

# It's Your Environment: **Protect It!**



# Air Pollution



You could go days without food and hours without water, but you would last only a few minutes without air. On average, each of us breathes over 3000 gallons of air each day. You must have air to live. However, breathing polluted air can make you sick.

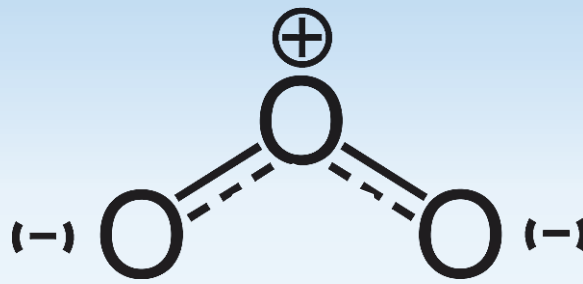
The amount of pollution in the air from all sources – natural and human – defines the quality of the air we breathe. Bad air quality can affect everybody's health. It can have direct effects on the lungs and can worsen an existing condition such as asthma. Some people are more sensitive to air pollution than others are. These include young children who are growing rapidly and older adults who have reduced immune systems.

The Clean Air Act establishes standards to protect the public and the environment from adverse health and welfare effects of air pollution. Air quality standards have been established for six pollutants. They are carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO<sub>2</sub>), ozone (O<sub>3</sub>), sulfur dioxide (SO<sub>2</sub>), and particulate matter (PM).

In Oklahoma, the primary pollutant of concern is ozone.

## What is Ozone?

Ozone is a form of oxygen. The molecule is made of three oxygen atoms (O<sub>3</sub>). Most oxygen we find in our lower atmosphere is made up of two oxygen atoms (O<sub>2</sub>).

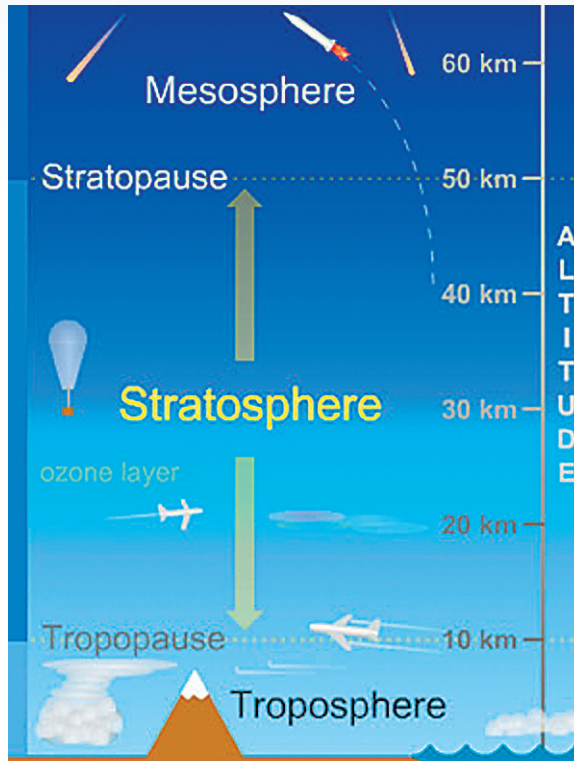


## Ozone: The Good and the Bad

### Good Ozone

The Earth's atmosphere is a mixture of gases that covers the planet; it is divided into distinctive layers.

The ozone layer, as it is called, is really a part of the stratosphere. Stratospheric ozone plays a protective role by absorbing harmful ultraviolet radiation from the sun.



"Illustration from Windows to the Universe: [www.windows2universe.org](http://www.windows2universe.org) Artwork by Randy Russell"

### Bad Ozone

In the lower portion of Earth's atmosphere, ozone is a harmful pollutant. At the ground level, ozone may also accompany man-made pollutants to form smog, a brownish haze that contaminates the air.

In the troposphere, ozone forms from the chemical reaction of gaseous pollutants. These gaseous pollutants are emitted from natural and man-made sources and require sunlight to chemically react.

