Surface Ozone

JD-EAEV-008

Abstract

This experiment focused on the question, how does the level of cloud cover affect the amount of ozone present? If there are more clouds in the sky, then there will be higher levels of bad ozone in the troposphere, because the clouds will prevent the ozone molecules from escaping higher into the atmosphere. The independent variable tested is the time. The dependent variables that will be measured are the ozone, clouds, current temperature, wind, air pressure, and relative humidity. The controls for this experiment are the time of the testing, and the materials- Zikua Ozone Testing Kit , a DIY Wind Direction Instrument, an Outside Instrument Shelter, (contains an alcohol thermometer and a Digital Dual Sensor Thermometer) (SN 89212), a Sling Psychrometer, Barometer, and a GLOBE Cloud Reading Chart. The ozone, clouds, current temperature, wind, air pressure, and relative humidity were all measured twice a week over a month and will resume in the spring. In conclusion, it was found that the more clouds there were the less ozone there was, and the less clouds there were the more ozone there was. In future experiments current temperature, wind, relative humidity, and air pressure would be added to see how they might affect the ozone reading.

Keywords: ozone, clouds, current temperature, wind, air pressure, relative humidity

Surface Ozone

This experiment is designed to discover how cloud cover affects the ozone. The independent variable tested is the time. The dependent variables that will be measured are the ozone, clouds, current temperature, wind, air pressure, and relative humidity. The controls for this experiment are the time of the testing, occurring within an hour of solar noon, and the procedures and materials, Zikua Ozone Testing Kit ,A DIY Wind, Direction Instrument, an Outside Instrument Shelter, (contains an alcohol thermometer and a, Digital Dual Sensor Thermometer) (SN 89212) , a Sling Psychrometer, Barometer, and a GLOBE Cloud Reading Chart. The hypothesis states, if there are more clouds in the sky, then there will be higher levels of bad ozone in the troposphere, because the clouds will prevent the ozone molecules from escaping higher into the atmosphere.

Question

The question this project focuses on is, how does the level of cloud cover affect the amount of ozone present?

Background Research

Ozone is one of the many gases in the air that determines the quality of the air Earth breathes. The molecular formula for ozone is O_3. Trace gases are small amounts of ozone that are present in the air. The layers of the atmosphere are the Troposphere, Stratosphere, Mesosphere, and the Thermosphere. Ozone exists in both the Stratosphere and Troposphere. Surface ozone is produced when certain chemicals are released to the atmosphere and these chemicals react with each other in the presence of sunlight. The ozone is reactive because it is constantly being formed and broken down when it interacts with UV radiation. This is important because ozone is crucial for life on Earth. Good ozone protects human life on Earth; and bad ozone puts it at risk. Photochemical smog is the term for pollution found near most urban areas. Ozone measuring is important because it shows the changes in good ozone and bad ozone, so we can try and do something about it (Bergman, 2005).

Ozone is the special trace gas that protects Earth from the sun's harmful rays. Ozone is spread out over the stratosphere and the troposphere. The ozone layer is the layer that is considered "good ozone", and protects Earth from the sun's rays. Atmosphere is the four layers that come before space. This is where the stratosphere and troposphere are located. Ozone affects life in many ways such as it protects Earth from the sun's harmful rays and it prevents us from easily getting skin cancer from the sun. When the ozone isn't good "bad ozone" it can be harmful to Earth. It can cause the destruction of the good ozone which has already been reported happening. This means Earth will no longer have protection from the sun's harmful rays ("Ozone", 2015).

