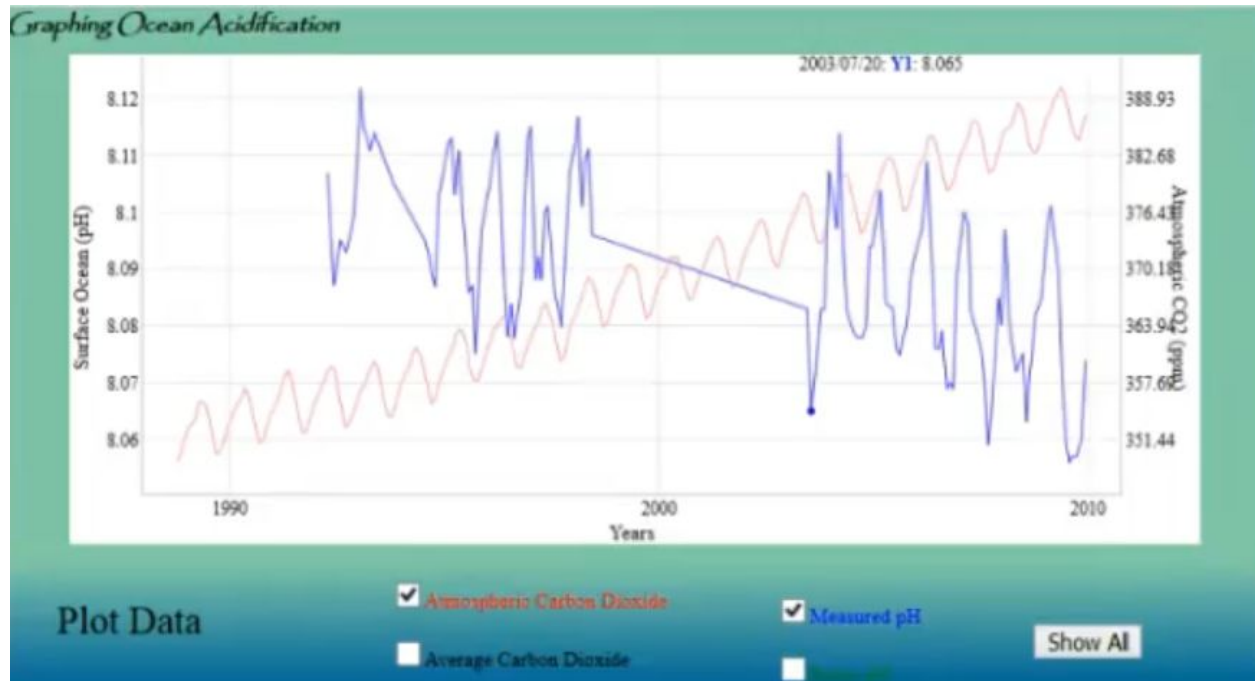


Ocean Acidification and Carbon

- In the 1950s, Charles Keeling at Mouna Loa recorded CO₂ conc in our atmosphere. The graph plotted was called 'Keeling curve'. The cyclic up and down are called seasonal variation of CO₂ emission.

When vegetation is less \Rightarrow lot of CO₂, vegetation is more \Rightarrow less CO₂



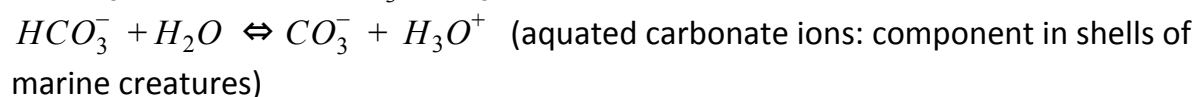
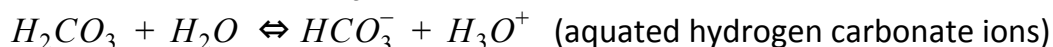
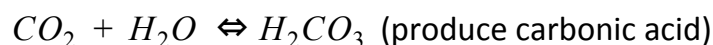
pH of the Ocean is considered. With time, pH is decreasing. (turning acidic)

- Ocean acts as a carbon sink(absorb more CO₂ than produce)
- Low pH means more H₃O⁺ (Hydronium ion)

The Great Ocean Conveyor Belt circulates water all around earth that contains gigatons of carbon from the surface layer to depths of ocean. CO₂ dissolves in water and undergo equilibrium reactions, bringing more CO₂ in water, shifting the 'speciation' of carbon in the ocean.

