

# Lecture 10

GLY102

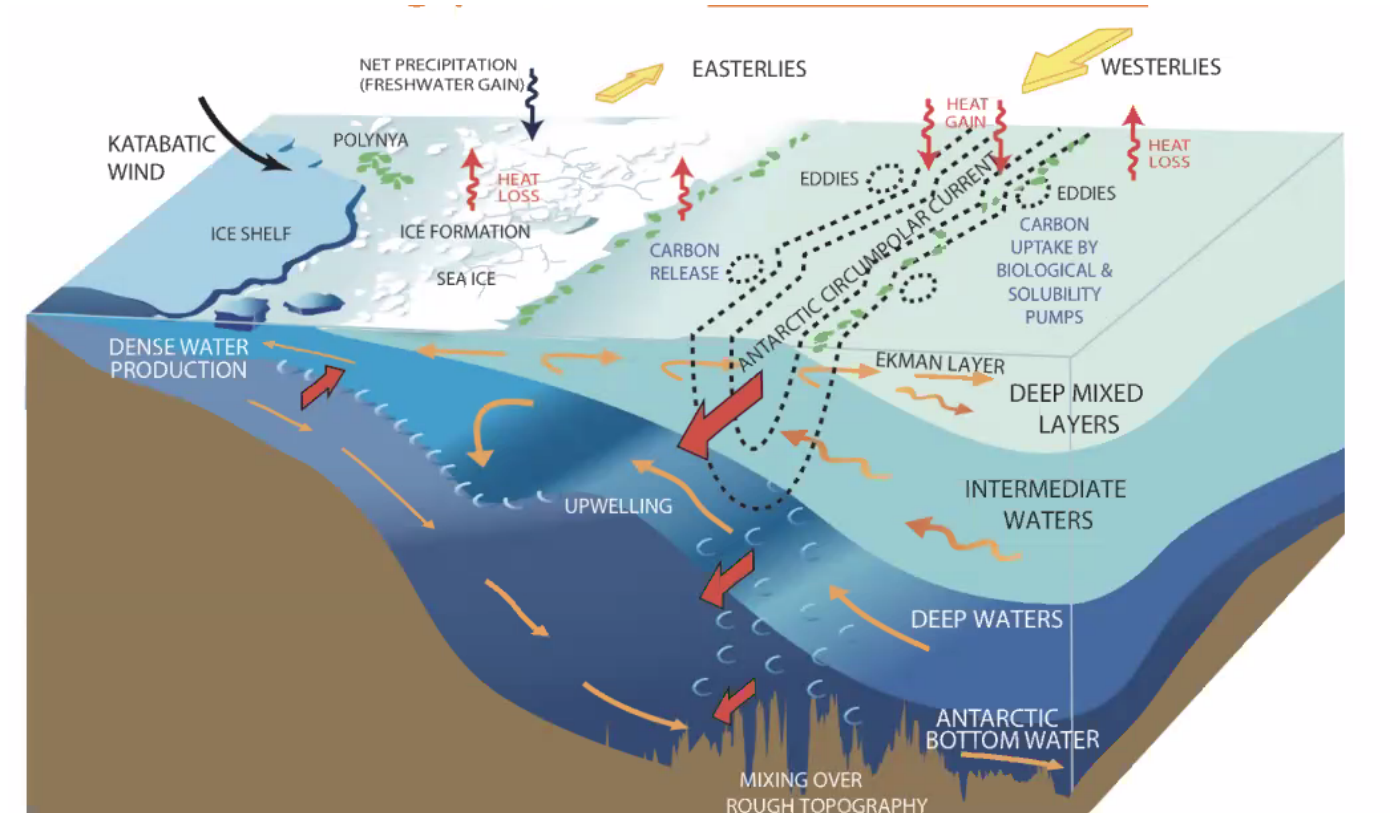
3/4/2021

## Motion of the