

# How Ozone Pollution Works

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## Introduction to How Ozone Pollution Works

The weather report on the [radio](#) or [TV](#) tells you that it is going to be sunny and hot and that an orange **ozone alert** has been issued. What is ozone? What does an orange alert mean? Why should you be concerned about it?



Photo courtesy U.S. EPA

**Ozone is a major component of smog.**

In this article, we will examine what ozone is, how it is produced, what health hazards it poses and what you can do to reduce ozone pollution.

**Ozone** is a molecule of three oxygen atoms bound together (**O<sub>3</sub>**). It is unstable and highly reactive. Ozone is used as a bleach, a deodorizing agent, and a sterilization agent for air and drinking water. At low concentrations, it is toxic.

Ozone is found naturally in small concentrations in the **stratosphere**, a layer of Earth's upper atmosphere. In this upper atmosphere, ozone is made when ultraviolet light from the [sun](#) splits an oxygen molecule (**O<sub>2</sub>**), forming two single oxygen [atoms](#). If a freed atom collides with an oxygen molecule, it becomes ozone. **Stratospheric ozone** has been called "good" ozone because it protects the Earth's surface from dangerous [ultraviolet light](#).

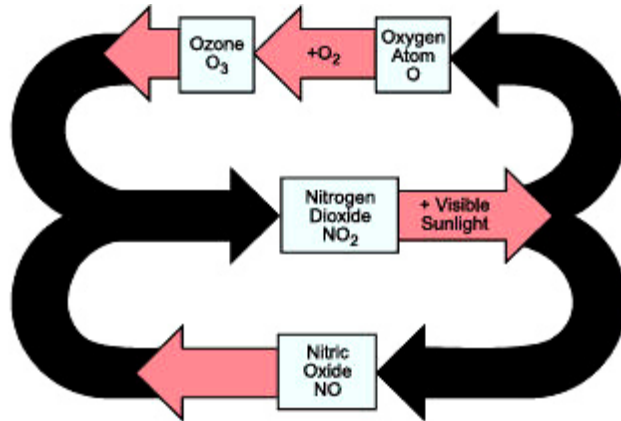
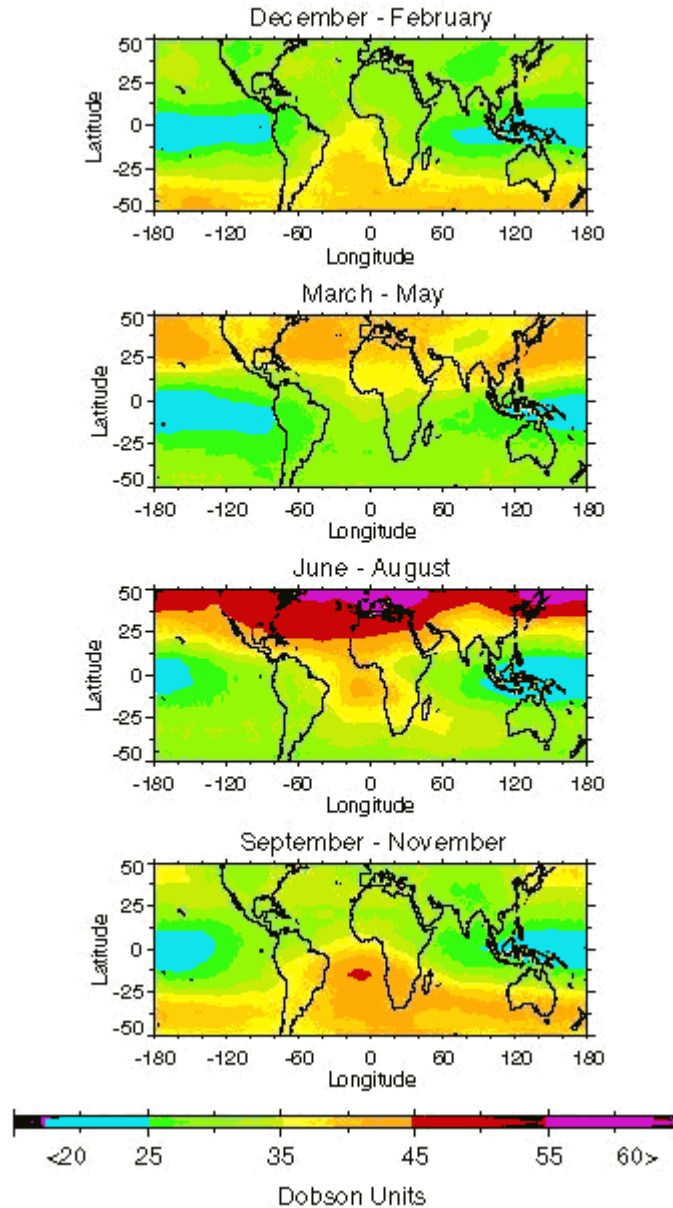


