Investigating Air Quality from Space: Exploring NASA's Aura Satellite Ozone Monitoring Instrument
Student Worksheet Name:_____

Information about the Aura Satellite:
Latin for breeze, **Aura** is the name of the NASA satellite launched in 2004 to make daily global observations of Earth's atmosphere. The satellite has four instruments that in combination monitor Earth's atmosphere and air quality. In this activity, you will look at data from Aura's Ozone Monitoring Instrument (OMI) to observe emissions of atmospheric gases such as sulfur dioxide (SO_2), along precursors to tropospheric ozone, nitric oxide (NO) and nitrogen dioxide (NO_2), collectively referred to as nitrogen oxides (NO_x).

Part A: The OMI Instrument: Visualizing emissions of atmospheric gases such as SO_2
1. Go to: http://earthobservatory.nasa.gov/IOTD/view.php?id=5251 to get oriented to an OMI image of a Sulfur Dioxide Plume from Manam Volcano in 2005. Answer the questions below:
   a. What color corresponds to a high concentration of SO_2? _____
   b. What color corresponds to a low concentration of SO_2? _____
   c. What unit is used to measure the concentration of SO_2? _____
   d. What is the highest concentration of SO_2 detected in this image? _____
   e. The black triangle indicates the location of the volcano. In which direction is the SO_2 plume traveling? _____
   f. According to the accompanying text, what will happen to this SO_2 now that it is in the atmosphere?

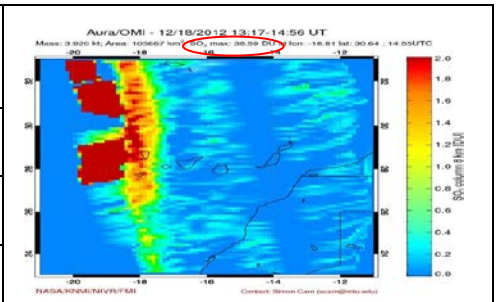
Part B: The OMI Instrument: Interesting Images and Datasets
1. Visit: http://aura.gsfc.nasa.gov/index.html
2. Click on *Science and Data*, and then select *OMI* from the *View by Sensor* option.
3. A variety of natural and man-made events resulting in SO_2 and/or NO_x emissions will be listed (a few events focus on bromine monoxide (BrO) but we will exclude those from this analysis). **Pick three of the data/image sets to investigate further.** Examine the corresponding OMI data visualization for each and complete the table below. Be prepared to discuss your findings with the class.

Title of Data/Image Set	What pollutant(s) was OMI measuring?	Location	Summarize finding

Part C: The OMI Instrument: Daily Images for SO_2

1. Next visit: http://aura.gsfc.nasa.gov/index.html
2. Click on *Science and Data*, and then select *OMI* from the *View by Sensor* option.
3. Click on *Data and Images* in the left tool bar, scroll down to find the OMI Data Centers on the right side of the page and then click on *OMI Sulfur Dioxide Group*. This will open a new window showing a world map.
2. Distinguish between the red, yellow, and orange boxed locations.
3. Click on one red box (representing a volcanic region) to get the *Latest Daily (OMI) Images of SO_2* for this region (perhaps you'll find evidence of an active volcano). Next, select a recent day by clicking on the image and then determine the **maximum SO_2 output** for that day (this value can be found above the image and is measured in Dobson Units (DU), the number of molecules in a square centimeter of the atmosphere). Enter this information in the first row of the table below.
4. Next, click on the orange box around China. This will bring you to a page of daily images from Eastern China for the current month. Before selecting a day, click on "Time Series Plot" at the bottom of the page and identify a day during the month where SO_2 levels were higher than usual (observe red data on time series plot). Then return to the set of images and select the daily image that corresponds to the day with higher than usual SO_2 levels. Record your observations on the second row of the table below and, time permitting, investigate and predict the cause(s) of the elevated SO_2 observed in this region.
5. If time permits, repeat these steps for another area of your choice. You can select from archived images by scrolling to the bottom of the page and selecting a region of interest along with the month and year of interest.

Box Color	**Location**	**Month, Day, Year**	**SO_2 Max (DU)**	**Source of SO_2 emissions (if known)**
Red *(volcanic region)*				
Orange *(pollution region)*	Eastern China			
Your choice				



6. Conclude your investigation of SO_2 emissions by answering the questions below. This reading from NASA's Earth Observatory may be useful: http://earthobservatory.nasa.gov/Features/Aerosols/page1.php along with this one from the US EPA: http://www.epa.gov/oaqps001/sulfurdioxide/health.html

a) What types of natural occurrences and/or human activities result in SO_2 emissions into the atmosphere?

b) What happens to SO_2 once it enters the atmosphere?

c) How can SO_2 emissions impact climate?

d) How can SO_2 emissions impact human health?

e) How can SO_2 emissions impact ecosystems?

f) In your own words, summarize why satellite observations of SO_2 are valuable to scientists.

Part D: The OMI Instrument: Daily Images for NO_2

1. Go to: http://www.knmi.nl/omi/news/temis/temis_en_nrt_trop_no2_other_regions.html to view OMI derived images of tropospheric NO_2 from around the world. Pick a region of interest and answer the questions below:
    a. What color corresponds to a high concentration of NO_2? _____
    b. What color corresponds to a low concentration of NO_2? _____
    c. What unit is used to measure the concentration of NO_2? _____
    d. Where in this region is NO_2 concentration highest? _____
    e. Based on what you know about this region, can you predict the source(s) of observed NO_2?

2. Select a region from around the globe that is exhibiting high concentrations of NO_2.
    a. Where in this region is NO_2 concentration highest? _____
    b. What is the highest concentration of NO_2 observed in this region? _____
    c. Based on what you know about this region, can you predict the source(s) of observed NO_2?
    d. If time permits, conduct research to investigate the actual source(s) of these NO_2 emissions.

3. Conclude your investigation of NO_2 emissions by answering the questions below. This reading from NASA's Earth Observatory may be useful: http://earthobservatory.nasa.gov/IOTD/view.php?id=80200 along with this one from the US EPA: http://www.epa.gov/air/nitrogenoxides/

    a) What types of natural occurrences and/or human activities result in NO_2 emissions into the atmosphere?

    b) What happens to NO_2 once it enters the atmosphere?

    c) How can NO_2 emissions impact climate?

    d) How can NO_2 emissions impact human health?

    e) How can NO_2 emissions impact ecosystems?

    f) In your own words, summarize why satellite observations of NO_2 are valuable to scientists.