El Nino Student Activity Book

I. Introduction

El Nino refers to the irregular warming in the sea surface temperatures from the coasts of Peru and Ecuador to the equatorial central Pacific. This causes a disruption of the ocean-atmosphere system in the tropical Pacific having important consequences for weather around the globe. This phenomenon is not totally predictable but on average occurs once every four years. It usually lasts for about 18 months after it begins.

During the 1997-98 El Nino, sea surface temperatures in the central and eastern equatorial Pacific were 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 occurred are 1951, 1953, 1957-1958, 1965, 1969, 1972-1973, 1976, 1982-1983, 1986-1987, 1991-1992, 1994, and 1997. High sea surface temperatures and the magnitude of increases in the westerly winds over the Pacific suggest that the strength of the 1997 El Nino event could equal or surpass that in 1982-1983, making it the strongest El Nino this century.

The El Nino of 1982-1983 was responsible for the loss of nearly 2000 lives and displacement of hundreds of thousands from their homes. Droughts and fires in Australia, Southern Africa, Central America, Indonesia, the Philippines, South America and India caused the losses. There were floods in the USA, Gulf of Mexico, Peru, Ecuador, Bolivia and Cuba. More hurricanes than usual affected Hawaii and Tahiti.

You will learn about El Nino as you complete the following activities.

Get Info Objectives

1. Explain what El Nino is, where it is located, and how it occurs.
2. Describe the weather changes caused by El Nino.
3. Draw El Nino patterns 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 the 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.

Before doing anything else, add the NOAA Research "El Nino" Web page to Bookmarks or Favorites on your browser.

- From the NOAA Research "El Nino" main page, click "Get Info."

II. Get Info

A. What is El Nino?

- Click on the "El Nino Definition" site.

Read and answer the following questions:

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?

_____

_____

_____

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

_____

_____

_____

_____

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

_____

_____

_____

_____

- Click "Back" to return to the El Nino "Get Info" web page.
- Click on the "El Nino Picture" site.

6. Using colored pencils, draw what the surface conditions/patterns look like in the Pacific Ocean during a typical El Nino. (Use brown to represent land and red for the warmest region, etc.)
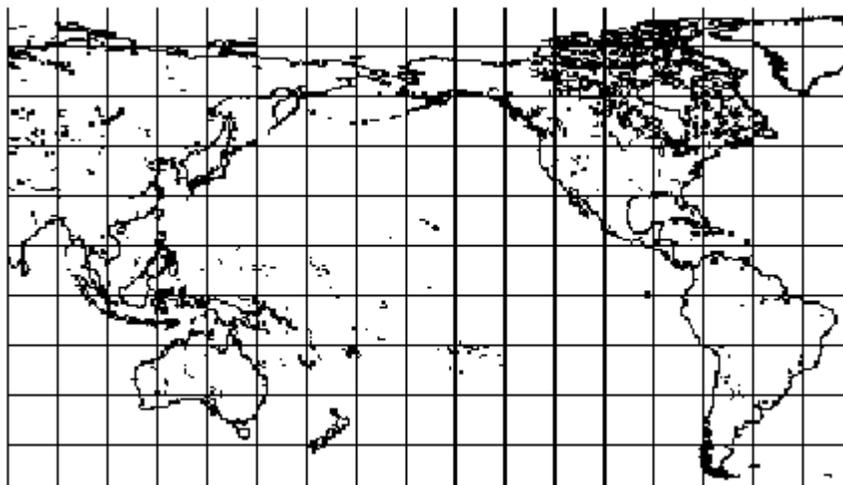
- Click "Back" to return to the El Nino "Get Info" web page.

B. El Nino Effects

- Click on the "El Nino Impacts" site and read the first paragraph.

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 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 normal.) _____ centimeters

- Click "Back" to return to the NOAA Research "El Nino" home page, or choose "El Nino" from your Favorites or Bookmarks.
- Click "Gather Data."

III. Gather Data

A. Comparison of Different El Ninos

- Click on the "El Nino Comparison Graph" site.
- Scroll down to 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 temperature
    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 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" to return to the El Nino "Gather Data.1" web page.
- Click "Forward" at the bottom of the page to go to the "Gather
  Data.2" Web page.
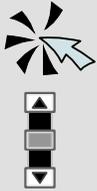
B. Comparison of Western Pacific Rainfall During El Ninos

- Click on the "Rainfall" site.
- Click on the statement, "I Agree to These Terms" to get the rainfall data.
- 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 – 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 for each year.
   Each horizontal line represents about 4 cm of rainfall.