Nearly 40,000 Gt of carbon are stored in water, and the atmosphere holds around 750 Gt.

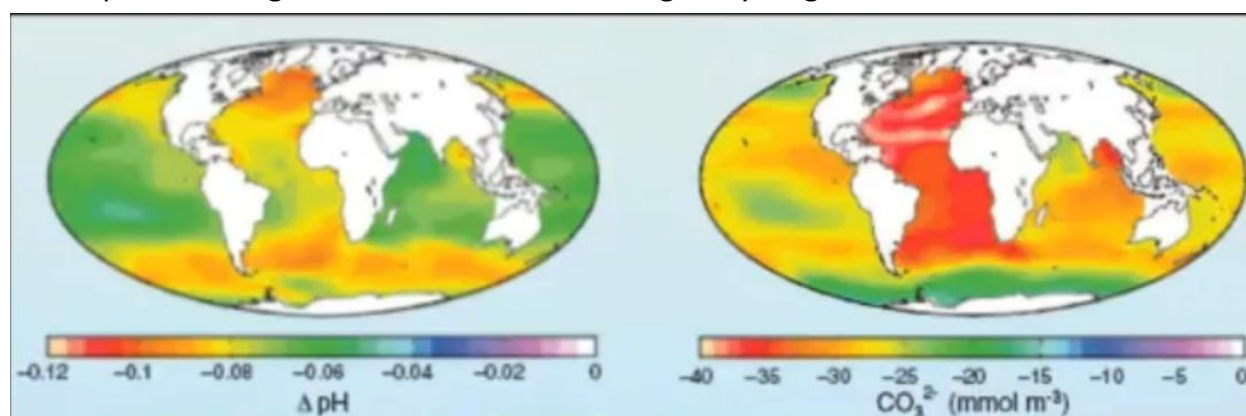
Reactions(Hydrolysis) happening:



- The oceans have absorbed 33-50% of all CO₂ humans have produced by burning fossil fuels since the Industrial Revolution. The accumulation of CO₂ in the ocean has led to ocean acidification. (movement of ocean pH from slightly basic to a slightly more acidic).
- Pre-industrial pH was around 8.2 now 8.1. 25% increase in H₃O⁺ ion.

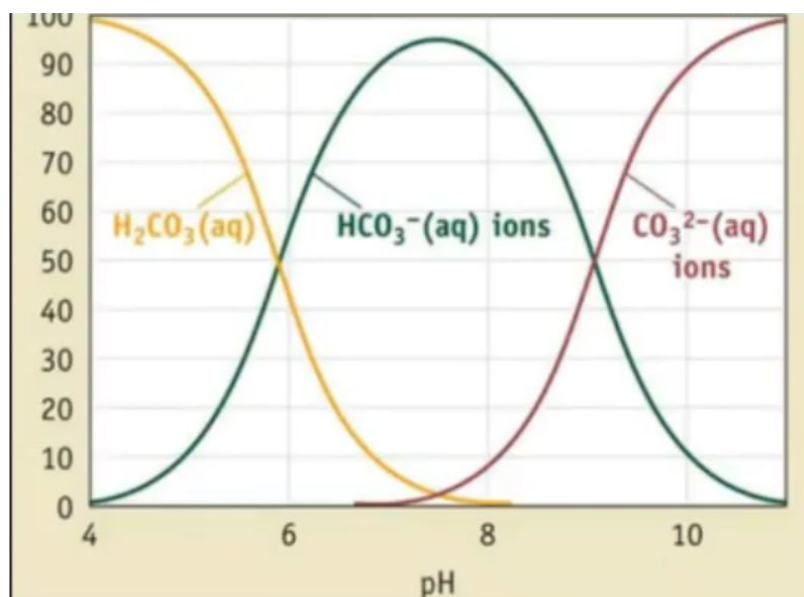
The Oceans' Carbon cycle and Carbon Speciation