## Glossary

**Air pollution:** The presence of contaminants or pollutant substances in the air that interfere with human health or welfare.

**Concentration:** The amount of ingredients or parts in relation to the other ingredients or parts.

**Nitrogen oxides (NO<sub>x</sub>):** A group of gases made up of nitrogen and oxygen that cause environmental problems like smog. Burning fossil fuels, such as coal and gasoline, releases NO<sub>x</sub> into the atmosphere.

**Ozone (O<sub>3</sub>):** A colorless gas found in the air we breathe. Ozone can be good or bad depending on where it occurs. At ground level, ozone is an air pollutant that can harm human health.

**Particulate Matter (PM):** A complex mixture of suspended small particles and liquid droplets. Particulate pollution is made of a number of components including chemicals, metals and soil or dust particles.

**Smog:** The brownish haze that pollutes our air, particularly over cities, in the summertime. The primary component of smog is ozone.

**Stratosphere:** The second layer of Earth's atmosphere. Approximately 90% of the ozone in Earth's atmosphere is here. Ozone in the stratosphere is good. It absorbs UV light and shields the Earth's surface.

**Troposphere:** The first layer above Earth's surface that contains one-half of Earth's atmosphere. Most weather occurs in this layer.

**Volatile Organic Compounds (VOCs):** Compounds emitted as gases from certain solids or liquids. They include a variety of chemicals some of which may have short- and long-term adverse health effects. VOCs are emitted from products we use every day like paints, cleaning supplies, pesticides, adhesives, and permanent markers.

# Oklahoma Ozone

## Tropospheric Ozone - A Recipe for Ozone

### Creating ozone requires the following:

#### Ingredients:

- \*Nitrogen Oxides (NOx): gases emitted from cars, refineries, power plants, and industrial facilities.
- \*Volatile Organic Compounds (VOCs): gases emitted from paints, cleaning supplies, pesticides, glues, and permanent markers.

#### Preparation

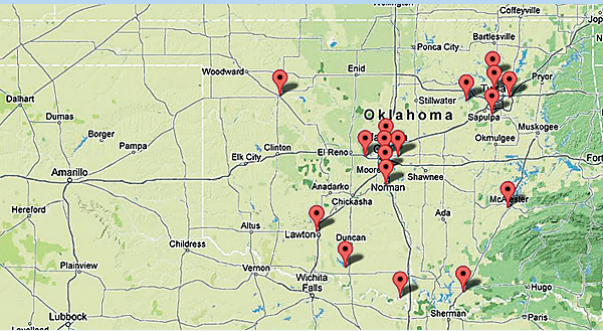
1. Combine the surrounding air with generous amounts of NOx and VOCs. \*Sources of NOx and VOCs can be of your choosing. Mix thoroughly.
  2. Using ample amounts of sunlight, bake the ingredients on high until they have reacted.
- \*Cooking time may vary depending on the amount of ingredients used and the amount of available sunlight.*

**Okay!** You now have a fresh batch of ozone! Serve with fine particles and other atmospheric pollutants to create smog.

## Where is Ozone?



The Air Quality Division (AQD) monitors ozone at 17 sites across the state. Each location is equipped with monitors that use ultra-violet absorption techniques to measure ozone concentrations on a continuous basis. Most sites report data hourly so current monitoring data is also posted to the website hourly at [www.deq.state.ok.us/aqdnw/monitoring](http://www.deq.state.ok.us/aqdnw/monitoring) (click on) “Current Monitoring Data”.



Many of the state’s ozone sites are located in and around Oklahoma City and Tulsa. Measured concentrations of ozone in these areas are above the federal standard. Continued high levels this year could put the state into non-attainment which could lead to additional air pollution controls for Oklahoma industry.

Ozone sites are also strategically placed along Oklahoma’s borders to measure ozone transported into the state from sources located in other states.

