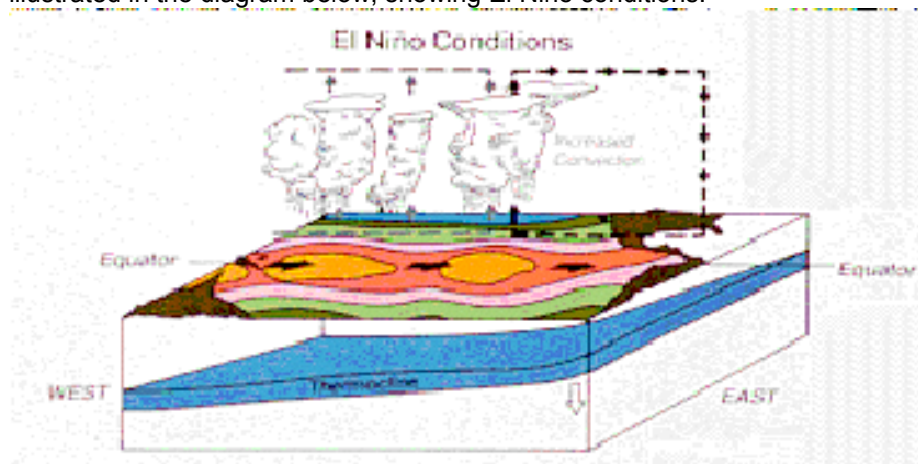


## El Niño – Silent Weather Maker

### Background:

El Niño, which means 'the Christ Child' in Spanish, is the name given to a warm ocean current which appears around Christmas time on the Pacific coast of South America, typically every three to seven years. El Niño lasts up to six months and brings warm coastal waters, heavy rainfall, and disrupted fishing. In a recent 40 year period nine El Niños have occurred off the South American coast. Most of these raised water temperatures as far as 5000 miles across the equatorial Pacific in addition to raising coastal temperatures. Weaker El Niños raised ocean temperatures one to two degrees Fahrenheit and did not cause major problems for South American fisheries. However, the strong El Niños, such as the one which occurred in 1982-83, increase ocean temperatures three to seven degrees Fahrenheit, and produce a disastrous effect upon marine life, fishing industries, local weather, and upon climate conditions worldwide. Scientists continue to study El Niño in order to understand the patterns and rhythms that are associated with it and to hopefully predict future El Niños. If this can be done accurately, perhaps the destruction that comes with El Niño can be planned for and minimized.

While El Niño refers to warm ocean currents, it cannot be understood in isolation from other natural events. We as humans live on a dynamic Earth whose energy systems constantly interact and affect one another. These systems are made up of the Hydrosphere (water in solid, liquid, gaseous forms), Lithosphere (land--above and under the water), Atmosphere (air, dust, gases), and Biosphere (living organisms). El Niño occurs because there is a weakening of the usually strong Westerlies. Normally strong westward winds drive the equator's currents, pushing warm Pacific surface waters westward toward Southeast Asia. This westward movement of surface waters causes upwelling of cold bottom water from the Antarctic along South America's west coast. In an El Niño year, as the trade winds relax, there is a surge of warm water eastward across the Pacific Ocean. As warm water warms the atmosphere and air rises and cools, there is an increase in rainfall over the ocean east of Indonesia. It is important to note that as the western coast of South America experiences low barometric pressure and increased rainfall, the western regions, normally wet from monsoons, experience abnormally high pressures and accompanying droughts. Since this chain of reactions is originally brought about by periodic changes in Atmospheric conditions and winds, resulting in a see-saw type oscillation of barometric pressure on the west and east sides of the Pacific Ocean basin. The term ENSO--'El Niño-Southern Oscillation', is used to show the relationship between pressure fluctuations and the arrival of El Niño. This is a term which you will see often as you pursue your Internet research. The process is illustrated in the diagram below, showing El Niño conditions.