As the pH is shifting, carbonate ions are shifting to hydrogencarbonate ions.



First one shows the difference in pH before and after industrialization.

As the pH decreases, the equilibrium will shift towards H₂CO₃ with little or no CO₃²⁻.



A decrease in pH will have a twofold effect: not only the decreased carbonate ion concentration will make it harder for shell-producing organisms to produce the necessary crystal structures, but increased acidity will also dissolve existing shells.

Changes in the oceanic variables occur at a slower rate. Due to their large influence on the climate, they are called 'Lungs of the Earth'. 70% of atmospheric oxygen comes from marine photosynthesizers (marine algae which only require seawater and light, can occupy a wide variety of habitats and a good chance of surviving future changes).

Bangladesh and the Netherlands are vulnerable to ocean level rising and effects of climate change due to low-lying floodplains. Agriculture in Europe may benefit from climate change as many parts will become ice free.

Due to the Gulf stream and its effects, not only coastal regions but places far from sea in Europe will also be influenced by its effects. European climates are milder than the corresponding same latitude location elsewhere on earth. For ex. Avg temp in Naples, Italy : 16 C and New York : 12 C (both at same latitude)

Due to melting of arctic ice, new sea routes are starting around Greenland and Russia.

EL - NINO and LA - NINA

These names originate from Spanish, El Nino: *the little boy* and La Nina: *the little girl*

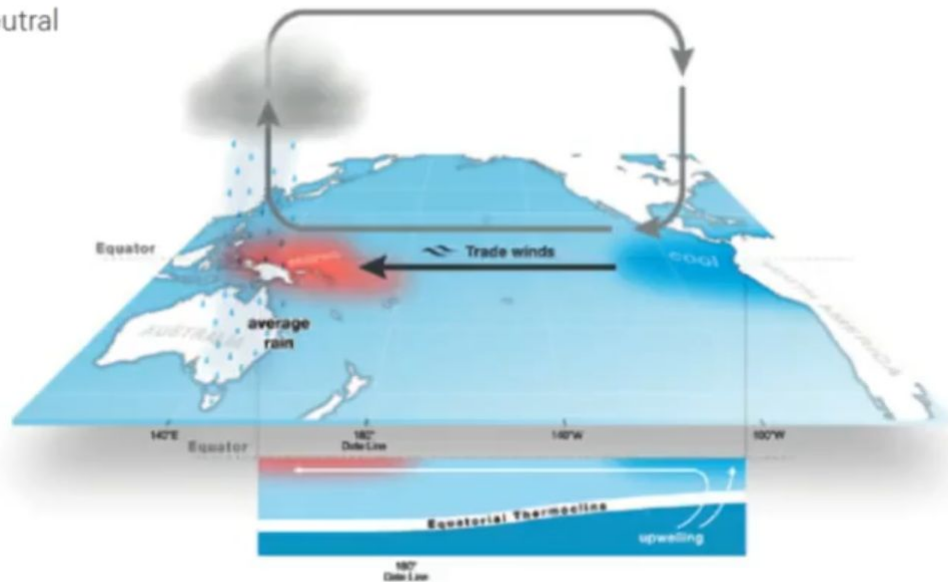
- These events are a natural part of the global climate system which occur when the Pacific Ocean and the atmosphere above it change from their normal state for several seasons.
- El Nino events are associated with a warming of the central and eastern tropical Pacific, while La Nina is the reverse, with a sustained cooling of these same areas.
- These changes in the Pacific Ocean and its overlying atmosphere occur in a cycle known as the El Nino - Southern Oscillation (ENSO).
- A typical El Nino or La Nina event may show its first signs of development during the southern hemisphere autumn and strengthen over winter and spring.
- It will normally start to decay in the mid to late southern summer, and finally dissipate in the subsequent autumn.



