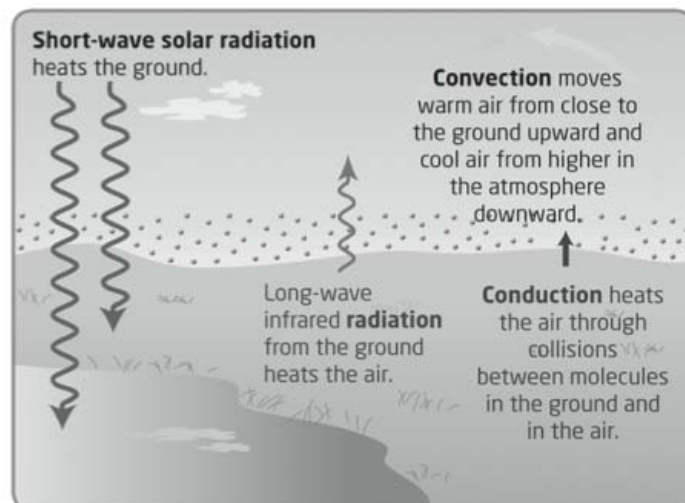


Grade 10 Science

Climate Change
Class 16

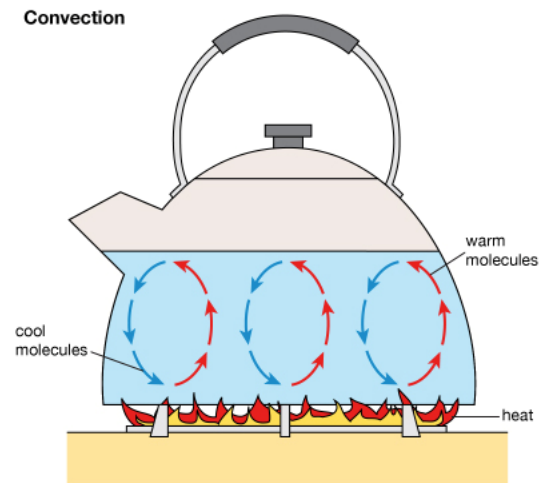
Heat Transfer

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



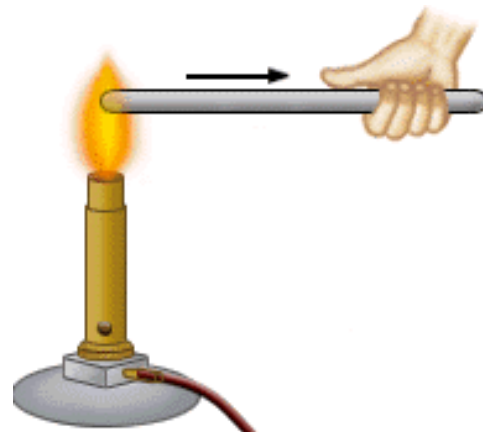
Convection

- 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



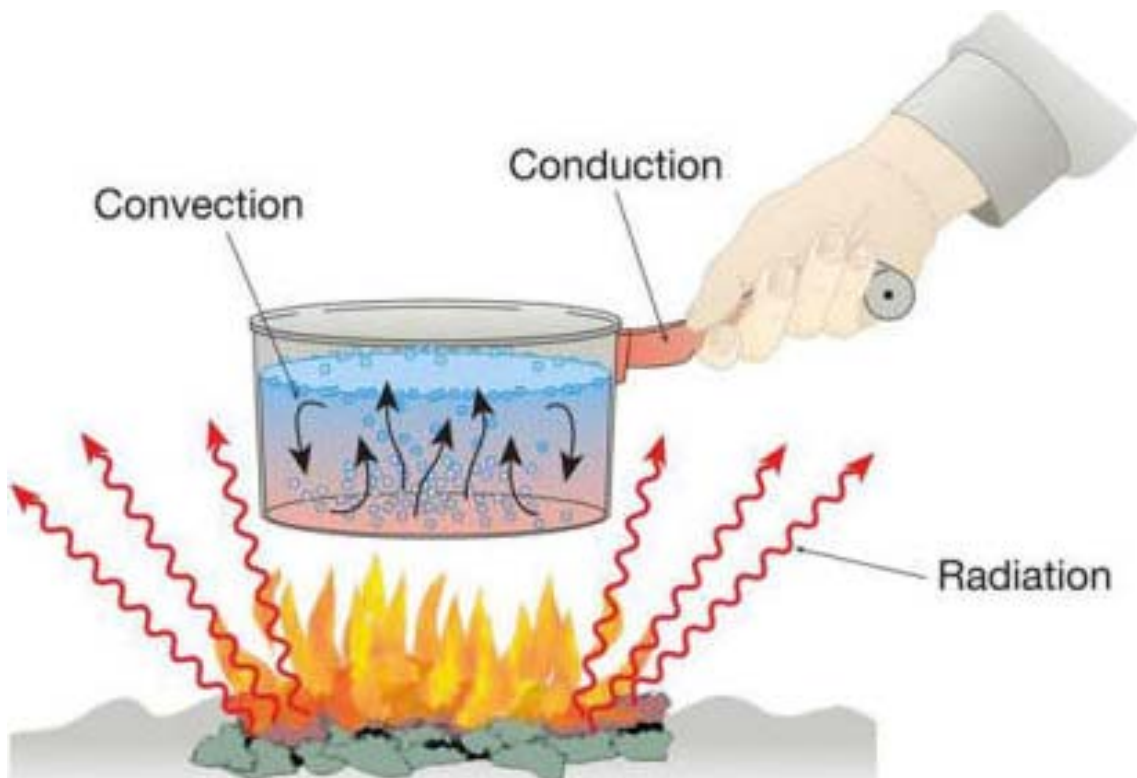
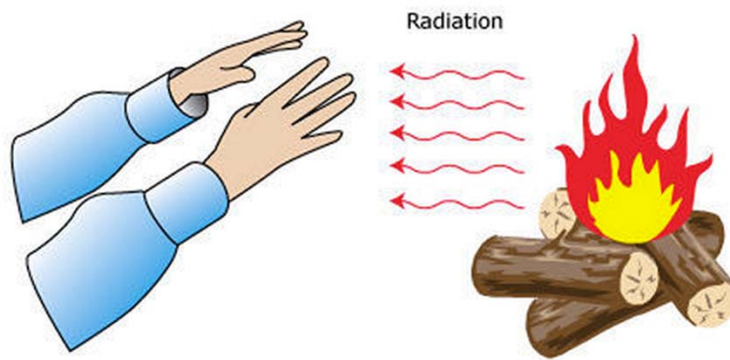
