
Understanding Air Quality
AIR & WASTE MANAGEMENT
ASSOCIATION
Since 1907

"Understanding Air Quality Presentation"

Presentation

FOREWORD

The members of the Air & Waste Management Association (A&WMA) believe that one of the best ways to achieve their goal of a clean and healthy environment is to improve the environmental literacy of teachers, students, and the general public. As a result, the Association has established a public education education program so that teachers, school children, and the public can get information they need to make responsible decisions every day about environmental issues.

The Association proudly presents the *Understanding Air Quality Slide Show Presentation,* which makes communicating about air quality issues a breeze… By combining an informative script with visually stimulating slides, your audience will learn about the composition of air, the various atmospheric layers, what air pollution is, how it is generated, why it's a problem, and what solutions are available.

ACKNOWLEDGEMENTS

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The Association would also like to thank Florida's Department of Environmental Protection's Division of Air Resources Management for the conversion of this presentation into PowerPoint format.

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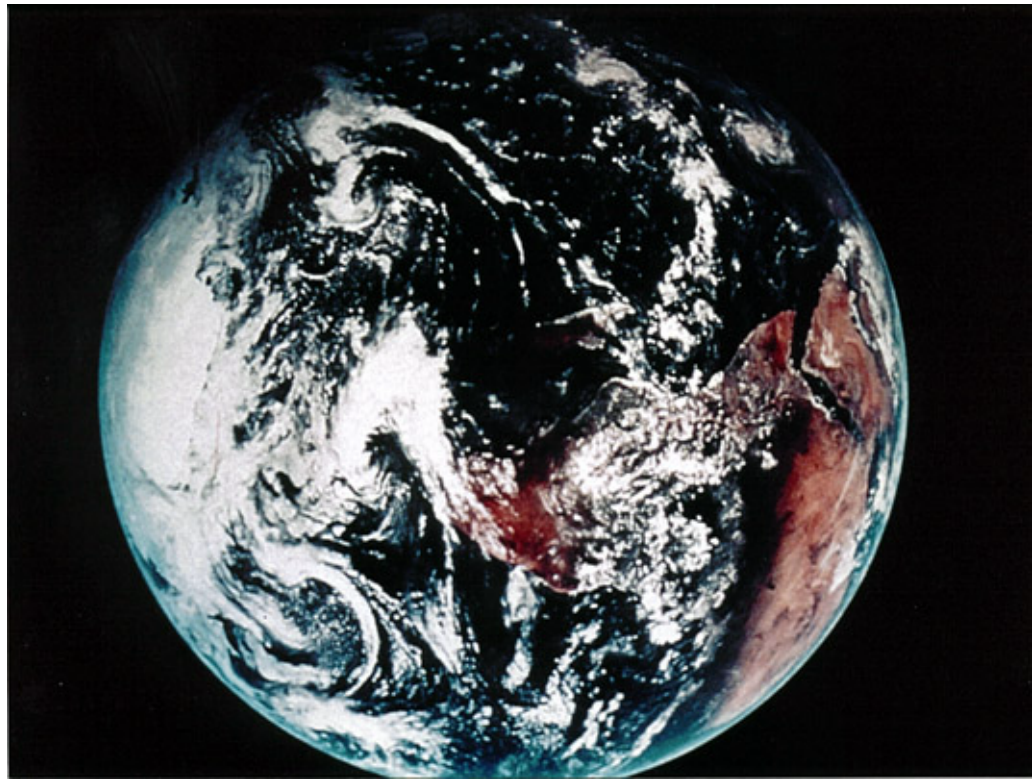
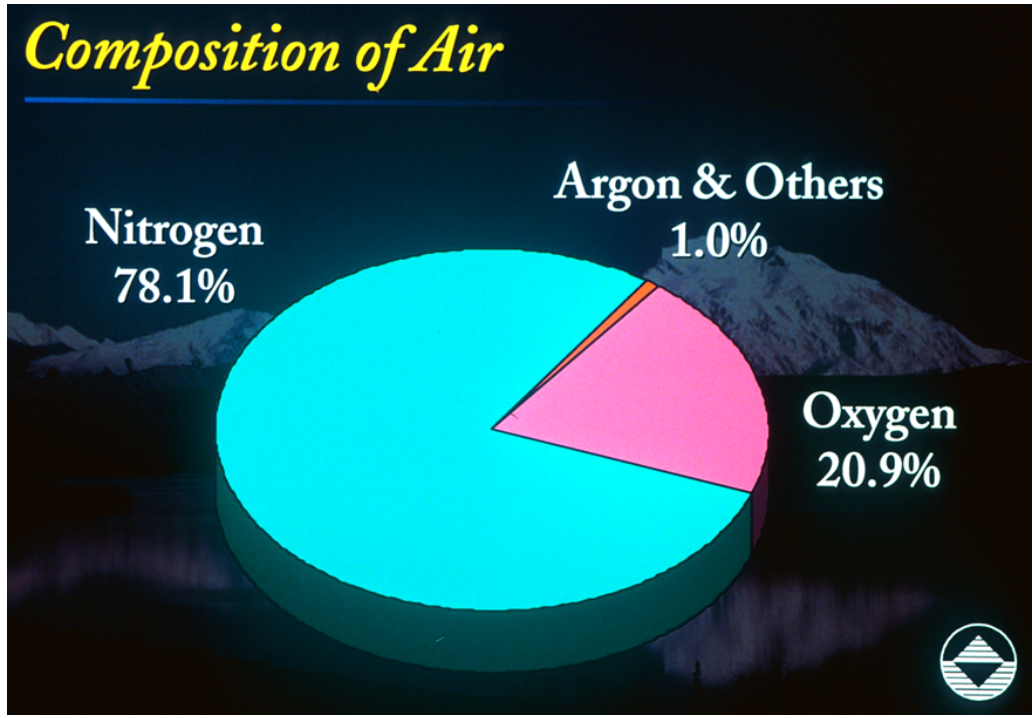
DEPARTMENT OF ENVIRONMENTAL PROTECTION
FLORIDA

The PowerPoint version of this presentation was developed by the Office of Air Programs Communication and Outreach of the Florida Department of Environmental Protection, Division of Air Resources Management.

Main Menu

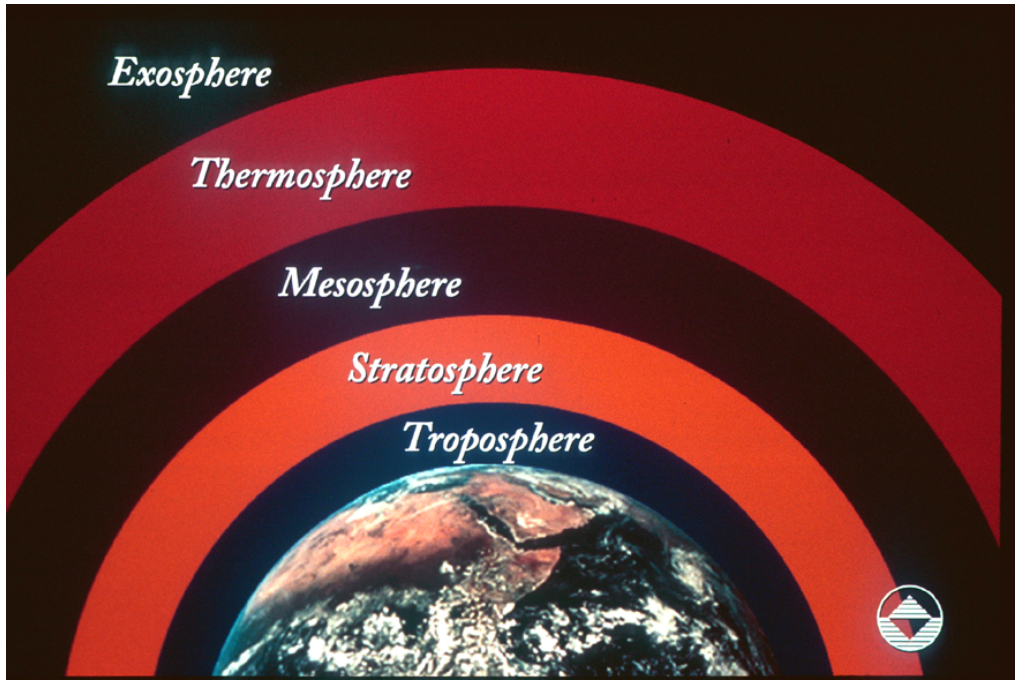


- The earth is a huge sphere covered with water, rock and soil and is surrounded by a mixture of gases. It is these gases to which we refer when we speak of air. The earth's gravity holds this blanket of air - our atmosphere - in place. Without gravity, the gases would drift into space.



- "Clean" air, which is found in few (if any) places on earth, is composed of nitrogen (78.1%), oxygen (20.9%), argon (0.9%), and other components (0.1%). The other components include carbon dioxide, neon, helium, methane and very small amounts of other gases. Air often also carries water droplets, ice crystals, and dust, but they are not considered part of the composition of the air.

- Air exhibits the properties of a fluid and has mass. Because air is invisible, it is easy to forget that it occupies space.

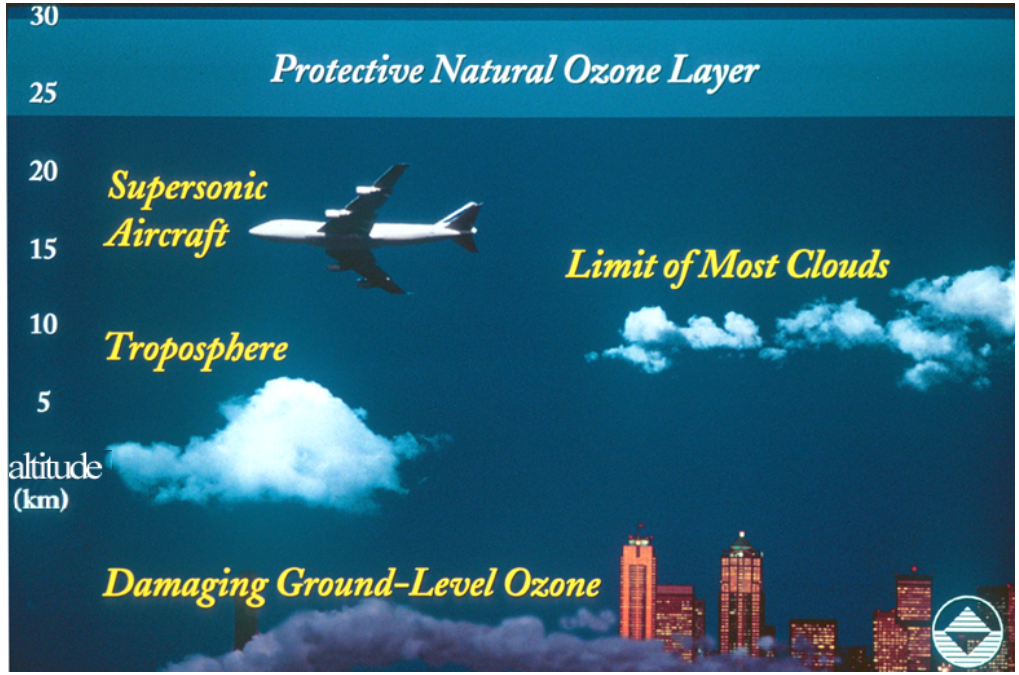


Major Subdivisions of the Atmosphere

- Scientist commonly divide the atmosphere into four layers, based on differences in air temperature. Air becomes less dense and colder (except in the thermosphere) as its distance from the earth increases.