Ocean (continued)

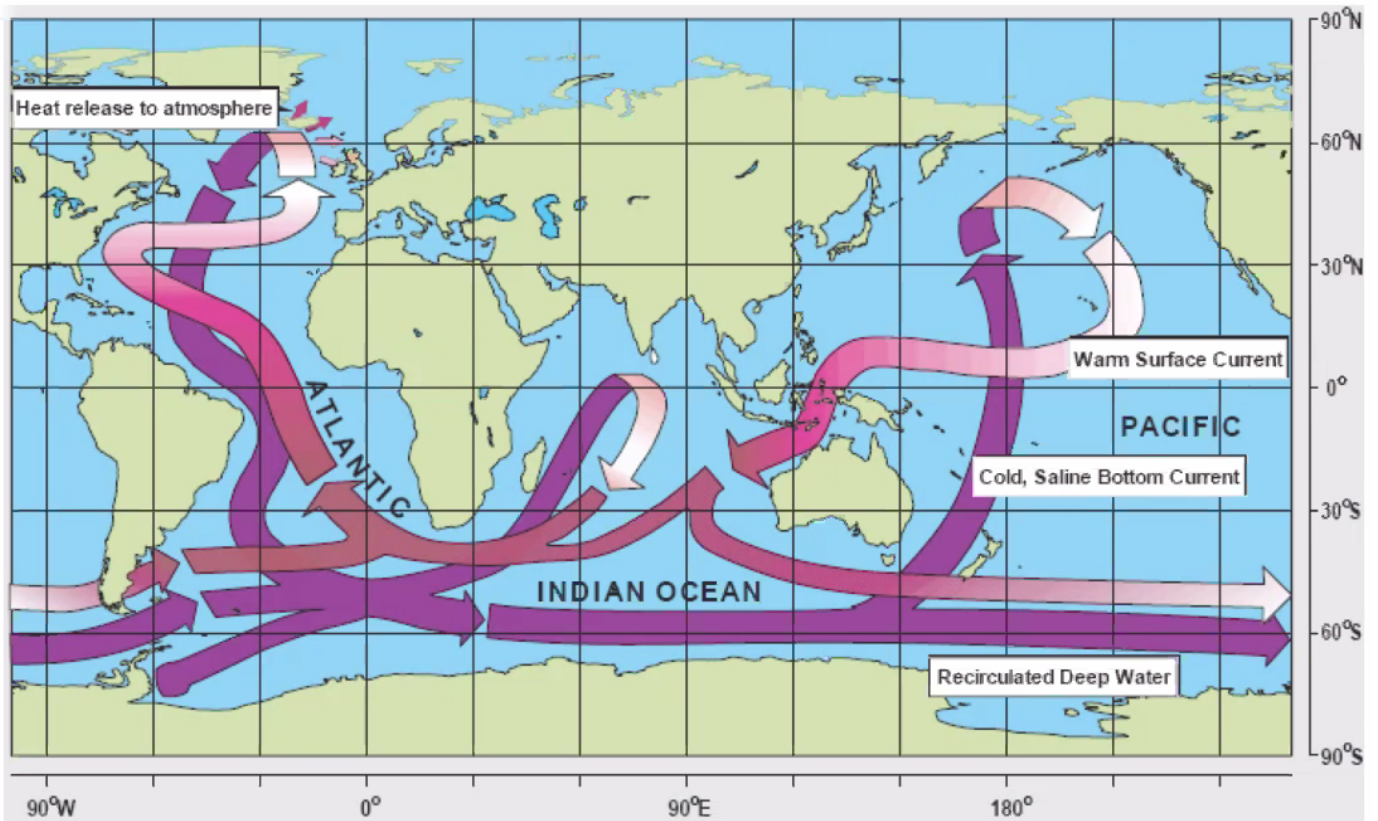
### Ocean Circulation (continued)