Conduction

- 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

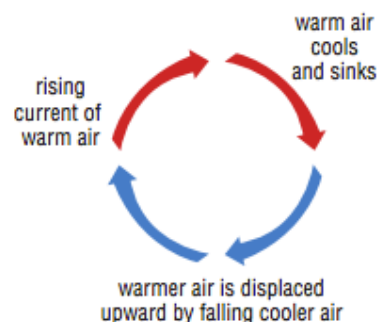


Which mechanism best describes the following energy transfers?

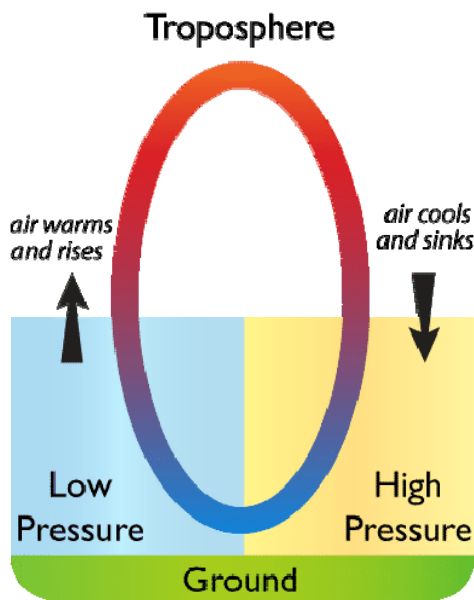
- A warm breeze blowing inland
- A damp cloth cooling your forehead
- A spoon warming in a coffee cup
- A microwave heating a bowl of soup
- A boy warming his hands by a fire