Orange=sea-surface temperatures >29.0 C

From Henson, Bob, UCAR Communications, and Trenberth, NCAR Climate and Global Dynamics Division

<http://www.ncar.ucar.edu/archives/asr/ASR94/EDUC/lasers.html>

In this investigation you will be collecting and analyzing data to see if there is a correlation or link between the occurrence of El Niño and the occurrence of global warming. Many scientists believe that El Niño may be a way in which nature tries to redistribute the extra energy available when global temperatures increase over a period of time. As you visit the Internet sites to find out more about El Niño, begin to form your hypothesis about that relationship. Go now to at least three of the sites listed and then prepare to test your knowledge in a fun, short quiz.

To learn more about El Niño, click on the following sites:

<http://www.pmel.noaa.gov/toga-tao/el-nino>--excellent site for global consequences, regional consequences, benefits of El Niño prediction, Illustrations, impacts.  
<http://octopus.gma.org/surfing/weather/elnino.html>--great site for detecting El Niño, determining if this is an El Niño year, societal impacts.  
<http://www.pmel.noaa.gov/toga-tao/el-ninoreport.html#part3>--El Niño and climate prediction  
<http://www.pmel.noaa.gov/toga-tao/figure22.html>--El Niño and Climate Prediction is an excellent source detailing actual costs of flooding, hurricanes, droughts, and fires in various countries as a result of the 1982-83 El Niño.  
<http://www.pmel.noaa.gov/tao/index.shtml>-- excellent site for global consequences, regional consequences, benefits of El Niño prediction, Illustrations, impacts.  
<http://www.coaps.fsu.edu:80/lib/elninolinks/> - Center for Ocean – Atmospheric Research

#### **Procedure:**

#### **Part I. Review of El Niño background information.**

1. Complete the following El Niño challenge . When you have answered all 5 questions have your teacher check your work.

1. El Niño is the warm ocean current which appears around Christmas time on:
  - a) the western coast of Africa
  - b) the eastern coast of Africa
  - c) the Pacific coast of South America
  - d) the Atlantic coast of North America
  
2. El Niño lasts for:
  - a) about two weeks
  - b) up to six months
  - c) ten years
  - d) the Christmas season
  
3. In addition to raising coastal water temperatures, El Niño raises water temperatures in the equatorial Pacific as far as:
  - a) 200 miles
  - b) 20 miles
  - c) 5000 miles
  - d) 50 miles
  
4. El Niño causes all of the following problems except:
  - a) destruction of marine life
  - b) flooding
  - c) drought
  - d) earthquakes

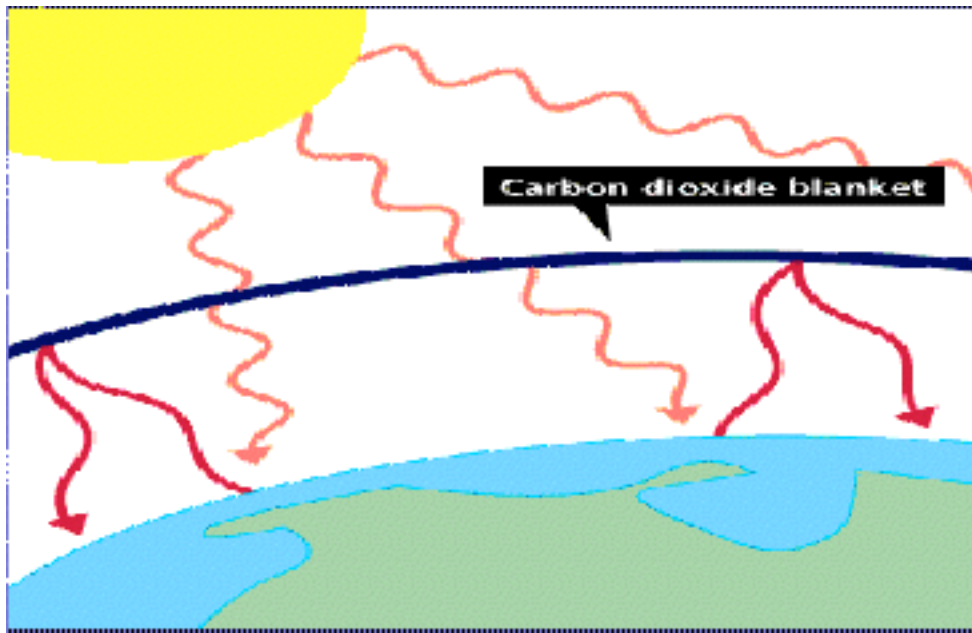
5. The word which is commonly used to refer to El Niño because it includes the pressure changes which cause the Eastern Pacific to have heavy rain and Western Pacific to have droughts is called:

- a) ESSO
- b) EXXON
- c) ENSO
- d) ELOISE

Congratulations, if you got most of these correct! If you need a little review, return now to those Internet sites we listed earlier.

