MY NASA DATA Lesson:

Trouble in the Troposphere – A Lesson on Tropospheric Ozone

Image courtesy EPA

Purpose:
Using data sets from MY NASA DATA, students will produce graphs comparing monthly and yearly ozone averages of several U.S. cities.

Grade Level: 6 – 8

Estimated Time for Completing Activity:
One 90-minute block or two 50-minute class periods

Learning Outcomes:

- Students will create graphs using NASA data.
- Students will compare ozone levels of several U.S. cities.
- Students will analyze and evaluate the data and predict trends based on the data.
- Students will discuss and describe how human activities have modified Earths air quality

Prerequisite

- Familiarity with accessing websites on the Internet,Ozone Background Information
- GLOBE Ozone Activities (Ex. Collecting Ozone Data and Constructing a Model of ppbv of Surface Ozone)

Tools

- Computers with Internet access
- Printer

AP Environmental Science Topics

- Air pollution
- Atmospheric composition, structure, and circulation
- Atmospheric structure
- Formation of stratospheric ozone
- Major air pollutants
- Primary and secondary sources of pollution
- Ultraviolet radiation

Vocabulary:

- dobson unit
- ozone
- stratosphere
- troposphere

Lesson Links:

- EPA Ozone Information
- EPA Air Quality Index
- Major City GPS Coordinate Locater
- Live Access Server (Advanced Edition)
- Convert this Lesson into a PDF

Background:

For excellent background information on Ozone and air quality, please visit EPA's AirNow website features listed in the Links section.

Ozone is an almost colorless, gaseous form of oxygen. It is a relatively unstable compound of three oxygen atoms. Ozone in the stratosphere is found in a layer from approximately 15 km to 50 km above the earth's surface. This 'good' ozone protects the earth from harmful ultraviolet radiation from the sun. Though the stratospheric ozone is helpful, ozone found in the troposphere can actually cause damage to plants and animals, including humans. Even at relatively low levels, ozone may cause inflammation and irritation of the respiratory tract. 'Bad' ozone, or tropospheric ozone, is a by-product

of photochemical processes associated with air pollution. Ozone levels can reach unhealthy levels when the weather is hot and sunny with relatively light winds.

Ozone levels are measured in a variety of ways. Levels can be measured in ppbs (parts per billion) or in Dobson Units (DU). One DU is 2.7 x 10E16 ozone molecules per square centimeter. One DU refers to a layer of ozone that would be 0.001 cm thick under conditions of standard temperature (0 degrees Celsius) and pressure (the average at the surface of the earth). The EPA uses a 0-300 scale Air Quality Index which rates air quality in six categories from Good to Very Unhealthy.

Procedure:

Part I: Expert Groups

Students will be grouped in 'Expert Groups' of three to four students. Each expert group will be assigned a U.S. city and be given that city's latitude and longitude.
See Lesson Links for the website 'Major City GPS Coordinate Locater' to find coordinates for major U.S. cities.

Using MY NASA DATA, students will collect and graph their city's tropospheric ozone residual monthly climate for a one-year period. Students need to print a completed graph for each member of the Expert Group.

To access data:

1. Click on 'Live Access Server' from the lesson links section above
2. Click on 'Choose Dataset' if you are not automatically prompted with it.
3. Click on Atmosphere, Air Quality, and Monthly Tropospheric Ozone Residual Climatology (TOR)

To create graph, select the following :

1. Select 'Time Series' from the menu to the left of the plot
3. Select Region: North America. This can be done by clicking on the double downward arrow above the navigation map in the upper left corner of the screen and selecting 'North America' from the drop down menu.
4. Either type your latitude and longitude into the compass rose, or move the indicator on top of the assigned city. If typing, enter the latitude and longitude of your city in the compass rose below the navigation map. For example, for 36N 76W, the value of 36 would be entered in both the North and South boxes and the 76 value would be entered in both the East and West boxes.
5. For your Date Range use: Begin-January , End-December
6. Click 'Update Plot' if this does not happen automatically, to see your changes.
7. Print one copy of the Tropospheric Ozone Residual Monthly Climatology graph for each member of the Expert Group.

Part II: Jigsaw Groups

Students will be regrouped using a cooperative jigsaw method. New groups will be formed containing one member from each of the Expert Groups. These 'Jigsaw' groups will meet to compile and compare data using the graphs that each member will bring from their former Expert Group. Experts from each area will discuss their group data. Using the graphs that each member of the group brings, compare the data of ozone averages from the represented cities. The Jigsaw groups will use member graphs, maps, and EPA guidelines provided by the teacher (see Teacher Notes) to answer the questions listed below.

Questions:

1. How do your city's seasonal ozone changes compare to the other cities in your Jigsaw group?

2. What climate, geographic, or population variations could be causing the differences?

3. During the solstices and equinoxes, what chance does each of the cities have of reaching dangerous ozone levels according to EPA's AQI?

4. How many ozone action days does your city have each year? How does that compare to the other cities in your Jigsaw group?

5. Look at global wind patterns. From where does your city's ozone travel?

Extensions:

1. Print graphs or maps for a given month for the last three decades. Have ozone amounts changed? Have they deviated from the average? How?

2. Have the entire class come back together for a Global Conference on Tropospheric Ozone. In the Global Conference, discuss what global citizens can do to protect themselves from harmful ozone levels and what citizens can do to decrease ozone levels. Discuss why there needs to be global cooperation in our attempt to lower tropospheric ozone levels.

Lesson plan contributed by Debbie Murphy, Tom Bean, TX

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