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

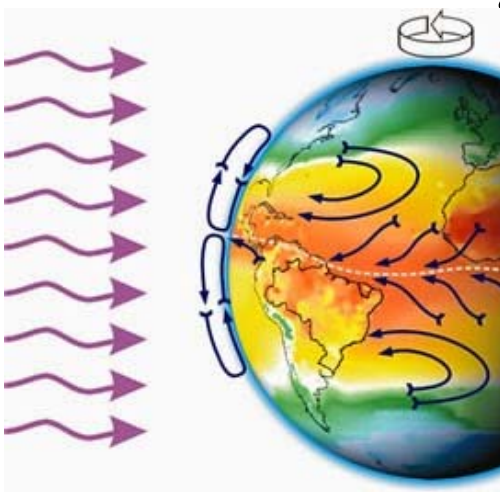


Atmosphere



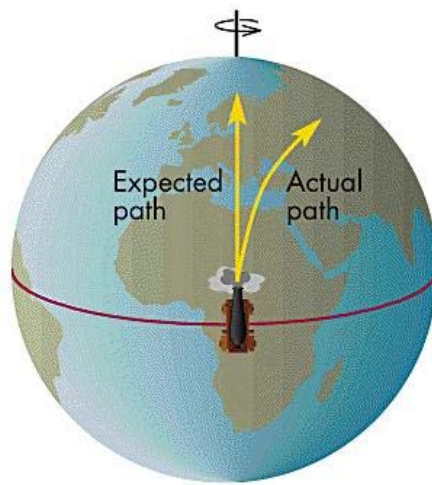
- Air heats up quickly and becomes less dense
- Colder, denser air falls and pushes the warm air up creating an area of low pressure below it
- Warm air spreads towards the poles and cools down which sinks back to the Earth's surface causing high pressure
- Causes convection current

Prevailing Winds

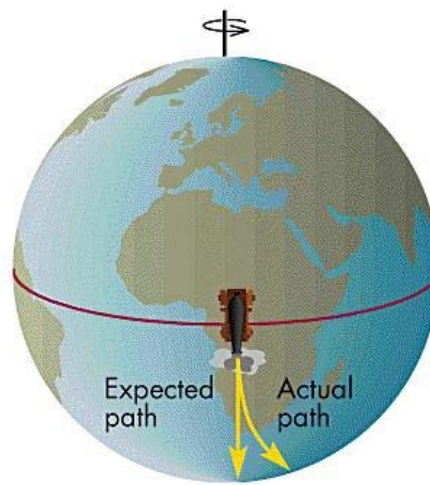


- Earth has permanent bands of high and low pressure parallel to the equator
 - 1) Sun's rays near the equator, causes air to rise
 - 2) Once it reaches the troposphere, air cools and descends to create a convection current

