AIR & WASTE MANAGEMENT ASSOCIATION

Fact Sheet:

Ozone

INTRODUCTION

The issue of ozone in the earth's atmosphere can be confusing. On the one hand, we know that high above the earth's surface is a layer of ozone that surrounds the planet and helps block out some of the sun's harmful radiation. We hear reports of "holes" developing in this ozone shield and the harm that the increased ultraviolet radiation can cause on earth.

On the other hand, we hear that higher-than-normal concentrations of ozone in the air we breathe can be harmful to people, animals, plants, and various materials.

WHAT IS OZONE?

Ozone is a form of oxygen that consists of three chemically-bonded atoms rather than two. Ozone is formed by the reaction of an oxygen atom with an oxygen molecule. Oxygen atoms can be formed by electrical discharges or certain forms of radiation, especially ultraviolet light, in air.

The ozone in both places is the same-it's the chemical O3-but in the upper atmosphere it greatly benefits all life, whereas near the earth's surface it can cause problems.

THE EARTH AND ITS ATMOSPHERE

We can envision outdoor air as a vast blanket of gases surrounding the earth. This blanket of air, the earth's atmosphere, is made up of a number of layers defined by their functions or characteristics. The layer near the earth's surface-the troposphere-contains the greatest concentration of gases and the ground-level air we breathe.

The troposphere reaches from the ground to about ten miles (16 kilometers) above the earth. When we discuss air pollution and air quality, we are primarily concerned with ambient air-the air that surrounds us in the troposphere.

Ambient air is the air we feel when the wind blows, the air we see when it is filled with mist or smoke, and the air we breathe. It contains most of the air pollutants that affect humans, including the nitrogen oxides, volatile organic compounds (VOCs), and other gases that react to form "ground-level ozone."

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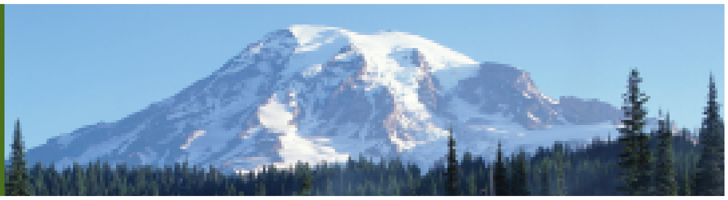

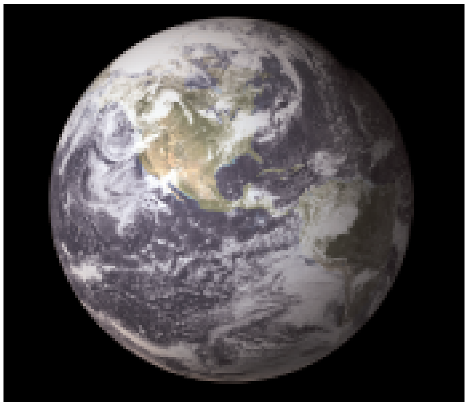

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The troposphere also contains the water droplets and dust particles that form clouds. The weather we experience on the earth occurs in this layer.

The stratosphere is from about 10 to 31 miles (16 to 50 kilometers) above the earth. In the stratosphere, a layer of ozone forms an important and effective protective barrier against the harmful ultraviolet light from the sun.

THE STRATOSPHERIC OZONE LAYER

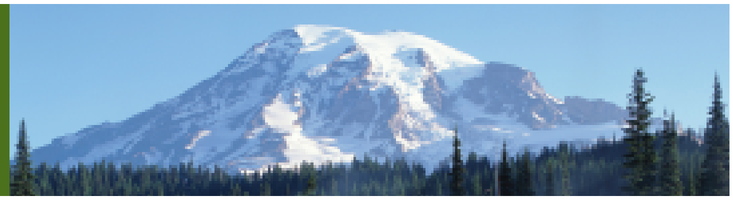
It is important to note that ground-level ozone in the troposphere does not usually travel upward to the stratosphere. Ozone in the stratosphere is made and destroyed naturally all the time. For this reason, the layer varies in thickness. Stratospheric ozone absorbs the sun's ultraviolet rays, thus both heating the air and filtering out excessive UV radiation from reaching the earth.

There is increasing global concern among scientists around the world that chemical pollutants are destroying the stratospheric ozone layer. The main culprits seem to be in a class of chemical compounds called chlorofluorocarbons, or CFCs. First introduced in the late 1920s, these gases, sometimes referred to as "freons," have been used as coolants for air conditioners and refrigerators, propellants for aerosol sprays, blowing agents for producing plastic foam, and cleaning solvents in the electronics industry.

CFCs do not degrade easily in the troposphere. They can rise to the stratosphere where they are broken down by ultraviolet light. The chlorine atoms from the CFCs then destroy the ozone molecules in a series of complex reactions. The chlorine atom acts as a catalyst and is unchanged in the process. One chlorine atom has the potential to destroy as many as 10,000 ozone molecules before it bonds with another atom and returns to the troposphere.