## Part II. Is the Earth Really Getting Warmer?

There is an ongoing debate about whether or not the world is really getting warmer. As we continue to use more fossil fuels and emit more carbon dioxide, we contribute to the greenhouse effect which helps to trap heat in Earth's atmosphere and heat our world. Scientists analyze temperature data to see if anomalies (abnormal or deviant patterns different from the expected norm or average) are occurring. The following diagram illustrates the global warming process.



( From <http://www.injersey.com/Media/IonSci/features/gwarm/html.7/15/97>)

Look at some of these global warming sites

<http://www.worldwildlife.org/climate/index.cfm?searchen> - site presents many topics related to global warming

<http://yosemite.epa.gov/oar/globalwarming.nsf/content/index.html> - EPA global warming site

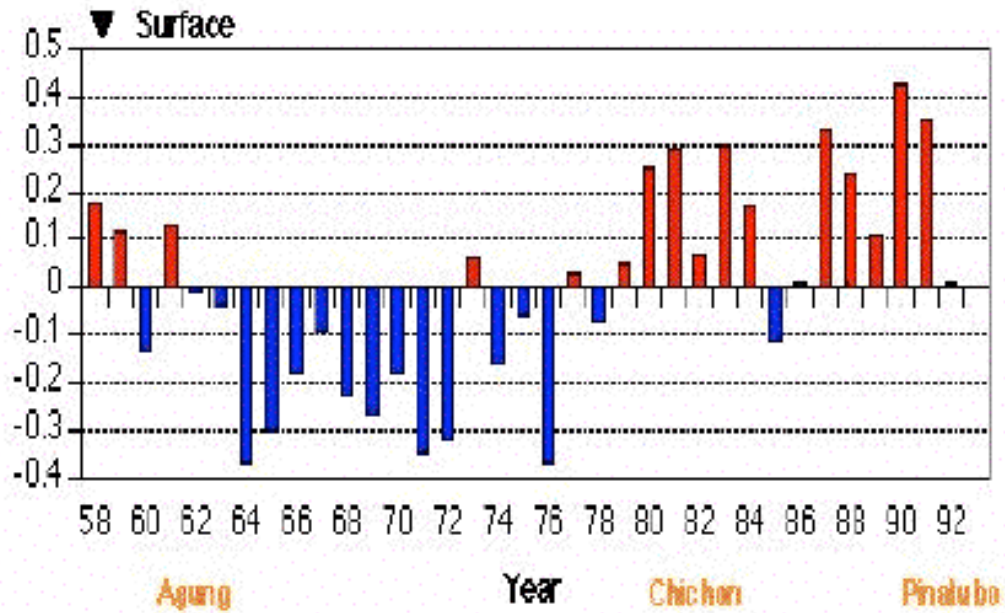
[http://news.bbc.co.uk/1/hi/in\\_depth/sci\\_tech/2004/climate\\_change/default.stm](http://news.bbc.co.uk/1/hi/in_depth/sci_tech/2004/climate_change/default.stm) - This site presents Global Warming information from the European Perspective.

Now that you have examined global warming concepts, try this next challenge:

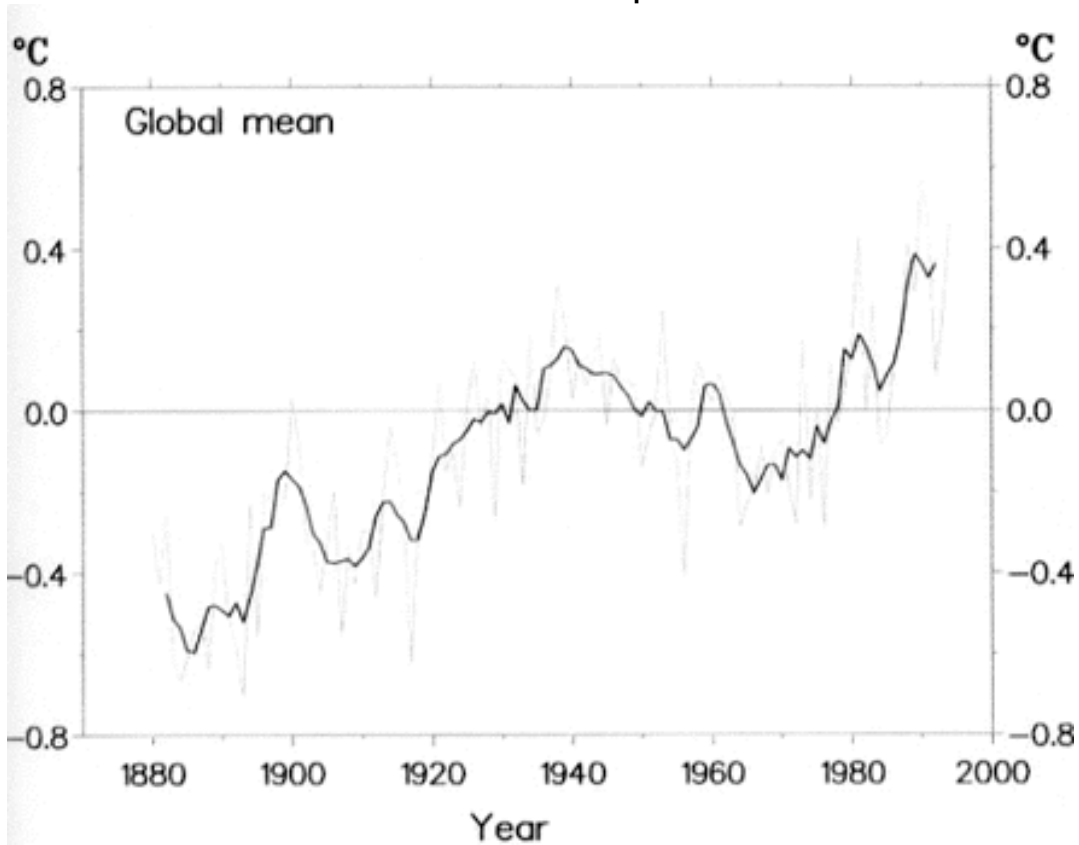
1. Observe the following climate graphs to see if you think that the Earth's average surface temperatures have been rising over the past one hundred years. Does the rate of rise seem to be increasing? Be careful to note that the data is not in degrees, but rather shows deviation from normal temperature averages ( - = colder and + = warmer).