Rockhampton, Australia				
Latitude = S			Longitude = E	
1957	1965	1972	1982	1986

1. When are the lowest annual precipitations shown?
   19_____ and 19_____

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

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

- 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 following questions.

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 for each year.
   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 return to the country menu.

Western Pacific – 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 about Kota Kinabalu.
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 for each year.
    Each horizontal line represents about 7.4 cm of rainfall.

Kota Kinabalu, Malaysia				
Latitude = N		Longitude = E		
1957	1965	1972	1982	1986

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_____ and 19_____

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

- Click "Back" three times to return 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 for each year.
   Each horizontal line represents about 0.7 cm of rainfall.

La Serina, Chile				
Latitude = S		Longitude = W		
1957	1965	1972	1982	1986/87

Answer the following questions about La Serina, Chile.
<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? 19____ and 19____

- 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 return to the "El Nino" main page, or choose the El Nino site from your 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, click 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 about Santa Cruz, California.
Keep in mind the effects of an El Nino on the eastern Pacific.

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 for each year.
   Each horizontal line represents about 3.5 cm of rainfall.

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

3. What as 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 32 – Los Angeles International Airport, California, USA

- Select Los Angeles International Airport.
- Click "Graph Data."

Answer the following questions about Los Angeles International Airport. Keep in mind the effects of an El Nino on the eastern Pacific.

1. Record the latitude and longitude of Los Angeles International 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 for each year.
    Each horizontal line represents about 1.6 cm of rainfall.

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

3. What as the most severe El Nino year in Loa 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? _____

- Choose Favorites or Bookmarks in your browser to return to the NOAA Research "El Nino" main page.
- Click on "Application."

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 U.S. Southwest if an El Nino increased the sea surface temperature by 3 degrees and the increase in temperature extended across the whole Pacific Ocean.

_____

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_____

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

_____

- Click "Back" to return to the NOAA Research "El Nino" main page.
- Click "Enrichment."

V. Enrichment Activities

A. Wind Patterns

If your class has studied 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" to return to the El Nino "Enrichment.1" Web page.

C. Math Activity

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

- Click on the "Rainfall" site to return to the Rockhampton data.
- Click on the statement "I Agree to These Terms" to get the 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, select Rockhampton Airport.
- Scroll down to the "Select a time period to graph" section and 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 1982/1983 El Nino and the rainfall amount for the same period in Rockhampton.

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

    Average yearly rainfall = _____ cm

2. Compute the average rainfall for 1982 and 1983, and then record the 1982/1983 average below.

    1982/1983 rainfall = _____ cm

3. Subtract the 1982/1983 rainfall from the average rainfall, then record the difference below.

    Deviation from normal = _____ cm

- Choose Favorites or Bookmarks in your browser to return to the NOAA Research "El Nino" main page.
- Click on "Enrichment" again.
- Click on the "El Nino Comparison Graph" site.
- Scroll to 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 = _____

Using your calculations, 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.

Rainfall Increase per Degree x 4.1 = Predicted Rainfall

Your answer 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.

- Choose Favorites or Bookmarks in your browser to return to the NOAA Research "El Nino" main page.
- Click on "Enrichment" again.
- Click "Forward" at the bottom of the page to go to the "Enrichment.2" web page.

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 an El Nino.

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

3. Find out 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 people 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 on each drawing.

G. Related Web Sites

1. "Comparison of Different El Ninos"
   http://www.esrl.noaa.gov/psd/enso/enso.different.html

2. El Nino Theme Page
   http://www.pmel.noaa.gov/toga-tao/el-nino

3. San Diego School District's "El Nino or El No-no"
   http://powayusd.sdcoe.k12.ca.us/projects/ElNino/

4. Climate Prediction Center – El Nino/La Nina Home
   http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/

5. Idealized El Nino Simulation
   http://www.esrl.noaa.gov/psd/people/joseph.barsugli/anim.html

6. Today's El Nino/La Nina Information
   http://www.pmel.noaa.gov/tao/elnino/1997.html