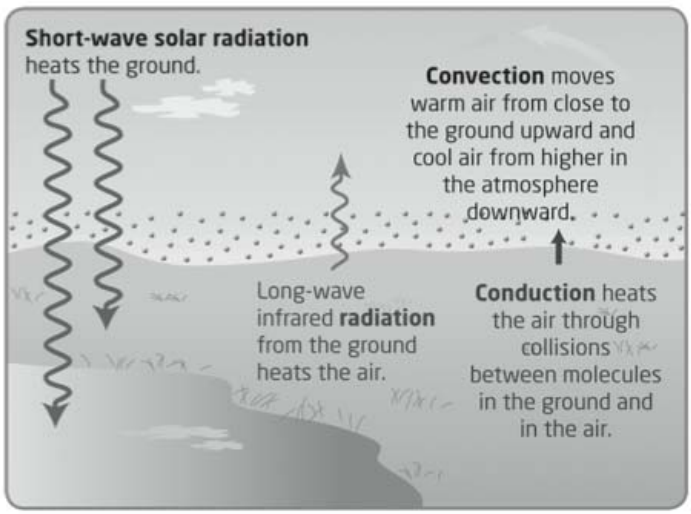
Grade 10 Science

Climate Change

Class 13

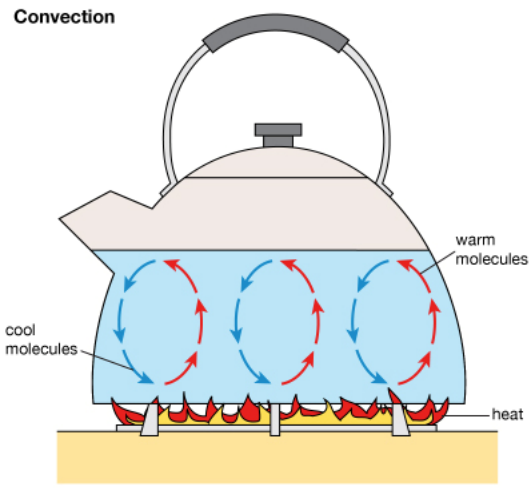
Heat Transfer

- How is the air heated?
  - Convection
  - Conduction
  - Radiation



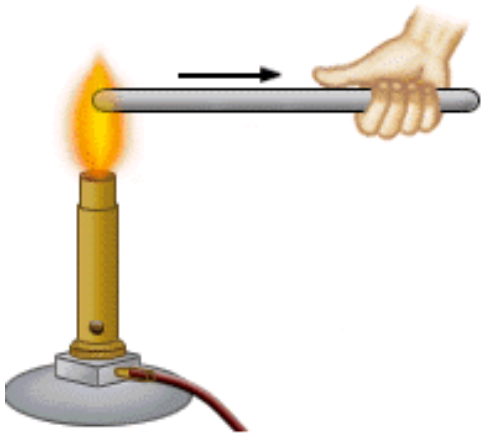
Convection

- Water is a heat sink because it can absorb heat and store thermal energy
- Convection is the circular movement of matter within a fluid or gas caused by the rising of a warm current while the cool current sinks



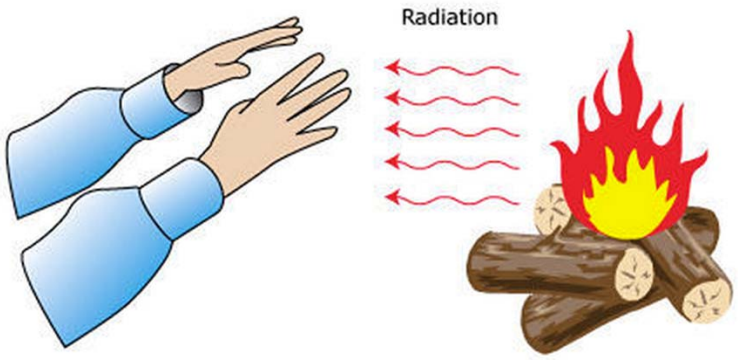
Conduction

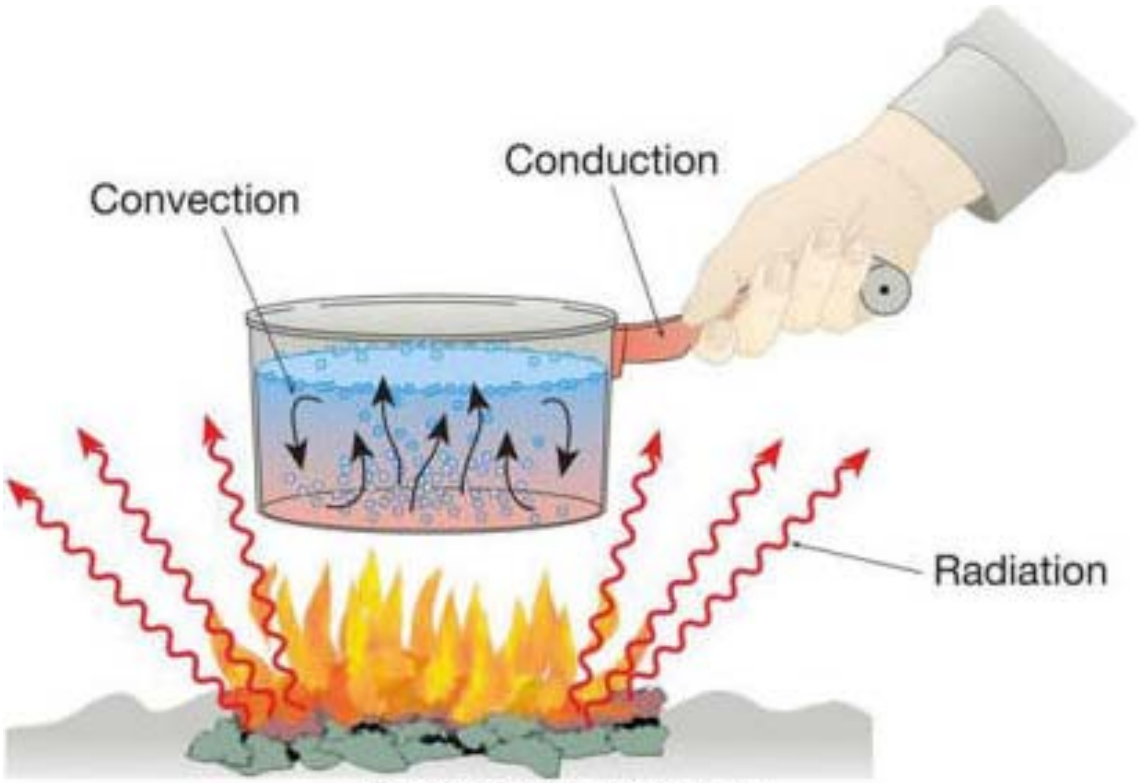
- The flow of heat via collisions between atoms and molecules from one object to another; can happen in solids as long as they are in direct contact with each other