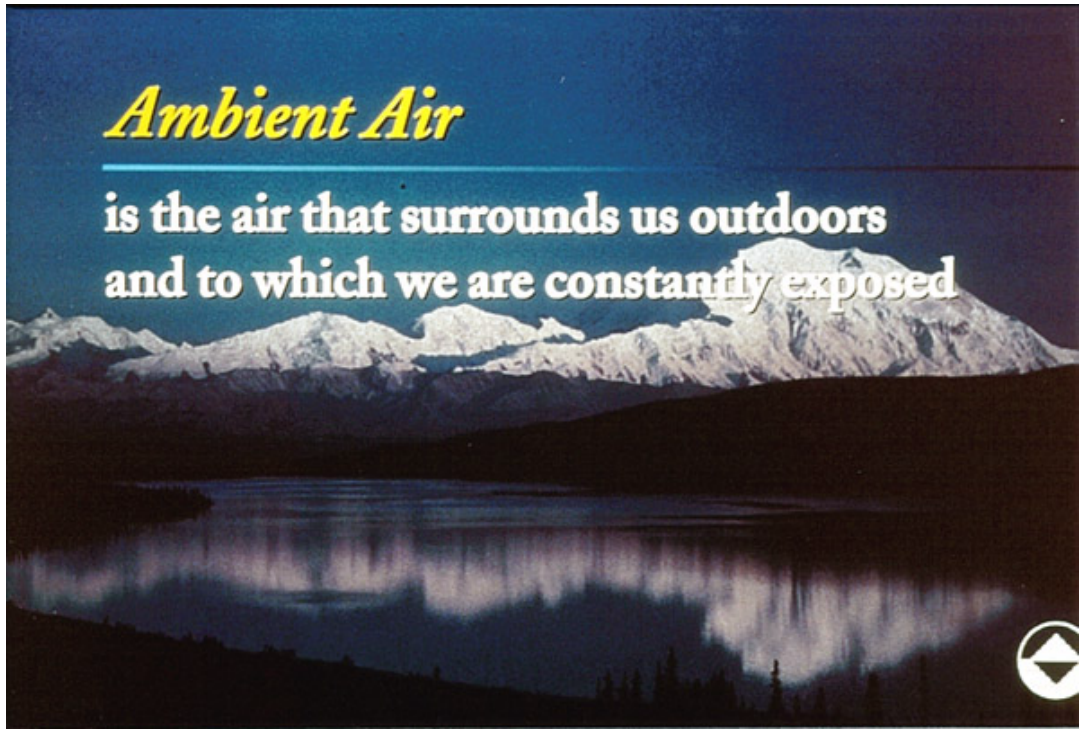
- The *troposphere* is the closest to the earth. It extends from the earth's surface to a height ranging from about 5 to 10 miles (8 - 16 km). Wind, weather systems, clouds, and the air we breath, are in the troposphere.

- The *stratosphere*, the next layer of the air, extends from the troposphere to approximately 31 miles (50 km) above the earth. While this layer contains very little moisture it does contain another very important component: ozone. Over 90% of the atmosphere,s ozone is in the stratosphere. Stratospheric ozone absorbs the sun's ultraviolet rays, thus both heating the air and keeping excessive radiation from reaching the earth. Although chemically identical, this is not physically the same as ozone that exists in the troposphere and can cause heath problems for humans. It *is* the same ozone that contains the well-known "hole."



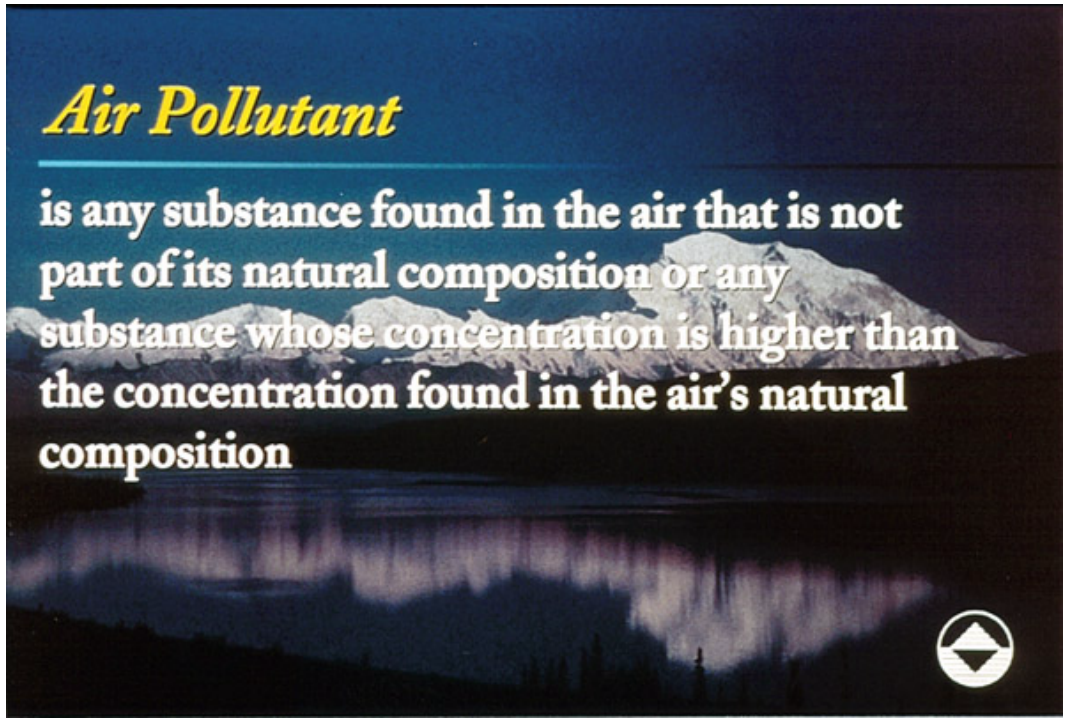
- Extending from the stratosphere to about 50 miles (80 km) above the earth's surface, is the *mesosphere*, followed by the uppermost layer of the atmosphere, the *thermosphere*. More than 99.9% of the atmospheric gases lie below the thermosphere.

- Our atmosphere is critical to sustaining life on earth as we know it. The troposphere provides the oxygen that humans and animals need to stay alive, provides carbon dioxide to help sustain plant life, provides for the transport of water (in the form of precipitation) to inland areas, and serves as a medium for sound. The stratosphere helps keep adequate heat near the earth's surface and shields the earth from harmful radiation. The thermosphere helps make possible long-distance radio communication; it reflects back radio waves that would otherwise end up in outer space. Every citizen of the world obviously has a vested interested in keeping the earth's atmosphere "healthy."

