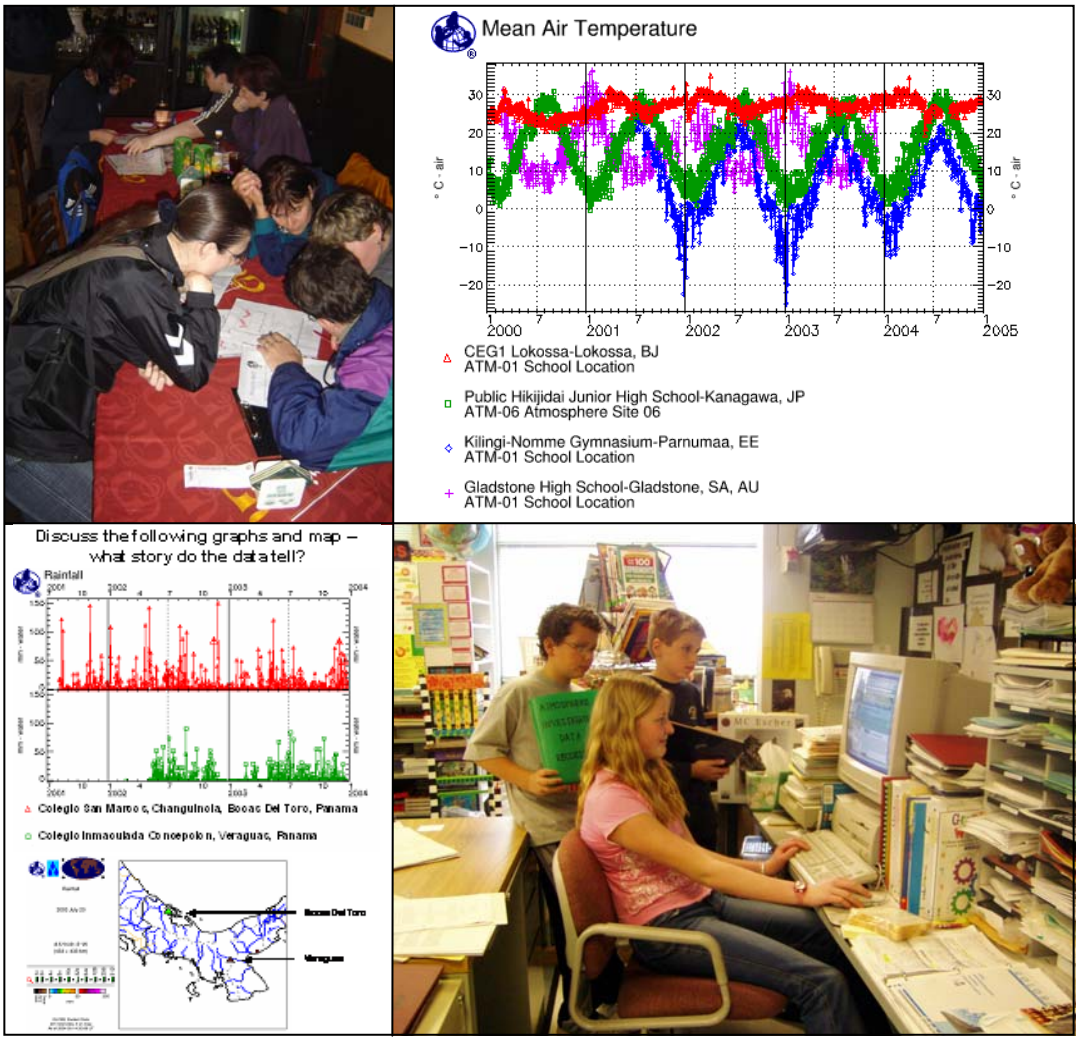
Understanding GLOBE Student Data

Activities using GLOBE data to support scientific inquiry and to inspire student understanding of Earth science.



The GLOBE Program

"…an excellent resource for teachers, allowing them to use GLOBE data in meaningful ways to inspire student understanding of earth science."

Independent NASA Reviewer

December 2009

Table of Contents

I. A Note About These Activities
- i. Purpose 3
- ii. The Inquiry Process 4

II. Looking at Data
- i. In Search of GLOBE Data Lesson Plan 5
  - I. Student Worksheets 7
  - II. Teacher Answer Sheet 11
  - III. Advanced Search 17
- ii. Where in the World…? Lesson Plan 20
  - I. Student Worksheet 29
  - II. Mystery Stations (1 through 5) 30
  - III. Student's and Teacher's world maps 35
  - IV. Clues for Mystery Stations 37
  - V. Further Investigations 38
  - VI. Assessment Sheet 42
- iii. What is the Temperature in…? Lesson Plan 45
  - I. Current Air Temperature – the Americas 50
  - II. Current Air Temperature – Africa, Europe and the Near East 56
  - III. Asia and the Pacific 62

III. Learning Activities That Encourage Inquiry
- i. Just Passing Through 68
- ii. Earth as a System Poster Activity 73

Acknowledgments

The author would like to acknowledge the following individuals who have acted as sounding boards and initial reviewers during the development of these activities as well as those who assisted with reviews during the later stages:

Becky Boger, Dixon Butler, Carol Conroy, Todd Ensign, Oliver Hay, Matt Hoover, Teresa Kennedy, Sue Lini, John McLaughlin, Christos Michalopoulos, Karen Milberger, Maureen Murray, Bill Myers, Noah Newman, Frank Niepold, Matt Rogers, Stefan Smolski, Mike Turpin, Melanie Whitmire, Sheila Yule, and scores of others whom I've either accidentally forgotten or neglected to take note of their identity (for these latter groups, I sincerely apologize). Others not listed have acted as anonymous reviewers under the NASA review process. Much appreciation is also due Karen Milberger for her work on the on-line version located at: http://viz.globe.gov/viz-bin/show.cgi?l=en&b=g&rg=n&enc=00&nav=1&page=gallery-activity.ht

This document would also not have been possible without the contributions made by the many thousands of teachers and perhaps millions of students who have collected and entered environmental data into the GLOBE database.

These activities were developed and compiled from 2002 to 2003 and revised based on user comments while being field-tested by over 250 teachers and students. In addition, these materials were utilized at various GLOBE events, for example:

Train-the-Trainer and Other Workshops:

- Colorado Springs, Colorado, USA (hosted by Catamount Institute and Colorado College), 2003;
- Carrollton, Georgia, USA (hosted by State University of West Georgia), 2003;
- Fairmont, West Virginia, USA (hosted by the Edventure Group and NASA IV & V Facility), 2003;
- Yverdon, Switzerland (hosted by GLOBE Switzerland), 2003;
- Druskininkai, Lithuania (hosted by GLOBE Lithuania), 2004;
- Niamey, Niger, (hosted by GLOBE Niger), 2005;
- Yaounde, Cameroon (hosted by GLOBE Cameroon), 2005;
- Kampala, Uganda (hosted by GLOBE Uganda), 2006;
- Akure, Nigeria (hosted by GLOBE Nigeria), 2006
- Riversdale, South Africa (hosted by GLOBE South Africa and Africa Regional Consortium), 2007;
- Iloilo, Philippines (hosted by GLOBE Philippines and Asia/Pacific Regional Consortium), 2007…

Conferences:

- Boulder, Colorado, USA (GLOBE Annual Conference), 2004;
- Arctic POPs Conference, Lofoten, Norway (hosted by GLOBE Norway), 2004;
- Denver, Colorado, USA (International Studies Schools Association Conference), 2005;
- Prague, Czech Republic (GLOBE Annual Conference), 2005;
- Česká Třebová, Czech Republic (European GLOBE Games), 2005;
- Corpus Christi, Texas, USA (GLOBE Learning Communities Meeting), 2005;
- Phuket, Thailand (GLOBE Annual Conference), 2006;
- Houston, Texas, USA (NASA Educational Products Workshop, Johnson Space Center), 2006;
- St. Louis, Missouri, USA (NCTM Conference), 2006;
- Omaha, Nebraska, USA (NESTA Conference), 2006;
- Atlanta, Georgia, USA (NCTM Conference), 2007;
- San Antonio, Texas, USA (GLOBE Annual Conference), 2007 …

A Note About These Activities

Purpose

The GLOBE Database, as of August 2009, houses over 20 million student data from over 8,500 schools in 93 countries! As the GLOBE Program has recently celebrated 15 years from its announcement on April 22, 1994, it seems appropriate to ask, "What can these data tell us? What can we do with these data?" The purpose of these activities is two-fold: first, to help guide the user through these millions of data, and second, to inspire teachers and students to collect, report and use GLOBE data in their own research.

Looking at and understanding data may at first seem difficult, confusing or uninteresting; however, data exploration can be exciting and a little addicting. "Understanding GLOBE Student Data" activities can fit into various parts of the curriculum: science (since they are environmental data), mathematics (since the data are mostly comprised of numbers), social studies (since data have a geographical location attached to them), art (since graphs and maps can take the form of shapes and colors), language arts (since written and/or oral reports on data can be generated by students), foreign, or second, language literacy (since students communicate their findings to their peers around the world),….

These activities have been linked to the Trends in International Mathematics and Science Study (TIMSS) and the U.S. National Science Education Standards. Writers of both the U.S. National Education Standards and the TIMSS 2007 Science Assessment Framework treat inquiry both as a learning goal and a teaching method and integrate the concept of inquiry into all levels of science content standards. The development of the ability to understand and engage in these kinds of activities requires direct experience and continued practice with the processes of inquiry. In order to assist the user, lesson plans within these activities include how teachers can meet some of their specific science standards. Visit the TIMSS Web site <**http://timss.bc.edu/index.html**> for more information on TIMSS standards; for more information on U.S. standards visit <**www.nap.edu/readingroom/books/nses/html/**> or <**www.aligntoachieve.com/**> for U.S. state standards.

The "Looking at Data" section is a collection of activities written in lesson plan format specifically focused on looking at GLOBE student data. Not all GLOBE data are suitable for use in looking at data activities (they actually require fairly consistent data over several years). The first activity, "In Search of GLOBE Data," contains two self-paced projects on using the graphing and mapping tools available on the GLOBE Web site. These sequential how-to guides on searching for schools with usable data include questions inquiring into what the user sees or thinks about the data presented. These questions are intended to stimulate the thinking process. An answer sheet has been provided to assist the facilitator of this activity. These student worksheets are followed by an advanced search for GLOBE data. This is a step-by-step, or click-by-click, how-to guide to help expand the list of tools when searching for GLOBE data. There are no questions associated with the Advanced Search, however if the user proceeds directly from the Student Worksheets they may be able to construct their own questions when visualizing the data using these new tools.

The second and third activities, "Where in the World…?" and "What is the Temperature in…?" are inquiry-based activities. "Where in the World…?" presents maps and graphs without the location identified, prompting the student to determine the locations using prior

knowledge and visual clues in the data. "What is the Temperature in…?" prompts the student to determine the shapes of graphs from around the world based on geographic location.

The section, "Learning Activities That Encourage Inquiry," contains GLOBE learning activities that have been revised to encourage more hands-on inquiry. The original "Just Passing Through" Learning Activity is included in the Soil Chapter of the GLOBE Teacher's Guide (**www.globe.gov/tctg/tgchapter.jsp?sectionId=86**) and the original "Earth as a System" Learning Activity is located in the supplemental Earth System Science packet (**www.globe.gov/fsl/html/templ.cgi?earth_system&lang=en&nav=1**).

The Inquiry Process

The key to looking at data in these activities is motivation. Why will students care about the outcome of these activities? Inquiry is one of the solutions. Meaningful and relevant questions are really the key component for the student to care about the answer. These activities incorporate data and already have questions associated with them. The questions could be re-created and thereby "owned" by the learner in order to motivate or stimulate genuine inquiry. Students could also be encouraged to come up with additional questions. The standard application of inquiry-based learning includes the "steps of the scientific method." (For more information, see the Implementation Guide of the GLOBE Teacher's Guide <**www.globe.gov/tctg/tgtoc.jsp**>, Appendix, pages 8-9.)

The activities included in this resource contain questions that have been formulated to encourage student interest and the data have been assembled. Therefore, in these activities, the data need only be compared to each other and conclusions drawn based on prior knowledge. Teachers/instructors can take several important actions to facilitate scientific inquiry in the classroom. Two methods that can promote student interest are: 1) begin discussions with questions and 2) be flexible with both time and planned focus in order to deviate in directions based on student comments and questions (see **www.globe.gov/tctg/globetg.jsp?rg=n&lang=en**, Implementation Guide, Appendix, page 19). A key to the stimulation of inquiry discussions and investigations includes encouraging the learner to present observations about data without the fear of being ridiculed. It may be worthwhile to discuss famous scientists and inventors in order to break down initial barriers to the sharing of ideas and thoughts. Scientists and inventors are known for their end results or knowledge rather than the numerous failures they experienced. Scientific knowledge is what it is today (and what it will become in the future) thanks in part to learning from errors. In fact, most learning has errors associated with it. It is important to emphasize to students that errors are a part of the learning process.

Another important key to using these activities is making science fun. Science should be seen as fun and interesting. These activities therefore should be presented not as assignments, per se, but as fun activities to aid in developing observational skills and applying prior knowledge to understanding GLOBE student data.

I hope you and your students enjoy these activities using GLOBE data.

In Search of GLOBE Data Lesson Plan

Purpose:

1. Encourage the use of on-line GLOBE visualization tools.
2. Understand the value of GLOBE data in science and technology instruction.

Overview:

Students use on-line GLOBE search tools to locate and display data from schools and use the data to answer questions regarding weather and climate.

Science Standards:

This activity addresses the following content and cognitive domains according to the Trends in International Mathematics and Science Study (TIMSS), 2007:

Fourth-Grade Content Domains

- Earth Science
  - Earth's Processes, Cycles, and History

Eighth-Grade Content Domains

- Earth Science
  - Earth's Processes, Cycles, and History

Cognitive Domains

- Knowing
  - Illustrate with Examples
- Applying
  - Compare/Contrast/Classify
  - Relate
  - Interpret Information
  - Explain
- Reasoning
  - Analyze/Solve Problems
  - Hypothesize/Predict
  - Draw Conclusions
  - Generalize
  - Justify

This activity addresses the following content science standards according to the (U.S.) National Science Education Standards:

Science as inquiry

- An appreciation of "how we know" what we know in science,
- Skills necessary to become independent inquirers about the natural world.

Earth and space science (Content Standard D)

- Changes in the earth and sky (Grades K-4)
- Structure of the earth system (Grades 5-8)
- Energy in the earth system (Grades 9-12)

Note: For state specific alignment, visit <**www.aligntoachieve.com**>.

Level:

This activity is suitable for students who possess a beginning understanding of cause-and-effect relationships; the ability to read simple graphs and tables and are able to make simple data comparisons; know basic weather-related phenomena; and are able to create, interpret, and make predictions from charts, diagrams, and graphs based on information provided; principally grades 6 to 12. For younger students, or students who do not possess these skills, teachers may need to provide more input at various steps, while for students with more experience at looking at graphs of data, less teacher input would be necessary.

Time:

One to two class periods.

Materials included:

1. In Search of GLOBE Data – Student Worksheets for two projects:
   a. Creating graphs (Project #1: parts 1, 2, and 3)
   b. Creating maps (Project #2)
2. In Search of GLOBE Data – Teacher Answer Sheet.
3. In Search of GLOBE Data – Advanced Search.

Materials needed:

1. Computers with Internet connection.
2. One (1) large world map to display on the wall (optional).

Lesson Preparation:

1. Review Lesson Plan; make copies of appropriate student worksheets.
2. Assure that GLOBE Web site is accessible through firewall (if applicable).

Procedures:

1. Present the activity to the students – they will be following two self-paced projects on creating graphs and maps using on-line tools available on the Classic GLOBE Web site <**http://classic.globe.gov**>. The first project contains three parts.
2. Student worksheets include questions inquiring into what the students see or think about the data presented.

Further Assignments:

1. Teacher provides “In Search of GLOBE Data – Advanced Search”.
2. Students work in pairs or teams search for science projects ideas.

Assessment:

1. Teacher can ask students to use their skills in finding GLOBE data to search for schools in certain countries or regions with Hydrology, Soil, or Land Cover data.
2. Good follow-up activities are “Where in the World” and “What is the Temperature in”

In Search of GLOBE Data – Student Worksheet

Project #1:

Part 1: Creating graphs using GLOBE data

Step 1: From the Classic GLOBE Home Page, **http://classic.globe.gov**, place your mouse cursor over *For Students*; move the cursor down to highlight *Maps and Graphs*; move the cursor over to highlight *Graphs*; click on *Graphs*.

Step 2: Choose *Benin* from the Country list under *SCHOOL LOCATION: Country Search* and click on *Go*.

Step 3: Place a checkmark by *Lycee Behanzin, in Porto-Novo*, by clicking in the square next to the school name and click on *Go* in the green box next to "Make a Graph" above the table of schools.

Step 4: The default graph will be for Maximum Air Temperature.

What do you notice about this graph? _____

_____

Step 5: Scroll down until the *Other Options* box is visible. Click on *Select Option* and move the cursor so that *Add or change schools* is highlighted and click on *Go*.

Step 6: Choose *Argentina* from the Country list under *SCHOOL LOCATION: Country Search* and click on *Go*.

Step 7: Place a checkmark by the two schools: *Escuela Provincial No. 38 Julio Argentina Roca* and *Escuela de Ensenanza Media 7 "Nicolas Copernico", Buenos Aires* by clicking in the squares next to the school names.

Step 8: Click on *Go* in the green box next to "Make a Graph" above the table of schools.

The graph that appears should contain 3 schools' data (the graph from *Lycee Behanzin* and the two that were just added).

What do you notice about this graph? (Note: Latitudes and Longitudes of the schools can be found below the graph in the list of Selected Schools under the *Other Options* box.)

_____

_____

Step 9: Scroll down so that the *Other Options* box is visible at the top of the screen and the information about the three selected schools is near the center of the screen. Notice that there are small squares under each school's information with a checkmark in the squares. Click in the squares for the two schools, *Escuela Provincial No. 38* and *Escuela de Ensenanza Media 7 "Nicolas Copernico"*, to remove the checkmarks in the boxes and click on *Redraw* above the list of schools. The graph will return containing only the *Lycee Behanzin* school.

You are now ready to proceed to Project #1, Part 2.

In Search of GLOBE Data – Student Worksheet

Project #1:

Part 2: Creating graphs using GLOBE data

The graph of Maximum Air Temperature for the Lycee Behanzin school, in Benin, should be on your screen. (Note: If you are beginning anew, and not continuing directly from Project #1, Part 1, follow steps 1 through 6 of Project #1, Part 1, before proceeding.)

Step 1: Scroll down until the *Other Options* box is visible. Click on *Select Option* and move the cursor so that *Add or change schools* is highlighted then click on *Go*.
Step 2: Choose *United States of America* from the Country list under *SCHOOL LOCATION Country Search* and click on *State/Province Search*.
Step 3: Choose *USPA – Pennsylvania* and click on *Go*.
Step 4: Place a checkmark by *Waynesboro Senior High School, Waynesboro, PA*, by clicking in the square next to the school name and click on *Go* in the green box next to "Make a Graph" above the table of schools.

What do you notice about this graph?_____

_____

_____

Step 5: Scroll down until the *Other Options* box is visible. Click on *Select Option* and move the cursor so that *Add or change schools* is highlighted and click on *Go*.
Step 6: Highlight *Australia* from the Country list under *School Location Country Search*.
Step 7: Scroll down until you see the *NUMBER OF DATA REPORTS* section. Type 3000 in the first box under *Find schools that have submitted at least:*.
Step 8: Click on the *Total* box and select *All Atmospheric Data* and click on *Go*.
Step 9: Place a checkmark by *Serpentine Primary School, in Serpentine*, by clicking in the square next to the school name and click on *Go* in the green box next to "Make a Graph" above the table of schools.
Step 10: Scroll down until you see *Graph Data and Display Selection*. Change the *Dates* to *Year:* 1998; *Month:* 01; *Day:* 01 through *Year:* 2001; *Month:* 01; *Day:* 01. Click on *Redraw*.

What do you notice about this graph?_____

_____

_____

You are now ready to proceed to Project #1, Part 3.

In Search of GLOBE Data – Student Worksheet

Project #1:

Part 3: Creating graphs using GLOBE data

The graph of Maximum Air Temperature for *Lycee Behanzin* in Porto Novo, Benin, *Waynesboro Senior High School*, in Waynesboro, PA USA, and *Serpentine Primary School*, in Serpentine, Australia, should be on your screen. (Note: If you are beginning anew, and not continuing directly from Project #1, Part 2, follow steps 1 through 6 of Project #1, Part 1, and steps 1 through 9 of Project #1, Part 2, before proceeding.)

Step 1: Scroll down below the graph. You will see a box entitled: *Graph Data and Display Selection*. Under the *Datasets (Choose a dataset)* option, click on *Maximum Temperature* (the current displayed dataset); this action will open the scroll menu of datasets. Click on *Mean Temperature*.

Step 2: Under the *Plot Type* option, click on *Combined Graph* (the current graph display). Click on *Stacked Graph*.

Step 3: Scroll down below the graph to the *Graph Data and Display Selection*. Below the "Dates" selections you will see ***Or** Select a pre-defined time period:* Click on *SELECT DATES* (the current display) and click on *2001*. Click on *Redraw*.

What is Mean Temperature? How is this temperature determined? _____

_____

What do you notice about the three graphs? Why are these three graphs of Mean Temperature different? (Note: Latitudes and Longitudes of the schools can be found below the graph in the list of Selected Schools under the *Other Options* box.) _____

_____

Do the data in the three graphs seem reasonable? Why or why not?_____

_____

Step 4: Scroll down below the graphs until you see *Graph Data and Display Selection*. Change the *Dates* to *Month:* 03; *Day:* 01 through *Month:* 03; *Day:* 31. Click on *Redraw*. (*Year:* 2001 should remain the same.)

Step 5: Scroll down below *Graph Data and Display Selection* and below the *Redraw* button. You will see a box entitled *Other Options*. Click on *Select Option*, click on *Show Table* and then click on *Go*.

The table of data is located below the graph and graphing tools. Scroll through the data. You'll notice that *Serpentine Primary School* reported 0° C on March 17 and 18. Does that seem reasonable? If not, what might have happened? _____

_____

You are now ready to proceed to Project #2.

In Search of GLOBE Data – Student Worksheet

Project #2:
Creating maps using GLOBE data

If continuing from Project #1, Part 3, the Mean Air Temperature graph for *Lycee Behanzin*, *Waynesboro Senior High School*, and *Serpentine Primary School* should be on the computer screen. Scroll to the top of the page until the Navigation Tabs (Home, Projects, etc) are visible. Place the mouse cursor over *For Students*; move the cursor down to highlight *Maps and Graphs*; move the cursor over to highlight *Maps*; click on *Maps*.

If you are beginning this activity and not continuing from Project #1, Part 3, enter the Classic GLOBE url <**http://classic.globe.gov**>; place the mouse cursor over *For Students*; move the cursor down to highlight *Maps and Graphs*; move the cursor over to highlight *Maps*; click on *Maps*.

Note: an image of the Globe will be on the right. Notice that the dataset is for Maximum Temperature and the date is set for today. The zoom level (identified by the small magnifying glass) is set at 1x. These are the default settings.

Step 1: Click on Europe (or as close as possible) on the Globe on the right. You will notice that the new view of the Globe has changed. Look at the top left of the map box (left of the list of zoom levels). You will notice that the part of the Globe on the right that is currently not visible is now shadowed on the Globe to the left.

Step 2: Scroll down below the map. You will see a box entitled: *Map Data and Display Selection*. Change the *Date* to *Year:* 2004; *Month:* 02; *Day:* 15. Click the radio button for *medium* under *Map size*. Click on *Redraw map*.

Step 3: Click on Europe (it should be easier to identify Europe this time). Notice that the image of the Globe has changed yet again. It is now a square. Notice that the magnification level is now 4x.

Step 4: Click on the *8x* zoom level. Notice that the map zooms in more.

Step 5: Scroll down below the map to the box entitled: *Map Data and Display Selection*. Click the radio button for *Both* under *Map type*. Click on *Redraw map*.

Looking at the map your queries produced, do the data look reasonable? ____ Why or why not? How might the Contours help answer this question? _____

_____

Step 6: Scroll down below the map and the box entitled: *Map Data and Display Selection*. You will see a box entitled *Other Options*. Click on *Select Option* and move the cursor so that *Create Scatter Plot* is highlighted. Click on *Go*.

This will generate an X, Y plot (or Horizontal, Vertical plot) of the data visible on the map. The X, or Horizontal, axis depicts Latitude and the Y, or Vertical, axis depicts Maximum Temperature. Do the data graphed in this manner help determine whether one or more data represent possible errors? Explain: _____

_____

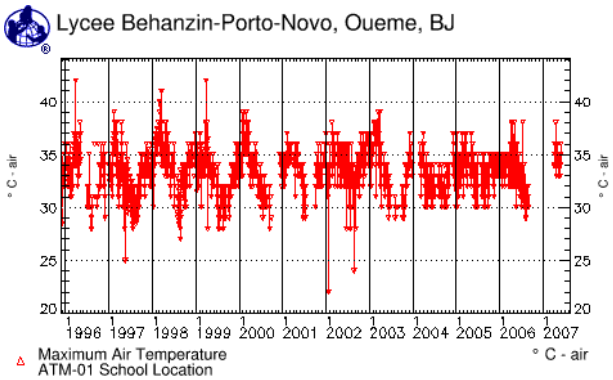
You are now ready to search for data from other GLOBE schools in other countries and in other investigation areas.

In Search of GLOBE Data – Teacher Answer Sheet

These answer sheets provide a number of possible answers for the open questions within the "***In Search of GLOBE Data – Student Worksheets***". These answers are by no means the only possible answers but rather some possible answers. If the student does not provide answers to these questions, the teacher can use the answers provided here to help the student begin to see what story the data can tell.

Project #1, Part 1: Creating graphs using GLOBE data

Graph 1: Lycee Behanzin, in Porto-Novo, Benin.

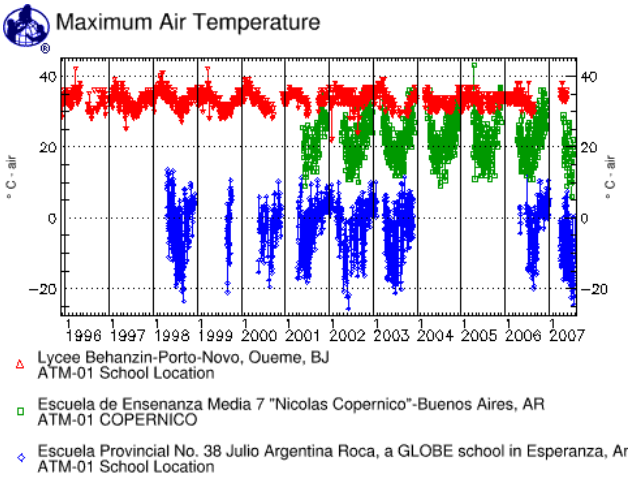


What do you notice about this graph? _____

Students may notice any of the following:

1) The temperature varies from (most often) 28 to 38° Celsius;
2) The temperature throughout the year does not vary much for this school;
3) The warmest months for this school are usually between February and April;
4) On several occasions, the temperature rises above 40° Celsius;
5) The coldest months for this school are usually between July and October;
6) On several occasions, the temperature falls below 25° Celsius.

Graph 2: Lycee Behanzin, in Porto-Novo, combined with Escuela Provincial No. 38 Julio Argentina Roca, in Esperanza, and Escuela de Ensenanza Media 7 "Nicolas Copernico", in Buenos Aires.



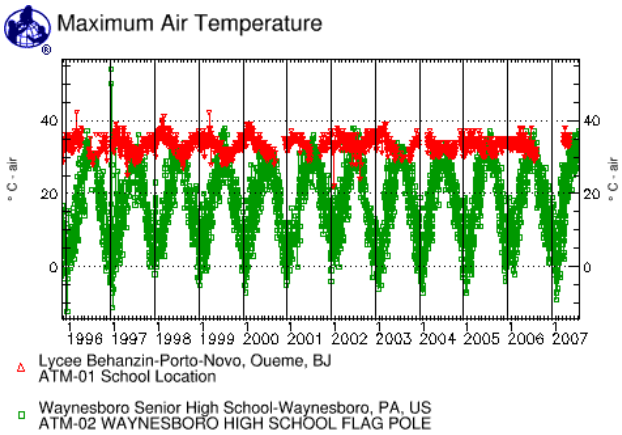
What do you notice about this graph? (Note: Latitudes and Longitudes of the schools can be found below the graph under the *Other Options* box.) _____

Students may notice any of the following:

1) The temperature graph for Benin (red line) doesn't change as much as the two from Argentina (blue and green lines);
2) Both Argentine schools report most of their data between March and December, while the Benin school reports almost every day;
3) The Argentine school, "Escuela Provincial No. 38," didn't enter data for 2004 or 2005;
4) Both Argentine schools have colder temperatures between June and August;
5) Both Argentine schools experience warmer temperature twice per year, between March and May and between October and December (note that peak temperatures for these 2 schools are at the points where they stop collecting data);
6) One Argentine school, Escuela Provincial No. 38, experiences much colder temperatures (barely over 0° Celsius) than the school from Buenos Aires;
7) Escuela Provincial No. 38 is much farther south than Escuela de Ensenanza Media 7 "Nicolas Copernico" (Latitude 63.4^{o} S compared to 34.5^{o} S);
8) Escuela Provincial No. 38 is an Argentine school located in Antarctica (by scrolling down to view Latitudes and Longitudes students may notice the long school name: "Escuela Provincial No. 38 Julio Argentina Roca, a GLOBE school in Esperanza, Antarctica, hosted by Argentina, AR").

Project #1, Part 2: Creating graphs using GLOBE data

Graph 1: Lycee Behanzin, in Porto-Novo, Benin combined with Waynesboro Senior High School, Waynesboro, Pennsylvania, U.S.A.



