TEACHER SUPPLEMENTAL INFORMATION

I. NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS) FROM THE ENVIRONMENTAL PROTECTION AGENCY (EPA):

The Clean Air Act, which was last amended in 1990, requires EPA to set **National Ambient Air Quality Standards** (40 CFR part 50) for pollutants considered harmful to public health and the environment. The Clean Air Act established two types of national air quality standards. ***Primary standards*** set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. ***Secondary standards*** set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

The EPA Office of Air Quality Planning and Standards (OAQPS) has set National Ambient Air Quality Standards for six principal pollutants, which are called "criteria" pollutants. They are listed below. Units of measure for the standards are parts per million (ppm) by volume, milligrams per cubic meter of air (mg/m^3), and micrograms per cubic meter of air ($\mu g/m^3$).

National Ambient Air Quality Standards

Pollutant	Primary Standards	
	Level	Averaging Time
Carbon Monoxide	9 ppm ($10 mg/m^3$)	8-hour
	35 ppm ($40 mg/m^3$)	1-hour
Lead	1.5 $\mu g/m^3$	Quarterly Average
Nitrogen Dioxide	0.053 ppm ($100 \mu g/m^3$)	Annual (Arithmetic Mean)
Particulate Matter (PM_{10})	150 $\mu g/m^3$	24-hour
Particulate Matter ($PM_{2.5}$)	15.0 $\mu g/m^3$	Annual (Arithmetic Mean)
	35 $\mu g/m^3$	24-hour
Ozone	0.075 ppm (2008 std)	8-hour
	0.08 ppm (1997 std)	8-hour
	0.12 ppm	1-hour (Applies only in limited areas)
Sulfur Dioxide	0.03 ppm	Annual (Arithmetic Mean)
	0.14 ppm	24-hour

II. Characteristics of Nitrogen Dioxide:

NO_2 is a brown colored poison. It allows more ozone to form in an airshed, and that ozone is not good for crops and respiration. This is converse to the fact that ozone is necessary high up in the stratosphere where it can block ultraviolet rays. So essentially, ozone saves life in the stratosphere but hurts it down near the ground. Burning things (gasoline, forests, or any fuel) creates air pollutants, and the physical process is called combustion. The combustion of fuels is the source of energy for vehicles and some power generators. Combustion causes nitrogen dioxide to form in our atmosphere since our air is primarily nitrogen and oxygen. Vehicles and power generators are the two largest sources of nitrogen dioxide in the United States. The spectra or "colors" of light rays change when they pass through molecules (i.e. the Beer-Lambert Law), and special instruments on NASA satellites can measure how much NO_2 is in a "column" of air by looking at the reflected sunlight. This is called spectroscopy. The Laboratory for Atmospheric Research at Washington State University numerically models clouds and air pollutants with computers, much like a weather forecast model. The AIRPACT air quality forecast model is based on emissions estimates, meteorology, and calculations based on the scientific laws of physics and chemistry. The two color maps shown in the worksheet represent a "cloud free" monthly average of the Pacific Northwest NO_2 "vertical column" in the troposphere from the NASA AURA satellite and WSU's AIRPACT-3 air quality model.

III. EXCEL Activity – Step by step computer instructions:

1. Have students turn on their computers and open the excel file provided.
2. Explain that the file has a list of latitude and longitude of the borders around Washington State.
3. Ask students to plot the latitude and longitude in a graph:
   a. Click the "A" Column
   b. Hold down the "Ctrl" Button
   c. Click the "B" Column
   d. Click the graph icon in the excel toolbar ("Chart Wizard")
   e. Click "X-Y Scatter"
   f. In the "Chart Sub-Type" section, click the curved lines with no points. ("Scatter with data points connected by smoothed lines without markers.")
   g. Click "Finish" – The borders of Washington State should be plotted.

4. Ask students to quickly format the graph:
   a. Right click the background of the graph, and click "Clear".
   b. Right click one of the black gridlines, and click "Clear".
   c. Students should be able to clearly see the borders of Washington.
   d. Click the title and change it to say "Washington State".

5. Ask students to plot the cities onto the same graph:
   a. Click the Washington State plot, so that it is selected.
   b. In the menu, click "Chart" and then "Add Data"
   c. Select the two short columns that have city coordinates, including the headers.
   d. Click "OK"
   e. Make sure that the boxes are checked for "Series Name in First Row" and "Categories (X values) in First Column"
   f. Click "OK"
   g. Students should see a curved line going through the state.
   h. Right click the new curved line and click "Format Data Series"
   i. Under the "Patterns" menu, click "None" for the line and "Automatic" for the marker.
   j. Click "OK"
   k. Students should see the selected cities plotted on the graph.

6. Ask students to identify where each city is located. On the board, engage students to help draw a sketch of the plot they made. Make sure to plot the cities and label them! Ask students to label the cities on the similar plot provided to them on their worksheet.
7. If there is ample time students can right click their graph and adjust their "Chart Options".
8. Students should now save their work.
9. Ask students to use the information they have to fill out the columns labeled "AIRPACT NO2" and "OMI NO2". Explain that the large numbers can be entered by using the capital "E". (i.e. 1.5×10^{15} can be typed "1.5E15")
10. Tell students they will now use a powerful tool in Excel to calculate the difference (and ratio) between the model and the satellite.
    a. In the first empty cell under "AIRPACT / OMI Ratio" press the equals ("=") button.
    b. Click the cell with the value of the AIRPACT NO2 in Seattle.
    c. Press the "/" key, which stands for division.
    d. Click the cell with the value of the OMI NO2 in Seattle.
    e. Press the Enter Key.
    f. Follow a similar process to calculate the difference in NO2 in Seattle, but this time use the "-" key which stands for subtraction.

11. Tell students they will now use another powerful tool in Excel, to duplicate the calculation process they just went through for Seattle, for all the other cities.
    a. Click the cell that has the value for the Seattle NO2 Ratio.
    b. Notice that the cell is highlighted and has a cross on the bottom right hand corner.
    c. Move the mouse cursor over the cross, click the cross and hold down the button, and then drag the corner down to the bottom of the table. (Release the mouse button).
    d. All the ratios should now be calculated.
    e. Follow a similar process to fill in the values for the difference column.

12. Students should now save their work.
13. Ask students to record their answers in the worksheet provided to them.
14. Discuss with students the meaning of their ratio and difference calculation. What is the significance of having a ratio equal to "1"? What is the significance of having a difference equal to "0"?
15. With time, students can make a bar graph of the AIRPACT and OMI pollution in various cities.
    a. Select the three columns with city name, AIRPACT NO2, and OMI NO2.
    b. Click the Graph Icon in the Excel Toolbar.
    c. Choose "Column" or "Bar"
    d. Click Finish
16. Students should now save their work.

17. Students should use the Bar Graph created to answer the final questions in their worksheet.

18. As an extension, students could use the "avg" function in Excel to calculate the average values obtained in their comparison.

19. Excel can be closed, and computers put away.

20. With time, review as a class over what was learned about both air pollution and excel.