The Earth Exploration Toolbook: Involving Students in Data Rich Geoscience Investigations

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The **EET** is a collection of computer-based activities that feature Earth science datasets and data analysis tools.

**EET** chapters provide step-by-step instructions for accessing and analyzing data to explore issues or concepts in Earth system science.

http://serc.carleton.edu/eet
Example EET Chapters

- Annotating Change in Satellite Images
  - [http://serc.carleton.edu/eet/measure_sat/index.html](http://serc.carleton.edu/eet/measure_sat/index.html)

- Measuring Distance and Area in Satellite Images
  - [http://serc.carleton.edu/eet/measure_sat2/index.html](http://serc.carleton.edu/eet/measure_sat2/index.html)

- Analyzing the Antarctic Ozone Hole
  - [http://serc.carleton.edu/eet/ozonehole/index.html](http://serc.carleton.edu/eet/ozonehole/index.html)

- Investigating the Precipitation-Streamflow Relationship
  - [http://serc.carleton.edu/eet/module_discharge/index.html](http://serc.carleton.edu/eet/module_discharge/index.html)

- Using GLOBE Data to Understand the Earth System
  - [http://serc.carleton.edu/eet/globe/index.html](http://serc.carleton.edu/eet/globe/index.html)
EET Chapter Review Process

Development
- Internal chapter review
- Review by two classroom teachers
- Review by one scientist

After modified EET chapter goes live
- Telecon-online workshops
- NASA Educational Product Review
- Periodic Technical Review
Using GLOBE Data to Study the Earth System

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Description

This chapter guides students through the process of locating and graphing Web-based environmental data that has been collected by GLOBE Program participants. It is based on an example developed for the GLOBE resource Earth System Science Investigation, which is a section of the GLOBE Teacher's Guide. This chapter highlights the opportunities for using GLOBE data to introduce basic concepts of Earth system science.

As they investigate a specific case study, students take full advantage of the GLOBE Graphing Tool's powerful features. They superimpose four different sets of environmental data in a single graph across a two-year time frame. The resulting patterns reveal a relationship that escapes casual observation: the seasonal changes in soil moisture. The case study provides opportunities to discuss such central Earth system concepts as reservoirs, places where energy and matter are stored, at least for a while (such as in the soil); flow or flux, the movement of energy or matter between reservoirs (such as the evaporation of water from the soil); and the role of solar energy as one of the major drivers of flux and all Earth system processes.

With more than 15,000 member schools throughout the U.S. and the world, the GLOBE program makes it possible for students to expand their investigation beyond a single case study, to search for additional examples of seasonal soil moisture variation, and to build a more comprehensive understanding of a basic Earth system process.
Teaching Notes

Example Output
This is one of the many graphs students will create using the GLOBE Graphing Tool and data collected by students at the Reynolds Jr. Sr. High School in Greenville, PA.
Case Study: Using Local Data to Study Global Patterns

You probably pay attention to local weather reports, so you'll know if it's going to be a rainy day, or if it's going to snow or become very humid. If you spend enough time living in one place, you'll get to know what the seasons are like in a general way, what to expect, and what the common patterns are. For example, depending where you live, winter may mean frozen lakes, or a rainy season, or just no need for air conditioning.

Most people know what the local seasonal patterns are, but not very much about what causes them. They may understand that the Earth's orbit around the sun is related to seasonal patterns, but they may not have heard about Earth's system, and the role it plays in our seasons, our natural environment, and our lives. This is not surprising, since most of Earth's natural processes are not at all obvious.

**Earth's System:**

In this chapter you will learn some things about Earth's system, the phrase that scientists use to describe the combination of Earth's major spheres—the atmosphere, the hydrosphere, the lithosphere, and the biosphere—and the way in which they interact and cause changes in one another.

Earth's system is large and complicated, but there are some simple ways to start learning about it. For example, scientists are studying changes in the rate at which water evaporates from the world's oceans. You could study the evaporation rates of smaller bodies of water close to your own school and learn about the way evaporation rates vary across the seasons. In this chapter you will start learning about Earth's system by studying weather and other environmental data that has already been collected by students from the Reynolds Jr. Sr. High School, and posted on the Internet.