#### Vertical Currents (continued)

Brine rejection: another downwelling process



#### The Global Conveyor Belt

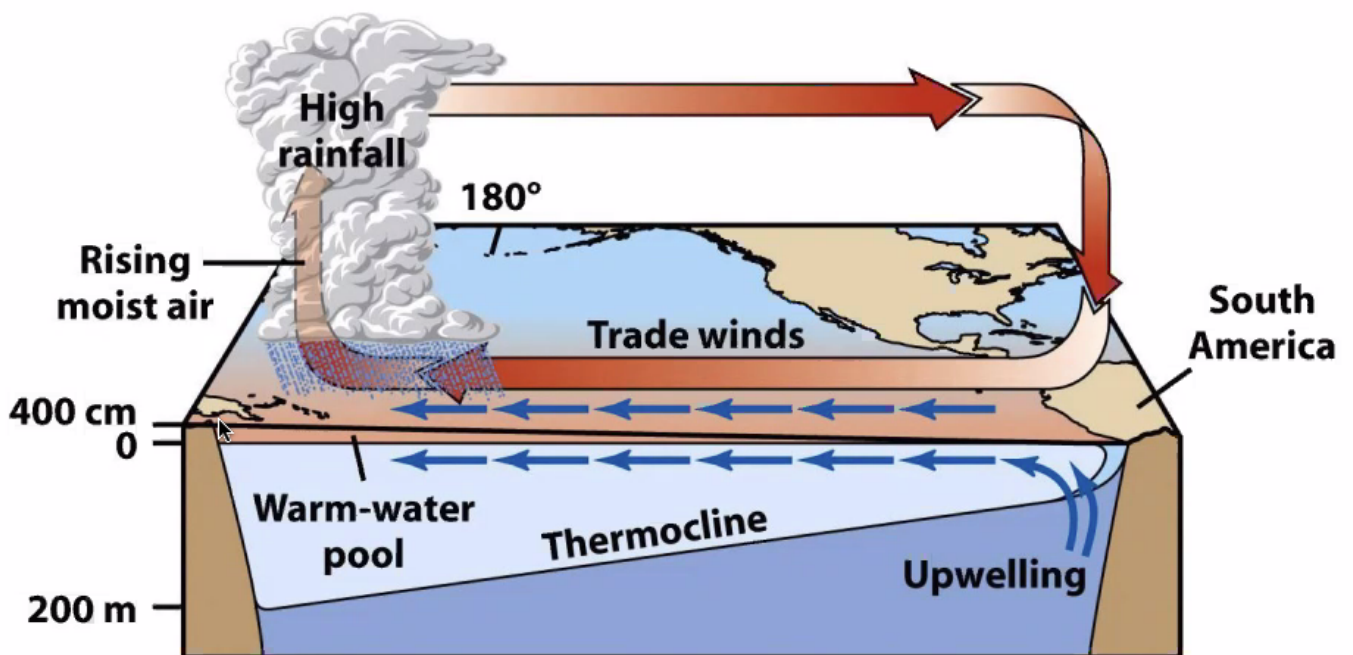


## El Niño

The largest ocean: The Pacific

El Niño takes place in it.

Look at this diagram:



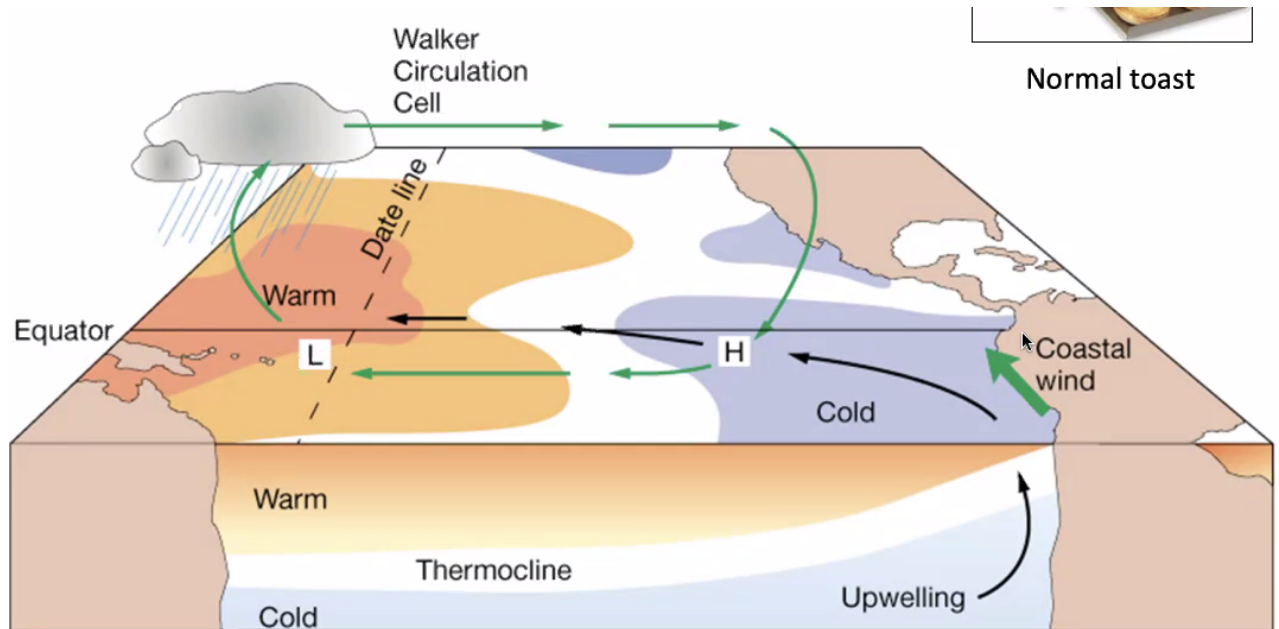
Notice there is always water moving from South America towards Australia. There is upwelling on the shore of Australia. There are trade winds blowing West. This is causing ocean circulation