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



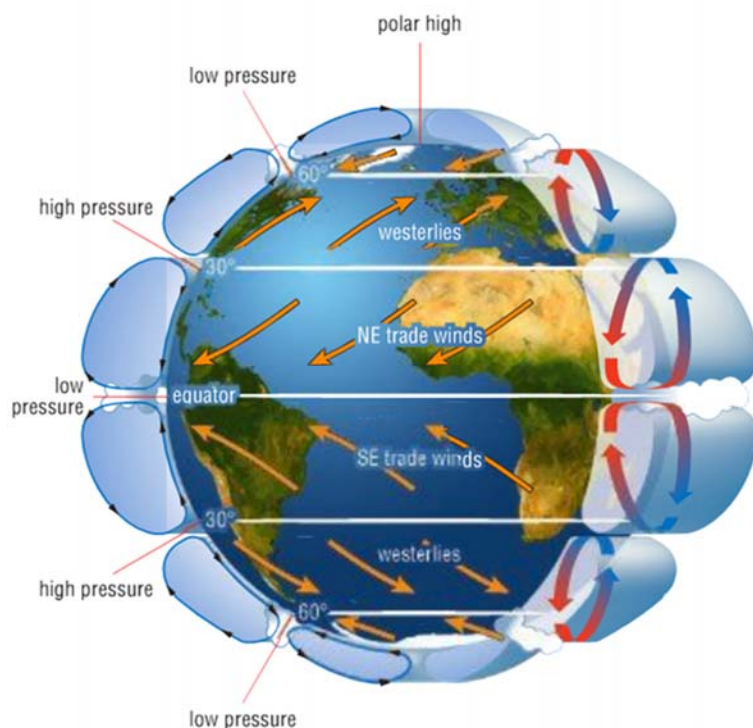
A Projectile fired northward

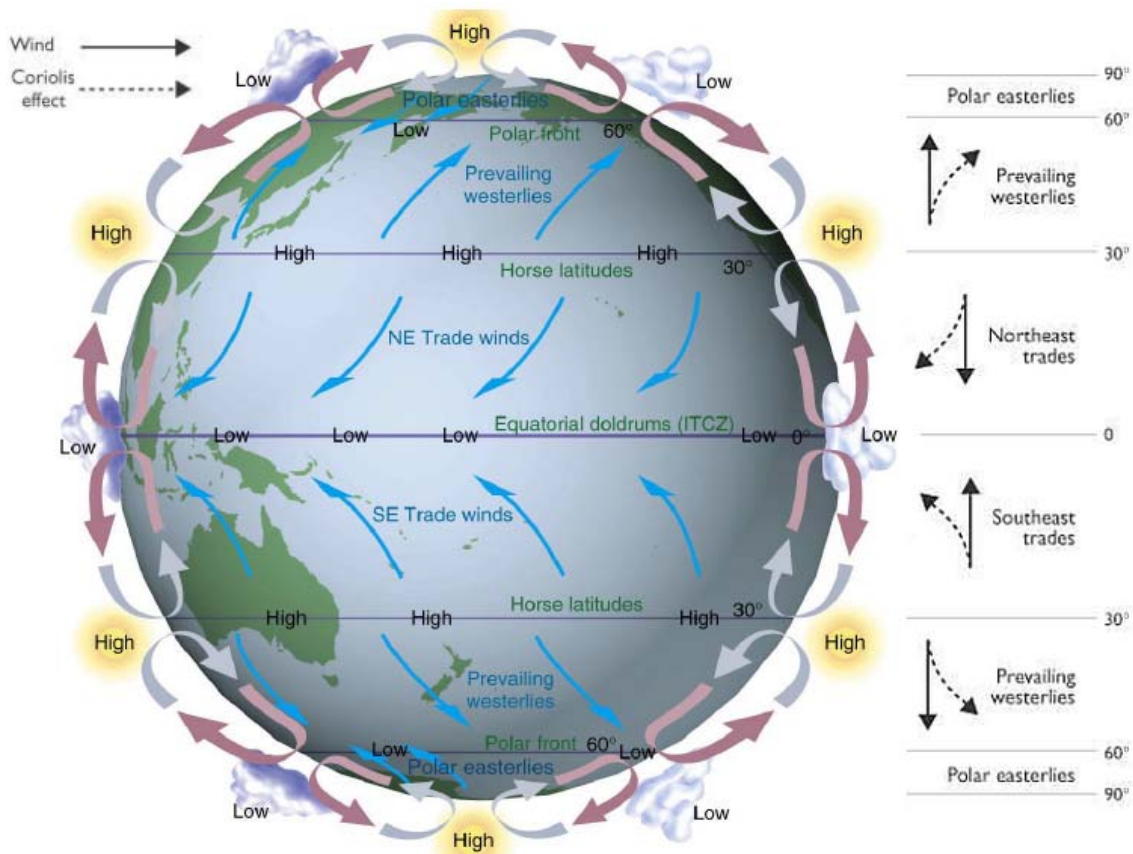


B Projectile fired southward

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

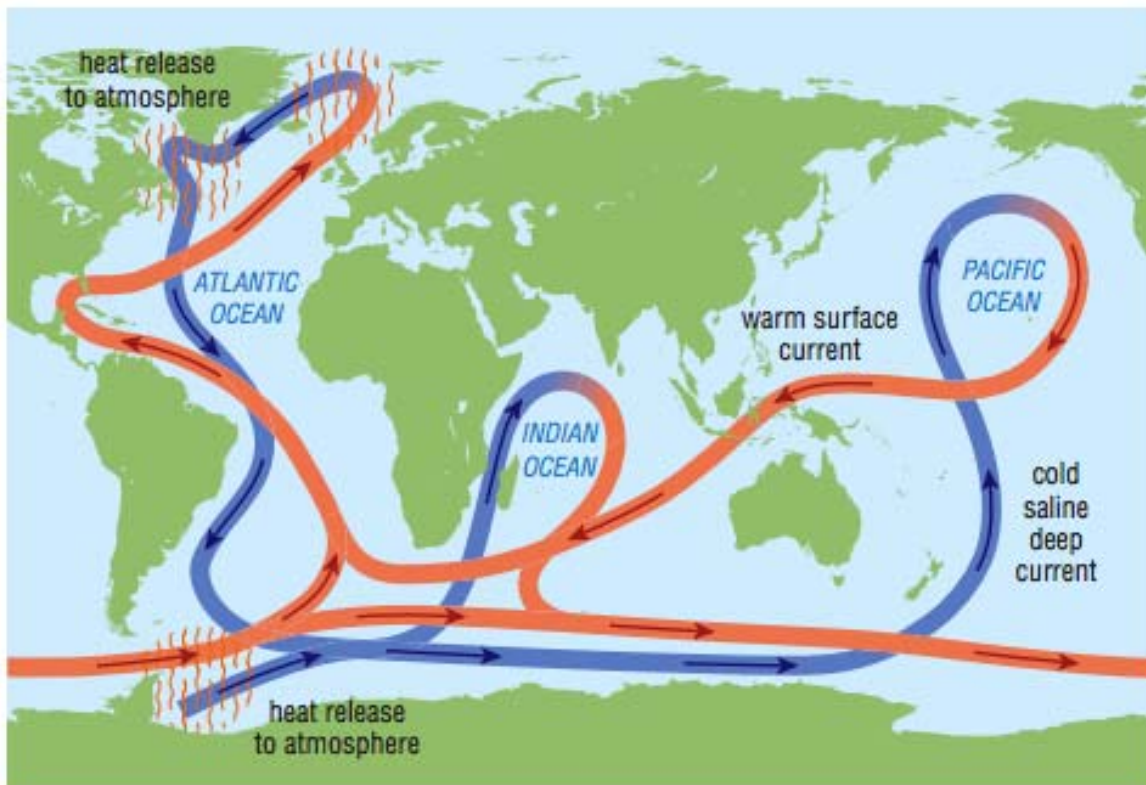
Prevailing winds allow warm air to move towards the poles to prevent extreme temperature differences