Data from designated monitoring sites are used to calculate the state’s Air Quality Index or AQI. The AQI correlates the monitoring data to a number and color that describe the quality of the air. There are six categories. The AQI is issued for Oklahoma City, Tulsa, and Lawton.

## How Ozone Can Affect Your Health

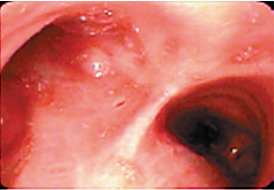
Health Risks	Symptoms
1. Irritation of respiratory system	Coughing, sore throat, and tightening of the chest
2. Reduction in lung function	Shallow and rapid breathing
3. Inflammation and lung damage	Swollen and constricted airway passage to lungs
4. Susceptibility to infection	Fever, coughing, and chest pain
5. Aggravation of asthma, emphysema, chronic bronchitis, etc.	Increased sensitivity to allergens, reduced lung function, and airway inflammation
6. Permanent lung damage	Reduced lung function and acceleration of the natural decline in lung function (aging)

Those groups who are more sensitive to ozone and air pollution in general are young children with developing lungs, elderly adults with weakened immune systems, people who frequently exercise or work outdoors, and individuals who suffer from pre-existing respiratory conditions.

Healthy Lung



Inflamed Lung



\*Photo courtesy of PENTAX Medical Company\*

Air Quality Index	Numerical Value	Meaning
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution
Unhealthy for sensitive groups	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects
Very Unhealthy	201 to 300	Health warnings of emergency conditions. The entire population is more likely to be affected
Hazardous	301 to 500	Health alert: everyone may experience more serious health effects



# Air Quality Tools

The following tools are available on the AQD website: <http://www.deq.state.ok.us/aqdnew> and are designed to help Oklahomans better understand Oklahoma's air quality.

## 1. AQI

The Air Quality Index can be accessed from the upper right hand corner of almost every page of the AQD web site. It is an index for reporting air quality for U.S. cities and is required for cities with populations of 350,000 or more. It predicts today's air quality using yesterday's monitoring data in combination with today's air pollution and weather forecasts. In Oklahoma, the index is calculated every weekday for Oklahoma City, Tulsa and Lawton. The AQI is available to all media and is posted on the weather page of Tulsa World and USA Today and online at sites like Weather Bug.

## 2. Watch/Alert

An ozone watch is a forecast by DEQ. When monitoring data, ozone models and weather forecasts indicate unhealthy levels of ozone in the state, the division calls an ozone watch so those sensitive to ozone can avoid exposure to high concentrations. An ozone watch can trigger a local ozone alert in Tulsa, Oklahoma City, and/or Lawton. Alerts may also be announced on TV weathercasts and highway signs and are always posted as a banner at the top of the AQD website. You can sign up for ozone alerts in your area on these sites:

**Tulsa:** [www.ozonealert.com/index.htm](http://www.ozonealert.com/index.htm)

**Oklahoma City:** [www.bettertogetherok.org](http://www.bettertogetherok.org)

**Lawton:** [www.enviroflash.info/signup.cfm](http://www.enviroflash.info/signup.cfm)

## 3. Advisory

Air Quality Health Advisories are email messages in a graphic format advising subscribers when concentrations of air pollution reach unhealthy levels in their area. These are not forecasts, but near real-time advisories of Oklahoma's air quality. Sign up for these advisories on the Air Quality website.

### If Ozone Levels are Unhealthy...

- Avoid unnecessary trips and drive-up windows
- Modify activities that require higher levels of exertion
- Reschedule outdoor events for the morning or evening hours
- Limit or avoid outdoor activity if necessary

## What You Can Do!

**Take mass transit, share a ride or carpool-** Fewer vehicles on the road translate into fewer sources of VOCs and NOx. A reduction in these ozone-forming components may result in an overall improvement of the local air quality.

**Trip chain more often-** When running errands, it is not only time-efficient to map out your route, but it is also environmentally friendly. When you first start a car after it has been sitting for more than an hour, it pollutes up to five times more than when the engine is warm.