### Global Warming

Yellow words indicate volcanic eruptions during years indicated

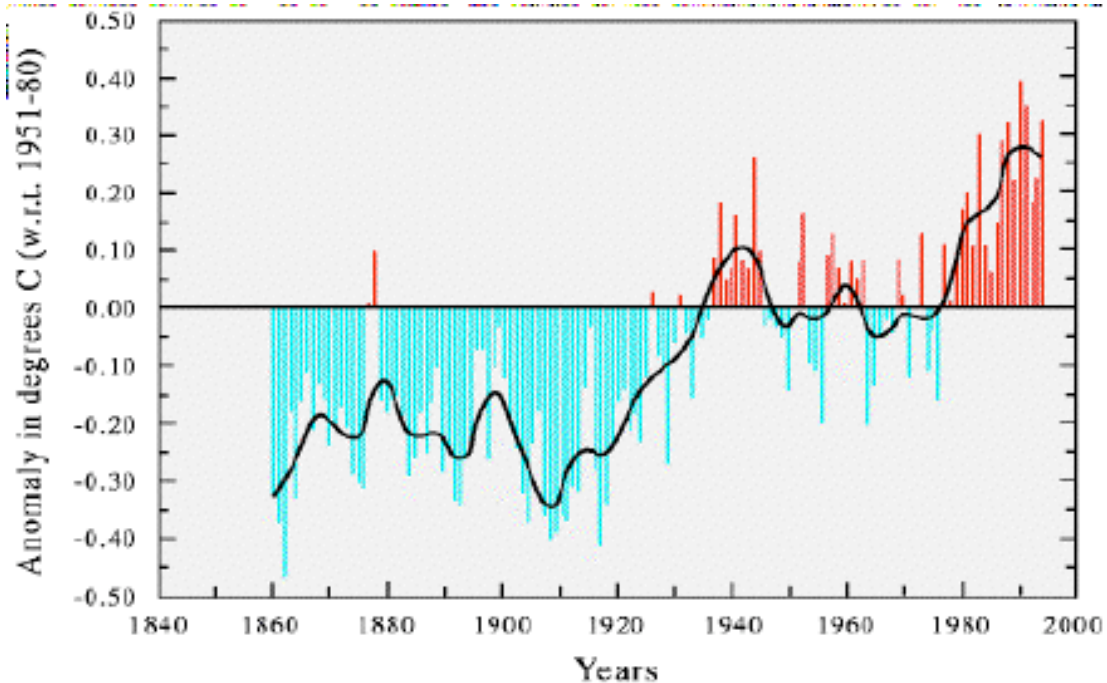


### Global Annual Surface Temperature Over Land



<http://jcdc.kishou.go.jp/jcdc/Temperature/GlobalMean/GlobalMean.html>

Global Temperature Anomalies, 1860-1995



From <http://www.globalchange.org/dataall/96may48d.htm> 7/15/97

These graphs all indicate patterns in earth's global temperatures over the past 135 years. Do you believe that global warming is occurring in a regular pattern over planet Earth? Keep in mind that these are only very small data sets compared with the age of the Earth and with the numbers of years we have been able to collect reliable data. Do you think that it would be more accurate to find and analyze data from millions or billions of years ago? If you answered yes, that should take you on a whole new adventure into research involving ice core samples, etc. For now, it is time to prove that you are now a global warming expert!

2. Complete the following Global warming challenge . When you have answered all 5 questions, have your teacher check your answers.

- Global Warming is contributed to by humans in all of the following ways except:
  - increased burning of fossil fuels
  - increased emission of chlorofluorocarbons into the atmosphere
  - stripping and burning of the rain forests
  - senseless killing of wildlife
- By the year 2100 the average global temperature is predicted to have risen by
  - 1 to 2 degrees Fahrenheit
  - 1.44 to 6.3 degrees Fahrenheit
  - 10 degrees Fahrenheit
  - 2 degrees Fahrenheit
- Burning of fossil fuels results in the release of carbon dioxide into the atmosphere, thus causing global warming. Which of the following is not a fossil fuel:
  - sodium
  - wood
  - oil
  - coal

4. Which of the following would probably not occur as a direct result of continued global warming?

- a) melting polar ice
- b) flooding
- c) more hurricanes and tornadoes
- d) earthquakes

5. All of the following are things which you can do to help reduce global warming except:

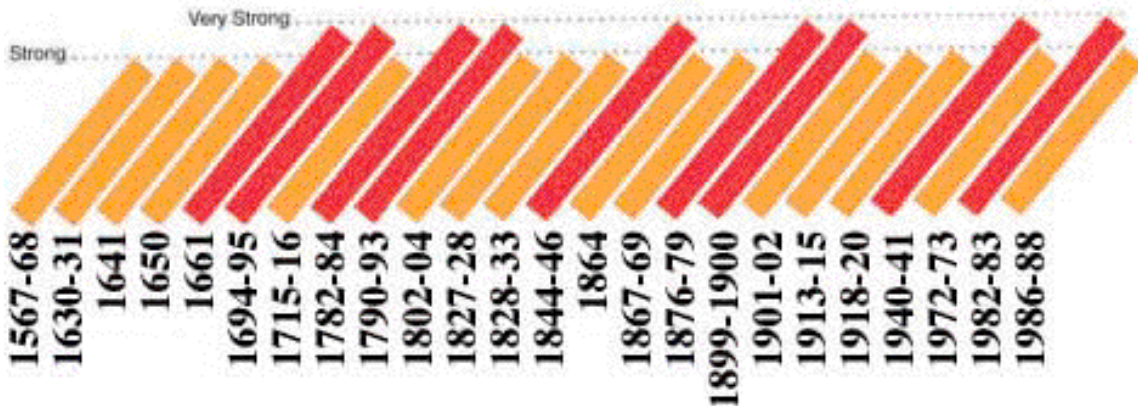
- a) use efficient and long-lasting light bulbs
- b) seal drafts around doors and windows to keep energy inside
- c) use aerosol hairspray instead of hairspray with a pump
- d) encourage your parents to carpool to work or take public transportation

Congratulations, if you got most of these correct! If you need a little review, return now to the Internet site we listed earlier.