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

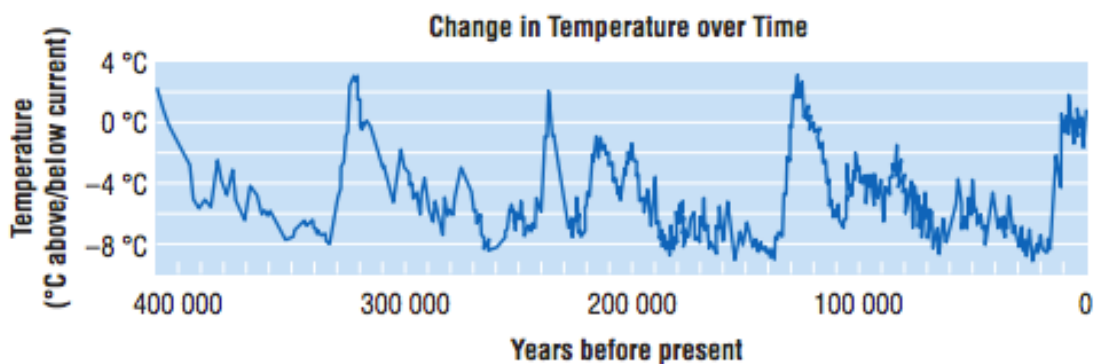


- Warm ocean currents heat the air above them which produces rain on land – determines the climate of that area
 - Warm Gulf Stream current gives the NW coast of Europe a warmer, damper climate than other countries at the same latitude
- Cool ocean currents cool the air above and creates desert areas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