**Have fun! Ride your bike-** Again, a decrease in the number of vehicles on the road directly translates into better air quality. Twenty-five percent of all the air pollution in the United States is the result of vehicles on the road.

**Take things in stride-** Instead of driving, try walking or in-line skating. Both are good forms of exercise and cut back on emissions.

**Maintain your vehicle-** Vehicle emissions could be drastically reduced if regular maintenance were performed. When vehicles have been properly cared for, their gas mileage and emissions rate will improve.

**Get fuel when it's cool-** Refueling during cooler periods of the day or in the evening can prevent gas vapors from heating up and creating ozone.

**Don't top off the tank-** Cars are now equipped with control devices that reduce escaping vapors during refueling, so don't override the pump!

**Telecommute-** A reduction in vehicular pollution can be further accomplished by working at home when possible.

**Know before you go-** Before commuting to your destination, stay informed of travel and transit information. Traffic reports can help you to avoid congested roadways that are ozone hotspots.

**Spread the word-** If everyone took just a few of these simple, easy steps, it could make a big difference because it all adds up to cleaner air

## Teacher's Column

### Teacher Tools:

#### The Teacher's Guide to OK Air Pollution

- Resource Information
- Lesson Plans
- Student Worksheet Downloads
- Answer Key

### The following lessons are posted on our website:

#### Lesson 1: What is Ozone?

- Good Ozone (ozone layer)
- Bad Ozone (surface-level ozone)
- How Do We Know When There Is Bad Ozone? (air quality monitoring network)
- Activity- Vocabulary Crossword Puzzle

#### Lesson 2: How Does Ground-Level Ozone Form?

- Components of Ozone Formation
- VOCs and NOx
- Activity- Ozone Formation Poster

#### Lesson 3: Why is Ground-Level Ozone Monitored?

- Importance of Air Pollution Monitoring (health and economic reasons)
- How Ozone Affects Health
- Activity- Air Quality Comparison Tables

#### Lesson 4: How is Ground Level Ozone Monitored?

- Monitoring Sites
- Monitoring Equipment
- Air Quality Data
- Activity- \*Combined with lesson 5 content. See below\*

#### Lesson 5: 3 Tools for Understanding Air Quality

- AQI
- Ozone Watches/Alerts
- Air Quality Health Advisories
- Activity- Monitoring Site Identification and Data Analysis

#### Lesson 6: Steps to Improving Air Quality

- Ozone Overview
- Ways You Can Help
- What Else Is Being Done?
- Activity- Alternative Fuel Vehicles Research

# Oklahoma Ozone

## A Case Study in Air Quality

Air pollution levels can vary greatly on a monthly, weekly, and even daily basis. Air quality can also vary from region to region as well. There are several factors that can be attributed to such variations.

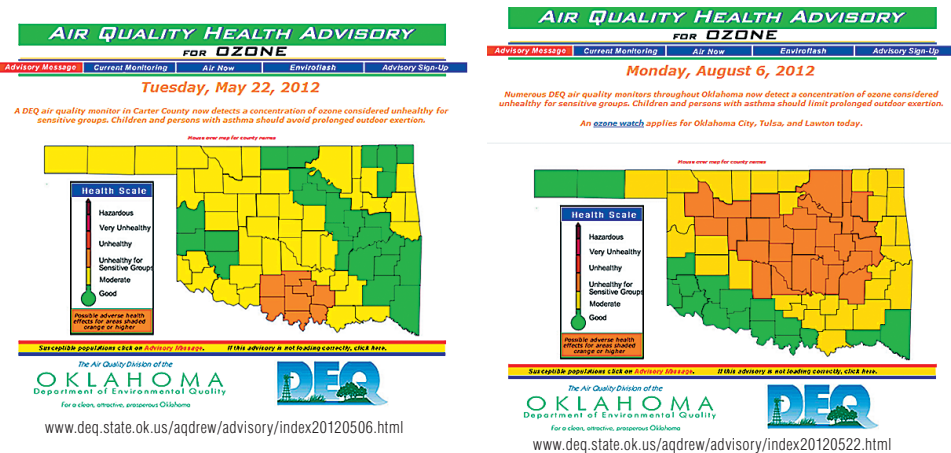
For example, population density, geography, and weather-related events are a few determining factors that can affect air pollution levels. Variables such as temperature, solar radiation, wind speed and direction, and sky coverage can further affect the rate of ozone formation.