### Part III. How Often Does El Niño Occur?

This graphic illustrates the timeline of El Niño years between 1567-1989. Notice the pattern of variation between the 'strong' and the 'very strong' El Niño events. Does there seem to be a regular cycle among these events?

El Niño Years



### Part IV. Putting It All Together

Now that you have become an expert on the two variables in the title of this investigation, it's time to put your science skills into action.

#### Procedure:

1. Form a hypothesis about the relationship between global warming and the frequency of occurrences of El Niño events. Do you believe that El Niño serves to redistribute the increasing heat energy of global warming? Write your hypothesis in the space provided on the learner's worksheet.
2. Using a colored pen or pencil, Place an X above the years on the graphs where an El Niño event occurred. Make a key at the bottom of each graph to indicate what the X means on your graphs.
3. Now analyze and evaluate your graphs. Do the El Niños occur after a warming trend? Does the global temperature then begin to drop after El Niño occurs?
- 4 Complete the answers on your worksheet in complete sentences and in correct style.

CONGRATULATIONS! You are now an El Niño expert! Who knows...one day you may become one of the world's leading experts on El Niño or global warming? You will of course be driving a small, fuel-efficient car, only when you are unable to use human foot power, and you will have given up your aerosol sprays and air conditioning. Maybe not.. but you will be a responsible, concerned, and informed citizen, capable of electing officials who will strive to save our world for future generations. Good luck on this quest for the rest of your life!

## TEACHER INFORMATION

### Overview

This lesson focuses upon the scientific phenomenon of El Niño. Activities will enable the learner to understand that El Niño is a climate event occurring every three to seven years, which starts in the tropical Pacific Ocean and effects atmospheric and oceanic changes causing drought and destruction far beyond its point of origin. Learners will also explore the possible link between human-induced global warming, and El Niño as a possible distributor of global warming's extra energy.

### Grade Level

**This investigation is intended to be used and enjoyed by Middle School students in grades 6-8.**

### Standards References

Massachusetts Frameworks Grades 6-8 #4

National Standards (Science): A.1, A.2,A.4, B.3, D.1, E.1,E.2

National Standards (Geography): 4,11

National Standards (Mathematics): 1.1,1.2, 1.4, 1.5, 2.4,3.1,4.4,5.5,8.1,8.2

### Objectives

At the conclusion of this lesson, students will:

1. Use technology to acquire, explore, and analyze data images.
2. Conduct scientific inquiry using a variety of technical resources.
3. Use Internet resources to conduct scientific investigation.
4. Use graphing skills to analyze and present data.
5. Describe in scientific terminology the definition and geographic origin of El Niño.
6. Identify and describe specific oceanic and atmospheric events inherent in the cyclic occurrence of El Niño in the Pacific Ocean.
7. Explain the physics of relaxed trade winds which allow warm water surges and oceanic changes in an Eastward direction across the Pacific.
8. Access and evaluate Internet data to determine dates of past occurrences of El Niño.
9. Analyze and interpret graphs to discern the correlation between El Niño events and global temperatures.

### Extensions:

There are numerous extensions which may be investigated from this investigation. Some of these include the following:

- a) What is the relationship between worldwide drought and El Niño?
- b) Does the surface temperature of the Earth correlate with temperature in the lower troposphere; the upper troposphere; the stratosphere? Are there also warming trends evident in those upper layers of Earth's atmosphere?
- c) If global warming is in fact a real and scientifically measurable phenomenon, is the increase warming of Earth causing more violent and frequent hurricanes, tornadoes, and El Niños?
- d) What effect does El Niño have upon phytoplankton in the equatorial Pacific Ocean?
- e) What can you do to help stop the human effect upon global warming? What are you doing right now to prevent increasing global temperatures?