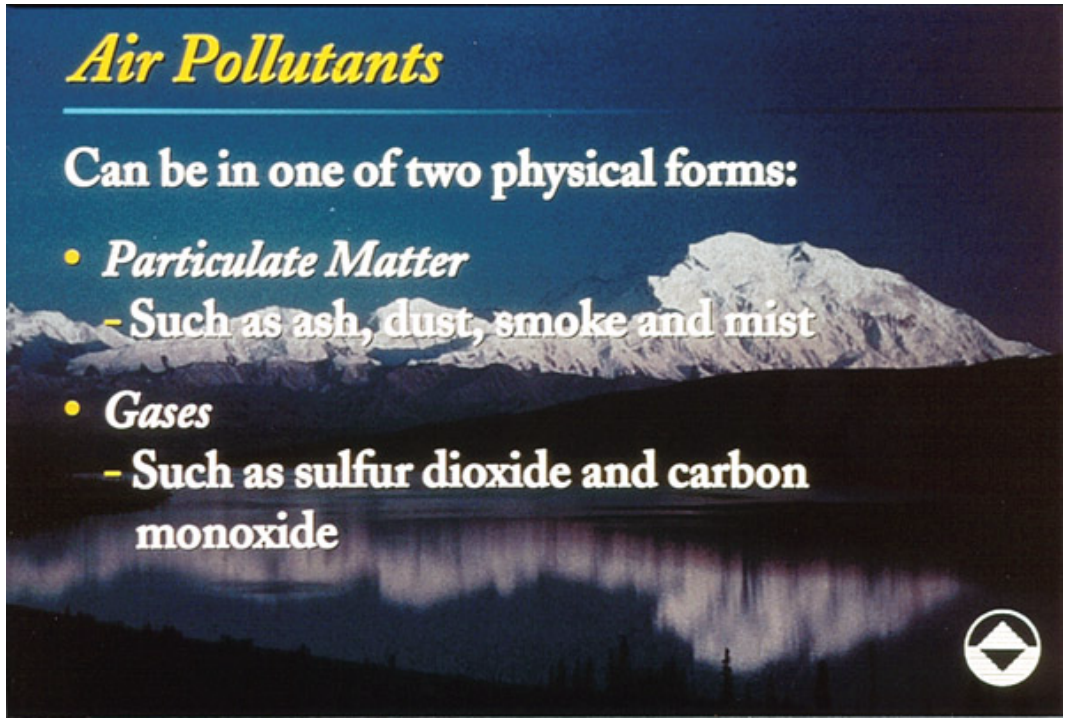


Air Pollutants

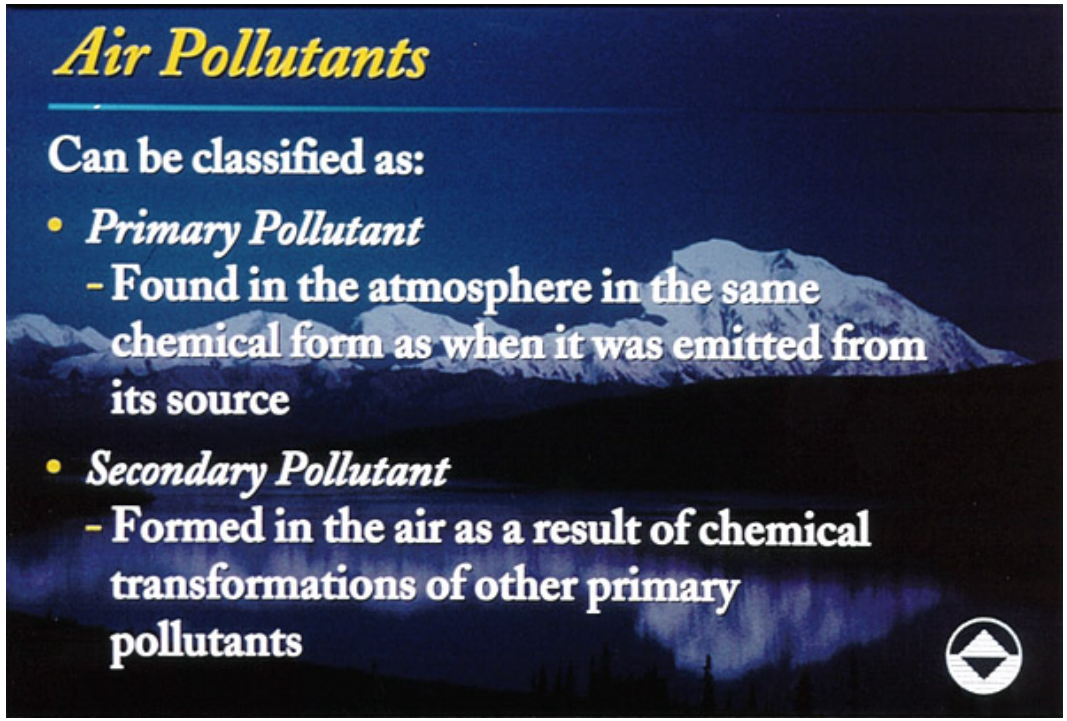
- In environmental science, you will frequently here the term "ambient air." Ambient air is the air that surrounds us outdoors and to which we are constantly exposed. Should this air become contaminated, we refer to it as being polluted.



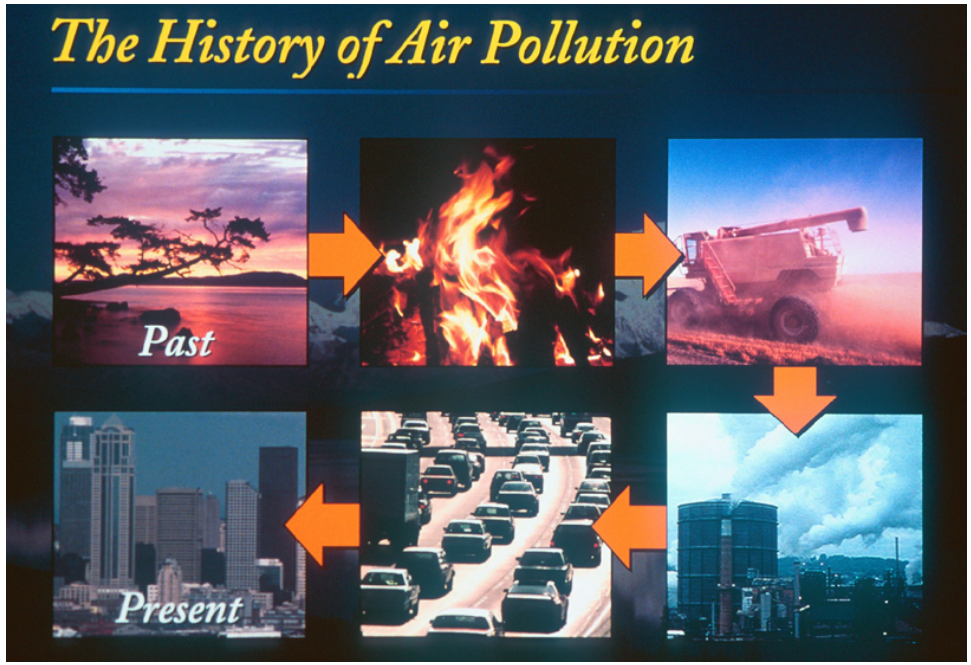
- An *air pollutant* is any substance found in the air that is not part of its natural composition or any substance whose concentration is higher than the concentration found in the air's natural composition.



- Air pollutants can be in one of two physical forms: particulate matter or gases. *Particulate matter* is the scientific term for small solid or liquid particles such as ash, dust, smoke, and mist. *Gases* include substances such as sulfur dioxide and carbon monoxide. *Volatile organic compounds (VOCs)* are liquids that evaporate readily under standard ambient conditions, thereby creating pollutant gases.



- In addition, pollutants are classified as being either primary pollutants or secondary pollutants. A primary pollutant is found in the atmosphere in the same chemical form as when it was emitted from its source. Carbon monoxide is an example of a primary air pollutant. A secondary pollutant is one that has formed in the atmosphere; that is, it has in the air as a result of chemical transformations of other primary pollutants or other substances. Tropospheric ozone is an example of a secondary pollutant. It is formed when nitrogen oxides react with organic compounds in the presence of sunlight.



History of Air Pollution

- Air pollution has been around for a long time. Natural phenomena such as volcanoes, wind storms, forest fires, and decaying matter contribute substantial amounts of air pollutants. Plants and trees also emit organic vapors and particles. For the most part, the earth, which has a well-balanced natural "cleansing" system, is able to keep up with natural pollution.

- However, our human contributions have overloaded that system. We have been contributing to air pollution for millions of years - first in small amounts and recently in large amounts. Early humans undoubtedly created small amounts of air pollution when they made fires in their caves.

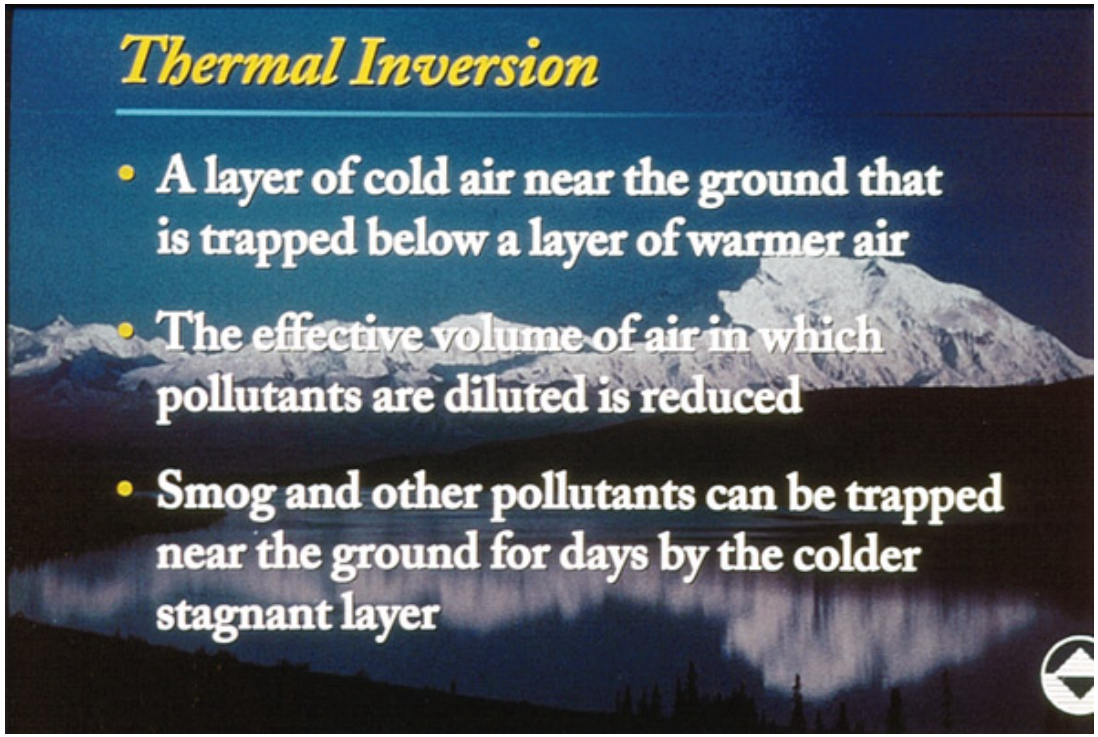
- As humans have gone from living in small, nomadic groups to settling in permanent agrarian communities, they have also put fire to more use, and the air pollution from it has increased.

- With the Industrial Revolution of the late 18th & 19th centuries came the beginning of our current pollution problems. New manufacturing processes required fuel for power, which brought about the burning of large amounts of coal and other fossil fuels and resulted in the spewing of tons of smoke and other pollutants into our atmosphere. As we manufacture and consume more and more goods, from plastics to automobiles, the amount of pollutants that we dump into our air also increases.

- *Mobile sources* of air pollution include automobiles, diesel trucks, buses, airplanes, trains, ships, etc.

- While low levels of air pollution can be harmful to our health, extremely high levels can be detrimental or even deadly to large numbers of people. Dangerously high concentrations of air pollutants can occur during *air pollution episodes* and *air pollution accidents*. Documented episodes and accidents have occurred in various parts of the world over then past 75 years or so.

- An *air pollution episode* occurs when routine releases of air pollutants coexist with unusual meteorological conditions, such as thermal inversions, to create unhealthy conditions.

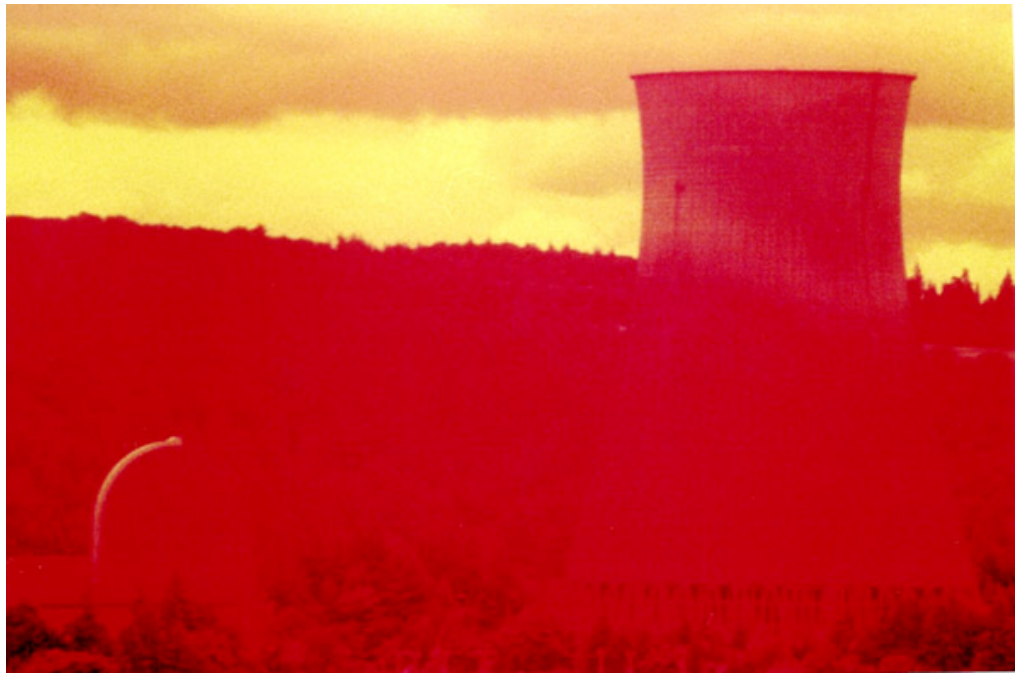


- Thermal (or temperature) inversions, which usually occur in valleys, are situations in which cooler air remains trapped and stagnant beneath a layer of warmer air, thus reducing the effective volume of air in which pollutants are usually diluted.

