



## SAGE III

# Ozone: Good, Bad or Both

Lesson Grades: 6-8

**Purpose:** The lesson addresses the difference between good ozone and bad ozone, providing students with information regarding factors that cause the formation of bad ozone and the depletion of good ozone. During the lesson students will experience how difficult it is to accurately measure objects that are very small, giving them an understanding of the importance and complexity of the SAGE III instrument that will be used to measure good ozone. Students will work to construct a poster that illustrates the differences between good ozone and bad ozone, recognizing the sources that are responsible for the production of bad ozone.

**Grade Level:** 6-8

**Estimated time for Completing Activity:** 2-4 class periods

### Learning Outcomes:

- The student will recognize the difference between good ozone and bad ozone
- The student will identify factors that cause a rise in bad ozone and a decrease in good ozone.
- The student will experience the difficulties associated with accurately measuring an object that is very small.
- The student will develop an understanding of the importance of the SAGE III instrument in the measurement of ozone.

### Standards

#### Grades 6-8 NGSS

- MS-ESS3-5 Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.
- MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

#### Virginia Science Standards:

- 6.1 /ES.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which precise and approximate measurements are recorded.

- 6.6 The student will investigate and understand the properties of air and the structure and dynamics of Earth's atmosphere: d) natural and human-caused changes to the atmosphere and the importance of protecting and maintaining air quality.
- ES.12 The student will investigate and understand the origin and evolution of the atmosphere and the interrelationship of geologic processes, biological processes, and human activities on its composition and dynamics.

**Prerequisites:**

- The atmosphere is made up of a combination of different gases.
- Some of those gases are referred to as trace gases.
- Trace gases make up a very small portion of our atmosphere.

**Vocabulary:**

good ozone	stratosphere
bad ozone	troposphere
trace gas	smog
parts per billion (ppb)	

**Lesson Links:**

- Video Real World: Ozone Alerts  
<http://www.nasa.gov/audience/foreducators/nasaclips/search.html?terms=%22ozone%20alerts%22&category=0100&disp=grid>
- MY NASA DATA Mission Support: <https://mynasadata.larc.nasa.gov/mnd-missions>

**Background:**

**SAGE III on ISS** is a key part of NASA's mission to provide crucial, long-term measurements that will help humans understand and care for Earth's atmosphere. Just like humans need to use sunblock, the Earth needs ozone for protection. SAGE III, the Stratospheric Aerosol and Gas Experiment III, measures Earth's sunscreen, or ozone, along with other gases and aerosols, or tiny particles in the upper atmosphere. SAGE III continues a long history of accurate measurements that provide the foundation for sound environmental policy. One of the first continuous Earth-observing instruments on the International Space Station, SAGE III will launch on SpaceX in 2016 and will be attached via robotic arm. SAGE III will be measuring levels of good ozone.

Ozone is found in very small amounts in our atmosphere, it is known as one of the trace gases and varies in amount from time to time and place to place. It is important to measure the amount of ozone to assist in monitoring the quality of the air we breathe. Ozone exists in two

levels of the atmosphere, the stratosphere and the troposphere. The majority of ozone is found in the stratosphere where it is considered to be good ozone as it acts as a barrier between Earth and the harmful UV rays being emitted by the Sun. The small, trace amount of ozone that occurs in the troposphere is known as bad ozone and is considered a pollutant. It is in the troposphere that ozone is the main component of smog. In this form it is harmful to life on Earth; both animal life and plant life are affected by bad ozone.

### **Pre-Lesson Activity:**

#### **Video Connection - Real World: Ozone Alerts (6-8)**

NASA's SAGE III instrument will provide valuable information to help us understand how our global Earth system is changing. Find out the difference between good ozone and bad ozone. Learn about the health problems that a small percent of our atmosphere, or only a few parts per billion, can create.

Video URL:

<http://www.nasa.gov/audience/foreducators/nasaclips/search.html?terms=%22ozone%20alerts%22&category=0100&disp=grid>

<http://www.nasa.gov/audience/foreducators/nasaclips/search.html?terms=%22Ozone alerts%22&category=0100&disp=grid>

<http://youtu.be/kMzkXPuWHL>

Video Lesson Connections:

- 1.) What is the difference between good ozone and bad ozone?
- 2.) Where is ozone located in the atmosphere?
- 3.) How is bad ozone formed?

### **Procedure:**

Part 1:

- Provide students with a variety of different weights of paper products (example: notebook paper, notecard, poster board, tissue paper, cardstock, construction paper, etc.)
- Give students the task of measuring the thickness of each of the different types of paper to get an accurate measurement without the use of any measuring device. Be sure that they describe how they devised a method to measure the paper thicknesses and what they came up for the thickness of each of the paper types. Have them also list the difficulties in measuring such a small item, as they will share and discuss this later.
- Have them discuss which tool they think they would need to use to find this measurement most accurately. This can be a tool that actually exists that would give them the exact or very close to the exact thickness of the paper.

- As a class discuss the difficulties students might have experienced when attempting to accurately measure the thickness of the various types of paper.

#### Part 2:

- Working with a partner or in a small group have students use magazines or the computer to obtain images that illustrate good ozone and bad ozone.
- Have students construct posters using the images that they collect to illustrate good ozone and bad ozone. (**Teacher Note:** Posters can be created on the computer or using poster board and actual images depending on the technology and resources available.)
- Instruct students to include the parts of the atmosphere where each type of ozone (good/bad) would be found on their posters. (**Teacher Note:** They would need to include good ozone found in the stratosphere and bad ozone located in the lower atmosphere near the surface of the Earth.)

#### Teacher Notes

- Introduce the SAGE III instrument that will be launched in 2016 to measure ozone in the atmosphere. (**Background information** is provided in the beginning sections of the lesson. Images of the SAGE III instrument can be located on the MY NASA DATA Website under Mission Support: <https://mynasadata.larc.nasa.gov/mnd-missions/>)
- Explain the importance of such an instrument to provide accurate measurements of ozone to enable us to better understand our atmosphere and how it is being affected by human activity.
- Relate to students that ozone is a trace gas and is measured in ppb. (An activity that models the unit ppb is provided in the Extension Section at the end of the lesson.)
- It is the level of available good ozone that the SAGE III instrument will be measuring.

#### **Lesson Questions:**

1. What is the difference between “good ozone” and “bad ozone”?
2. Where is ozone located in our atmosphere?
3. What role does ozone play in the stratosphere?
4. What effect can bad ozone have on the quality of the air we breathe?
5. Why is ozone in the troposphere considered to be a pollutant?
6. What is the difference between an oxygen molecule and a molecule of ozone?
7. What are some of the sources for the chemical reaction that results in the formation of “bad ozone”?

#### **Extensions:**

**Parts Per Billion Activity:** <https://mynasadata.larc.nasa.gov/docs/modelppb.pdf>

(Activity allows students to develop a model that demonstrates the concept of the size of a part per billion by volume of surface ozone in the air. )

#### **Assessment:**

Good Ozone vs. Bad Ozone Matching Game: Students sort game pieces to illustrate the location and distinctions between good ozone and bad ozone:

Good\_Ozone\_vs\_Bad\_Ozone\_gameboard.pdf

Good\_Ozone\_vs\_Bad\_Ozone\_game\_pieces.pdf

Good\_Ozone\_vs\_Bad\_Ozone\_Game.pptx