Radiation

- The transfer of heat through empty space by thermal radiation (infrared radiation)
- No mass is exchanged, and no medium is required





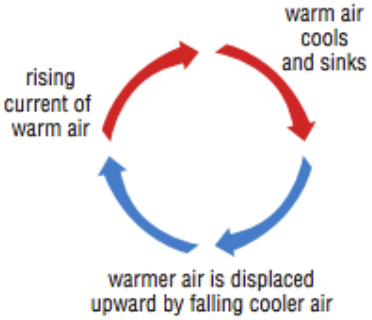
Checkpoint

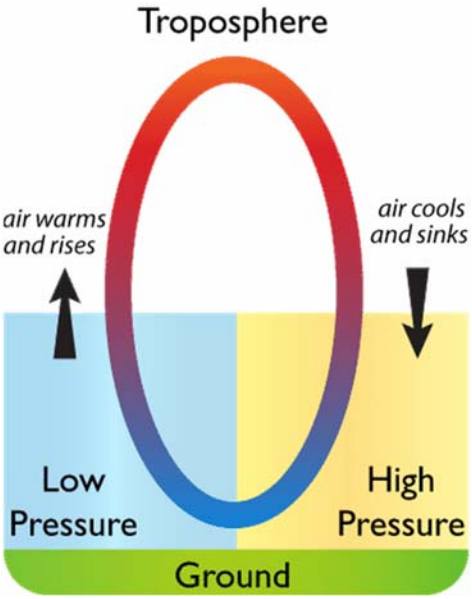
Which mechanism best describes the following energy transfers?

- A warm breeze blowing inland
- A damp cloth cooling your forehead
- A spoon warming in a coffee cup
- A microwave heating a bowl of soup
- A boy warming his hands by a fire

Energy Transfer

- Atmosphere and hydrosphere are **heat sinks** – absorb and store thermal energy
  - When air is warmer than ocean, ocean absorbs the heat
  - When air is cooler than ocean, ocean releases the heat

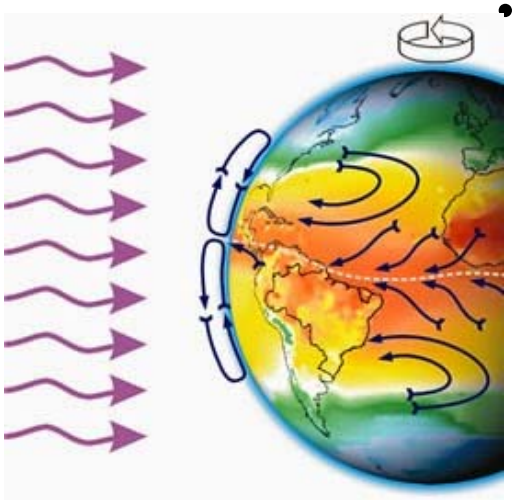




Atmosphere

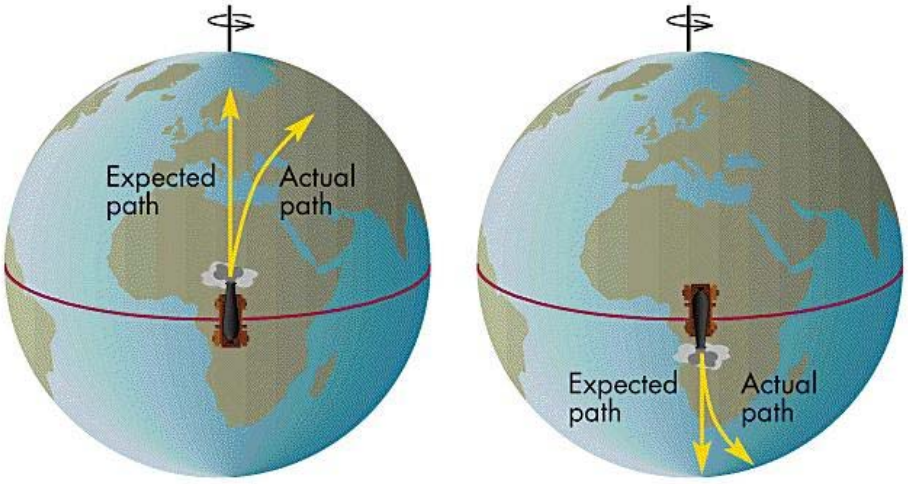
- Air heats up quickly and becomes less dense
- Colder, denser air falls and pushes the warm air up creating an area of low pressure below it
- Warm air spreads towards the poles and cools down which sinks back to the Earth's surface causing high pressure
- Causes convection current