- An air pollution episode occurred in Donora, Pennsylvania (USA) in 1948. The area was experiencing a thermal inversion. Of the 14,000 inhabitants of Donora, approximately 43% (6,000) became ill and 20 people died. Sulfur dioxide and particulate matter were suspected to have been the pollutants causing the problems.

- In 1952, in London, England, a disastrous episode occurred. From December 5 through December 9, the British Isles were covered by a fog and a temperature inversion. London was one of the most severely affected areas. There were between 3,000 and 4,000 excess deaths during this episode. The only reason, as revealed by autopsies, for the deaths was respiratory tract irritation.

- An *air pollution accident* is an inadvertent, preventable release of toxic chemicals, usually resulting from human error or mechanical failure. In December 1984, there was a disastrous air pollution accident in Bhopal, India. Thirty tons of a poisonous gas (methyl isocyanate, which is heavier than air) escaped through a broken valve at a chemical plant. Although there were no adverse meteorological conditions, the resulting acute air pollution injured about 200,000 people and killed more than 2,000.

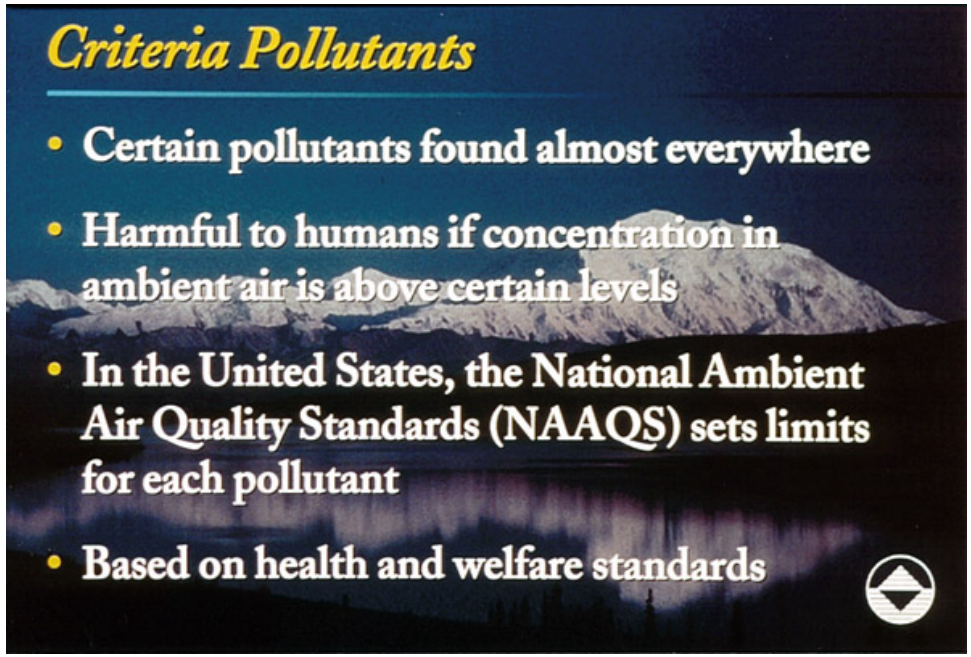


- In 1986, a major nuclear accident occurred in the city of Chernobyl in the former Soviet Union. A secondary effect of that accident was a "cloud" of radioactivity that spread through the air to other parts of the world. A chain of events caused by both mechanical failure and human error in the nuclear power plant resulted in the radioactive release. The resulting radiation exposure killed 30 workers and made 200 other workers and fire fighters ill with severe radiation sickness. Millions of people, in both the former Soviet Union and Eastern Europe, were exposed to the radioactive fallout. The radiation cloud was able to be tracked as it moved across the globe.

Environmental Legislation and Regulations

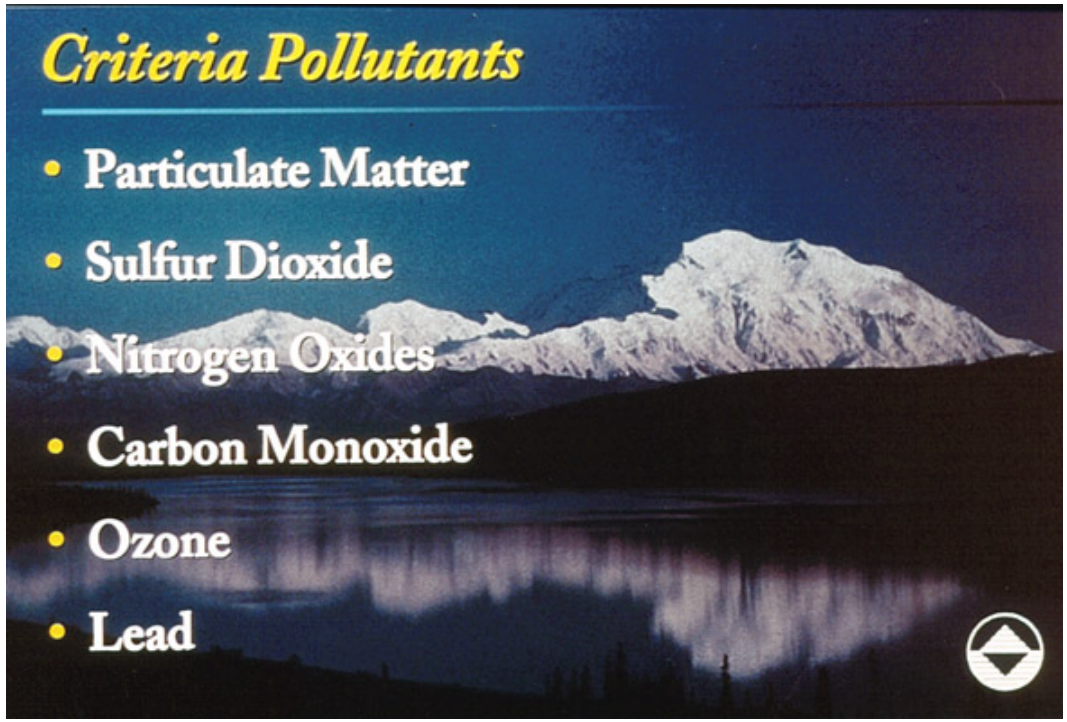
- Although air pollution has been around for a long time, it has been in only the past 50 years or so that the governments of many countries have taken active roles in doing something about it.

- In the United States, the U.S. Environmental Protection Agency (EPA) was created in December 1970 to address the nation's urgent environmental problems and to protect public health. While legislative efforts in air pollution control began prior to 1970, the landmark legislation which formed the basis for current air pollution regulations occurred with the passage of the Clean Air Act Amendments on December 31,1970.



Criteria Pollutants

- There are certain pollutants that are found almost everywhere and that are harmful to humans if their concentration in the ambient air is above certain levels. In the United States, National Ambient Air Quality Standards (NAAQS-*pronounced "naks"*) have been set for each of these pollutants. The NAAQS sets limits for the ambient concentration of each pollutant. The NAAQS state how much of that pollutant is allowed to exist in the ambient air and for what time periods. If too high a concentrations of any of these pollutants is found in the air in a particular geographic region, that region is legally determined to be a "non-attainment area," and steps must be taken to reduce emissions of that pollutant.

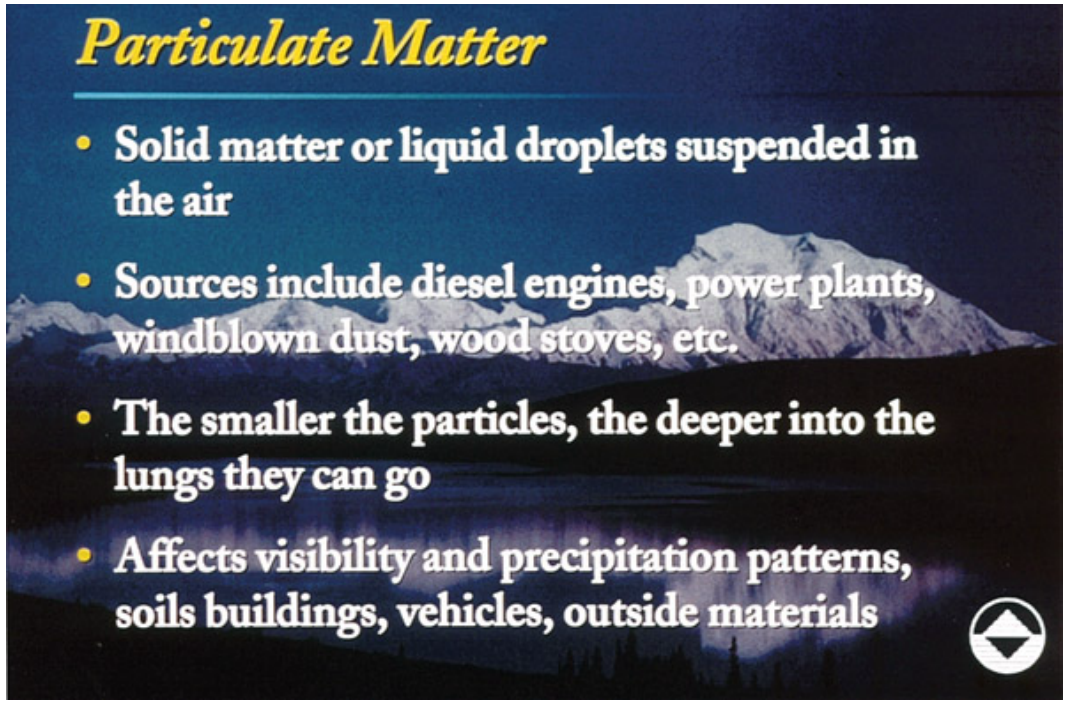


- In the United States, NAAQS have been established for six pollutants: particulate matter (PM10 and PM2.5), sulfur dioxide, nitrogen oxides, carbon monoxide, ozone, and lead. These pollutants are referred to as "criteria pollutants" because concentrations standards for these pollutants were based on information in air quality "criteria documents." That is, there were criteria available upon which to base health and welfare standards.

