

The Good, the Bad, and the Ugly of Ozone



Background

Ozone (O_3) is colorless and consists of three oxygen atoms (the third oxygen makes it highly reactive). There are two main types of ozone: the good ozone and the bad ozone. The good ozone is found in the upper atmosphere (located in the stratosphere). There it filters potentially damaging ultraviolet light from reaching the Earth's surface, preventing it from hurting humans. The bad ozone, also known as ground-level ozone (located in the troposphere), is an air pollutant with harmful effects on the respiratory systems of animals and humans. Ground level ozone is related to emissions from burning and internal combustion engines, especially those from industrial plants and vehicles, but also from charcoal grills and lawn mowers. To reduce the production of ozone, cars and trucks are required to have air pollution controls that are regularly inspected.

Ground level ozone has also been shown to affect plant growth. Typically plants will begin to exhibit damage when the ozone level reaches 40 ppb (parts per billion). This means that for every one billion molecules of air, there are 40 molecules of ozone. Now this doesn't seem like much, but the plants begin to show signs of biological change. If the level reaches greater than 80 ppb, the result is more evident, damaging their leaves and resulting in a 10% decrease in growth in susceptible species. This bad ozone is at its highest level during the hot and dry months of the year, typically over the summer. Studying the effects of ground level ozone is easily done on plant life, since leaves are replaced each year and it is easier to evaluate sources of damage on leaves than in people's lungs.

Objectives

- differentiate between the good and bad ozone,
- locate a monitoring station using latitude and longitude
- locate the position in the atmosphere where the good and bad ozone reside
- plot monthly ozone data
- understand the ground level ozone effects on humans and plants.

Standards

- S 1, KI 1: The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.
- S 2, KI 1: Information technology is used to retrieve, process, and communicate information as a tool to enhance learning.
- S5, KI 5: Identifying patterns of change is necessary for making predictions about future behavior and conditions.
- S6, KI 1: Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions.

Procedure

- Using the data from the Babylon Ozone Monitoring Station, plot the "Highest Concentration of O_3 " versus "Date" on the attached graph paper. Use a pencil and be sure to plot all points. Then after all of the points have been plotted connect the dots carefully.
- If you recall from the reading, ground level ozone can cause damage to certain plants if its levels are too high. On your graph, using a yellow color pencil, lightly shade in the range of values where plants would have chronic exposure of 40 to 80 ppb. Then using a red pencil, lightly shade on your graph where the plants would get acute exposure > 80 ppb.
- Answer questions.

NOTE: If you do not live near Nassau or Suffolk Counties and would like to generate data closer to your New York location, visit: <http://www.dec.ny.gov/airmon/index.php> and locate the nearest O₃ monitoring station. Generate your data by extrapolating the highest daily ozone levels.

