LESSON 2: GET YOUR TECHNO ON!
An Introduction to My NASA Data

PURPOSE/QUESTION
Students will familiarize themselves with accessing environmental data through the My NASA Data portal, mapping and plotting the data, and importing the data into Excel to do further analysis.

GRADE LEVEL
9-12

TIME TO COMPLETE
1-2 – 50 minute time periods

STANDARDS
See appendix below-page 7

LEARNING OUTCOMES
- Students will access data over various periods of time.
- Students will use NASA data systems to make observations and inferences, communicate scientifically, formulate hypotheses, and draw conclusions.

STUDENT OBJECTIVES
- Access and collect surface temperature data.
- Analyze and compare the data to evaluate seasonal and geographic patterns, as well as variation over multiple years.
- Draw conclusions from dataset evidence

TEACHER BACKGROUND

This first lesson in the Eco-Schools USA Climate Connections Curriculum is intended to help students get acquainted with the My NASA Data portal and some of the basics of mapping, plotting, and analyzing environmental data. Future lessons will build on the skills presented here. Note that this lesson provides more detailed instructions for navigating My NASA Data, while future lessons assume students have learned these basics.

Throughout this curriculum, students are challenged to examine the data with a critical eye and to think about the data in the context of their prior knowledge of the climate system. In some cases, this will mean studying the spatial patterns or the seasonal variation of the data. In other cases, it will involve quantifying correlations between variables or trends over time. Lesson 1 introduces some of these analysis techniques focusing on aspects of weather and climate with which students should already have some familiarity.

PREREQUISITES
- Experience with creating Excel spreadsheets
- Experience with taking Excel data and formulating graphs within the program
- Difference between weather and climate

MATERIALS & TOOLS
- Computer with Internet
- Color Printer (optional)
- Excel
- Eco-Schools CCC Tech Tips Sheet

VOCABULARY
- ISCCP
- Parameter
- Microset
- Satellite
- Earth Observing Satellite-EOS

LESSON LINKS

- Live Access Server (LAS)
- My NASA Data (MND)
- State of the Climate, National Overview August 2007, National Oceanic and Atmospheric Administration, National Climatic Data Center.

WHAT IS THE ISCCP DATA SET?

The International Satellite Cloud Climatology Project was established in 1982 as part of the World Climate Research Programme (WCRP) to collect and analyze the global distribution

PART 1: Learn about the My NASA Data portal

ESSENTIAL QUESTIONS

1. The ISCCP data incorporate observations from both *geostationary* and *polar-orbiting* satellites.
   a. What is a geostationary satellite? How often do these satellites observer a specific location?
   b. What is a polar-orbiting satellite? How often do these satellites observer a specific location?

2. Any satellite- based measurements are recording average conditions over a certain geographical area or footprint.
   a. What is the footprint for the Near-Surface Temperature data in degrees latitude and longitude?
   b. About how many kilometers is this equivalent to over the United States, if 1 degree latitude is approximately 110 km and 1 degree longitude is approximately 80 km?

PROCEDURE

1. Read/review the introduction to the Live Access Server - http://mynasadata.larc.nasa.gov Go through the My NASA Data "Overview of the LAS tutorial - http://mynasadata.larc.nasa.gov/using-my-nasa-data/
2. Examine the list of data sources and their time coverage - http://mynasadata.larc.nasa.gov/data-sources-2/
3. For this lesson, we will be using the Near-Surface Temperature data from the ISCCP platform. Go to the My NASA Data Earth Science Glossary and learn about the ISCCP platform and surface temperature. The entry for ISCCP provides a link to the ISCCP project site. Follow this link and review the "Project Description". Also, go to the "Science Focus" tab on the My NASA Data website, and click on the "Products and Parameters" link on the left under "Learn more about our Data".

PART 2: Create temperature maps for January, April, July, and October 2007

ESSENTIAL QUESTIONS

1. Explain how the equation converts from Kelvin to Fahrenheit.
2. What do you notice about how temperature varies from the North Pole to the South Pole? How does this pattern change for each season?
3. What do you notice about how temperature varies from continents to oceans? How does this pattern change from January to July?
4. Identify three places on the continents that have a significantly different temperature from the surrounding land. Why do you think the temperature is higher or lower in each location?