Another class of chemicals, "halons," which are used in fire extinguishing foam, also destroy ozone in a similar catalytic fashion. Halons contain a bromine atom, which acts like the chlorine atom in CFCs, to destroy ozone.

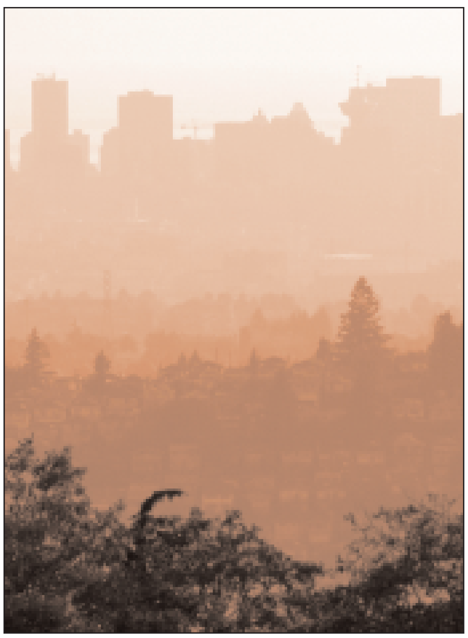
To combat the growing problem with CFCs worldwide, the United States, Canada, and some European countries banned nonessential use of CFCs, such as propellants or aerosols used in spray cans, in 1978. In 1987, thirty-one countries met in Montreal and signed the Montreal Protocol, which requires countries to cut CFC use in half by 1999. Since the Protocol was signed, there have been major advances in CFC-alternative technology for use in food packaging and solvents and refrigeration. But even if all use of CFCs was halted today, some scientists predict that CFCs already released into the atmosphere will continue to deplete the ozone layer for decades to come.



GROUND-LEVEL OZONE

What we often refer to as "smog" is mostly ground-level ozone. Smog (whose name derives from smoke and fog) can be visualized as the brown haze commonly found in Southern California and major cities.

The recipe for the formation of ground-level ozone includes natural atmospheric gases, volatile organic compounds (VOCs), nitrogen oxides, and sunlight. Because sunlight is a key factor, ozone pollution is generally worse during the day and in the summertime. Vehicle exhaust provides much of the VOCs and nitrogen oxides, so times of increased vehicle use (such as morning and afternoon rush hours) also increase the possibility of ozone problems.



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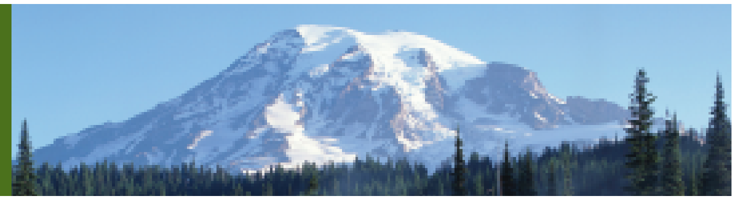
VOCs are chemical compounds made up of carbon and hydrogen, and may contain other atoms. These compounds form gases and vapors easily. Often referred to as hydrocarbons, VOCs are found in nature (e.g., from plants) as well as in gasoline, charcoal lighter fluid, paint, solvents, and even clothes that have been dry- cleaned. Industrial sources emit VOCs as well.

Each time we refill the gas tank in our cars, lawn mowers, or motor boats, VOCs are being released into the ambient air. During the refueling process, we can actually smell the VOCs that are being released as the strong, pungent gasoline fumes escape. Pumps at many gasoline stations now have rubber attachments that help trap VOCs that would escape during refueling.

Nitrogen oxides are produced by high temperature combustion processes, such as burning the fossil fuels coal, oil, and natural gas, and some industrial processes.

Ground-level ozone found in the troposphere is one of the "criteria pollutants," those harmful substances that are most widespread in the ambient air. In the United States, the federal government sets national standards for criteria pollutants to define levels that protect human health and the environment. It is interesting to note that ozone is the only criteria pollutant that is almost exclusively a "secondary pollutant." This means that a chemical reaction, which involves "precursor" pollutants, needs to take place in order to form ozone. The major precursors to ground-level ozone are volatile organic compounds (VOCs), nitrogen oxides (NOx), and energy (sunlight).

Meteorological conditions such as surface temperature, humidity, wind speed, and cloud cover are factors in the development of ground-level ozone. In addition, weather patterns can either help to disperse the problem, transport it to a different location, or stall it and foster the build-up of pollutants to extremely hazardous levels.



EFFECTS OF GROUND-LEVEL OZONE

High concentrations of ozone in the air we breathe can present many problems. Because ozone molecules are highly reactive, they have an oxidizing effect on practically every material they contact, whether it be lung tissue, crops or other vegetation, rubber, plastic, paints, and so on.