Prevailing Winds



- Earth has permanent bands of high and low pressure parallel to the equator
  1) Sun's rays near the equator, causes air to rise
  2) Once it reaches the troposphere, air cools and descends to create a convection current

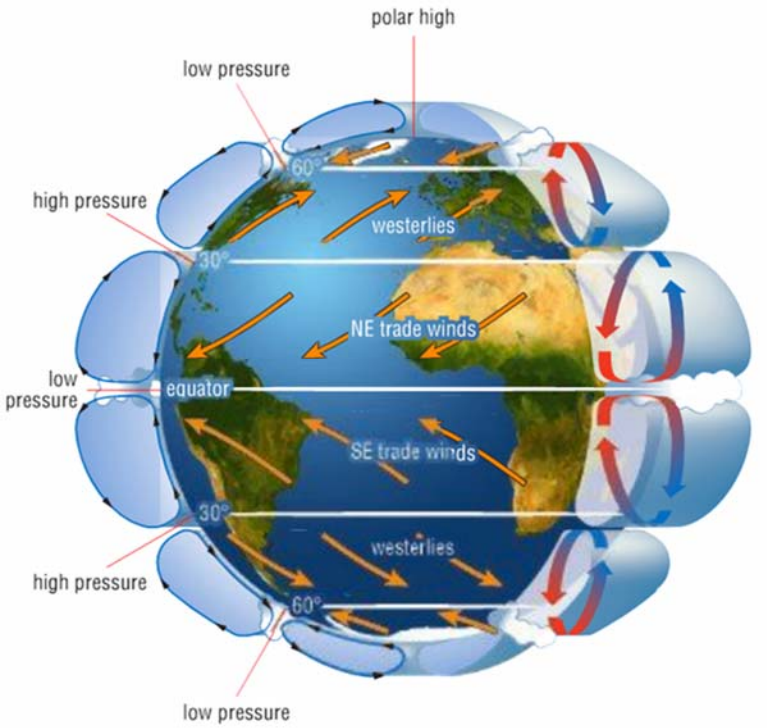
Coriolis Effect - Rotation of the Earth from the east to west direction causes winds to twist