Photo courtesy [NIEHS/NIH](#)

**Ozone production from NO<sub>x</sub> pollutants: Oxygen atoms freed from nitrogen dioxide by the action of sunlight attack oxygen molecules to make ozone. Nitrogen oxide can combine with ozone to reform nitrogen dioxide, and the cycle repeats.**

Ozone can also be found in the **troposphere**, the lowest layer of the atmosphere. **Tropospheric ozone** (often termed "bad" ozone) is man-made, a result of air pollution from [internal combustion engines](#) and [power plants](#). Automobile exhaust and industrial emissions release a family of **nitrogen oxide gases** (NO<sub>x</sub>) and **volatile organic compounds** (VOC), by-products of burning [gasoline](#) and coal. NO<sub>x</sub> and VOC combine chemically with oxygen to form ozone during sunny, high-temperature conditions of late spring, summer and early fall. High levels of ozone are usually formed in the heat of the afternoon and early evening, dissipating during the cooler nights.



**Worldwide seasonal changes in tropospheric ozone: Tropospheric ozone increases during summers in the northern and southern hemispheres when the climate is hot. The most tropospheric ozone is observed during summer in the northern hemisphere.**

Although ozone pollution is formed mainly in urban and suburban areas, it ends up in rural areas as well, carried by prevailing winds or resulting from cars and trucks that travel into rural areas. Significant levels of ozone pollution can be detected in rural areas as far as 250 miles (150 km) downwind from urban industrial zones.

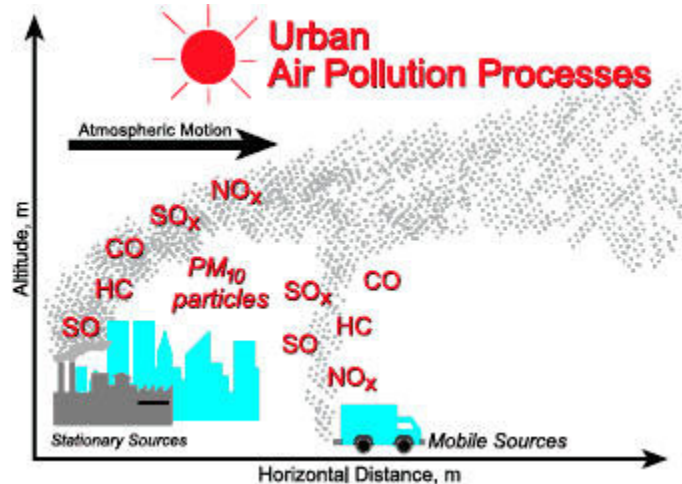


Photo courtesy [NIEHS/NIH](#)

Ozone pollution can travel from urban to rural areas.