- For each criteria pollutant except carbon monoxide, both primary and secondary standards have been established. The primary standards are set at levels that protect public health. In other words, if the ambient concentrations of those pollutants remain below their primary NAAQS, it is believed that the most sensitive members of the public (e.g., the very young, the elderly, or the very sick) will not be harmed by breathing the air. The secondary standards are set at levels that protect public welfare.

- This means that if the concentrations remain below the secondary standards, crops, buildings, etc., will not be damaged.

- Other countries have also established air quality goals, some as "legally bound" standards, while others such as Canada, have set "objectives"(or targets) for clean air. Whatever the terminology, the goal is the same: protection of public health and the environment.

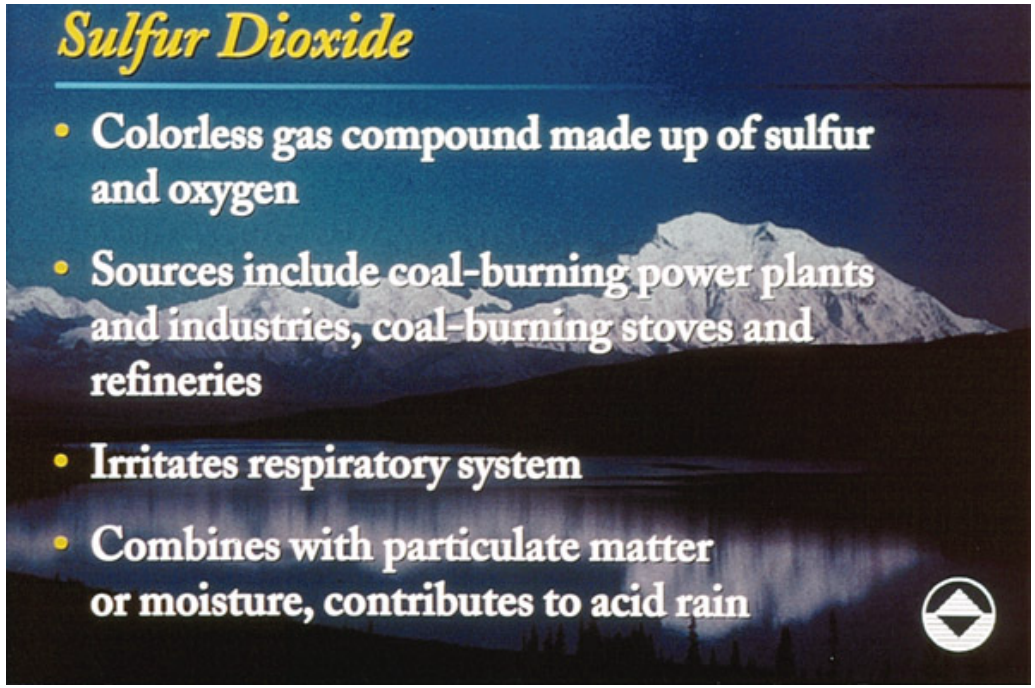


Particulate Matter

- Particulate matter is made up of very small solid or liquid particles, such as soot, dust or other matter, that float in the air and settle very slowly, with the smallest particles remaining suspended indefinitely. Sources of particulate matter include diesel engines, power plants, windblown dust, and wood stoves, among others.

- The degree of damage that particulate matter does depends on the type of particles inhaled, the number of particles inhaled, the size of the particles inhaled, and the general health of the person who inhaled them. Particulate matter that has entered the lungs can cause or worsen the effects of cardiovascular diseases. The size of the particles affect the type of effect they can have. The smaller the particles, the deeper into the lungs they can go.

- Particulate matter can have an adverse effect on visibility, which can reduce our enjoyment of vistas. Particulate matter's ability to absorb and reflect light can also affect the amount of light available for photosynthesis and heating. Particulate matter can affect precipitation patterns, by providing more condensation nuclei. It can also speed up the deterioration of many man-made materials and cause soiling of buildings, vehicles, articles left outside, etc.



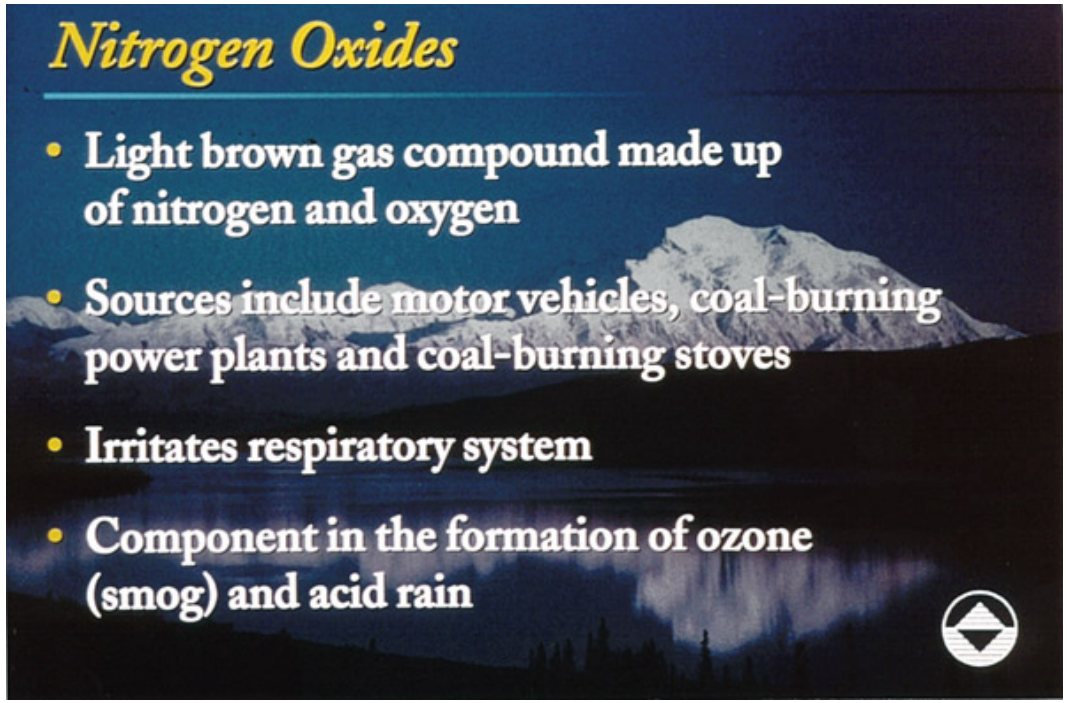
Sulfur Dioxide

- Sulfur dioxide (SO2) is a colorless gaseous compound made up of sulfur and oxygen. Sources of SO2 include coal-burning power plants and industries, coal-burning stoves, and refineries.

- Sulfur dioxide can irritate the respiratory system, particularly in people who suffer from chronic bronchitis, asthma, and similar diseases. People chronically exposed to SO2 have a higher incidence of coughs, shortness of breath, bronchitis, and fatigue. SO2 causes increased resistance to air movement in and out of the lungs, decreases the ability of the lungs to expel foreign matter, and adversely changes the respiratory tissues. When the airways are restricted by irritation from sulfur dioxide, there is a greater burden placed on the heart, as well. Thus sulfur dioxide can aggravate cardiovascular disease.

- The effects of sulfur dioxide are even worse when it combines with particulate matter or moisture in the air. This is referred to as a synergistic effect, because the combination of the two substances creates more of an ill effect than would the total of the ill effects from each of the substances alone.

- Sulfur dioxide also adversely affects our welfare. Most notably, it contributes to the formation of acid rain. Acid rain damages lakes and aquatic life, plant life, building materials, statues, cloth, metals, etc. Sulfur dioxide can also react to produce sulfate particles, which reduce visibility and soil materials.

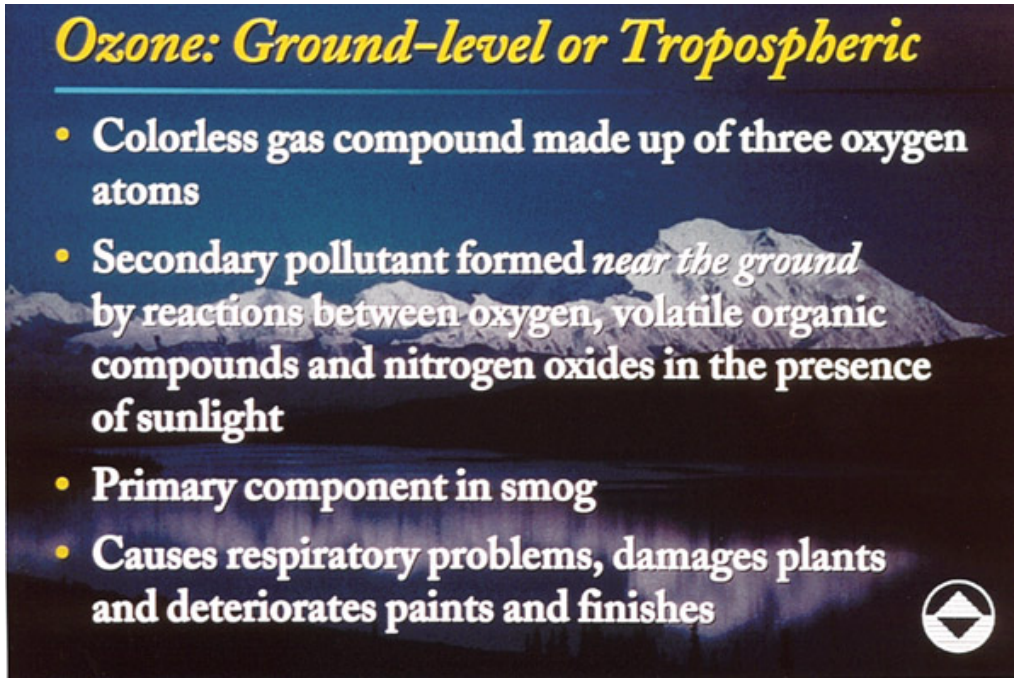


Nitrogen Oxides

- Nitrogen oxides (NOx - *pronounced "noks"*) include several gaseous compounds made up of nitrogen and oxygen which are usually light brown in color. Sources of NOx include motor vehicles, coal-burning power plants, and coal-burning stoves.