What do you notice about this graph? _____

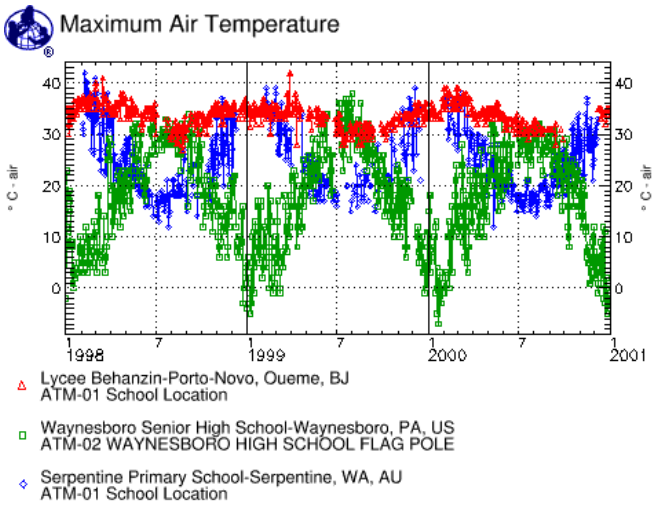
Students may notice any of the following:

1) Temperature at the U.S. school rarely rises above those at the Benin school;
2) The temperature varies greatly at the U.S. school, from below 0° Celsius to most often about 35° Celsius;
3) The warmest months for the U.S. school are usually between July and August;
4) The coldest months for the U.S. school are usually between December and February;

a. On several occasions, the temperature falls to nearly, or below, –10° Celsius;

5) The warmest months for the Benin school are usually between February and April;
   a. On several occasions, the temperature rises above 40° Celsius;
6) The coldest months for the Benin school are usually between July and October;
   a. On several occasions, the temperature falls below 25° Celsius;
7) When the U.S. school experiences the warmest temperatures, the Benin school is often experiencing the coldest temperatures.

Graph 2: Lycee Behanzin, in Porto-Novo, Benin, and Waynesboro Senior High School, Waynesboro, Pennsylvania, U.S., combined with Serpentine Primary School, in Serpentine, Australia.



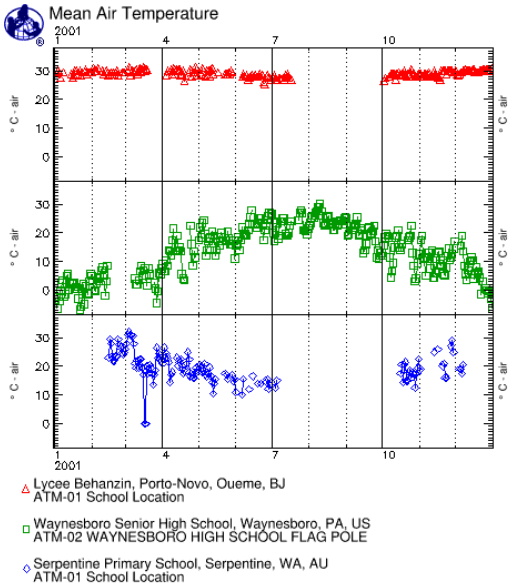
What do you notice about this graph? _____

Students may notice any of the following:

1) Temperature at the Australian school ranges from 15 to about 40° Celsius;
2) Temperature at the Australian school varies more than at the Benin school but not as much as at the Pennsylvania school;
3) The warmest months for the Australian school are usually February and December;
   a. Data are not available during late December through January;
4) The coldest months for the Australian school are usually between July and August;
   a. On several occasions, the temperature falls to nearly 10° Celsius;
5) The warmest months for the U.S. school are usually between July and August;
   a. On several occasions, the temperature rises to nearly 40° Celsius;
6) The coldest months for the U.S. school are usually between December and February;
   a. On several occasions, the temperature falls to nearly, or below, –10° Celsius;
7) The warmest months for the Benin school are usually between February and April;
   a. On several occasions, the temperature rises above 40° Celsius;
8) The coldest months for the Benin school are usually between July and October;
   a. On several occasions, the temperature falls below 25° Celsius;
9) When the Australian school experiences the warmest temperature, the U.S. school is often experiencing the coldest temperature;
10) The schools in Benin and Australia experience the coldest and warmest temperatures during (nearly) the same months.

Project #1, Part 3: Creating graphs using GLOBE data

Graph 1: Lycee Behanzin, in Porto-Novo, Benin; Waynesboro Senior High School, Waynesboro, Pennsylvania, U.S.; and Serpentine Primary School, in Serpentine, Australia (stacked graph).



What is Mean Temperature? How is this temperature determined? _____

Mean temperature is defined as the average of a series of temperatures taken over a period of time, such as a day or a month; within GLOBE that period of time is one 24-hour period (Solar Noon to Solar Noon).

Within GLOBE, mean temperature is calculated by averaging the Maximum and Minimum daily temperatures, which is dividing the sum of these by 2 [(maximum daily temperature + minimum daily temperature)/2].

What do you notice about the three graphs? Why are these three graphs of Mean Temperature different? Note: Latitudes and Longitudes of the schools can be found below the graph in the list of Selected Schools under the "*Other Options*" box. _____

Students may notice any of the observations noted under Project #1, Graph 2.
They may also notice:

1) A datum (or several data) in the Australian graph seem to approach zero, not conforming to the pattern of the graph.
2) The Australian and Benin schools did not collect temperature data during the entire year. Both schools have a gap in their data from sometime in July until sometime in October.

Do the data in the three graphs seem reasonable? Why or why not? _____

Students should question the reliability of the data associated with the strange line coming down out of the graph of the Australian school's data, not conforming to the pattern. This day (or these days), the school reported 0° Celsius (or nearly 0°) which does not fit the pattern of the data at all. This datum (or these data if there are more than 1 day associated with this anomaly) should be considered suspect.

The table of data is located below the graph and graphing tools. Scroll through the data. Students should notice that *Serpentine Primary School* reported 0° Celsius on March 17 and 18 (see data and arrow below). Does that seem reasonable? If not, what might have happened? _____

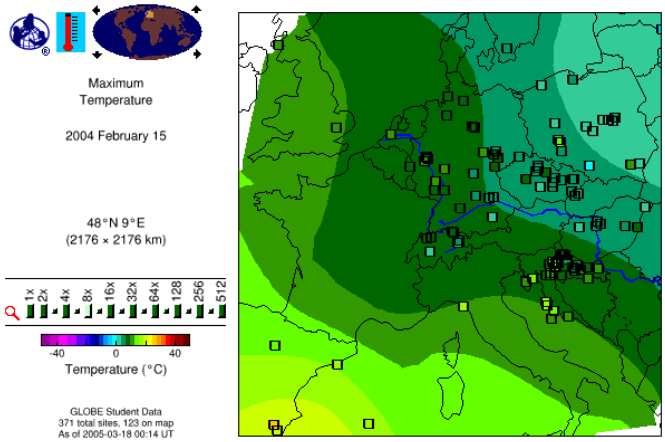
31 dates in this time series

Date[+]	Porto- AvTmp ATM-01	Porto- ATYP ATM-01	Waynes AvTmp ATM-02	Waynes ATYP ATM-02	Serpen AvTmp ATM-01	Serpen ATYP ATM-01
20010301	--	--	--	--	26.0	4
20010302	--	--	--	--	28.0	4
20010303	30.5	4	--	--	31.0	4
20010304	31.5	4	--	--	32.0	4
20010305	28.5	4	--	--	31.0	4
20010306	29.5	4	--	--	31.0	4
20010307	30.0	4	--	--	30.5	4
20010308	29.5	4	--	--	28.0	4
20010309	30.0	4	4.0	4	21.0	4
20010310	30.5	4	2.0	4	19.5	4
20010311	29.0	4	2.0	4	22.0	4
20010312	30.8	4	3.5	4	19.5	4
20010313	31.0	4	6.5	4	22.5	4
20010314	29.5	4	8.5	4	22.5	4
20010315	30.0	4	5.0	4	19.5	4
20010316	31.5	4	7.0	4	17.0	4
20010317	30.0	4	7.5	4	0.0	4
20010318	30.8	4	5.0	4	0.0	4
20010319	30.5	4	1.5	4	20.0	4
20010320	--	--	7.5	4	17.5	4
20010321	--	--	5.5	4	20.5	4
20010322	--	--	--	--	19.5	4
20010323	--	--	--	--	17.5	4
20010324	--	--	--	--	13.5	4
20010325	--	--	2.5	4	17.0	4
20010326	--	--	0.5	4	18.5	4
20010327	--	--	-4.5	4	26.5	4
20010328	--	--	-0.5	4	23.0	4
20010329	--	--	6.0	4	24.5	4
20010330	--	--	5.5	4	24.0	4
20010331	--	--	7.5	4	22.0	4

When looking at the table of data (shown above), students should clearly see that the Australian school entered 0° Celsius for two days during March 2001. Days prior and following these two measurements the school reported temperatures in the upper teens and low 20s. The temperatures do not seem reasonable when comparing them to all the data entered by this school. It is entirely possible that the students entered 0, not as a temperature value but rather meaning the absence of data or no data. However, this could cause confusion in data interpretation since zero is a number on thermometers and in many parts of the world is a very reasonable temperature reading.

Project #2: Creating maps using GLOBE data

Map 1: Europe, Maximum Temperature



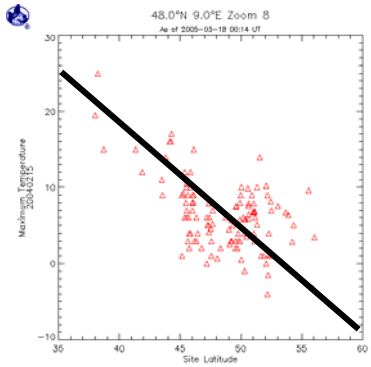
Looking at the map your queries produced, do the data look reasonable? Why or why not?

_____

How might the Contours help answer this question? _____
Students may not know how to interpret map data at first. Provide hints such as describing how temperature contours, or Isotherms (lines connecting points of equal temperature, commonly seen on weather maps to show large-scale temperature distributions), connect points of equal temperature within an area. Data within close proximity to each other should be the same or similar color as well as that of the surrounding isotherm. Individual data points that are not the same or of similar color as those points near it or to the surrounding isotherm may show this difference due to a change in elevation, proximity to a large water body, or other geological or geographical differences. Students should look for those points that are not similar and ask "why" and/or "how do they differ?" If temperatures are greater than or less than 10° Celsius from surrounding points they may be worth investigating.

Step 7 will generate an X, Y plot (or Horizontal, Vertical plot) of the data visible on the map. On the Horizontal, or X, axis is Latitude and on the Vertical, or Y, axis is Maximum Temperature. Do the data graphed in this manner help determine whether one or more data represent possible errors? Explain: _____

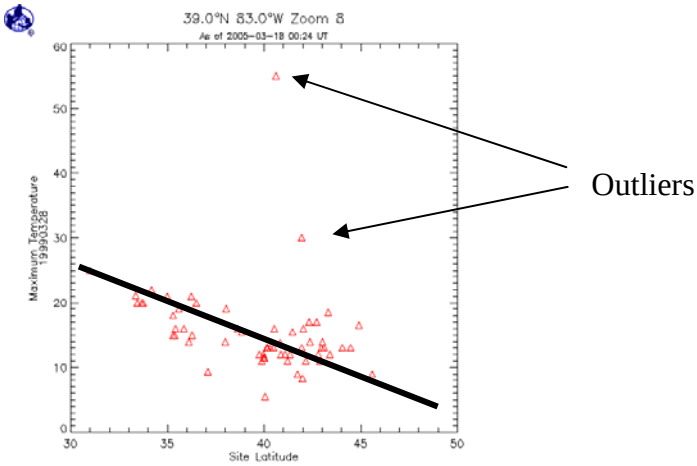
Graph 1: Scatter Plot



When looking at scatter plots students should look for "outliers." Outliers are those data that do not fit the shape of the graph or the flow of the data. If the data are expected to have a linear relationship then placing an imaginary line or a pencil on the scatter plot through the data as they seem to flow may help students visualize possible outliers.

Graph 2 shows a scatter plot containing two outliers. Why do outliers occur? Often incorrect dates are recorded but most often digits are transposed (entering 32 instead of 23) or using an incorrect measurement (for example, recording Fahrenheit instead of Celsius) or using a non-calibrated instrument. Calibration is the process of comparing an instrument's measuring accuracy to a known standard (for example, ensuring that a thermometer reads 0° Celsius in an ice water bath).

Graph 2: Scatter Plot Showing outliers



In Search of GLOBE Data – Advanced Search

Searching for GLOBE data can be monotonous and frustrating without the proper tools. The "In Search of GLOBE Data" series can be used as an introduction to searching and using GLOBE data. Project #1, parts 1 through 3, and Project #2 of "In Search of GLOBE Data – Student Worksheets," offered step-by-step instructions on searching for schools by selecting Country, by entering a specific school name, and by entering values for data entered for the investigation under study. However, other methods of searching for GLOBE data exist. Try the following:

If continuing from Project #2, the scatter plot of GLOBE Data should be on the computer screen. Scroll to the top of the page until the Navigation Tabs (Home, Projects, etc) are visible. Place the mouse cursor over *For Students*; move the cursor down to highlight *Finding Data*; move the cursor over to highlight *Advanced School Search*; click on *Advanced School Search*.

If you are beginning anew, and not continuing directly from Project #2, enter the Classic GLOBE url <**http://classic.globe.gov**>; place the mouse cursor over *For Students*; move the cursor down to highlight *Finding Data*; move the cursor over to highlight *Advanced School Search*; click on *Advanced School Search*.

Below the "SCHOOL LOCATION: Country Search" box, are five (5) gray buttons entitled, "State/Province Search" (this was introduced in Project #1, Part 2), "Lat/Lon Point Search," "Lat/Lon Regional Search," "Display Map of Selected Region," and "Choose selected location(s) for Data Access." These will be examined (except for "State/Province Search") in the order listed above:

Latitude/Longitude Point Search

Click on *Lat/Lon Point Search*. Notice that you still have the option to search by "School, City or Teacher Name." Under "SCHOOL LOCATION: Point Search", you will see "Find schools within" followed by a pull-down box. This lists the following possibilities: 1 km, 5 km, 10 km, 20 km, 50 km, 100 km, 500 km, and 1000 km. Following the pull down box you will notice: "Lat" (Latitude) and "Lon" (Longitude). Note: Positive values entered in the "Lat" box will search for schools north of the Equator, negative values will search for schools south of the Equator; positive values entered in the "Lon" box will search for schools east of the Prime Meridian, negative values will search for schools west of the Prime Meridian.

Try this example to familiarize yourself with the system: Enter 1000 km in the "*Find schools within*" box, 30 in the "*Lat*" box and 130 in the "*Lon*" box and click on *Go*. This will bring up schools in China (CN), Japan (JP) and South Korea (KR). There are actually more than 100 schools within this range, so the Web site database will display only the first 50 schools. If you wish to see all of the schools within this area, click on "Follow this link to view all table entries."

Click the "Back" button on your browser to return to the *Advanced Search* page. Change the "*Lat*" to –30 (keep the "*Lon*" at 130) and click on *Go*. This will bring up schools in Australia (AU). A quick look at a World map will confirm that these regions are on opposite

sides of the Equator. Similarly, entering 30 in the "*Lat*" box and –130 in the "*Lon*" box will bring up California (US) while –30 in the "*Lat*" box and –130 in the "*Lon*" box will return you to the search page with the note: "Warnings and error messages: No schools were found using your search parameters. Please modify your values and try again." A quick look at a World map will confirm that the latter location is in the South Pacific, Southeast of French Polynesia – just open ocean.

This type of search is useful when you want to start from a known point (for example, your school) and locate all schools within a certain distance (1 km, 5 km, 10 km, 20 km, 50 km, 100 km, 500 km, or 1000 km) from it.

Latitude/Longitude Regional Search

Scroll to the top of the page until the Navigation Tabs (Home, Projects, etc) are visible. Place the mouse cursor over *For Students*; move the cursor down to highlight Finding Data; move the cursor over to highlight Advanced School Search; click on Advanced School Search.

Click on *Lat/Lon Regional Search*. This search tool looks similar to the Lat/Lon Point Search tool. However, rather than having the function of distance (1 km to 1000 km) there are four (4) boxes, "Northern Lat," "Western Lon," "Eastern Lon," and "Southern Lat." This will search within a geographic box defined by the user. Let's look at an interesting example: enter 10 in "Northern Lat," -10 in "Western Lon," 10 in "Eastern Lon" and –10 in "Southern Lat" and click on *Go*. This will bring up schools in Western Africa (for example: Benin (BJ), Cameroon (CM), Ghana (GH), and Nigeria (NG)). What you have just done is asked the database to look for GLOBE schools within a box 10° north of the Equator, 10° south of the Equator, 10° east of the prime meridian and 10° west of the prime meridian.

This search tool can be very useful for searching for schools in a specific region. However, if the area you're searching is somewhat densely populated with GLOBE schools, your search may bring up hundreds of schools (for example, the search above brought up over 100 schools). You can narrow the search criteria by adding a tool you are already familiar with: Number of Data Reports (see "In Search of GLOBE Data – Student Worksheet, Project #1, Part 2: Creating graphs using GLOBE data" Step 7). Try the example search above (10 in "Northern Lat," -10 in "Western Lon," 10 in "Eastern Lon" and –10 in "Southern Lat") but this time, under "Number of Data Reports," enter 5000 in the "Find schools that have submitted at least [ ] data reports for [Total]" and click on *Go*. The number of schools the computer will find will decrease to a more manageable number.

Choose an area on Earth that you would like to search for GLOBE schools. Refine the search by entering how many data schools should have (either "Total" data or select an investigation) to make your list. If you receive a message "No schools were found using your search parameters. Please modify your values and try again," you should either change the geographic area of your search using a World map to make sure that you're not selecting an area over the open ocean or over a country that has not yet joined GLOBE, or reduce the number of data in your search.

Display Map of Selected Region

Scroll to the top of the page until the Navigation Tabs (Home, Projects, etc) are visible. Place the mouse cursor over *For Students*; move the cursor down to highlight *Finding Data*; move the cursor over to highlight *Advanced School Search*; click on *Advanced School Search*. The "Display Map of Selected Region" tool will create a map of a selected geographic area (country or countries) based on the selections made in the "SCHOOL LOCATION: Country Search" box.

Try the following example: scroll down in the "SCHOOL LOCATION: Country Search" box until you see Hungary (HU). Click on Hungary and then click on "*Display Map of Selected Region*." Change *Map Size* to *Medium* and click on *Redraw map*. A map will be generated showing Hungary and all Hungarian schools – as well as schools in neighboring countries that are within the area displayed on the map. Notice that the schools within the Hungarian border are triangular in shape while all others (outside of Hungary) are small squares. This will help you identify where Hungarian schools are located. Notice also that the default display is "How Many Data Are There?" If you wish to view actual student data, click on the pull down menu currently entitled "How Many Data Are There" and highlight "Measurements" under "STUDENT DATA" and click on *Redraw map*. Notice that the default date for the map is today.

Choose selected location(s) for Data Access

Scroll to the top of the page until the Navigation Tabs (Home, Projects, etc) are visible. Place the mouse cursor over *For Students*; move the cursor down to highlight *Finding Data*; move the cursor over to highlight *Advanced School Search*; click on *Advanced School Search*. The "Choose selected location(s) for Data Access" tool is useful for pulling the raw data out of the database of a selected geographic area (country or countries) based on the selections made in the "SCHOOL LOCATION: Country Search" box. These data can then be placed in a spreadsheet or GIS program. Try the following example: scroll down in the "SCHOOL LOCATION: Country Search" box until you see Saudi Arabia (SA). Highlight Saudi Arabia and click on "Choose selected location(s) for Data Access." You can click on one round button (investigations: Atmosphere, Surface Water, etc.) choosing all protocols within that investigation or you can click on one or more square buttons within an investigation. Experiment by clicking the different round buttons and square buttons to become familiar with the selection process.

Click on "Air Temperature" under the "Atmosphere" investigation. Next scroll down below the table of investigations and protocols. You will see "Start date (YYYYMMDD)"; "End date (YYYYMMDD)"; and "Output format." Defaults are: Start Date = the first date of measurement; End Date = the last date of measurement; Output format = "View results in browser." Other options for Output format are: "Download tab-delimited results to disk," "Download comma-delimited results to disk," and "Download shapefile (zipped)." When you have selected the format you want, click on "Get the data now!" Follow the instructions of your spreadsheet or GIS program for displaying these data.

This is not meant to be an exhaustive collection of search tools available on the GLOBE Web site, but rather just enough to whet your appetite. GLOBE data await – enjoy!

WHERE IN THE WORLD...? Lesson Plan

Purpose:

1. Use GLOBE visualizations and other data to determine site locations.
2. Understand the value of GLOBE data for classroom instruction.
3. Understand that temperature may vary due to latitude.

Overview:

Students work in small groups to identify specific GLOBE school locations based on observations and clues gleaned from mean temperature, rainfall and land cover data for each mystery site.

Science Standards:

This activity addresses the following content and cognitive domains according to the Trends in International Mathematics and Science Study (TIMSS), 2007:

Fourth-Grade Content Domains

- Earth Science
  - Earth's Processes, Cycles, and History

Eighth-Grade Content Domains

- Earth Science
  - Earth's Processes, Cycles, and History

Cognitive Domains

- Knowing
  - Illustrate with Examples
- Applying
  - Compare/Contrast/Classify
  - Relate
  - Interpret Information
  - Explain
- Reasoning
  - Analyze/Solve Problems
  - Hypothesize/Predict
  - Draw Conclusions
  - Generalize
  - Justify

This activity addresses the following content science standards according to the (U.S.) National Science Education Standards:

Science as inquiry

- An appreciation of "how we know" what we know in science,
- Skills necessary to become independent inquirers about the natural world.

Earth and space science (Content Standard D)

- Changes in the earth and sky (Grades K-4)
- Structure of the earth system (Grades 5-8)
- Energy in the earth system (Grades 9-12)

Note: For state specific alignment, visit <**www.aligntoachieve.com**>.

Level:

This activity is suitable for students who possess a beginning understanding of cause-and-effect relationships; the ability to read simple graphs and tables and are able to make simple data comparisons; know basic weather-related phenomena; and are able to create, interpret, and make predictions from charts, diagrams, and graphs based on information provided; principally grades 6 to 12. For younger students, or students who do not possess these skills, teachers may need to provide more input and provide clues (see "Graph and Map Notes") at various steps, while for students with more experience looking at graphs of data, less teacher input would be necessary.

Time:

One to two class periods.

Materials included:

1. Five Graph/Map Mystery Stations containing a total of six graphs (2-3 years of mean temperature and rainfall data) and five maps showing land cover sample site data and student comments.
2. Latitude and longitude clues for the five mystery stations.
3. World map for student use and world map for teacher use.
4. "Further Investigations" graphs and maps.
5. "Where in the World" Student Worksheet, Assessment Sheet, and Assessment Graphs (Mean Air Temperature and Rainfall).
   Note: Additional School Sites can be found at Classic GLOBE <**http://classic.globe.gov**>.

Materials needed:

1. One large world map to display on the wall (optional).
2. Field notebook or science log to record information.
3. Index cards containing the prompts for group formation (optional: see Group Structure example below).
4. GLOBE MUC (Modified UNESCO Classification) Field Guide may be helpful but not necessary. (See <**http://classic.globe.gov**> to access the GLOBE MUC System Table and Glossary of Terms.)

Lesson Preparation:

1. Review Lesson Plan; make copies of appropriate handouts as prompted.
2. Arrange the classroom to facilitate group activity.
3. Label each table with a sign indicating the name of the groups if prompts are utilized (i.e. Atmosphere, Land Cover, Soil, Hydrology, and Phenology).
4. Distribute the mystery stations to each table or station. Variations include: distribution of one mystery station at a time; distribution of all mystery stations at once; or placing mystery stations one through five on five consecutive tables for each group. Note: Mystery Station 5 has two (2) graphs and one (1) land cover map while the other four (4) mystery stations have only one (1) graph and one (1) map.

Group Structure (optional):

1. Make index cards with prompts (examples listed below) for each of the following GLOBE investigation areas. One card is needed for each student in the class.

Atmosphere	**Land Cover**	**Soil**
Clouds	MUC	Soil Color
Precipitation	Landsat	Bulk Density
Relative Humidity	Canopy Cover	Soil Moisture
Aerosols	Pixel	Horizon
Air temperature	MultiSpec	Soil Temperature
Hydrology	**Phenology**	**GPS**
Water pH	Green Up	Make a card for GPS (for fun – since it could fall under any of the groups!)
Transparency	Clonal Lilacs	
Alkalinity	Budburst	
Dissolved O_2	GreenDown	
Conductivity	Bird Migrations	

2. Distribute one (1) card to each student.
3. Instruct students to go to the table that corresponds to the information on their card.
4. Once students are located in their small groups (at separate tables), instruct them to determine individual roles, such as:
   facilitator
   recorder(s)
   presenter(s)

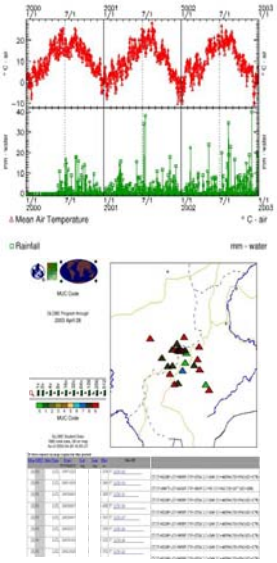
Procedures:

1. Distribute "Where in the World Worksheets" to the groups – they will be examining data from various schools from different parts of the world. The information regarding the location has been removed. Their task is to determine the location based only on the data contained in the graph, the map and/or the comments under the maps. Teacher should set sufficient time for each mystery station.
2. Groups begin with Mystery Station #1, examining and discussing the information provided on the graph and map.
3. The recorder should note all observations on the "Where in the World" Worksheet.
4. Groups rotate through each of the four (4) remaining mystery stations (or tables) when prompted by the teacher and repeat the instructions from procedures 2 and 3 listed above. Groups should notify teacher when they have completed the "Maps and Graphs Alone" column on their Where in the World Worksheets.
5. Teacher provides clue packets to each group. Each packet contains a world map and latitudes and longitudes for all mystery stations.
6. Repeat instructions from procedures 2 through 4 above. Teacher should provide groups with sufficient time to review their mystery stations using the clues provided to further narrow down the locations. Groups should notify teacher when they have completed the "Maps and Graphs with Clues" column on their Where in the World Worksheets.
7. Teacher provides each group with a list of the schools.
8. Groups identify the mystery stations. Groups present their results and discuss the activity. Which mystery stations were easiest to identify? Why? Which data available in the graphs and maps were most helpful in determining the locations?

Graph and Map Notes:

The following clues are contained in the mystery stations. Students with more experience interpreting graphs of data should be able to find these clues. Many discoveries from these clues may fall into the "Aha!" category. These clues are best presented after all groups have presented their results. Some of the data within the maps and/or the comments under the maps will be viewed as extraneous or useless information. However, as with looking at any collection of data, it is not possible to determine the usefulness or uselessness of data until it is examined. This is a part of scientific discovery – evaluating data and determining which data might contribute information to your specific needs while setting aside those data that won't.

Mystery Station 1

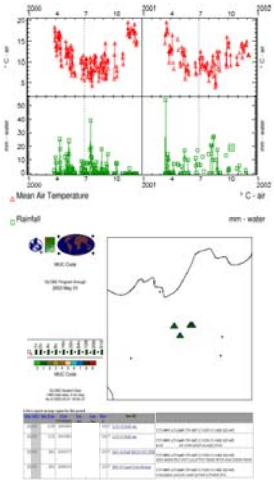


Students should note the shape of the Air Temperature graph. This should tell them that this school is in the northern hemisphere. Mean temperature ranges from just under 0° Celsius to 25–30° Celsius with rainfall throughout the year, most occurring from approximately March until about November. Alone, Mystery Station 1 does not help in determining location beyond mid-latitude Northern Hemisphere.

The data presented on the map and in the student comments under the map will not assist in determining the school location.

The location is Mittelschule Elsterberg, in Elsterberg, Germany.

Mystery Station 2

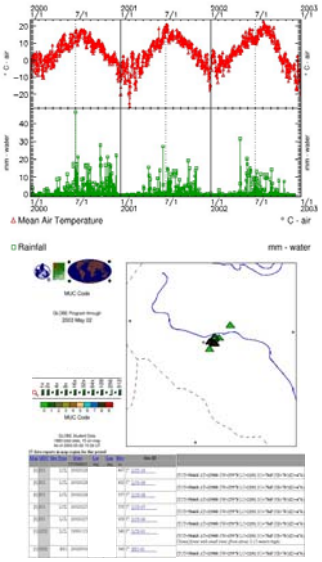


Students should note the shape of the Air Temperature graph. This should tell them that this school is in the southern hemisphere. Mean temperature ranges from just about 5° Celsius to almost 20° Celsius with rainfall from approximately March until about November (fall, winter and spring in the southern hemisphere). Based on these temperatures, the location might be slightly closer to the Equator than Mystery Station 1.

The student comments in the far right under the map should be helpful: "typical dry schlerophyll eucalypt forest," "Predominantly Euclaliptus Trees…" "dry eucalypts, acacia's,…." If students are referring to a MUC Guide, they should note that the MUC values presented in the student data table (MUC 131) are "Extremely Xeromorphic (Dry), Sclerophyllous-Dominated." Note also that Sclerophyllous is defined as: "A plant with usually evergreen leaves that are thickened, hard, and leathery. These adaptations resist water loss and are common in, but not restricted to, regions with a long summer drought and predictable yet limited winter rain." This suggests a quite dry area. These should all help point to Australia.

The location is Scottsdale High School, in Scottsdale, Tasmania, Australia.

Mystery Station 3

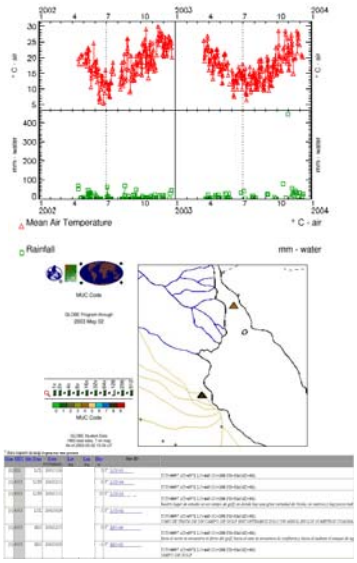


Students should note the shape of the Air Temperature graph. This should tell the students that this school is in the northern hemisphere. Mean temperature ranges from -10° to about 20° Celsius with rainfall primarily from about March until November. Alone, Mystery Station 3 does not help in determining location beyond northern hemisphere and possibly higher-latitude than Mystery Station 1.

