Summary: Participants learn what an upwelling is and the importance of changes in sea temperatures.

Grade Level:
Intermediate (grades 5-8)
Secondary (grades 9-12)

Time needed:
One 90 minute block class

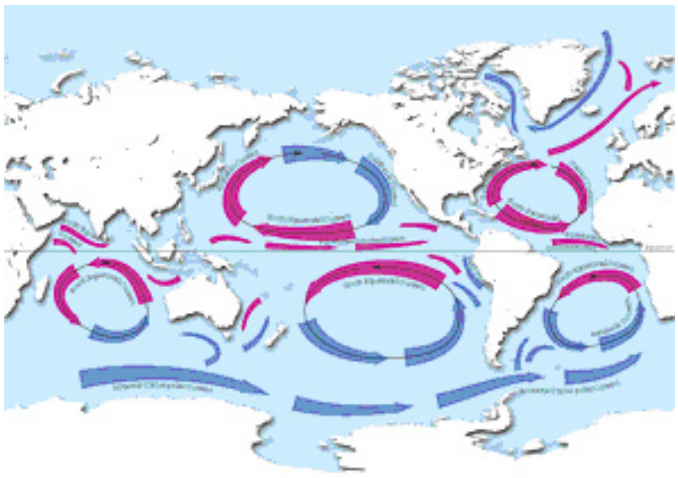
Learning Objectives:
- Understand scientific inquiry
- Understand ocean motions and forces
- Understand populations and ecosystems
- Understand environmental quality and natural resources

Materials:
- Computer with internet connection
- Colored pencils

Background

The combination of the uneven heating of the earth's surface and the spinning of the Earth on its axis prevents the movement of air and water on earth from moving in a straight path from the equator to the poles. Ocean surface currents and wind currents move in circulation patterns away from the equator transporting heat toward the poles.

Where the cold ocean water currents moving from the poles contact the warm equatorial currents, deep nutrient rich water moves to the surface. This process is called upwelling and is essential to ocean patterns and the food web on earth. The nutrient rich waters nourish marine life, which in turn feed birds, larger marine mammals, and onward up the food chain to humans.



Surface Ocean Currents

Every 3 - 7 years, an El Niño occurs. Scientists believe that warmer than normal waters in the Pacific Ocean prevents the current from moving as far northerly as usual. This disrupts the Ocean circulation patterns and the upwelling does not occur. The cold current is shifted more easterly which causes the air masses above to move north and east finally reaching Texas & California. These areas now get heavier than normal precipitation resulting in severe flooding and mudslides.

B. Print the above map and place a star to identify 3 possible locations where an upwelling would normally occur under non-El Nino circulation conditions.

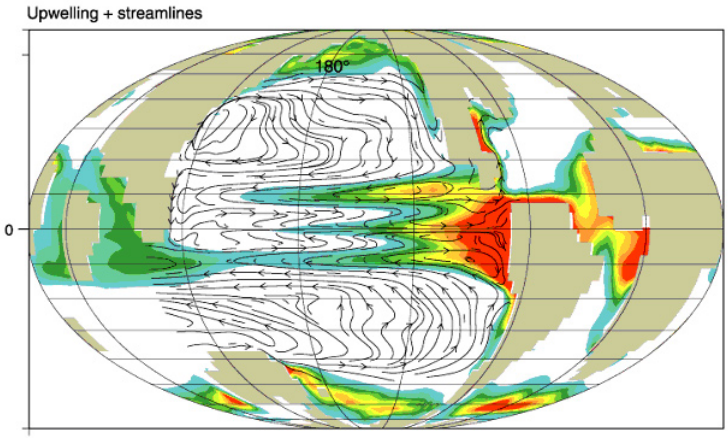
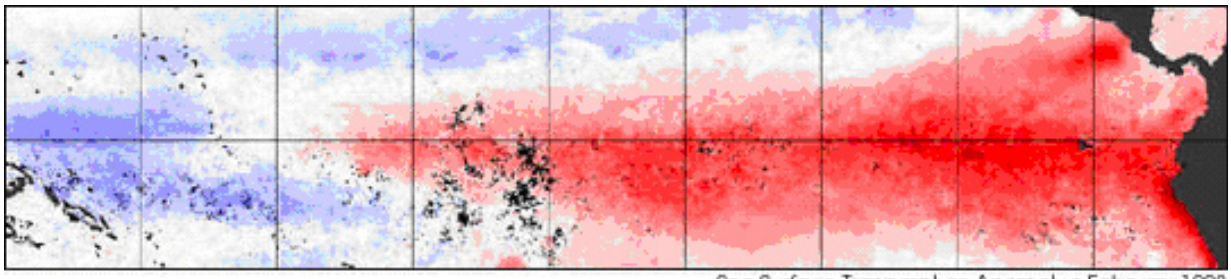
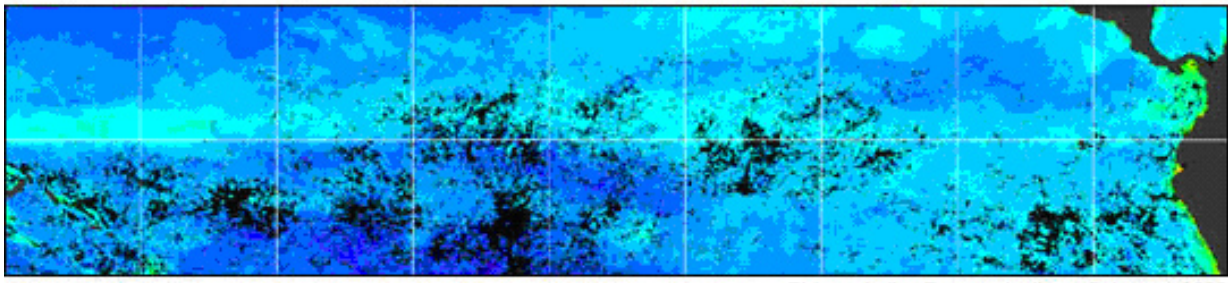