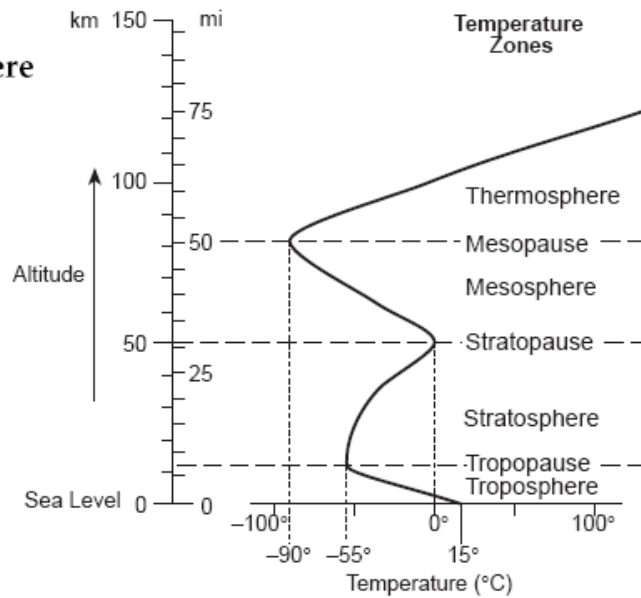
Babylon Ozone Monitoring Station*	
Date (Day-Month-Year)	Highest Conc. O₃ (ppb)
01-Jul-2008	75.7
02-Jul-2008	65.0
03-Jul-2008	77.5
04-Jul-2008	73.6
05-Jul-2008	57.3
06-Jul-2008	54.9
07-Jul-2008	48.6
08-Jul-2008	68.9
09-Jul-2008	57.1
10-Jul-2008	53.4
11-Jul-2008	65.6
12-Jul-2008	52.7
13-Jul-2008	45.4
14-Jul-2008	53.5
15-Jul-2008	85.9
16-Jul-2008	95.9
17-Jul-2008	113.5
18-Jul-2008	110.3
19-Jul-2008	91.5
20-Jul-2008	41.5
21-Jul-2008	84.2
22-Jul-2008	55.4
23-Jul-2008	52.9
24-Jul-2008	57.3
25-Jul-2008	71.5
26-Jul-2008	69.9
27-Jul-2008	51.6
28-Jul-2008	74.4
29-Jul-2008	89.2
30-Jul-2008	92.8
31-Jul-2008	85.5

* <http://www.dec.ny.gov/airmon/stationStatus.php?stationNo=46>

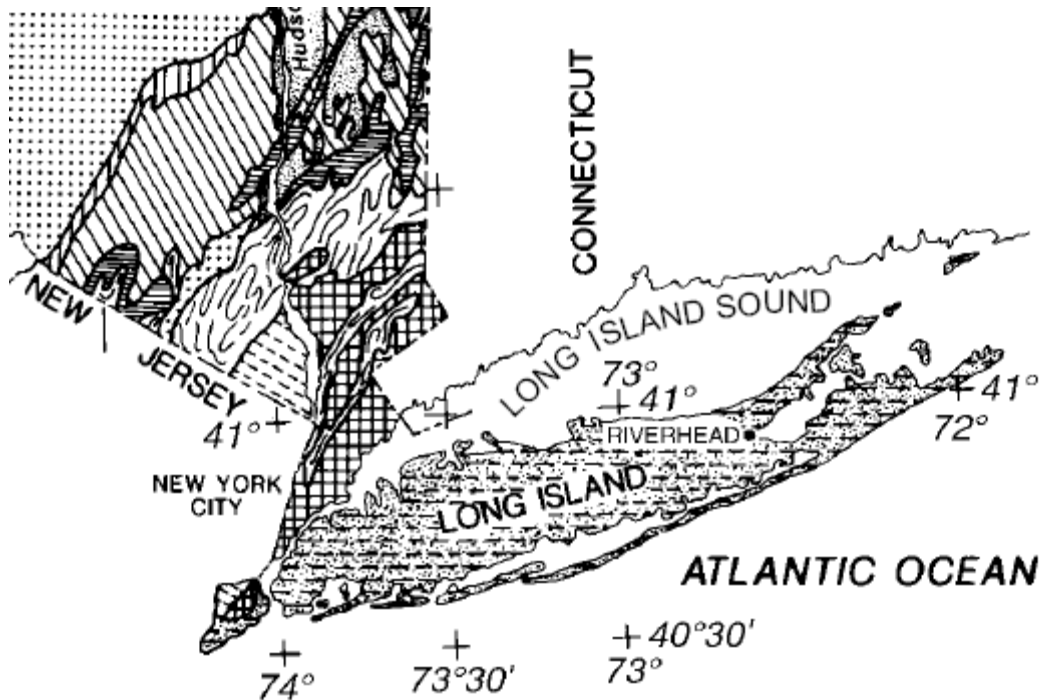
Questions

- On the diagram below, please label where 1) good ozone and 2) bad ozone are located.

