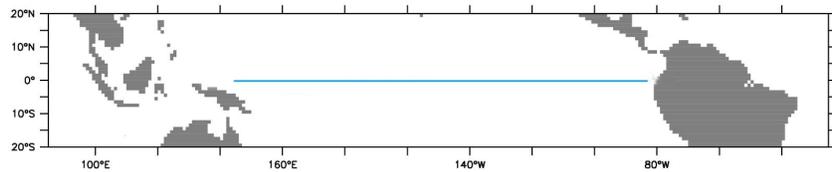
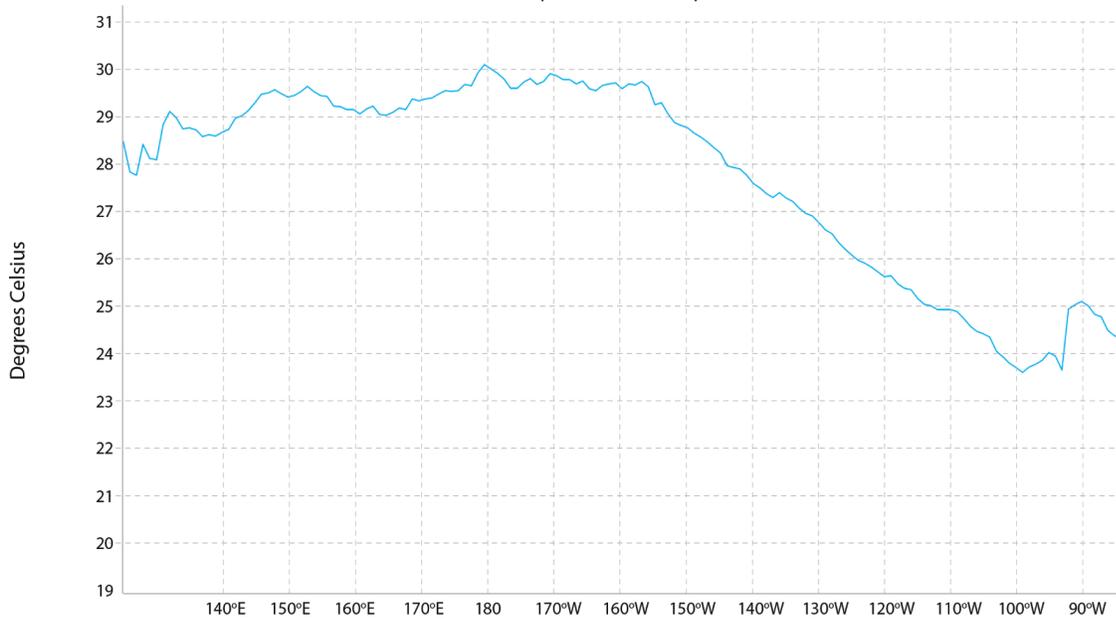


