Name: _____ Date: _____

OCN 104: Our Dynamic Ocean

Lab 12: El Nino Southern Oscillation

Part 1: Observations of the tropical Pacific Ocean during a "normal" year

The National Oceanographic and Atmospheric Administration (NOAA) maintains several laboratories around the country for specialized atmospheric and oceanic research. Data for this exercise come from NOAA's Pacific Marine Environmental Laboratory (PMEL) (http://www.pmel.noaa.gov).

The ocean data in this exercise were collected in the tropical Pacific Ocean to help monitor the development of El Niño and La Niña events, which are phenomena of the surface and near-surface Pacific Ocean. An array of moored buoys was established in the 1990's as part of the Tropical Atmosphere-Ocean (TAO) Project. Sensors attached to the buoys measure temperature, salinity, and other water properties from the surface to a depth of about 500 meters. **Figure 1** shows the buoy locations.

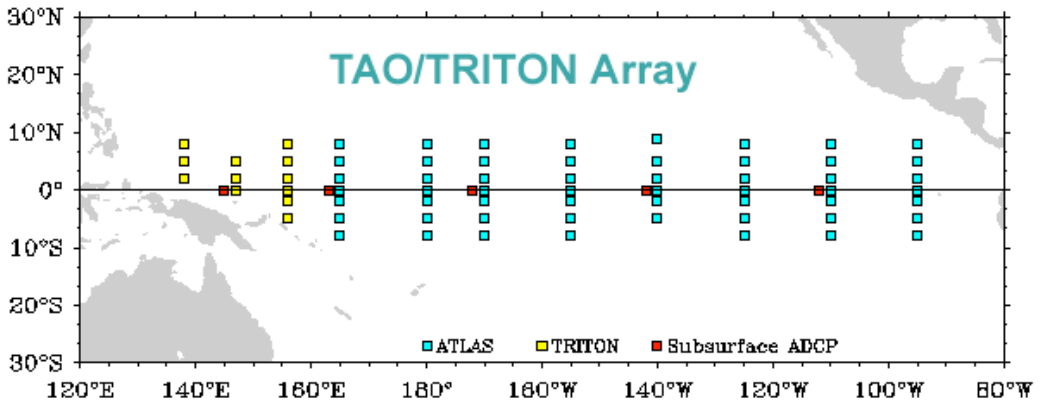

Figure 1

Questions

(1) Spatial variation, Part 1. Figure 2 is a color-filled contour plot showing water temperatures in a vertical slice 500 meters deep along the equator in the tropical Pacific Ocean, during a five-day period in March 2003. The sensors that recorded the data were located at positions marked by "×"s in **Figure 2**. The data were averaged meridionally (that is, along a line of longitude) across sensors located within ±2° latitude of the equator. (This plot came from the TAO web site: http://www.pmel.noaa.gov/tao/jsdisplay/.)

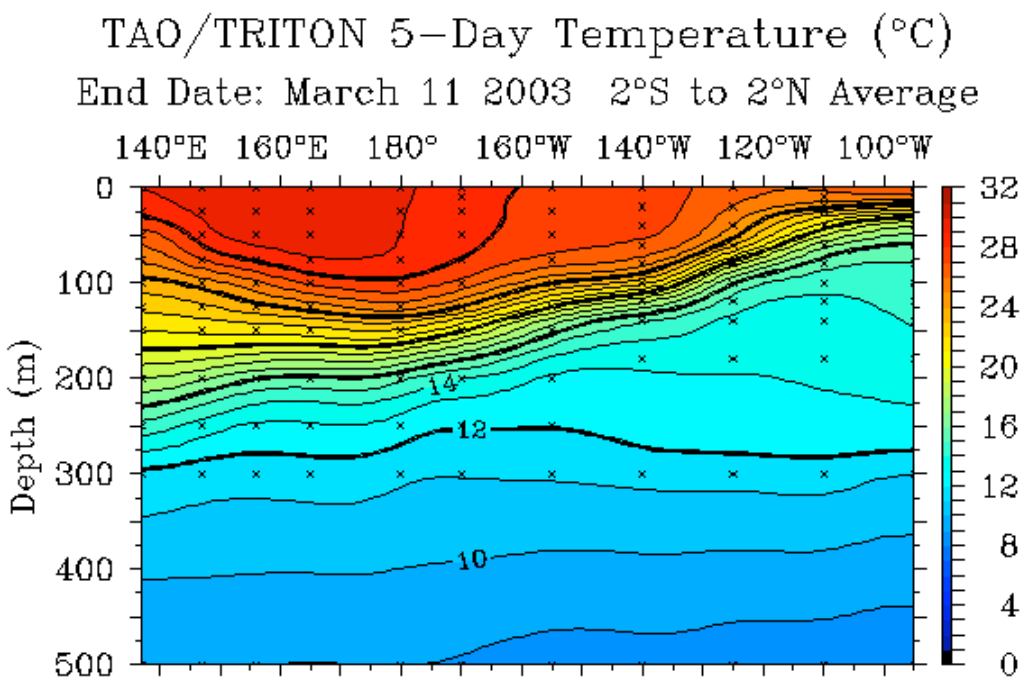

Figure 2

Based on the contour plot in **Figure 2**, fill in the following data tables for temperature vs. depth down to 500 meters at 165°E and at 110°W longitude. Note that the contour lines are plotted at intervals of 1°C and that the thicker contour lines correspond to temperatures of 12°, 16°, 20°, 24°, and 28°C. Your plot will be more accurate, and hence be more likely to capture the key features, if you don't rely on the colors to determine temperature but instead rely on the contours and interpolate between them as needed.