**Reynolds Jr. Sr. High School:**

Reynolds Jr. Sr. High School is located in Greenville, Pennsylvania, in the northwest corner of the state. Greenville sits on a forested plateau 350 meters above sea level. The entire area is cut by rivers and streams, which flow off the plateau. The Shenango River, which flows close to the school, eventually flows into the Ohio River, the Mississippi River, and finally into the Gulf of Mexico.
The instructions for this chapter have 4 main parts. Click each Part name to see the steps in that part.

<table>
<thead>
<tr>
<th>Part 1: Navigate to the Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use the GLOBE Web site search engine to navigate to the data collected by students at the Reynolds Jr. Sr. High School in Greenville, PA.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part 2: Display Data in the Graphing Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use the GLOBE Graphing Tool to display four different sets of environmental data.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part 3: Zoom in for a Closer Look</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make use of the extensive set of Graphing Tool features to customize your view of the data.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part 4: Drawing Connections Between the Local and Global Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Studying Earth system processes at the local scale can help build your understanding of global Earth system processes.</td>
</tr>
</tbody>
</table>
Part 1: Navigate to the Data

In any step, click the Show me link to reveal extra information. If you prefer a printout of the full set of instructions for this part, choose Print from the File menu.

Step 1-Enter the GLOBE Web site.

Go to GLOBE's HOME page (www.GLOBE.gov).
### Advanced School Search

**SEARCH PARAMETER SUMMARY**
Country/State/Province Search: **Pennsylvania**

**SEARCH RESULTS**
(540 schools in list)

*Note: This list may take a long time to download. If so, you may use the “Stop” button (on your browser) to stop the download, followed by the “Back” button (also on your browser) to go back to the search form. You may then modify and re-submit your search request.*

Choose items from the table, select the desired action and press “Go”.

![Make a Graph](link)

The table has been truncated to 50 entries.
The complete table contains 540 entries.

<table>
<thead>
<tr>
<th>TOT</th>
<th>AT</th>
<th>SW</th>
<th>LC</th>
<th>SO</th>
<th>PH</th>
<th>MD</th>
<th>Lat</th>
<th>Lon</th>
<th>Elev</th>
<th>Location and Name of School</th>
</tr>
</thead>
<tbody>
<tr>
<td>102355</td>
<td>65305</td>
<td>14868</td>
<td>63</td>
<td>21925</td>
<td>15</td>
<td>179</td>
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<td>-77.5703</td>
<td>250</td>
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<tr>
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<td>24596</td>
<td>6508</td>
<td>0</td>
<td>14460</td>
<td>0</td>
<td>40</td>
<td>41.3393</td>
<td>-80.3955</td>
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<tr>
<td>33457</td>
<td>17969</td>
<td>5524</td>
<td>722</td>
<td>8867</td>
<td>189</td>
<td>186</td>
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<td>-75.6018</td>
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<tr>
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<td>0</td>
<td>0</td>
<td>36</td>
<td>40.5343</td>
<td>-80.1802</td>
<td>316</td>
<td><strong>Quaker Valley Middle School</strong>, Sewickley, PA, US</td>
</tr>
</tbody>
</table>
Part 2: Display Data in the Graphing Tool

In any step, click the Show me link to reveal extra information. If you prefer a printout of the full set of instructions for this part, choose Print from the File menu.

Step 1 - Display the Default Graph: Maximum Air Temperature

Be sure Reynolds High School is still checked (see Part 1). The default graph will be maximum temperature unless you select a different column for which the school has data. Let us look at maximum temperature measurements for Reynolds school. Above the list of schools, choose Make a Graph in the green box and click on Go.

Show me details

When you click Make a Graph, GO, you open the GLOBE Graphing Tool. The default graph always shows the Maximum Air Temperature data for the entire period of time that a school has been participating in the GLOBE program, but as you'll see later, there are many options for customizing your view of any data that the school has collected. In this case you are looking at the daily maximum temperature reading at Reynolds Jr Sr High School across an eight year time period.
GLOBE Graphs

Reynolds Jr Sr High School-Greenville, PA, US

Maximum Air Temperature
ATM-02 WEATHER STATION

Click on graph to:
- [+] zoom
- recenter
- show data
- Create a map: Maximum Temperature