PROCEDURE

1. In the Live Access Server (Advanced Edition), click on the ***Choose Dataset*** button. Then choose ***Atmosphere > Atmosphere Temperature > Monthly Near-Surface Air Temperature (ISCCP)***.
2. A map will automatically appear in the right-hand side of the window. Next change the ***Date*** to get a map for January 2007. Notice that the ***Update Plot*** button turns green when changes have been made in the options. Click the ***Update Plot*** button to get the map for January 2007.
3. Notice the color bar on the right of the plot and that the temperature data is in units of Kelvin (K). In order to display the map in units that most of us are more familiar with, we'll convert the units to degrees Fahrenheit (F) and redraw the map.
   a. Click on the ***Set plot options*** button.
   b. Enter the following equation into the ***Evaluate expression*** box: **$ * 1.8 - 459.4**. This equation is recognized by the computer as the calculation to convert Kelvin to Fahrenheit. [Note: you must keep the spaces the same in the equation: $(space)*(space)1.8(space)-459.4]
   c. Click ***Update Plot*** to recreate the map.
   d. Print or save this new map. [Note: see the Eco-Schools CCC Tech Tips Sheet if you need help printing or saving.]
4. Now, let's compare the map for four different months to see how the temperature distribution changes seasonally. .
   a. Click the ***Compare*** button. A new window will pop up, which should have 4 separate maps on it.
   b. Click ***Plot Options*** and enter the same equation in the ***Evaluate expression*** box to convert from Kelvin to Fahrenheit.
   c. Select the ***Start date*** for each map so that you get maps for January 2007, April 2007, July 2007, and October 2007. Click the ***Update Plots*** button to refresh the maps.
   d. Note that the color bars for the four maps are not the same. This makes it difficult to compare the maps to each other. Reset the color intervals by clicking the ***Auto Colors*** button, and then clicking the ***Update Plots*** button to refresh the maps again.
   e. Save or print the resulting four maps.
5. Finally, animate the temperature maps to visualize how temperatures changes throughout the year.
   a. In the main window, click on the ***Animate*** button. Click ***OK*** to accept the default parameters.
   b. A new window will pop up. Click ***Submit*** to accept the default parameters.
   c. The animation will load slowly, and then begin to play in a loop. Use the controls at the bottom of the screen to manipulate how the animation plays and to explore the data.

PART 3: Import surface temperature data into Excel and examine trends over time

ESSENTIAL QUESTIONS

1. How does temperature vary through the year? 645
2. How has temperature varied for the month of August from 1994 – 2007?
3. Does the satellite data agree with ground-based measurements that indicate 2007 was the hottest August on record? What might explain any differences?
4. What are some limitations of the satellite record for studying long-term trends in temperature?

PROCEDURE

1. Columbia, SC set a record for the hottest August on record in 2007, with 14 days topping 100°F. This conclusion is based on weather-station observations. See the link above to the "State of the Climate, National Overview August 2007," published by the National Oceanic and Atmospheric Administration, for more information. We will examine whether the satellite observations of temperature also have a maximum in 2007.
2. Create a text file of the data for Columbia, SC.
    a. Return to the first window and keep everything the same as above (i.e., selection of data and the conversion from K to F).
    b. Under "Line Plots", select: ***Time Series***
    c. Enter the coordinates for Columbia, SC (34 N, 81.2 W) into the appropriate boxes just below the small grey map on the left of the screen.
    d. Keep the time settings to include the entire ***Data Range*** (January 1994 to June 2008).
    e. Click ***Update Plot*** and a time series plot will appear.
    f. We want to access the data used to create this plot, so that we can do our own calculations. Click the ***Show Values*** button and then click ***OK*** to accept the defaults. The data will appear in the second window.
    g. Follow the instructions in the Eco-Schools CCC Tech Tips Sheet to import the data into the Microsoft Excel worksheet for this lesson. Using the template spreadsheet provided, put the raw data in the tab titled "Columbia-SC Temperatures - RAW"
3. Copy the temperature data for Columbia, SC into the appropriately labeled column in the tab titled "Temperature Data". The data in the table to the right should automatically be filled in.
4. The tabs "Columbia – Annual T" and "Columbia – August T" should automatically plot the temperature data.