Scientist and future generations will care about this project one day if it helps stop bad ozone from becoming even more of a problem today. The project applies to the real world because the damage seems to be affecting people as well, not just plants and animals.There are air quality alerts frequently, especially in the summer months. There are places where people must wear masks to go outside. There is good ozone and bad ozone. Good Ozone is what prevents some of the sun's unhealthy ultraviolet rays from coming down to Earth and harming our skin.This is important because without a healthy ozone layer, the sun's rays would have more impact on the plants, animals, and people on Earth. Bad ozone buildups mean that edible plants may be affected which leaves less to eat. Trees may be affected which harms the habitat of some animals. The risk of skin cancer would increase without the ozone layer. Some people have tried to limit the amount of toxins released into the air that are causing the damage to the ozone. Ozone is one of the main causes of Global Warming. Pollutants in the air affect the ozone layer, and that causes the harmful rays of the sun to start Global Warming. Others have worked on the issue of Global Warming. Global Warming is the increase in the Earth's temperature causing ice on the poles to melt. This leads to higher water levels and habitats for some animals lost. (Bergman, 2005).

Ozone is the special trace gas that protects Earth from the sun's harmful rays. Ozone is spread out over the stratosphere and the troposphere. The ozone layer is the layer that is considered "good ozone", and protects Earth from the sun's rays. Atmosphere is the four layers that come before space. This is where the stratosphere and troposphere are located. Ozone affects life in many ways such as it protects Earth from the sun's harmful rays and it prevents us from easily getting skin cancer from the sun. When the ozone is bad it can be harmful to Earth. It can cause the destruction of the good ozone which has already been reported happening. This means Earth will no longer have protection from the sun's harmful rays ("Ozone" 2015).

Problem Statement

This experiment focused on the question, how does the level of cloud cover affect the amount of surface ozone present?

Hypothesis

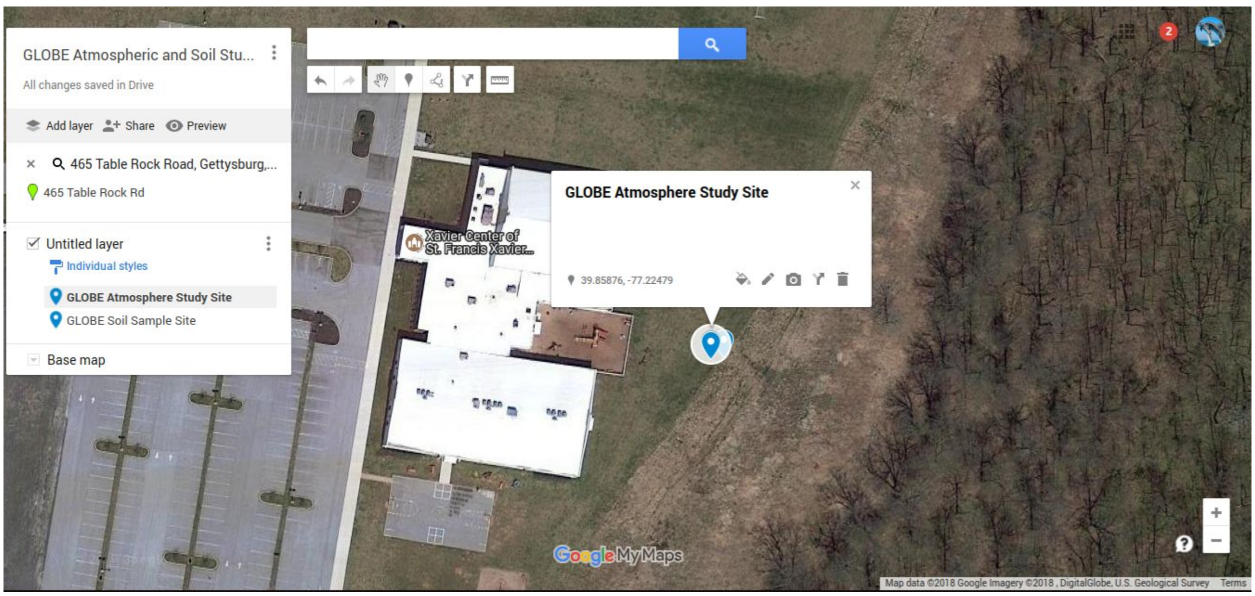
If there are more clouds in the sky, then there will be higher levels of bad ozone in the troposphere, because the clouds will prevent the ozone molecules from escaping higher into the atmosphere.

