

MY NASA DATA Lesson:

Linkages between Surface Temperature and Tropospheric Ozone

Purpose:

To use data microsets of mean near-surface air temperature and tropospheric ozone residual averages to infer patterns.

Analyze changes in tropospheric ozone and then hypothesize about the consequences of these changes.

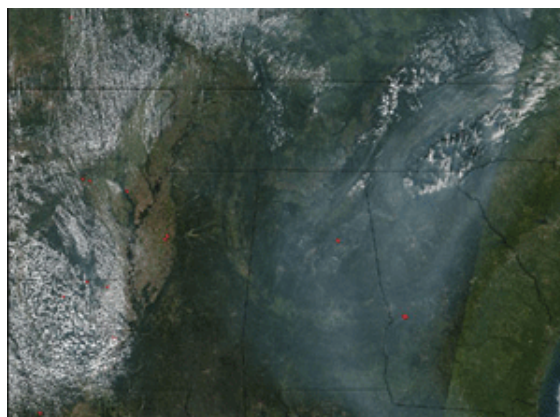


Image courtesy MODIS Rapid Response Team at NASA GSFC

Grade Level: 9-12

Estimated Time for Completing Activity:

90 minutes

Learning Outcomes:

- Organize data into graphs
- Relate temperature to ozone concentration
- Analyze and interpret data
- Conversion of measurement units

Prerequisite

- Activity – Constructing a Model of ppbv of Surface Ozone
- Powerpoint: Surface Ozone
- Powerpoint: Surface Temperature
- Globe Protocol – Ozone
- Globe Protocol – Surface Temperature
- Familiarity with using a software-based graphing utility
- Knowledge of formulas within software-based graphing utility

Tools

- Graph paper
- Graphing utility (e.g. Microsoft Excel)

Vocabulary:

- atmosphere
- ozone
- surface temperature
- TOR
- trace gas
- tropopause
- troposphere

Lesson Links:

- [Ozone Spreadsheet](#)
- [The Ozone We Breathe](#)
- [Comparison Graph](#)
- [Globe: Ozone, Surface Temperature, Construcing A Model of ppbv of Surface Ozone](#)
- [Surface Temperature Powerpoint](#)
- [Surface Temperature Spreadsheet](#)
- [Ozone Powerpoint](#)
- [Live Access Server \(Advanced Edition\)](#)

Background:

Ozone (O₃) is a gas that has two different personas. Good ozone occurs in the stratosphere, where it absorbs energy (including harmful UV rays) from the Sun. This warms the air and keeps the ozone from sinking into the lower atmosphere. Bad ozone is found in the troposphere, where humans and animals could be harmed. Here ozone is formed as a byproduct from fossil fuel burning such as in power plants and cars. Ozone is one of many gases in the air present in small amounts. The gases are called trace gases, and they play a role in the complex chemistry that determines the quality of

the air we breathe. The amounts (concentrations) of these trace gases vary hourly, day to day and place to place. One variable that affects ozone levels in the troposphere is changing air temperature. High levels of ozone in the troposphere can be harmful, which is why careful measurements of ozone are needed to better understand the linkage between ozone and other physical processes.

This lesson seeks to determine if there is a linkage between surface temperature and tropospheric ozone by graphing each dataset and comparing the results. The measurements are taken over Chattanooga, TN. The data for the tropospheric ozone residual monthly averages for recent years are provided by the AURA, NOAA 14, and NOAA 16 satellites.

Procedure:

To obtain the microset for Tropospheric Ozone Residual Monthly Averages:

1. Click Live Access Server (Advanced Edition) in the lesson links above
2. If not automatically prompted, click on 'Choose Dataset' in the top left corner of the screen and then
3. Select Dataset: Atmosphere
4. Select Dataset: Air Quality
5. Select Dataset variable: Monthly Tropospheric Ozone Residual (TOR)
6. Choose 'Time Series' from the list to the left of the screen under 'Line Plots'
7. Input longitude and latitude: 35 N in the top box and press Tab, 85 W in the left box and press Tab
8. Set Time range: Jan 1999 to Jan 2001
9. Make sure to click on the 'Update Plot' radio button to display your new data.
10. From the menu at the top select 'Save As', select ASCII from the drop down menu, verify your time range and click 'OK' to save your data file for use later in the lesson.
11. A screen showing the microset will appear. Check to make sure the data are for the correct latitude and longitude (35 N and 85 W or 275 E). Save as a text (.txt) file. Note the filename and location on your computer, so you can find this later.

To graph Tropospheric Ozone Residual Monthly Average data:

A. Importing data into a spreadsheet program (such as Excel):

- Launch spreadsheet software
- File, Open, select the file you just saved. Text Import Wizard should automatically start
- Step 1: Select Delimited (usually the default)
- Click Next
- Step 2: In addition to Tab, check Space
- Click Finish

B. You should now have 3 columns of data in your spreadsheet, along with some header and footer rows.

- Select all headers (rows 1-7), Edit, Delete. Highlight rows containing footer information, Edit, Delete.
- Remove unneeded Column B: Click on B (of Column B), Edit, Delete. There should now be 2 columns of data.
- Rename A1:Date, rename B1: Ozone
- Click on A (of Column A), go to Format menu, Cells, Number tab, Category: Date, Select: 3.14.01 or your preference (. stands for slash), OK.