# Graphing Sea Surface Temperature Measurements

Sea Surface Temperature at the Equator, December 2015



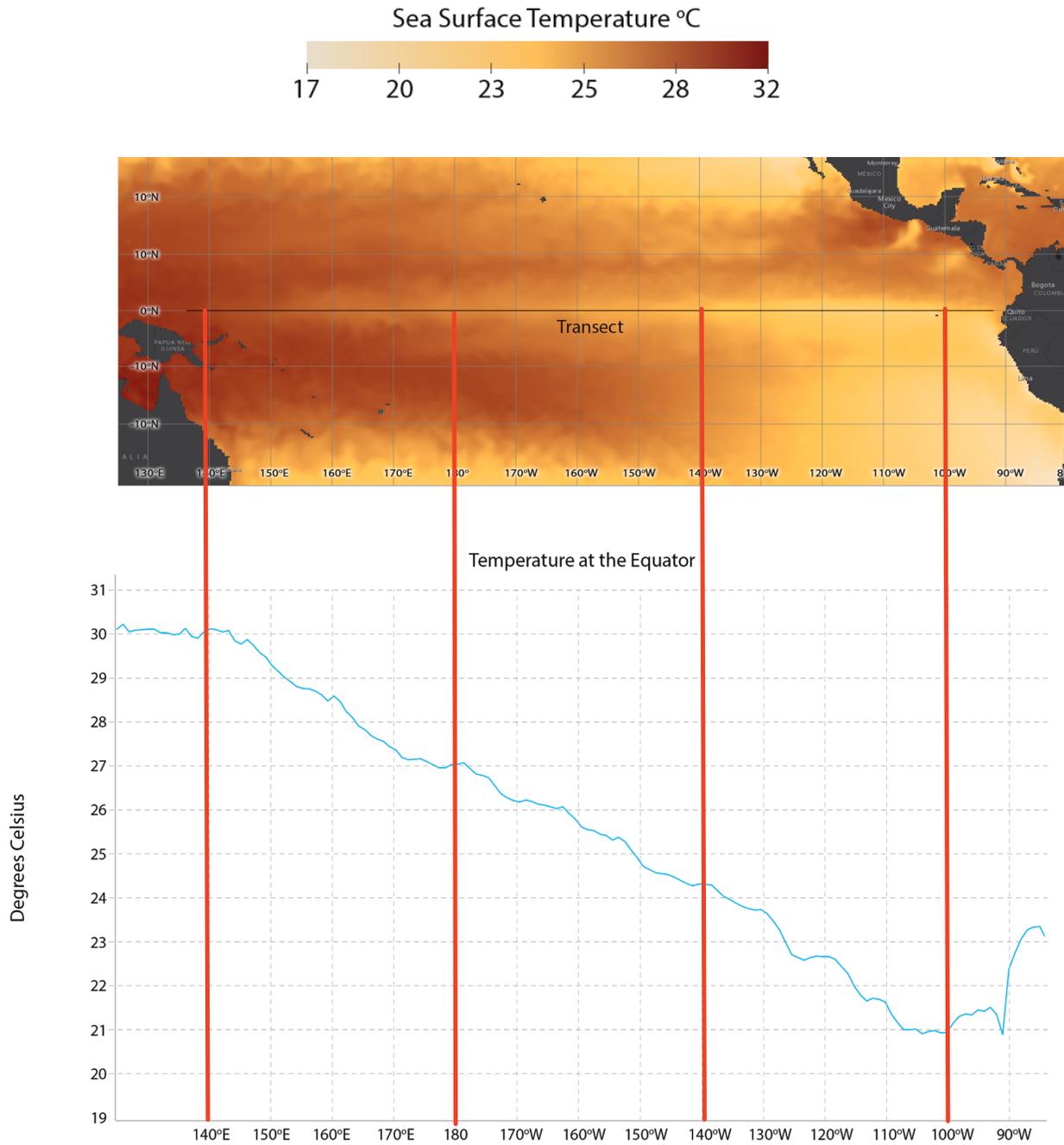
**Instructions:** Examine the line graph showing sea surface temperature at the equator. Below the graph is a reference map showing an area of the Pacific Ocean. The line running west to east is the area represented by the data on the graph.

**Question 1:** What were the monthly average sea surface temperatures along 0° latitude at these locations? Fill in the chart below.

Longitude	140° E	180°	140° W	100° W
SST	28.8 C	30.0 C	27.6 C	23.7 C

# Understanding Maps and Graphs

Sea Surface Temperature Across the Pacific Ocean, December 2010



---

The map on the previous page shows sea surface temperature (SST) for December 2010. Notice the 'transect' line across the equator. Below the map is the corresponding line graph of sea surface temperature at the equator.

Instructions:

- Locate 140° E along the x-axis of the line graph. Using a ruler, draw a vertical line from this point on the line graph to the above map, along the same 140° E line of longitude. End the line at the transect (the Equator). Repeat - drawing these same connecting lines between the map and graph at 180°, 140° W and 100° W.
- On the map, use the colorbar to estimate the values of temperature at each line of longitude. Enter your temperature estimates in the chart below. Repeat the same process with the graph.