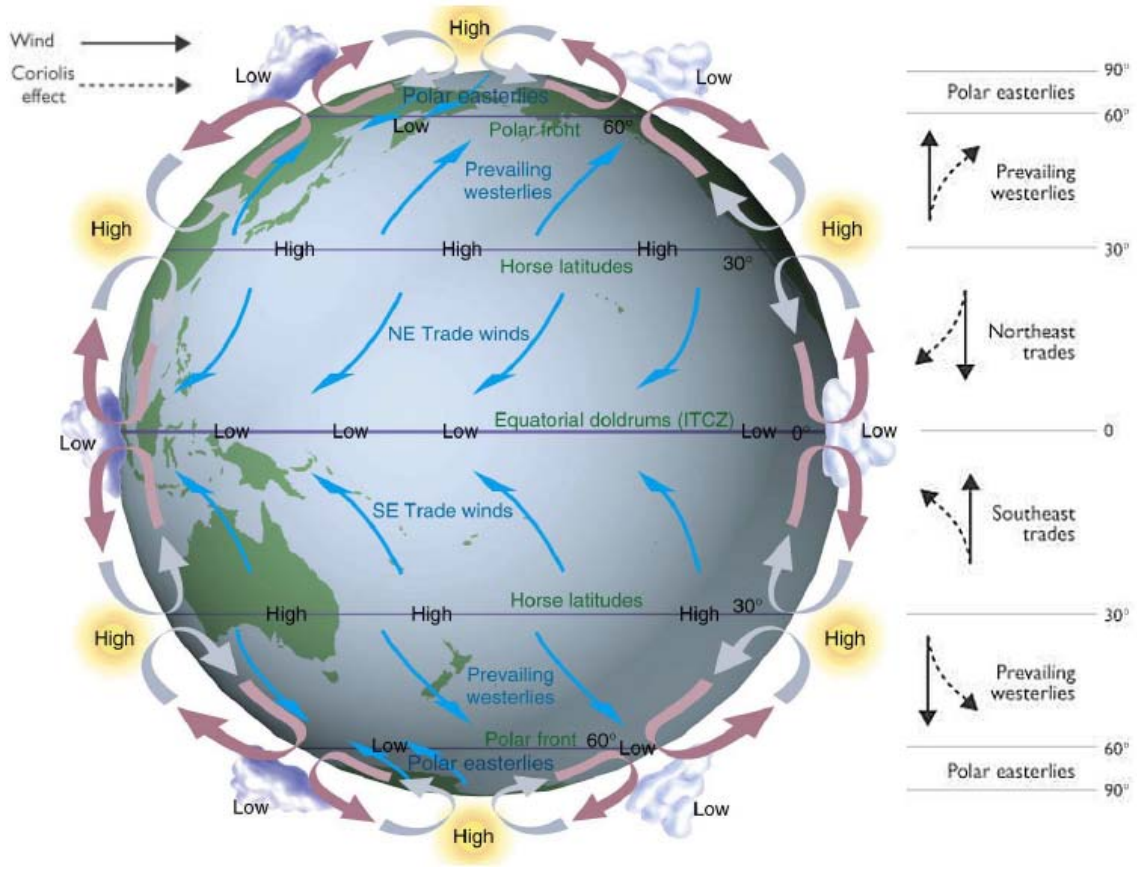


A Projectile fired northward **B** Projectile fired southward

3) The twisting winds are called **prevailing winds**

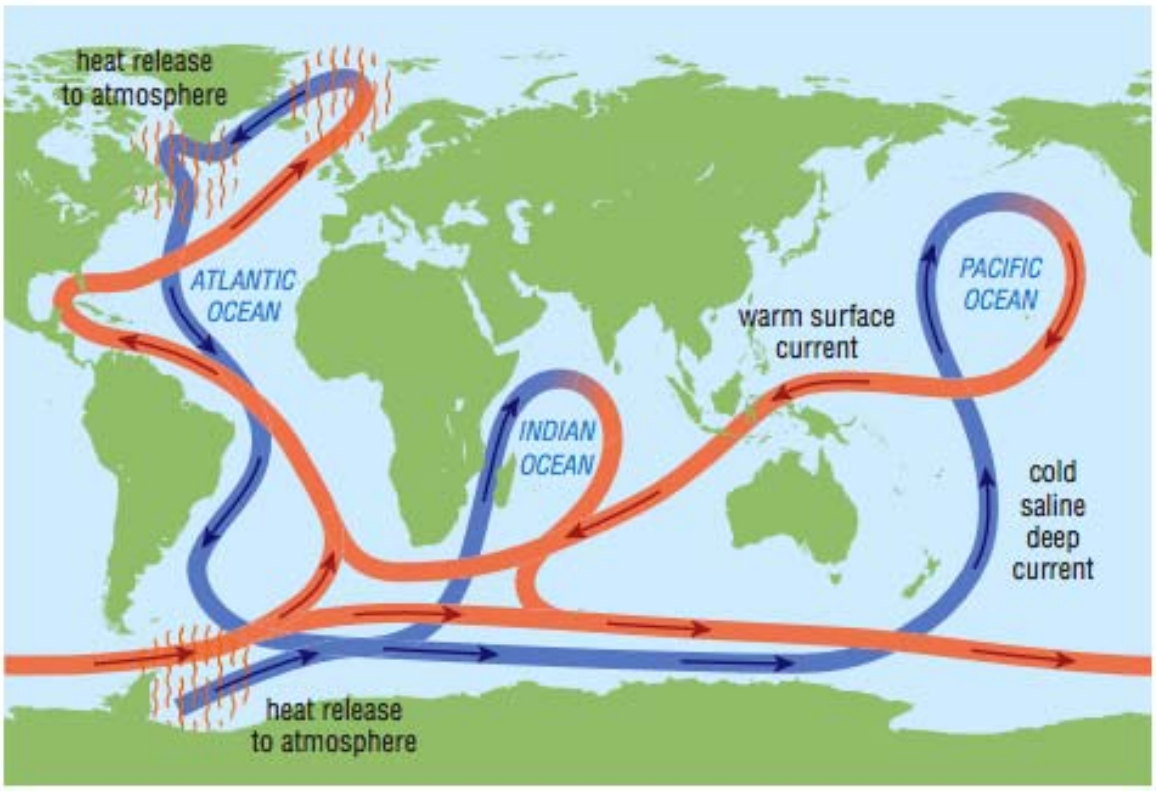
Prevailing winds allow warm air to move towards the poles to prevent extreme temperature differences





Oceans

- As water travels toward the poles, it gets colder
- Some of the water freezes into ice, the remaining water becomes saltier and more dense
- Dense water sinks and warmer surface water from equator flows to the poles to replace it
- **Thermohaline circulation –** the continuous flow of water around the world's oceans driven by differences in water temperatures and salinity