ASSESSMENT TOOLS

- Concept Quiz – found on pg. 11
- Essay – found on pg. 14
- Foldable®
- Science Notebook and Student Reading Assessment Tool – found in ***Rubrics*** folder

WEBSITES FOR FURTHER LEARNING

- NASA for Teachers
- NASA for Students
- NASA's Eyes on the Earth
- NASA's Earth Observatory

STUDENT READING RESOURCES

- Perspectives: Why EOS Matters, 10 years later
- About TERRA
- AQUA
- ICESat
- After Five Years, NASA's Aura Shines Brightly
- About LandSat-7

LESSON 2-APPENDIX

HYPER LINK WEB ADDRESSES

PREREQUISITES

- **Creating an Excel Spreadsheet**
  http://www.ischool.utexas.edu/technology/tutorials/office/excel/
- **Formulating Graphs**
  http://exceltutorial.info/excel_tutorial_part6.htm
- **Weather and Climate**
  http://www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html

VOCABULARY

- **ISCCP**
  http://mynasadata.larc.nasa.gov/science-glossary/
- **Parameter**
  http://mynasadata.larc.nasa.gov/science-glossary/
- **Microset**
  http://mynasadata.larc.nasa.gov/science-glossary/
- **Satellite**
  http://mynasadata.larc.nasa.gov/science-glossary/
- **Earth Observing Systems (EOS)**
  http://eospso.gsfc.nasa.gov/

LESSON LINKS

- **Live Access Server – LAS**
  http://mynasadata.larc.nasa.gov/live-access-server/
- **My NASA Data – MND**
  http://mynasadata.larc.nasa.gov/
- **State of the Climate**
  http://www.ncdc.noaa.gov/sotc/national/2007/8

PART I: PROCEDURE

- **MND Earth Science Glossary**
  http://mynasadata.larc.nasa.gov/science-glossary/
- **"Science Focus" tab on the MND website**
  http://mynasadata.larc.nasa.gov/1552-2/

WEBSITES FOR FURTHER LEARNING

- **NASA for Teachers**
  http://www.nasa.gov/audience/foreducators/index.html
- **NASA for Students**
  http://www.nasa.gov/audience/forstudents/index.html
- **NASA's Eyes on the Earth – Website devoted to student understanding of climate change. (Grades 7-12)**
  http://climate.nasa.gov/
- **NASA's Earth Observatory – This site shares images, stories, and discoveries about climate and the environment that emerge from NASA research, including its satellite missions, in the field research, and climate models.**
  http://earthobservatory.nasa.gov/

STUDENT READING RESOURCES

- **Perspectives: Why EOS Matters, 10 years later**
  http://earthobservatory.nasa.gov/Features/WhyItMatters09/
- **About Terra**
  http://earthobservatory.nasa.gov/Features/AM1/
- **Aqua**
  http://earthobservatory.nasa.gov/Features/Aqua/
- **ICESat**
  http://earthobservatory.nasa.gov/Features/ICESat/
- **After Five Years, NASA's Aura Shines Brightly**
  http://earthobservatory.nasa.gov/Newsroom/view.php?id=39444
- **About LandSat-7**
  http://earthobservatory.nasa.gov/Features/Landsat/landsat.php

Lesson 2-Standards

National Science Education Standards

Unifying Concepts and Processes

- Systems, Order, and Organization
- Evidence, Models, and Explanations
- Change, Constancy, and Measurement

Standard A – Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Standard B – Physical Science

- Conservation of energy

Standard C – Life Science

- Matter, energy, and organization in living systems

Standard D – Earth and Space Science

- Energy in the earth system
- Geochemical cycles

Standard E – Science and Technology

- Abilities of technological design
- Understandings about science and technology

Standard F – Science in Personal and Social Perspectives

- Personal and community health
- Natural resources
- Environmental quality
- Natural and human induced hazards
- Science and technology in local, national, and global challenges

Standard G – History and Nature of Science

- Science as a human endeavor
- Nature of scientific knowledge
- Historical perspectives

National Education Technology Standards

Standard 1: Creativity and Innovation

- Use models and simulations to explore complex systems and issues
- Identify trends and forecast possibilities

Standard 3: Research and Information Fluency

- Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
- Process data and report results

Standard 4: Critical Thinking, Problem Solving, and Decision Making

- Collect and analyze data to identify solutions and/or make informed decisions.