Materials

- Zikua Ozone Testing Kit
- A DIY Wind Direction Instrument
- An Outside Instrument Shelter

Contains an alcohol thermometer and a Digital Dual Sensor Thermometer (SN 89212)

- A Sling Psychrometer
- Barometer
- A GLOBE Cloud Reading Chart



Map 1: The study site was at the top of a small hill between the school and the woods. It is mowed grass right where the measurements were taken, but a meadow right below the site. It is a humid subtropical climate.

Procedure (as taken from GLOBE Protocols)

1. Fill out the top of the Ozone Data Sheet.
2. Remove a single ozone test strip from the plastic bag.

3. Record the date and starting time.

Calibrating the Scanner

4. Place the scanner on a steady surface out of direct sunlight, preferably inside the Instrument Shelter.
5. Turn on the scanner and see the following in LCD readout. (Older scanners may display 170 for the number under SAVE and need to be recalibrated. Contact the GLOBE Help Desk for assistance.)
6. Place the unexposed ozone test strip into the scanner with the chemical side facing toward the display.
7. Press button 1 (left button) until SELECT>CALIB pops up on the display.
8. Press button 2 (right button) and see 1 HR WHT = and fluctuating numbers. This is ok.
9. Press both buttons simultaneously to save unexposed strip reading.
10. Turn off the scanner, and remove the unexposed strip. (NOTE: turning off scanner before removing the strip will prevent accidentally changing the settings in the scanner.)

In the Field

11. Place the ozone test strip in the clip on the monitoring station. Do not touch the chemical part of the strip at any time. (It is not harmful, but touching it may prevent from getting an accurate measurement.) Record the time.
12. Determine cloud cover and cloud type following the *Cloud Cover and Cloud Type Protocols.*

13. Measure and record the current temperature on the thermometer in the instrument shelter (to the nearest 0.5C).
14. Record the wind direction.
15. Measure and record the relative humidity using a sling psychrometer (“Ozone”2015)

Clouds

16. Observe how much of the sky is covered by clouds, including contrails. Choosing between these categories is easy at the extremes, but harder where they meet. Estimate what fraction of the sky is covered by clouds.
17. Complete the top section of your Data Sheet.
18. Look at the sky in every direction (above 14 degrees).
19. Estimate how much of the sky is covered by clouds and contrails.
20. Record the cloud/contrail cover for the overall sky, as well as each level.
21. If the sky is Obscured, record what is blocking your view of the sky. Report as many as observed from the following: fog, smoke, haze, volcanic ash, dust, sand, spray, heavy rain, heavy snow, blowing snow. (“Clouds” 2015)

Barometric Pressure

22. Record the time and date on the Atmosphere Data Sheet. (Skip this step if using the Aerosols, Ozone, or Water Vapor Data Sheet.)
23. Tap gently on the glass cover of the aneroid barometer to stabilize the needle.
24. Read the barometer to the nearest 0.1 millibar (or hectopascal).
25. Record this reading as the current pressure.

26. Set the set needle to the current pressure. ("Barometer" 2015)

Relative Humidity

27. Stand far enough away from other people and the instrument shelter so that the instrument does not hit them. Stand in the shade if possible with back to the sun. If there is no shade near the shelter, move to a shady spot nearby, but not too close to trees or buildings.
28. Keep the sling psychrometer as far away as possible from body to prevent body heat from changing the temperature readings. This is very important in cold weather. Do not touch or breathe on the temperature-sensing parts of the thermometer as this, too, may affect the reading.
29. Open the sling psychrometer case by pulling out the slider, which contains the two thermometers.
30. Wait three minutes to allow the thermometer to read the current air temperature and then read the current dry bulb temperature to 0.5˚ C using the thermometer with no wick attached. Make sure eyes are level with the instrument. Then record the dry bulb temperature.
31. Check to be sure that there is still distilled water in the reservoir, and that the wick is wet. If it is dry, add distilled water to the reservoir.
32. Sling the psychrometer for 3 minutes.
33. Let the psychrometer stop whirling on its own! Do not stop it with hand or other object.

