



Fundamentals of synoptic meteorology

Lecture 20

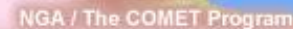
Sahraei

Physics Department

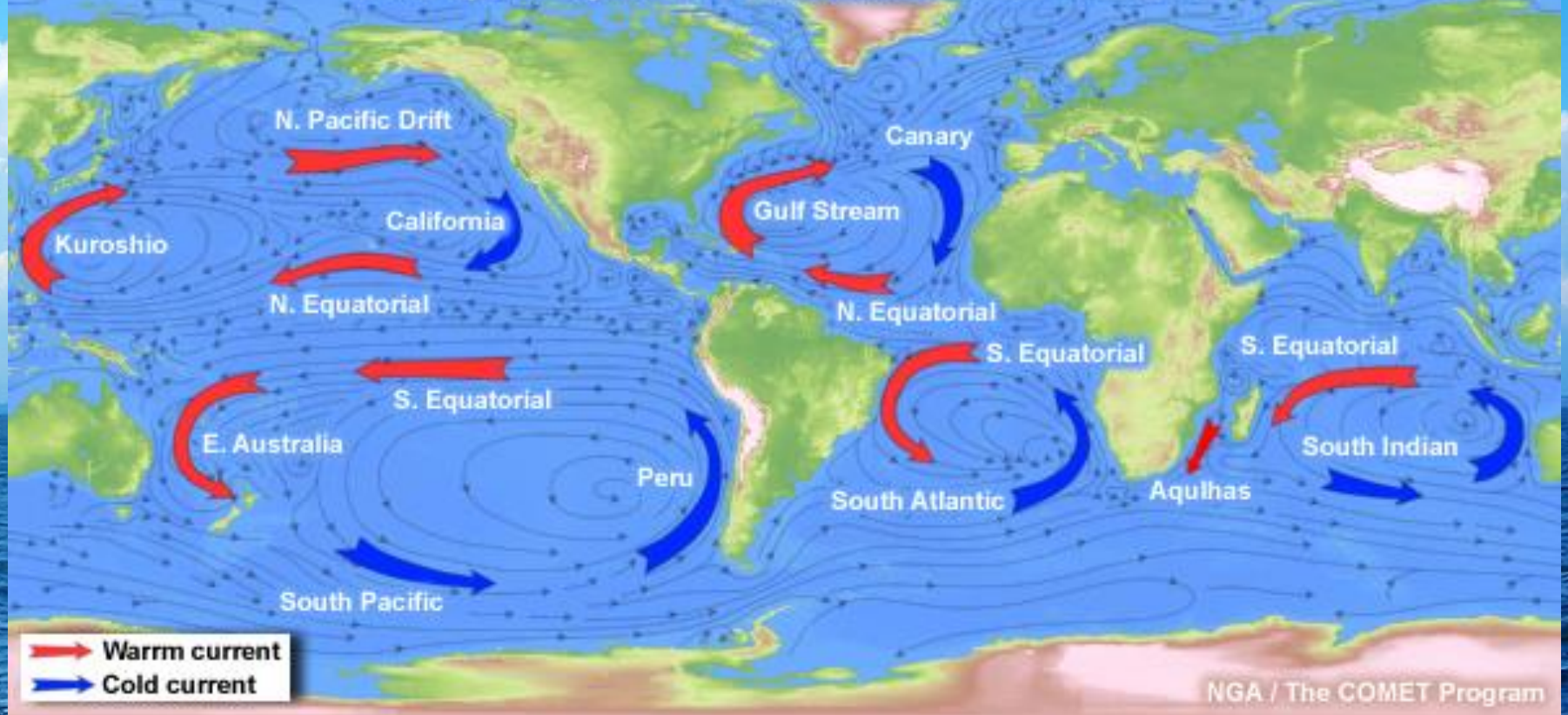
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Subtropical Gyres and Associated Ocean Currents