Standard 5: Digital Citizenship

- Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior.

Standard 6: Technology Operations and Concepts

- Understand and use technology concepts
- Select and use applications effectively and productively
- Troubleshoot systems and applications
- Transfer current knowledge to learning of new technologies

National Council of Teachers of Mathematics Education Standards

Algebra

- Understand patterns, relations, and functions
- Use mathematical models to represent and understand quantitative relationships
- Analyze change in various contexts

Measurement

- Understand measurable attributes

Data Analysis and Probability

- Develop and evaluate inferences and predictions that are based on data

Process

- Connections
  - Recognize and apply mathematics in contexts outside of mathematics
- Representation
  - Use representations to model and interpret physical, social, and mathematical phenomena

Climate Literacy Principles

Principle 1: The sun is the primary source of energy for Earth's climate system.
Principle 2: Climate is regulated by complex interactions among components of the Earth system.
Principle 4: Climate varies over space and time through both natural and man-made processes.
Principle 5: Our understanding of the climate system is improved through observations, theoretical studies, and modeling.

Energy Literacy Principles

Principle 1: Energy is a measurable quantity that follows physical laws.
Principle 2: Physical Earth processes are the result of energy flow through the earth system.
Principle 7: The energy choices made by individuals and societies affect quality of life.

LESSON 2-ESSENTIAL QUESTIONS ANSWER KEY

Essential Questions-1

1. The ISCCP data incorporate observations from both *geostationary* and *polar-orbiting* satellites.
   a. What is a geostationary satellite? How often do these satellites observe a specific location?
   [Geostationary satellites orbit the Earth from a very high altitude and constantly observe the same location. These satellites are always looking at the same location.]
   b. What is a polar-orbiting satellite? How often do these satellites observer a specific location?
   [Polar-orbiting satellites have a lower-altitude orbit and circle the Earth multiple times per day, observing many different locations. The polar orbiting satellites may observe a specific location only once a day or even once every few days, depending on the orbit. For this reason, many of the variables are provided as monthly or weekly averages.]

2. Any satellite- based measurements are recording average conditions over a certain geographical area or footprint.
   a. What is the footprint for the Near-Surface Temperature data in degrees latitude and longitude?
   [2.5 degree squares, as indicated on the Time Coverage at a Glance page.]

   b. About how many kilometers is this equivalent to over the United States, if 1 degree latitude is approximately 110 km and 1 degree longitude is approximately 80 km?
   [Over the United States this is approximately 275 km from north to south, and 200 km from east to west.]

Essential Questions-2

5. Explain how the equation converts from K to F.
   [Answer: [Temp in F] = ([Temp in K] – 273) * 9 / 5 + 32
   [Temp in F] = [Temp in K] * 1.8 – 491.4 + 32
   [Temp in F] = [Temp in K] * 1.8 – 459.4
   The $ in the conversion equation is the [Temp in K].]

6. What do you notice about how temperature varies from the North Pole to the South Pole? How does this pattern change for each season? [Temperatures are hottest in the tropical regions and coldest at the poles, due to the distribution of heating by the Sun. In January, the hottest temperatures are located from about 20°S to 20°N. There appears to be more very cold air in the Northern Hemisphere than the Southern. In July, the hottest temperatures extend further northward, up to about 40°N. There are no extremely cold temperatures in the Northern Hemispheres, while all of Antarctica experiences average temperatures below 0°F. In April and October, temperatures are more symmetrically distributed on either side of the equator.]