Graph Data and Display Selection

<table>
<thead>
<tr>
<th>Dates</th>
<th>Datasets (choose up to 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year: 1995</td>
<td>CURRENTLY SELECTED DATASETS</td>
</tr>
<tr>
<td>Month: 10</td>
<td>Maximum Temperature - ATM-02 WEATHER STATION</td>
</tr>
<tr>
<td>Day: 01</td>
<td></td>
</tr>
<tr>
<td>through</td>
<td>AIR TEMPERATURE</td>
</tr>
<tr>
<td>Year: 2009</td>
<td>- Minimum Temperature</td>
</tr>
<tr>
<td>Month: 07</td>
<td>- Current Temperature</td>
</tr>
<tr>
<td>Day: 09</td>
<td>- Mean Temperature</td>
</tr>
<tr>
<td>Or</td>
<td>- Temperature Range</td>
</tr>
<tr>
<td>Select a pre-defined time period: SELECT DATES</td>
<td></td>
</tr>
</tbody>
</table>
GLOBE Graphs

Reynolds Jr Sr High School-Greenville, PA, US

Maximum Air Temperature
ATM-02 WEATHER STATION

Click on graph to:
- zoom
- recenter
- show data
- Create a map: Maximum Temperature

Graph Data and Display Selection

Dates
Year: 1999  Month: 01  Day: 01

Year: 2000  Month: 12  Day: 31

Select a pre-defined time period:
SELECT DATES

Datasets (choose up to 6)
CURRENTLY SELECTED DATASETS
- Maximum Temperature - ATM-02 WEATHER STATION

AIR TEMPERATURE
- Minimum Temperature
- Current Temperature
- Mean Temperature
Part 3: Zoom In for a Closer Look

In any step, click the Show me link to reveal extra information. If you prefer a printout of the full set of instructions for this part, choose Print from the File menu.

Step 1 - Reduce the Time Frame from Two Years to One

Most of the graphs in Part 2 showed data across a two-year time frame. This was helpful for looking at patterns that repeat on an annual cycle. In this part of the challenge you will use various date features to zoom in for a more detailed look at the data sets and the relationships that exist among them.

Click the Select Date option. In the list that opens, scroll down to 1999 and click on it. Then click Redraw.

Show me how
Part 4: Drawing Connections Between the Local and Global Processes

Reservoirs and Flows

Today Earth system scientists are studying reservoirs and flows, and trying to understand their impact on the Earth's environment. What are reservoirs and flows? Here is a simple example. There is a fixed amount of water on Earth. That water is divided up into smaller parts, called reservoirs. Earth's largest reservoir of water is in the ocean. Another reservoir is the water that is frozen in ice caps and glaciers. A third reservoir is the water that is in the ground. Another reservoir is atmospheric water, called water vapor.

- Can you think of other reservoirs of water on Earth?

Flow refers to the movement of water from one reservoir into another. In the work you just completed you saw that, at least in Greenville, PA, the reservoir of water in the soil became smaller as spring advanced towards summer, and just the reverse happened as fall advanced towards winter.

- Which reservoir do you think gained water in the summer? In other words, to which reservoir did that soil moisture flow?

Flows at Various Scales

Although you have studied data for just one location, the movement of water between reservoirs happens all over the Earth. During the Ice Ages, the reservoir of frozen water in glaciers, ice caps, and sea ice all increased, while other reservoirs, such as water in the oceans, decreased. Sea level was lower during the ice ages than it is now.

- How do you think Earth's water reservoirs might change if Earth became a lot warmer than it is today?

- What else do you think would change if the water reservoirs changed due to a warmer Earth?

Now that you know how to find GLOBE data for other places around the world, and you know how to use the GLOBE Graphing Tool, you can look for evidence of flows in places other than in Greenville, PA.
GLOBE Graphs

Reynolds Jr Sr High School-Greenville, PA, US

- Maximum Air Temperature
  ATM-02 WEATHER STATION
- Soil Moisture at 10 cm
  SMS-01 School Location
- Soil Moisture at 90 cm
  SMS-01 School Location
- Rainfall
  ATM-02 WEATHER STATION

Click on graph to:
- [ ] zoom
- [ ] recenter
- [ ] show data

Create a map: Rainfall