El Nino Student Activity Book

I. Introduction

El Nino refers to the irregular increase in sea surface temperatures from the coasts of Peru and Ecuador to the equatorial central Pacific. This phenomenon is not totally predictable but on average occurs once every four years. It usually lasts for about 18 months after it begins.

Since March of 1997, sea surface temperatures in the central and eastern equatorial Pacific have been higher than normal. The sea surface temperature for September 1997 was the highest in the last 50 years. Also, in late September easterly winds over the equatorial Pacific between 150E and 120W decreased the most in the last 30 years.

Recent years in which El Nino events have occurred are 1951, 1953, 1957-1958, 1965, 1969, 1972-1973, 1976, 1982-1983, 1986-1987, 1991-1992, 1994 and 1997. The high sea surface temperatures and the magnitude of the westerly wind anomalies over the Pacific are very high. These conditions suggest that the strength of 1997 El Nino event could equal or surpass that in 1982-1983, making it the strongest El Nino this century.

The El Nino of 1982-83 was responsible for the loss of nearly 2,000 lives and displacement of hundreds of thousands from their homes. The losses were caused by droughts and fires in Australia, Southern Africa, Central America, Indonesia, the Philippines, South America and India. There were floods in the USA, Gulf of Mexico, Peru, Ecuador, Bolivia and Cuba. More hurricanes than usual affected Hawaii and Tahiti.

In this activity, you'll learn about El Nino. Specifically, you'll learn the information below as you do the activities.

Get Info Objectives

1. Explain what El Nino is, where it is located, and how it is created.
2. Describe the weather changes caused by El Nino.
3. Draw the patterns of El Nino on a world map.

Gather Data Objectives

1. List the years of previous El Nino events.
2. Locate and graph precipitation for locations in the eastern and western Pacific.
3. Analyze precipitation in eastern and western Pacific in terms of amount and when it occurred.
4. Compare precipitation amounts in the eastern and western Pacific to occurrences of El Nino.

Application Objectives

1. Predict the economic effects El Nino will have on the areas it affects.
2. Predict when the next El Nino will develop.
3. Predict what would happen to coastal areas of the Atlantic Ocean if El Ninos developed off the coast of Africa.

II. Get Info

Before doing anything else, add the OAR El Nino site to bookmarks or favorites on your web browser.

A. What is El Nino?

- Click on the "El Nino Definition" site.
- Read the first paragraph and answer the following questions in the space provided.

1. Explain what El Nino is.

_____

_____

_____

2. What effect does El Nino have on the United States?

_____

_____

_____

3. What effect does El Nino have on the western Pacific?

_____

_____

_____

- Read the second and third paragraphs.

4. How are El Nino sea temperatures and weather conditions different from normal conditions?

_____

_____

_____

5. What effects are there on Pacific sea life and productivity?

_____

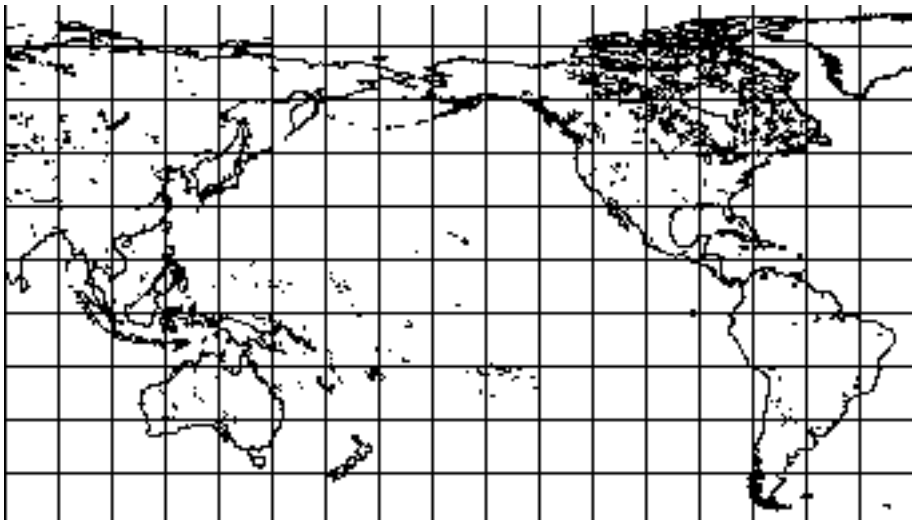
_____

_____

_____

- Click the "Back" button in the bar at the top of your web browser to get back to the OAR El Nino Activity.
- Click on the "El Nino Picture" site.

6. Using colored pencils, draw what the patterns on El Nino look like in the Pacific Ocean.



- Click "Back" until you get back to the OAR El Nino Activity.

B. El Nino Effects

- Click on the "El Nino Impacts" site.