El Niño & La Niña

El Niño

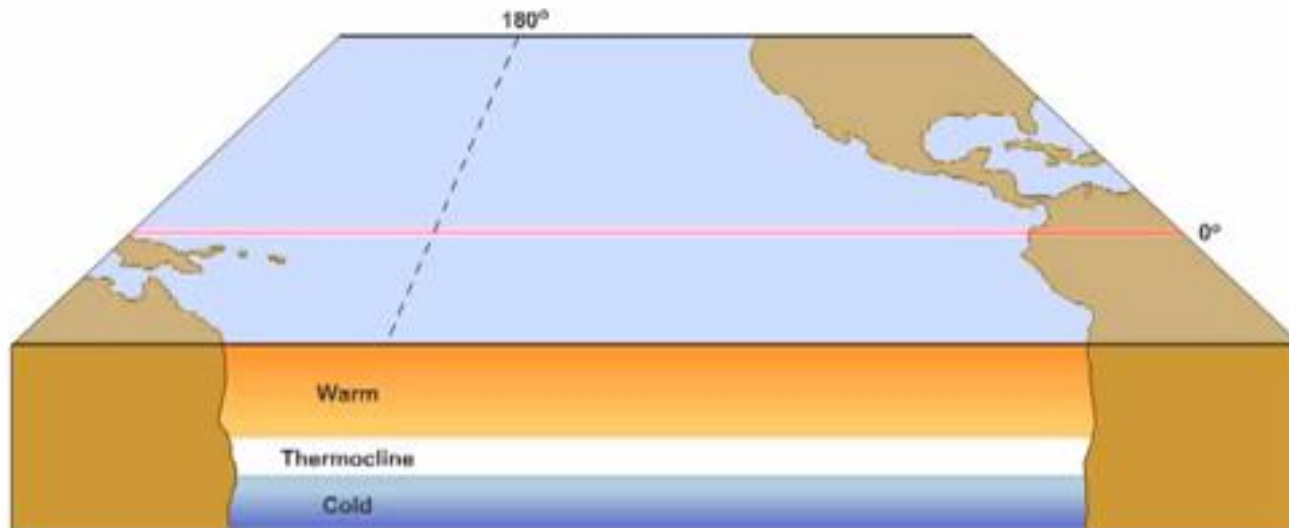


La Niña



Ocean Circulation

Normal Conditions



Develop
Normal Conditions

Develop
El Niño Conditions

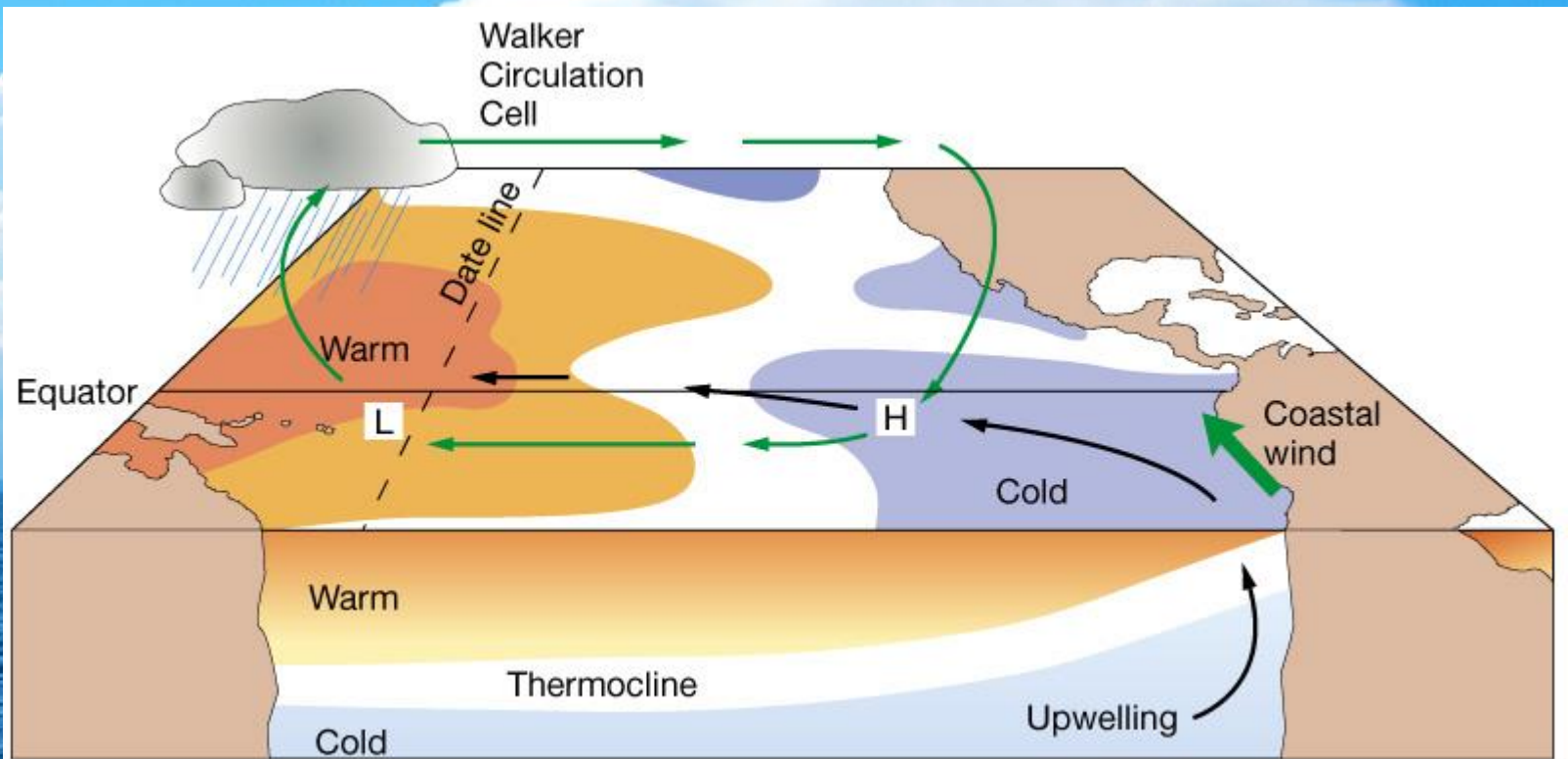
Develop
La Niña Conditions

Clear All

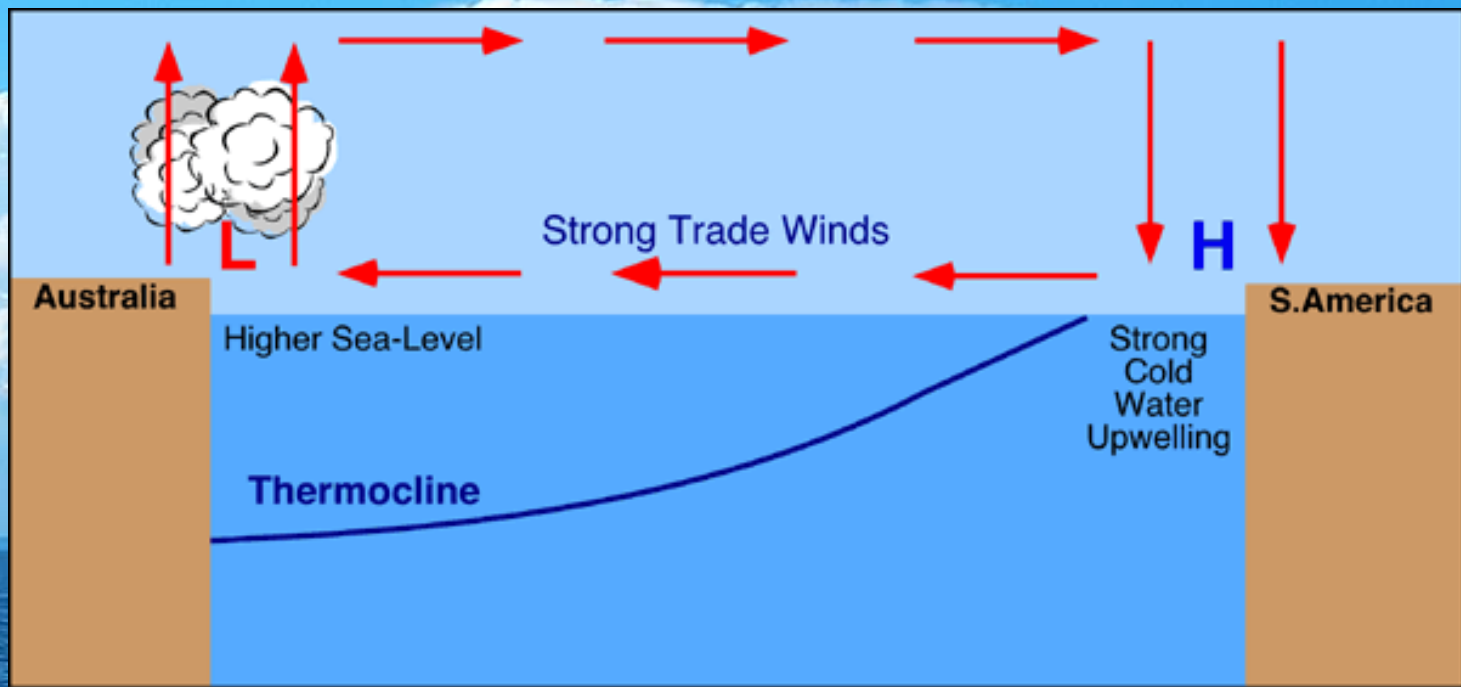
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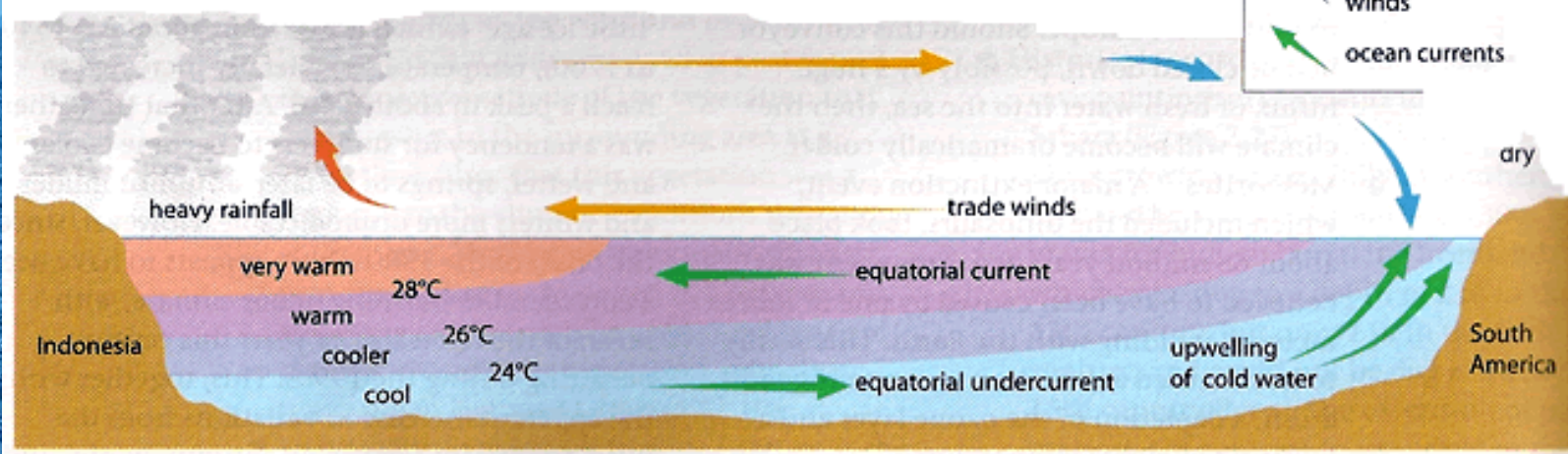
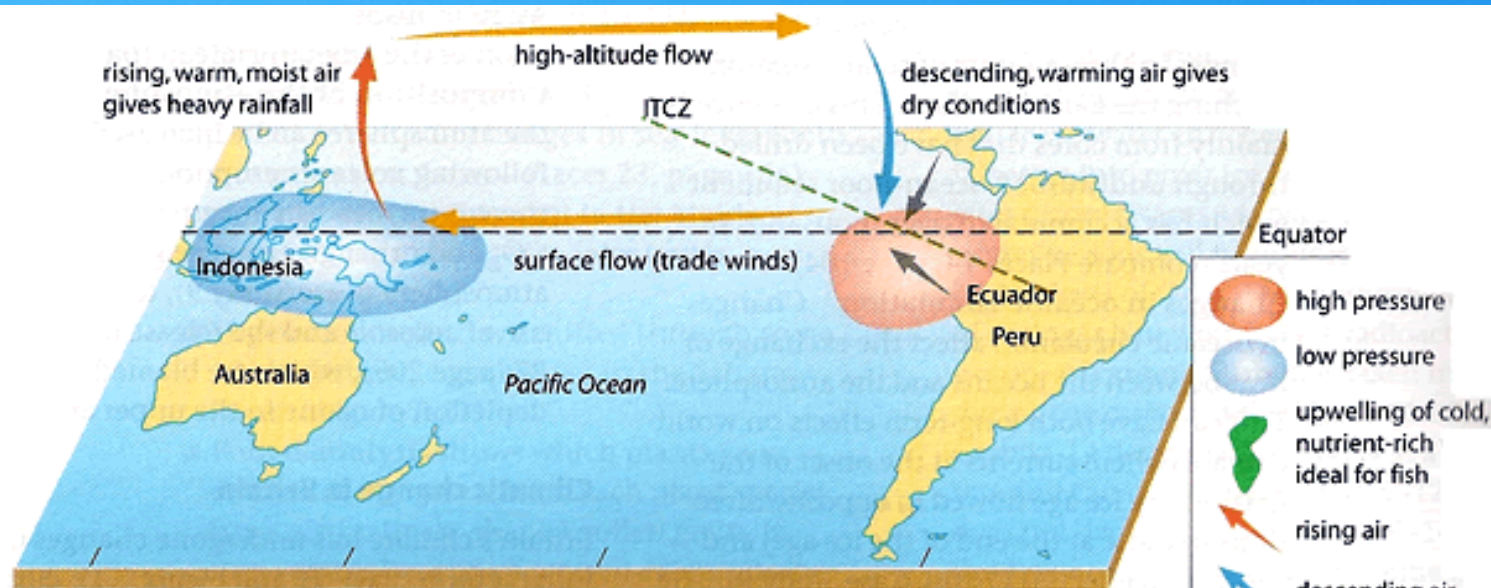