### Make Your Own Ozone Detector

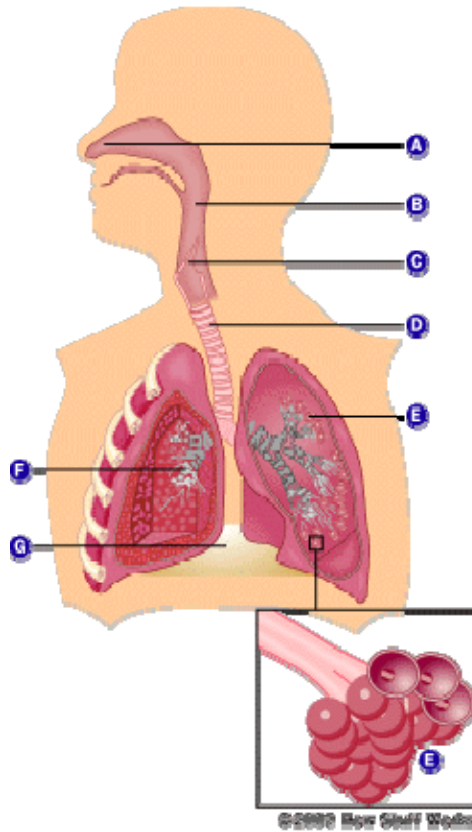
You can make ozone test strips to detect and monitor ozone levels in your own backyard or around your school. You will need:

- corn starch
- filter paper (coffee filters work well)
- potassium iodide (can be ordered from a science education supplier such as [Carolina Biological Supply](#) or [Fisher Scientific](#))

Basically, you make a paste from water, corn starch and potassium-iodide, and you paint this paste on strips of filter paper. You then expose the strips to the air for eight hours. Ozone in the air will react with the potassium iodide to change the color of the strip. You can then read the ozone concentration from a chart that is available at [this Web site](#). You will also need to know the [relative humidity](#), which you can get from a newspaper, weather broadcast or home weather station. See [Ground Level Ozone Testing](#) for details.

### Avoiding and Reducing Ozone

When you inhale ozone, it travels throughout your respiratory tract. Because ozone is very corrosive, it damages the bronchioles and alveoli in your [lungs](#), air sacs that are important for gas exchange (see [How Your Lungs Work](#) for details). Repeated exposure to ozone can inflame lung tissues and cause respiratory infections.



- A Nasal cavity**
- B Pharynx**
- C Larynx**
- D Trachea**
- E Alveoli**
- F Bronchial tree**
- G Diaphragm**

Ozone exposure can aggravate existing respiratory conditions such as asthma, reduce your lung function and capacity for exercise and cause chest pains and coughing. Young children, adults who are active outdoors and people with respiratory diseases are most susceptible to the high levels of ozone encountered during the summer.

In addition to effects on humans, the corrosive nature of ozone can damage plants and trees. High levels of ozone can destroy agricultural crops and forest vegetation.



Photo courtesy [NARA](#), photographer Gene Daniels/U.S. EPA  
**Ozone-damaged plant (left) and normal plant (right)**

### Avoiding Ozone Exposure

To protect yourself from ozone exposure, you should be aware of the Air Quality Index (AQI) in your area everyday -- you can usually find it in the newspaper or on a morning weather forecast on TV or radio. You should also be familiar with the [U.S. Environmental Protection Agency](#) (EPA) guide for ozone-alert values.

What do the numbers in the AQI mean? The AQI measures concentrations of five air pollutants: ozone, sulfur dioxide, particulate matter, carbon monoxide and nitrogen dioxide. The EPA has chosen these pollutants as criteria pollutants, but these are not all of the pollutants in the air. These concentrations are compared to a standard set out in federal law. An index value of 100 means that all of the criteria pollutants are at the maximum level that is considered safe for the majority of the population -- a yellow alert on the chart below. Numbers above 100 indicate higher concentrations and therefore a greater risk to most individuals.

U.S. EPA Air Quality Guide for Ozone			
Air Quality Index	Color	Air Quality	Prediction
0 to 50	Green	Good	No health impacts are expected.
51 to 100	Yellow	Moderate	Unusually sensitive people should limit prolonged outdoor activity.
101 to 150	Orange	Unhealthy for sensitive groups	Active people and those with respiratory disease should limit prolonged outdoor activity.
151 to 200	Red	Unhealthy	Active people and those with respiratory disease should avoid

			prolonged outdoor activity; all others should limit prolonged outdoor activity.
201 to 300	Purple	Very unhealthy	Active people and those with respiratory disease should avoid all outdoor activity; all others should limit outdoor activity.