Selected Properties of Earth's Atmosphere



- The ozone monitoring station used for the data above was from Babylon NY (40° 40' N, 73° 20' W). Make a star (*) on the map below showing the location of monitoring station.



3. Based upon your data for July 2008, determine the number of days that the local plants on Long Island might have suffered from **chronic exposure (40 to 80 ppb)**.

4. Based upon your data for July 2008, determine the number of days that the local plants on Long Island might have suffered from **acute exposure (> 80 ppb)**.

5. Plant damage due to ozone typically occurs at temperatures hotter than 86 ° F. Using your Earth Science Reference Tables (ESRT's), convert that temperature into ° C.

6. Too much ozone contributes to the creation of smog. Smog is a kind of air pollution; the word "smog" is a combination of smoke and fog. Smoke comes from burning or vehicular/industrial emissions that are acted on in the atmosphere by sunlight. List **three** things that a community can do to help reduce their emission of pollutants into the atmosphere.
 - 1.
 - 2.
 - 3.

7. There are several local species of trees and plants that are affected by ground level ozone. These include: Sweet-Gum, Tulip Tree, Black Locust, Winged Sumac, Milkweed, Black Cherry, and Northern Fox Grape. Ozone damaged plants will exhibit stippling with symptoms occurring on the upper leaf surface and the veins remain unaffected.

As stated earlier, plants affected by ozone are 10% smaller than non-affected plants. If the normal milkweed in the picture to the right had a total mass of 2500 grams, what would the mass of the milkweed damaged by ozone expected to be?



Normal Milkweed



Ozone Damaged Milkweed

8. Ground-level ozone is present on Long Island (as you can see from your data plotted) and it is causing a problem in a number of communities. Senior citizens, children, and people with heart and lung conditions such as emphysema, bronchitis, and asthma have a hard time breathing during high ozone days. It can inflame breathing passages, decreasing the lungs' working capacity, and causing shortness of breath, wheezing, and coughing.

The table below shows what precautions the general public should take when the ground level ozone is at a certain level. Read over the chart, then using your data from your graph, determine the number of days in July each level was relevant for.

EPA Air Quality Index for Ozone			
Index Values (ppb)	Levels	Cautionary Statements	Number of Days in July
0-50	Good	None	
51-100	Moderate	Unusually sensitive people should consider reducing prolonged or heavy exertion outdoors.	
101-150	Unhealthy for Sensitive Groups	Active children and adults, and people with lung disease, such as asthma, should reduce prolonged or heavy exertion outdoors.	
151-200	Unhealthy	Active children and adults, and people with lung disease, such as asthma, should avoid prolonged or heavy exertion outdoors. Everyone else, especially children, should reduce prolonged or heavy exertion outdoors.	
201-300	Very Unhealthy	Active children and adults, and people with lung disease, such as asthma, should avoid all outdoor exertion. Everyone else, especially children, should avoid prolonged or heavy exertion outdoors	

NOTE: To check the status of the ozone in your area, you can visit: <http://www.dec.ny.gov/airmon/index.php> , then select “Air Monitoring Stations”, then select the “Zone” you belong to, then select the station nearest your location.