7. What do you notice about how temperature varies from continents to oceans? How does this pattern change from January to July? [In January, air over the oceans is warmer on average than air over the continents for the Northern Hemisphere. The reverse is the case in July. This pattern is due to the fact that it takes water longer to heat up or cool down than land.]

8. Identify 3 places on the continents that are significantly different temperature from the surrounding land. Why do you think the temperature is higher or lower in this location? [Mountainous regions are colder because the air is at a higher altitude. Desert regions are hotter because there is little vegetation and moisture. With so little water, all the Sun's heat goes into heating up the surface and the atmosphere, rather than into evaporating water.]

Essential Questions-3

1. How does temperature vary through the year? Does the plot give you confidence that you have correctly averaged and plotted the data?
   [Temperatures are highest during the summer months, with a maximum in July averaging 85°F, and lowest in winter months, with a minimum in January at 53.6°F. The plot is consistent with expectations and confirms that the data is correctly plotted.]

2. How has temperature varied for the month of August from 1994 – 2007?
   [August temperatures during this time period vary from a minimum of 76.6°F in 2003 to a maximum of 90.1°F in both 1998 and 1999. There does not seem to be any apparent trend or pattern.]

3. Does the satellite data agree with ground-based measurements that indicate 2007 was the hottest August on record? What might explain any differences?
   [According to the satellite data, 1998 and 1999 (at 90.1°F) were warmer than 2007, which averaged 89.4°F. The weather station data are for a single location, whereas the satellite observations are averaged over a larger area. The spatially averaged value will include some measurements that are hotter and colder than the average. The weather station may be located at a place that is hotter than the average.]

4. What are some limitations of the satellite record for studying long-term trends in temperature?
   [The primary limitation of the satellite record is that it is rather short for studying long-term trends. This makes it difficult to distinguish patterns due to natural variability from those due to human-caused emissions of greenhouse gases.]

Name: ___________________________________ Date: ____________

Science Concept Quiz
Lesson 2: Get Your Techno On!

What are the limitations of the satellite record for studying long-term trends in temperature?

A. Not all scientists agree on the average August temperatures.
B. It would be difficult to distinguish patterns due to natural variability and human caused emissions.
C. Graphs indicate the average temperatures are getting warmer.
D. There is too much data to draw a reasonable conclusion.

______ points out of 20

I. Answer

A.○ B.○ C.○ D.○

______ points out of 15

II. What is the main science concept behind the question?

1. Drawing conclusions
2. Making predictions
3. Trends in temperature
4. Limitations of models

_____ points out of 25

III. Provide the science reasoning for choosing your answer.

_____points out of 40

IV. Why are the other responses not the best answer chose?

A.

B.

C.

D.

Use the rest of this page if more room is needed to fully communicate your thoughts.

Teacher Answer Key

1. B

2. 4

3. Answers will vary. The questions specifically states “limitations of the satellite record”. Graphs are models of the actual data.

4. Answers will vary.

   A) The average August temperatures are fact based on evidence from satellite data.

   B) This is the correct answer. Because the satellite record measures only one variable we cannot make assumptions without evidence, therefore we can look at the facts from this satellite record.

   C) This is a fact and not a limitation to temperature record models based on satellite data.

   D) This is a false statement. The purpose of satellites is to tell us very detailed specific information regarding the various parts of the earth system. Taking data from several missions help us understand how our climate is changing.

Student Name
Teacher/Class
Date

Lesson 2: Get Your Techno On!
An Introduction to My NASA Data

Based on your analyses, collaborations, and writings provide a review of the My NASA Data, MND site, answering questions regarding:

a. Accesses data
b. Importing to Excel
c. Formulating Graphs
d. Using the data what basic information have you learned about Earth Observing Satellites, EOS?

Next explain what you learned about land surface temperature, specifically addressing:

a. Variations across continents and oceans
b. Variations seasonally
c. Variations at the poles
d. Limitations of the satellite record for studying long-term trends in temperature

What Is the Expectation?

Accurate science relating to land surface temperature

Evidence supporting your claims

Visual representations when appropriate

Key vocabulary

Evidence of on grade level spelling and grammar usage