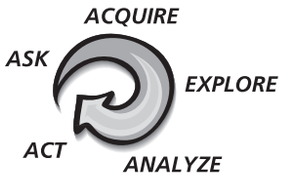
NAME _____ DATE _____

Sibling Rivalry

An advanced investigation

Note: Due to the dynamic nature of the Internet, the URLs listed in this lesson may have changed, and the graphics shown below may be out of date. If the URLs do not work, refer to this book's Web site for an updated link: www.esri.com/mappingourworld.



Answer all questions on the student answer sheet handout

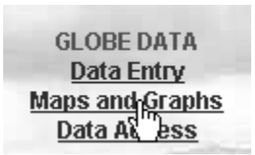
Every two to seven years, the climatic phenomenon El Niño occurs over the tropics just south of the equator and off the western coast of Central and South America. In this GIS Investigation, you will record your observations of this event and identify characteristics of both El Niño and its counterpart, La Niña.

Step 1 Visualize and acquire GLOBE data

The GLOBE program (Global Learning and Observations to Benefit the Environment) is a joint effort between several U.S. agencies: NASA (National Aeronautics and Space Administration), NSF (National Science Foundation), and the U.S. State Department, along with more than 100 other countries, to bring real-world environmental science into the classroom. The data that is displayed at the GLOBE site is a combination of the work of students and scientists from around the world using everything from the naked human eye to satellites to make their observations. GLOBE has a special series of maps dedicated to El Niño and La Niña. You will create your maps online and then download the images into ArcMap for further analysis.

a Go to the GLOBE home page on the Internet at www.globe.gov and click **Enter the GLOBE Site**.

b Under **GLOBE DATA**, click **Maps and Graphs**.



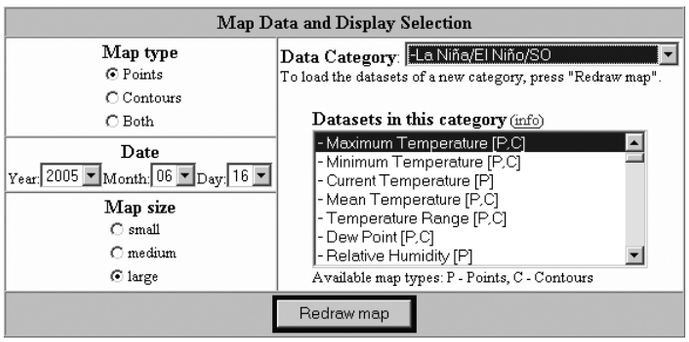
c **click the GLOBE Maps link.**

GLOBE Maps	Student and reference data
GLOBE Graphs	Time plots of student data
Diurnal Graphs	For measurements taken more than once per day
GLOBE Sites	Special visualizations of individual GLOBE experiment sites.
Search	Search for schools to map or graph
What's New?	Map and graph enhancements, shapefiles!
Features	Highlighted features of the visualization website
Image Gallery	Additional visualizations related to GLOBE
GLOBE PVA	Personal Visualization Archive - create collections of GLOBE images

The Globe Maps page opens and you see options to click and create your own map.

d **Change the following parameters to create your map:**

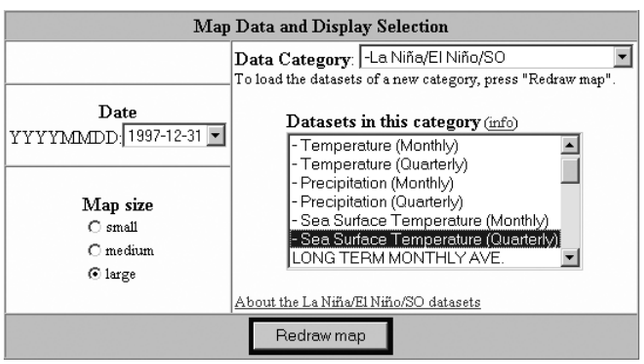
- **Change the Map size to large.**
- **Change the Data Category to La Niña/El Niño/SO**



e **Click the Redraw Map button** Redraw map.