Normal conditions in the Pacific Ocean



(a) Normal conditions





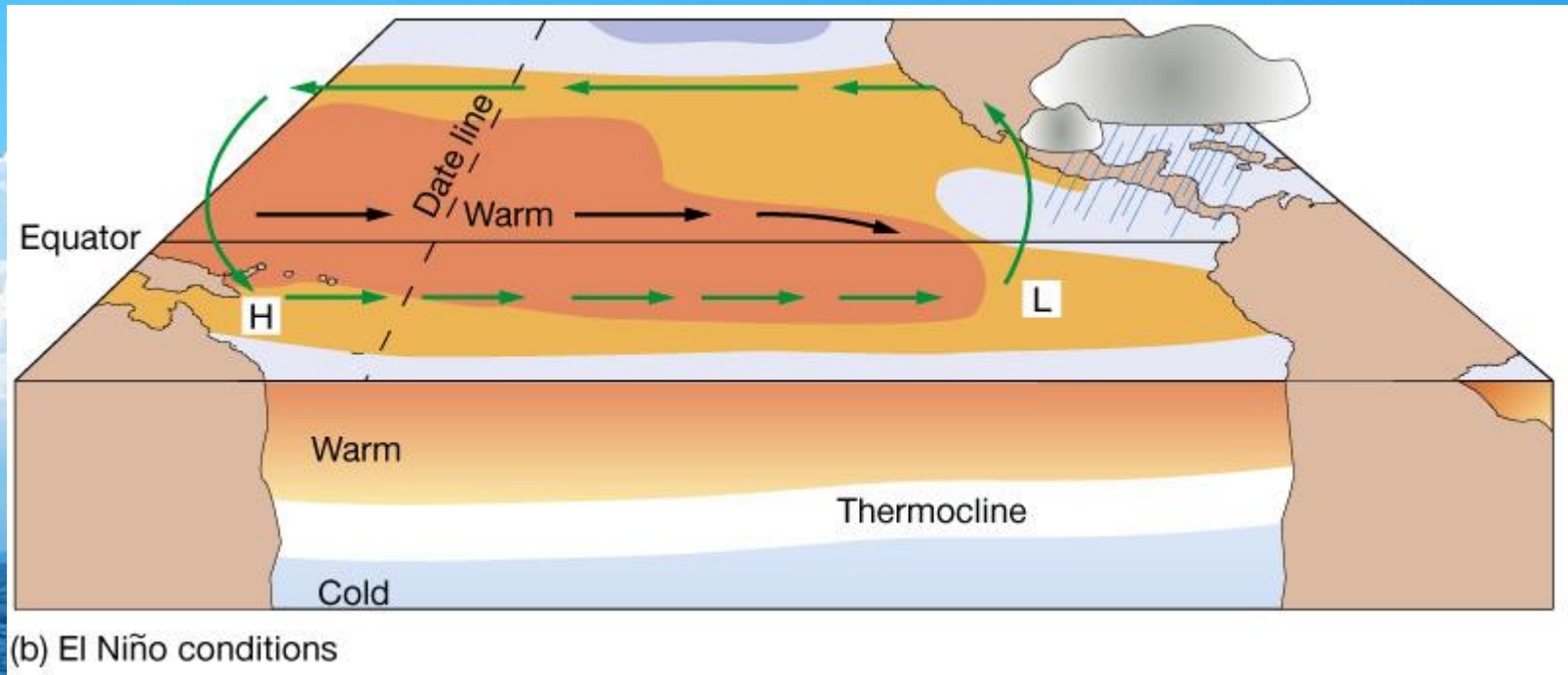
El Niño-Southern Oscillation (ENSO)

El Niño (Spanish for "the Child" in reference to baby Jesus) = warm surface current in equatorial eastern Pacific that occurs periodically around Christmastime

Southern Oscillation = change in atmospheric pressure over Pacific Ocean accompanying El Niño

ENSO describes a combined oceanic-atmospheric disturbance

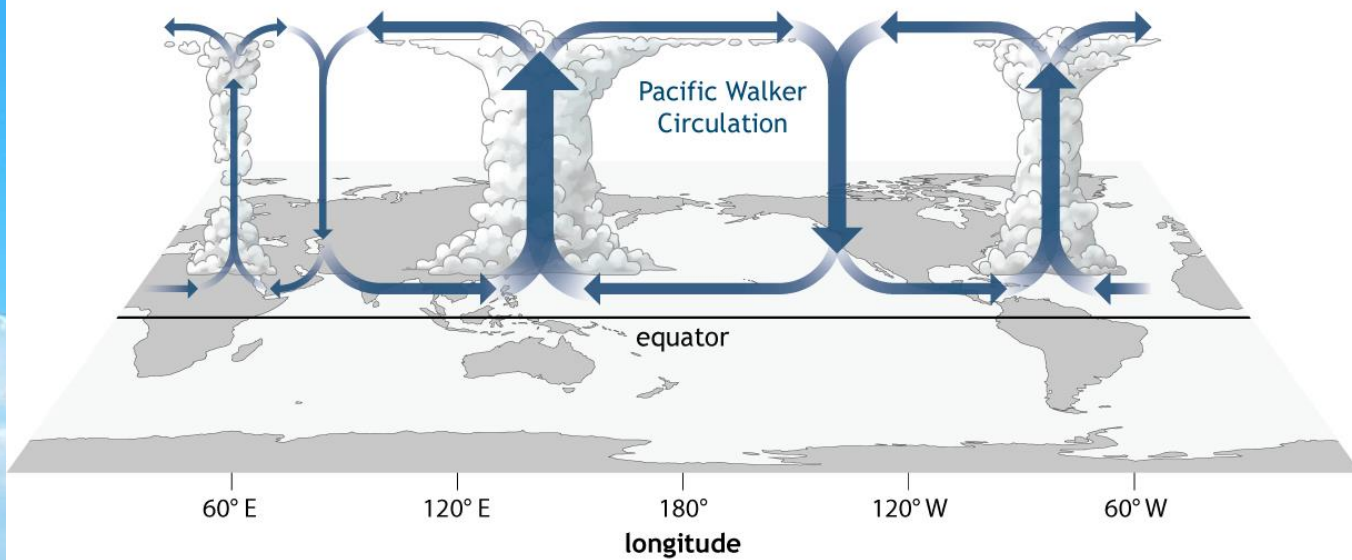
El Niño conditions (ENSO warm phase)



El Niño refers to the large-scale ocean-atmosphere climate phenomenon linked to a periodic warming in sea-surface temperatures across the central and east-central equatorial Pacific.

