

Lecture 10 –Urban Air Pollution in the USA

We start this lecture by finishing up the discussion of atmospheric circulation. The notes for this are in lecture9.doc

The environmental protection agency (EPA) was formed in the 1970's and it is estimated that 96% of the health benefits of EPA regulations result from their efforts to improve air quality. The EPA monitors six air pollutants in urban areas

- Particulate Matter
- Lead (Pb)
- Sulfur Dioxide (SO₂)
- Nitrous Oxides (NO, NO₂)
- Ozone (O₃)
- Carbon Monoxide (CO)

The lecture below is based on the accompanying PowerPoint presentation

Particulate Matter

In terms of its effect on human health particulate matter is the most serious pollutant. Large particles tend to get trapped in the nose and air passages but small particles get into the lungs where they get lodged, cause irritation (Bronchitis) and affect local chemistry. We do not fully understand why particulates harm our health and it is only in past 20 years that environmental scientists and health professionals have fully realized the poor health implications of smaller particles.

Particle pollution can be caused by natural processes such as dust storms, forest fires and volcanic eruptions (the 1st and 2nd can be exacerbated by humans) but particulate pollution is primarily manmade.

PM₁₀ refers to the concentration in $\mu\text{g}/\text{m}^3$ of particulates with diameters exceeding 10 μm (10 millionths of a meter or one seventh the diameter of a human hair). These particles are created primarily by mechanical wear and dust. PM_{2.5} is a more recent measure that includes particles as small as 2.5 μm . Smaller particles are created by incomplete combustion of fossil fuels.

Particle pollution has improved enormously as a result of society no longer burning coal in cities for industrial and home-heating application (e.g., the 1952 London Smog), smoke scrubbing in power plants, and the use of low sulfur coal. It is estimated that over 100,000 still die every year in the US as a result of airborne particulates (40,000 die in traffic accidents).

Lead

Lead is the second worst pollutant in terms of its health effects. At fairly low levels it causes birth defects, low IQ and mental retardation. At higher levels it can kill. In the USA ~15,000 children per year are still treated for lead poisoning mostly from ingesting lead paints that were widely used up until the 1950's. About 200 children die per year of lead poisoning.

Lead pollution in the air used to come from automobiles as a result of lead additives in gasoline. These were phased out in the 70's and early 80's and as a result lead pollution in the air has decreased by over 95% to levels that can be hard to measure. As a result 22,000 lives are saved per year and the average IQ of children born today is 3 points higher than 30 years ago.

Sulfur dioxide

Sulfur dioxide is a major cause of acid rain that corrodes metal structures and buildings, stunts forests and acidifies lakes. Emissions of SO₂ have been reduced substantially over the past 20-30 years and it is estimated that this has saved 10,000 lives per year in the US mainly as a result of reducing particulate matter (many particles are made up of sulfates).

Nitrous Oxides and Ozone

Nitrous Oxides and Ozone are the primary components of smog. Nitrous oxides come from burning fossil fuels while ozone forms when unburned hydrocarbons react with nitrous oxides in the presence of sunlight. Atmospheric inversions then trap the smog layer above cities and the problem is particularly bad when mountains stop the smog spreading out horizontally. Smog has been reduced substantially although it is still a problem in cities like LA and Houston.

Carbon monoxide

Carbon monoxide comes from incomplete combustion of hydrocarbons and is poisonous in large concentrations (e.g., when you run your car in a garage). It is not a serious health risk.

Third World

As a result of regulation and increased affluence, air pollution has decreased substantially in the western world over the last 50 years. The same is not true for the third world and many megacities in China, India and elsewhere (e.g., Mexico City) have air quality that is many times worse than recommended maximum levels and this kills 10,000 of people each year in each large city. However, this is a problem we know how to solve and as the prosperity of these nations increases we can expect air quality in urban areas to improve.