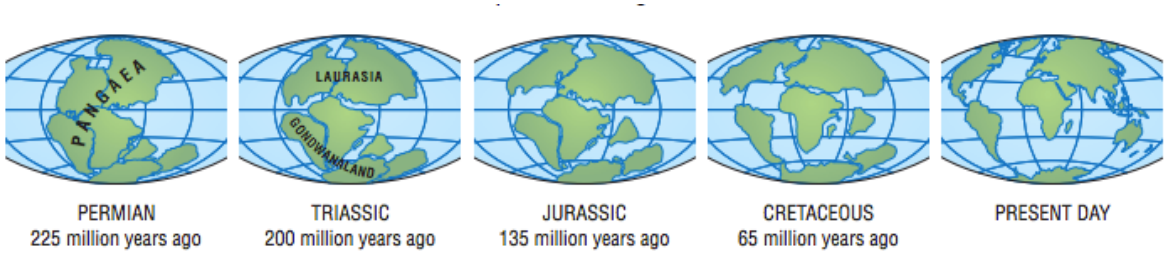


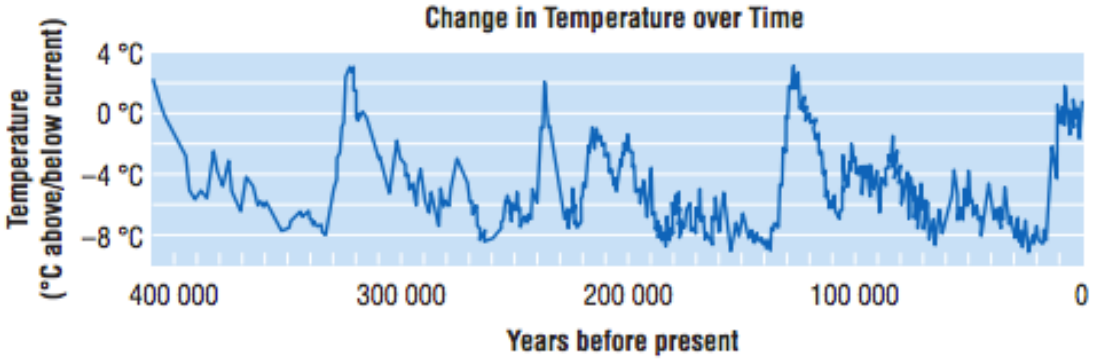
- Warm ocean currents heat the air above them which produces rain on land – determines the climate of that area
  - Warm Gulf Stream current gives the NW coast of Europe a warmer, damper climate than other countries at the same latitude
- Cool ocean currents cool the air above and creates desert areas
  - California and Mexico are near a cold ocean current so they are cooler and drier

Long-Term Changes in Climate

1) Continental Drift – movement of the large plates of the Earth's crust

- Ocean currents and wind patterns change
  - Northern Hemisphere – more land mass; less water therefore coldest winters and warmest summers





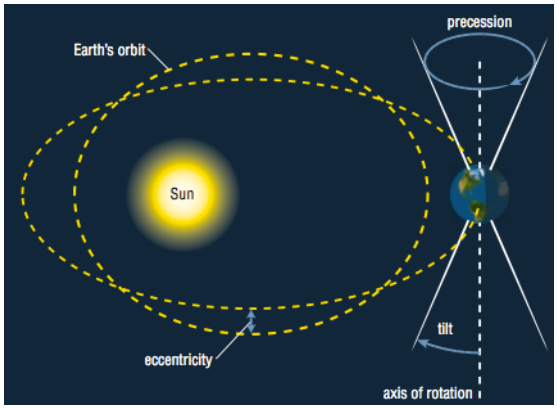
2) Milankovitch Cycles (Ice-Age Cycles)

- Last ice age: 20,000 years ago
- Interglacial Periods – time between ice ages when Earth warms up
- Factors that affect the amount of solar radiation affect climate:

  1. Eccentricity 2. Obliquity 3. Precession

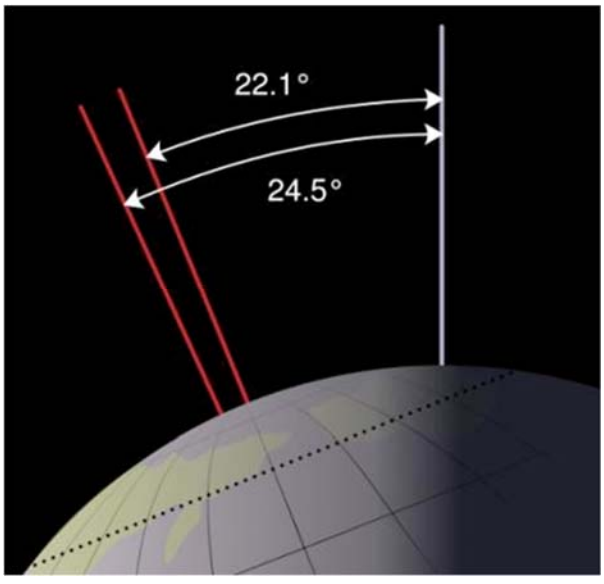
Eccentricity (Shape of the Orbit)

- Earth's orbit around the Sun varies from circular to elliptical due to the gravities of Jupiter and Saturn
- Approximate cycle = 100,000 years
- Orbit closer to the Sun (more solar radiation)
- Orbit farther from Sun (less solar radiation)
- Current = elliptical



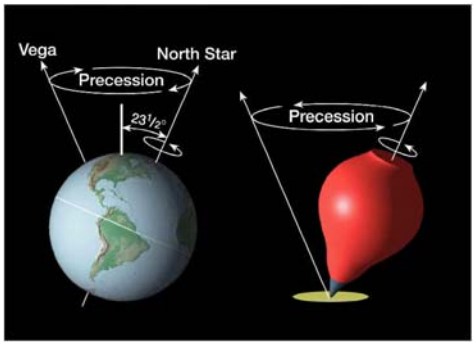
Obliquity (Tilt)