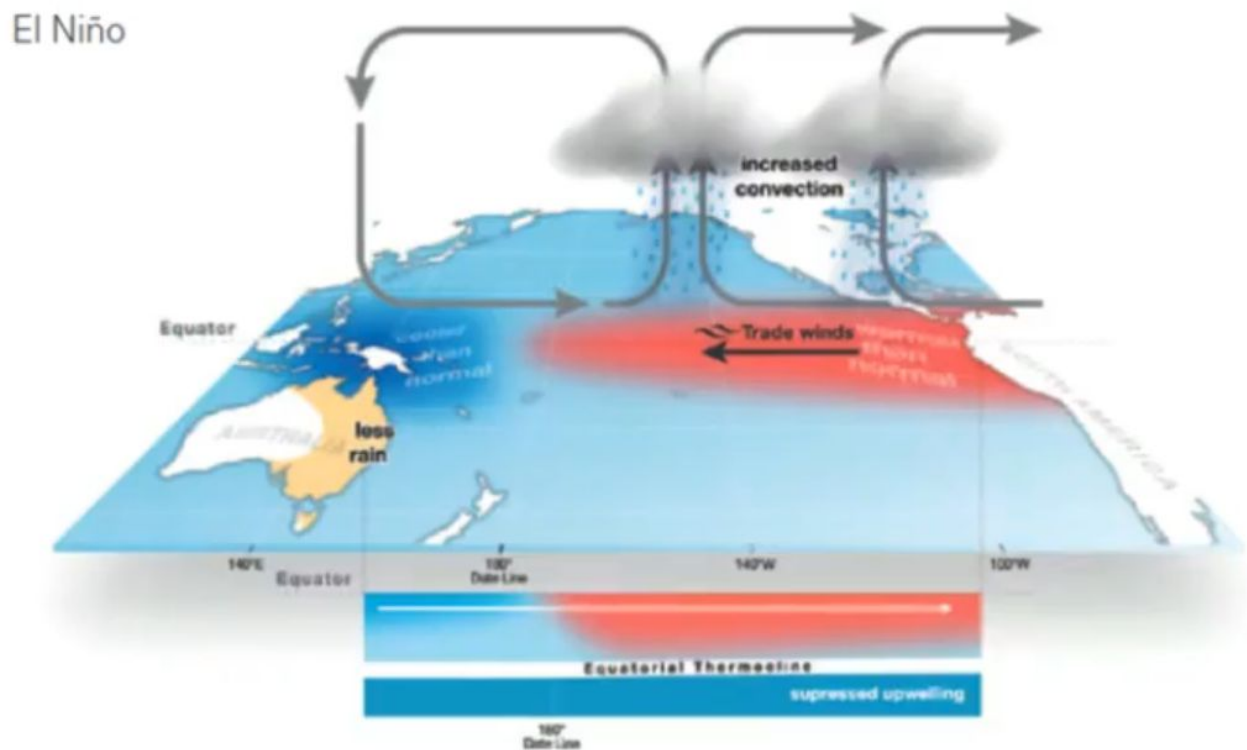
Pacific Ocean – even in neutral state the Western Pacific is warm