Normal oceanic circulation is driven by the trade winds.

- Tropical easterlies push equatorial surface water west.
- Upwelling replaces the water moving west.
- Periodic warming of waters off the South American Pacific coast --> 2-7 year cycle
- Originally described by Peruvian fisherman
  - Normal is cold, nutrient rich upwelling fosters enormous fish populations
  - Abnormal is conditions of warm waters every 2-7 years: this kills fishing industry
  - Phenomenon most noticeable in December --> "el Niño," Spanish for "The Child", as in Jesus child, coincidence with Christmas
- In 1910's Sir Gilbert Walker noticed a relationship between variable air pressure readings between Darwin, Australia, and Tahiti
  - "**Seesaw effect**": When one was higher, the other was lower than average
  - Coincided with weather pattern changes
  - Called the Southern Oscillation

### El Niño Southern Oscillation (ENSO)

- Impacts:
  - Sea surface Temp
  - Trade wind variations
  - Changes in precipitation
  - Alteration to upwelling
- Three phases of ENSO cycle:
  - "normal" conditions in the Pacific Ocean

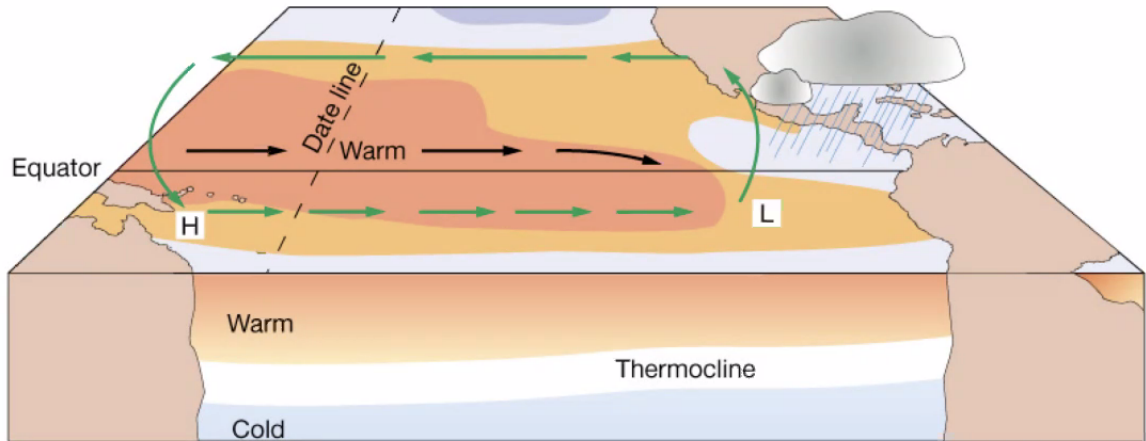


(a) Normal conditions

- **el niño conditions:** ENSO warm phase

- Easterly winds slacken... water not pushed to the west

Burnt toast

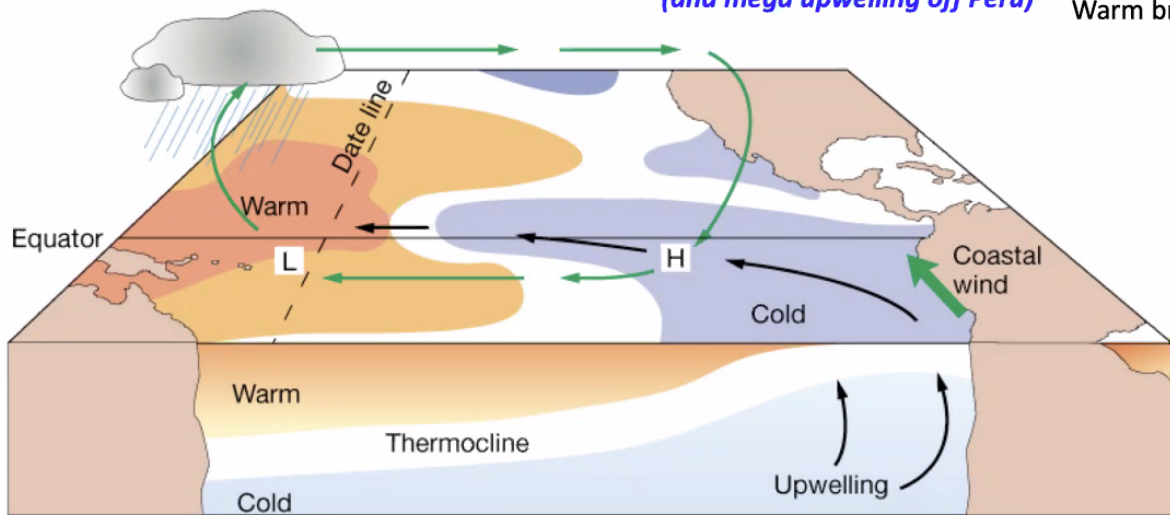


(b) El Niño conditions

- **la niña conditions:** ENSO cool phase
- Super wind!! Strong pushing of water to west (and mega upwelling off Peru)

(and mega upwelling off Peru)