**This Activity is modified from an activity prepared at the NASA Goddard Space Center.**

**Credits:**

Lynn Birdsong, Principal Investigator  
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Kimmie Kiesgen; Farzad Mahootian; Eleanor Smith;  
Linda Spruill  
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**Answers to Part I and Part II Challenge Questions**

Answers to Part I Challenge: 1) C; 2) B; 3) C; 4) D; 5) C  
Answers to Part II Challenge: 1) D; 2) B; 3) A; 4) D; 5) B

Internet Access is suggested for this activity, as there are references to several web sites which students should check

**Data Sets**

Print the activity as well as the following worksheets for students to use in completing this activity.

1. El Nino Worksheet
2. El Nino/Southern Oscillation Categorized Years Chart
3. Temperature Anomalies in Three Month Intervals January, 1950- July, 1997
4. Global Lower Tropospheric Temperature Variations (Jan 1979 - October 2005)  
from <http://www.ghcc.msfc.nasa.gov/MSU/msusci.html>

**El Nino/Southern Oscillation Categorized Years**

Cold Phase	Neutral Phase	Warm Phase
1945	1944	1951 W/M
1946	1950 X	1957
1947	1952	1963
1948	1953 M	1965
1949	1958 S	1969
1954	1959	1972
1955 X	1960	1976 M
1956 X	1961	1982 VS
1964 X	1962	1986
1967	1965 M	1987 M
1970	1966	1991 M
1971 X	1968	
1973	1974 X	
1975	1977 X	
1988	1978	
	1979	
	1980	
	1981	
	1983 VS	
	1984	
	1985	
	1989 X	
	1990	
	1992 S	
	1993 M	
	1994 W	
	1995	
	1996	

El Niño years are ranked as VS (very strong), S (strong), M (medium), and W (weak). La Niña prior to 1925 are not yet defined and are not ranked for intensity (so all have an "X").

NAME \_\_\_\_\_ Date \_\_\_\_\_ Period \_\_\_\_\_

## El Niño Worksheet

Directions: Use this worksheet to answer questions presented throughout the investigation and at its conclusion. Please use complete sentences to respond to all questions.

1. What is the title of this investigation?

\_\_\_\_\_

What do you think this title means?

\_\_\_\_\_

\_\_\_\_\_

2. What are the two variables being correlated in this investigation?

a) \_\_\_\_\_ b) \_\_\_\_\_

3. Write down your hypothesis about the relationship between El Niño and global warming.

\_\_\_\_\_

\_\_\_\_\_

4. Examine the three graphs of global temperature anomalies.

a) What is an 'anomaly'?

\_\_\_\_\_

b) Why is this data presented in the form of anomalies?

\_\_\_\_\_

\_\_\_\_\_

c) Examine the graph titled 'Global Annual Surface Air Temperature Over Land.'. Looking at the graph titled 'Global Temperature Anomalies, 1860-1995' (GTA graph), use a blue pencil or pen to graph the points from the GTA graph with a negative (-) value. Use a red pencil or pen to graph the points from that graph which have a positive (+) value. Plot the points from the GTA graph for each ten years, starting with 1880, onto the 'Global Annual Surface Air Temperature Over Land.' graph.

d) Do the points align exactly? \_\_\_\_\_ Explain. \_\_\_\_\_

\_\_\_\_\_

e) Do you see a pattern of temperature anomalies in the three graphs examined in the global warming section? \_\_\_\_\_

f) What is that pattern, if any? \_\_\_\_\_

\_\_\_\_\_

5. Do you believe that global warming is a reality? \_\_\_\_ What evidence supports your viewpoint?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

6. Examine the data sets for the frequency or occurrence dates of El Niño events. Are they all the same in that they denote the same years for the ` occurrence and severity of El Niños' Explain your answer.

\_\_\_\_\_

\_\_\_\_\_

a) On the chart El Nino Southern Oscillation look for a pattern in the El Niño events. How often do they seem to occur? \_\_\_\_\_ Do they appear to be increasing in frequency and/or severity? \_\_\_\_\_ What might this begin to lead us to conclude about El Niño's role in dissipating or dispersing global warming energy?