1. In the space below, write the weather effects El Nino has on the area where you live.

   _____

   _____

   _____

- Click on picture (a) of the United States that shows temperature differences.

2. What difference in the average temperature does El Nino cause where you live?
   0 degrees indicates zero difference from normal temperature.

   _____degrees Celsius

- Click "Back" one time.
- Click on picture (b) of the United States that shows precipitation (rain, snow, hail) amounts.

3. What difference in average rainfall does El Nino cause where you live?
   0 indicates zero difference from normal rainfall.

   _____centimeters

b. Will you get more or less rain? _____

- Click "Back" until you get back to the OAR El Nino Activity.

III. Gather Data

A. Comparison of Different El Ninos

- Click on the "El Nino Comparison Graph" site.
- Scroll down to the bottom of the site to see the graph of El Ninos.
- Record the years of El Ninos in the chart below then answer the following questions about the El Ninos.

El Nino Years						
19____	19____	19____	19____	19____	19____	19____

1. Which El Nino year before 1997 was the most severe? 19_____

2. What was the greatest recorded sea surface temperature increase above normal? _____ degrees Celsius

3. What is the approximate month / year of the greatest sea surface temperature increase above normal? _____

4. What was the greatest recorded sea surface decrease below normal? _____ degrees Celsius

5. What is the approximate month / year of the greatest sea surface temperature decrease below normal? _____

6. In what year was El Nino the weakest? 19____

7. During the period around June on the left side of the graph, what was the difference in temperatures between the 1986 El Nino and the 1997 El Nino? _____ degrees Celsius

- Click "Back" until you get back to the OAR El Nino Activity.

B. Comparison of Western Pacific Rainfall during El Ninos.

- Click on the "Rainfall" site.
- Scroll down to the "Select a Graph Type" box.
- Choose "graph total precipitation each year for a period of years."
- Scroll down to the world map.

Western Pacific 1 - Rockhampton, Australia

- Click on the picture of Australia.
- In the box that appears, click on Australia if it is not highlighted.
- Click "Okay".
- At the "Select a station" page, scroll down and click on Rockhampton Airport.
- Scroll down to the "Select the type of units you prefer" section.
- Click metric units.
- Scroll down to the "Select a Time Period to Graph" section.
- You can use the tab key to move to the next box without scrolling.
- Enter the years 1955 and 1988 in the boxes.
- Click "Graph Data".
- Answer the following questions about Rockhampton airport.

<u>Keep in mind the effects of an El Nino on the western Pacific.</u>

1. Record the latitude and longitude of Rockhampton in the chart under question 2 below.

2. What are the rainfall amounts for Rockhampton in the El Nino years? Fill in the rainfall amounts below the years.
Each horizontal line represents about 4 cm of rainfall.

Rockhampton, Australia

Latitude = S			Longitude = E	
1957	1965	1972	1982	1986

3. When are the lowest annual precipitations shown?

19 ____ and 19 ____

4. What two back-to-back years show the greatest increase in rainfall from year to year? _____

- To get to the stations (city) directory to get information about Melbourne Australia's rainfall, click "Back" once.

- To leave the western Pacific and go to the eastern Pacific (U.S. and South American) cities, click "Back" three times to get to the map menu. Skip the rest of section B and go directly to section C.

- To continue with the western pacific, answer the questions beginning on the next page.

Western Pacific 2 - Melbourne, Australia

- From the stations menu, scroll down and select Melbourne.
- Scroll down to the "Select the type of units you prefer" section.
- Click metric units.
- Click "Graph Data".
- Answer the following questions about the graphed data.

Keep in mind the effects of an El Nino on the western Pacific.

1. Record the latitude and longitude of Melbourne in the chart under question 2 below.

2. What are the rainfall amounts for Melbourne in the El Nino years? Fill in the rainfall amounts below the years.

Each horizontal line represents about 2 cm of rainfall.

Melbourne, Australia				
Latitude = S			Longitude = E	
1957	1966	1972	1982	1986

3. What was the most severe El Nino year in Melbourne? 19 _____

4. What was the rainfall total for the most severe El Nino year in Melbourne? _____ centimeters

5. What was the least severe El Nino year in Melbourne? 19 ____

6. What two back-to-back years show the greatest decrease in rainfall from year to year? _____

- Click "Back" twice to get to the country menu.

Western Pacific 3 - Kota Kinabalu, Malaysia

- Select Malaysia.
- Click "Okay".
- At the "Select a station" page, select Kota Kinabalu.
- Scroll down to the "Select the type of units you prefer" section.
- Click metric units.
- Scroll or tab down to the "Select a Time Period to Graph" section.
- Enter the years 1955 and 1988 in the boxes.
- Click "Graph Data".
- Answer the following questions.

Keep in mind the effects of an El Nino on the western Pacific.