Warm bread

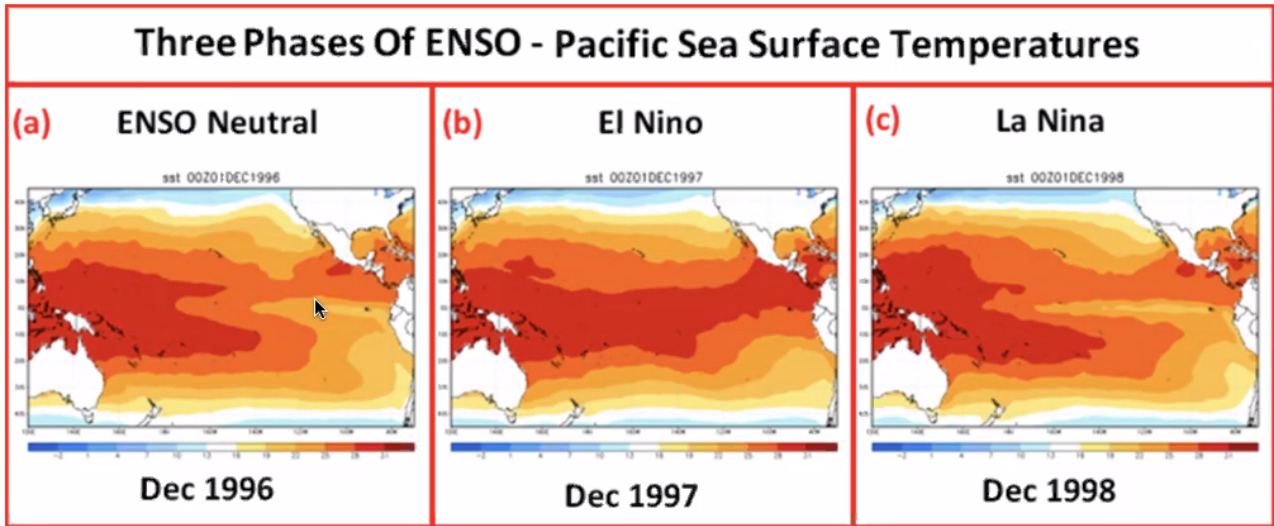


(c) La Niña conditions

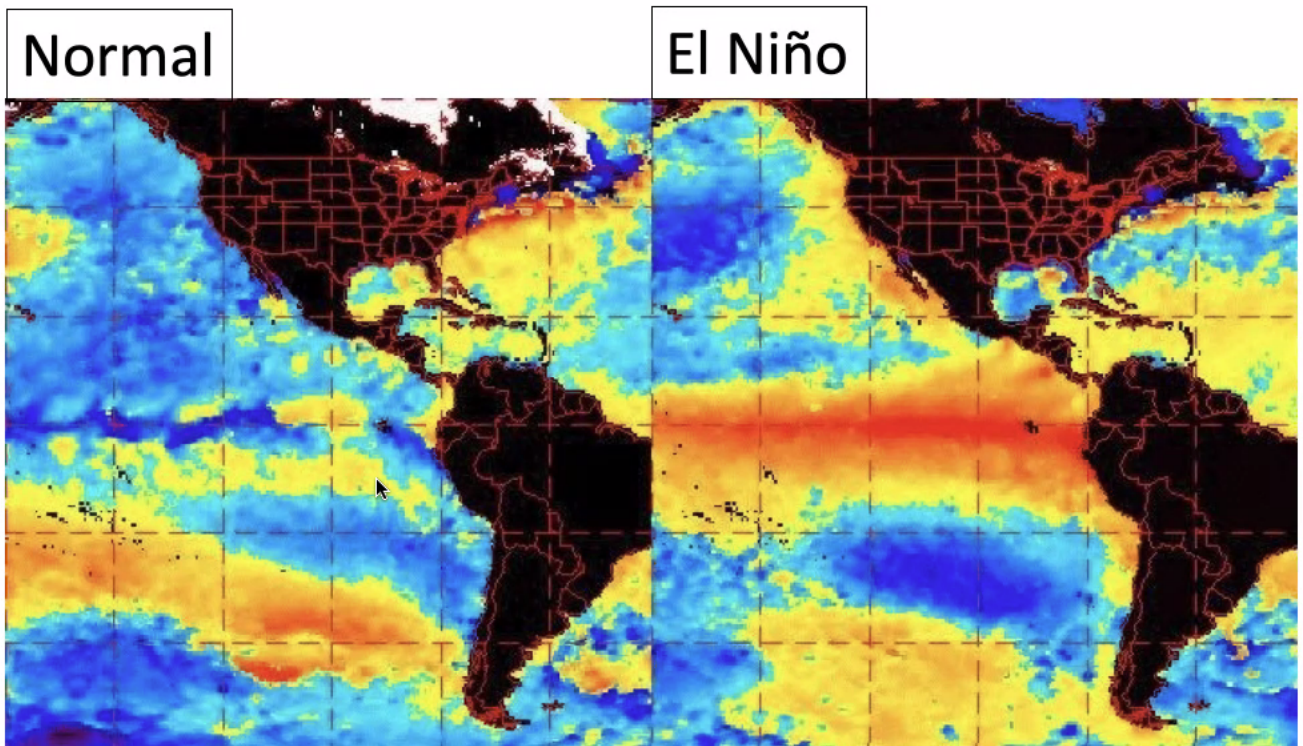
## The 3-phase ENSO cycle

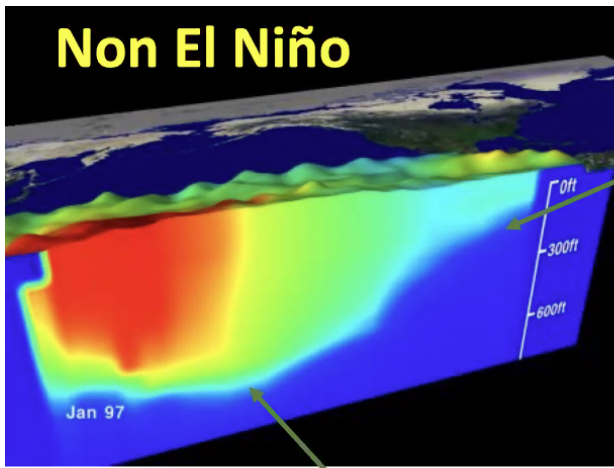
1. *Neutral:* Some cool water migrates west
2. *El Niño:* Weak trade winds allow warming in the eastern Pacific (Aus --> drought, Peru fishing collapse)