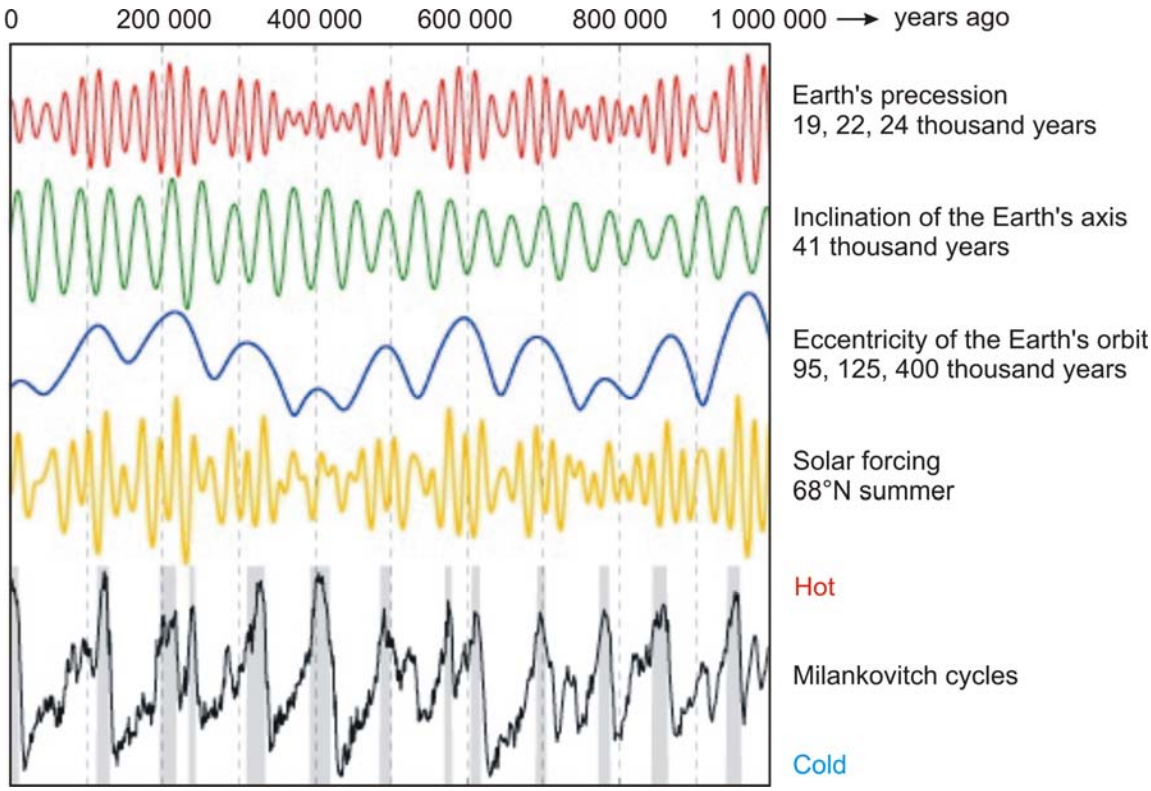
- Earth tilts back and forth from 22.1° to 24.5° every 41,000 years
- Current = 23.5° and the angle is slowly decreasing



Precession (Wobble)

- Direction of the tilt of the Earth's axis changes in a 26,000 year cycle
- Similar to a spinning top as it slowly changes the direction in which it points
- Earth's axis currently points towards Polaris (North Star)
- In 1000 years, Earth will point toward star Airai



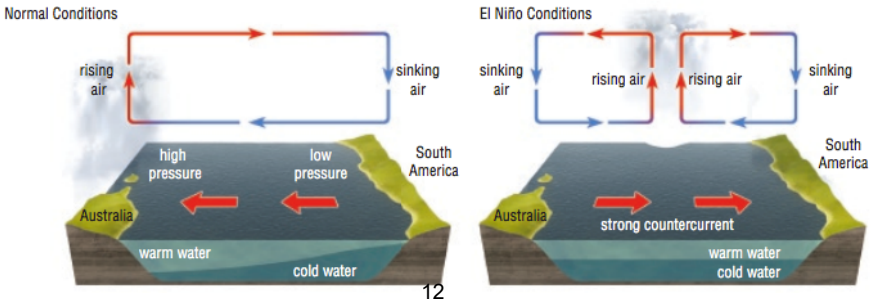


Short Term Changes in Climate

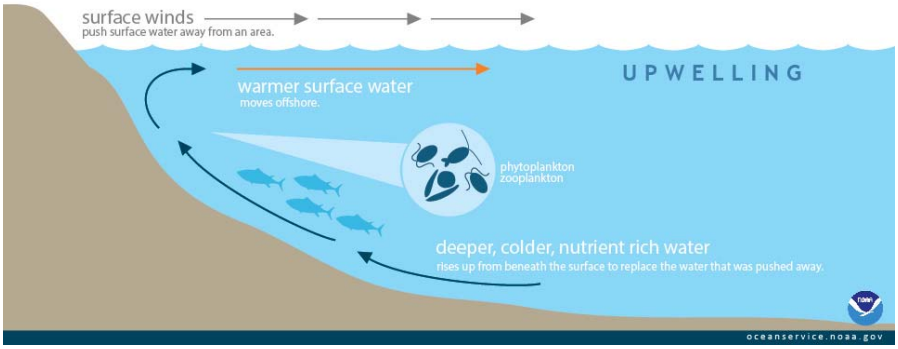
1) **Volcanic Eruptions** – spews dust and gas into the atmosphere which reflect the Sun's energy
   - – SO_2 released reflects solar radiation; cools down the area temporarily
   - – Indonesia in 1815 – "Year with No Summer" due to eruption of Mount Tambora

2) El Nino

- Every 2-7 years in the Pacific Ocean, prevailing winds temporarily switch direction and push the warm water towards South America rather than the west Pacific
- Impacts ocean temperatures, speed and strength of ocean currents, coastal fisheries and local weather in Australia and South America