If students are referring to a MUC Guide, they should note that MUC 0232 is “Closed Forest, Mainly Deciduous, Cold-Deciduous without Evergreen Trees, Montane and Boreal.” Boreal is defined as: “Pertaining to climate with cool wet summers and cold winters lasting more than six months. A boreal zone can also be called a cold temperate zone.” This information should support the hypothesis that the graph is higher-latitude northern hemisphere than Mystery Station 1.

The location is Vang barne- og ungdomsskule (6-16), in Valdres, Norway.

Mystery Station 4



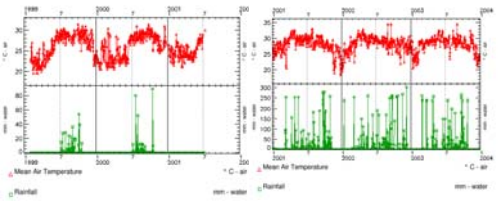
Students should notice that the shape of the Air Temperature graph is similar to that of Mystery Station 2. Students should therefore understand that this school is also in the southern hemisphere. Mean temperature ranges from about 5° to almost 30° Celsius with rainfall from approximately March until December.

The Land Cover map and MUC codes will not be of much help in determining the location. However, students should make note of the student comments below the map. The information itself will not be as useful as the language – Spanish. Putting together the shape of the Air Temperature graph and Spanish should point to South America.

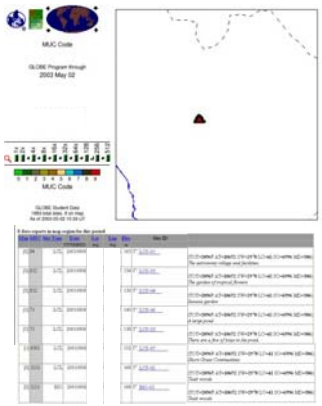
The location is Escuela de Ensenanza Media 7 Nicolas Copernico, in Buenos Aires, Argentina.

Mystery Station 5

Which graph belongs to the map?



Graph A **Graph B**



Students should notice that the shapes of graphs A and B look similar. Mean temperature ranges from about 20° to about 30° Celsius in Graph A and from about 20 to 33° Celsius in Graph B. This should tell them that both schools are in or near the tropics. Rainfall occurs from July through October in Graph A and from about March until November in Graph B. The shape of the graphs (highest temperatures between June and August, lowest temperatures between November and March) should indicate slightly north of the Equator.

Students should make note of the student comments below the map, such as, “The garden of tropical flowers,” “Banana garden,” and “Teak woods.” These comments should point to a greater amount of precipitation. Comparison of the rainfall amounts in the two graphs should point to Graph B as the more logical choice.

The location of Graph B and the map is Banyangsung, in Kanchanaburi, Thailand. The location of Graph A is Lycee Blaise Diagne, in Dakar, Senegal.

Using the Clues:

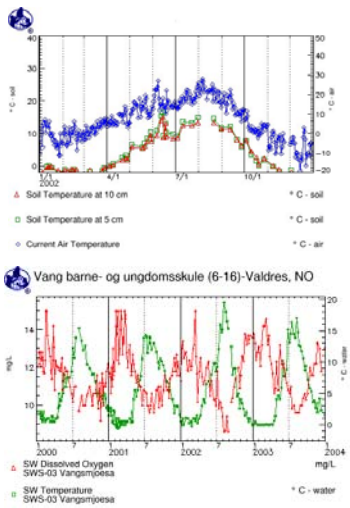
Several clues are included for use with this activity: the world map; mystery station latitudes and longitudes; and the list of schools used in this activity. Teachers should decide, based on time available for this activity and student knowledge of biomes, climate and geography, how to appropriately distribute these clues. If a longer time period is available and students possess prior knowledge of world biomes and climate as well as geography the teacher can begin by distributing the “Student’s World Map” alone to have the student groups narrow the focus of possible locations. This would then be followed by the “Mystery Station Latitudes and Longitudes”, and finally the “List of Schools in this Activity”. For shorter time periods and for students who don’t possess prior knowledge of world biomes and climate and/or geography, the teacher can distribute the “Student’s World Map” and “Mystery Station Latitudes and Longitudes” together followed by the “List of Schools in this Activity”. The list of schools should be handed out as a final clue. The teacher can use a wall-mounted world map to focus students’ attention together during group presentations. Each group should present a mystery station in the following manner: What information was available in the graph? What information was available in the map and/or student comments under the map? When were they able to narrow the location down to a continent? A region? A country? Were the mystery station latitudes and longitudes helpful? How was the list of schools used? After they present their determination of the mystery station location other groups should follow. After all mystery station locations have been presented, discuss the activity: How were they able to use their prior knowledge about biomes and climate and geography? Which Mystery Station was the most difficult? Why? Which Mystery Station was the easiest? Why? If they were provided additional graphs and maps, similar in design, would they be able to use the knowledge gained in this activity to help determine other locations?

Further Investigations:

The following graphs and maps can be used as supplemental questions to the five mystery stations (above) in order to further develop observational skills or for discussion.

1. Teacher provides a soil and air temperature graph and a water temperature and dissolved oxygen graph to each group.
   a. Groups determine which of the six (6) locations from above is identified in the graph. Note: students are now looking at two graphs with different time ranges.
2. Teacher provides a graph of Mean Air Temperature and New Snow entitled, "Where might this school be located? What clues in the data can help you?" Have groups examine the graph and map and discuss the information provided. Note: This is a new location. Students should not choose from the 6 locations from above.
3. Teacher provides "Are the Data Reasonable?" graphs and tables for investigation.
4. Teacher provides "Panama Rainfall" graphs and maps for discussion

These 2 graphs belong to which of the 6 schools?



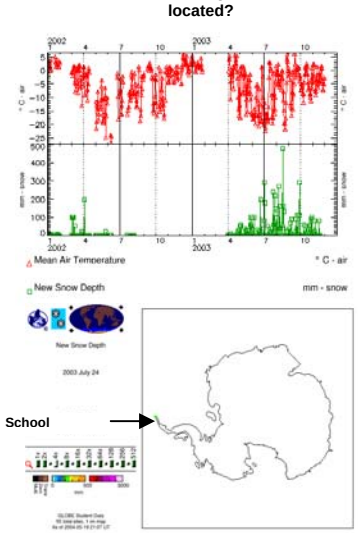
These 2 graphs belong to which of the 6

Students should notice the shape of the graph as a school in the northern hemisphere. The current (or Solar Noon) temperature ranges from 5° Celsius in January/February to about 20° Celsius from June to August. Soil temperature is at or near 0° Celsius from mid-November to mid-March.

The water temperature/dissolved oxygen graph should confirm that this is a northern hemisphere location, with water temperature ranging from near 0° Celsius in late January through mid-April to nearly 15° Celsius in August. Interesting information to discuss is: heating of water versus land and air; relevancy of dissolved oxygen – why is it inversely proportional to temperature (Hint: Henry's Law and the Solubility of Gases)?

This information should combine to point to a high-latitude location in the northern hemisphere, or Mystery Station 3, Vang barne- og ungdomsskule (6-16), in Valdres, Norway.

Where in the world might this school be located?

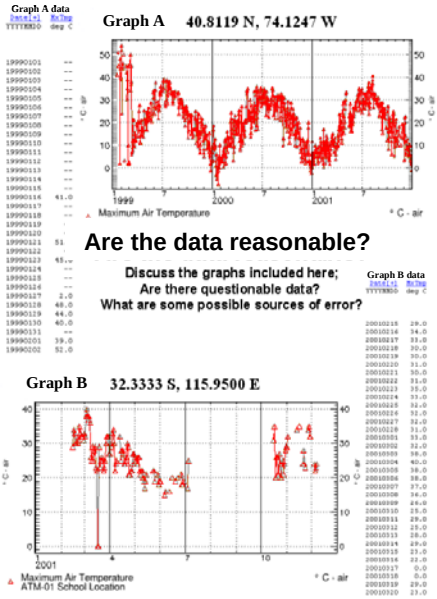


Where might this school be located?

Note to the students that this is a new location. However, based on the knowledge they have used thus far they should be able to determine the location. Students should notice the shape of the graph as being from a Southern Hemisphere location. The air temperatures range from below –20° Celsius in May and June to near 5° Celsius in December and January. The students should also notice that rather than rainfall, "New Snow" is graphed. Data from 2002 (collected from January to August) shows that new snow fell primarily in March and April, and only between 100 and 200 mm, while data from 2003 (collected from April to November) shows that much more snow fell more often and in greater amounts, several days between 200 and 300 mm and once in mid-August near 500 mm! The shape of the graph may help – it is a continent – Antarctica. Notice that the one GLOBE school located on Antarctica ("Escuela Provincial No. 38 Julio Argentina Roca) is an Argentine GLOBE school in Esperanza, Antarctica, and is near South America. For more information about the school see the GLOBE Star:

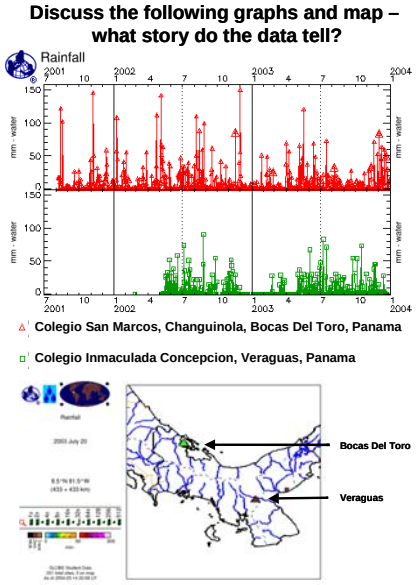
www.globe.gov/fsl/STARS/ART/Display.opl?star=antstar&lang=en&nav=1

Are the data reasonable?



Graph A: Students should notice that the data entered during January and February of 1999 do not fit the shape of the graph. Also, when looking at the location (NE USA) 40–50° Celsius are not reasonable values (at any time of year, let alone during January and February). One possible cause is entering Fahrenheit values instead of Celsius. A quick conversion of Fahrenheit to Celsius for the questionable data provides the following information: 39° F = 4° C; 52° F = 11° C. Entering Fahrenheit instead of Celsius seems likely.

Graph B: Students should notice that the values entered in mid-March do not fit the shape of the graph. Looking at the table of data they should notice that on March 17 and 18, 0° Celsius was entered. A conversion, as was done above for Graph A, provides the following information: 0° F = -18° Celsius. Entering Fahrenheit values doesn't seem likely. Could the school have entered 0, meaning "no data collected?" This is more likely; however, since 0 has a mathematical value this is not the correct procedure. If no data were collected for these days, the fields should remain blank. This error could present teachers with a good educational opportunity.



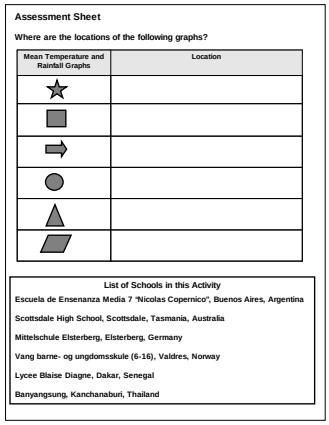
What storv do the data tell?

Students should notice the different amounts of rainfall for the two schools in Panama: Colegio San Marcos, Changuinola, in Bocas Del Toro, receives rainfall throughout the year while Colegio Inmaculada Concepcion, in Veraguas, doesn't receive any rainfall between November and February.

Looking at the map of where the schools lie provides more interesting information. The school in Bocas Del Toro, that receives more rainfall, is near the coast while the school in Veraguas is inland. Wind coming from over the ocean brings in moisture; therefore the coastal location should receive more rainfall than the inland location, as displayed in the graph. This can provide a good geography-climate discussion.

Assessment:

1. Teacher provides each student with "Where in the World Assessment Sheet" (Page 42) and mean air temperature and rainfall graphs containing all six of the graphs used for the above activity (pages 43–44) that contains all six of the graphs used for the above activity. Assessment Notes for teachers are on page 28.
2. Students individually identify the location of each of the schools by comparing the temperature and rainfall data presented.



Assessment Sheet

Where are the locations of the following graphs?

Mean Temperature and Rainfall Graphs	Location
★	
■	
➡	
●	
▲	
▰	

List of Schools in this Activity

Escuela de Ensenanza Media 7 "Nicolas Copernico", Buenos Aires, Argentina

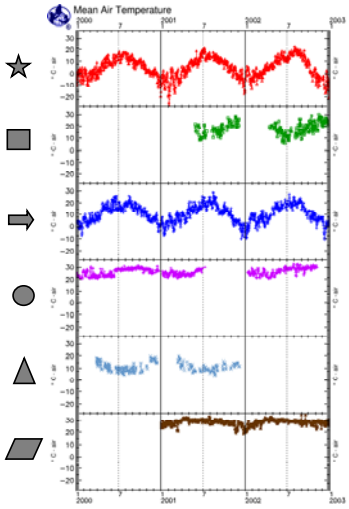
Scottsdale High School, Scottsdale, Tasmania, Australia

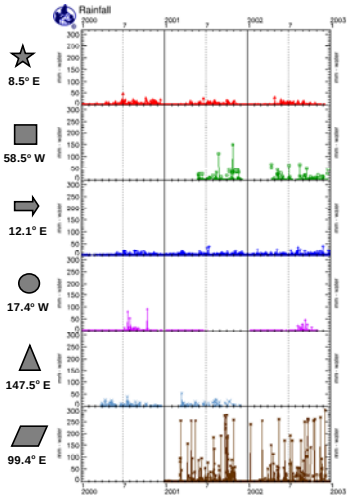
Mittelschule Elsterberg, Elsterberg, Germany

Vang barne- og ungdomsskule (6-16), Valdres, Norway

Lycee Blaise Diagne, Dakar, Senegal

Banyangsung, Kanchanaburi, Thailand





Assessment

Students should be able to determine the locations of the six schools by observing the shapes of the graphs, mean temperature and rainfall, in conjunction with the world map and the list of schools.

There are two schools in the northern hemisphere (Elsterberg, Germany and Valdres, Norway), two schools in the southern hemisphere (Buenos Aires, Argentina and Tasmania, Australia), and two schools in the tropics (Kanchanaburi, Thailand and Dakar, Senegal). Students should be able to determine which two graphs belong to schools in the northern hemisphere (★ and ➡), which two belong to schools are in the southern hemisphere (■ and ▲) and which two belong to schools are in the tropics (● and ▰) by the shape of the graphs.

A comparison of the graphs from the two schools in the northern hemisphere (★ and ➡) should allow the students to notice that the ★ graph reaches about –20° Celsius in January while the ➡ graph only reaches –10° Celsius. A reasonable hypothesis would be that the ★ graph is from a school farther north. Since Norway is farther north than Germany, the ★ graph is from the school in Norway and the ➡ graph is from the school in Germany.

A comparison of the graphs from the two schools in the southern hemisphere (■ and ▲) will need to include the longitudes (under the symbols on the Rainfall Assessment graphs). The Longitude for the ■ graph is 58.5° W and the ▲ graph is 147.5° E. Using the list of schools and basic geography, students should be able to determine that the ■ graph belongs to the school in Argentina and the ▲ graph belongs to the school in Australia.

A comparison of the graphs from the two schools in the tropics (● and ▰) should allow the students to determine that the ▰ school experiences a tropical climate with heavy rainfall from March to November while the ● school experiences a tropical climate with much less rainfall and mainly from July to October. Longitudes can also be used to determine that the ▰ graph (99.4° E) is Thailand and the ● graph (17.4° W) is Senegal.

Schools Used in this Activity:

The selection of schools for this activity was based primarily on global distribution and quality of data in the GLOBE Data Archive. Schools used were: Escuela de Ensenanza Media 7 Nicolas Copernico, in Buenos Aires, Argentina; Escuela Provincial No. 38 Julio Argentina Roca, a GLOBE school in Esperanza, Antarctica, hosted by Argentina; Scottsdale High School, in Scottsdale, Tasmania, Australia; Serpentine Primary School, Serpentine, West Australia, Australia; Mittelschule Elsterberg, in Elsterberg, Germany; Vang barne- og ungdomsskule (6-16), in Valdres, Norway; Colegio Inmaculada Concepcion, in Veraguas, Panama; Colegio San Marcos, Changuinola, in Bocas Del Toro, Panama; Lycee Blaise Diagne, in Dakar, Senegal; Banyangsung, in Kanchanaburi, Thailand; and Lyndhurst High School, Lyndhurst, NJ, USA.

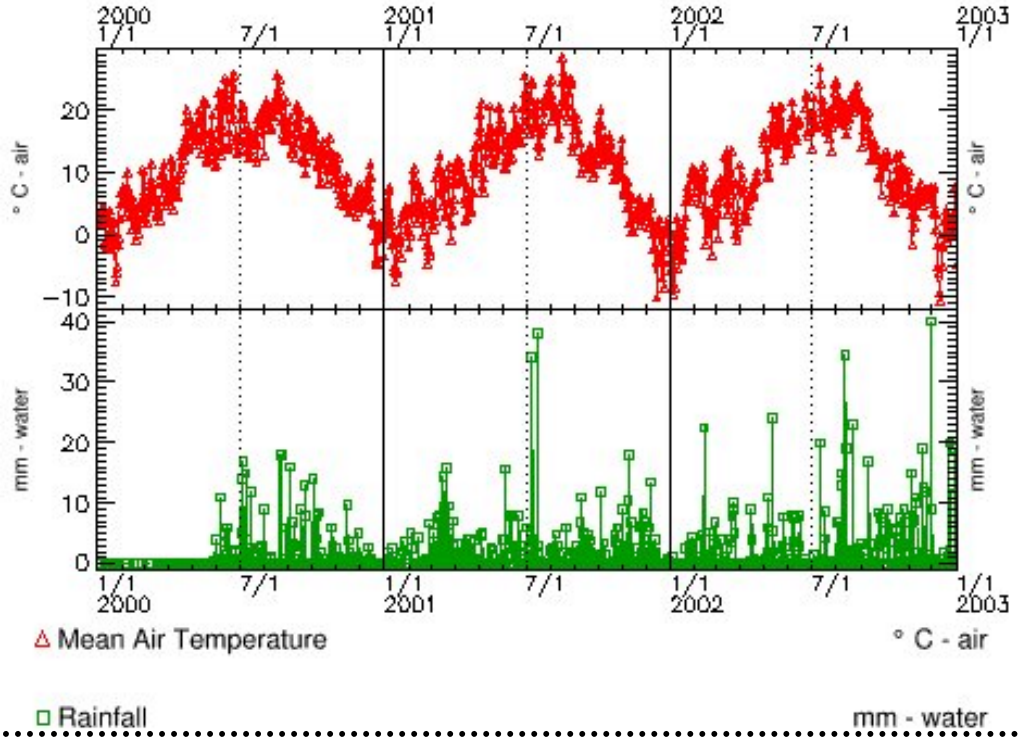
Where in the World…?
Student Worksheet

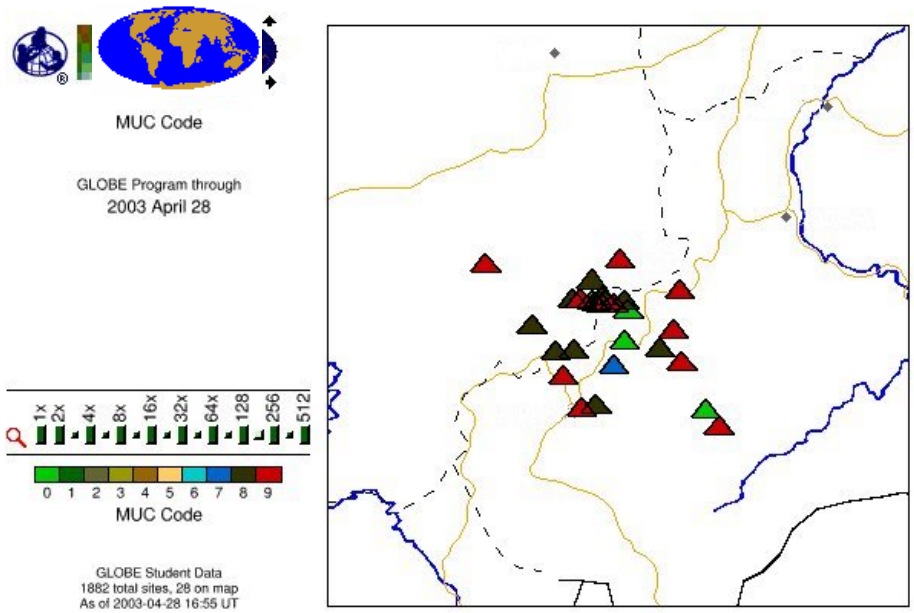
Based on the data and maps of each mystery station, where in the world are the following locations?

Mystery Station	Maps and Graphs alone	Maps and Graphs with Clues	Maps and Graphs with School List*
1			
2			
3			
4			
5	**Which graph (A or B) goes with the map and where in the world is it located?**		

*Which school from the list does not fit a map?_____

Mystery Station 1

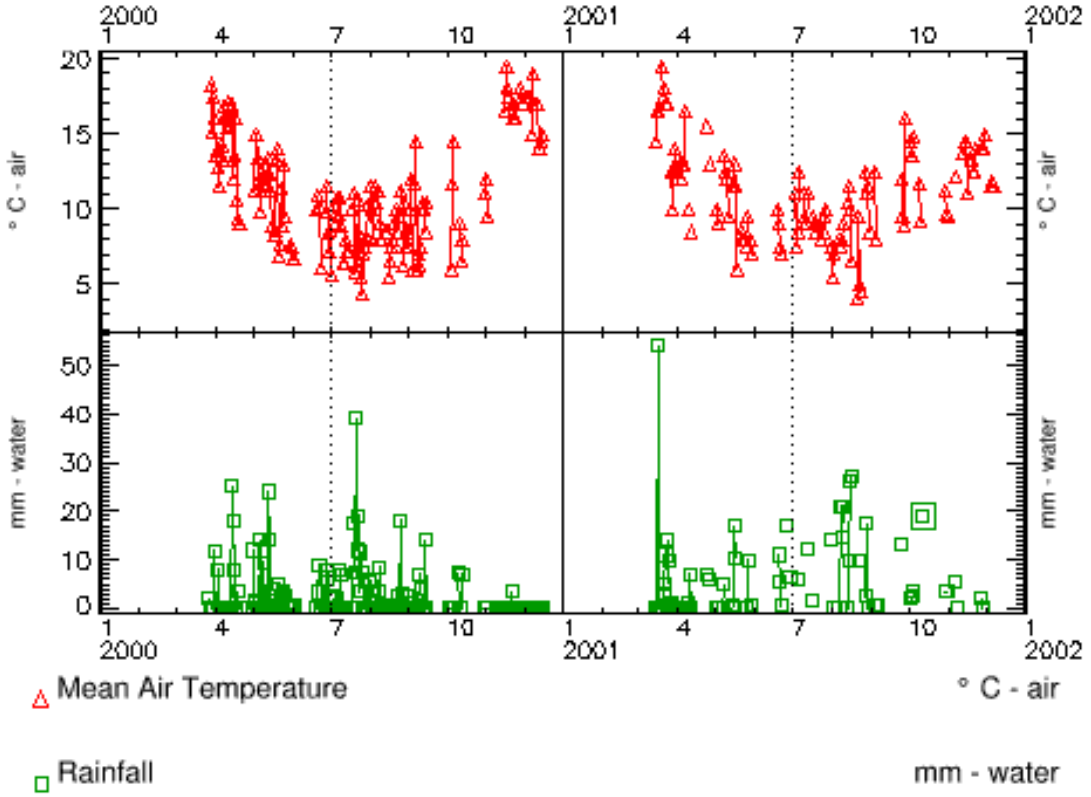


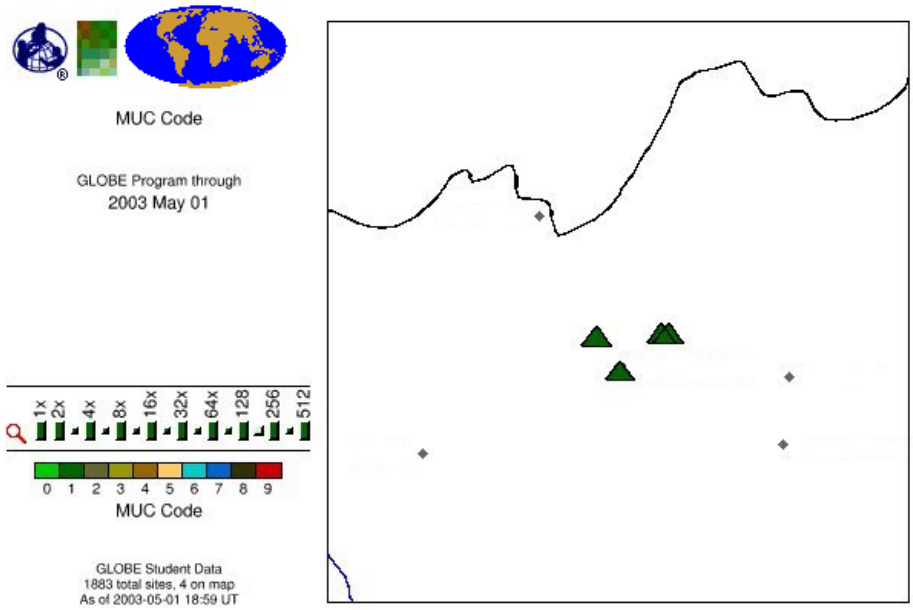


28 data reports in map region for this period

Map	MUC	Site Type	Date	Lat	Lon	Elev	Site ID	
			YYYYMMDD	deg	deg	m		
[X]	92	LCL	19971223			374	LCS-02	(TOT=82189 AT=30385 SW=2526 LC=260 SO=48394 PH=354 MD=270)
[X]	91	LCL	20011025			200	LCS-10	(TOT=18073 AT=16265 SW=1029 LC=92 SO=362 PH=137 MD=188)
[X]	91	LCL	20030425			289	LCS-31	(TOT=82189 AT=30385 SW=2526 LC=260 SO=48394 PH=354 MD=270)
[X]	91	LCL	20030417			458	LCS-29	(TOT=82189 AT=30385 SW=2526 LC=260 SO=48394 PH=354 MD=270)
[X]	91	LCL	20030417			507	LCS-27	(TOT=82189 AT=30385 SW=2526 LC=260 SO=48394 PH=354 MD=270)
[X]	91	LCL	20030217			350	LCS-26	(TOT=82189 AT=30385 SW=2526 LC=260 SO=48394 PH=354 MD=270)
[X]	91	LCL	20030102			232	LCS-24	(TOT=82189 AT=30385 SW=2526 LC=260 SO=48394 PH=354 MD=270)
[X]	91	LCL	20021026			372	LCS-22	(TOT=82189 AT=30385 SW=2526 LC=260 SO=48394 PH=354 MD=270)

Mystery Station 2

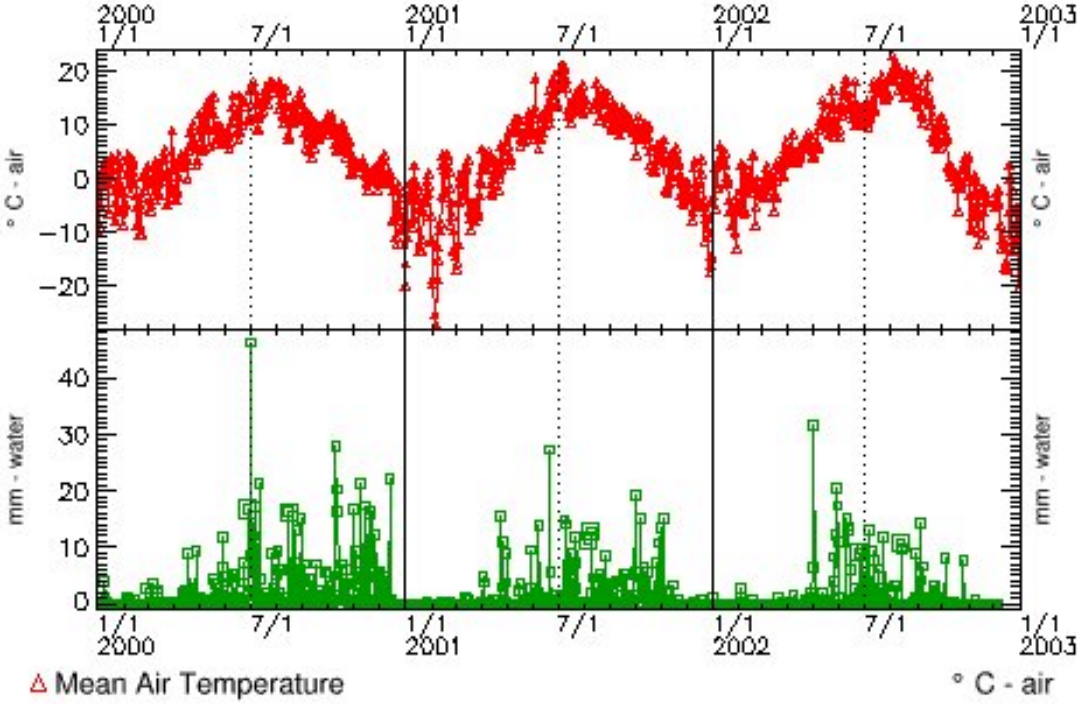


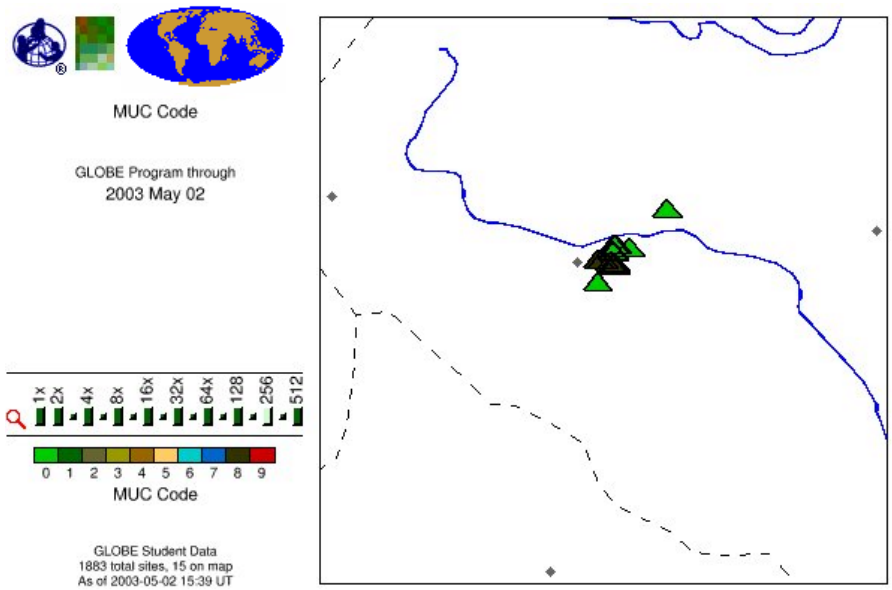


4 data reports in map region for this period

Map	MUC	Site Type	Date	Lat	Lon	Elev	Site ID	
			YYYYMMDD	deg	deg	m		
[X]	131	LCN	20010801			120	LCS-02 RAP site	(TOT=3093 AT=2449 SW=165 LC=233 SO=181 MD=65)
[X]	131	LCL	20010801			120	LCS-01 RAP site	(TOT=3093 AT=2449 SW=165 LC=233 SO=181 MD=65) *typical dry schlerophyll eucalypt forest*
[X]	131	BIO	20010717			125	BIO-02 RAP BIOLOGY SITE	(TOT=3093 AT=2449 SW=165 LC=233 SO=181 MD=65) *PREDOMINATELY EUCLALIPTUS TREES WITH BRACKERN FERN*
[X]	131	BIO	20000515			123	BIO-01 Land Cover Biology	(TOT=3093 AT=2449 SW=165 LC=233 SO=181 MD=65) *dry eucalypts, acacia's, under growth of braken fern.*