1. Record the latitude and longitude of Kota Kinabalu in the chart under question 2 below.

2. What are the rainfall amounts for Kota Kinabalu in the El Nino years? Fill in the rainfall amounts below the years.
   Each horizontal line represents about 7.5 cm of rainfall

Kota Kinabalu, Malaysia				
Latitude = N			Longitude = E	
1957	1965	1972	1982	1987

3. What was the most severe El Nino year in Kota Kinabalu? 19 ___

4. What was the rainfall total for the most severe El Nino year in Kota Kinabalu? _____ centimeters

5. What were the least severe El Nino years in Kota Kinabalu?
   19 ___ 19 ___

6. What was the increase in rainfall from 1972 to 1973?
   _____centimeters

- Click "Back" three times to get to the map menu.

C. Comparison of eastern Pacific Rainfall during El Ninos.

Eastern Pacific 1 - La Serina, Chile

- Click on western South America.
- At the country menu, select Chile.
- Click "Okay".
- At the "Select a station" page, select La Serina.
- Scroll down to the Select the type of unit" section.
- Click metric units.
- Scroll or tab down to the "Select a Time Period to Graph" section.
- Enter the years 1955 and 1988 in the boxes.
- Click "Graph Data".

1. Record the latitude and longitude of La Serina in the chart under question 2 below.

2. What are the rainfall amounts for La Serina in the El Nino years? Fill in the rainfall amounts below the years.
   Each horizontal line represents about 0.7 cm of rainfall.

La Serina, Chile				
Latitude = S			Longitude = W	
1957	1965	1972	1983	1986/87

- Answer the following questions.

<u>Keep in mind the effects of an El Nino on the eastern Pacific.</u>

3. What was the most severe El Nino year in La Serina? 19 ____

4. What was the rainfall total for the most severe El Nino year in La Serina? _____ centimeters

5. What was the least severe El Nino year in La Serina? 19_____

6. What two back-to-back years show the greatest increase in rainfall from year to year? _____

- To continue investigating the eastern Pacific, click "Back" three times to return to the map menu. Go to the "Eastern Pacific 2" section below.

- To skip the eastern Pacific and go on to the next section, click "Back" until you get back to the OAR El Nino site, or click OAR site under favorites or bookmarks.

Eastern Pacific 2 - Santa Cruz, California, USA

- Click on the United States.
- At the "Select a country" page, click "Okay".
- At the "Select a State" page, select California.
- Click "Okay".
- At the "Select a station" page, select Santa Cruz.
- Scroll down to the Select the type of unit" section.
- Click metric units.
- Scroll or tab down to the "Select a Time Period to Graph" section.
- Enter the years 1955 and 1988 in the boxes.
- Click "Graph Data".

- Answer the following questions.

<u>Keep in mind the effects of an El Nino on the eastern Pacific.</u>

1. Record the latitude and longitude of Santa Cruz in the chart under question 2 below.

2. What are the rainfall amounts for Santa Cruz in the El Nino years? Fill in the rainfall amounts below the years.
   Each horizontal line represents about 3.5 cm of rainfall.

Santa Cruz, USA				
Latitude =		N	Longitude =	W
1957	1966	1973	1983	1986

3. What was the most severe El Nino year in Santa Cruz? 19____

4. What was the rainfall total for the most severe El Nino year in Santa Cruz? _____ centimeters

5. What was the least severe El Nino year in Santa Cruz? 19____

6. What two back-to-back years show the greatest increase in rainfall from year to year?

_____

- Click "Back" once to return to the stations menu.

Eastern Pacific 3 - Los Angeles International Airport, California, USA

- Select Los Angeles Int.
- Click "Graph Data".
- Answer the following questions. Keep in mind the effects of an El Nino on areas of the eastern Pacific.

1. Record the latitude and longitude of Los Angeles Internat'l Airport in the chart under question 2 below.

2. What are the rainfall amounts for Los Angeles in the El Nino years? Fill in the rainfall amounts below the years.
Each horizontal line represents about 1.6 cm of rainfall.

Los Angeles, USA				
Latitude =		N	Longitude =	W
1957	1965	1973	1983	1986

3. What was the most severe El Nino year in Los Angeles? 19___

4. What was the rainfall total for the most severe El Nino year in Los Angeles? _____ centimeters

5. What was the least severe El Nino year in Los Angeles? 19____

6. What two back-to-back years show the greatest increase in rainfall from year to year? _____

- Click "Back" 5 times until you get back to the OAR El Nino Activity or choose OAR Site from the "Favorites" or "Bookmarks" menu at the top of the screen.

IV. Application

A. Predictions

1. Predict what would happen to the coastal areas of the Atlantic Ocean if El Ninos developed off the coast of Africa.

_____

_____

_____

_____

2. Predict the effect of a severe El Nino on the salinity (saltiness) of the northern Gulf of Mexico and write the reason for the effect on salinity.