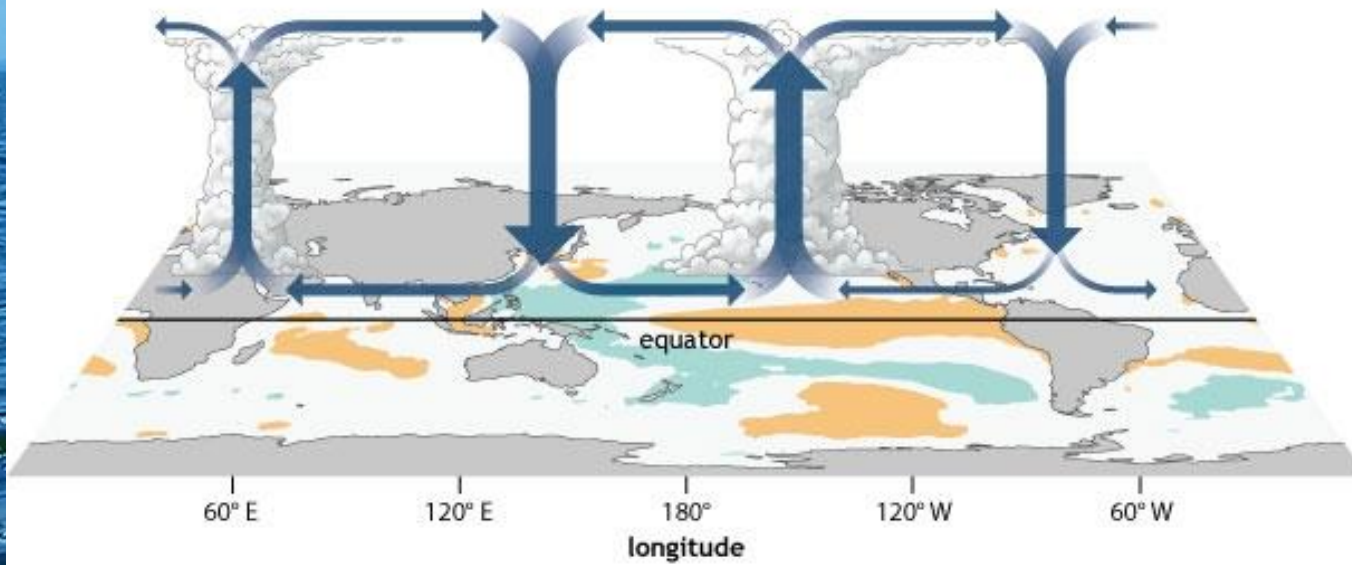
El Niño originally referred to an annual warming of sea-surface temperatures along the west coast of tropical South America.

Neutral conditions



NOAA Climate.gov

El Niño conditions



NOAA Climate.gov

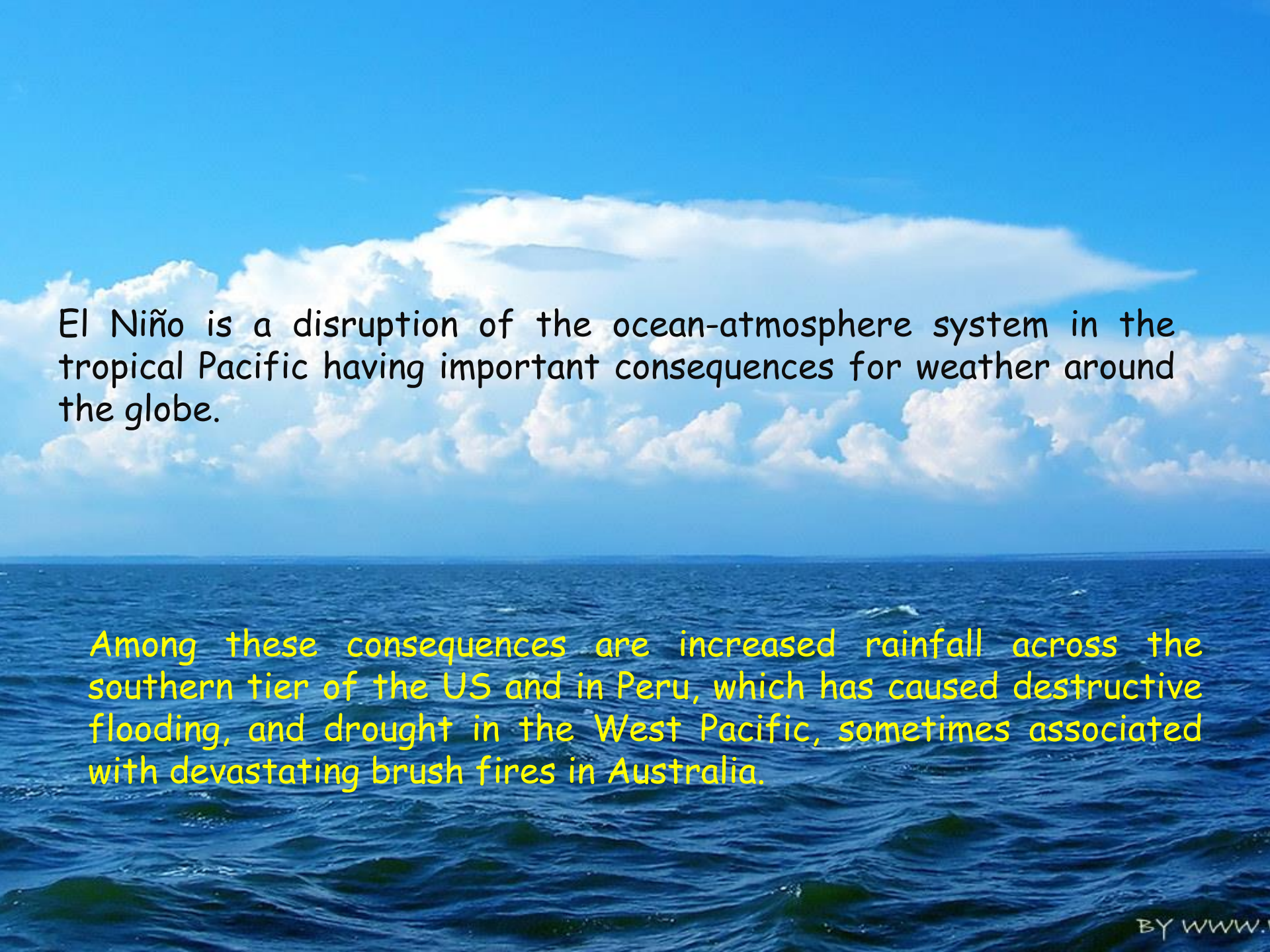
Why El Niño occurs?

El Nino is thought to occur due to changes in the normal patterns of trade wind circulation.

Normally, these winds move westward, carrying warm surface water to Indonesia and Australia and allowing cooler water to upwell along the South American coast.