Mystery Station 3

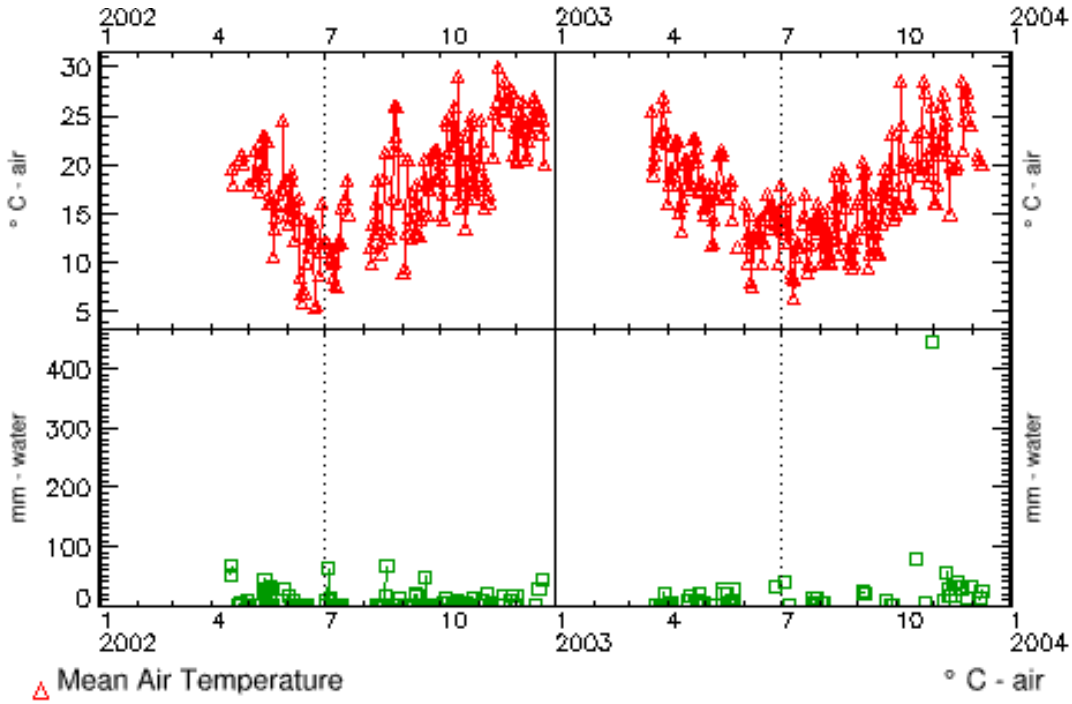


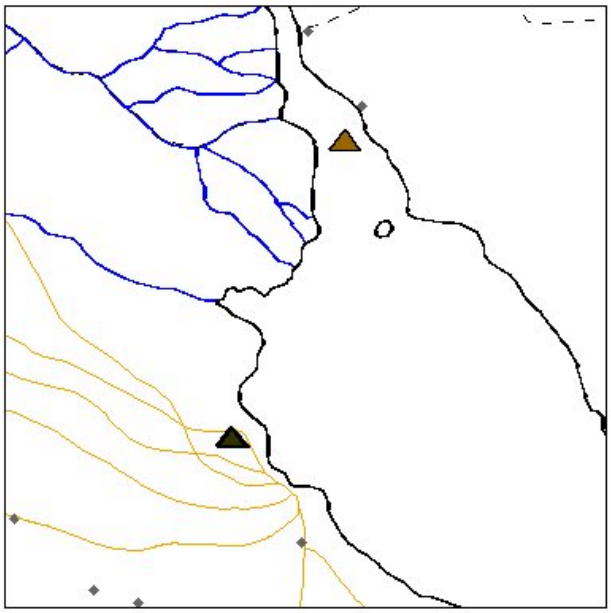


15 data reports in map region for this period

Map	MUC	Site Type	Date	Lat	Lon	Elev	Site ID	
			YYYYMMDD	deg	deg	m		
[X]	811	LCL	20020228			467	LCS-10	(TOT=50468 AT=13908 SW=25978 LC=2191 SO=7845 PH=70 MD=476)
[X]	811	LCL	20020228			482	LCS-09	(TOT=50468 AT=13908 SW=25978 LC=2191 SO=7845 PH=70 MD=476)
[X]	811	LCL	20020228			537	LCS-08	(TOT=50468 AT=13908 SW=25978 LC=2191 SO=7845 PH=70 MD=476)
[X]	811	LCL	20020227			570	LCS-07	(TOT=50468 AT=13908 SW=25978 LC=2191 SO=7845 PH=70 MD=476)
[X]	811	LCL	20020227			609	LCS-06	(TOT=50468 AT=13908 SW=25978 LC=2191 SO=7845 PH=70 MD=476)
[X]	0232	LCL	19991115			540	LCS-01 ...	(TOT=50468 AT=13908 SW=25978 LC=2191 SO=7845 PH=70 MD=476) *Closed forest with small trees (from about 5-15 meters high).*
[X]	0232	BIO	20020916			540	BIO-01	(TOT=50468 AT=13908 SW=25978 LC=2191 SO=7845 PH=70 MD=476)

Mystery Station 4



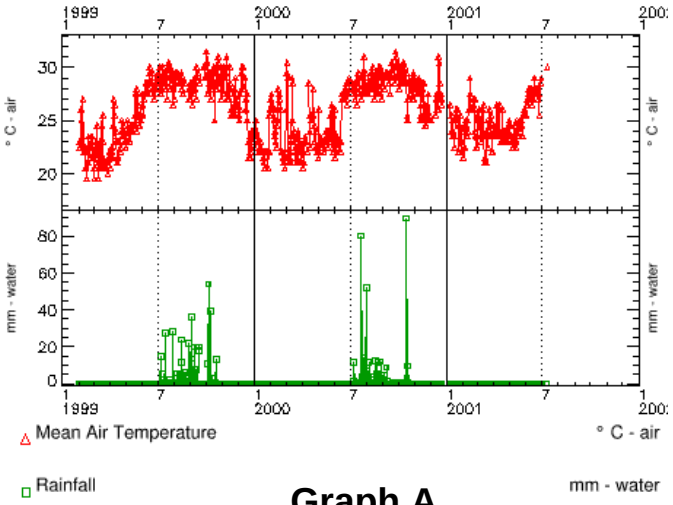


7 data reports in map region for this period

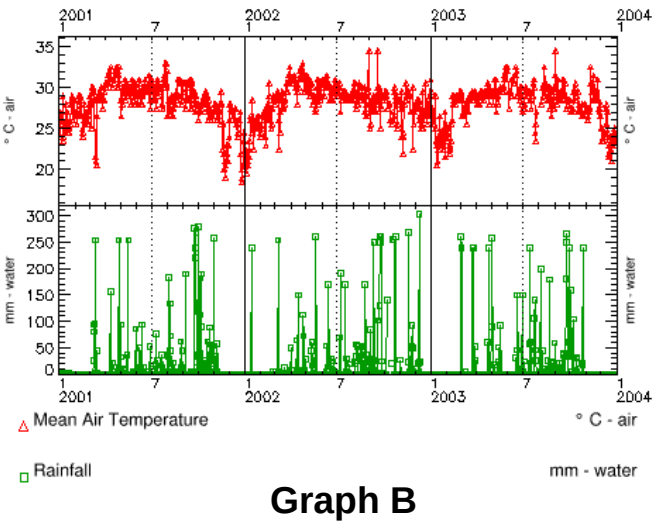
Map	MUC	Site Type	Date YYYYMMDD	Lat deg	Lon deg	Elev m	Site ID	
[X]	822	LCL	20011126			5	LCS-01	(TOT=8097 AT=6971 LC=443 SO=288 PH=314 MD=81)
[X]	4313	LCN	20021211			0	LCS-04	(TOT=8097 AT=6971 LC=443 SO=288 PH=314 MD=81)
[X]	4313	LCN	20021111			15	LCS-03	(TOT=8097 AT=6971 LC=443 SO=288 PH=314 MD=81) *Nuestro lugar de estudio es un campo de golf, en donde hay una gran variedad de rboles, no nativos y hay pocos indi*
[X]	4313	LCL	20021029			-1	LCS-02	(TOT=8097 AT=6971 LC=443 SO=288 PH=314 MD=81) *COMO SE TRATA DE UN CAMPO DE GOLF ENCONTRAMOS SOLO UN ARBOL EN LOS 30 METROS CUADRA*
[X]	4313	BIO	20021217			0	BIO-04	(TOT=8097 AT=6971 LC=443 SO=288 PH=314 MD=81) *Hacia el norte se encuentra el drive del golf, hacia el este se encuentra la confiteria y hacia el sudeste el tanque de ag*
[X]	4313	BIO	20021029			-1	BIO-02	(TOT=8097 AT=6971 LC=443 SO=288 PH=314 MD=81) *CAMPO DE GOLF*

Mystery Station 5

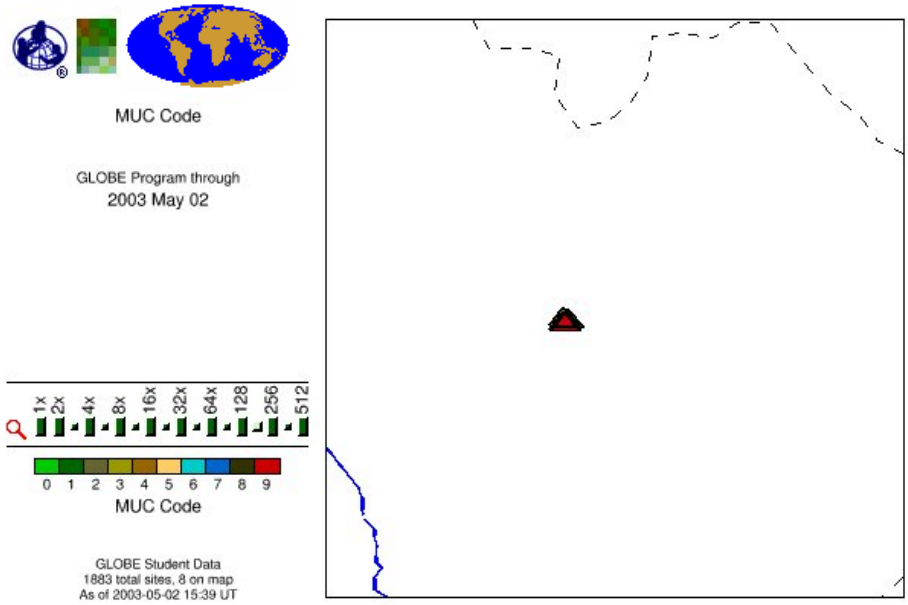
Which graph belongs to the



Graph A



Graph B

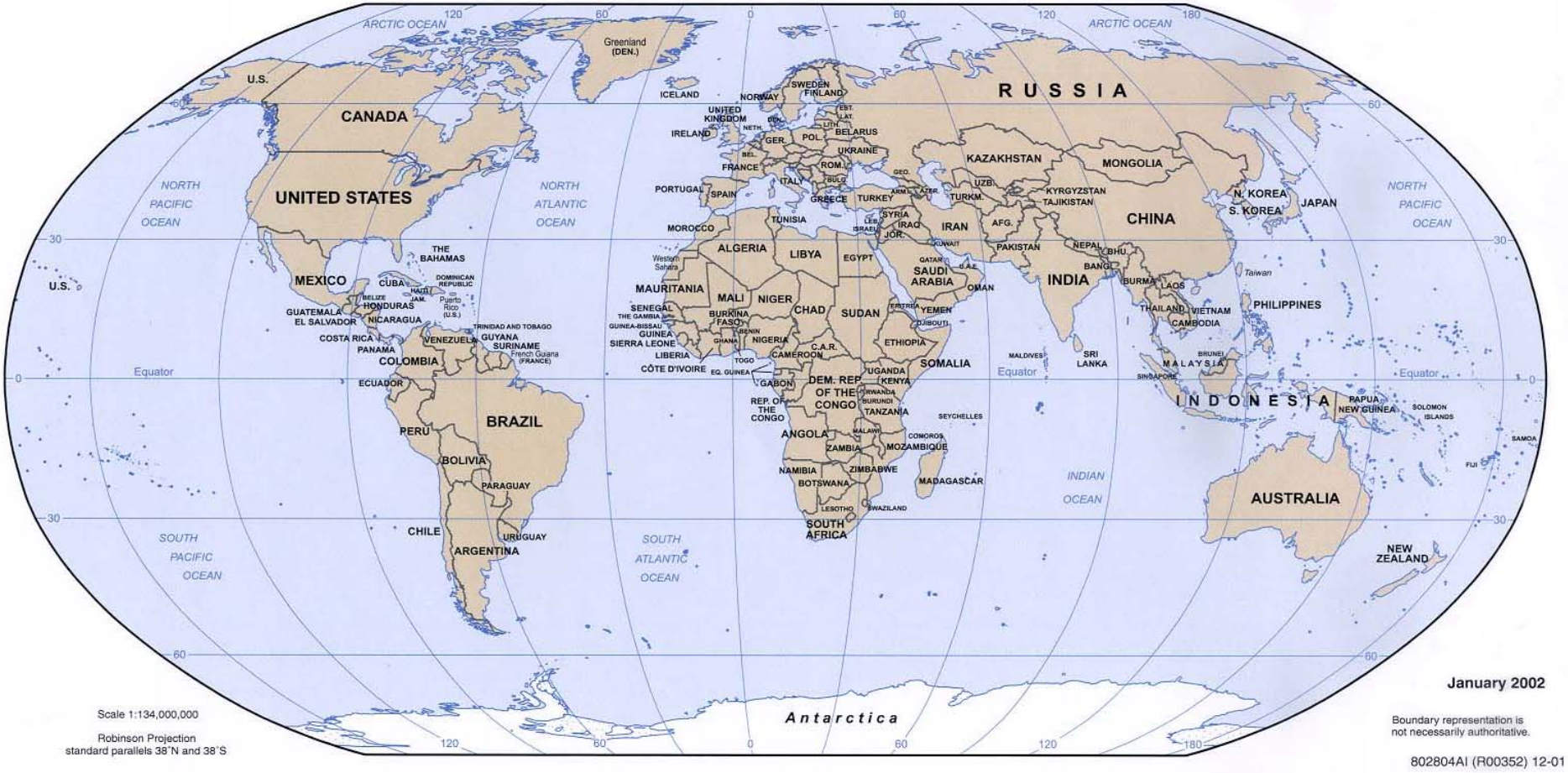


8 data reports in map region for this period

Map	MUC	Site Type	Date	Lat	Lon	Elev	Site ID	
			YYYYMMDD	deg	deg	m		
[X]	94	LCL	20010909			165	LCS-01 ...	(TOT=20965 AT=10652 SW=2970 LC=41 SO=6996 MD=306) *The astronomy village and facilities.*
[X]	812	LCL	20010908			154	LCS-05	(TOT=20965 AT=10652 SW=2970 LC=41 SO=6996 MD=306) *The garden of tropical flowers*
[X]	812	LCL	20010909			130	LCS-04	(TOT=20965 AT=10652 SW=2970 LC=41 SO=6996 MD=306) *Banana garden*
[X]	71	LCL	20010909			140	LCS-06	(TOT=20965 AT=10652 SW=2970 LC=41 SO=6996 MD=306) *A large pond*
[X]	71	LCL	20010908			138	LCS-03	(TOT=20965 AT=10652 SW=2970 LC=41 SO=6996 MD=306) *There are a few of lotus in the pond.*
[X]	4361	LCL	20010908			152	LCS-07	(TOT=20965 AT=10652 SW=2970 LC=41 SO=6996 MD=306) *Short-Grass Communities*
[X]	1212	LCL	20010908			149	LCS-02	(TOT=20965 AT=10652 SW=2970 LC=41 SO=6996 MD=306) *Teak woods*
[X]	1211	BIO	20010908			149	BIO-01	(TOT=20965 AT=10652 SW=2970 LC=41 SO=6996 MD=306) *Teak woods*

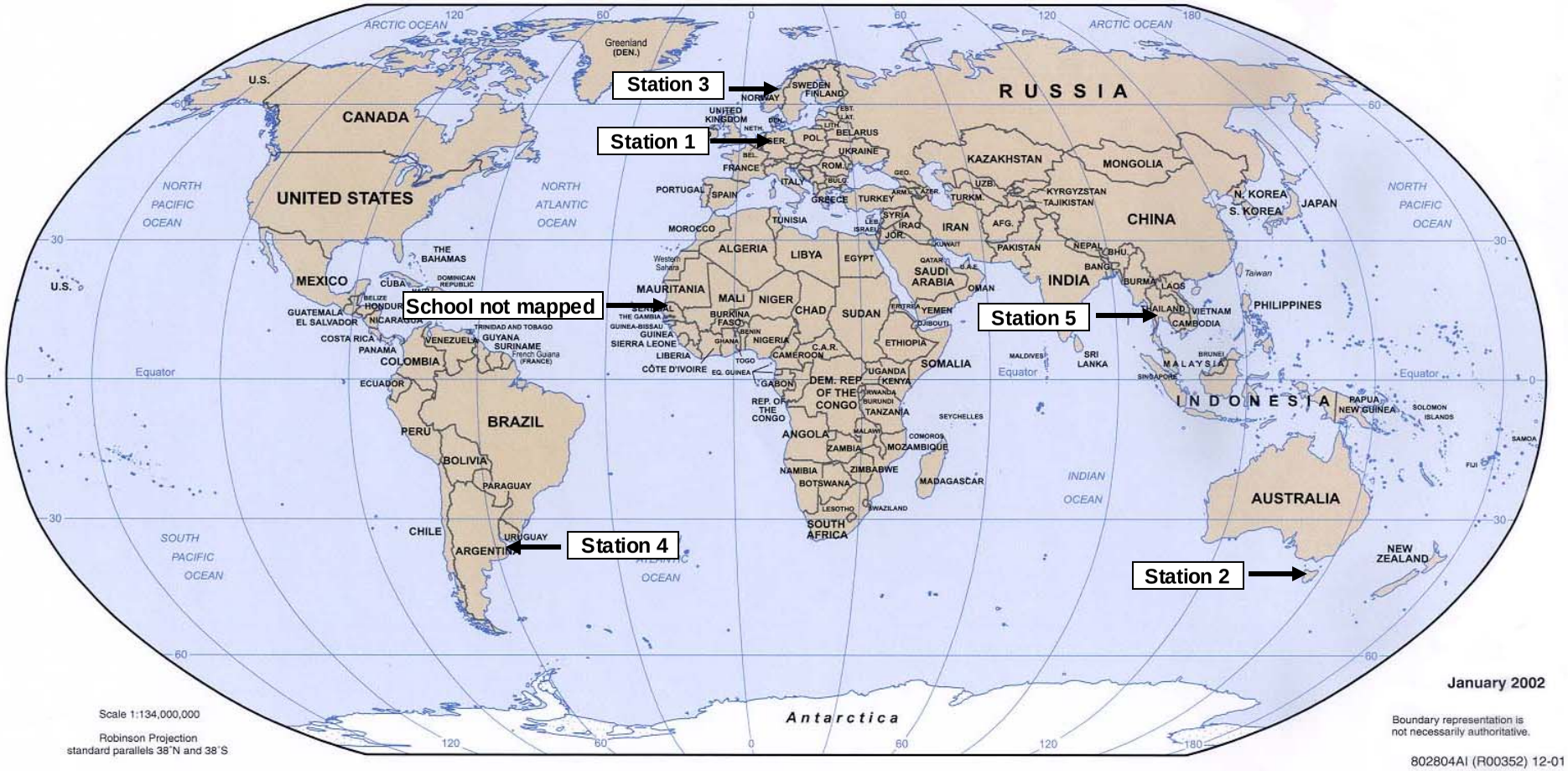
Student's World Map – Where in the World…?

Map source: http://geography.about.com



Teacher's World Map – Where in the World…?

Map source: http://geography.about.com



Mystery Station 1 – Elsterberg, Germany

Mystery Station 2 – Scottsdale, Tasmania, Australia

Mystery Station 3 – Valdres, Norway

Mystery Station 4 – Buenos Aires, Argentina

Mystery Station 5 – Kanchanaburi, Thailand

School not mapped – Dakar, Senegal

Clues for Mystery Stations

List of Schools in This Activity

Escuela de Ensenanza Media 7 “Nicolas Copernico”, Buenos Aires, Argentina

Scottsdale High School, Scottsdale, Tasmania, Australia

Mittelschule Elsterberg, Elsterberg, Germany

Vang barne- og ungdomsskule (6-16), Valdres, Norway

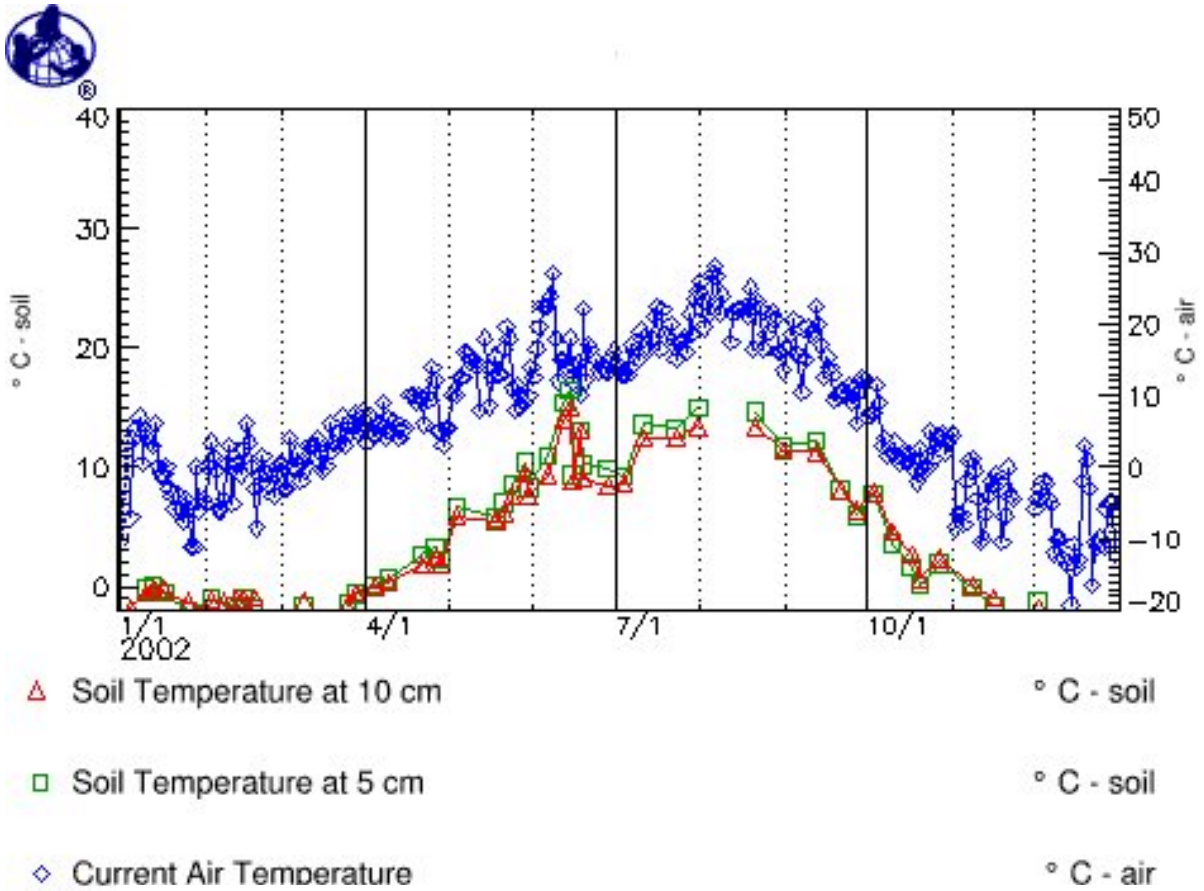
Lycee Blaise Diagne, Dakar, Senegal

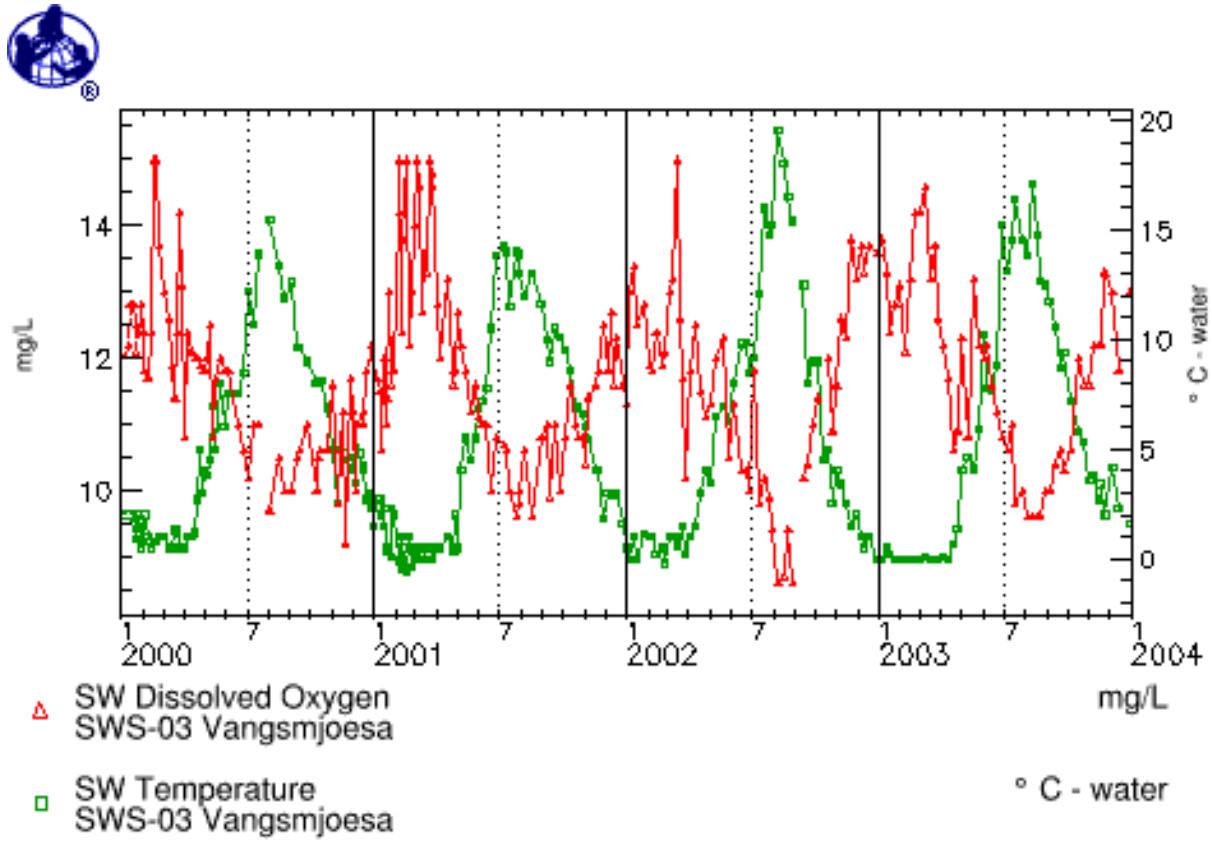
Mystery Station Latitudes and Longitudes

Latitude		Longitude	
Mystery Station 1	50° N	Mystery Station 1	12° E
Mystery Station 2	41° S	Mystery Station 2	147° E
Mystery Station 3	61° N	Mystery Station 3	8° E
Mystery Station 4	34° S	Mystery Station 4	58° W
Mystery Station 5	14° N	Mystery Station 5	99° E

Further Investigations:

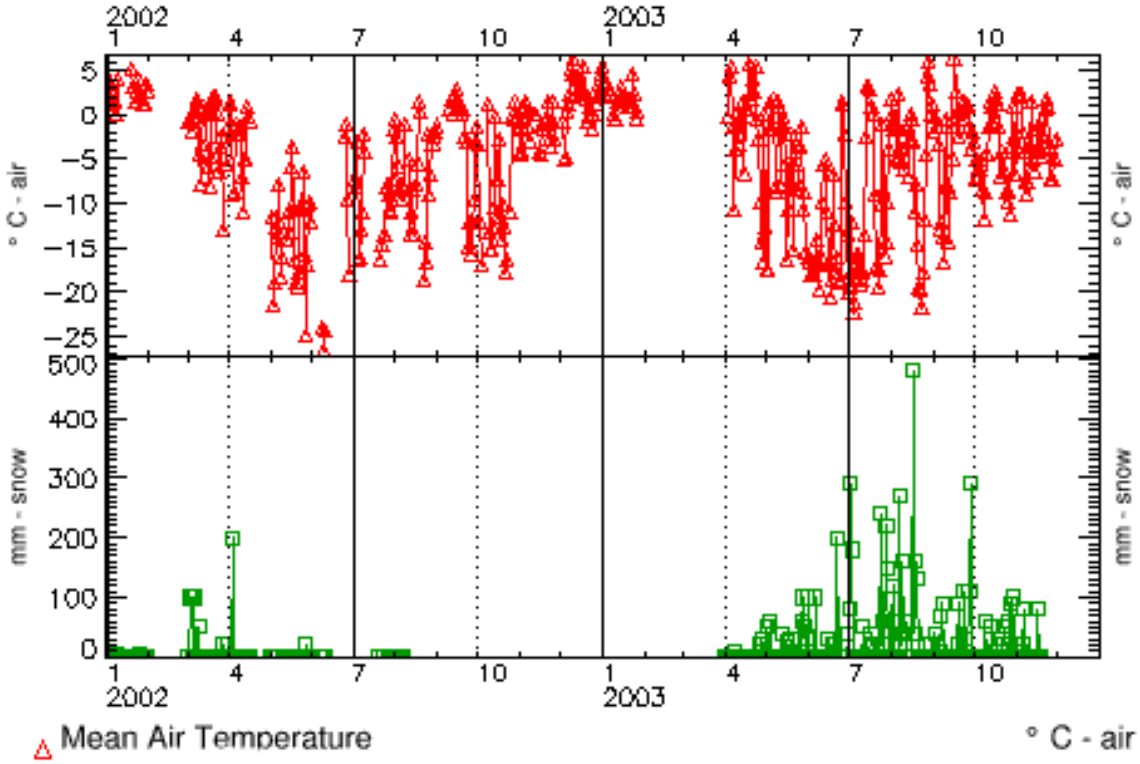
These 2 graphs belong to which of the six

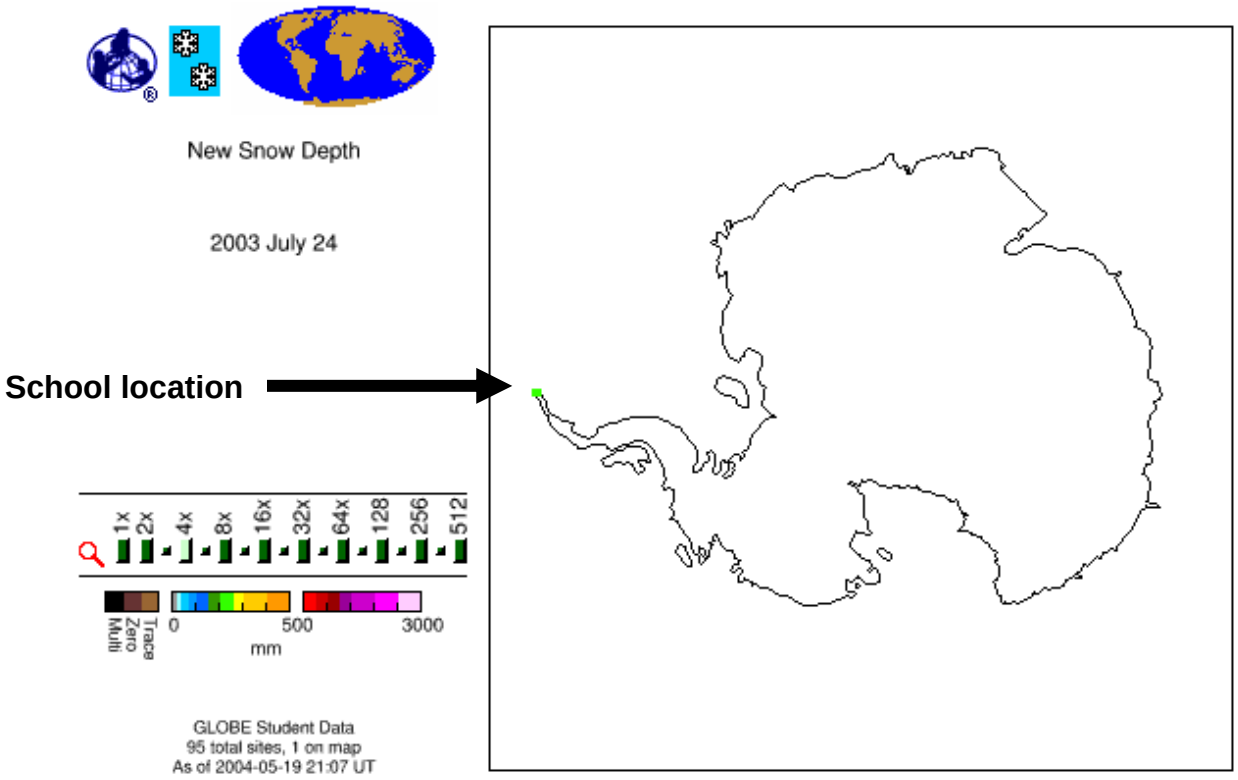




Further Investigations:

Where in the world might this school be located? What clues in the data can help you?



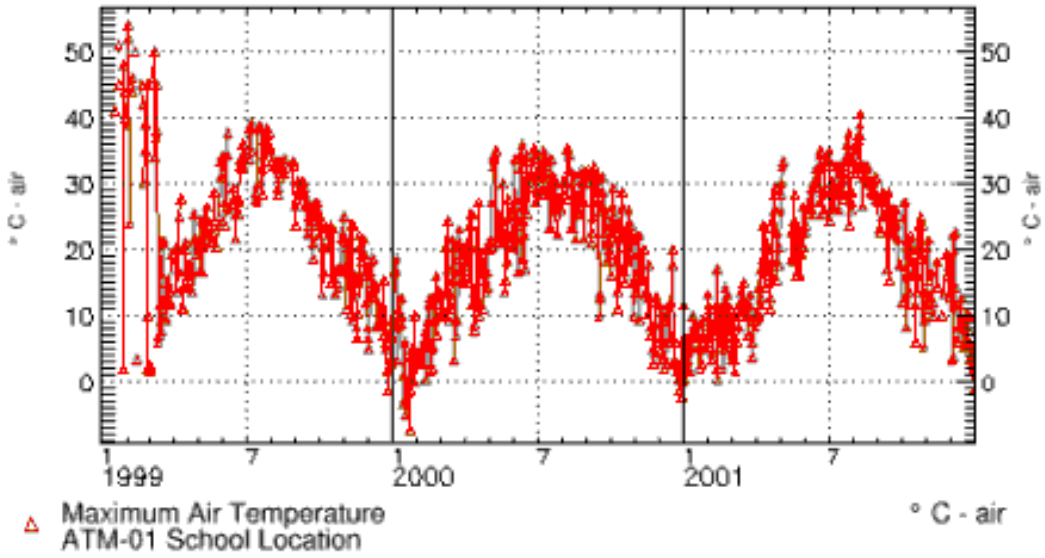


Further Investigations:

Graph A data

Date[+]	MxTmp
YYYYMMDD	deg C
19990101	--
19990102	--
19990103	--
19990104	--
19990105	--
19990106	--
19990107	--
19990108	--
19990109	--
19990110	--
19990111	--
19990112	--
19990113	--
19990114	--
19990115	--
19990116	41.0
19990117	--
19990118	--
19990119	--
19990120	--
19990121	51.0
19990122	--
19990123	45.0
19990124	--
19990125	--
19990126	--
19990127	2.0
19990128	48.0
19990129	44.0
19990130	40.0
19990131	--
19990201	39.0
19990202	52.0

Graph A 40.8119 N, 74.1247 W



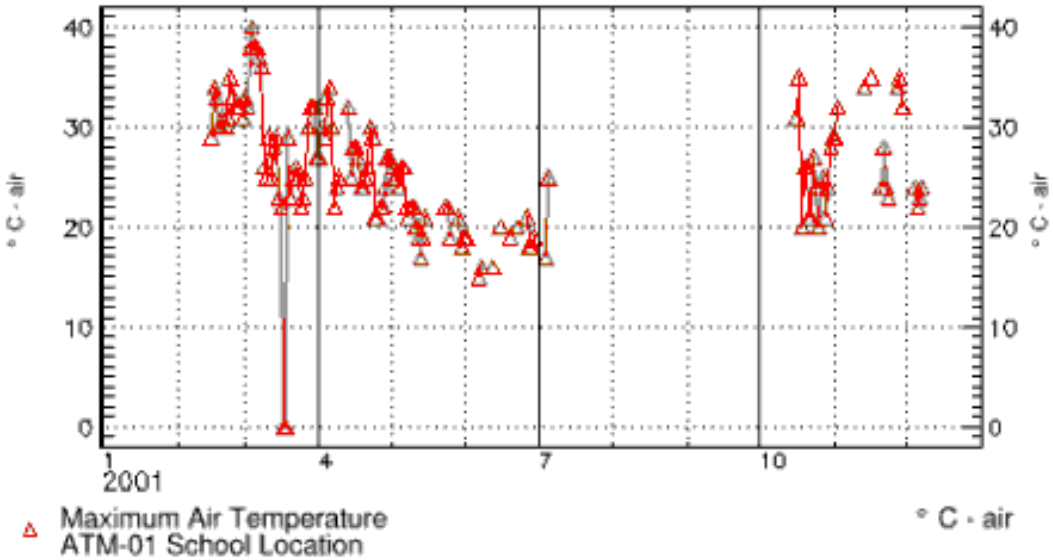
Are the data reasonable?

Discuss the graphs included here;
Are there questionable data?
What are some possible sources of error?

Graph B data

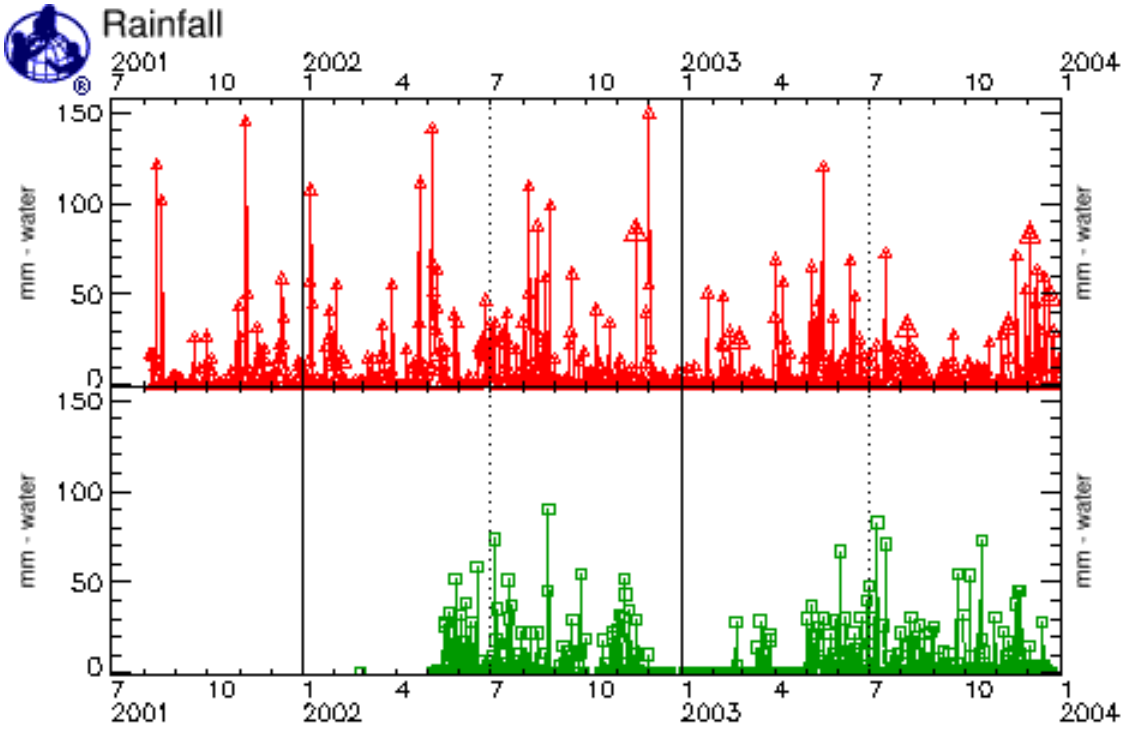
Date[+]	MxTmp
YYYYMMDD	deg C
20010215	29.0
20010216	34.0
20010217	33.0
20010218	30.0
20010219	30.0
20010220	31.0
20010221	30.0
20010222	31.0
20010223	35.0
20010224	33.0
20010225	32.0
20010226	32.0
20010227	32.0
20010228	31.0
20010301	33.0
20010302	32.0
20010303	38.0
20010304	40.0
20010305	38.0
20010306	38.0
20010307	37.0
20010308	36.0
20010309	26.0
20010310	25.0
20010311	29.0
20010312	25.0
20010313	28.0
20010314	29.0
20010315	23.0
20010316	22.0
20010317	0.0
20010318	0.0
20010319	29.0
20010320	23.0

Graph B 32.3333 S, 115.9500 E



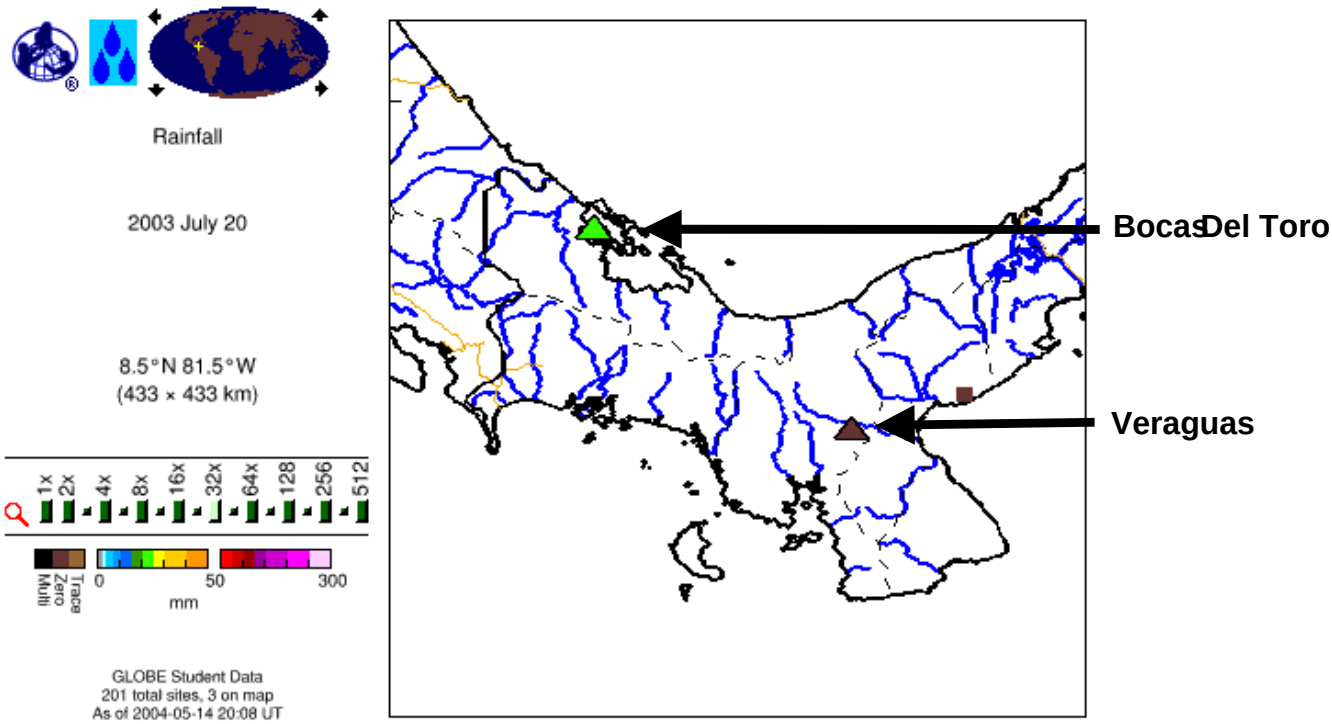
Further Investigations:

Discuss the following graphs and map: What story do the data tell?



△ **Colegio San Marcos, Changuinola, Bocas Del Toro, Panama**

□ **Colegio Inmaculada Concepcion, Veraguas, Panama**



Where in the World

Assessment Sheet

Where are the locations of the following graphs?

Mean Temperature and Rainfall Graphs	Location
★	
■	
➡	
●	
▲	
▰	

List of Schools in this Activity

Escuela de Ensenanza Media 7 "Nicolas Copernico", Buenos Aires, Argentina

Scottsdale High School, Scottsdale, Tasmania, Australia

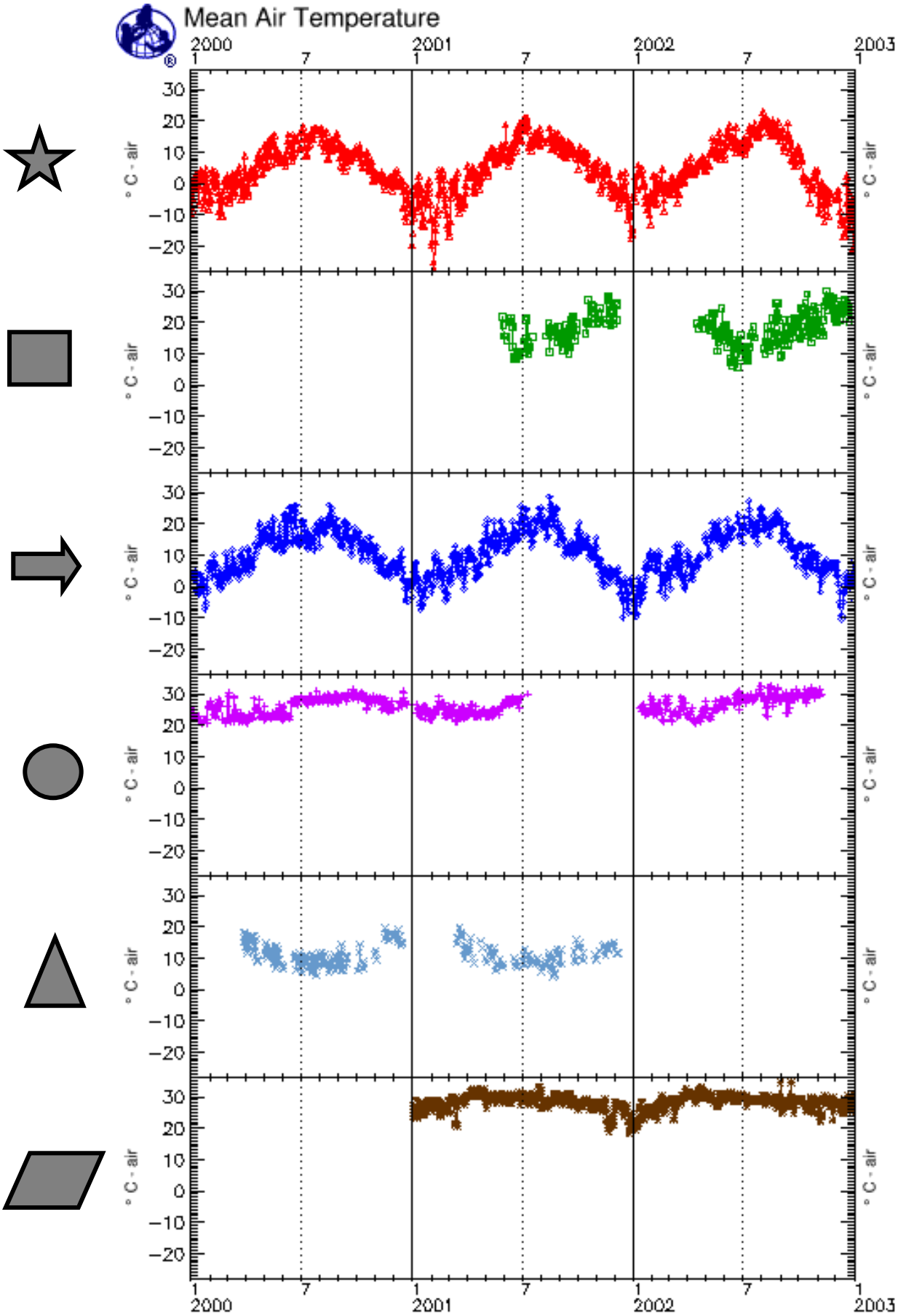
Mittelschule Elsterberg, Elsterberg, Germany

Vang barne- og ungdomsskule (6-16), Valdres, Norway

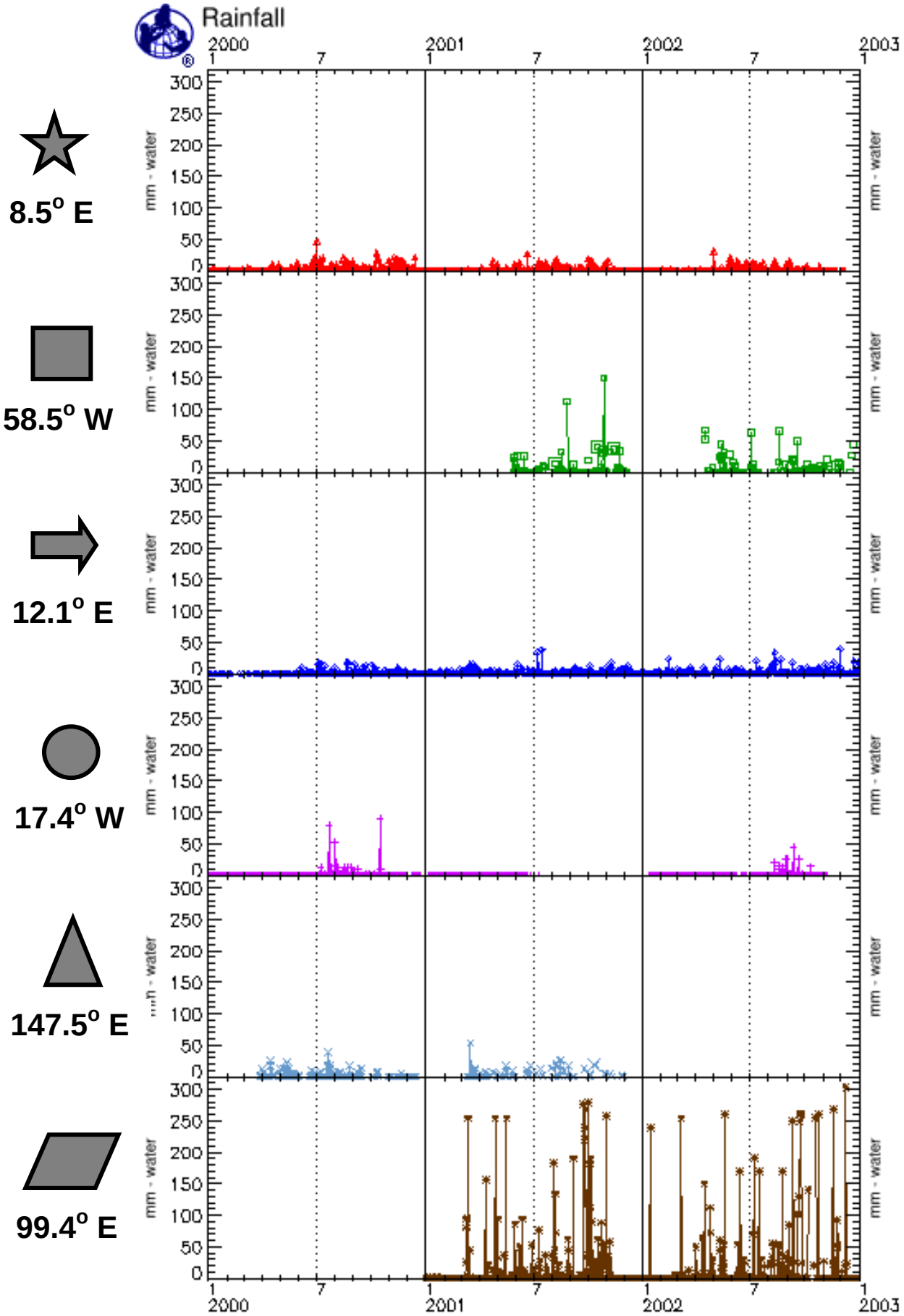
Lycee Blaise Diagne, Dakar, Senegal

Banyangsung, Kanchanaburi, Thailand

Where in the World Assessment Graphs – Mean Air Temperature



Where in the World Assessment Graphs – Rainfall



WHAT IS THE TEMPERATURE…? Lesson Plan

Purpose:

1. Use geographic knowledge and other data to determine air temperature at local solar noon for one year at six locations.
2. Comparison of student hand-drawn graphs with actual graphs of data.
3. Understand the value of GLOBE data for classroom instruction.
4. Understand that temperature may vary due to latitude

Overview:

Students work in small groups to determine the local solar noon temperature for one year at different GLOBE school locations based on observations and clues gleaned from geographic locations and by using GLOBE data from each school.

Science Standards:

This activity addresses the following content and cognitive domains according to the Trends in International Mathematics and Science Study (TIMSS), 2007:

Fourth-Grade Content Domains

- Earth Science
  - Earth's Processes, Cycles, and History

Eighth-Grade Content Domains

- Earth Science
  - Earth's Processes, Cycles, and History

Cognitive Domains

- Knowing
  - Illustrate with Examples
- Applying
  - Compare/Contrast/Classify
  - Relate
  - Interpret Information
  - Explain
- Reasoning
  - Analyze/Solve Problems
  - Hypothesize/Predict
  - Draw Conclusions
  - Generalize
  - Justify

This activity addresses the following content science standards according to the (U.S.) National Science Education Standards:

Science as inquiry

- An appreciation of "how we know" what we know in science,
- Skills necessary to become independent inquirers about the natural world.

Earth and space science (Content Standard D)

- Changes in the earth and sky (Grades K-4)
- Structure of the earth system (Grades 5-8)
- Energy in the earth system (Grades 9-12)

Note: For state specific alignment, visit **<www.aligntoachieve.com>**.

Level:

This activity is suitable for students who possess a beginning understanding of cause-and-effect relationships; the ability to read simple graphs and tables and are able to make simple data comparisons; know basic weather-related phenomena; and are able to create, interpret, and make predictions from charts, diagrams, and graphs based on information provided; principally grades 6 to 12. For younger students, or students who do not possess these skills, teachers may need to provide more input at various steps, while for students with more experience at looking at graphs of data, less teacher input would be necessary.

Time:

One to two class periods.

Materials included:

This activity is divided into three regional sections: 1) the Americas; 2) Africa, Europe and the Near East; and 3) Asia and the Pacific.

Each of the three regional sections includes:

1. Blank stacked (six locations) current air temperature graph for one year (**Graph A**);
2. Stacked (six locations) current air temperature graph for one year (**Graph B**);
3. Blank visualization map with the six locations identified (**Map A**);
4. Visualization map for one day indicating current air temperature for the six locations (**Map B**);
5. Visualization map (different date than **Map A**) indicating current air temperature with six locations not identified (**Map C**);
6. Table of data (randomly selected) from the six locations. Note: To see all data visit <**http://classic.globe.gov**>.

Materials needed:

1. One large world map to display on the wall (optional);
2. Pencils (colored pencils recommended);
3. Index cards containing the prompts for group formation (Optional: See group structure example below).

Lesson Preparation:

1. Review Lesson Plan; make copies of appropriate handouts as prompted;
2. Arrange students into groups of two to four (use of prompts may facilitate random distribution);
3. Arrange the classroom to facilitate group activity;
4. Label each table with a sign indicating the name of the group if prompts are utilized (I.e. Atmosphere, Land Cover, Soil, Hydrology, and Phenology);
5. Distribute blank stacked current air temperature graphs (Graph A) for the selected region(s).

Group Structure (optional):

1. Make index cards with prompts (examples listed below) for each of the following GLOBE investigation areas. One card is needed for each student in the class.

Atmosphere	**Land Cover**	**Soils**
Clouds	MUC	Soil Color
Precipitation	Landsat	Bulk Density
Relative humidity		Pixel Soil Temperature
Surface Ozone	Canopy Cover	Soil Moisture

Hydrology	**Phenology**	**GPS**
Water pH	Green Up	Make a card for
Transparency	Bird Migrations	GPS (for fun –
Alkalinity	Budburst	since it could fall
Dissolved O_2	Green Down	under all groups!)

2. Distribute one card to each student.
3. Instruct students to go to the table that corresponds to the information on their card.
4. Once students are located in their small groups (at separate tables), instruct them to determine individual roles, such as:
   facilitator
   recorder(s)
   presenter(s)

Procedures:

The intention of this activity is to provide three different sections that can be presented either separately or in conjunction. For example, one of these sections (perhaps the one that contains the students' home country) could be used initially leaving the other two sections as assessment opportunities. However, it might also facilitate global learning to have different groups of students work on different sections; thus, during the presentation phase students would all see how countries at similar distances from the equator experience similar temperatures while countries at different distances from the equator experience different temperatures. Additionally, students should see that countries on opposite sides of the equator experience opposite temperatures.

1. The teacher should facilitate a class discussion on air temperature fluctuations throughout the year at their school location. If the school has collected at least one year of GLOBE data they can examine this information. When during the year is the lowest temperature? The highest temperature? Why? What time of day do GLOBE schools collect current air temperature? The understanding of this last question is important for this activity. GLOBE schools collect current air temperature one hour +/- from Local Solar Noon (when the Sun is at its zenith). For more information on Solar Noon or GLOBE Protocols, see the online GLOBE Teacher's Guide at <**http://classic.globe.gov**>.