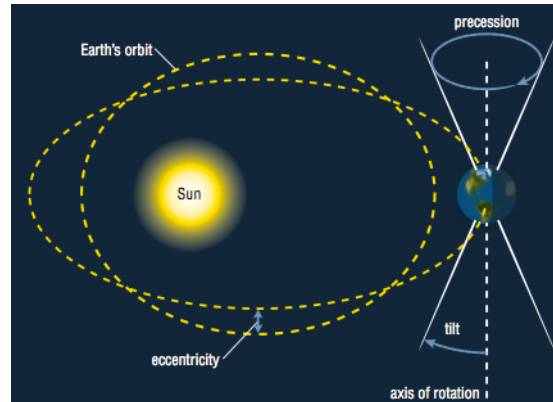


2) Milankovitch Cycles (Ice-Age Cycles)

- 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

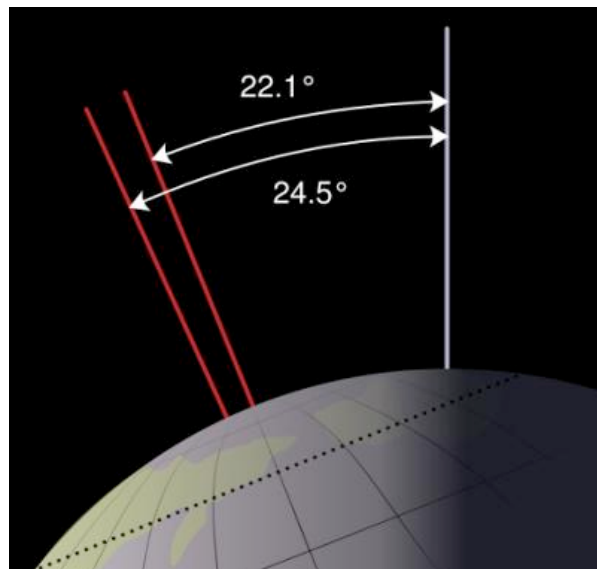
Eccentricity (Shape of the Orbit)

- 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



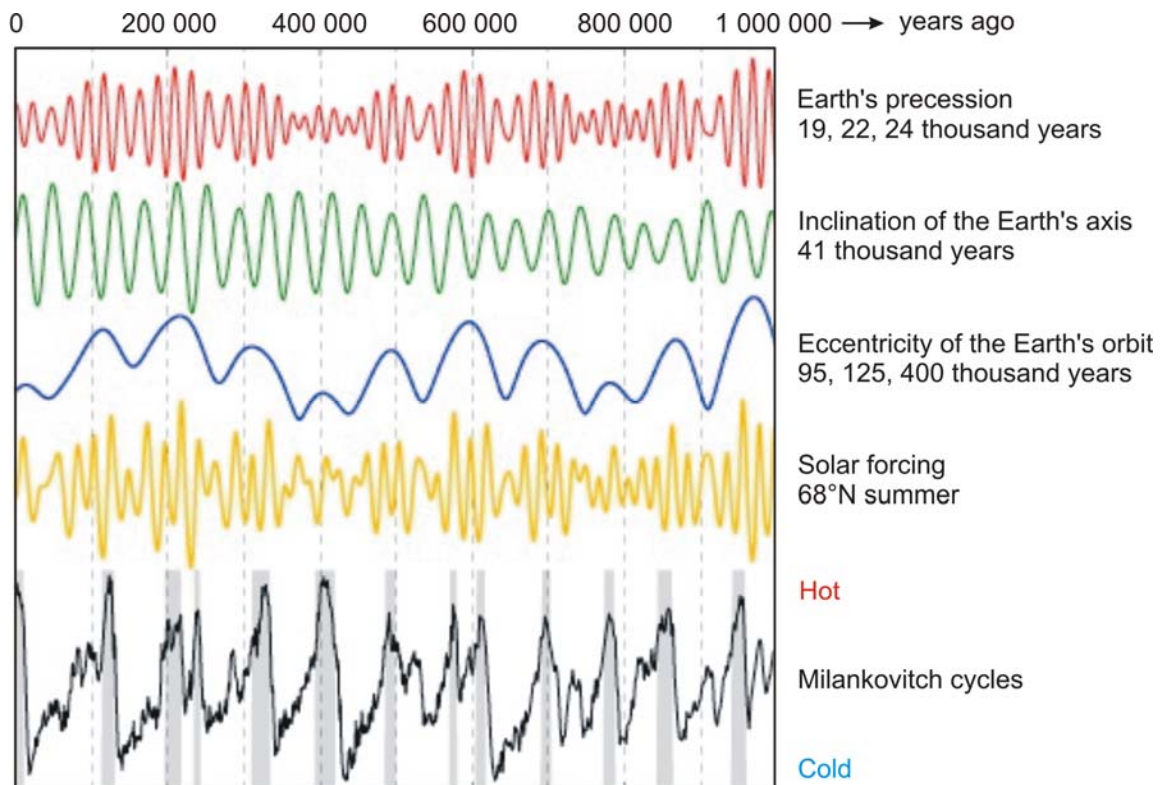
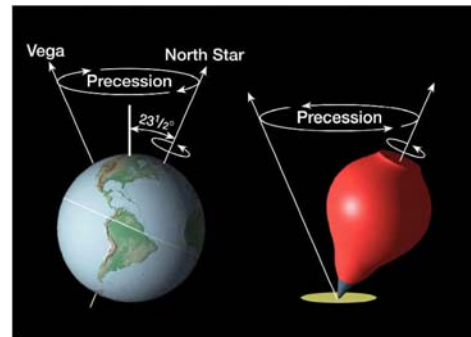
Obliquity (Tilt)