- Because of its low solubility in water, nitrogen oxides can penetrate to the remote parts of the lungs, the alveoli, causing irritation of the respiratory system. This can contribute to bronchitis, pneumonia, chronic fibrosis, emphysema, and lowered resistance to infection. It can also adversely affect those with asthma, cause coughing and throat irritation, and possibly damage lung structure after long-term exposure to high levels.

- Nitrogen oxide is a prime component in the formation of ozone, and it also contributes to the formation of acid rain. In addition, NOx can stunt the growth of plants, cause fabrics to fade and deteriorate, and corrode some materials.



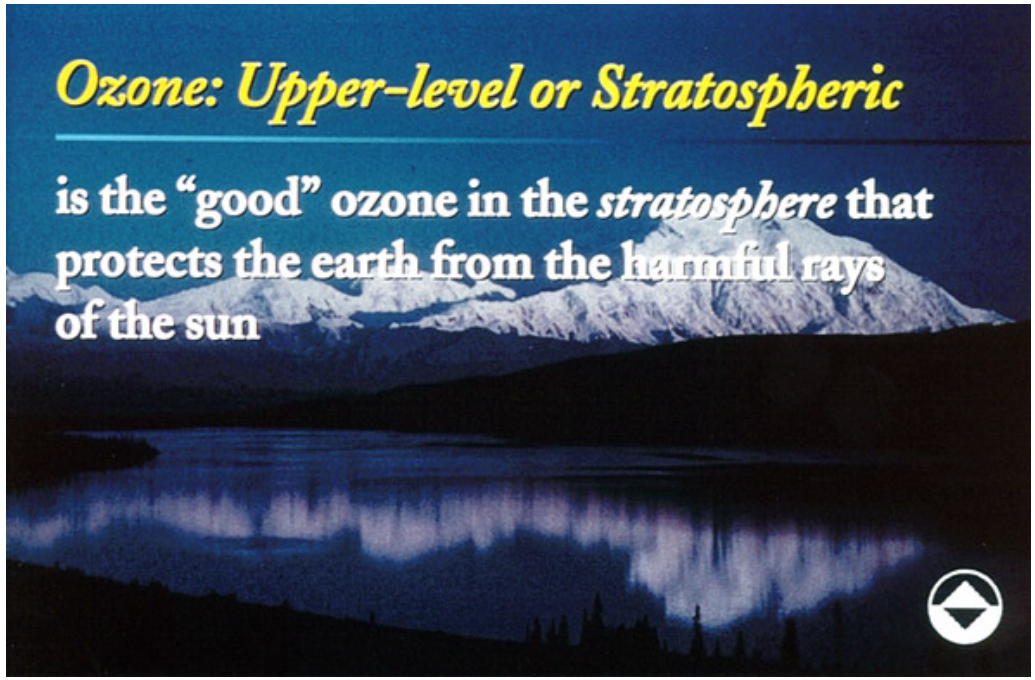
Ozone

- Ozone, the only criteria pollutant that is almost exclusively a secondary pollutant, is a colorless gaseous compound of three oxygen atoms. Ozone is formed primarily by the chemical reaction of nitrogen oxides (NOx) and volatile organic compounds (VOCs) in the presence of sunlight.

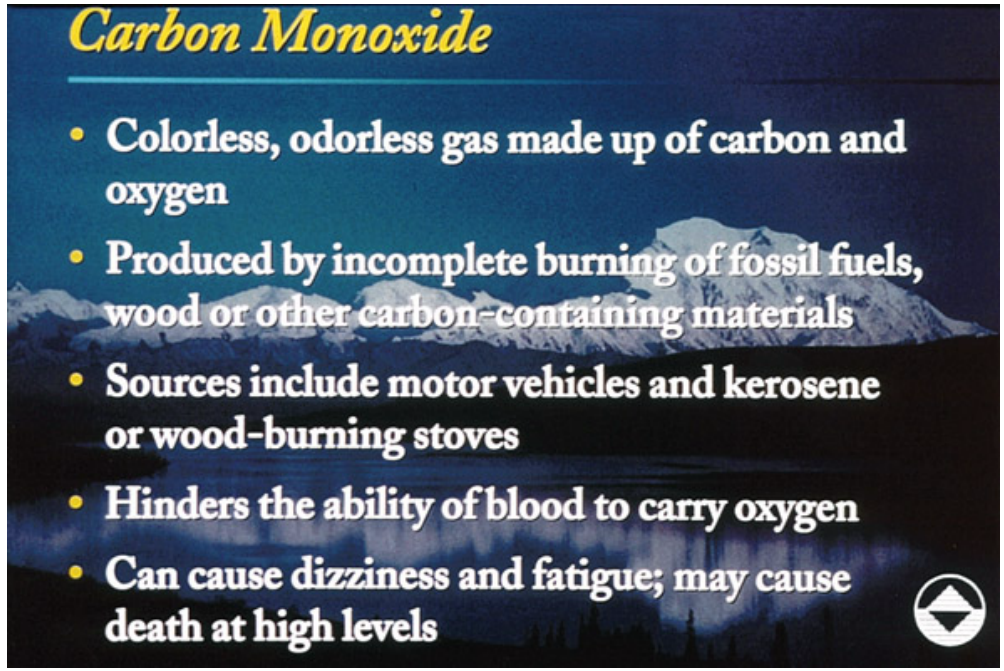
- Sources of NOx include motor vehicles, power plants burning fossil fuels, and coal-burning stoves. VOCs are chemical compounds made up of carbon, oxygen, hydrogen, and other atoms that can form gases easily. They are found in nature as well as in glue, charcoal lighter fluid, solvents, gasoline, tobacco smoke, pesticides and clothes that have been dry-cleaned.

- Ozone is considered to be the primary component of smog. The health effects of ozone are many. It can cause dryness of the mucus membranes in the mouth, nose, and throat; headaches; vision changes; functional changes in the lungs; lung congestion; and edema. It can also increase susceptibility to lung infection and worsen existing respiratory problems, such as asthma. Some people experience nausea, coughing, and chest pain after exposure to ozone. The danger from ozone is greatest among the most vulnerable of the population - the elderly, the sick, newborn babies and infants - but it can affect anyone. The effects of ozone can be acute (immediate) and /or chronic (long-term).

- From a welfare standpoint, ozone is believed to cause more damage to plants than does any other criteria pollutant. The smog, to which it contributes, affects visibility, in addition to the health damage it does. Ozone also deteriorates oil paints, acrylic latex paints, and causes fabrics to fade.



- It is important to note that the ozone about which we are talking is lower-level tropospheric ozone, the pollutant ozone, which is often referred to as "ground-level ozone." Ozone is also found in the stratosphere, where it helps shield the earth from harmful radiation from the sun. It is the stratosphere that contains the well-known "ozone hole." The ozone pollutant does not travel upward to the stratosphere. Stratospheric ozone forms through natural processes at high altitudes.

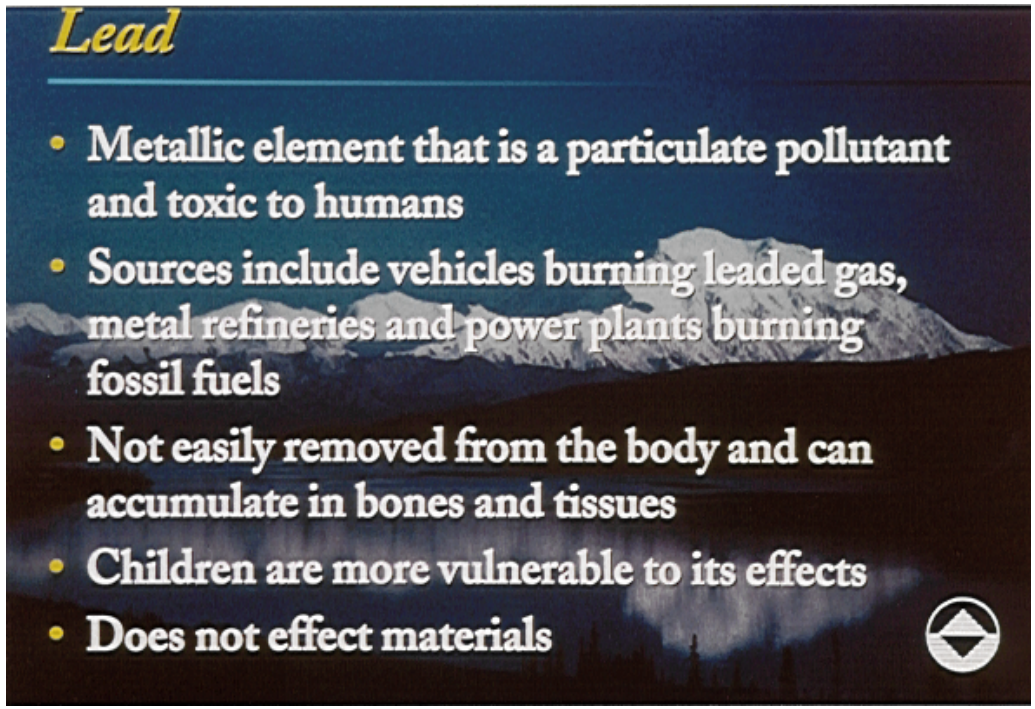


Carbon Monoxide

- Carbon monoxide (CO) is a colorless, odorless gas made up of carbon and oxygen that can be deadly in high concentrations. CO is produced primarily by the incomplete burning of fossil fuels, wood, or other carbon-containing materials. Motor vehicles and kerosene- or wood-burning stoves produce carbon monoxide.

- The seriousness of the effects of carbon monoxide depends upon its concentration and how long a person is exposed to it. Carbon monoxide affects the oxygen-carrying ability of red blood cells. Normally, red blood cells carry oxygen to, and remove carbon dioxide from, almost every cell in the body. However, hemoglobin, which is the oxygen carrier in red blood cells, has a much greater affinity for carbon monoxide than for oxygen. As a result, in the presence of CO, the blood cells carry less oxygen, depriving the body of an adequate supply.

- Short-term exposure to carbon monoxide results in the type of fatigue one feels from anemia. Carbon monoxide can also worsen existing heart and lung disease. At high levels, it deprives the body of enough oxygen to cause death. Those most susceptible to the ill effects of carbon monoxide are the unborn, newborn, aged, and infirm, but anyone can be subject to its effects if the exposure dose is high enough.