Figure F1 (above). Global land-sea distribution and annual average map of upwelling into the thermocline. Red = regions of vigorous upwelling, Green to blue = regions of weak upwelling, White = areas of mean downwelling.


Sea Surface Temperature Anomaly • February 1998

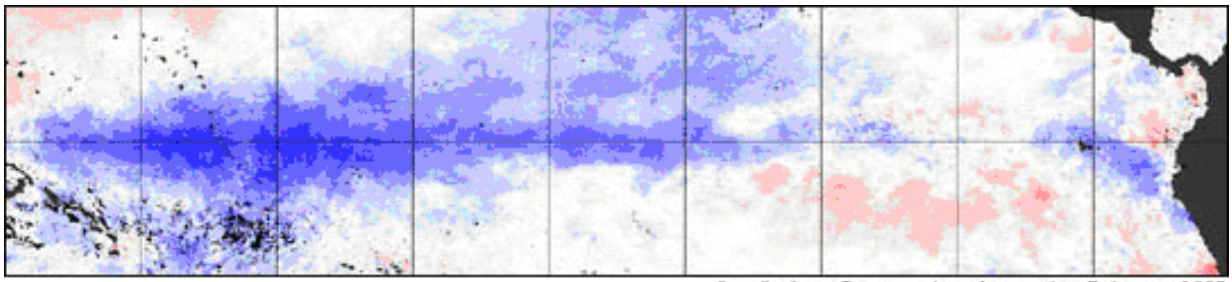

Chlorophyll a Concentration • February 1998

The SeaWiFS Satellite recorded above normal sea temperatures in 1998 off the western coast of South America in 1998. The band of green indicates the growth of phytoplankton north of the equator The satellite that carries the instrument moves in a near-circular orbit from pole to pole and allows SeaWiFS to scan a majority of Earth's oceans every five days. The data beamed back to scientists are used to create weekly maps of the algae. During a normal year the currents produce equatorial upwelling and give rise to beds of algae. When El Niño hits, warm water prevents this upwelling, as it does in many other parts of the ocean, and the algae

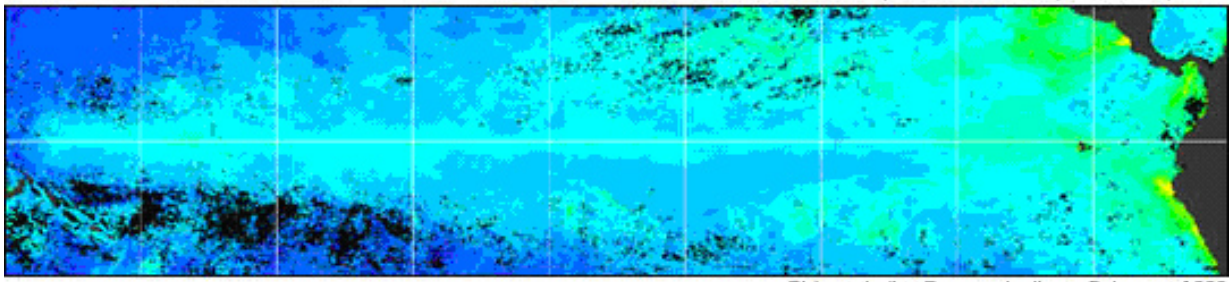
die off. At the end of the cycle the algal bloom should re-establish themselves at the equator.

La Niña is essentially the opposite of the El Niño phenomenon and is characterized by unusually cold ocean temperatures in the equatorial Pacific, as compared to El Niño, where ocean temperatures are warmer than normal. La Niña and El Niño often are spoken of together and termed the El Niño/Southern Oscillations, or "ENSO." La Niña sometimes is referred to as the cold phase of the ENSO.

C. Now compare the above images with the images below. Determine whether the following images were from an El Niño year or a La Niña year. Explain your answer.



Sea Surface Temperature Anomaly • February 1999



Chlorophyll a Concentration • February 1999

D. Describe how satellites collect information (data) about planet Earth. List one satellite that can provide scientists information about El Niño.

E. How does upwelling affect life in the ocean? Describe why algae are important.