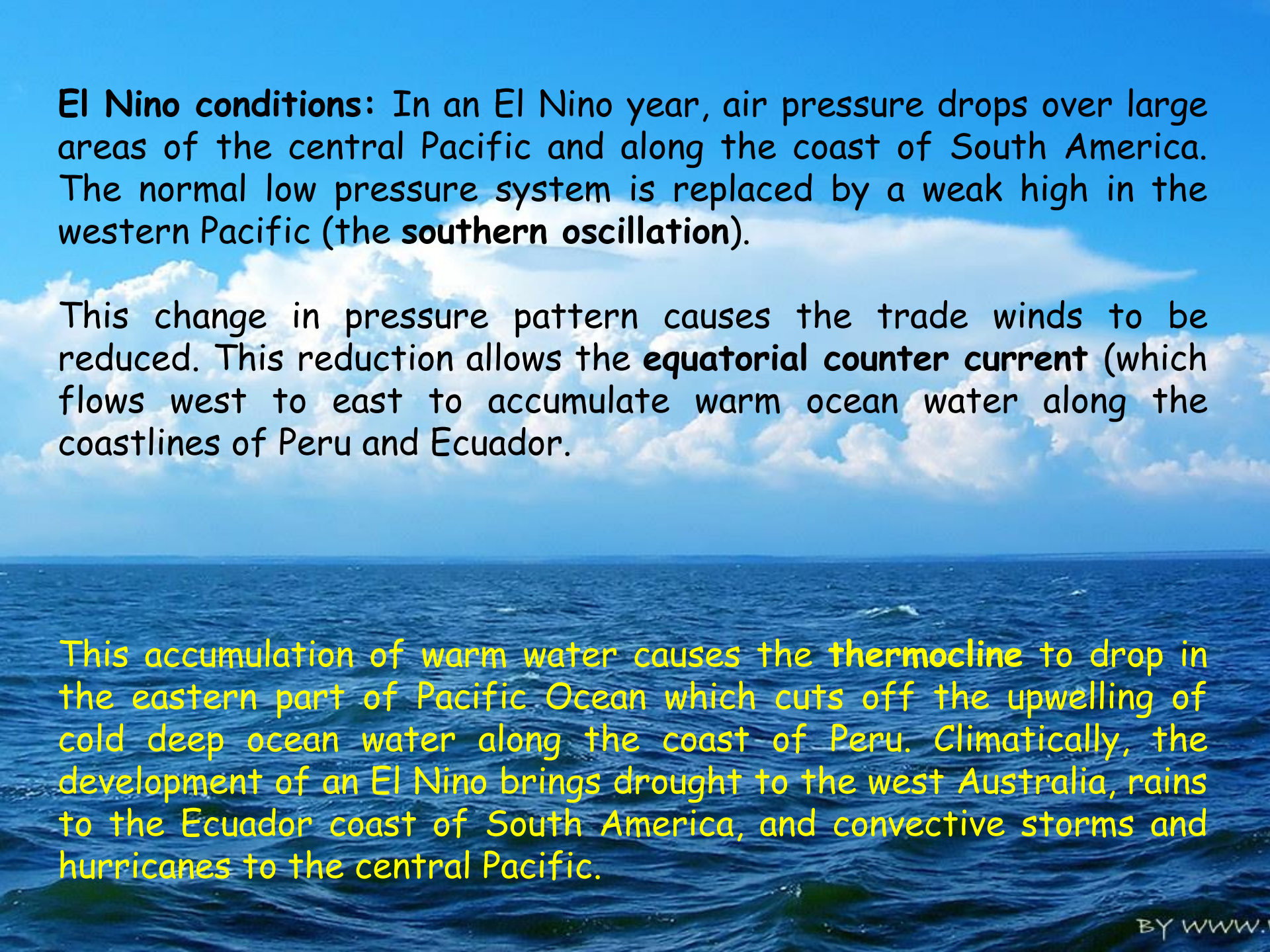
For reasons not yet fully understood, these trade winds can sometimes be reduced, or even reversed. This moves warmer waters toward the coast of South America and raises water temperatures.

Warmer water causes heat and moisture to rise from the ocean off Ecuador and Peru, resulting in more frequent storms and torrential rainfall over these normally arid countries.



El Niño is a disruption of the ocean-atmosphere system in the tropical Pacific having important consequences for weather around the globe.

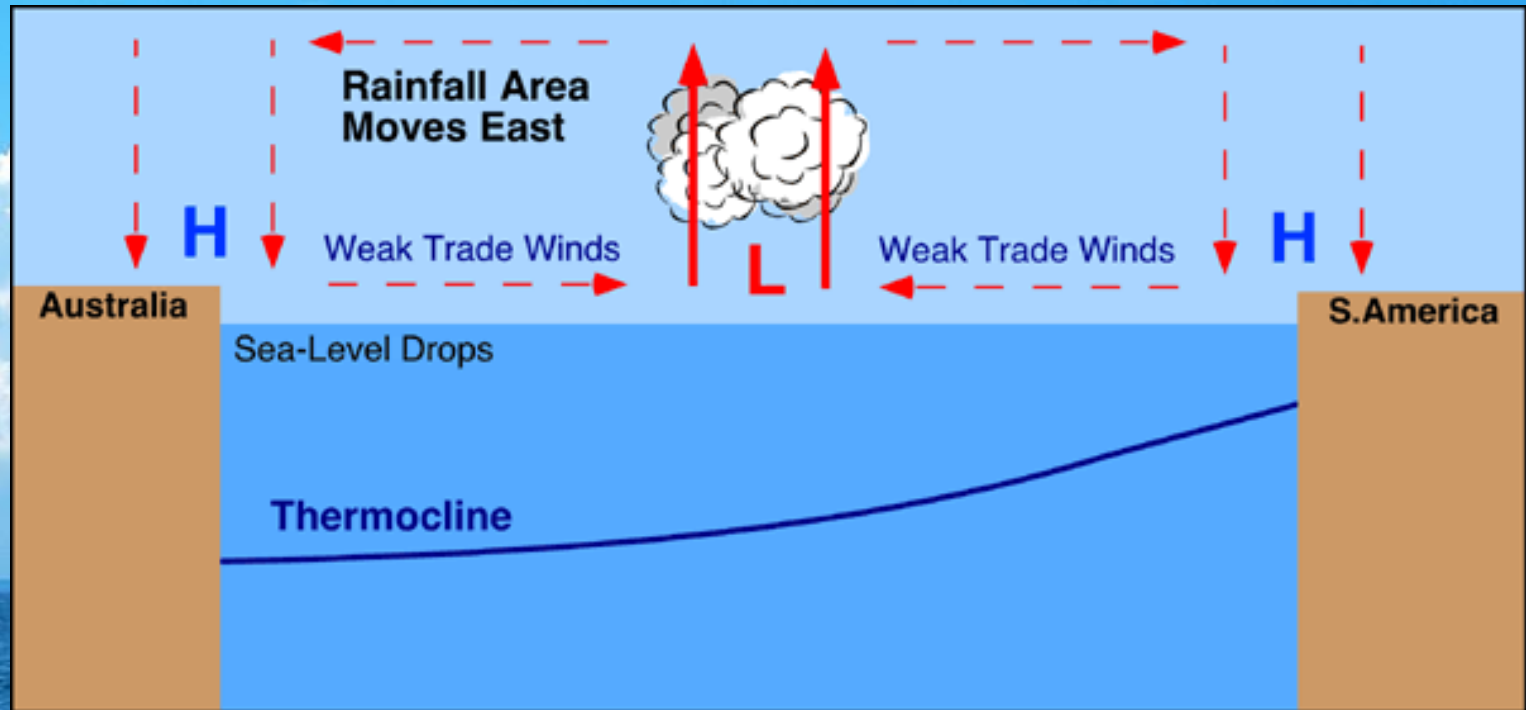
Among these consequences are increased rainfall across the southern tier of the US and in Peru, which has caused destructive flooding, and drought in the West Pacific, sometimes associated with devastating brush fires in Australia.