- 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



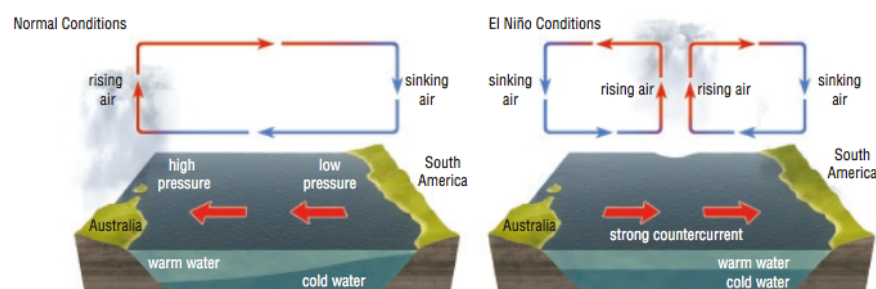
Short Term Changes in Climate

- 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

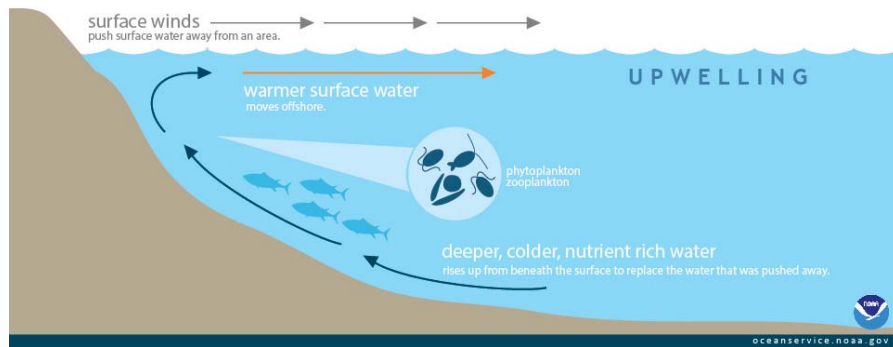


2) El Nino

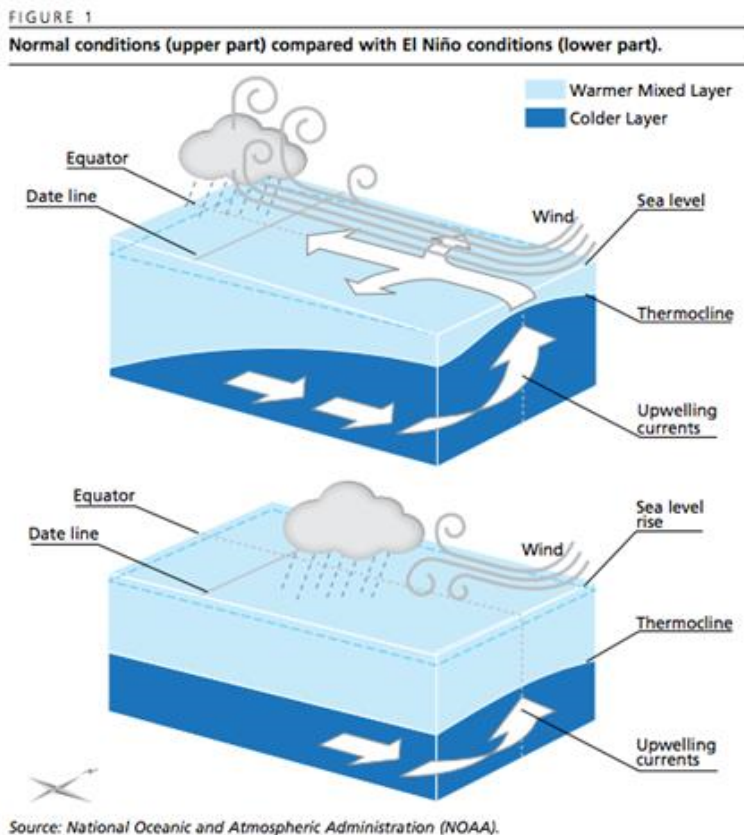
- Every 2-7 years in the Pacific Ocean, prevailing winds temporarily switch direction and push the warm water towards South America rather than the west Pacific
- Impacts ocean temperatures, speed and strength of ocean currents, coastal fisheries and local weather in Australia and South America