Additional Reviewed Internet Resources

Online Game on Ground Level Ozone - <http://reviewgamezone.com/game.php?id=695>

EPA Ground Level Ozone Information - <http://www.epa.gov/groundlevelozone/>

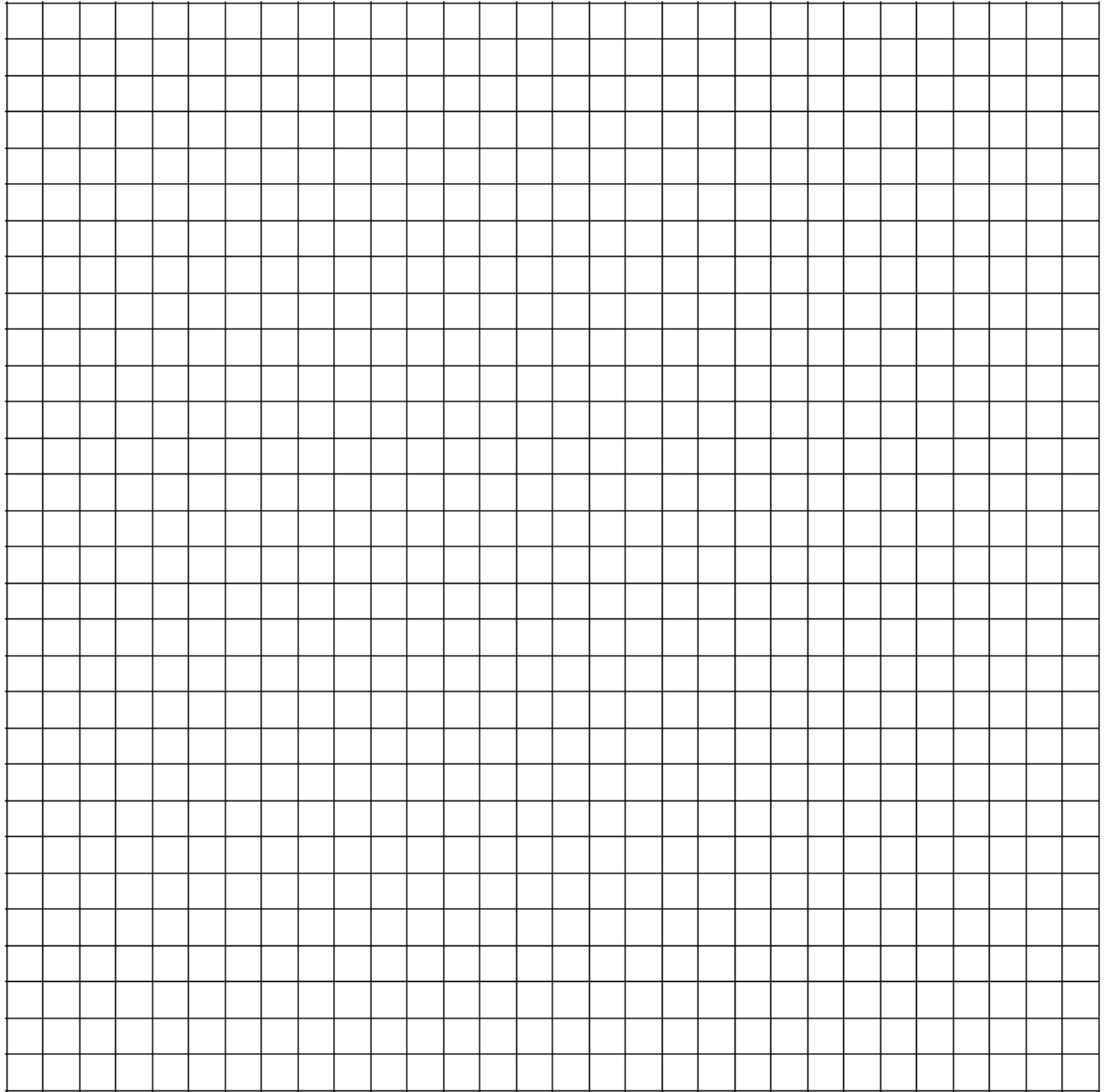
American Lung Association - <http://www.lungusa.org/site/pp.asp?c=dvLUK9O0E&b=50328>

Ozone Basics - <http://www.atmosphere.mpg.de/enid/23c.html>

How To Identify Ozone Injury - <http://www.fs.fed.us/r8/foresthealth/pubs/ozone/r8-pr25/ozoneh2.htm>

Highest July Concentration of Ozone – Babylon New York

Highest Conc. O₃ (ppb)



Date (Day)