\_\_\_\_\_

\_\_\_\_\_

7. Study the 2 graphs:

A) Temperature Anomalies in Three Month Intervals  
January, 1950-July, 1997

B) Global Lower Tropospheric Temperature Variations  
January 1979-Oct 2005

a) Using the El Niño occurrence or frequency data that you just examined, and the two graphs above which you just printed out, place an X above the correct year in which the El Niño events occurred. Make your X blue if it occurs in year whose value is below the zero (0) line and make your X red if it occurs below the zero (0) line. If on the line, make it the color of your gorgeous graphite pencil.

b) When you have completed this task for both of the graphs, examine and analyze your findings. Do you find that El Niño's tend to occur after a period of increased global temperatures?

\_\_\_\_\_ What is the pattern you discovered?

\_\_\_\_\_

How might you explain this and how might you predict the next El Niño?

\_\_\_\_\_

\_\_\_\_\_

8. Discuss at least three effects which El Niño has upon the world or its living organisms.

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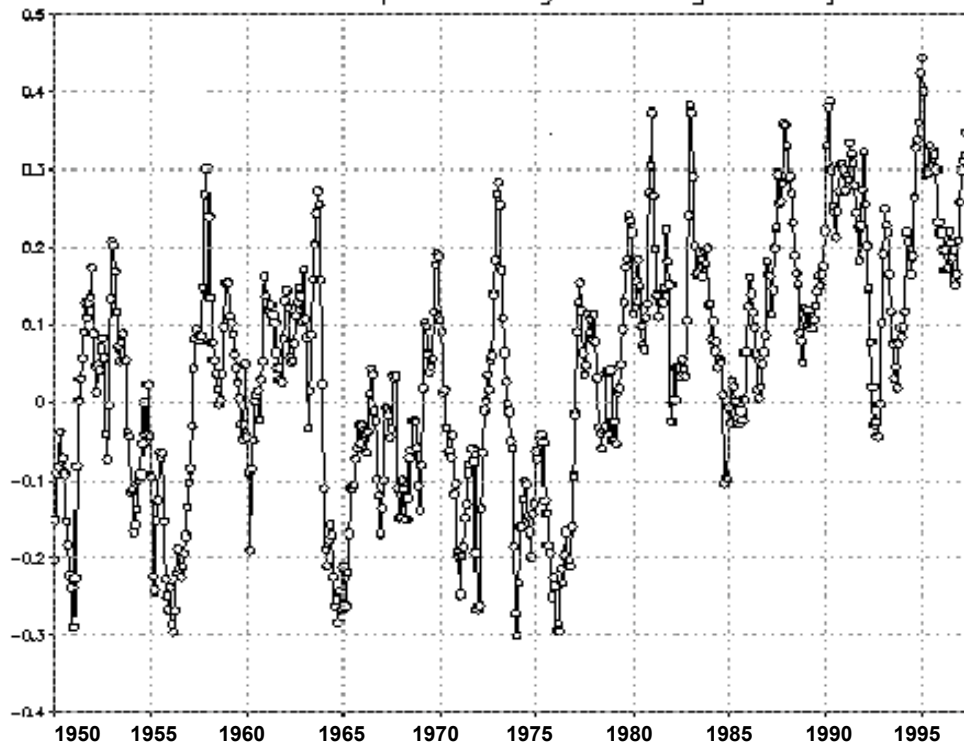
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9. You have learned much about el Niño and global warming through this investigation. Perhaps more important than your newly found knowledge, is the reality that you can use this knowledge to make a difference in your world and in the life of your future children. In the final phase of this investigation, take a few minutes to review and collect your thoughts about ways in which you can help to decrease global warming and therefore perhaps decrease El Niño events which bring drought, floods, and devastation to many parts of our world.

Write a brief essay about how you plan to intervene in behalf of preventing the global warming which may one day ensure the demise of our Earth. Include at least four concrete actions which you and/or your friends, family, community, and state or country may take. Why and how might each of these steps lead to decreased global warming? You are writing an action plan to save the Earth. We're all counting on you! You are indeed in the driver's seat in this race to save the planet!

# Temperature Anomalies in Three Month Intervals January, 1950-July, 1997

CAMS 3 Month Temp Anomaly starting from jan 1950



## Global Tropospheric Temperature Anomalies Jan. 1979 - Oct. 2005