3. *La Niña*: Strong trades move colder water to the western Pacific



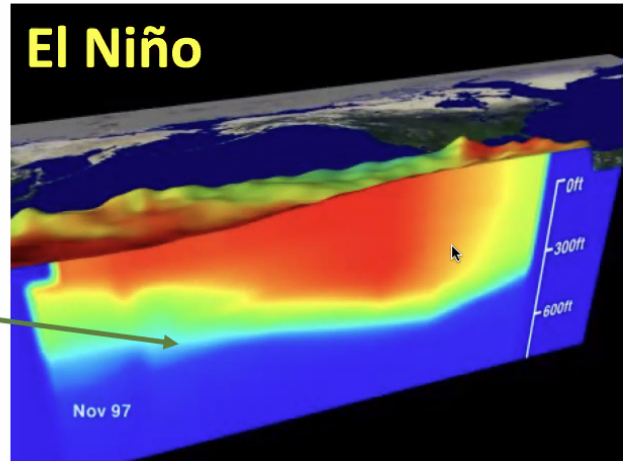
- Eastern Pacific sea surface temps: 1997 cycle



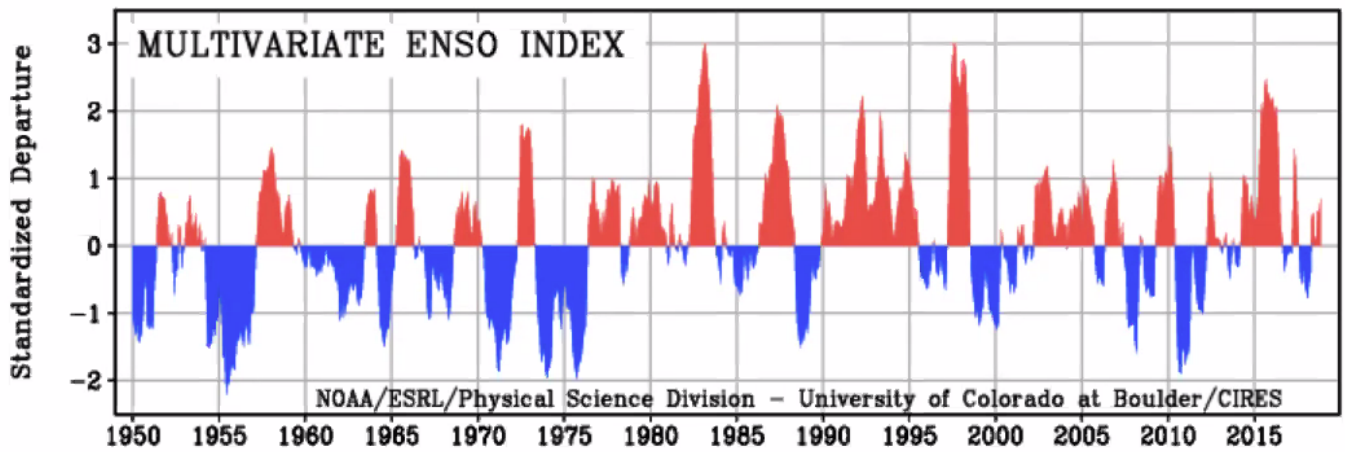


Upwelling driven by strong coastal winds (recall: Ekman transport)

Thermocline – layer of ocean right beneath the “mixed layer” where temperatures decrease rapidly.