2. The teacher should choose the graphs and maps appropriate for the class. The teacher provides the blank stacked graphs (**Graph A**) of current air temperature to each group. The teacher can also distribute colored pencils, one color to be used at a time through this activity to allow teacher and students, at the conclusion of this activity, to see the progression of their graphs.

3. Groups discuss independently how the temperature may vary throughout the year at the six locations on the graph. When they are in agreement, they should sketch

with a pencil how they think the graphs of data would look at the six locations. After the groups have finished, ask what problems they experienced in determining the shape of the data. What additional clues might be valuable? Help them to understand that location or geographic distribution – where these schools are located relative to each other – could be useful.

4. The teacher provides the groups with the blank visualization map with the six locations identified (**Map A**). Groups discuss independently how this information will help determine the shape of the graphs. When they are in agreement, they should sketch with a pencil (a different color if they are using colored pencils) how they think the graph of data should be modified based on this new information. The six graphs should now each have two lines (the original sketches by the groups should remain on the graphs). Ask the groups if the map helped them modify their graphs and by how much. The teacher should ask the groups if additional information would help them better determine the shapes of the graphs?

5. The teacher provides the groups with the visualization map for one day of current air temperature for the six locations (**Map B**). The groups should work independently to estimate the temperature values for the six locations (based on the temperature color bar in the lower left). When they are in agreement, they should sketch with a pencil (a different color if they are using colored pencils) how they think the graph of data should be modified based on this new information. The six graphs should now each have three lines. Discuss as a class how well these data fit into their sketched graphs (from Procedures 2 and 3 described above). The teacher should ask the groups if still more information might help them determine the shapes of their graphs.

6. The teacher provides the groups with the visualization map for one day of current air temperature with the six locations not identified (**Map C**). The groups should work independently to determine the location of the schools based on previous maps (**Maps A and B**) and then estimate the current temperature values for the six locations (based on the temperature color bar in the lower left). When they are in agreement, they should sketch with a pencil (a different color if they are using colored pencils) how they think the graph of data should be modified based on this new information. The six graphs should now each have four lines. Discuss as a class how well these data fit into their sketched graphs (from Procedures 2, 3 and 4 described above). The teacher should ask the groups if more information might help them determine the shapes of their graphs.

7. The teacher should provide groups with the appropriate current air temperature data (based on the graph and maps they have been working with) for the six locations. Note to the students that only random data have been included from the actual data sets for the purposes of this activity. Complete datasets can be found at <**http://classic.globe.gov**>. Groups should work independently to estimate the placement of the current air temperature data on to the six different graphs. They should sketch with a pencil (a different color if they are using colored pencils) how they think the graph of data should be modified based on these data. The six graphs should now each have five lines. Discuss as a class how well these data fit into their sketched graphs (from Procedures 2, 3, 4 and 5 described above). Ask the groups to present their graphs and explain the series of modifications.

8. The teacher should provide the groups with the actual graphs of data for the six locations (**Graph B**). Discuss how scientists make predictions based on previous knowledge and then incorporate new information as it becomes available into their predictions, making them more accurate (Invite a local climatologist to visit the classroom and discuss atmospheric models). Explain that, through collecting data, GLOBE schools can help enhance weather models used by scientists to better predict atmospheric phenomena. Discuss the student data from the various schools. How do incomplete data sets affect weather models? Explain that even government or university-funded scientific data sets can have gaps in the data; scientists often must make assumptions based on prior knowledge or alternative data to fill in these gaps. Discuss the effects of geography, such as latitude, elevation, and proximity to large bodies of water, on temperature.

Assessment:

1. Teacher provides each student with the blank stacked graph for one year of six different school locations of current air temperature (**Graph A** – from a different region).
2. Students individually determine the shapes of the graphs based on knowledge gained from looking at the previous six locations. Since there are three sets of graphs and maps, teachers can choose which set is used in the initial activity and which set is used in the assessment.
3. Have students present their results. Which graphs from the assessment activity seem similar to graphs from the initial activity? How are they similar and why would they have similar graphs? Where else on Earth might you expect to find patterns similar to these? Have the students explain their reasoning.

Schools Used in this Activity:

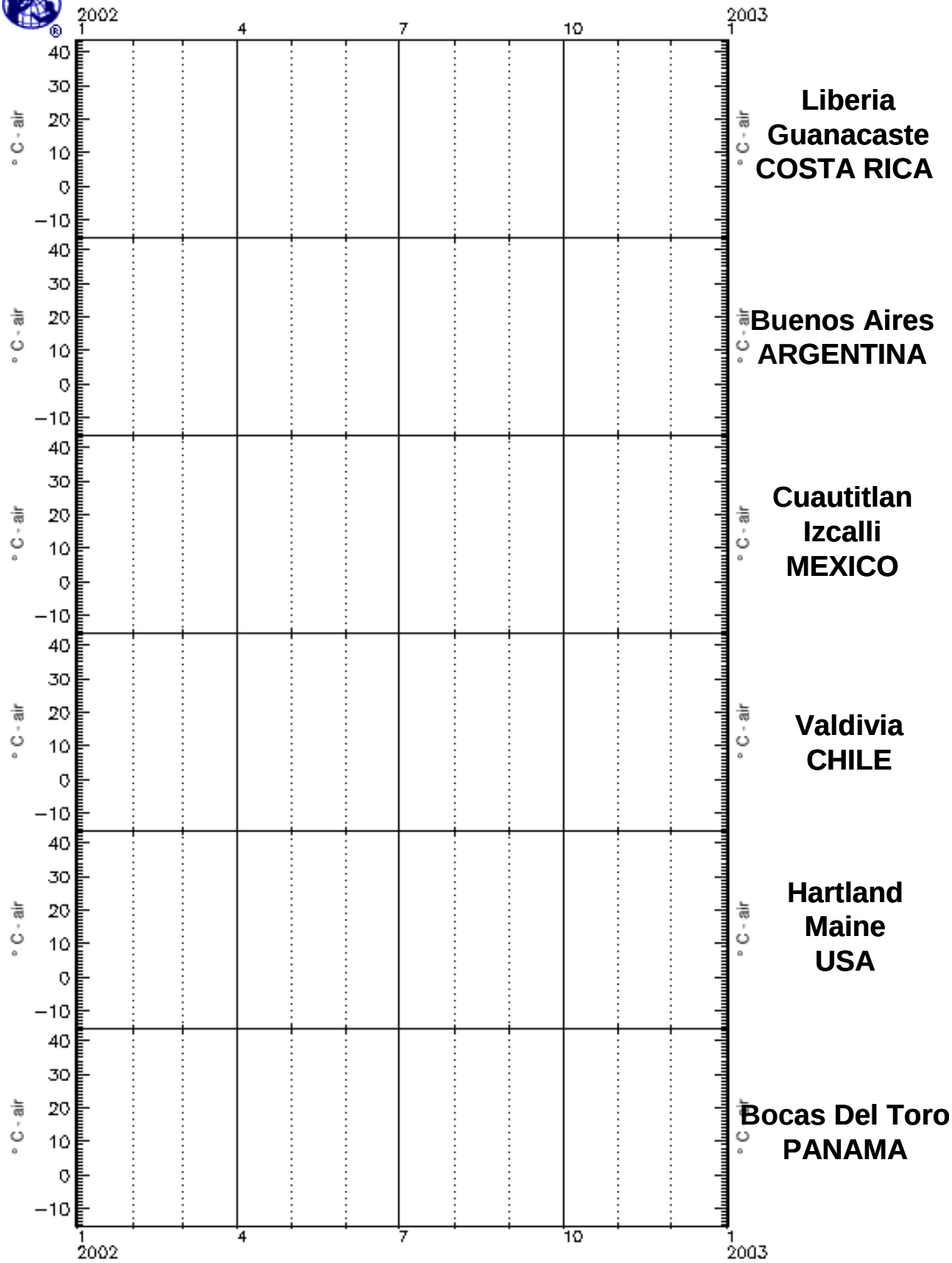
The selection of schools for this activity was based merely on regional representation and quality of data in the GLOBE Data Archive.

Schools used in the development of “the Americas” stacked graphs for Current Air Temperature were: Escuela de Ensenanza Media 7 "Nicolas Copernico, in Buenos Aires, Argentina; Escuela Rural de Niebla, in Valdivia, Chile; Instituto de Guanacaste, in Liberia, Guanacaste, Costa Rica; Facultad de Estudios Superiores Cuautitlan, in Cuautitlan Izcalli, Mexico; Colegio San Marcos, in Changuinola, Bocas Del Toro, Panama; and Hartland Consolidated School, in Hartland, Maine, USA.

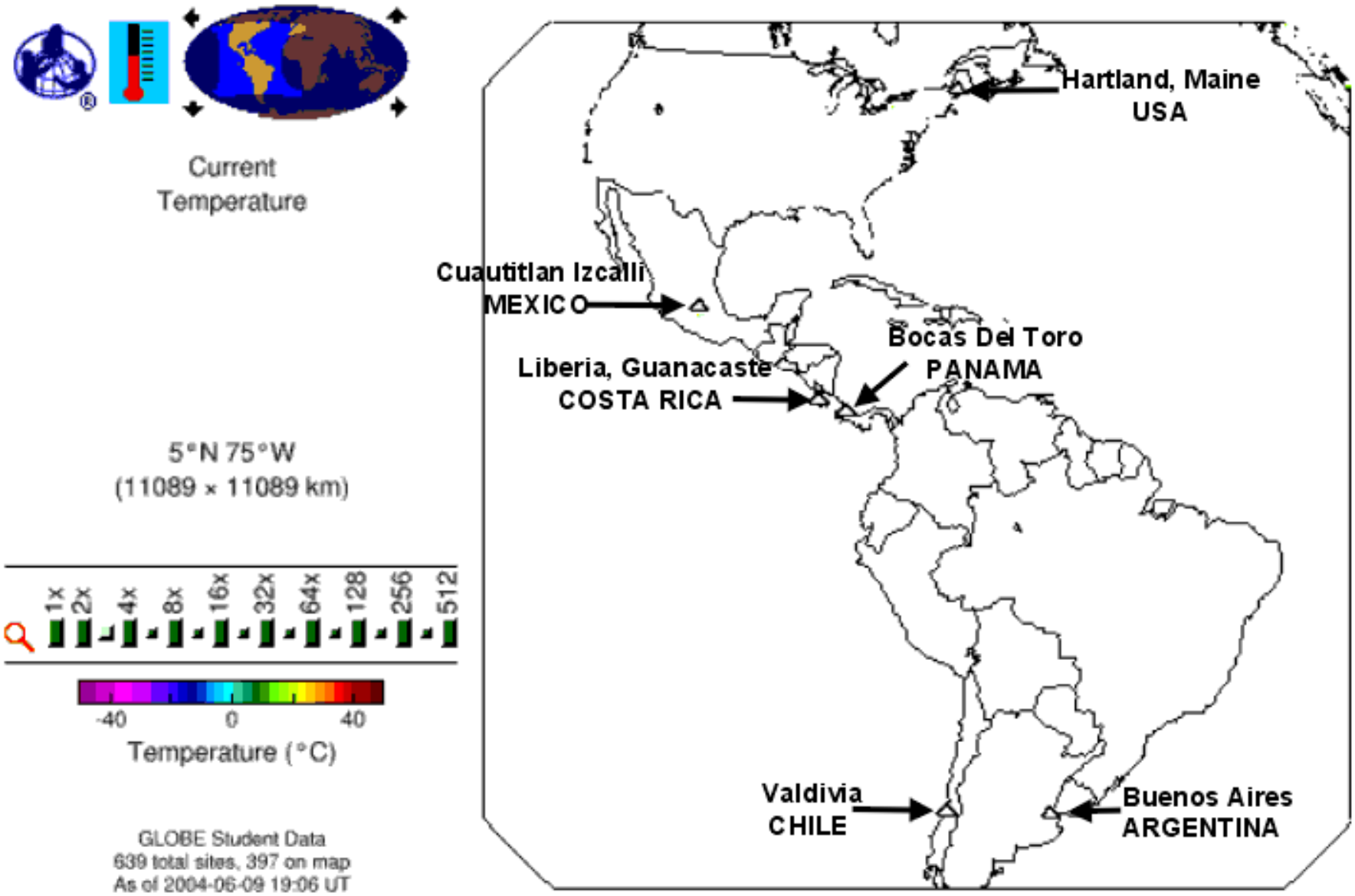
Schools used in the development of the “Africa, Europe and the Near East” stacked graphs for Current Air Temperature were: Konigliches Athenaum Eupen, in Eupen, Belgium; GBSS Downtown Bamenda, in Bamenda, Cameroon; Suomussalmen Lukio, in Suomussalmi, Finland; ORIENTATION AND EDUCATION, in Aley, Lebanon; Lycée Marovoay, in Marovoay, Madagascar; and IES "A Pinguela", Monforte De Lemos, in Lugo, LU, Spain.

Schools used in the development of the “Asia and the Pacific” stacked graphs for Current Air Temperature were: Gladstone High School, in Gladstone, South Australia, Australia; Nanjing Langya Road Primary School, in Nanjing, China; St. Edmund's School, in Shillong, India; Ecopolis Center Junior Eco Club, in Tokyo, Japan; Rotorua Girls High School, in Rotorua, Bay of Plenty, New Zealand; and Banyangsung, in Kanchanaburi, Thailand.

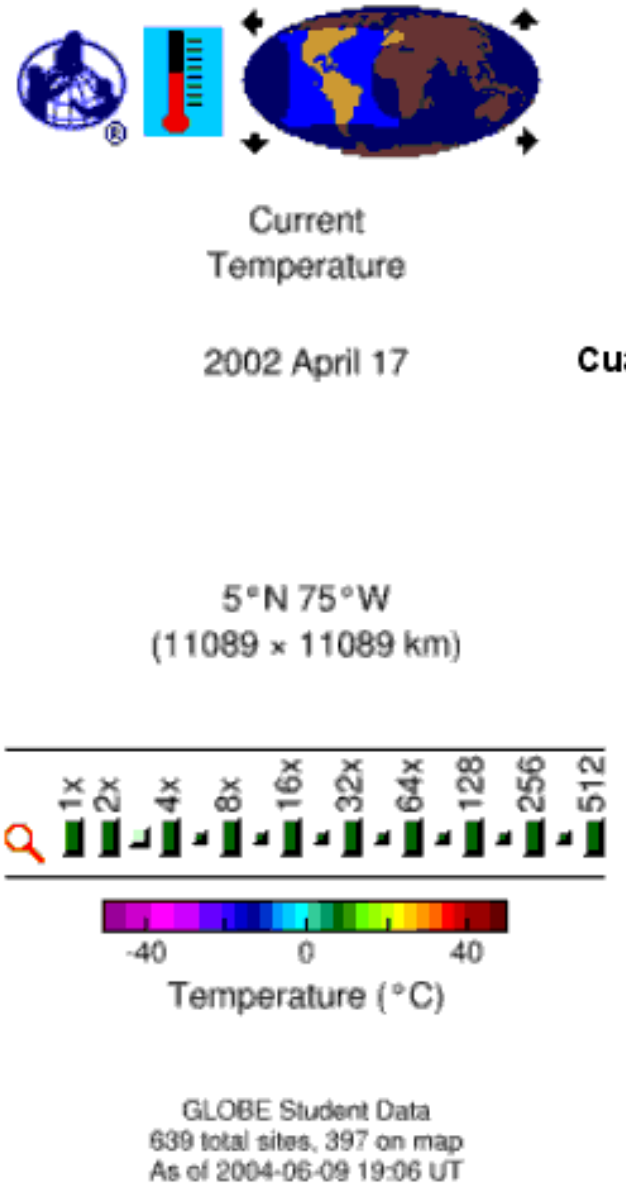
Graph A: Current Air Temperature – the Americas

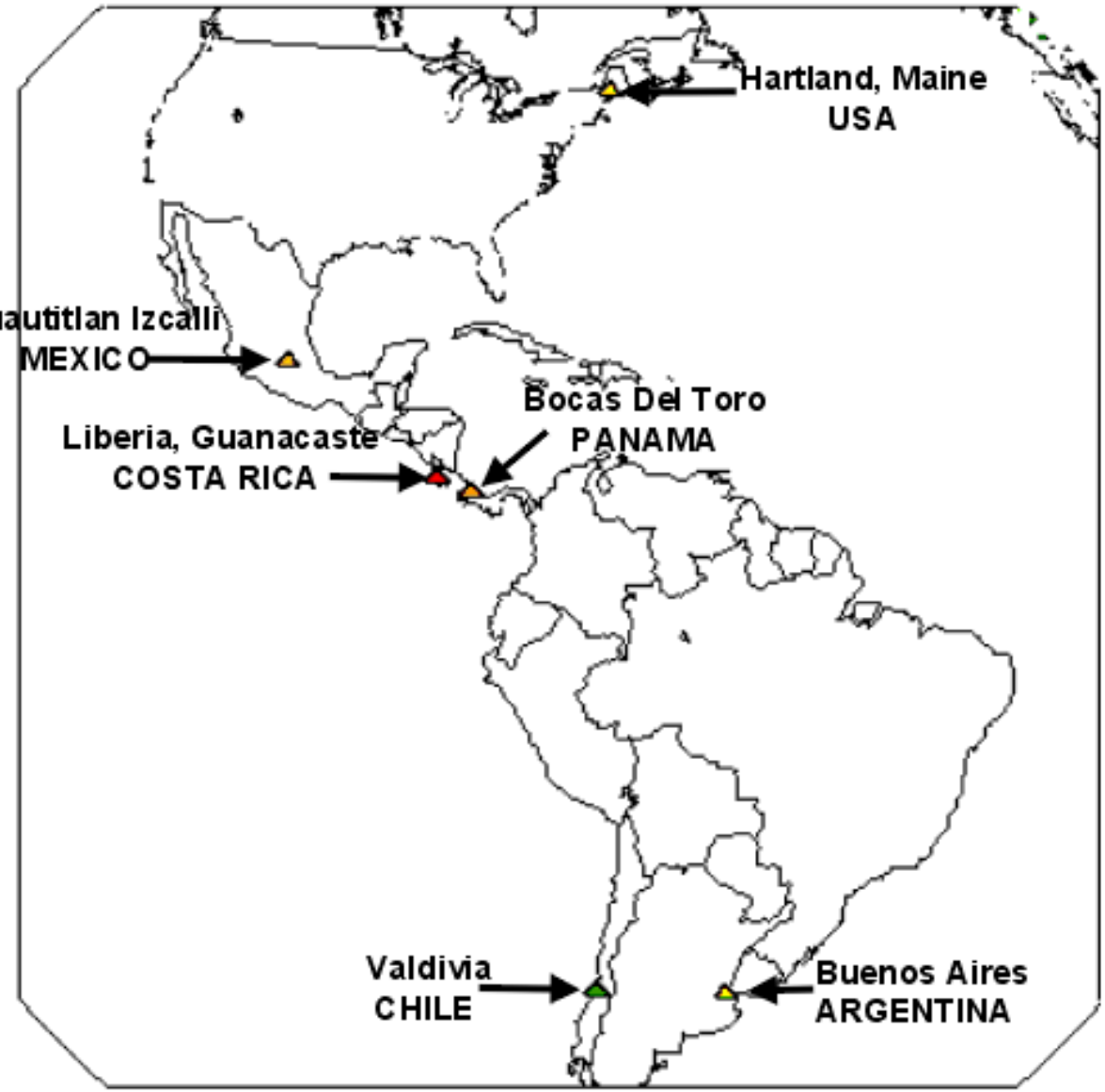


Map A: Current Air Temperature – the Americas

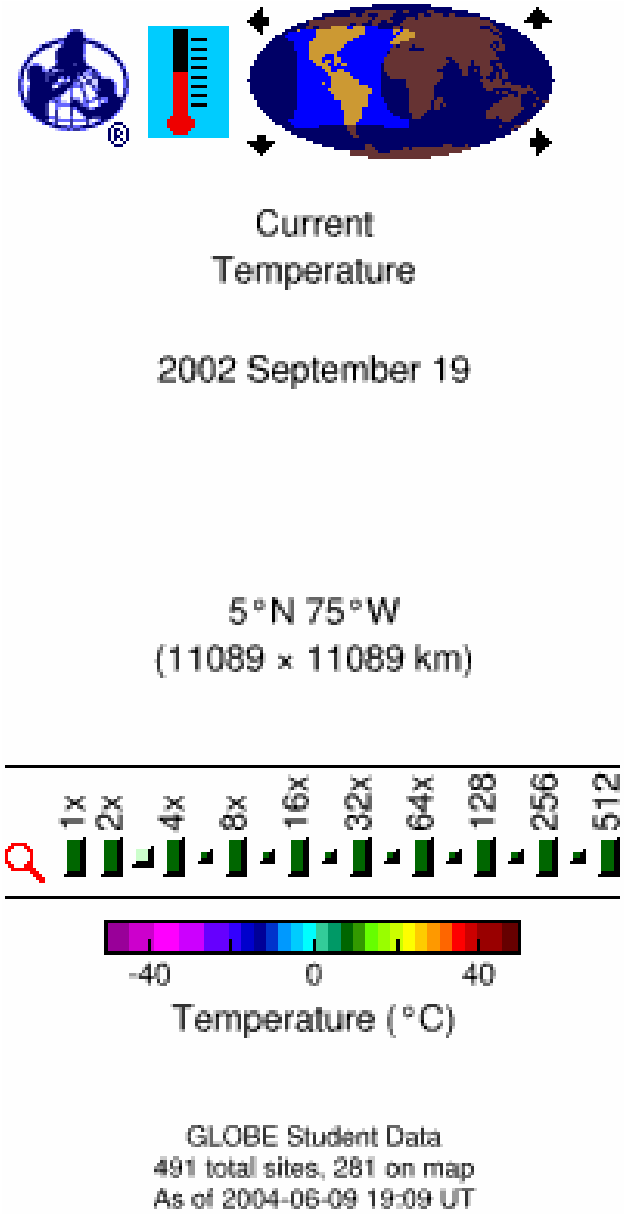


Map B: Current Air Temperature – the Americas





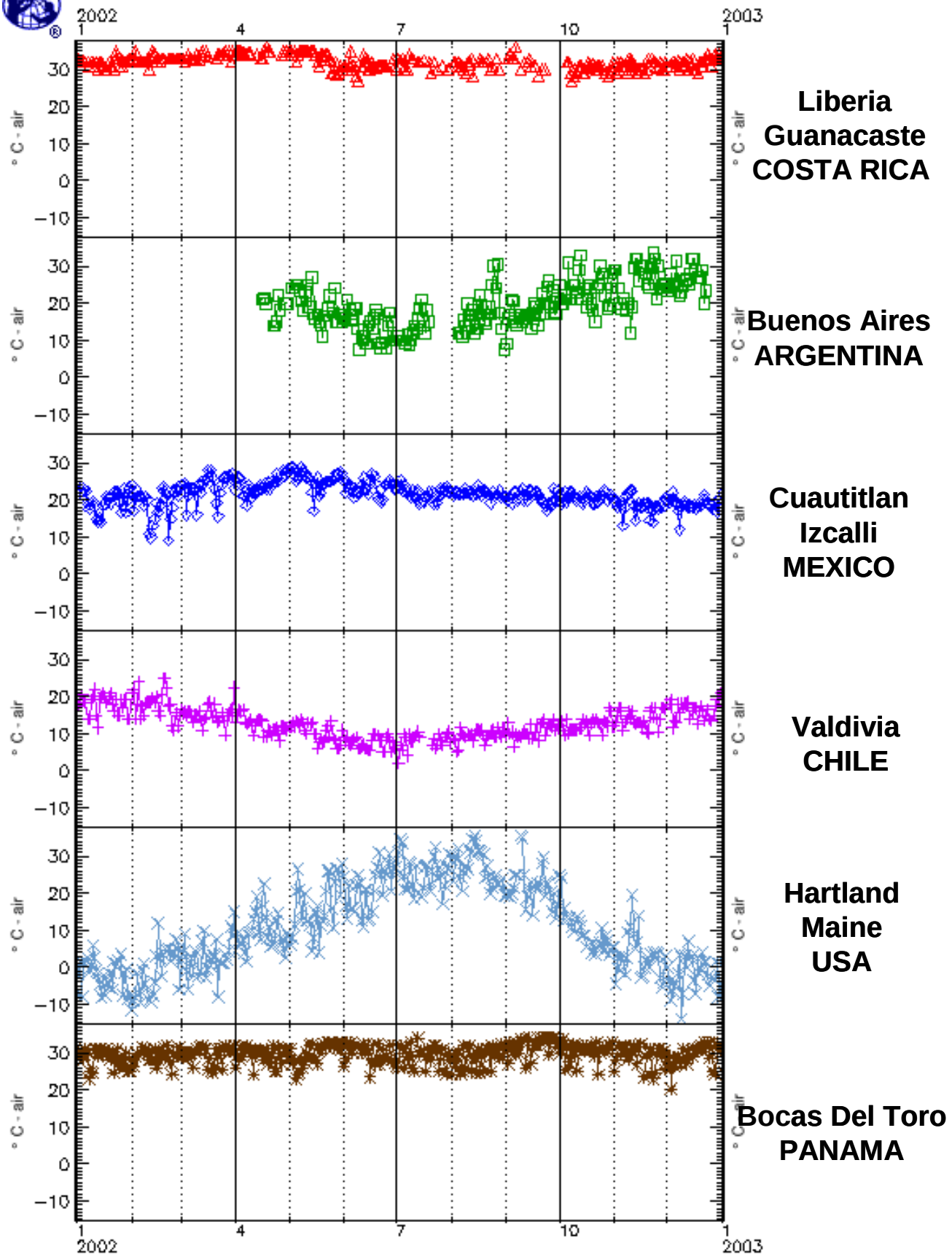
Map C: Current Air Temperature – the Americas



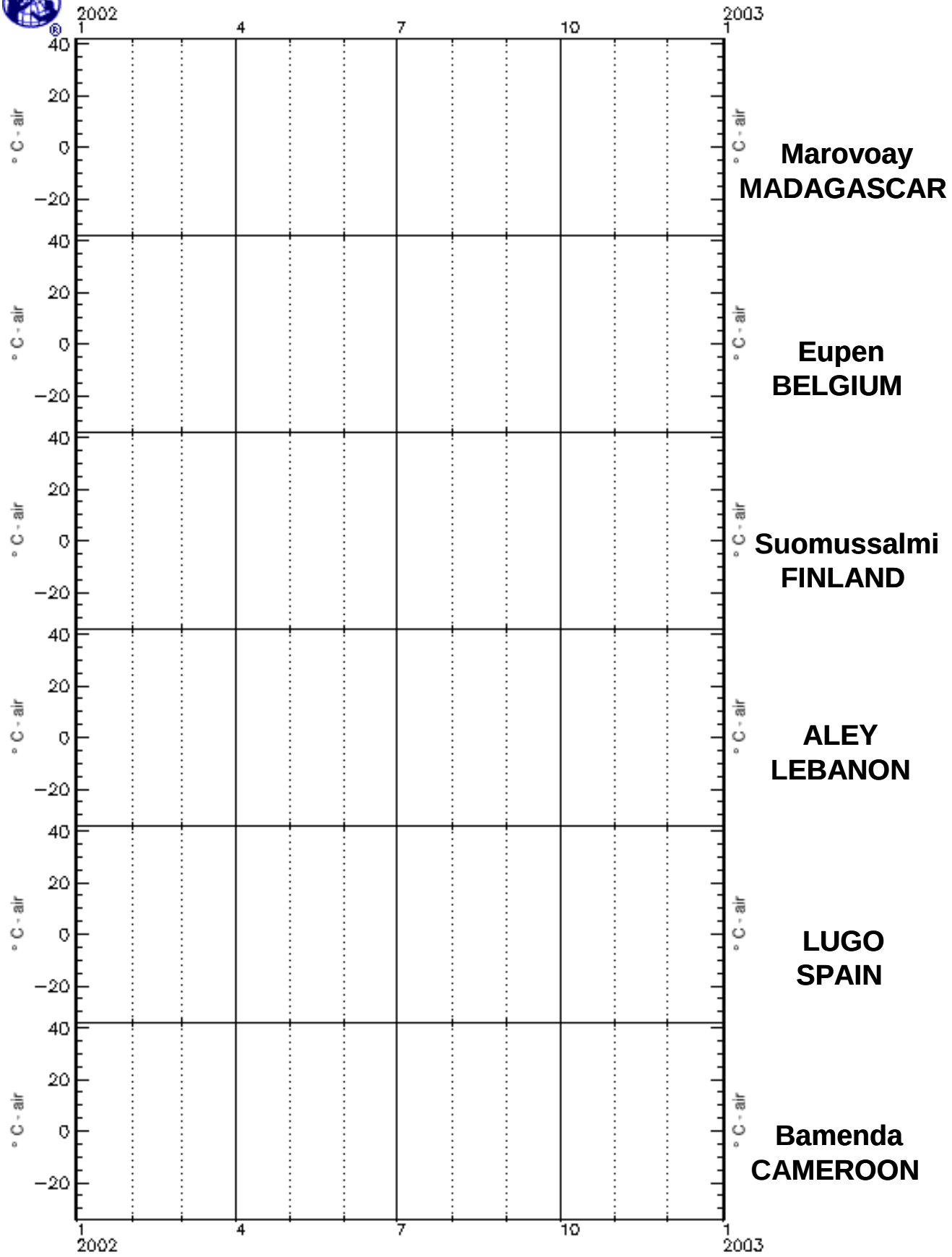
Current Air Temperature Data – the Americas

Date	Guanacaste COSTA RICA	Buenos Aires ARGENTINA	Cuautitlan Izcalli MEXICO	Valdivia CHILE	Hartland Maine USA	Bocas Del Toro PANAMA
1/1/2002	32.5		22	19	-7	29.5
1/15/2002	32		14	20	-8	31
1/31/2002	33		23	14	-7	25
2/15/2002	32		19	20	3	26
3/1/2002	33		24	16.5	2	30
3/15/2002	34.8		25.5	14.5	-3	31
3/31/2002	34		23	22.5	15	32
4/15/2002	33		24	14	7.5	30.5
4/30/2002	35	20	28	11	9.5	31
5/15/2002	35	17	17	10	8	29
5/31/2002	30	15	27	11	28	33
6/15/2002	30	14	21.5	5.5	12.5	30
6/30/2002	31	10	23	6	27	27.5
7/15/2002		21	19.2		19	30.5
7/31/2002			22	7.5	30.5	28
8/15/2002		13	21.5	11	34	24.7
8/31/2002		7.5	21	11	19.5	30.5
9/15/2002	31	13	22.5	12.5	23	27
9/30/2002		21.5	22.5	11.5	17	31.5
10/15/2002	29	24	19.8	12.5	8.5	30.5
10/31/2002	32	28	21	12	5.5	33
11/15/2002	30	26	19	13	14	31.5
11/30/2002	32	25.5	20.5	16.5	3	25.5
12/15/2002	33	32	18	16	3	29
1/1/2003	34.5		22	21.5	1	32

