Photochemical smog

Photochemical smog is a type of smog produced when ultraviolet light from the sun reacts with nitrogen oxides in the atmosphere. It is visible as a brown haze, and is most prominent during the morning and afternoon, especially in densely populated, warm cities.

Photochemical smog, often referred to as "summer smog", is the chemical reaction of sunlight, nitrogen oxides and volatile organic compounds in the atmosphere, which leaves airborne particles and ground-level ozone. Photochemical smog depends on primary pollutants as well as the formation of secondary pollutants. These primary pollutants include nitrogen oxides, particularly nitric oxide (NO) and nitrogen dioxide (NO_2), and volatile organic compounds. The relevant secondary pollutants include peroxylacyl nitrates (PAN), tropospheric ozone, and aldehydes. An important secondary pollutant for photochemical smog is ozone, which is formed when hydrocarbons (HC) and nitrogen oxides (NO_x) combine in the presence of sunlight; nitrogen dioxide (NO_2), which is formed as nitric oxide (NO) combines with oxygen (O_2) in the air. In addition, when SO_2 and NO_x are emitted they eventually are oxidized in the troposphere to nitric acid and sulfuric acid, which, when mixed with water, form the main components of acid rain. All of these harsh chemicals are usually highly reactive and oxidizing. Photochemical smog is therefore considered to be a problem of modern industrialization. It is present in all modern cities, but it is more common in cities with sunny, warm, dry climates and a large number of motor vehicles. Because it travels with the wind, it can affect sparsely populated areas as well. Airplane used to collect airborne hydrocarbons, May 1972.

The composition and chemical reactions involved in photochemical smog were not understood until the 1950s. In 1948, flavor chemist Arie Haagen-Smit adapted some of his equipment to collect chemicals from polluted air, and identified ozone as a component of Los Angeles smog. Haagen-Smit went on to discover that nitrogen oxides from automotive exhausts and gaseous hydrocarbons from cars and oil refineries, exposed to sunlight, were key ingredients in the formation of ozone and photochemical smog. Haagen-Smit worked with Arnold Beckman, who developed various equipment for detecting smog, ranging from an "Apparatus for recording gas concentrations in the atmosphere" patented on 7 October 1952, to "air quality monitoring vans" for use by government and industry.

Natural Cause

Volcano

An erupting volcano can emit high levels of sulfur dioxide along with a large quantity of particulates matter; two key components to the creation of smog. However, the smog created as a result of a volcanic eruption is often known as vog to distinguish it as a natural occurrence. The chemical reactions that form smog following a volcanic eruption are different than the reactions that form photochemical smog. The term smog encompasses the effect when a large number of gas-phase molecules and particulate matter are emitted to the atmosphere, creating a visible haze. The event causing a large number of emissions can vary but still result in the formation of smog.

Plants

Plants are another natural source of hydrocarbons that could undergo reactions in the atmosphere and produce smog. Globally both plants and soil contribute a substantial amount to the production of hydrocarbons, mainly by producing isoprene and terpenes. Hydrocarbons released by plants can often be more reactive than man-made hydrocarbons. For example when plants release isoprene, the isoprene reacts very quickly in the atmosphere with hydroxyl radicals. These reactions produce hydroperoxides which increase ozone formation.

Health Effects

Smog is a serious problem in many cities and continues to harm human health. Ground-level ozone, sulfur dioxide, nitrogen dioxide and carbon monoxide are especially harmful for senior citizens, children, and people with heart and lung conditions such as emphysema, bronchitis, and asthma. It can inflame breathing passages, decrease the lungs' working capacity, cause shortness of breath, pain when inhaling deeply, wheezing, and coughing. It can cause eye and nose irritation and it dries out the protective membranes of the nose and throat and interferes with the body's ability to fight infection, increasing susceptibility to illness. Hospital admissions and respiratory deaths often increase during periods when ozone levels are high.

There is a lack of knowledge on the long-term effects of air pollution exposure and the origin of asthma. An experiment was carried out using intense air pollution similar to that of the 1952 Great Smog of London. The results from this experiment concluded that there is a link between early-life pollution exposure that leads to the development of asthma, proposing the ongoing effect of the Great Smog. Modern studies continue to find links between mortality and the presence of smog. One study, published in Nature magazine, found that smog episodes in the city of Jinan, a large city in eastern China, during 2011–15, were associated with a 5.87% (95% CI 0.16–11.58%) increase in the rate of overall mortality. This study highlights the effect of exposure to air pollution on the rate of mortality in China. A similar study in X'ian found an association between ambient air pollution and increased mortality associated with respiratory diseases.