Longitude	140° E	180°	140° W	100° W
SST from map	28.0 C	26.0 C	24.0 C	23.8 C
SST from graph	28.8 C	30.0 C	27.6 C	23.7 C

Question 2: Compare your results using the map and the line graph. Are they exactly the same? If not, explain why you may have obtained different results.

The results are not very consistent using the map and line graph. For two of the data points, the values are close but for the other two values, the numbers are off by about 4 C. The difference in results is probably associated with interpreting the color scale. I feel more confident with the line graph results than the map results. It is more subjective to read the color scale.

Question 3: What is one advantage of using a map over a line graph? *Circle the answer.*

A) A map can help determine precise data along a line of latitude.

B) A map can help to identify data patterns over large areas.

# Answering a Question with Data

Your mission: It's the winter of 2015. The water along the coast of California is unusually warm. Tiny red crabs that are typically common in the warm waters of Mexico are now washing up along beaches of California. Are these observations the result of an El Niño? Your mission is to find out - using data.



*Red crabs, common in Mexico, washed ashore in CA.*

Question: Did an El Niño event occur during the winter of 2015-2016?

Yes

Make a Plan: Make a list below of the specific TEMPERATURE data you will need to answer the question. *Hint: can you answer the question by looking at data from only one year? Will you need maps, graphs or both?*

Data Set	Date	Map or Graph?
Example: Sea surface temperature	December 2001	map
sea surface temperature	June 2015	map
sea surface temperature	June 2013	map
sea surface temperature	June 2015	graph
sea surface temperature	June 2013	graph

---

Get the data: Use the website to download the data you need.

*Need a line graph, but not sure how to make them with the data tool? You can find sea surface temperature graphs from years 2014-2016 on the following page.*

Interpret the data: What does your data show? Be specific and descriptive.

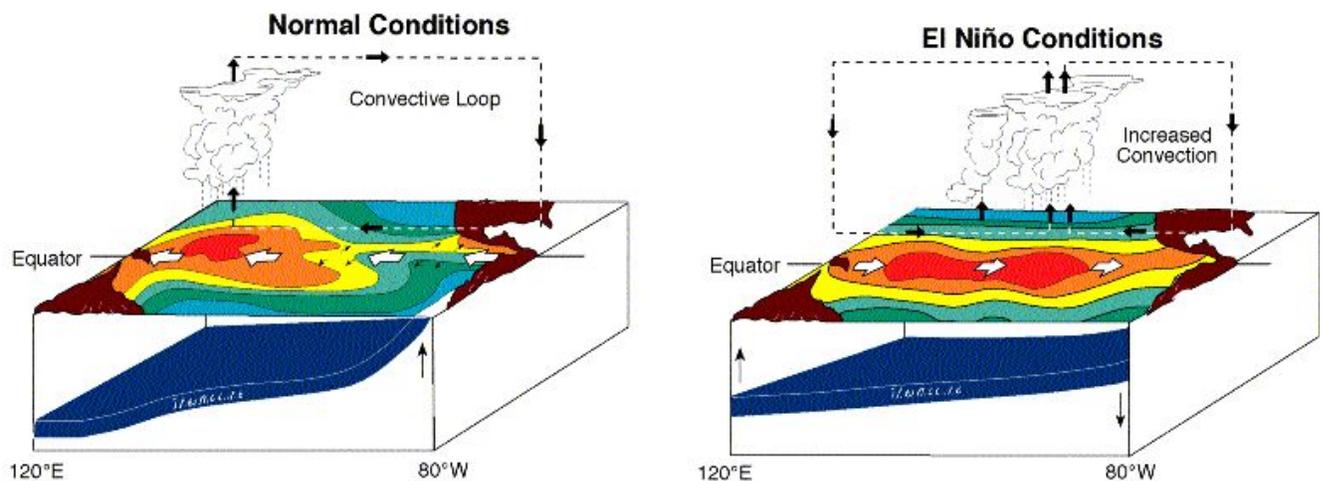
Using sea surface temperature maps and graphs from June 2013 and June 2015,