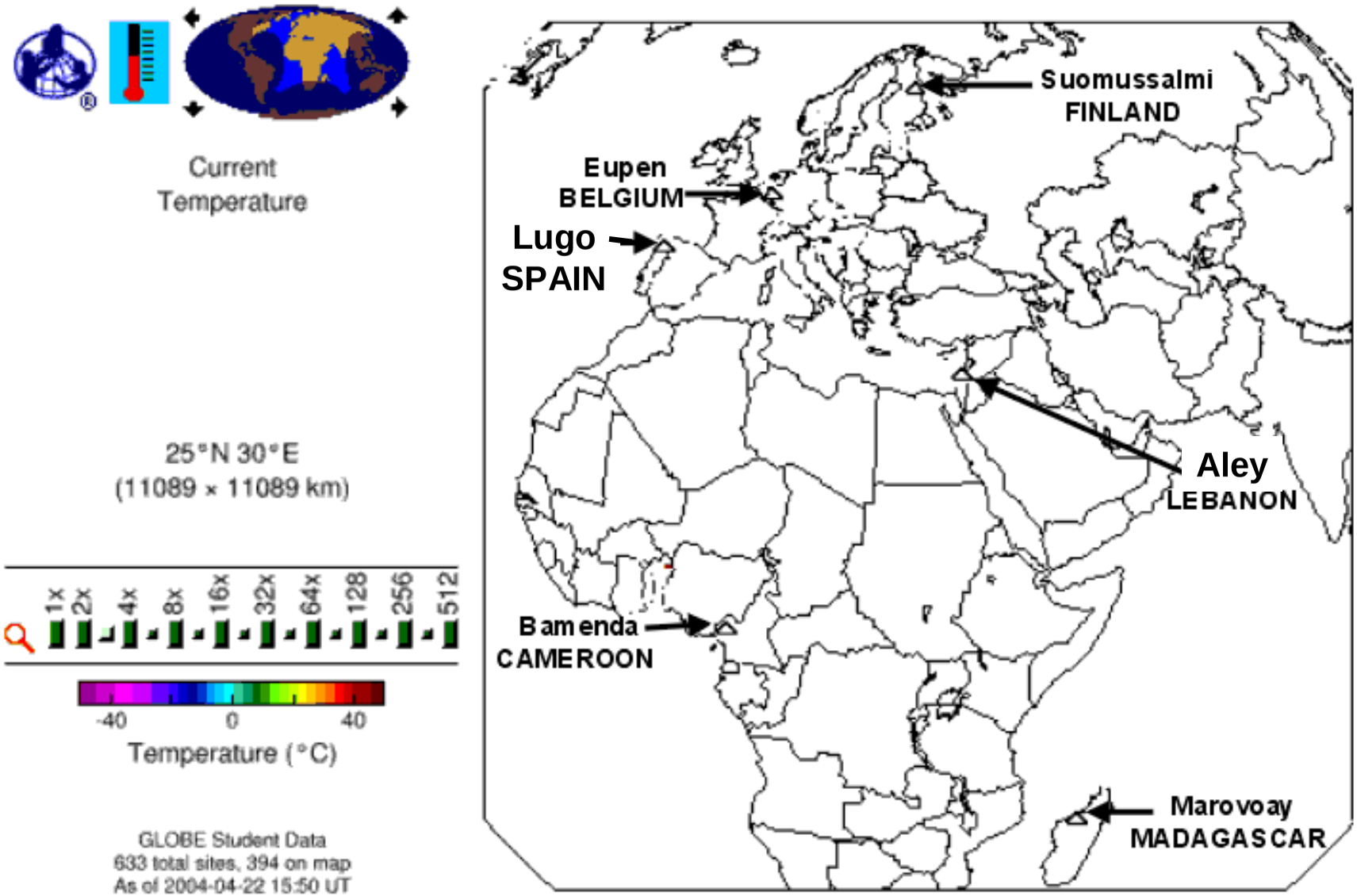
Graph B: Current Air Temperature – the Americas



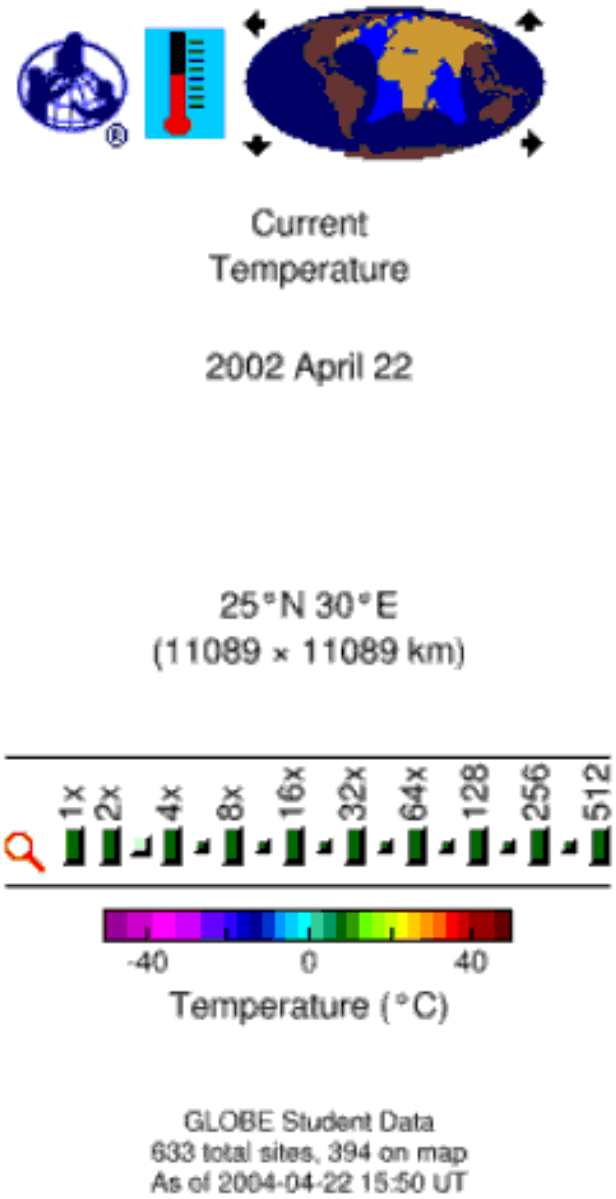
Graph A: Current Air Temperature –Africa, Europe, and the Near



Map A: Current Air Temperature – Africa, Europe, and the Near East



Map B: Current Air Temperature – Africa, Europe, and the Near East

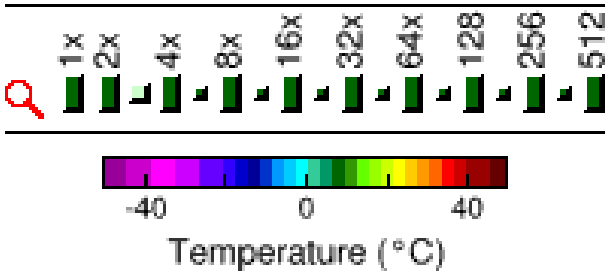


Map C: Current Air Temperature – Africa, Europe, and the Near East

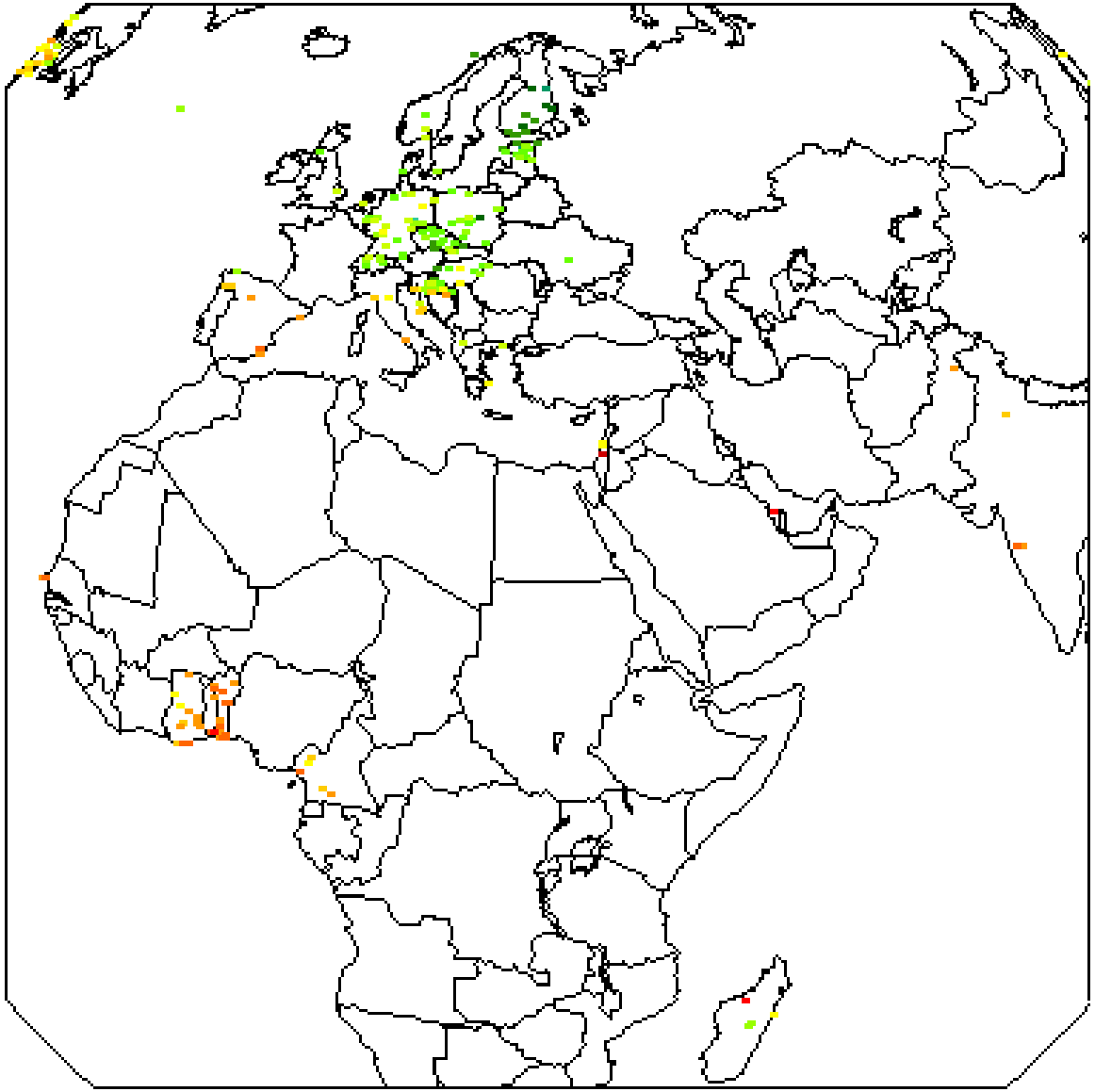
Current
Temperature

2002 September 15

25°N 30°E
(11089 × 11089 km)



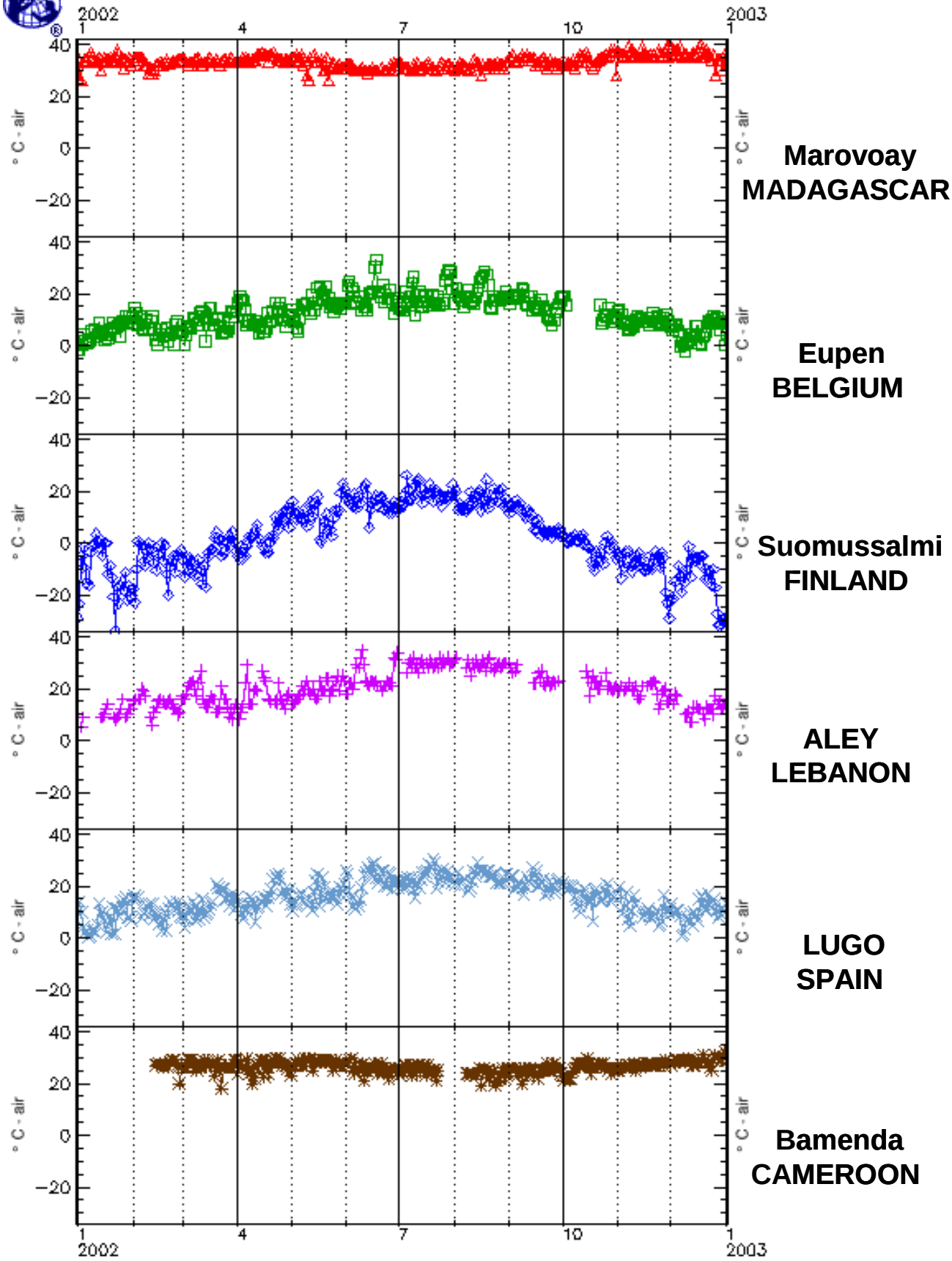
GLOBE Student Data
326 total sites, 238 on map
As of 2004-06-07 23:04 UT



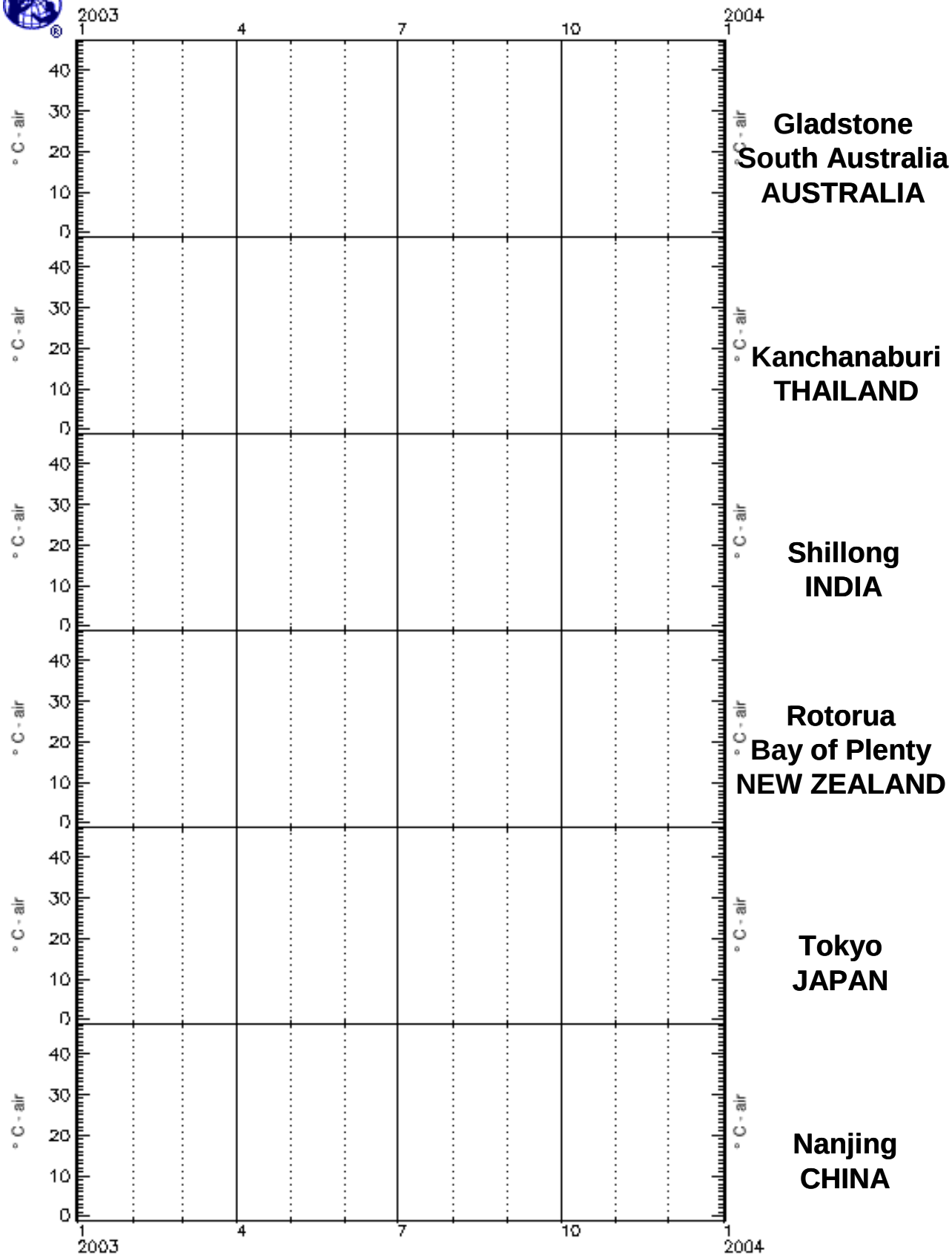
Current Air Temperature Data – Africa, Europe, and the Near East

Date	Marovoay MADAGASCAR	Eupen BELGIUM	Suomussalmi FINLAND	Aley LEBANON	Lugo SPAIN	Bamenda CAMEROON
1/1/2002	35.5	-1.5	-29	5	10	
1/15/2002	33	4.6	-5	9	10.1	
1/31/2002	32	8.6	-20.5	12	6.6	
2/15/2002	32	0.3	-4.5	15	8.3	27.5
3/1/2002	34	5.2	-6.5	17	7.6	26
3/15/2002	34	10.4	-4	13	9.6	29
3/31/2002	33	13.4	-3	14	15.4	29
4/15/2002	37	5.3	-1	27	13.6	29
4/30/2002	33	11.8	6	18	19.2	26.5
5/15/2002	33	16.1	15.5	16	21.9	28
5/31/2002	31	16.6	21	23	20.6	28
6/15/2002	30	19.8	13	23	24.4	26
6/30/2002	32	18.4	12.5	34	19.1	24
7/15/2002	31	16.5	18.5	29	23.6	27
7/31/2002	31	21.7	22.5	30	21.5	
8/15/2002	32	24.6	20	28	26	26
8/31/2002	33	19.2	14		24.4	26
9/15/2002	35	16.2	5	22	24	23
9/30/2002	33	18	4		20.5	24
10/15/2002	35		-2	24	14.2	30
10/31/2002	28	10.4	-6	21		26
11/15/2002	39	9	-9.5	21	8	27
11/30/2002	40	7.6	-29	15	11.5	28
12/15/2002	36	7.6	-6	13	8.5	28
1/1/2003	33	4.9	-30	16	13.6	31

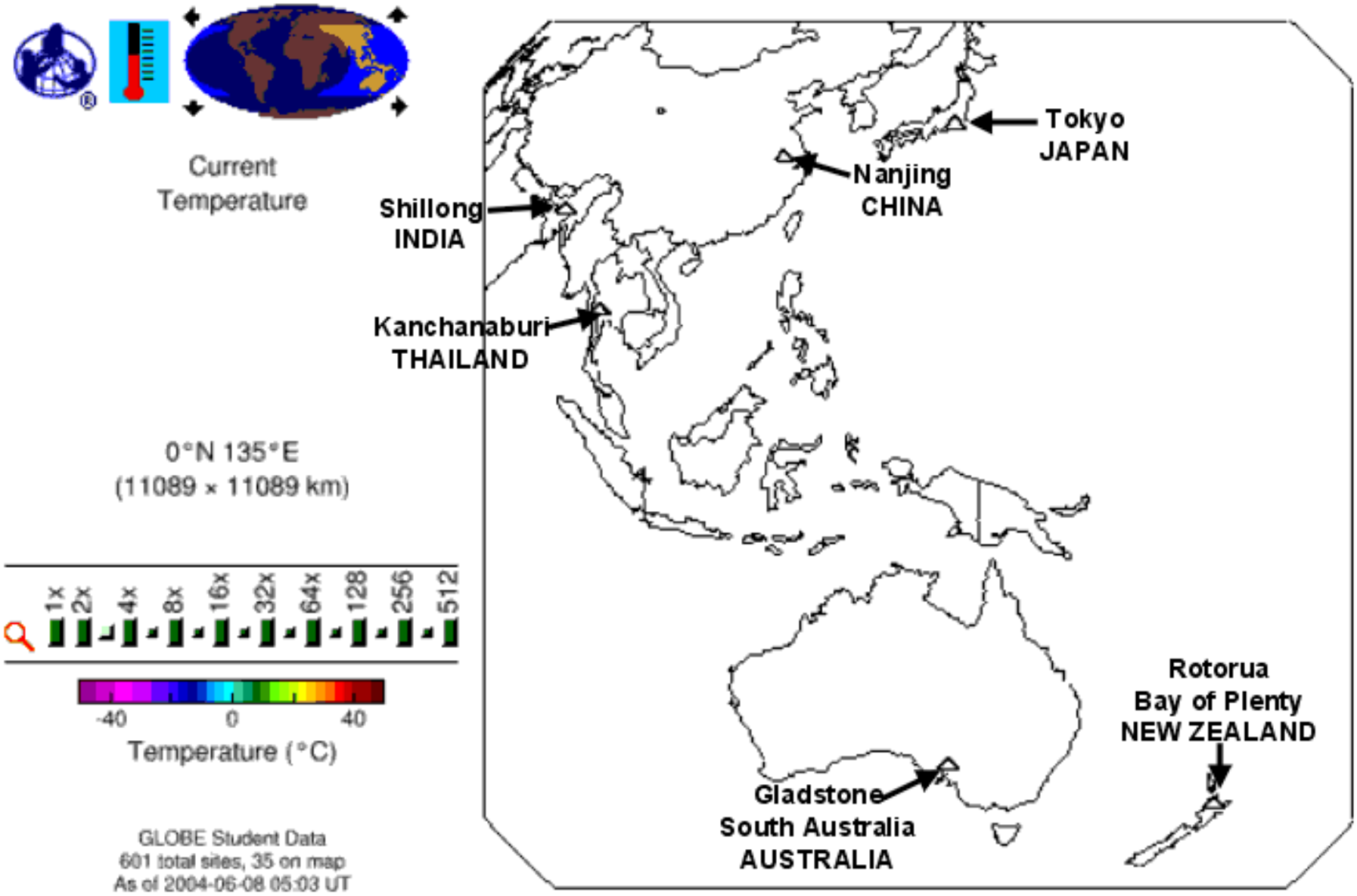
Graph B: Current Air Temperature –Africa, Europe, and Near East



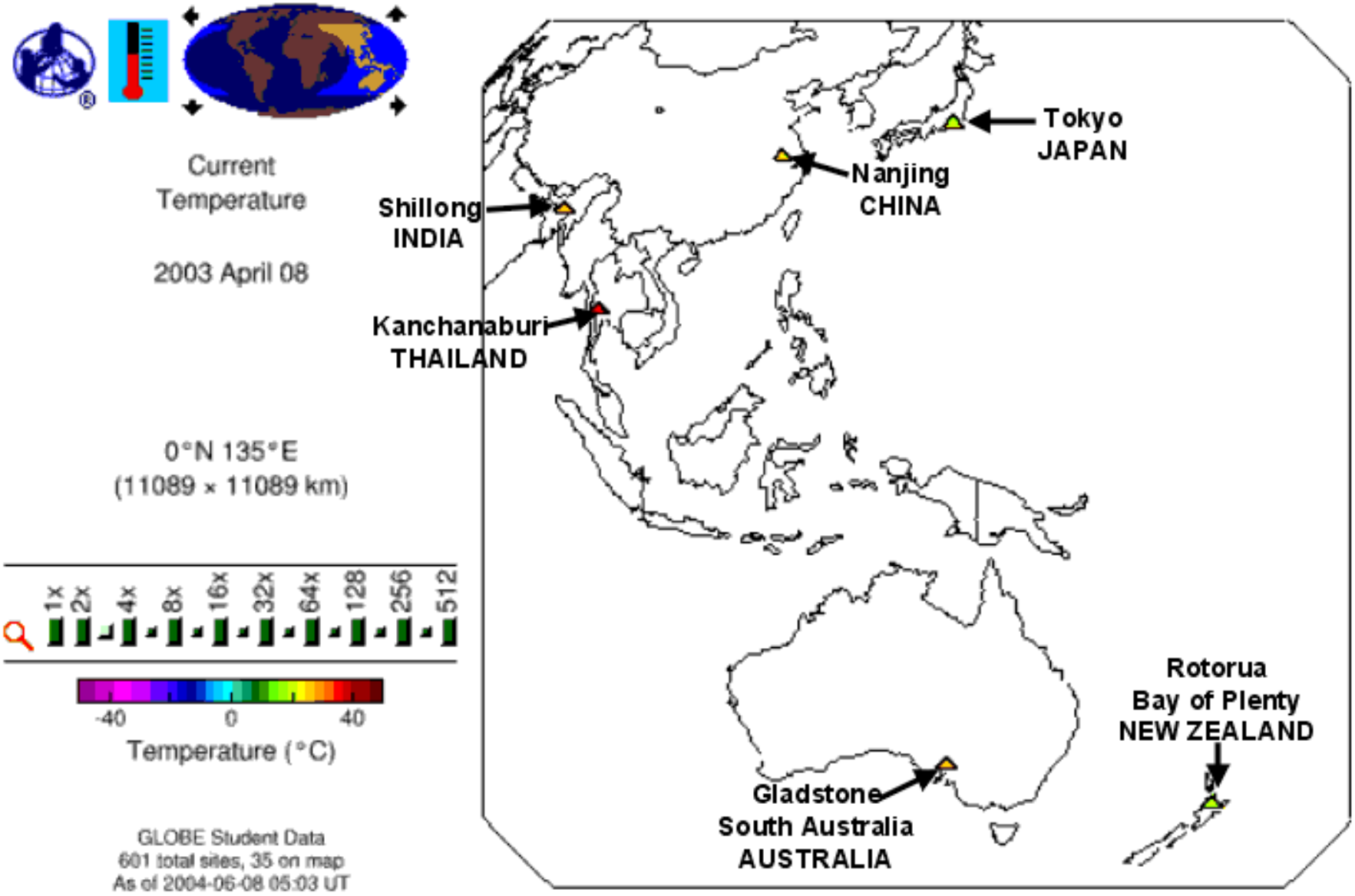
Graph A: Current Air Temperature –Asia and the Pacific