In order to understand why ozone episodes tend to be seasonal occurrences in Oklahoma, it is helpful to consider these factors in relation to actual events.

The following case study uses actual ozone data collected from Oklahoma City on January 17th, May 22nd, July 1st, and August 6th of 2012. The selected dates do not have any relation to one another; however, the data collected on those dates allow for an effective evaluation of factors that can affect ozone concentrations.

Air quality health advisory maps are provided for May 22nd and August 6th to display Oklahoma County and the surrounding areas affected by ozone.

\*Note: there are no health advisory maps for January 17th and July 1st due to the low ozone levels reported on those days. Health advisories are issued when ozone levels are unhealthy for sensitive groups.



In addition to the health advisory maps, corresponding AQI values and weather data for Oklahoma City have been supplied for each day. The weather data include total solar radiation, average temperature, sky coverage conditions, and average wind speed and direction.

1. Using the maps and accompanying data, create four separate bar graphs — one for each factor being considered: one graph to display the AQI values, another graph to display the total solar radiation, another graph to display the average temperature, and the last graph to display the average wind speed.

The horizontal axis of each bar graph should represent the four dates being analyzed in the study, while the label on the vertical axis will differ depending on the information conveyed by each graph i.e., AQI values (number—no units), total solar radiation (MJ/m<sup>2</sup>), average temperature (°F), and average wind speed (mph).

When creating multiple bar graphs, it is easier to evaluate the data by assigning a different color for each graph.

2. Be sure to select appropriate increments to best represent the data for each graph. Also, title the graphs and label the axes.

## Case Study Fact Sheet

- Solar radiation is energy emitted by the sun.
- Ozone formation often occurs hours or days after the emissions of VOCs and NO<sub>x</sub> pollutants and can occur hundreds of miles downwind.
- Chemical reactions between VOCs and NO<sub>x</sub> occur in the presence of solar radiation.
- When clear sky conditions are present, a greater proportion of solar radiation is able to reach the Earth's surface. Clouds reflect or scatter solar radiation.
- Widespread heavy rain typically cleans the air of pollutants.
- Thermal inversions are important because they trap pollutants beneath them. Temperature inversions occur when there are warmer temperatures aloft and cooler temperatures below.
- If wind speeds are calm for an extended period, air can become stagnant and does not mix well.

## Weather Data Chart

Date	1/17/12	5/22/12	7/01/12	8/06/12
AQI Value (O <sub>3</sub> )	21	80	39	132
Total Solar Radiation (MJ/m <sup>2</sup> )	13.04	27.21	28.94	23.88
Avg. Temperature (Degrees F.)	33.5	73.4	83.4	90.6
Wind	Avg. Speed (mph)		SSE	S
	Direction		12.3	7.7
		8.3	4.1	
Sky Coverage	Mostly Clear	Partly Cloudy	Few Clouds	Scattered Clouds

## Case Study Questions

- Using a color-coded AQI chart and the data tables corresponding with each day, describe what the reported AQI value means in terms of air quality.
- Why are high AQI values associated with high temperatures and high solar radiation?
- Based on the comparison provided by the graphed data, what time of the year are ozone episodes more likely to occur? Why?
- Describe the wind speeds on the days with lower AQI values and the wind speeds on the days with higher AQI values. What is the relationship between wind speed and AQI values?
- Based on the Air Quality Health Advisory maps and the average wind directions provided for May 22nd and August 6th, which areas could have been affected by ozone on the following days (assuming the wind remained steady and continued to blow out of that direction)?
- What factors may have led to a lower ozone concentration on July 1, 2012, despite the high amounts of solar radiation?