Now you see the default map for this particular data source. It is the El Niño Predicted Temperature Anomaly for the month ending March 31, 1999. This is the default map because the winter of 1998–1999 was determined to be an El Niño year. You will change the map parameters so you get a map for sea surface temperatures.

f **Scroll down and change the map parameters to match the settings in the graphic below.**

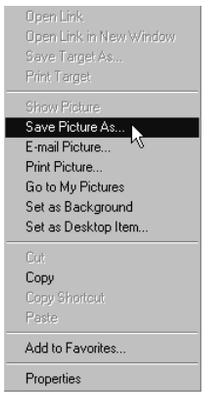


g Click the Redraw map button Redraw map.

An anomaly means any significant variation from the norm. In this case, the map shows any deviation from the normal average quarterly sea surface temperatures. Any temperature that is within the normal range is identified by the color gray on the map. Temperatures that are above normal are identified in the color range of yellow-orange-red. Temperatures that are below normal are in the color range of aqua-blue-purple. A color legend is located at the top left-hand corner of the map image.

In order to se this map image in ArcMap, you need to save it.

h Right-click on the map image. If you don't see the Save Picture As menu option, right-click again. Click the Save Picture As option to save the image.



i In the Save Picture dialog that opens, navigate to the module 3 images folder (**C:\MapWorld9\Mod3\Data\Images**) or a location your teacher designates.

j Change the name of the image to **ABC_sstemp1297.gif**, where ABC are your initials. Click Save.

k Repeat steps 1f–1j to draw and save a map with the following parameters:

- Sea Surface Temperature (Quarterly)
- Date: 1999-03-31
- Save picture as: **ABC_sstemp0399.gif** (ABC are your initials)

l Minimize your Web browser.

Step 2 Georeference the images

a Use "My Computer" or "Windows Explorer" to navigate to the Images folder (**C:\MapWorld9\Mod3\Data\Images**).

b Copy the file **master.flw** and paste it twice into the same Images folder. Now you have three copies of master.flw in the Images folder.

Note: If you did not save your downloaded images to this images folder, you need to paste the two copies of master.flw into the folder where the two images are saved.

Master.flw is a master georeferencing file (also known as a world file) to use with all the large-format images you retrieve from the GLOBE home page. It will "tell" ArcMap where to place the image.

c Rename one of the world files to match the file name of the first image you downloaded. You also need to change the file extension from .flw to .gifw. The "gif" tells ArcMap to georeference the .gif file with the same name; the "w" tells ArcMap that it is a world file. For the image named ABC_sstemp1297.gif, you need to rename the world file **ABC_sstemp1297.gifw**.

d Change the file name of the other pasted world file to match the other downloaded image. It now reads **ABC_sstemp0399.gifw**.

You still have a copy of the original master.flw file in the Images folder. When you need to download additional images later, you can copy this file again.

Step 3 Start ArcMap and add the georeferenced images

a Start ArcMap. Navigate to the module 3 folder (**C:\MapWorld9\Mod3**) and open **Adv3.mxd** (or **Adv3**).

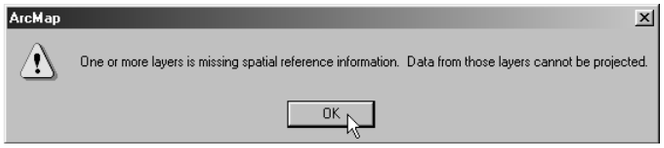
When the map document opens, you see the following layers displayed: Latitude & Longitude, Climate, Countries, and Ocean.

b Stretch the ArcMap window so the map is bigger.

c Click the Add Data button and navigate to the folder where the georeferenced images are saved (**C:\MapWorld9\Mod3\Data\Images**).

d Add both images (**ABC_sstemp1297.gif** and **ABC_sstemp0399.gif**).

e A message displays, warning you that the images are missing spatial reference information. In this case, the spatial reference information is not missing—it is simply stored in the "world" file instead of with the image. Click OK to dismiss the message.



f Drag the two images up in the table of contents and place them just below Latitude & Longitude.

The two images match up with the other layers in the map. This is because the images are in the same projection (Mollweide) as the World Climate data frame.

Note: If you cannot see the images display properly, it is because there was an error in georeferencing. Go back to step 2 and check that you changed the world file to match the file name of the image. Also, check that the extension is "gifw." If the file name or extension is incorrect by even one character, you will not see the image properly. After you correct the file names, replace the image layers in ArcMap.