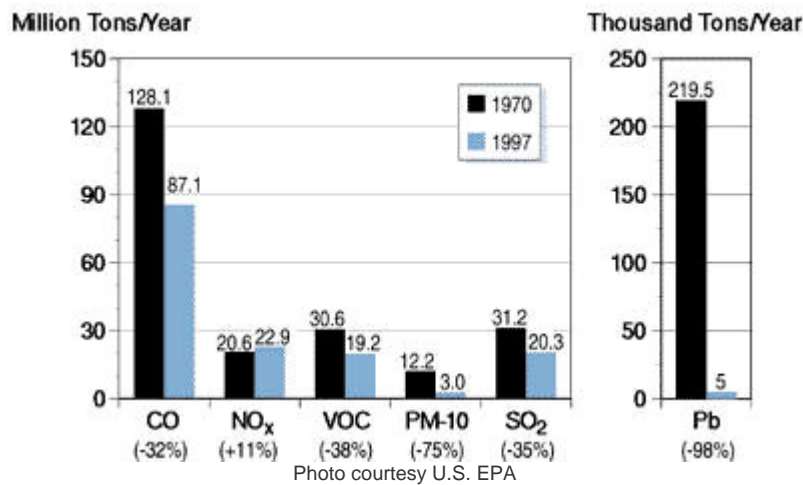
To reduce your exposure to ozone, you should avoid exercising during afternoon and early evening hours in the summer.

### Reducing Ozone Pollution

There are several ways you can help to decrease ozone pollution:

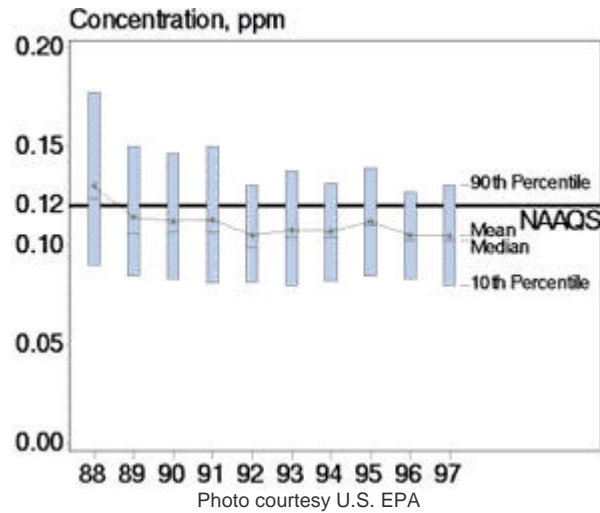
- Limit using your automobile during afternoon and early evening hours in the late spring, summer and early fall.
- Do not use gasoline-powered lawn equipment during these times.
- Do not fuel your car during these times.
- Do not light fires or outdoor grills during these times.
- Keep the engine of your car or boat tuned.
- Make sure that your tires are properly inflated.
- Use environmentally safe paints, cleaning and office products (some of these chemicals are sources of VOC).
- Conserve energy.

Besides personal attempts to reduce ozone pollution, the EPA has initiated more stringent air-quality standards (such as the Clean Air Act and its modifications) to reduce air pollution. Compliance with these standards by industries, manufacturers and state and local governments has significantly reduced the levels of many common air pollutants.



Changes in air-pollution emissions in the United States

Ozone concentration in the troposphere has also decreased in the past 10 years.



**Changes in ozone concentration in the United States (black line represents air-quality standard)**

With continued conservation and reduction practices, adherence to ozone-pollution warnings, research and government regulation, ozone-pollution levels should continue to fall. Perhaps future generations will not be threatened by this environmental pollutant.