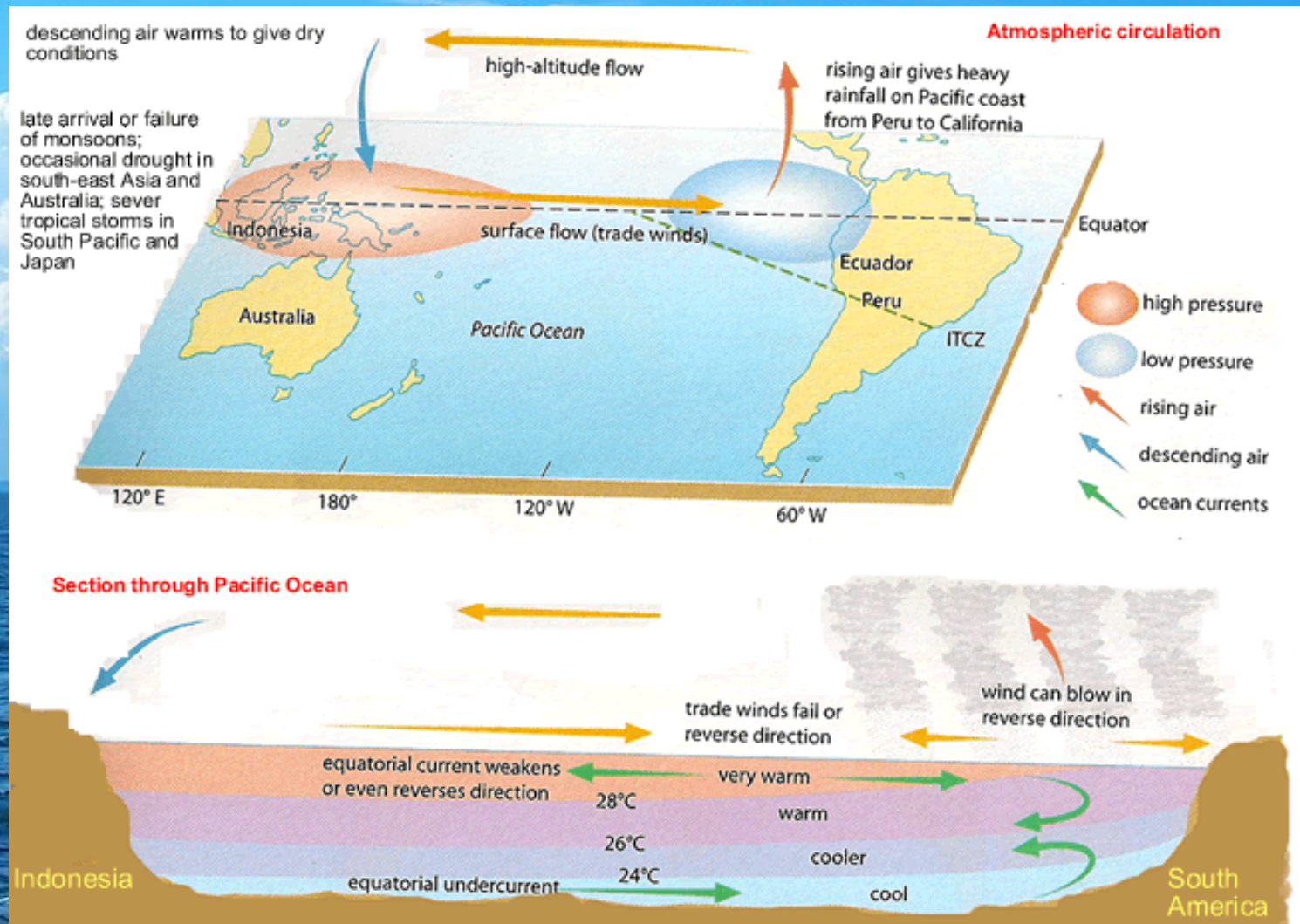
El Nino conditions: In an El Nino year, air pressure drops over large areas of the central Pacific and along the coast of South America. The normal low pressure system is replaced by a weak high in the western Pacific (the **southern oscillation**).

This change in pressure pattern causes the trade winds to be reduced. This reduction allows the **equatorial counter current** (which flows west to east to accumulate warm ocean water along the coastlines of Peru and Ecuador).

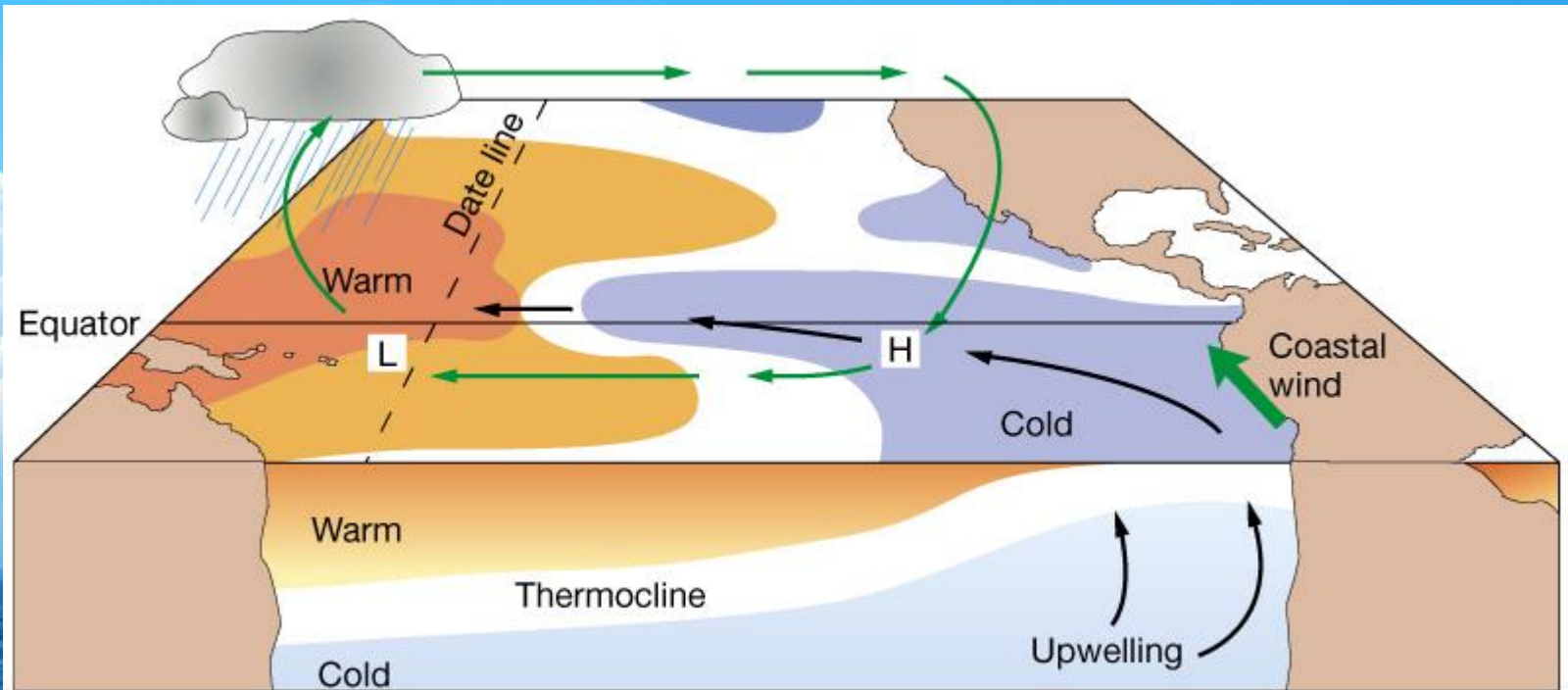
This accumulation of warm water causes the **thermocline** to drop in the eastern part of Pacific Ocean which cuts off the upwelling of cold deep ocean water along the coast of Peru. Climatically, the development of an El Nino brings drought to the west Australia, rains to the Ecuador coast of South America, and convective storms and hurricanes to the central Pacific.



