

MY NASA DATA Lesson:

Investigating Seasonal Variability in NO₂ Concentrations

Purpose:

Students will examine data in several formats in order to determine the presence or absence of seasonal variability in tropospheric nitrogen dioxide (NO₂) concentrations

Grade Level: 8 – 10

Estimated Time for Completing Activity:

50 minutes

Learning Outcomes:

- Students will be able to understand the role NO₂ plays in air quality
- Students will be able to understand the relationship between NO₂ variability and seasonal changes
- Students will be able to make connections between graphically-represented and spatially-represented data

Prerequisite

- Familiarity with graphing variables in Microsoft Excel
- Ability to examine and understand data presented in spatial and temporal formats

Tools

- Microsoft Excel
- Google Earth (for extensions)

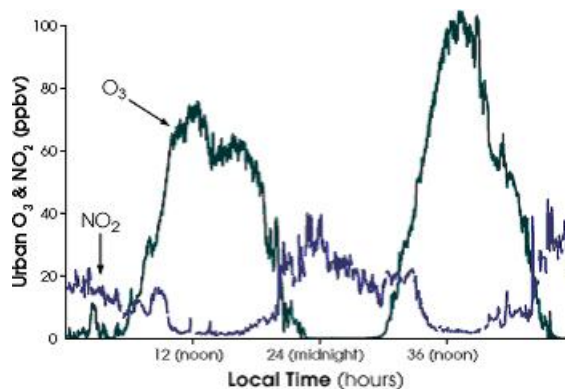


Image courtesy William Brune, Penn State Earth Systems Science Center

AP Environmental Science Topics

- Atmospheric circulation
- Atmospheric structure
- Formation of ozone
- Measurement units
- Seasons

Vocabulary:

- [air quality](#)
- [atmospheric column](#)
- [nadir](#)
- [nitrogen oxide](#)
- [number density](#)
- [OMI](#)
- [trace gas](#)
- [troposphere](#)

Lesson Links:

- [EPA Web site about NO2](#)
- [Graph of NO2 vs. Ozone](#)
- [EPA NOx website](#)
- [NPS Article on nitrogen deposition](#)
- [Population Density](#)
- [Live Access Server](#)
- [Understanding Scientific Units – Air Quality](#)

Background:

For background information about NO₂, please refer to the EPA website and the graph of NO₂ in the Lesson Links.

The dataset used in this lesson is monthly averages of NO₂ as measured from NASA's EOS Aura spacecraft. NO₂ is measured using the Ozone Monitoring Instrument (OMI). OMI is a nadir-pointing instrument that measures trace gases in a column of air directly

below the spacecraft. NO₂ concentrations are measured in number densities, or the amount of NO₂ molecules found in a cubic centimeter of air. Alternately, units of parts per billion can be used, as in the graph at the top of the page. This tells how many NO₂ molecules would be found in a sample containing a billion molecules of air. The OMI instrument measures the amount of NO₂ in the entire vertical column of air below it, thus the units for OMI measurements are molecules per square centimeter (of the surface). See the units page for more explanation of this.

Measurements of nitrogen dioxide (NO₂) [in blue on graph] and ozone (O₃) [in green] indicate rise and fall over a 48-hour period. Nitrogen dioxide participates in ozone formation, so after its concentrations peak, so do concentrations of ozone. Ozone concentrations peak during hours of maximum sunlight, around the middle of the day. (Graph courtesy William Brune, Penn State Earth Systems Science Center)

Procedure:

Part I: Examining Seasonal variations in NO₂

Obtaining NO₂ data from the Live Access Server (LAS):

1. Click on the Live Access Server (Advanced Edition) link above in the lesson links section of the lesson.
2. If you are not automatically prompted with the data sets, click on 'Choose Dataset' from the menu at the top of the screen then click on Atmosphere, Air Quality and then Tropospheric Total Column NO₂ (OMI)
3. Change the location, by making the following changes to the compass rose below the navigation map to the left of the screen.
4. Click in the upper latitude box and type 41 N
5. Click in the lower latitude box and type 36 N
6. Click in the left longitude box and type 90 W
7. Click in the right longitude box and type 82 W
8. Click on 'Update Plot' found in the menu at the top of the page to see your updated plot.
9. Click on the 'Compare' found in the menu at the top of the page
10. For the plot in the upper left corner, choose January 2007. This can be done by scrolling down and using the drop down menus below each of the plots.
11. For the second variable, choose May 2007
12. Be sure to click 'Update Plot' at the top of the screen to see your new data plots.
13. You can now click on each of the plots to enlarge the image and save them for later use in the lesson.

Part II: Graphing NO₂ data in Excel

1. Return to the LAS page found in the lesson links section of the lesson.
2. If you are not automatically prompted with the data sets, click on 'Choose Dataset'

from the menu at the top of the screen then click on Atmosphere, Air Quality and then Tropospheric Total Column NO₂ (OMI)

3. Under the 'Line Plots' option found on the left hand side of the screen, choose 'Time Series'

4. Enter the following location in the latitude and longitude box: 39 N, 85 W in the compass rose found under the navigation map to the upper left of the screen.

5. Under 'Date Range' use the drop down menu to select, Jan 2006 to Jun 2007

6. To save the data set as a text file to import into excel, click on 'Save As' Found in the menu at the top of the screen, use the drop down menu to select 'ASCII', verify your date and click 'OK' to save your file to your computer.

7. Once the file is saved, import the NO₂ file into Excel. For information on how to import data, please see the tools section of the MY NASA DATA website.

8. Graph the time series NO₂ data.

Questions:

Part I Questions:

1. What observations can be made about the plots? Explain your observations.
2. Why do you think the plots for these two months look the way they do?
3. What seasons occur during these two months?
4. Given the differences in seasons, are the similarities and differences what you expected?
5. Speculate why you think this location was chosen.
6. Predict how the data would behave if you were to graph a time series for a single location within this area

Part II Questions:

1. Describe any patterns you observe in the graph. Based on your answer from Part I, does the graph look like what was predicted? If not, what was different?
2. List possible reasons why the graph appears the way it does from January 2006 to June 2007.

Extensions:

Investigate other factors that affect NO₂ variability:

1. Compare the NO₂ from this location with the NO₂ from the Los Angeles area in CA. How do the plots compare? Are there any similarities or differences? Explain your reasoning.

2. Explore the relationship between NO₂ and population density using the Population Density lesson link. What comparisons can be drawn between population densities and NO₂ concentrations?

3. Predict what you think the NO₂ concentrations for your area would be for spring and fall. Find the NO₂ satellite data for your area and plot the time series data. Does the data agree with your predictions? Investigate possible causes for any discrepancies between your predictions and the data.

Lesson plan contributed by Brooke Carter, Greenbelt, Maryland

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