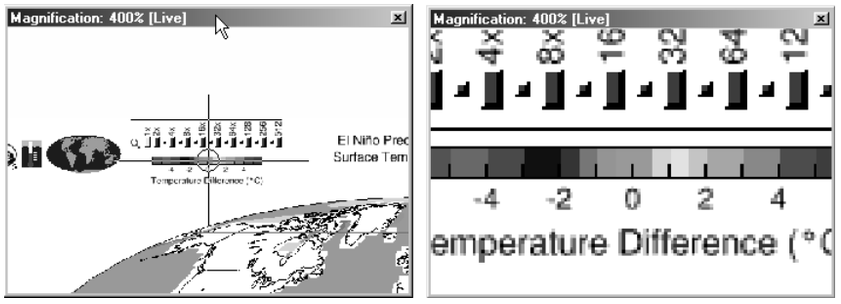
g Save your map document according to your teacher's instructions.

Record the new name of the map document and its location on your answer sheet.

Step 4 Analyze characteristics of El Niño and La Niña

El Niño and La Niña are climate anomalies that affect sea surface temperature and precipitation. The scientific term for El Niño/La Niña is the "Southern Oscillation." The image maps you are exploring are Predicted Anomaly Maps. They show and describe scientists' predictions for anomalies in sea surface temperature.

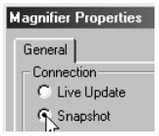
a **Click the Window menu and click Magnifier. Drag the Magnification window by its title bar and center it over the legend in the upper left of the map image. (Note: The legend is the colored bar, not the zoom scale above it.) When you let go, you will see a magnified view of the legend.**



You will reduce the magnification so you can see the entire legend.

b **Right-click the Magnifier window title bar and click Properties. Change the zoom factor to 200%. Click Apply.**

c **In the Magnifier Properties, click the Snapshot option. Click OK.**



Now the view in the Magnification window is locked on the legend location and will not change when you drag it around or zoom the map.

Note: The Snapshot window displays the legend for the topmost image that is turned on in the table of contents.

d **Zoom in on the area of the Pacific Ocean just west of the coast of South America.**

e **Record your temperature observations in the table on your answer sheet, taking note of the legend in the Snapshot window.**

f **Go back to the GLOBE Web site and download precipitation maps for the same time period. Follow the procedure in steps 1–3 to create and add the images to ArcMap.**

Record your observations of precipitation characteristics for the same time period and location on your answer sheet.

g **Save your map document.**

The impact of El Niño and La Niña is felt at a global scale; it is not limited to the small region of the Pacific where these climate anomalies are born.

h **If time permits, download other GLOBE map images that you think will help you create a detailed definition for the global climate events of El Niño and La Niña. Compare these patterns with the Climate layer already in the table of contents.**

Synthesize the information you've recorded and develop a definition of El Niño and La Niña. Write these definitions on your answer sheet.

i **Save your map document.**

Step 5 Are El Niño and La Niña equal and opposite?

According to Sir Isaac Newton's third law of motion, for every action there is an equal and opposite reaction. The same holds true for the weather—which is, after all, influenced by physical elements and properties. Is La Niña the "equal and opposite" reaction to El Niño? Is one event better than the other? Your answer depends on where you live.

a **Look at the images you've downloaded and focus on different regions of the world. Complete the table on your answer sheet by filling in your observations for El Niño and La Niña's effect on the different regions of the world. Consult your teacher for what kinds of weather phenomena you should investigate under "Other."**

b **Based on the data you recorded in the previous question, do you think La Niña is equal and opposite to El Niño? Explain your answer.**

c **Analyze the climate in your region and local area during the 1997 El Niño and the 1999 La Niña. Consult basic climate data (temperature, precipitation, and storms). Refer to the following questions to guide you, and record your answers on the answer sheet:**

(1) Was one year better than the other for you and your community?

(2) If in one year you received greater than normal rainfall, did your town have problems with flooding?

(3) If weather was unseasonably warm and mild, did outdoor activities such as amusement parks have greater turnout?

(4) How did these things affect the local economy?

d **As an assessment for this GIS Investigation, write an essay that answers the questions above and create ArcMap maps to support your conclusions. Check with your teacher for additional guidelines for this assignment.**

Step 6 Exit ArcMap

When you are finished analyzing the El Niño and La Niña data, you may exit ArcMap.

a **Save your map document.**

b **Exit ArcMap by choosing Exit from the File menu.**