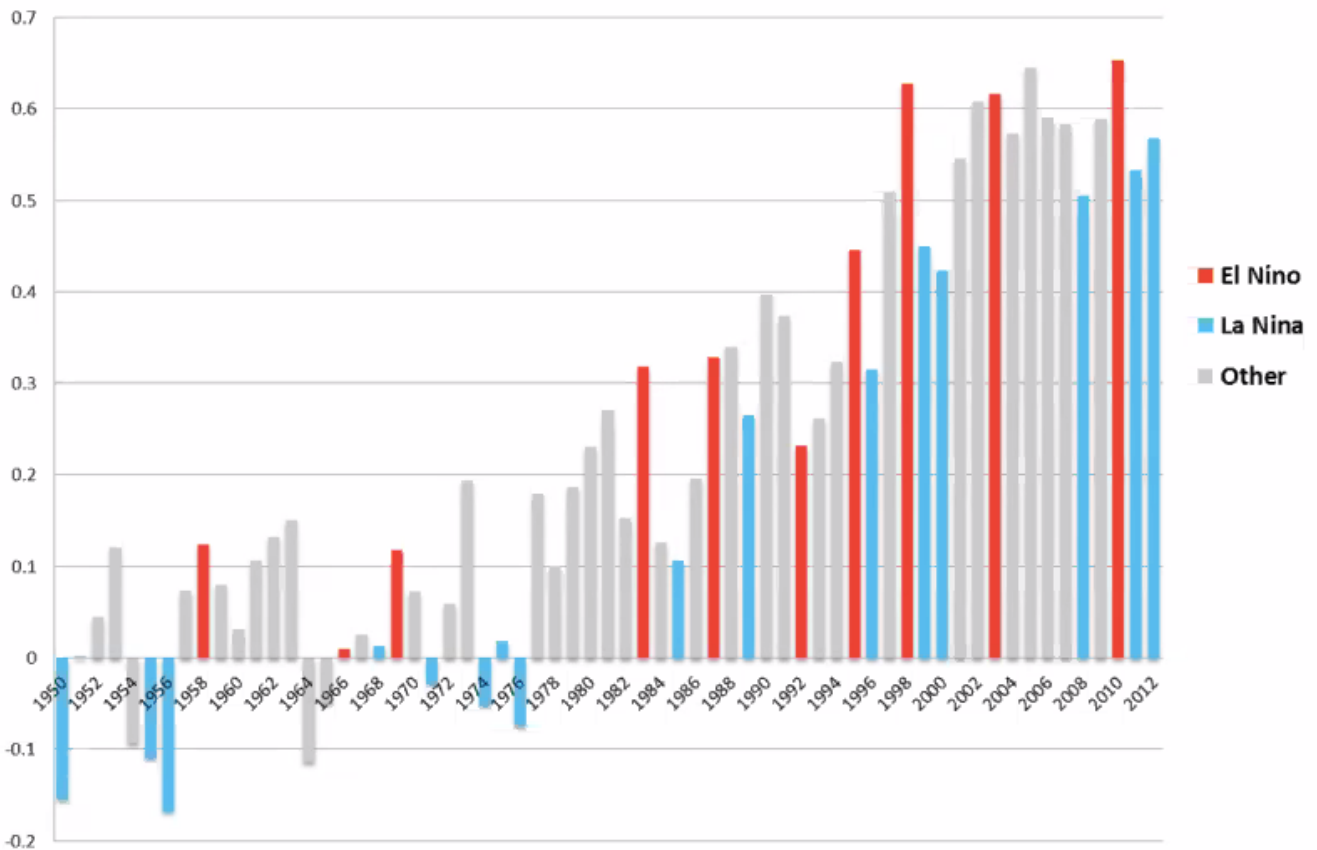
### ENSO record for 1950-2019



Notice that whether it is El Niño / La Niña is not binary, it can be to a specific degree and vary over time.

### Global Temperature: 1950-2012

## Annual Global Temperature Anomalies 1950 - 2012



### Effects of ENSO on Global Temperature

Events like the ENSO cycle can cause warmer global temperatures which is why the graph above doesn't show a constant increase.

The deep ocean is like a buried refrigerator. Normally, the door is ajar so some cold seeps into the atmosphere **but** ENSO adjusts how "open" the door is.

There are other factors to the global temperature, it's not just ENSO, which is why the graph is not just a constant up and down, either.