34. Read the wet bulb temperature to 0.5˚ C (from the thermometer with the wick attached).
35. Record the wet bulb temperature.
36. Determine the relative humidity using a psychrometric chart or the sliding scale found on the cases of some psychrometers. Leave this blank as GLOBE can calculate relative humidity from your wet and dry bulb temperatures.
37. When done with the instrument, close it up and return it to the shelter properly. (“Relative Humidity” 2015)

Wind

38. Place wind direction instrument on a table or bench so that it is about 1 meter off the ground.
39. Use the compass to find magnetic north and align the base of model marked N to match true north.
40. Look at the wind sail to see if there is any wind blowing.
41. Put right hand on hip and left arm out straight.
42. Turn body so that the straight arm is pointing in the same direction as the wind sail. The right elbow is now pointing in the direction of the wind.
43. Record this direction on Data Sheet. (“Wind” 2015)

Current temperature

44. Open the instrument shelter and the cover flap of the digital max/min thermometer being careful not to breathe on or touch the air temperature sensor.
45. Record the time and date on your Data Sheet.

46. Turn the air temperature display on by pressing the air sensor ON button (upper left button labeled ON on the front of the instrument casing).
47. Read the current air temperature shown in the upper section of the digital display. Record this temperature on Data Sheet.
48. After all measurements have been taken close the cover flap of the instrument. It will shut off automatically after a short time. (“Current Temperature” 2015)

Important Points

- It is important to keep the ozone strip contained because as soon as it is exposed to the air it starts collecting surface ozone present.
- Solar noon is when the sun is at its highest point in the sky each day; meaning that it is directly overhead.
- Leave the strip exposed for one hour.
- Other GLOBE protocols to follow are current temperature, relative humidity, clouds, and wind. These protocols are related to ozone because they can all affect the levels of ozone that are present.
- The scanner should stay in the shelter for five minutes
- Calibrate the scanner.
- Reset the scanner after every use.
- To protect the scanner you could If the temperature difference is too great, bring the scanner inside to do the reading.
- The other GLOBE protocol measurements need to be taken as well because they can affect the amounts of ozone that are present.

- If the strip gets wet, use that strip, but note that the strip got slightly wet.

Data

Date	Ozone (ppb)	Cloud Cover (%)
9/27/17	56	10
9/29/17	42	25
10/2/17	46	0
10/5/17	62	50
10/12/17	30	90
10/16/17	51	50
10/18/17	54	0
10/20/17	46	25
10/23/17	40	90
10/25/17	55	25
10/30/17	26	25
11/1/17	25	25
11/13/17	25	50
11/15/17	38	50
11/17/17	31	25
12/1/17	25	25

Figure 1: This data table shows the cloud cover and ozone level from September to December. Some dates are missing do to extreme cold, snow, school events, and the schedule. The testing will be continued for the GLOBE project in the spring