_____

_____

_____

_____

_____

_____

3. Predict what would happen to the US Southwest if an El Nino increased the sea surface temperature by 3 degrees and the increase in temperature extended across the whole Pacific Ocean.

_____

_____

_____

_____

4. Using the dates of previous El Ninos, predict when the next El Nino will occur.

_____

- Click "Back" until you get back to the OAR El Nino Activity.

V. Enrichment Activities

A. Wind Patterns

1. If your class has covered global winds, explain in detail why El Nino sea surface temperatures affect weather patterns and where the effects occur.

B. Social Studies / Language Arts

- Click on the "Economic Impacts" site.

- Read the data and write an explanation of the economic impacts of an El Nino event.

- Click "Back" until you get back to the OAR El Nino Activity.

C. Math

Predict the effect of 1997 El Nino on Rockhampton Australia based on the departure from normal of the sea surface temperature during the 1982 El Nino

- Click on the "Rainfall" site to return to the Rockhampton data.
- Choose "graph total precipitation each year for a period of years".
- Click on the picture of Australia.
- Click "Okay".
- At the "Select a station" page, scroll down and select Rockhampton Airport.
- Scroll down to the "Select a Time Period to Graph" section.
- Enter the years 1955 and 1988 in the boxes.
- Click "Graph Data".
- Scroll down to and click on "View the dataset".
- Follow the directions below to compare the abnormal sea surface temperature during the 1982/83 El Nino on the "Comparison of Different El Ninos" page and the rainfall amount for the year in Rockhampton.

1. Average the rainfall amounts for Rockhampton Australia for the years 1955 - 1989 to obtain an average yearly rainfall. Record the average below.

Average Yearly Rainfall = _____cm.

2. Average the rainfall for 1982 and 1983, then record the 82/83 average below.

1982 /1983 Rainfall =_____cm.

3. Subtract the 82/83 rainfall from the average rainfall, then record the difference below.

Deviation from Normal =_____ cm.

- Click "Back" 4 times to get back to the OAR El Nino Site.
- Click on the El Nino comparison graph site.
- Scroll down to the bottom of the site to see the graph of El Ninos.

4. Find the 1982 /83 abnormality in temperature measured at the March/April closest to the middle of the graph. Record the temperature abnormality below.

Temperature Difference =_____ degrees.

5. Divide the Deviation from Normal by the Temperature Difference. This gives you a number telling you how much the rainfall should increase for each degree that the sea surface temperature is above normal. Record the answer below.

Rainfall Increase per Degree =_____ .

- Follow the directions below. Use your calculations above to predict what the rainfall increase will be in Rockhampton, Australia during the March / April period If an El Nino occurred that was 4.1 degrees above normal.

6. Multiply your Rainfall Increase per Degree value times the 4.1 degree increase. See example below.

   Rainfall Increase per Degree x 4.1 = Predicted Rainfall

Your answer to step 6 will give you an idea of how much additional rain will fall (above normal) in Rockhampton if an El Nino of 4.1 degrees above normal were to happen.

D. Research

1. Research other El Ninos using the Internet. Here's an idea of information to look for;
   a. When it occurred
   b. How long it lasted
   c. What countries and areas were most and least affected?
   d. What happened to the weather as a result of each one?
   e. On a map, draw the greatest sea surface area covered by the El Nino.

2. Collect newspaper and magazine articles about El Nino. Write a brief summary of each one.

3. Find out the differences between El Nino, La Nina, and El Viejo.

E. Interviews

1 Interview local weather people about the reports they have done on El Ninos.

2. Interview 10 individuals to find out how much they know about El Ninos and what effect they think El Nino has on the weather. Develop eight to ten questions and write them out leaving space to write their answers.

F. Class Reports

1. Prepare a two-minute news report on El Nino. If you have a video camera, film your report. Interview one "expert" in your report.

2. Create a series of drawings on a map showing the increase and decrease in the area (size) covered by the 1997 El Nino. Make sure you include the date of the drawing on each drawing.

G. Related Web Sites

1. "Comparison of Different El Ninos" graph
   http://www.cdc.noaa.gov/ENSO/enso.different.html
2. El Nino Theme Page
   http://www.pmel.noaa.gov/toga-tao/el-nino
3. A Globe Activity - El Nino vs. Non-El Nino Years
   http://www-co-cas.colorado.edu/oasis/science /mods/ElChange.html
4. "El Nino Climate Anomalies can be Predicted Several Seasons in Advance"
   http://www.ncdc.noaa.gov/ogp/papers/cane.html
5. Animation of an El Nino Event - you'll need an MPEG viewer program to view the animation.
   http://www.pmel.noaa.gov/toga-tao/mpeg/TAO_SST_ Wind.mpeg
6. USA Today El Nino web site
   http://www.usatoday.com/weather/nino.wnino0.htm