C. To make line graph:

- Highlight both columns of data
- Click on Chart Wizard or Insert menu then Chart
- Step 1: Standard Types Tab, Chart type: Line. Suggested Chart Sub-type: default or the sub-type directly above the default
- Step 2: Next
- Step 3: Next
- Step 4: Chart title: Tropospheric Ozone Residual Monthly Averages over Chattanooga, TN, Category (X) axis: Time (months), Value (Y) axis: Ozone (Dobson units). You can chose to have a legend or other features.
- Step 5: Next
- Step 6: Choose whether to have the chart appear within your spreadsheet (default) or on a separate page (As new sheet). To see an example of what you should get, click on Ozone spreadsheet in the Links section.

To obtain microset for Mean Near-Surface Air Temperature(ISCCP):

1. Click data access
2. Click Live Access Server (Advanced Edition)
3. Dataset: Atmosphere
4. Dataset: Atmospheric Temperature
5. Select Dataset variable: Monthly Near-Surface Air Temperature (ISCCP)
6. Click Next
7. Select View: Time Series
8. Select Output: Text File (ASCII)
9. Select Region: Full Region (default)
10. Input longitude and latitude: 35 N in the top and press tab, 85 W in the left box and press tab
11. Time range: 15-Jan-1999 to 15-Jan-2001 (Note this is a still a monthly average data value. The date descriptor is just using a different standard format.)
12. Click Next. (Note: If you have pop-up blockers on your web browser, press and hold the control (CTRL) key and then click Next or turn off pop-up blockers for this website.)
13. A screen showing the microset will appear. Make sure that is is for the right latitude and longitude, then save as a text (.txt) file. Note the filename and location.

To graph Mean Near-Surface Air Temperature data:

A. Importing data into spreadsheet program:

- Launch spreadsheet program
- File, Open, select the file you just saved. Text Import Wizard should automatically start
- Step 1: Select Delimited (usually the default selection)
- Click Next
- Step 2: In addition to Tab, check Space
- Click Finish

B. You should now have 3 columns of data in your spreadsheet, along with some header and footer rows.

- Select all headers (rows 1-7), Edit, Delete. Highlight all footer rows, Edit, Delete.
- Click on cell B2, in formula box type: =C2-273.15, press enter or click on the green check next to the formula box. This step converts temperature in degrees Kelvin to degrees Celsius.
- Highlight cells B2 down to B26. Edit, Fill Down. This copies the formula you typed in B2 into cells B3-B26.
- Rename A1:Date, rename B1: Temperature (Celsius), rename C1: Temperature (Kelvin)
- Click on A (of Column A), go to Format menu, Cells, Number tab, Category: Date, Select: 3.14.01 or your preference (. stands for slash), OK.

C. To make line graph:

- Highlight columns A and B
- Click on Chart Wizard or Insert menu then Chart
- Step 1: Standard Types Tab, Chart type: Line. Suggested Chart Sub-type: default or the sub-type directly above the default
- Step 2: Next
- Step 3: Next
- Step 4: Chart title: Mean Near-Surface Air Temperatures over Chattanooga, TN, Category (X) axis: Time (months), Value (Y) axis: Temperature (Celsius). You can choose to have a legend or other features.
- Step 5: Next
- Step 6: Choose whether to have the chart appear within your spreadsheet (default) or on a separate page (As new sheet). To see an example of what you should get, click on Surface Temperature spreadsheet in the Links section.

Options:

1. For ease in comparison, you can copy and paste the 2 graphs into a word processing program (e.g. MS Word, Word Perfect).
2. If you are more familiar with the graphing utility's functions, you can make a graph that contains the date, ozone and temperature (Celsius) values in one spreadsheet. You would choose to have a custom type of graph (Lines on 2 axis) that will graph both the ozone and temperature data on one graph with the common x-axis of time. To see an example click on Comparison Graph in the Links section.

3. If computer access is limited, students can graph the data by hand. The unit conversion can be done by hand as well

Questions:

1. What patterns do you observe in the tropospheric ozone residual monthly averages?
2. What patterns do you observe in the mean near-surface air temperature?
3. What is the relationship between mean near surface air temperature and tropospheric residual monthly averages?
4. What do you think causes the changes in the mean near-surface air temperatures? Tropospheric ozone residual monthly averages? Use the graphs for your hypothesis.
5. Do you think temperature will affect regional air quality? Explain.
6. What kind of effects do you think high levels of tropospheric ozone will have on people, animals and plants?

Extensions:

1. How does ozone affect you, your family and your community?
2. Repeat the procedure for different coordinates, compare a metropolitan area to a rural area. Do you see any patterns? Which type of location has the easiest to see relation between temperature and ozone concentration?

Lesson plan contributed by Sarah Smith, Charlotte, NC

[Click here for Teachers Notes](#)

[View lesson without Standards](#)