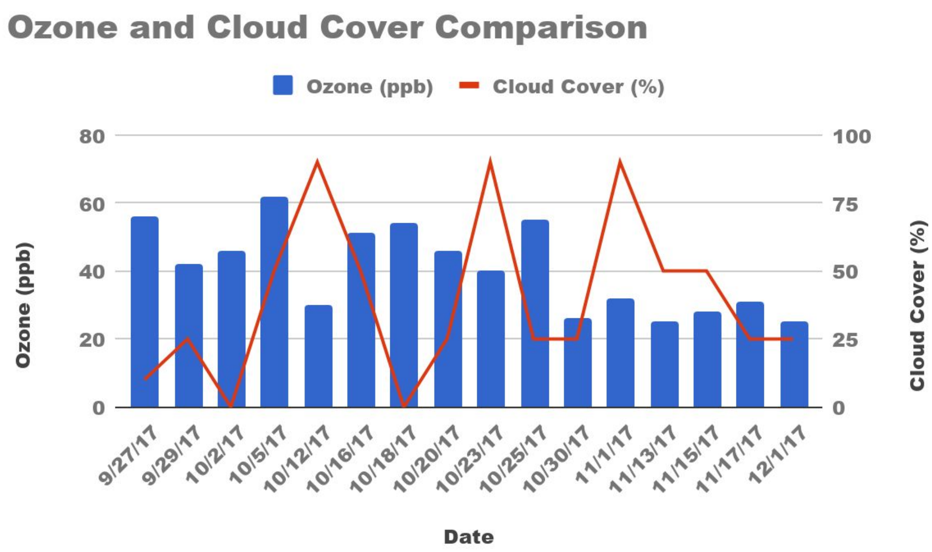
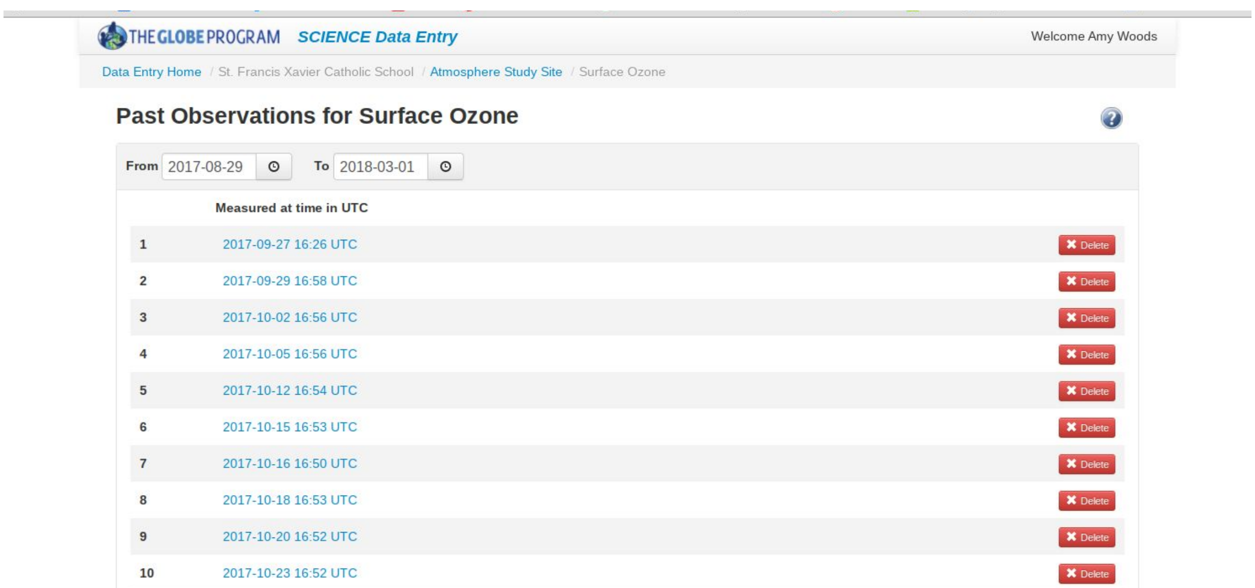


Figure 2: This graph shows the way cloud cover affected the ozone over the past month, and it also shows that the data did not support the hypothesis.