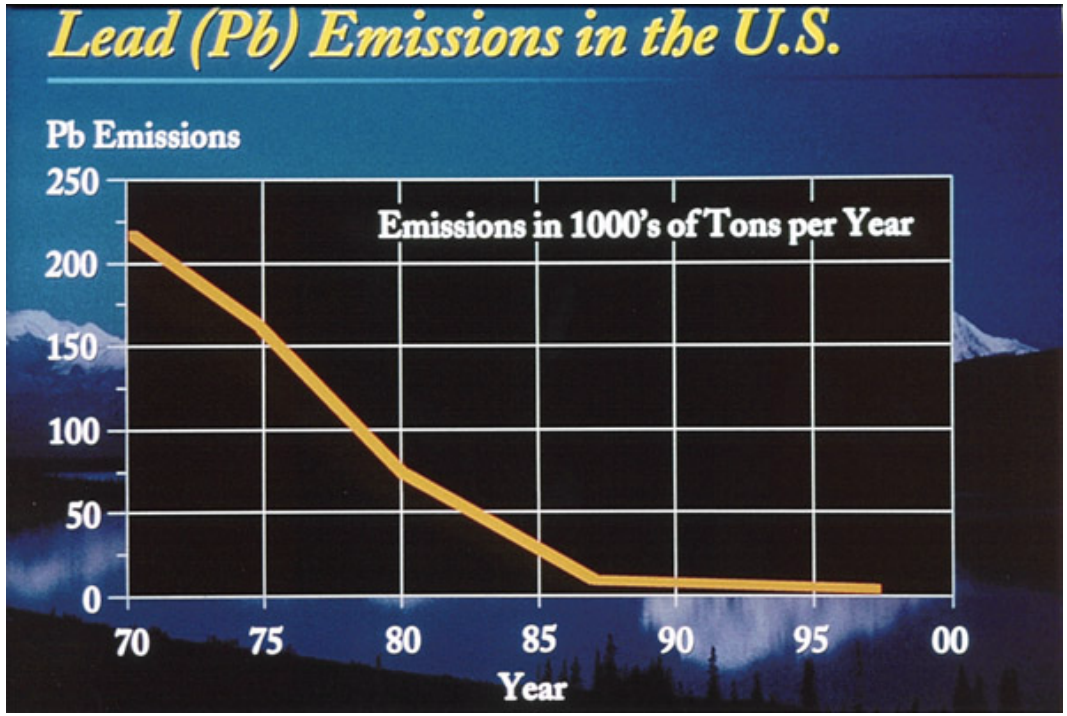


Lead

- Lead is a metallic element that is a particulate pollutant. It is toxic to humans. Although eating and drinking are the principal mechanisms for entry into the body, lead particles can also be inhaled. Sources include vehicles that burn leaded gasoline, metal refineries, and power plants burning fossil fuels.

- Unfortunately, lead is not easily removed from the body, and it can accumulate in the bones and the tissues of various organs. Pregnant woman are especially sensitive to lead pollution, which can cause miscarriages, stillbirths, and deaths of the newborn. In all segments of the population, lead can impair the formation of red blood cells, leading to anemia, irreversible brain damage, and deaths.

- Children are especially vulnerable to lead's effects. Animal studies have shown that lead has adverse effect on cell division, embryos, and cell growth and character. Lead does not seem to have an adverse effect on materials.



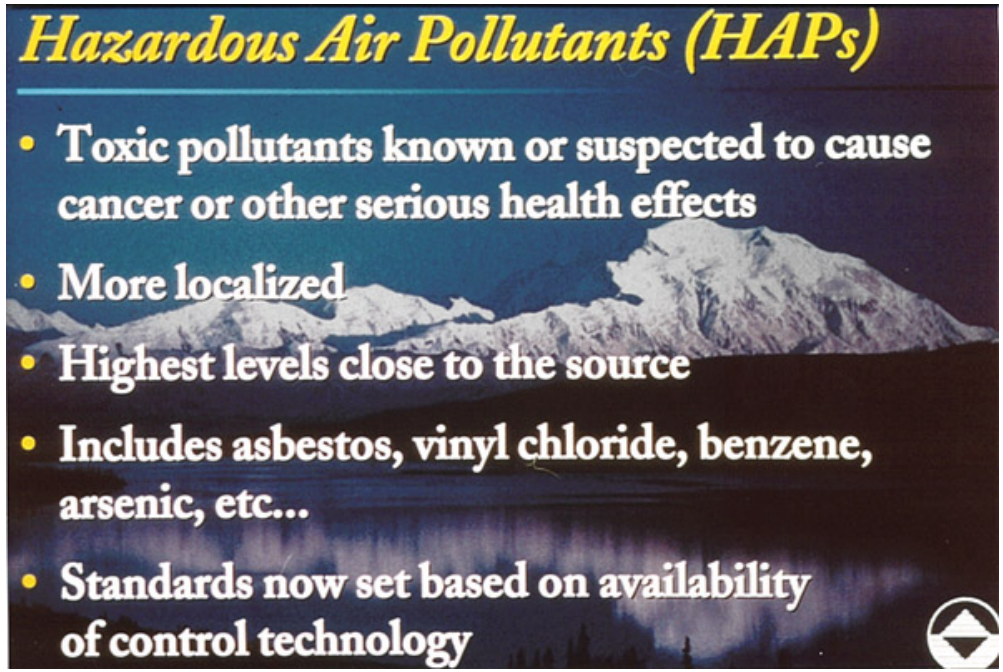
- In the United States and Canada, since the mandated reduction and phase out of lead in gasoline, these problems have been greatly reduced.

Transport and Dispersion of Air Pollutants

- The transport and dispersion of air pollutants are influenced by many factors, including global and regional weather patterns and local topographic features. In the United States and Canada, the prevailing direction for weather patterns is from the west to east. On a more local level, wind and atmospheric stability are the primary factors affecting pollutant transport and dispersion.

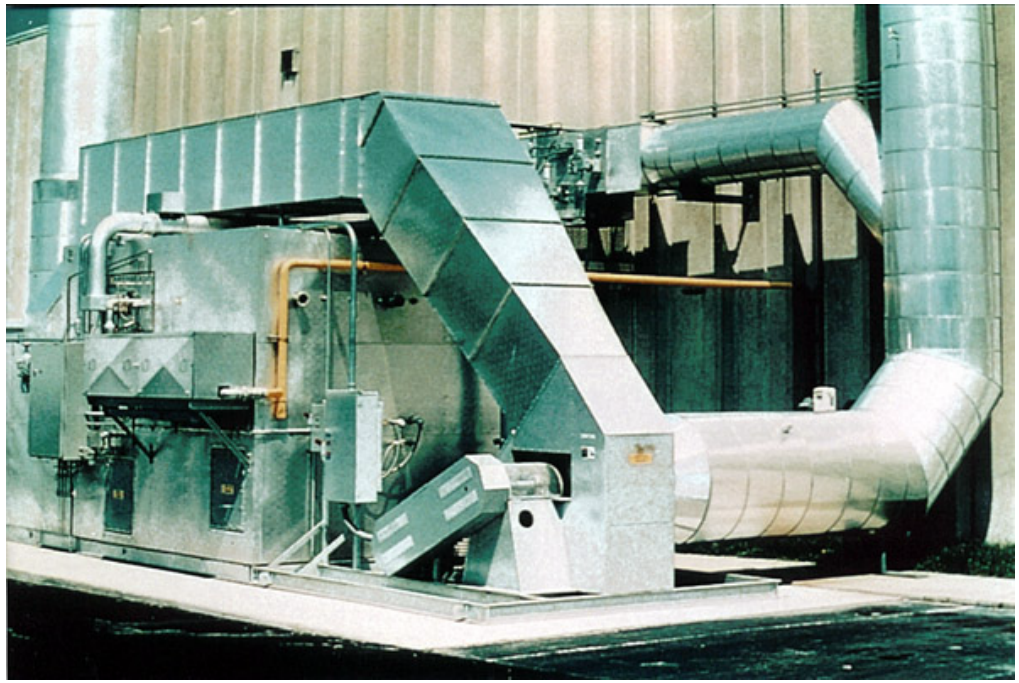
- The movement of air, both horizontally (as with wind) and vertically (as with vertical mixing), have a lot to do with the dispersion of pollutants from a source. Wind dilutes pollutants and also rapidly disperses them. Vertical mixing creates a constant turnover of air

- Dispersion modeling is a technique that uses mathematics and computers to simulate how pollutants are transported and dispersed under varying conditions. It is used to estimate the concentration of pollutants at various distances from a source.



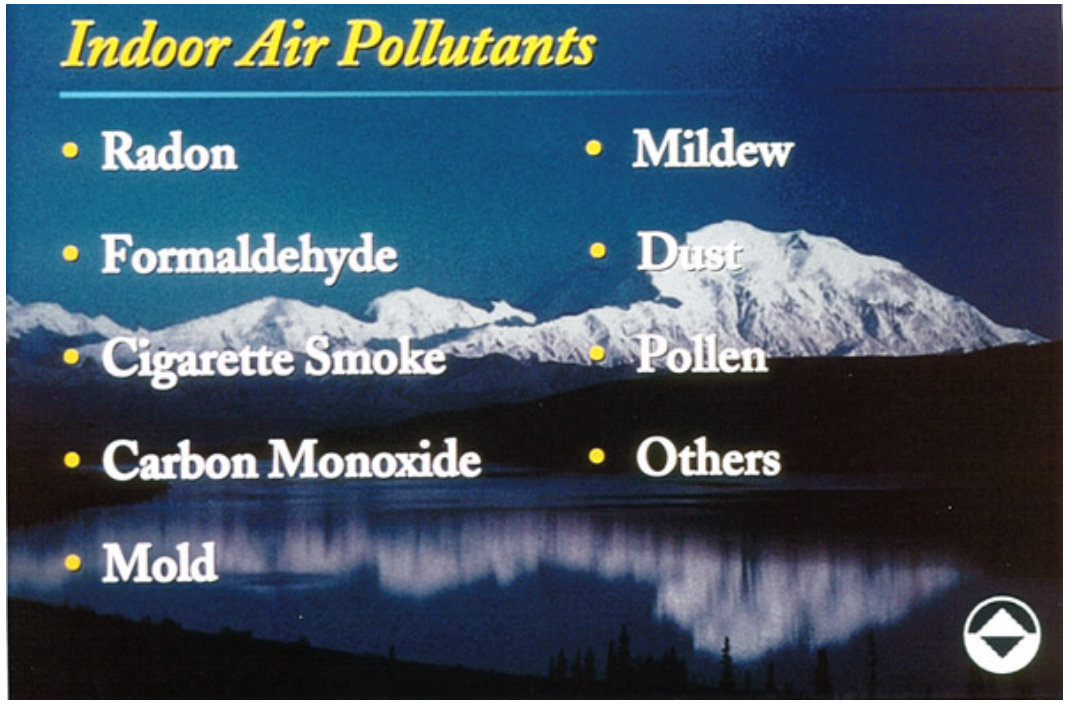
Other Air Quality Concerns

- Hazardous air pollutants (HAPs) are toxic pollutants that are either known or suspected to cause cancer and/or other serious health effects. Their presence in the air is more localized than are criteria pollutants, and they are usually found at highest levels close to their sources.
- In the U.S., after the 1970 amendments to the Clean Air Act, eight HAPs were regulated - asbestos, vinyl chloride, benzene, arsenic, beryllium, mercury, radon, and radionuclides other than radon. However, the 1990 Clean
- Air Act Amendments changed EPA's approach to regulating HAPs. This approach calls for a two-phase regulatory scheme: a technology-based HAPs emission reduction plan to be followed by a second phase of further HAPs emission reduction to eliminate any remaining risk to public health. One hundred eighty-eight specific HAPs are targeted under Phase I of this plan. If the resulting HAPs emissions still cause a public health threat, then those sources emitting such HAPs will be subjected to a second round of emissions reduction requirements. Similar HAPs control approaches are now being adopted in other countries (e.g., Canada).