El Nino and cross-section of Pacific,



La Niña conditions (ENSO cool phase; opposite of El Niño)

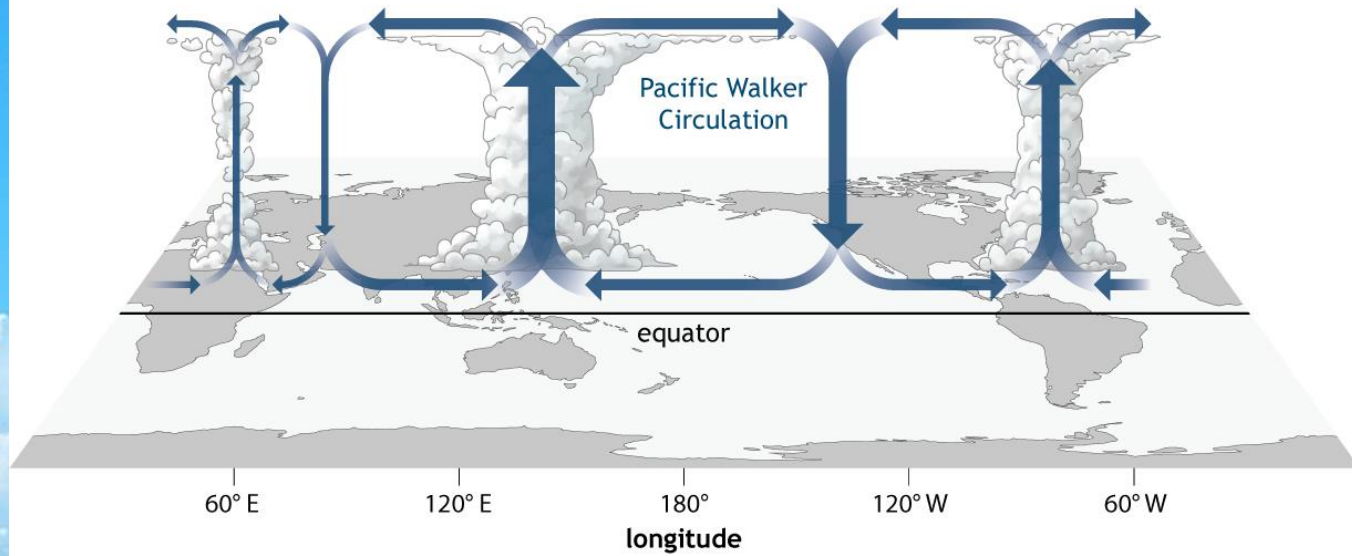


(c) La Niña conditions

La Niña refers to the periodic cooling of ocean surface temperatures in the central and east-central equatorial Pacific.

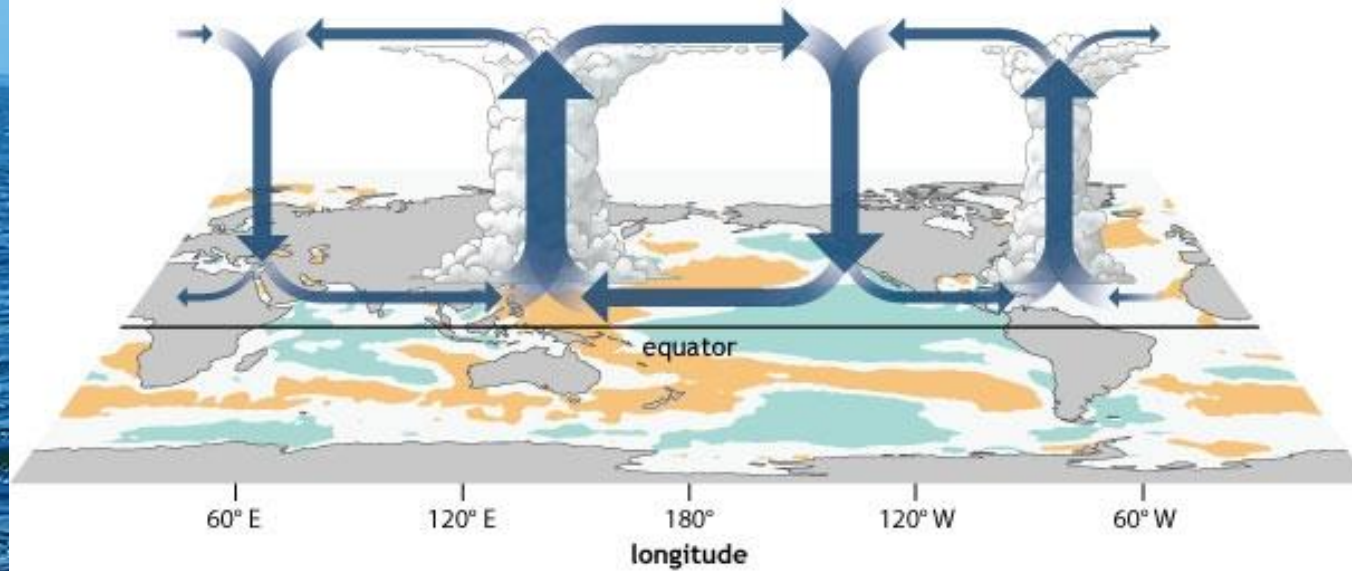
La Niña originally referred to an annual cooling of ocean waters off the west coast of Peru and Ecuador.

Neutral conditions



NOAA Climate.gov

La Niña conditions



NOAA Climate.gov

What is La Niña?

La Niña is characterized by unusually cold ocean temperatures in the Equatorial Pacific, compared to El Niño, which is characterized by unusually warm ocean temperatures in the Equatorial Pacific.

In contrast to El Niño, La Niña (female child) refers to an anomaly of unusually cold sea surface temperatures found in the eastern tropical Pacific. La Niña occurs roughly half as often as El Niño.

Why La Niña Occurs?

La Niña is thought to occur due to increases in the strength of the normal patterns of trade wind circulation.

Under normal conditions, these winds move westward, carrying warm surface water to Indonesia and Australia and allowing cooler water to upwell along the South American coast.

For reasons not yet fully understood, periodically these trade winds are strengthened, increasing the amount of cooler water toward the coast of South America and reducing water temperatures.



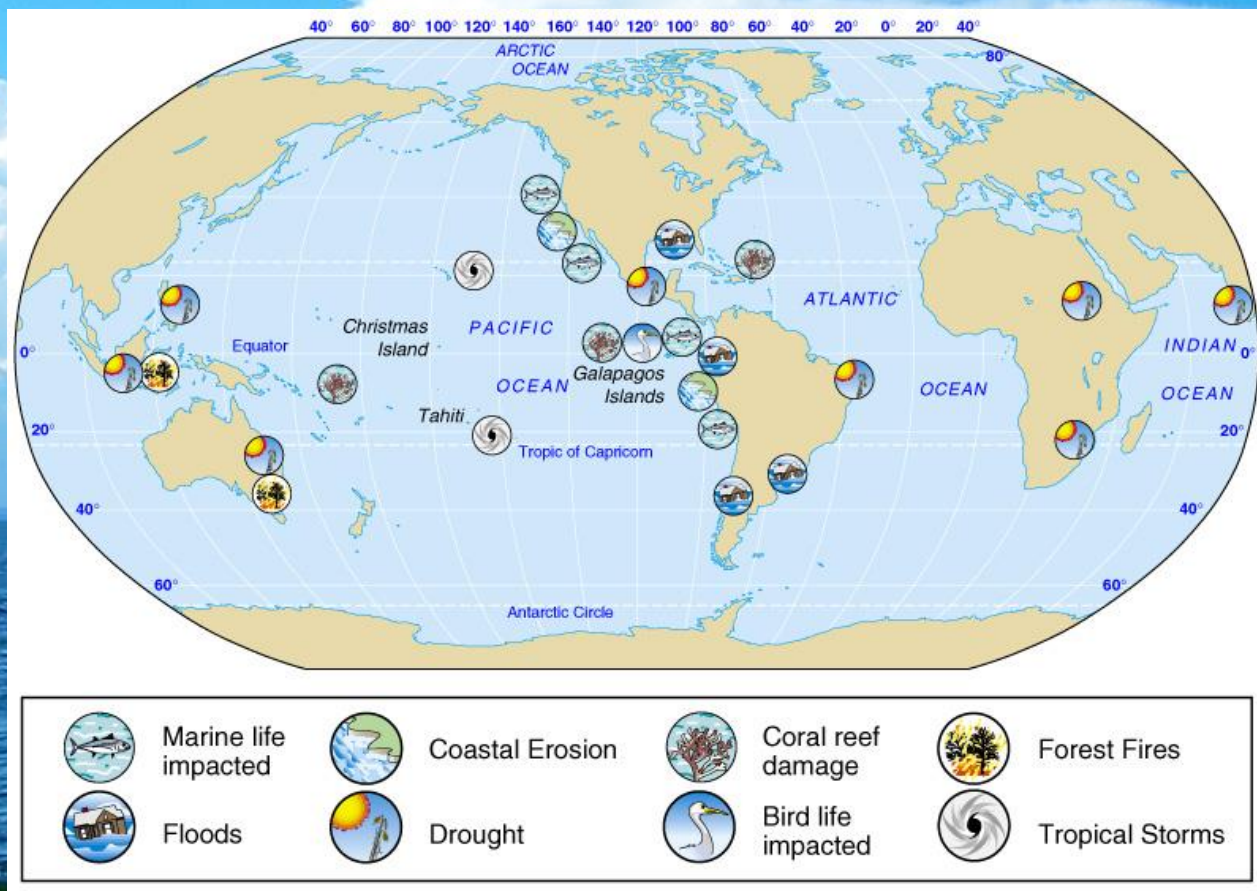
La Niñas appear approximately every 4-5 years.