Map A: Current Air Temperature – Asia and the Pacific



Map B: Current Air Temperature – Asia and the Pacific

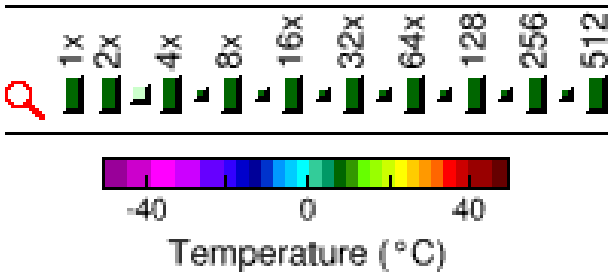


Map C: Current Air Temperature – Asia and the Pacific

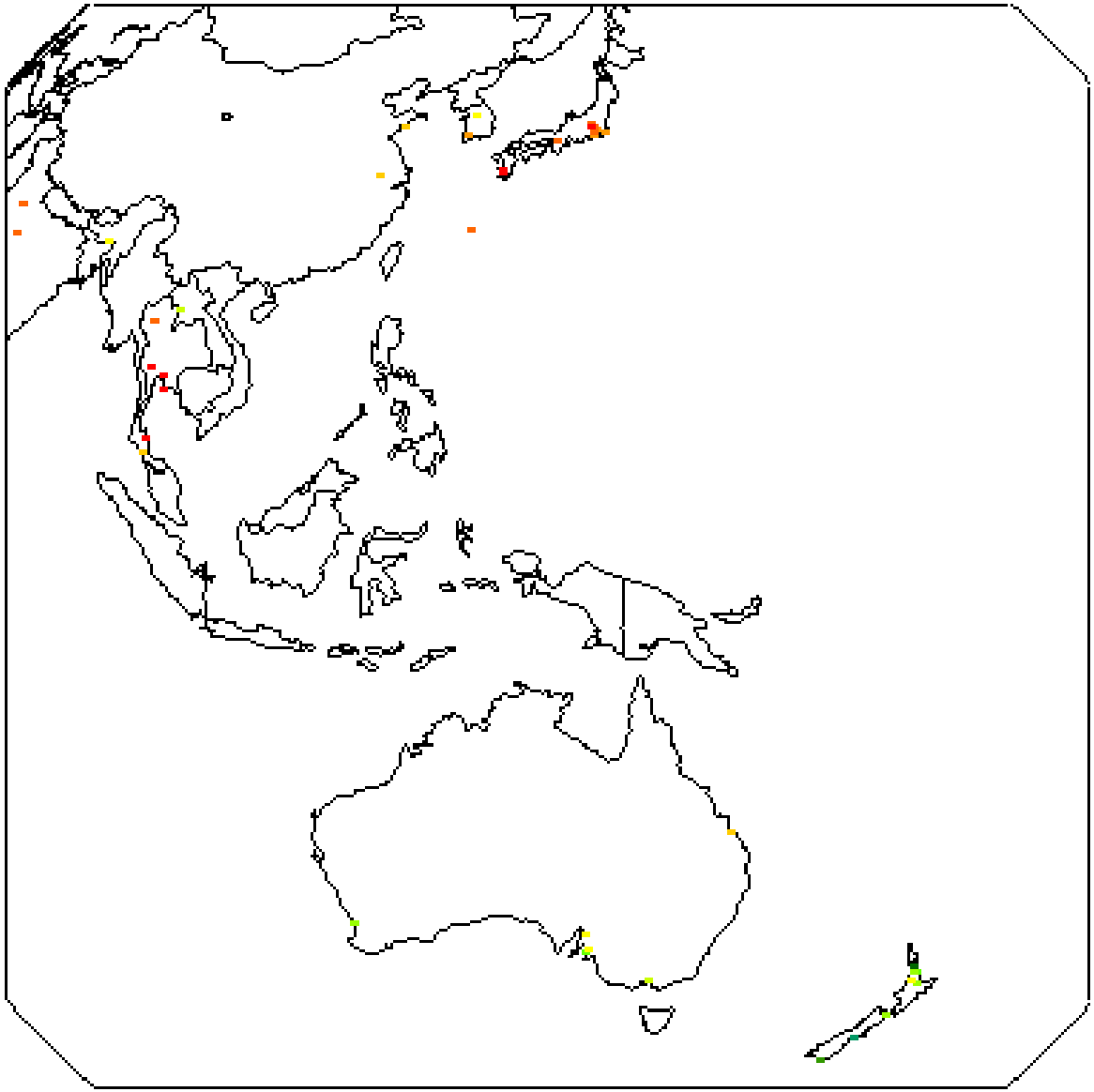
Current
Temperature

2003 September 09

0°N 135°E
(11089 × 11089 km)



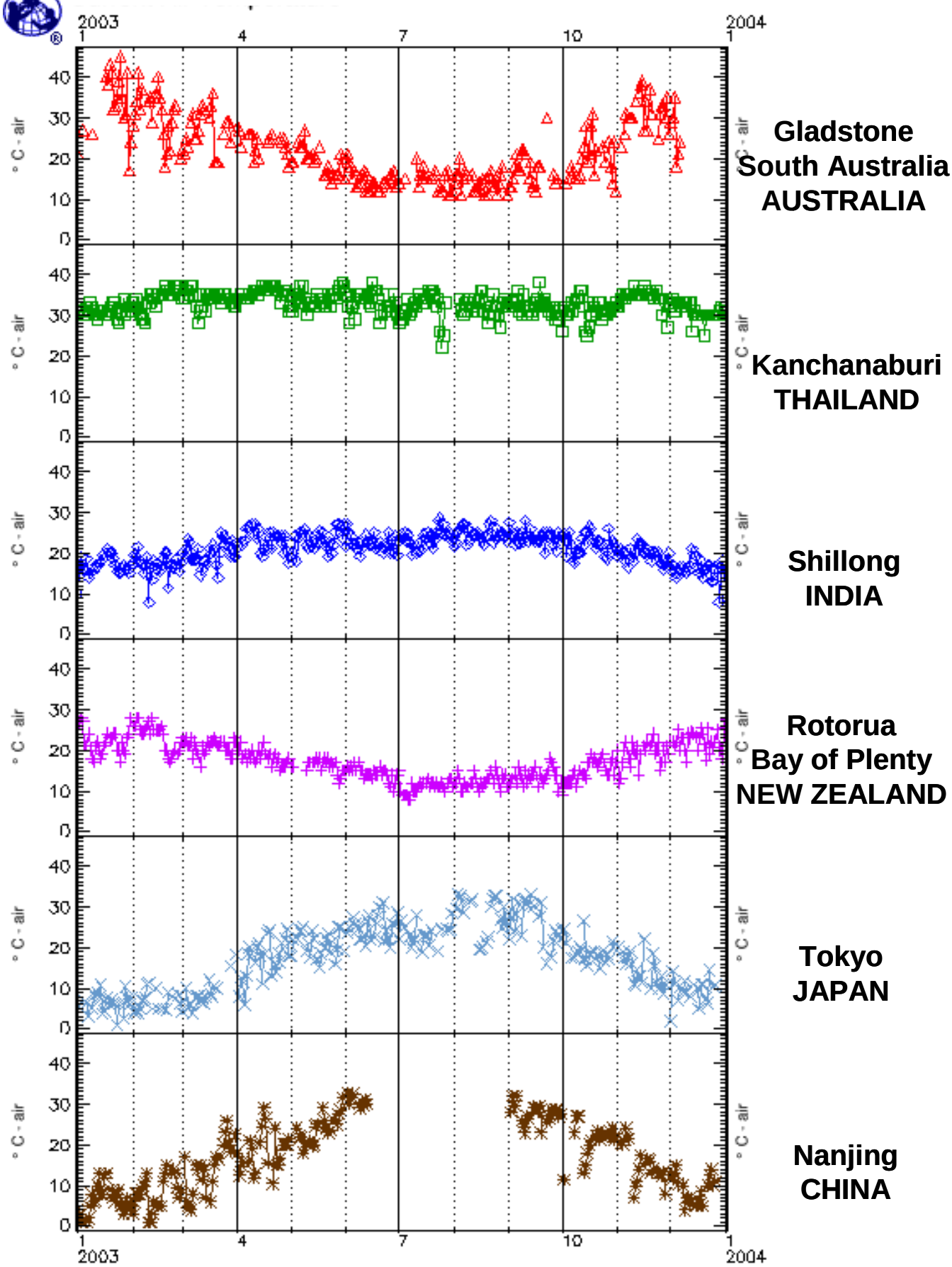
GLOBE Student Data
452 total sites, 42 on map
As of 2004-06-08 05:32 UT



Current Air Temperature Data – Asia and the Pacific

	Gladstone	Kanchanaburi	Shillong	Rotorua BoP	Tokyo	Nanjing
Date	South Australia	THAILAND	INDIA	NEW ZEALAND	JAPAN	CHINA
1/1/2003	21	32	10	25	5.8	4
1/15/2003		31	19.5	19	3.8	8
1/31/2003	24	32	17	28	7.5	5
2/15/2003	40	35	17.5	25		5
3/1/2003	22	34	20	23	4.1	
3/15/2003		34	17.5	22		
3/31/2003		32	19	22	18.2	22.5
4/15/2003		37	19	20	11	24.5
4/30/2003	18	31	17.5	18	18	21.5
5/15/2003	20	32	24.5	18		24.5
5/31/2003	15	37	27	15	19	
6/15/2003	12	32	22	14	22	
6/30/2003	15	30	19.5	14	28.5	
7/15/2003	18	33	24.5	12	22.8	
7/31/2003	12		23	11	28.4	
8/15/2003	14	34	24.5	10	19.5	
8/31/2003	11	33	23	11	25.5	
9/15/2003	14	32	23.5	14	30.2	29
9/30/2003		31	24	12	22	27.5
10/15/2003	19	25	25	17	15.5	18
10/31/2003	12	33	21	17		22
11/15/2003	39	36	22		11.5	
11/30/2003	26	32	20	19		
12/15/2003		30	19	23.5		5
1/1/2004		32	9	27.5		

Graph B: Current Air Temperature –Asia and the Pacific



Just Passing Through Learning Activity

Purpose:

To develop an understanding of some of the relationships between different types of soil and water, including how water affects these different soils when flowing through it.

Overview:

Students time the flow of water through different soils and observe the amount of water held in these soils. Students will also observe the filtering ability of soils by noting the clarity of water before and after it passes through the soil.

Student Outcomes:

- Students will be able to identify some of the physical and chemical changes that occur as water is poured through soil.
- Students will be able to design grade level appropriate experiments that test soil and water properties.
- Students will be able to apply the Scientific method.
- Students will be able to explore the concepts of Earth as a System.
- Students will apply the "re-use" conservation concept by salvaging disposable items for experimentation.

Science Concepts:

Earth and Space Science

- Soil consists of weathered rocks and decomposed organic material.
- Soils have properties including color, texture, structure, and density.
- Water circulates through soil changing its properties.

Scientific Inquiry Abilities:

- Identify answerable questions.
- Design and conduct an investigation.
- Use appropriate mathematics to analyze data.
- Develop descriptions and explanations using evidence.
- Communicate procedures, observations and explanations.

Level:

Primary; however this activity could be enhanced and used as an introduction to soil science for upper secondary. It could also serve as an introduction to experimental design.

Time:

One class period; additional class periods may be necessary if including additional activities (See "Further Investigations"); this activity can also be used as an introductory activity, thereby needing only 15 to 20 minutes.

Materials and Tools:

*Materials needed for each group of 3-4 students**

# of Items	Items
1	1.5-litre clear water bottles (empty)
1	2-litre clear soda bottles (empty)
1	0.5 litre clear water bottles (empty)
1	Panty hose or other material with small mesh size
1	Small rubber bands
1	100 mL graduated cylinder or other volumetric measuring device
500 cm^3 (approximate)	Different types of soil (For example, sand, non-clumping clay cat litter, potting soil, mulch, etc.)
1	Newspaper or small white paper plates
1	Stop watch (or watch with second hand)
1	Scissors

Optional materials for "Further Investigations"
Distilled (or De-Ionized) water
Salt
Vinegar
Baking soda
pH Paper or meter (see Hydrology Chapter of the **GLOBE Teacher's Guide** or manufacturer's instructions for proper use)
Conductivity (TDS) meter (see Hydrology Chapter of the **GLOBE Teacher's Guide** or manufacturer's instructions for proper use)
Alkalinity Test Kit (see Hydrology Chapter of the **GLOBE Teacher's Guide** or manufacture's instructions for proper use)
NPK Test Kit (see Soil Chapter of the **GLOBE Teacher's Guide** or manufacture's instructions for proper use)
Locally-available plant seeds

*Teachers can also present this activity to the class using different soil types in several 2-litre bottles as a whole-class activity.

Prerequisites:

None

Preparation:

Teachers can prepare the materials themselves, or they may direct their students to do the preparation.
Preparation Time: 20 to 30 minutes

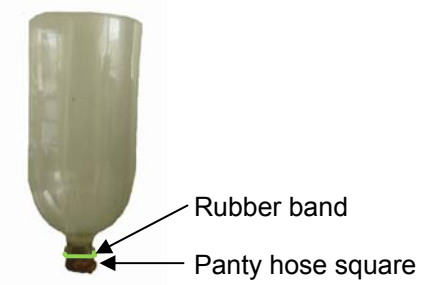
1. Empty and rinse all bottles and remove labels.

2. Cut off bottom of 2-litre bottles, leaving at least 2/3 of the original bottle (**Figure 1A**).
3. Cut off top of 1.5-litre bottles, leaving at least 2/3 of the original bottle (**Figure 1B**).

Cut 2-litre soda bottle (inverted)
Figure 1A

Cut 1.5-litre bottle
Figure 1B

4. Discard (or recycle) bottoms of 2-litre bottles (tops of 1.5-litre bottles can be cut to act as trowels).
5. Cut panty hose into (approximately) 5 cm by 5 cm double-layer squares (by beginning your cutting at the toes of the panty hose, sections can be cut off providing you with immediate double layered pieces).
6. Place each double-layered panty hose section over the mouth of each 2-litre bottle. Slip a small rubber band over each panty hose square and onto the threaded part of mouth of the 2-litre bottle (rubber bands may need to be doubled to provide snug fit). This will ensure that the panty hose section is fastened securely to the 2-litre bottle (panty hose should extend beyond the rubber band and can be tugged on to tighten against the 2-litre mouth). The panty hose will act as a filter (**Figure 2A**).
7. Measure out 100 millilitres of water and pour into the bottoms of the cut 1.5-litre water bottles; mark level of water with a permanent marker; continue until 200, 300, 400, and 500 mL levels are also marked on the bottle bottoms. These will act as beakers (**Figure 2B**).
8. Measure out 100 millilitres of water and pour into the 0.5-litre water bottles; mark level of water with a permanent marker; continue until 200, 300, 400, and 500 mL levels are also marked on the bottles. These will act as graduated cylinders (**Figure 2C**).



Cut 2-litre bottle with rubber band and panty hose square
Figure 2A

Cut 1.5-litre bottle mL levels marked
Figure 2B

0.5-litre water bottle mL levels marked
Figure 2C

9. Choose soil and/or soil-like substances (potting soil, mulch, sand, clay cat litter, etc.) or have substances for students to choose.
10. Set 2-litre bottles into the openings of the cut 1.5 mL bottles (**Figure 3**), panty hose should not be below 500 mL mark.
11. Add soil(s) to 2-litre bottle, panty hose should not allow any substances to spill through. (Note: Amount of soil in 2-litre bottle can be determined by mass, volume, or randomly depending on direction of class or emphasis desired.)

2-litre bottle on 1.5-litre bottle

Figure 3

12. Place a small amount of each soil on small white paper plates or newspaper for students to examine.
13. Fill 0.5 mL drinking water bottles with locally available water.
14. The following table (or one similar) can be created on blank paper, in students' journals, or on the blackboard.

Prediction	Outcome

Procedure:

1. Motivation:

- Present some background information on soil. (See the Introduction of the Soil Chapter of the GLOBE Teacher's Guide; online this can be found at http://classic.globe.gov
- Ask the groups to determine their individual roles; who will record information, who will keep time, who will pour the water.
- Explain to the class that students who have been selected to pour the water will pour the contents of his/her drinking water bottle into the pre-cut 2-litre bottle to see what happens. There is something in the 2-litre bottle (potentially soil of some type) and a double-layer of panty hose to act as screening at the bottom of the pre-cut 2-litre bottle.

2. Student Inquiry:

- Before the students pour the water, have the students (either individual groups or as a class) predict what will happen.
- If students have trouble coming up with predictions, guide them with such questions as "Which substance will allow the first drop of water through?" or "Which substance will retain the most water?" Have the students indicate within their tables their predictions of how the water will act with the various samples.

3. Experimental Design:

- Ask the students what additional parameters they might consider when doing this activity. The following questions might be used to lead students to designing their experiments:

- Does it matter how fast or slow the water flows through the individual bottles?
- What rate should the water be poured into the soil samples?
- How can the stopwatch be used in this experiment? What could they time?
- Will the amount of water that flows through the soil samples vary? How can they measure this?

- Ask the students how the water should be poured. Does it matter if water is or is not poured at the same rate? This discussion can lead into the importance of following a measurement protocol – good for schools implementing GLOBE. If students are in disagreement or are not certain if it matters, suggest that a common rate of pouring be established. Once a rate has been established, have the students pour the water (as determined) into the pre-cut 2-litre bottles. The students should pour water so as not to obstruct observation by other students. Table/chair arrangements may need to be slightly modified prior to this activity to allow maximum viewing. Allow the groups time to make observations. ***Recording Observations:***
- Have students record their observations in the "Outcome" section of the table. Ask if there were any surprises. Explain that unexpected outcomes do not mean incorrect questions or hypotheses. Rather, many scientific discoveries are not expected. Explain that this activity helps to model the properties of different soils – however, these soils have been disturbed. Interaction between soil and water in the natural environment may be different. This could facilitate interest in studying soil.

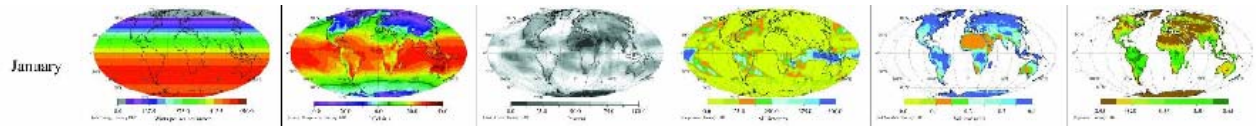
5. ***Further Investigations:***
   - Ask if there are any questions or further investigations that could come out of this. For example, "Would the same results occur the next day? Why or why not?"
   - Add salt, vinegar, and baking soda to different samples of distilled water, mix. Have students predict and measure the conductivity, pH and/or alkalinity of the water before it is poured and after it has filtered through the soil. Discuss how these characteristics, pH, alkalinity and presence of dissolved salts, affect soil, plants and animals.
   - Discuss soil nutrients that plants use, mainly N, P, and K (Nitrogen, Phosphorous, and Potassium). Using an NPK Kit, measure the amount of N, P, and K in various soils before and after activity. Compare soils and NPK values of the region. How do agriculture specialists address differing amounts of N, P, and K in different soils?
   - Plant the same locally-available seeds in each of the soil types used in this activity. Providing the same amount of water, which soil promotes the best seed germination and plant growth? Discuss how plants around the world have adapted to different soils, differing amounts of water and nutrients.

6. ***Extensions:***

   Ask students the following questions to relate this activity to the ecosystem:
   - How does this activity model the natural environment?
     - How are different environmental concepts represented in this activity?
       - How is precipitation represented? How is soil represented?
   - How might different factors in the soil or water affect plants or animals in the soil?
   - How might plants or animals affect the soil?
   - How might an increase or decrease in temperature or humidity affect the properties of the soil? The water? The plants and animals?
   - Ask students to describe the path of an imaginary drop of water from the bottle to the soil and beyond. How does this drop of water fit into the Hydrologic Cycle?

Earth as a System Learning Activity

Activities to accompany the GLOBE Earth System Poster



Purpose:

To identify global patterns and connections in environmental data contained in the GLOBE Earth Systems Poster; to develop an understanding of the interactions of Earth systems.

Overview:

Maps displaying global environmental data through the course of a year are compared in order to understand how the Earth works as a system.

Student Outcomes:

Science Concepts

Earth and Space Science

- Students will be able to explore the concepts of Earth as a System.
- Students will be able to find patterns and connections between and among maps containing different environmental data.
- Students will understand the relationship between time and space in regard to global environmental data.

Scientific Inquiry Abilities:

- Discover, analyze, and interpret patterns in a graphic display of data.
- Analysis of mapped data.
- Develop descriptions and explanations using evidence.
- Communicate observations and explanations.

Level:

Secondary

Time:

One to two class periods.

Materials and Tools:

- One "GLOBE Earth System Poster." This poster can be found on the GLOBE Web site at <**www.globe.gov/page?earth_system**>.
- Scissors

Background:

The processes comprising the global environment are interconnected. Understanding how these connections operate on a global scale is to understand the Earth as a system. Understanding the Earth as a system requires a quantitative exploration of the connections among various parts of the system. These processes take place in the atmosphere, oceans, fresh water, ice, soil, and vegetation. These processes also include energy from the Sun and the gases and particles that enter the atmosphere and oceans from both space and layers of molten and solid rock beneath the Earth's surface.

The following activities will help students to understand variations in environmental parameters by examining connections among different phenomena measured on local, regional and global scales. As students look at the connections between and among environmental data, they will gain a perception that the environment is the result of the interplay among many processes that take place on varying time and spatial scales.

Preparation:

Cut the GLOBE Earth System Poster into:

- The 36 global data maps:
  6 – Solar Energy; 6 – Average Temperature; 6 – Cloud Cover; 6 – Precipitation;
  6 – Soil Moisture; 6 – Vegetation
- The 6 Data type labels (Solar Energy, Average Temperature, Cloud Cover, Precipitation, Soil Moisture, Vegetation)
- The 6 Month labels (January, March, May, July, September, November)

Note: Lamination of the various maps and labels can ensure many uses.

Procedures:

Activity 1 – Exploring a Single Map

1) Arrange students into 6 groups (preferably no more than 4 students in a group).
2) Provide each student with one global data map corresponding to the data type labels as shown in the table below (I.e., each student in Group One receives a global data map of Solar Energy, each student in Group Two receives a global data map of Average Temperature, etc.):

GROUP	Data Type Label
One	Solar Energy
Two	Average Temperature
Three	Cloud Cover
Four	Precipitation
Five	Soil Moisture
Six	Vegetation

3) Ask students to study and interpret their data maps.
4) Ask the six groups, one at a time, to share with the entire class the information provided on their data maps. Use the following guiding questions:
   - *What is the range of values shown on the scale bars on each map?*
   - *Where in the world do you find the highest and lowest values of the data on your map? Where are the extremes? Why do these locations experience the extremes and not other locations?*
   - *Are any patterns in the data noticeable? Are patterns different on different continents? Different over water than over land? Explain these patterns.*

Activity 2 – Exploring Annual Changes in a Data Type

1) Distribute all global data maps of each data type to groups designated in Activity 1.
2) Have groups arrange their maps in chronological order, beginning with January.
3) Ask groups to identify annual cycles for their data type. Use the following guiding questions:
   - *What changes do you see through the year? What seasonal changes and annual cycles emerge? What explanations can you suggest for these patterns?*
   - *Choose a location or region. During which months do the extreme highs and lows occur? What explanations can you suggest for the timing of those extremes?*
   - *Which regions experience both the extreme highs and lows? Which regions don't experience the extremes? Why do you think this occurs?*
   - *What differences, if any, do you find between the year's variations over the oceans versus the year's variations over the continents?*
   - *Are there regions that remain relatively unchanged over the year? Why do you think this occurs?*
4) After several minutes, ask the groups to share with the entire class their discoveries of patterns and their interpretation of those patterns.

Activity 3 – Exploring Relationships Between Two Data Types
(Follows Activity 2)

1) Instruct groups to come together in the following pairs:
   - Group One (Solar Energy) with Group Two (Average Temperature)
   - Group Three (Cloud Cover) with Group Four (Precipitation)
   - Group Five (Soil Moisture) with Group Six (Vegetation)
2) Have groups arrange their data maps in chronological order for each data type.
3) Have groups line their data maps next to each other (January next to January, etc.).
4) Ask groups to identify the relationships and associations between the data types. Use the following guiding questions:
   - *What relationship do you see between solar energy and average temperature? Cloud cover and precipitation? Soil moisture and vegetation?*
   - *Are the relationships proportional or inverse?*
5) After several minutes, ask groups to share with the entire class the relationships they have identified between the two data types. Have them also share the methods they used to identify these relationships.

Activity 4 – Exploring Relationships Among Data Types for a Particular Month

1) Collect all data maps from the groups.
2) Ask students to reform their 6 original groups (See Activity 1, Step 1).
3) Distribute the Month labels to each group as shown in the following table:

GROUP	Month Label
One	January
Two	March
Three	May
Four	July
Five	September
Six	November

4) Redistribute the global data maps to groups according to month. Groups receive all six data types for their month.
5) Ask students to identify relationships among data for each month. Use the following guiding questions:
   - *Which regions experience the extreme highs and lows for each data type?*
   - *Which regions don't experience the extremes? Why do you think this occurs?*
   - *What differences, if any, do you find between variations of data types over the oceans versus variations in data types over the continents?*
   - *What amounts of solar energy, temperature, cloud cover, precipitation and soil moisture characterize the world's most vegetated regions for a particular month?*
6) After several minutes, ask groups to share with the entire class their discoveries of patterns and their interpretations of those patterns.

Activity 5 – Exploring Relationships Among Data Types Six Months Apart

1) Instruct groups to come together in the following pairs:
   - Group One (January) with Group Four (July).
   - Group Two (March) with Group Five (September).
   - Group Three (May) with Group Six (November).
2) Have groups line their global data maps next to each other by data type (Solar Energy January next to Solar Energy July, Average Temperature January next to Average Temperature July, etc.).
3) Ask students to identify the changes that occur in the data types over the six-month period. Use the following guiding questions:
   - *What data types have the largest variations over the six-month period? The smallest variations? Why do you think this is occurring?*
   - *Do you see any relationships among the data types that you didn't see previously?*
4) After several minutes, ask groups to share with the entire class the relationships they have identified among the data types. Have them also share the methods they used to identify these relationships.

ASSESSMENT

Assessment Activity – Applying the Data

1) Have students look at data types that are six months apart, or have them look at all the global data maps put in order by data type and month (they could also look at an uncut GLOBE Earth System Poster).
2) Ask them to use the global data maps or the Earth System Poster to answer the following questions:
   - *If global cloud cover were reduced by 25%, what changes would you predict for the equatorial region of Africa? Why would you predict those changes?*
   - *Choose a location where you would like to go on vacation. What is the best month to visit that location? Why?*
   - *If you were to go on vacation in May, where would be the best location for your trip? Answer the same question for the other 5 months available.*
3) Have participants justify their answers by referencing the specific data types and months that helped them formulate their responses.

EXTENSION

Extension Activity – Sequencing Annual Changes in a Data Type

1) Cover the dates on the global data maps.
2) Distribute the data maps (in random order) by data type to groups of students.
3) Ask students to arrange the maps in order.
4) After several minutes, ask students to share with the entire class the methods and patterns they used to place the maps in order without date information.
5) Have students uncover the dates on the maps to check their order. Have them discuss the difficulty or ease of arranging the data maps.

GLOBE has recently developed a new Earth System Poster utilizing 2007 satellite imagery from NASA's Earth Observations (NEO) Web site. For this new poster, activities guide and other Earth system resources, visit: <**www.globe.gov/page?earth_system**>.

Comments on "Understanding GLOBE Student Data"

Comments from NASA Reviewers:

"Compelling need – answers the question, 'What can we do with the GLOBE data?'"

"The lessons and inquiry-based approach hit the heart of the goals of NASA ESE Education program."

"Product meets NASA directives – provides activities using GLOBE data to support Inquiry, includes hands-on labs and requires little (or inexpensive) additional resources. Excellent!"

"The content is useful and reliable and meets teachers' needs as well as NASA's. …it's very interesting to students – they get to work with data collected by other students around the world. It heightens their interest in STEM studies."

"Excellent extensions and open ended investigations."

"Teacher sheets are great – showing what the students should find and listing a variety of possible responses."

"Overall I think these will make a good contribution to atmospheric learning in the US and possibly the world."

"This data-based and interactive approach is essential to NASA ESE objectives."

"This manual clearly is written by a scientist experienced in the analysis of complex datasets."

"This tutorial is quite useful as a basis to analyze (and quality-control) GLOBE data, and thus an excellent teaching/learning resource…."

"The activities are interesting; they draw upon the compelling nature of Earth system science to promote student achievement and enrollment in STEM. They also engage students in shaping and sharing the experience of NASA's exploration and discovery as [they] work with data collected worldwide."

"…offers students a first-hand opportunity to develop an interest in STEM careers."

Comments from Practitioners:

"As a trainer for GLOBE, your materials are my most important tool. We have several new teaching tools but it was your toolkit that most helped me as a new GLOBE trainer."
Mr. Todd Ensign, GLOBE Partner Coordinator, NASA IV&V Facility, WV, USA

"Your work is clearly the type of curriculum support that is needed in our schools."
Dr. Allan Ludman, Director, GLOBE NY Metro, Queens College, NY, USA

"This [is] an excellent tool for teachers to use with their classes. I would feel comfortable giving them to my middle school students and having them work independently through it."
Mr. Bill Meyers, GLOBE Teacher, Alexander Dawson School, CO, USA

"The use of GLOBE data to inspire students to collect more data and conduct their own analysis is a crucial part of the GLOBE program."
Mr. Frank Niepold, NOAA Climate Program Office

"These student data activities are some of the most authentic activities I have ever used. They require students to apply what they have learned using GLOBE and integrate that knowledge with geography and climate to critically use data."
Dr. Michael Odell, GLOBE Partner Coordinator, University of Texas at Tyler

"The science of the activities is outstanding; I wish I'd had activities like these when I was teaching my undergraduate lab!"
Dr. Matt Rogers, Stephens Research Group, Colorado State University

"This is a home run! 'In Search of' is well written and organized for both teacher and student. I've used it three times now and it is fantastic. 'Where in the World' is another phenomenal activity…the results exceeded my expectations. I will definitely use these activities again."
Mr. Stefan Smolski, GLOBE Teacher, Oak Glen High School, New Cumberland, WV, USA

"I recently did a short workshop at a climate change conference and did some of the activities. They all thoroughly enjoyed it! One participant commented, 'This session was so enlightening - I'm a changed man.'"
Ms. Suzanne Welch, Training Coordinator, GLOBE in the United Kingdom

About the Author

Gary Randolph has been with the GLOBE Program Office since February 1997. Prior to this, he worked as environmental educator for the International Society for Endangered Cats, Inc, from 1989 to 1993, after which he served as Peace Corps Volunteer in the Czech Republic at Krkonoše National Park and Biosphere Reserve, Centre for Environmental Education and Ethics at Rýchory, and Ekocentrum Pardubice. Gary extended his Peace Corps service for a third year to assist TEREZA Association, the Country Coordinating organization for GLOBE in the Czech Republic, in the development of the GLOBE Program in the Czech Republic. Upon returning to the United States in late 1996 he was offered a position at GLOBE Program Headquarters in Washington, D.C., where he worked as Training Coordinator and U.S. Partner Liaison. Gary was offered the position of Desk Officer for Europe and Eurasia as well as support person for Education and Science projects when GLOBE Program headquarters relocated from Washington, D.C. to Boulder, CO in 2003. Gary currently serves as the GLOBE Earth System Science Team Lead and Educational Designer on the GLOBE Education and Science Team.

Gary has a B.S. in Natural Resources and a M.S. in Environmental Studies and over twenty years experience in environmental education.