

Power Plants and Ozone



Ground-level ozone, sometimes called smog, is the product of atmospheric reactions that are enhanced during the earth's warmest seasons.

When concentrated up high in the stratosphere, ozone (O_3) protects the earth from harmful ultraviolet rays; closer to the earth's surface, ozone is an air pollutant. This ground-level ozone is also known as tropospheric ozone or, more commonly, smog. Ozone is formed when volatile organic compounds (VOC) react in sunlight with nitrogen oxides (NO_x).

A variety of sources, both natural and man-made, emit VOC, including motor vehicles, chemical plants, oil refineries, factories, consumer products, and trees. NO_x is a common by-product of combustion. Principal sources of NO_x in the United States are motor vehicles, industrial processes, and fossil fuel power plants.

As a source of NO_x , power plant emissions play a role in ground-level ozone formation, but quantifying that role has been difficult.

Power plants emit negligible amounts of VOC, but they do account for about one-quarter of NO_x emissions in the United States. Attributing the role of power plants in ozone formation is difficult because (1) ozone is not emitted, but rather produced in the atmosphere from a combination of pollutants from thousands of stationary and mobile sources, and (2) its production depends on many meteorological variables and emissions from a variety of sources, which can change from hour to hour.

Moreover, a region's ozone level cannot be predicted solely on the basis of local NO_x and VOC emissions. In some areas of the United States, the amount of NO_x in the air is the primary determinant of ground-level ozone formation; in other areas the primary determinant is VOC. Another complicating factor is that NO_x and VOC, and ozone itself, can be transported hundreds of miles downwind of their sources. Sophisticated computer models have been developed and used to predict ozone concentrations and assist regulators in developing action plans to attain clean air standards. These models are also used to determine reductions in VOC and NO_x emissions needed to assure meeting allowable ozone levels. The models must account for such factors as variations in NO_x and VOC emissions from all sources in a region, the location and height of emission sources (e.g., tall smokestacks vs. car tailpipes), and a host of meteorological factors.

Over the past several years, the models have been improved with respect to their ability to accurately establish the role of NO_x and VOC emissions in ozone formation. Accordingly, researchers have developed more precise methods to estimate how reducing NO_x or VOCs from specific sources will affect the intensity of ground-level ozone. The Electric Power Research Institute's (EPRI) plume-in-grid model and photochemical model research are making significant contributions to these efforts. For example, EPRI research has found that NO_x emitted from tall stacks is less efficient in producing ozone than NO_x emitted from more dilute, ground-based sources, and that this trend will continue into the future.

Strategies to reduce ozone levels must consider a complex mixture of local and regional factors.

Regulators measure the level of ozone in the air to determine if a region is in compliance with national ambient air quality standards (NAAQS); these standards set limits on pollutant levels in order to protect human health and the environment. Currently, the U.S. Environmental Protection Agency (EPA) enforces a NAAQS for ambient ozone concentrations of 0.08 parts-per-million (ppm) averaged over an 8-hour period. In 2005, EPA set forth final rules for implementation of the ozone standard: state, tribal and local governments must develop plans showing how they will attain or

maintain the 8-hour ozone standard. These plans, known as state implementation plans or SIPs, were due to EPA by June 2007.

In March 2005, EPA issued the Clean Air Interstate Rule (CAIR) to address the transport of air pollutants across state boundaries. This federal regulation specifically addresses the contributions of power plants in the eastern U.S. to ozone and particulate matter in states lying in the downwind direction. By 2015, CAIR will reduce power plant NO_x emissions by 2 million tons, achieving an emissions level of 1.3 million tons in the eastern U.S., a 61% reduction from 2003 levels. The combination of CAIR and the Acid Rain Program will result in a national emissions level of 2.2 million tons, equivalent to a 67% reduction from 1990 levels. Notwithstanding federal regulations, state implementation plans may include more-stringent regulations on emissions sources, including more-stringent controls on power plants beyond the requirements of CAIR, if necessary to demonstrate attainment of the NAAQS.

At levels above current government standards, ground-level ozone can aggravate human health conditions, such as asthma. At lower levels, scientists disagree about the human health impacts.

Ozone is a respiratory irritant. It has been associated with respiratory symptoms and temporarily impaired lung function in moderately exercising subjects at 0.08 ppm for an exposure period of between 6 and 7 hours. These studies did not examine subjects at levels below 0.08 ppm. Animals exposed to ozone have been shown to have increased inflammation of the airways, changes in breathing pattern, and airway hyper-responsiveness at concentrations similar to those at which effects are observed in humans.

Many epidemiological studies have examined the association between ozone and health effects; however, the results of these studies have not been consistent. Some studies, including some results for the EPRI-funded ARIES study, report an association between ozone levels and asthma, but there are other recent studies that implicate other pollutants, especially some carbon-containing compounds. It is unclear whether ozone itself is the culprit or whether the observed associations are due to other unmeasured pollutant(s) that form in the atmosphere under conditions similar to those under which ozone is produced. In addition, ozone effects can be confounded by weather.

A recent paper using data from 95 large U.S. cities has reported a statistical association between short-term (less than 24-hour) ozone exposure and increased mortality; however, some questions have been raised about the lack of correspondence between ozone levels and health effects in the different cities. The EPRI-Washington University Veterans study found an association between longer-term ozone exposure and mortality, although other studies suggest that the current annual ozone air quality standard is protective.

Ground level ozone can also affect sensitive plant species.

EPA is proposing to revise the national ambient air quality standard for ozone by March 2008.

On June 20, 2007, EPA proposed to lower the NAAQS for ground-level ozone. EPA proposes to set the primary (health) standard to a level within the range of 0.07 to 0.075 ppm. EPA is also proposing a secondary ozone standard designed specifically to protect sensitive plants from excessive ozone exposure throughout the growing season. This cumulative standard would add daily ozone concentrations across a three-month period. EPA is proposing to set the level of the cumulative standard within the range of 7 to 21 ppm-hours. EPA will issue final standards in March 2008; EPA will make non-attainment designations on June 2010 and require submission of new SIPs by June 2013.

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