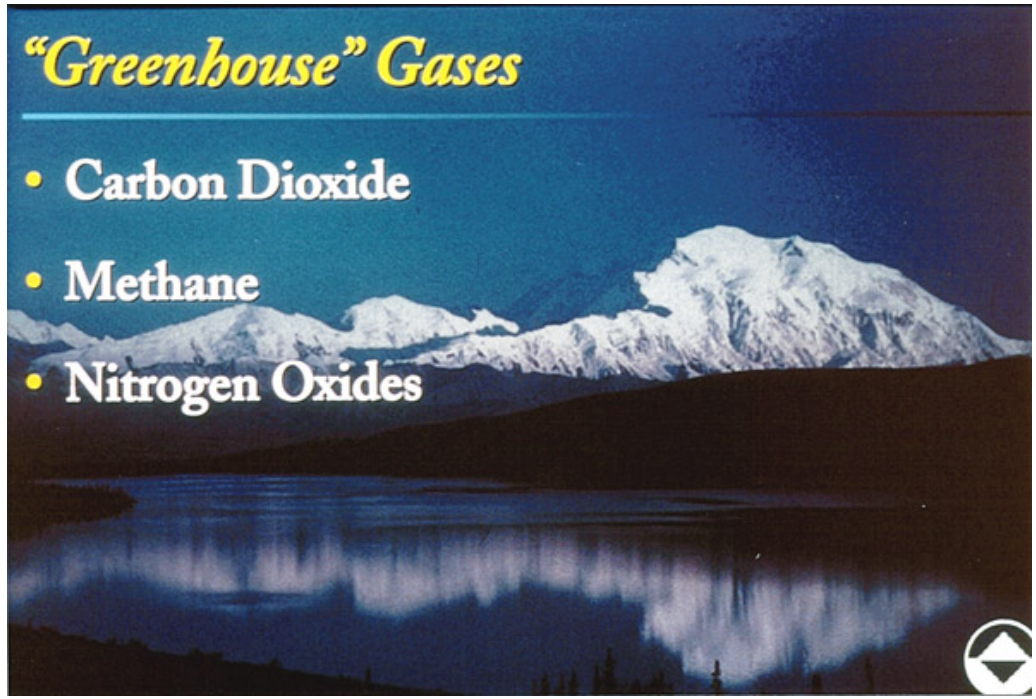
- Rather than basing these standards on health risks, EPA can now set standards based solely on the availability of control technology.

- For many years the study of air pollution was focused almost entirely on outdoor air. An outbreak of Legionnaires' disease at an American Legion convention in Philadelphia, Pennsylvania (USA) during the summer of 1976 helped refocus attention on the problems that can arise from polluted indoor air. Government agencies and industries now devoted a great deal of time and money in effort to prevent and alleviate indoor air pollution problems.

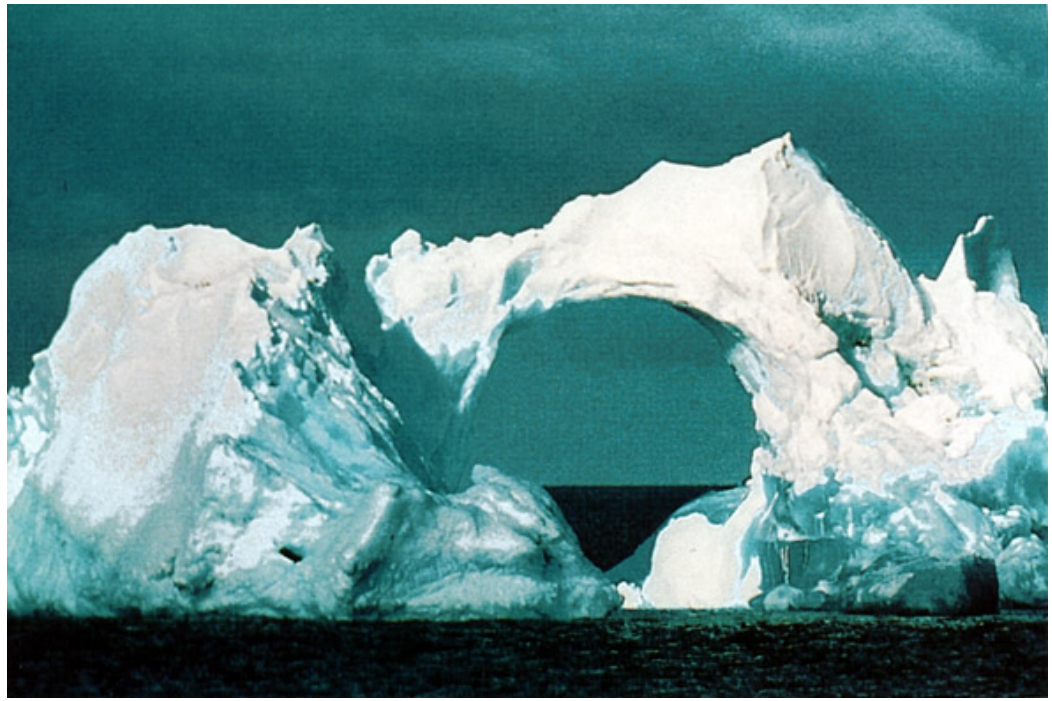


- Examples of indoor air pollutants include radon, formaldehyde, cigarette smoke, carbon monoxide, mold, mildew, dust and pollen.

- There is also an increasing widespread concern that air pollution caused by human activities has potential to create global climate change. Two prominent theories have emerged.



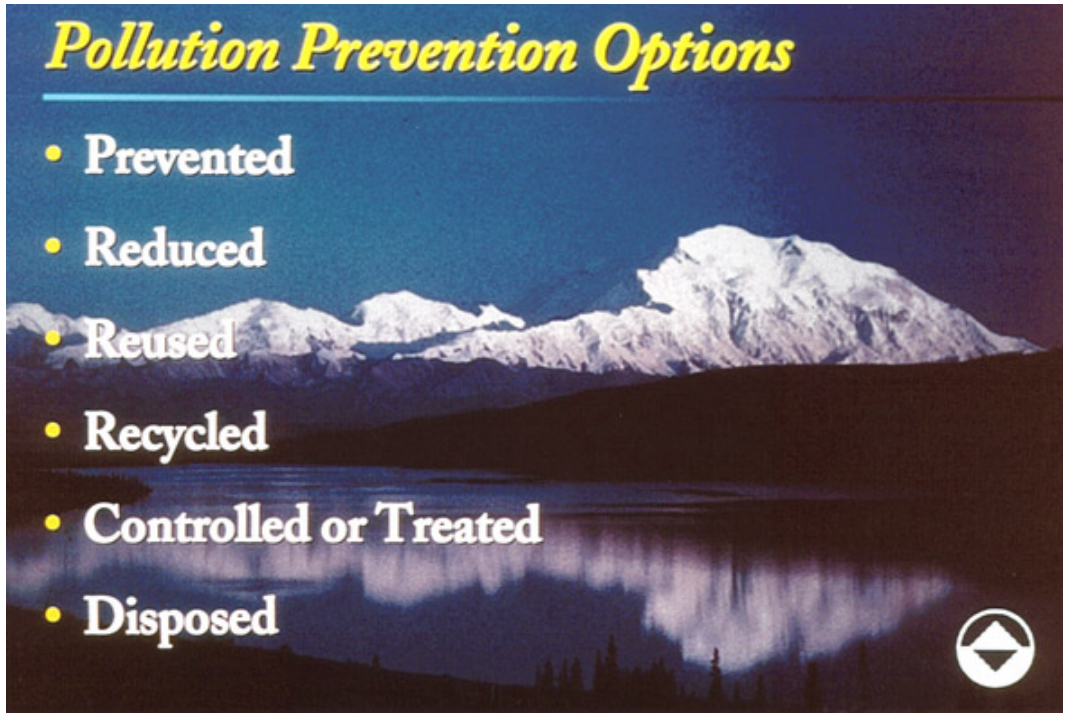
- Some scientists warn that the buildup of carbon dioxide, methane, nitrogen oxides, and other "greenhouse" gases in the atmosphere will cause global warming, with subsequent polar ice cap melting and coastal flooding.



- Others propose that the increased atmospheric load of air pollutants will actually prevent some of the sun's rays from reaching the earth, thereby reducing the earth's temperature and causing a mini ice age.

- In any event, any climate change brought about by air pollution could drastically affect all life on earth.

- During December 1997, ministers and other high-level officials from 160 countries met in Kyoto, Japan. After 10 days of negotiations, they reached agreement on a legally binding Protocol under which industrialized countries will reduce their collective emissions from a group of six greenhouse gases by 5.2% by the years 2008-2012.



Pollution Prevention

- In many jurisdictions, regulatory officials are now focused on the generation of pollutants rather than on the capture and disposal of pollutants. The primary objective is to prevent or reduce pollution at its source. If pollutants cannot be prevented or reduced, they should be reused or recycled in an environmentally acceptable manner. If pollutants cannot be prevented, reduced, or recycled, then they should be controlled or treated to reduce their harmful effects on humans and the environment. Disposal of untreated pollutants should be used only as a last resort. The idea is to analyze the production, use, and ultimate disposal of the product to avoid creating pollution.

- In attempting to prevent or reduce pollution, regulated sources have some cost-effective and prudent alternatives to consider that do not require add-on controls.These include process changes, changes in fuel, good operating practices, marketing by-products (such as flyash from power plants), and temporary plant shutdowns.

- As with most things, deciding to reduce or prevent pollutant emissions comes at a price, and industries, communities, and governmental agencies must weigh the alternatives to come up with plans that in the long run will benefit the most people.

- Continued industrial development will surely generate new challenges to human health and the well-being of the earth's environment as a whole. Addressing the associated problems requires a global perspective, and solving the problems will take a global commitment.

- By thinking globally, and acting locally, we can better ensure the future of the earth and its atmosphere for our children and future generations.

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