---

I can see that the sea surface temperatures are warmer in 2015 along the same transect line and closer to the California coast. Additionally, the SST graphs provided for 2014 and 2016 show SST values around 25 to 26 C while in 2015, the SST was much warmer at 29 C. The definition of El Niño is warmer sea surface temperatures along the eastern Pacific coast. So, SST increased in 2015 and then returned to its normal range as shown in the 2013, 2014, and 2016 data and maps.

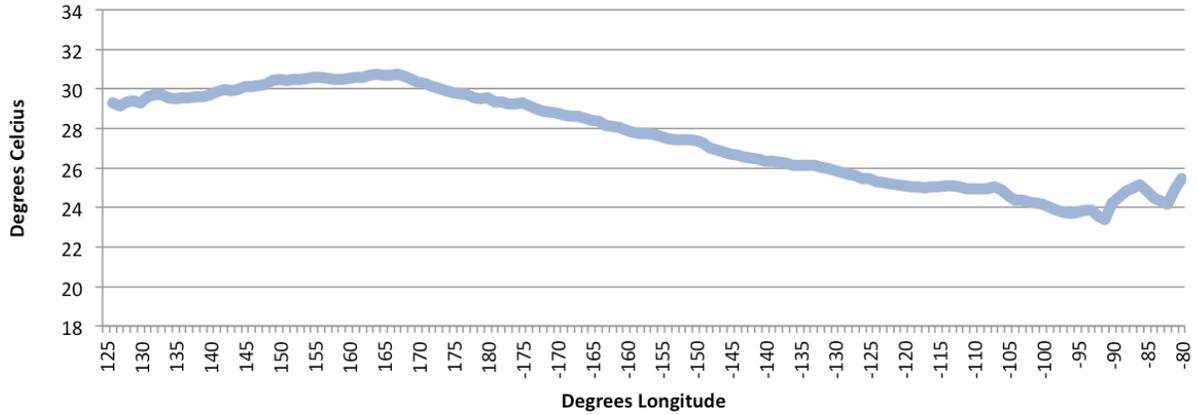
---

Draw a Conclusion: Did an El Niño event occur during the winter of 2015-2016? yes