Observations of conditions in the tropical Pacific are considered essential for the prediction of short term (a few months to 1 year) climate variations.

effects of El Nino on Global Climate

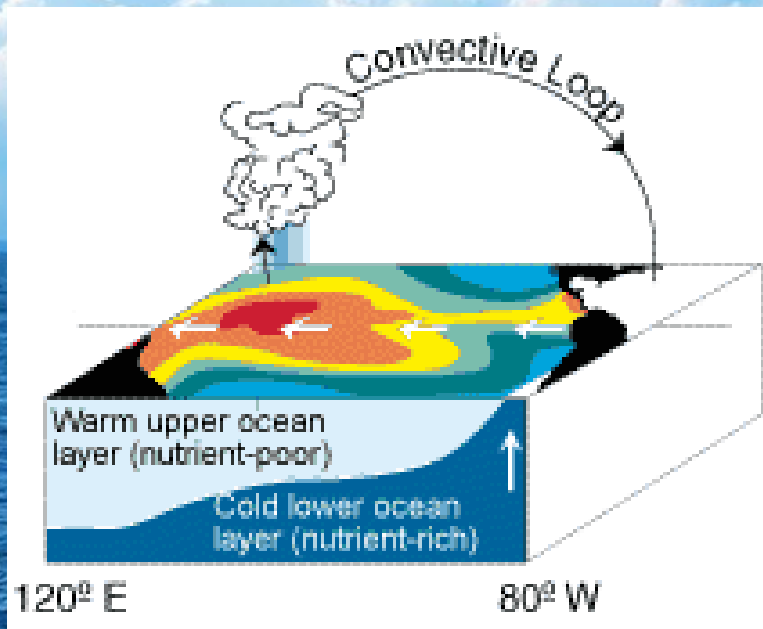


Effects of severe El Niños

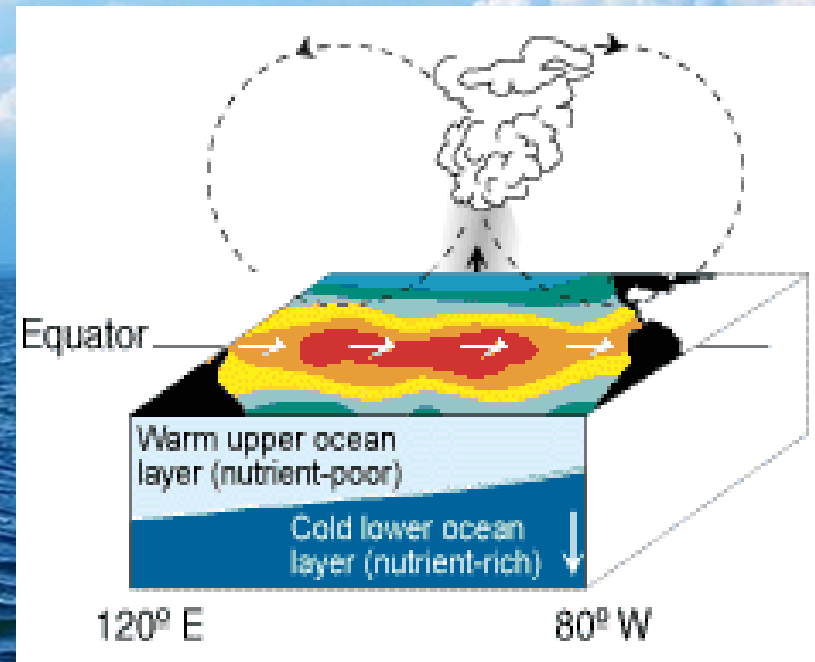


Comparison of Normal and El Niño Conditions

Normal conditions

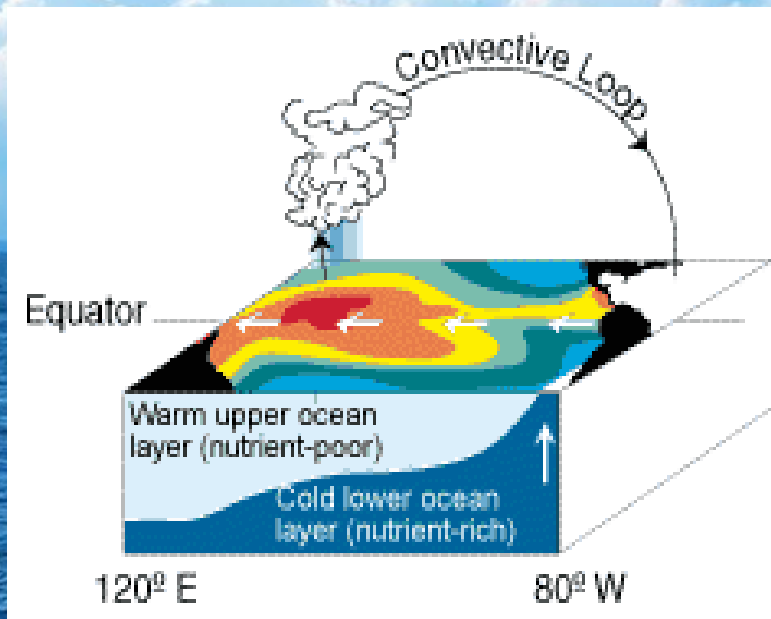


El Niño conditions

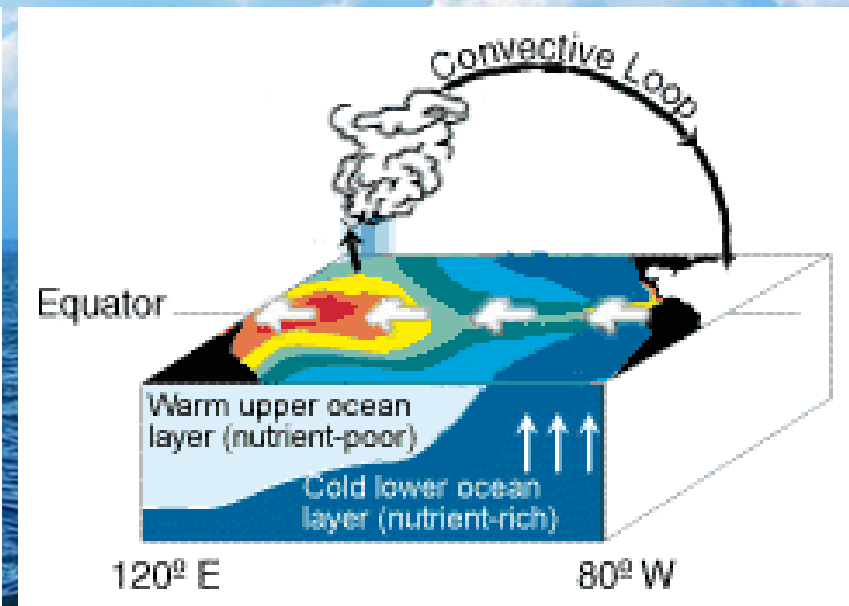


Comparison of Normal and La Niña Conditions

Normal conditions



La Niña conditions



Anomaly maps

Anomaly (a = *without*, nomos = *law*) maps show the difference from normal conditions

Sea Surface Temperature (SST) anomaly maps are useful for identifying unusually warm or cool water:

Positive SST anomaly values = water warmer than normal

Negative SST anomaly values = water cooler than normal