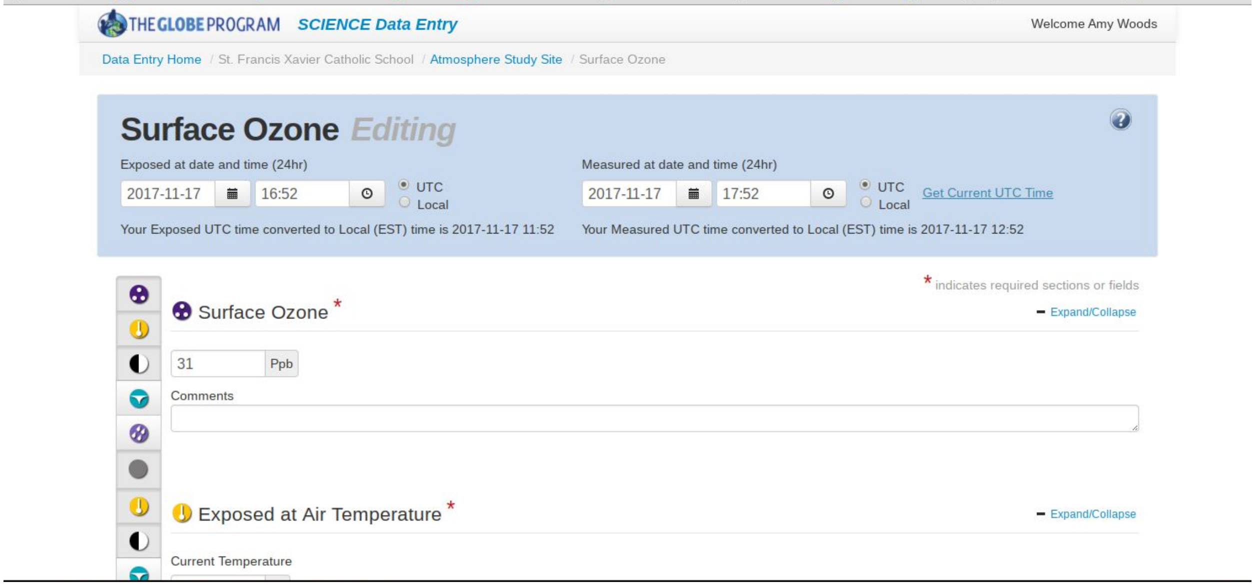


Figure 3: These images show the data uploaded to the GLOBE Database.

Data Analysis

The trends in the data showed data that when there is a lower amount of clouds, then there is a bigger amount of bad ozone. When there is a higher amount of clouds, then there is less bad ozone.

Conclusion

This experiment focused on the question, how does the level of cloud cover affect the amount of ozone present? If there are more clouds in the sky, then there will be higher levels of bad ozone in the troposphere, because the clouds will prevent the ozone molecules from escaping higher into the atmosphere. The hypothesis was not supported by the data. This is so because the more clouds there were, the smaller amount of ozone. The smaller amount of clouds the more ozone there was. Knowing this now, the revised hypothesis states if there are more clouds, there will be the less ozone because bad ozone is formed by photochemical smog, which reacts with the UV radiation from the sun. If there are more clouds, then no sun can release UV radiation that reacts with the smog creating bad ozone. The data was surprising, but when the research was looked at once again, it did make sense that this would happen. Some problems encountered along the way were the time that the instruments were received, bringing the amount of tests down to twelve, and the snow, extreme cold, school events, and changes in the schedule prevented data collection at times. There will be a continuation of this project for later competitions. In these future experiments, current temperature, wind, relative humidity, and air pressure will be added to see how they might affect the ozone reading, as well as a comparison with other locations to see if the same trend is happening. The rest of the data has been collected for the continuation of the GLOBE project.

Collaboration

I worked with my classmate Jacob to collect the data. I also compared how GLOBE protocols affect us with two other students who are collecting GLOBE data. I learned how to collect surface ozone data from Mr. Todd Toth, a scientist at NASA Goddard. He was very helpful in my training and putting me in touch with a scientist who is studying surface ozone. I plan to coordinate with her as I continue my research in the spring.

Exploring STEM Careers

I think my research will help prepare me for a career in climatology or as an environmental scientist. Gathering data and analyzing to determine why things are happening are very important. It is also helpful to show the data and explain what it means to others, especially regarding climate change. I think my research is helping to prepare me for a path that will help make a better climate for everyone.

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