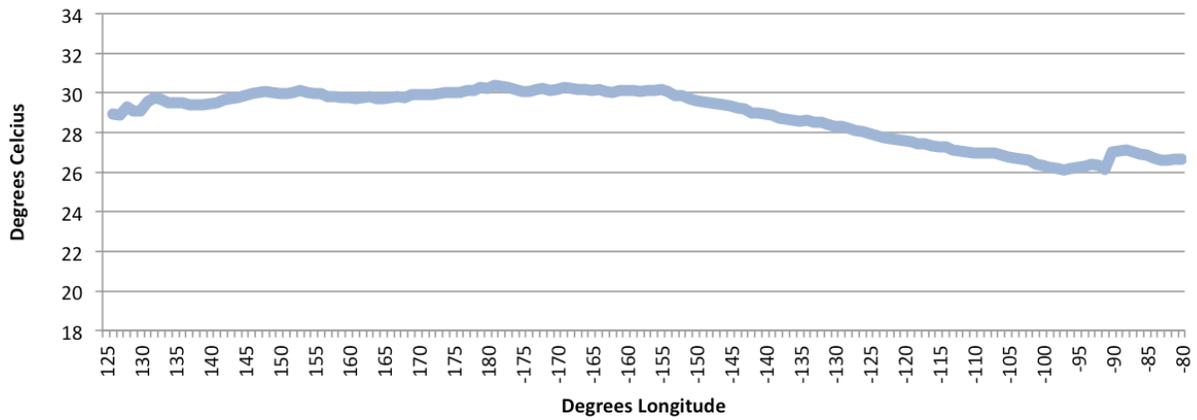


## REFERENCE DATA

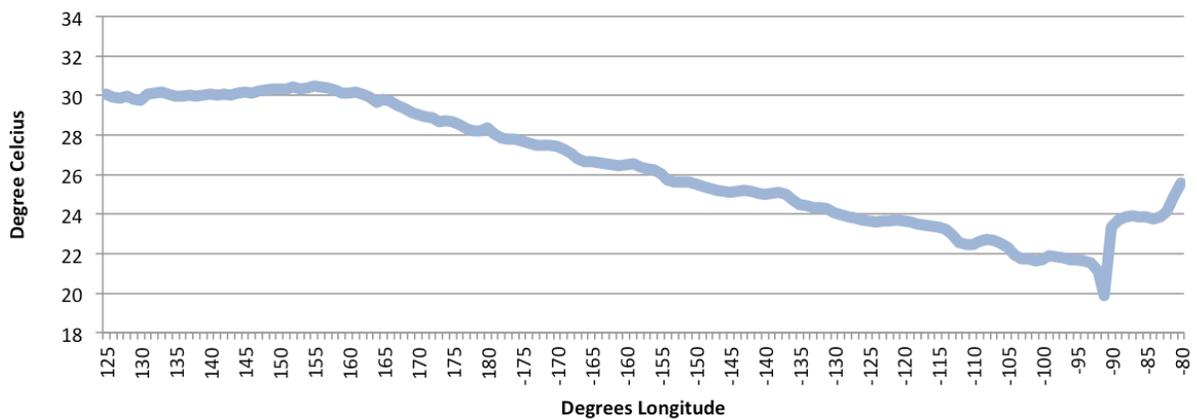
### Sea Surface Temperature at the Equator, December 2014



### Sea Surface Temperature at the Equator, December 2015

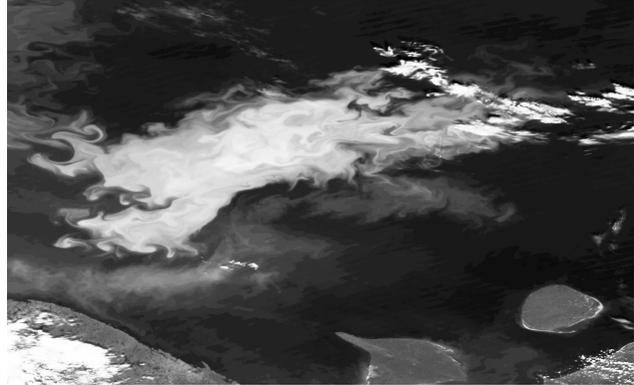


### Sea Surface Temperature at the Equator, December 2016



# Research Project: Exploring El Niño and Chlorophyll Data

Your mission: You have joined a team of scientists who are studying the effects of El Niño on biological systems in the ocean. Specifically, you are interested in the relationship between sea surface temperature (SST) and productivity, as measured by the amount of chlorophyll.



Your task is to determine if there is a relationship between sea surface temperature and the distribution of phytoplankton, and, if so, how this relationship is impacted during El Niño. The team has decided that you will compare two time periods: December 2009 and December 2010.

**1. Form a hypothesis:** Form a hypothesis to answer the research question below:

Research Question: Is there a relationship between sea surface temperature and the distribution of phytoplankton? If so, how is this distribution impacted during El Niño?

Hypothesis: During an El Niño event, when sea surface temperatures in the eastern Pacific ocean increase, the amount of phytoplankton, as measured using chlorophyll-a, decrease. \_\_\_\_\_ (fill in).

**2. Test Your Hypothesis with Data:** In order to test your hypothesis, closely observe the data maps and graphs presented in the Level 4 online activity, *Understanding El Niño*. Record your observations and analyze your data on the following page.

---

Compare the DATA MAPS for 2009 and 2010.