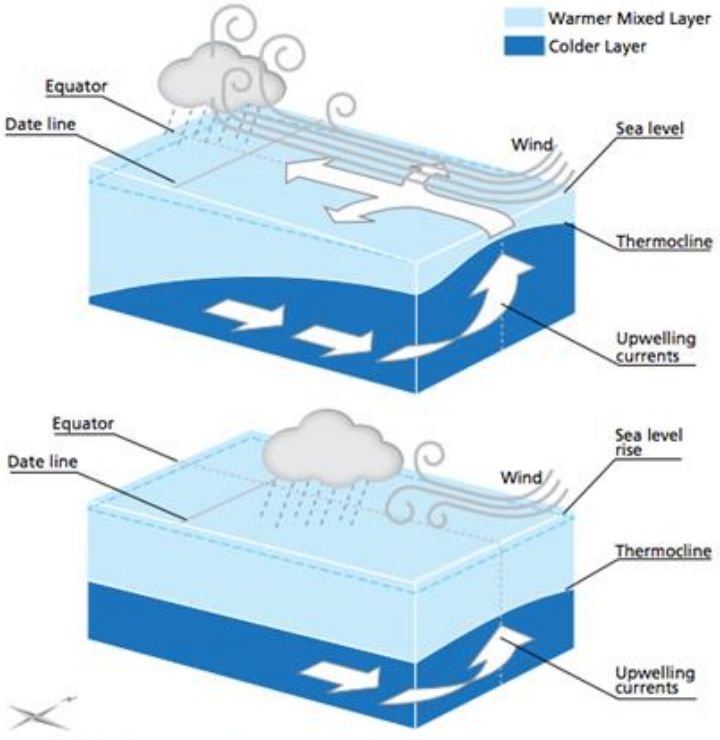
Normal Conditions: Upwelling



- Normally strong trade winds blow west across the tropical Pacific which push warm surface water toward the west Pacific
- Movement of water causes cooler waters to rise toward the surface = Upwelling
- Upwelling elevates cold water (rich in nitrates and phosphates) to be used by plankton, providing food for a wide variety of marine life

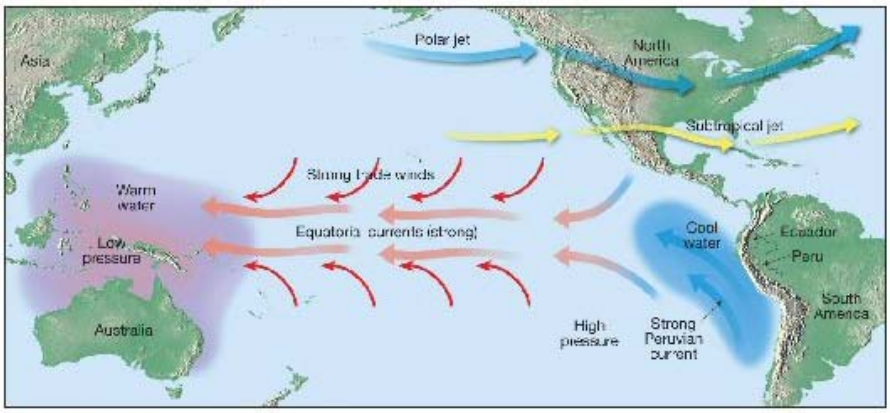
FIGURE 1

Normal conditions (upper part) compared with El Niño conditions (lower part).

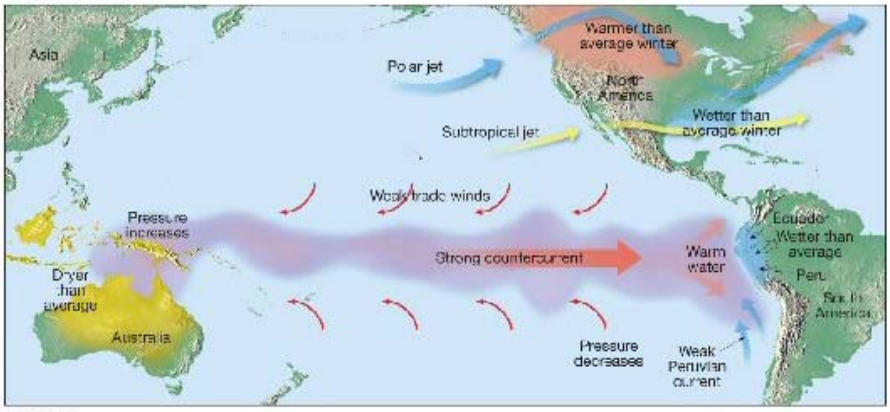


Source: National Oceanic and Atmospheric Administration (NOAA).

- During an El Nino event, the westward-blowing trade winds weaken so the warm water builds up to 152 metres
- Upwelling does not occur therefore marine ecosystem is greatly affected



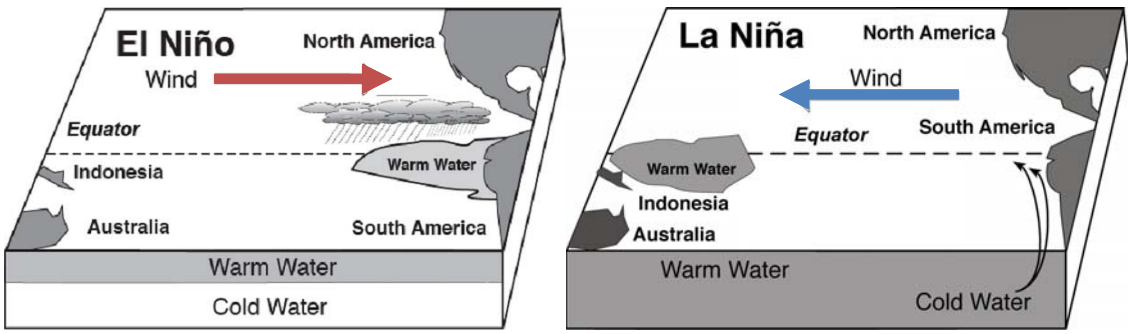
A. Normal conditions



B. El Niño

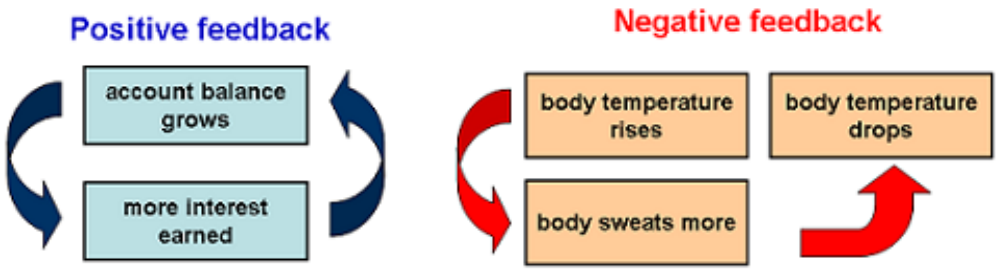
La Nina

- Describes the cooling of surface ocean waters along the tropical west coast of South America
- Caused by a buildup of cooler-than-normal waters and lower-than-normal air pressures leading to increased rainfall