Three phases of ENSO

Neutral



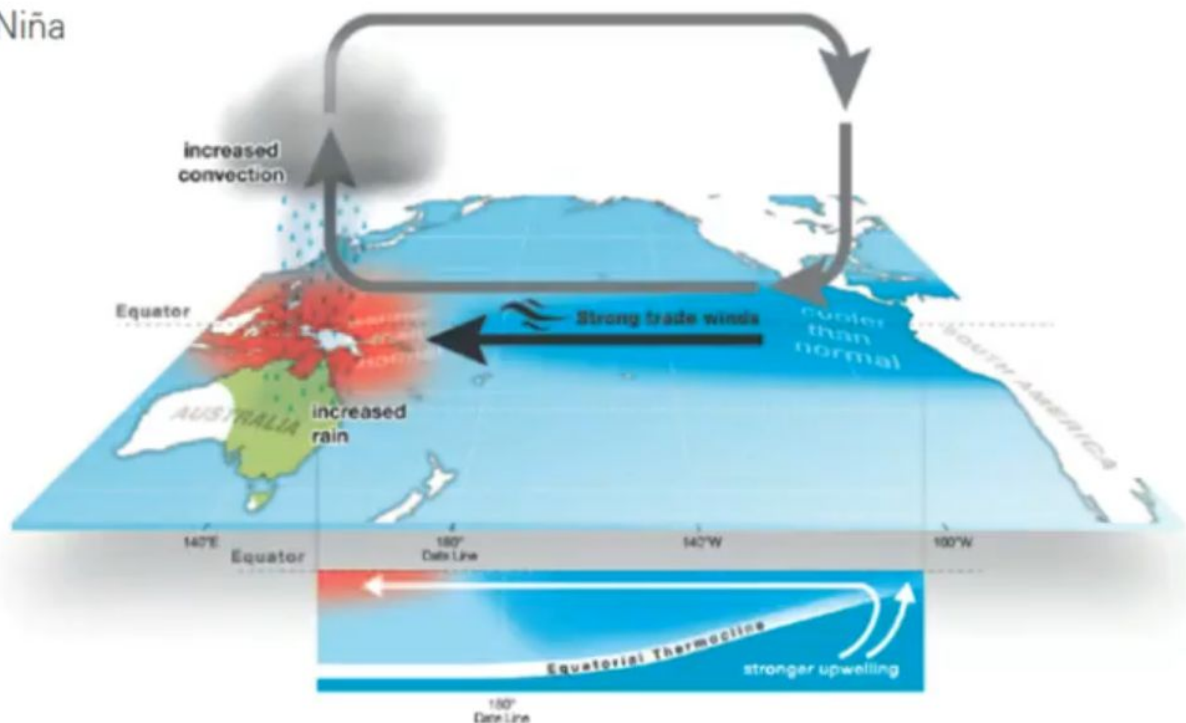
Neutral(When there is no El Nino/La Nina): Tradewind starts from Eastern Pacific to Western Pacific, and rainfall happens.



El Nino: Process is reversed. Trade wind direction changes. All because of sea surface temperature. Now temp has increased in Eastern Pacific. Moisture occurs in the Peru area in South America. When this happens there is a chance of drought in Australia.

The ocean is cooler than usual, bringing lower than average monsoon rainfall over Indian subcontinent. Sometimes drought is associated with El Nino events.

La Niña



La Nina: Temp has increased much more in Western Pacific and strong trade winds have formed. Flood/Heavy rains can be observed in Australia and Western part. Peruvian side will have less rainfall.

La Nina events are associated with greater convection over the warmer ocean to Australia's north, typically leads to higher than average rainfall.

- The increased cloudiness and rainfall associated with La Nina periods typically reduces daytime temp and keeps nights warmer, particularly over northern and eastern Australia.
- Global temp is also influenced by these events due to exchange of heat between atmosphere and ocean. End of El Nino is associated with higher than average global temperature.

ENSO Indicators

- short-term bursts of tropical rainfall activity
- water temperatures at sea surface and depth
- ocean heat content
- atmospheric air pressure
- cloudiness
- the strength of the trade winds and winds higher in the atmosphere
- ocean currents