1. Which year shows warmer sea surface temperatures in the eastern Pacific (near the equator)? 2009
2. Which year shows higher chlorophyll concentrations in the eastern Pacific (near Mexico City)? 2010

Compare the GRAPHS for 2009 and 2010. Complete the table below.

		Date: 2009		Date: 2010	
Latitude	Longitude	SST	Chlorophyll	SST	Chlorophyll
0°	140° E	.41	.13	.45	.10
0°	180°	.44	.09	.35	.19
0°	140° W	.41	.19	.26	.22
0°	100° W	.31	.19	.14	.22

**3. Interpret the data:** Answer the questions below.

3. Which is the El Niño year? Which is the non-El Niño year? **2009 is the El Niño year.**
4. Can you see any patterns between SST and chlorophyll distribution? **yes**
5. Describe the pattern of SST and chlorophyll distribution during an El Niño year. **SST increases and chlorophyll decreases.**
6. Describe the pattern of SST and chlorophyll distribution during a non-El Niño year. **In a non-El Niño year, SST is lower and the chlorophyll distribution is higher.**

**4. Draw conclusions:**

7. Was your hypothesis supported? **Yes**
8. Based on your analyses of the data, how would you describe the relationship between El Niño, SST, and chlorophyll concentration?  
**In El Niño years, the SST is greater in the eastern Pacific and the chlorophyll concentration is lower in that same area. The warmer SST results in less upwelling and fewer nutrients being brought to the surface.**

# DESIGN YOUR OWN INVESTIGATION

Develop Your Question:

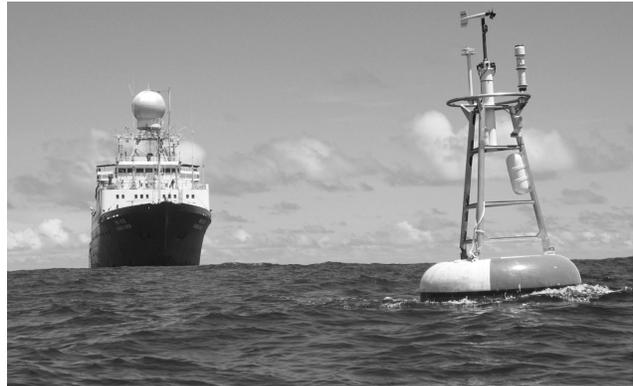
Are El Nino events becoming stronger?

---

---

---

---



Make a Plan: Make a list below of the specific data you will need to answer the question.

Data Set	Date	Map or Graph?
Example: Sea surface temperature	December 2015	map
El Nino Historical Index	Jan 1950 - Jan 2018	graph
SST and chlorophyll concentration	Jan-March 2015	graph
SST and chlorophyll concentration	Jan-March 1997	graph
SST and chlorophyll concentration	Jan-March 91	graph
SST and chlorophyll concentration	Jan-March 87	graph

Other than the data listed above, what other information (if any) will you need to answer your question?

I would like to have rainfall totals for those same time periods in the Pacific regions.

---

---

---

Get the data: Use the website to download the data you will need.

Interpret the data: What does your data show? Be specific and descriptive.

The El Nino historical index shows that there have been 8 years of very strong El Nino events and 7 years of moderate to strong events since 1950. Each decade seems to have 2-3 moderate to strong events. Since I do not have Microsoft tools on my computer, I am currently not able to create the graphs to get actual data. The maps I generated are not as easy to interpret. I also discovered that the rainfall data is listed under the climate tab but the images that are produced are very difficult to read and are pixlated. Ultimately, I am not getting easy to read data from this in order to evaluate my question.

---

---

---

---

---

---

---

---

Draw a Conclusion: What is the answer to your question? Use evidence and data to support your conclusion.

Based only on the one readable graph I have (El Nino historical index), I would say that it appears the events are getting stronger as the peak of the events is higher with later years; however I do not know if that anomaly is based on SST or rainfall totals. I definitely need to work with the tools more in order to have my students do activity 5.

---

---

---

---

---

---

---

---