165°E

Depth	Temperature
0 m	
25 m	
50 m	
75 m	
100 m	
150 m	
200 m	
250 m	
300 m	
400 m	
500 m	

110°W

Depth	Temperature
0 m	
25 m	
50 m	
75 m	
100 m	
150 m	
200 m	
250 m	
300 m	
400 m	
500 m	

Now use these data to **create plots of the vertical temperature profile at each location** using Excel. Following convention, plot depth on the vertical axis, with the ocean surface at the top of the graph and depth increasing downward. Plot temperature on the horizontal axis, increasing to the right. Plot both profiles on the same graph (it is easiest to create a scatter plot without connecting lines first, and then add the lines). Make sure there is a key so that it is clear which line represents which location.

Based on your vertical profile plots and the contour plot answer the following questions:

Describe the pattern of temperature at the <u>surface</u> as you move from the east side of the basin to the west side of the basin. (Note that West is on the LEFT side and east is on the RIGHT).

How does the temperature profile differ in the eastern tropical Pacific compared to the western tropical Pacific? For example, where is the thermocline at each location? How deep is the mixed layer at each location?

Based on the pattern of sea surface temperature, and remembering that the atmosphere is heated from below, where would you expect to find warmer air? And therefore, where would you find higher air pressure? In the eastern or western Pacific?

Given your answer to the question above, which way would you expect the winds to blow along the equator?

Looking at your vertical temperature profiles, if the wind was blowing across the surface and causing equatorial divergence to a depth of approximately 75m, what would be the temperature of the water upwelled in the eastern tropical Pacific? What about in the western tropical Pacific?

Part 2: Observations of the tropical Pacific Ocean during an "El Nino" year

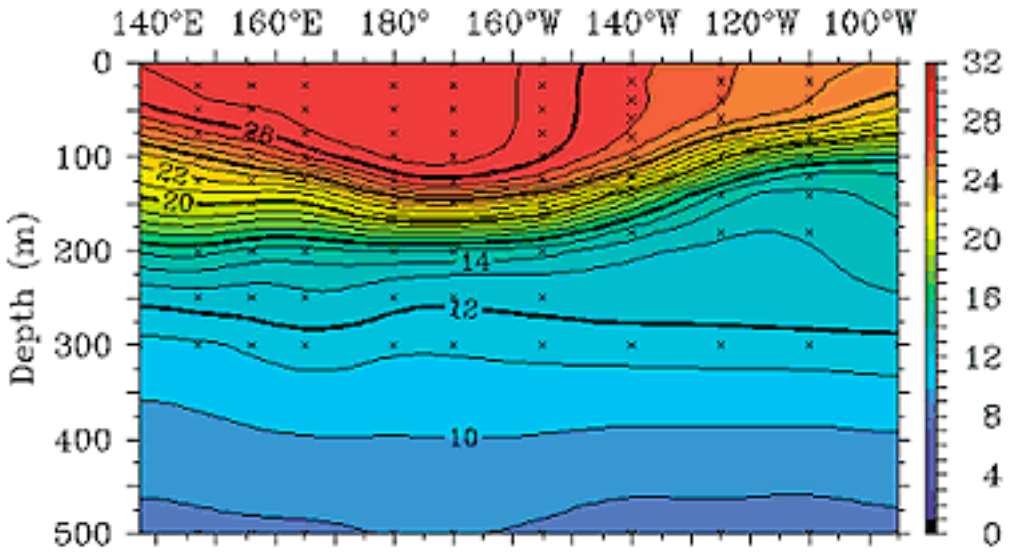

Figure 3

Figure 3 is the same as figure 2, but for December of 2002, which was an El Nino year. Again, fill in the data tables and use those data to make a plot of the temperature profiles for 165°E and at 110°W longitude.

165°E

Depth	Temperature
0 m	
25 m	
50 m	
75 m	
100 m	
150 m	
200 m	
250 m	
300 m	
400 m	
500 m	

110°W

Depth	Temperature
0 m	
25 m	
50 m	
75 m	
100 m	
150 m	
200 m	
250 m	
300 m	
400 m	
500 m	

Describe the pattern of temperature at the surface as you move from the east side of the basin to the west side of the basin. What are the similarities or differences between this and the "normal" year from part 1?

How do the vertical temperature profiles for this time period differ from the "normal" year? Be sure to describe differences in both the east and west Pacific ocean. For example, is the thermocline at the same depth?

Looking at your vertical temperature profiles, if the wind was blowing across the surface and causing equatorial divergence to a depth of approximately 75m, what would be the temperature of the water upwelled in the eastern tropical Pacific? What about in the western tropical Pacific?

Part 3: More information from the NOAA website

Go to the following website:
http://www.pmel.noaa.gov/toga-tao/el-nino-story.html

This site will help you answer the basic questions about El Nino.

With patterns evident in the data you can use this table to keep track of the physical changes that occur as the El Nino and La Nina phenomena cycle.

Conditions	Trade winds	Sea surface temp	Sea surface level
Normal			
El Nino			
La Nina			

What is the El Nino phenomenon?

What is La Nina?

How is La Nina different than El Nino?

Hypothesize what happens to coastal productivity during an El Nino event: (*Hint: check out the "Marine Life" link on the following website: http://www.elnino.noaa.gov/impacts.html*)

Lastly, click on the weblink below:
http://www.pmel.noaa.gov/tao/elnino/la-nina-pacific.html

Carefully examine the three graphics, of sea surface temperatures (SST) for La Nina, normal conditions, and El Nino.

What are the differences between the sea surface temperatures for the three conditions?