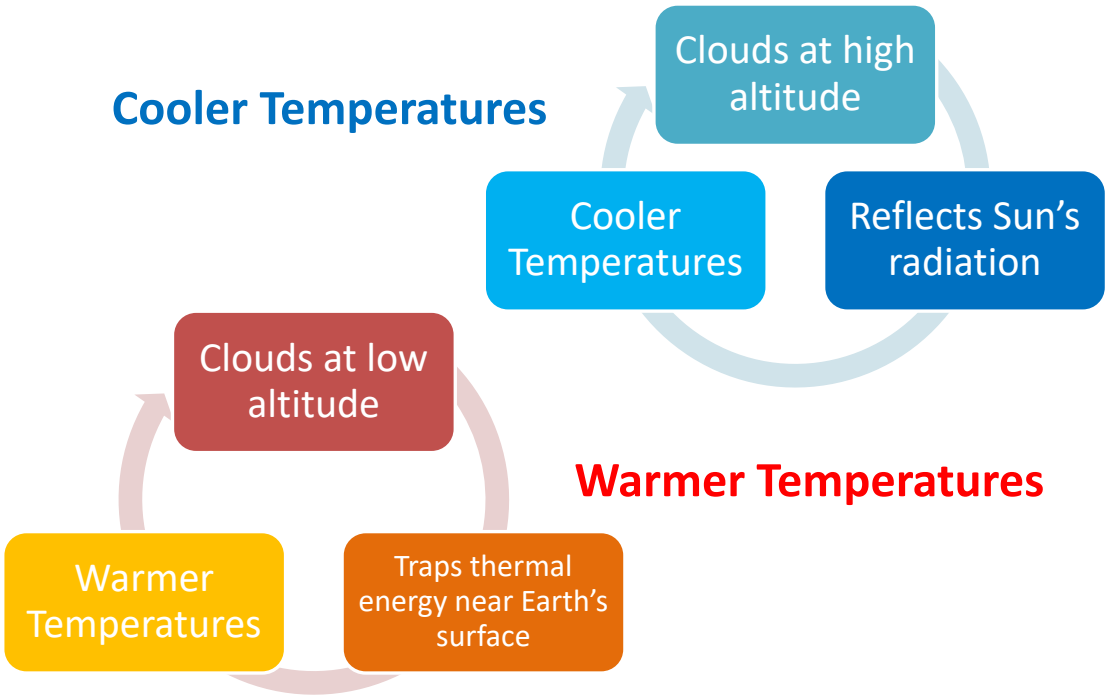


Feedback Loops and Climate

- A process whereby an initial change in the process will either:
  - Reinforce the process – Positive Feedback
  - Weaken the process – Negative Feedback

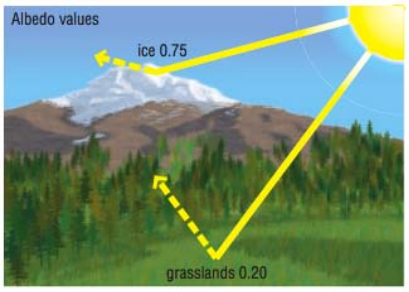


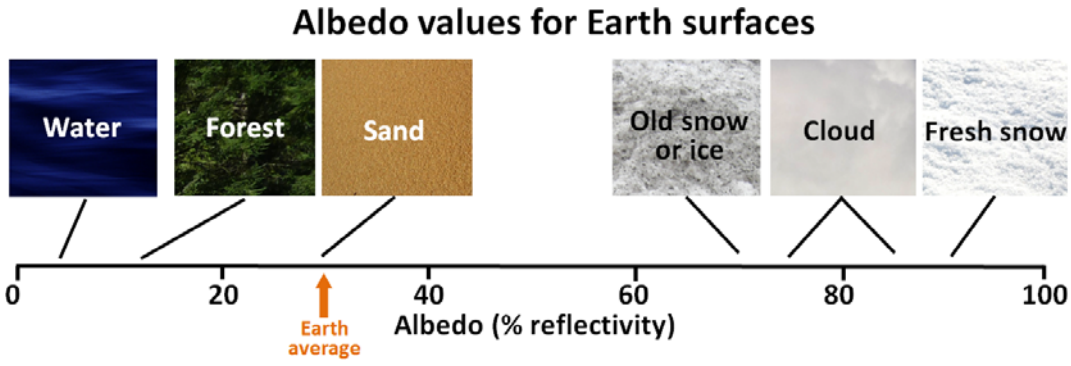
- **Water Vapour Loop (Positive Feedback)**



The Albedo Effect

- Albedo – the proportion of radiation reflected by the surface
  - Ice and snow have high albedos
  - Green plants and soil have low albedos





- **Albedo Effect (Positive Feedback Loop)**