For humans, the potential health symptoms include dryness of 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 the greatest among the most vulnerable of the population (the elderly, the sick, young children), but it can affect anyone. The effects of ozone can be acute (immediate) and/or chronic (long-term).

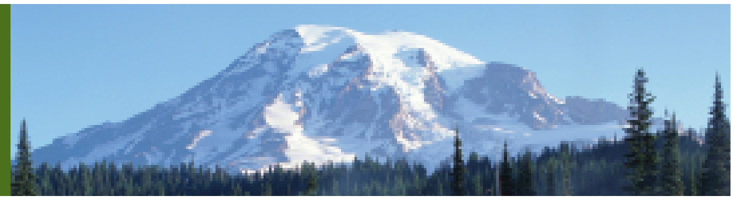
GROUND-LEVEL OZONE REGULATIONS

Many countries have implemented regulatory programs to reduce ground-level ozone. These programs require the monitoring of ground-level ozone to ensure that the health-based air quality standards are being met and require lower emissions of VOCs and NOx.

For example, in 1997 the U.S. Environmental Protection Agency (EPA) revised its National Ambient Air Quality Standard (NAAQS) for ground-level ozone. The new standard is 0.08 parts per million measured over eight hours, replacing the old standard of 0.12 parts per million measured over 1 hour. In addition, the average fourth highest concentration over a three-year period will determine whether an area is out of compliance.

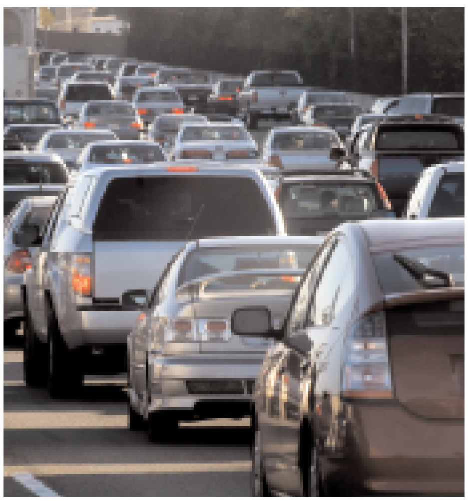
Based on the number of “exceedances” over a certain period of time, a geographic area may be given a classification, such as being “in attainment” or “non-attainment” with the ambient air standard. The non-attainment classification is further broken down into classifications such as “moderate” or “severe.” Once an area has received a non-attainment classification, it has to comply with other special regulations that reduce emissions of VOCs and NOx in an attempt to improve air quality and bring the area into attainment with the ozone standard.

In April 2004, the U.S. EPA announced designations of nonattainment for the eight-hour ozone standard. Areas of the country that have been designated as nonattainment now have to formulate and submit plans to EPA on how they will meet the standard. The plans are due in 2007.



WHAT CAN BE DONE?

Both ozone problems, -stratospheric depletion and tropospheric build-up, -are created in large part by air pollution. The only practical approach to stopping the destruction of the ozone layer and to minimizing ozone pollution in our ambient air is to reduce the human-generated pollutants that contribute to these problems. Finding and using alternatives to CFCs is an essential part of the solution. Decreasing NOx and VOC emissions are critical to solving the problem of ground-level ozone. Important sources of these emissions include power plants and industrial sources, as well as our use of fossil-fuel burning vehicles. Assuring that our vehicle emission control systems are functioning properly is critical to reducing these emissions. Here are some more examples of what we can do:



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STRATOSPHERIC OZONE

Promptly repair leaks in your refrigerator and air conditioner
Make sure the CFCs are recycled when these units are serviced
If you scrap your car, make sure the CFCs in the air conditioner are recycled
Use alternatives to home air conditioning
Purchase halon-free fire extinguishers
Support laws requiring CFC recycling

GROUND-LEVEL OZONE

You can access daily air quality forecasts for over 300 major U.S. cities and real-time ozone air quality data for 46 U.S. states and parts of Canada via the Internet at www.epa.gov/airnow. During the ozone season (summer months), many areas have “ozone action” or “spare the air” days, which encourage citizens and industries to voluntarily follow procedures to reduce the amount of precursor pollutants released into the air that may produce ozone. Here are a few examples:
Limit driving
Combine errands to avoid “cold starts”
Ride the bus or carpool to work
Walk or bicycle for short trips
Avoid prolonged idling and jack rabbit starts
Refuel carefully (preferably at night) - don’t top off your tank
Postpone using gasoline powered lawn and garden equipment and postpone mowing lawns until evening
Switch to electric or push mowers
Use latex rather than oil based paints
Save energy - don’t overcool houses/offices
Wash dishes and clothes with full loads
Reduce industrial VOC and NOx emissions

Many cities and, regions have voluntary ozone action programs with which individual citizens and businesses can become involved. Contact your state/provincial or local environmental protection agency or health department for more information.