains a large number of anthropogenic species including hydrocarbons, nitrogen oxides, sulfur oxides, and particulate matter.
- The most damaging component of smog to human health is ozone (O_3).
- Other components of particular health concern include particulate matter— PM_{10} and $PM_{2.5}$

Urban Smog



Alveoli: exchange of oxygen across the lung lining and into the blood as well as expiration of carbon dioxide occurs in the alveoli

Urban Smog



Ozone reacts with the lung lining in the alveoli which results in the formation of edema (build up of fluid) at the entrance to the alveoli and with the alveoli themselves.

Urban Smog

Results of reaction of ozone within alveoli:

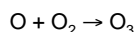
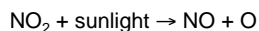
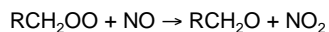
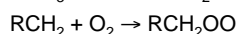
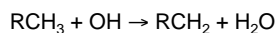
- Decreased *tidal volume*—the total volume available in the lungs.
- Increased *residual volume*—because of constriction at alveolar entrance less air can be exchanged on breath-by-breath basis resulting in increased volume of “used” air in lungs.
- Decreased rate of transport of oxygen across lung lining.

Formation of Ozone in Smog

- Ozone is not a primary pollutant—species emitted directly into air. It is formed by a series of chemical reactions involving primary pollutants and sunlight.
- The following things are necessary for production of ozone:
 - Hydrocarbons
 - Nitrogen monoxide (NO)
 - Sunlight
 - Hydroxyl radical (OH)

Formation of Ozone in Smog

- The following reactions produce ozone:



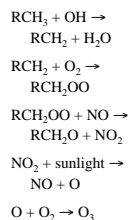
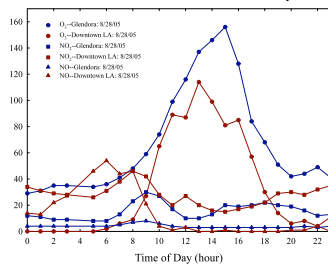
Sources of Primary Pollutants

- Hydroxyl radical: formed in several chemical systems including aerosols.
- Hydrocarbons: industrial and transportation emissions.
- Nitrogen monoxide: ~70% of NO in LA Basin comes from car and truck engines

$$\text{N}_2 + \text{O}_2 \rightarrow 2 \text{NO}$$
 Reaction only occurs at very high temperatures found, for example, within combustion cylinders of engines.

Formation of Smog

Pollutant Concentration vs Time of Day



Smog in Los Angeles

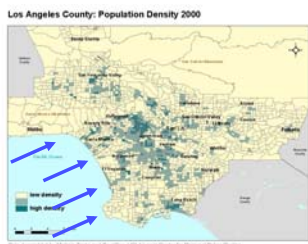
- There are four factors that make smog in LA consistently the worst in the country:

1. Topography—LA is a basin surrounded by relatively high mountains.



Smog in Los Angeles

2. Predominant on-shore breeze—the warm land next to the cool ocean water produces an on-shore breeze that tends to push the air inland toward the mountains



Smog in Los Angeles

3. Large population base—the five counties that comprise the LA region have a total population nearing 17 million people. Those 17 million people produce a tremendous amount of anthropogenic emissions into the troposphere due to industrial, transportation, and other support activities.

Smog in Los Angeles

3. Large population base (con't.)

| County | Population (2000 census) |
|----------------|--------------------------|
| Los Angeles | 9,519,338 |
| Orange | 2,846,289 |
| Riverside | 1,545,387 |
| San Bernardino | 1,709,439 |
| Ventura | 753,197 |

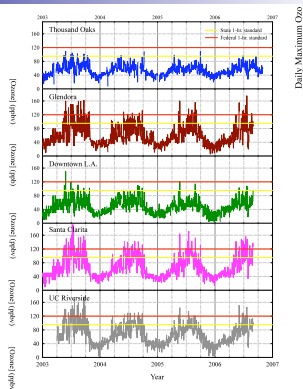
- Additionally, the population of the Southern California region is expected to increase by 10 million people over the next 25 years.

Smog in Los Angeles

4. Sunlight—light drives the photolysis of NO_2 to form oxygen atoms that combine with molecular oxygen to create ozone. LA boasts some of the best weather of any large urban center in the world—more than 300 sunny days per year.

Daily maximum O_3 mixing ratios for several location throughout Southern California:

- Thousand Oaks
- Glendora
- Downtown LA
- Santa Clarita
- Riverside



AQMD Regulations to improve air quality

The South Coast Air Quality Management District (AQMD) is the governmental agency charged with improving air quality in the LA Basin.

Steps taken include:

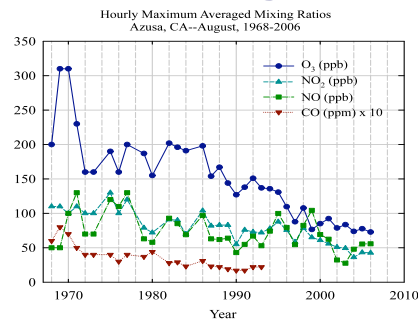
- Decreased automotive emissions
- Restrictions on solvent use—LA Times required to change type of ink used
- Severe restrictions on industrial emissions—refineries in South Bay
- Required change in barbecue lighter fluids

AQMD Regulations to improve air quality

Proposed ideas for further improvement:

- Regulations on diesel engines—reduce emissions of both hydrocarbons and particulates
- Ban of “drive-thru” restaurants—idling cars emit hydrocarbons and NO with useful work being done
- Impose strict emission technologies on dry-cleaners
- Further restrictions on industrial emissions

Formation of Smog



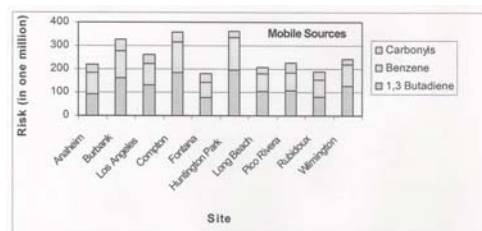
South Coast AQMD Study of Cancer-Causing Air Pollutants:

Multiple Air Toxics Exposure Study in the South Coast Air Basin (MATES-II)
(Published March 2000)



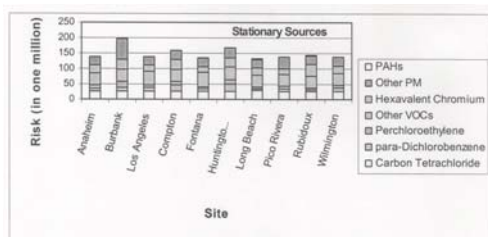
MATES II fixed sampling sites

Cancer Risks and Air Pollutants



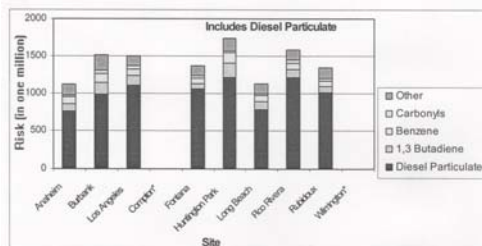
Cancer risks at the MATES II fixed sites from mobile sources excluding diesel toxicity. (AQMD MATES II Report, Figure 3-3)

Cancer Risks and Air Pollutants



Cancer risks at the MATES II fixed sites from stationary sources excluding diesel toxicity. (AQMD MATES II Report, Figure 3-3)

Cancer Risks and Air Pollutants



Cancer risks including diesel particulate toxicity at MATES II fixed sites. (AQMD MATES II Report, Figure 3-4)