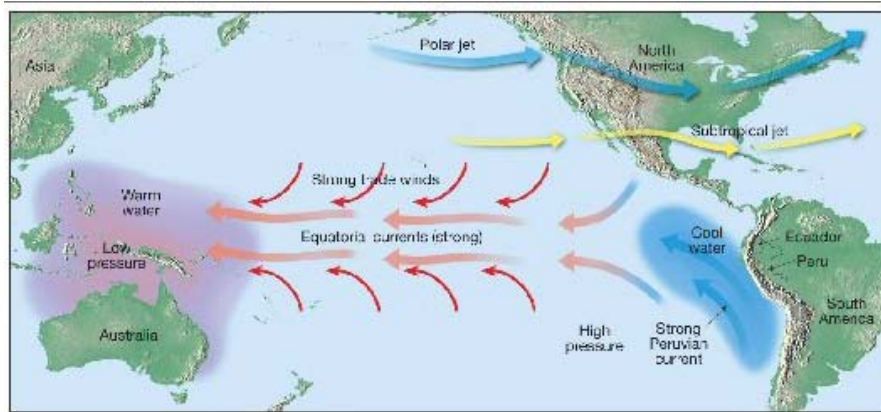
Normal Conditions: Upwelling



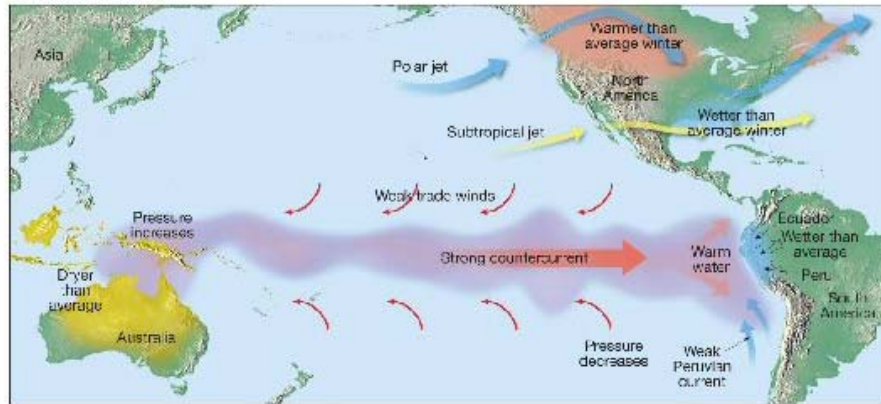
- Normally strong trade winds blow west across the tropical Pacific which push warm surface water toward the west Pacific
- Movement of water causes cooler waters to rise toward the surface = Upwelling
- Upwelling elevates cold water (rich in nitrates and phosphates) to be used by plankton, providing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



- During an El Niño 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



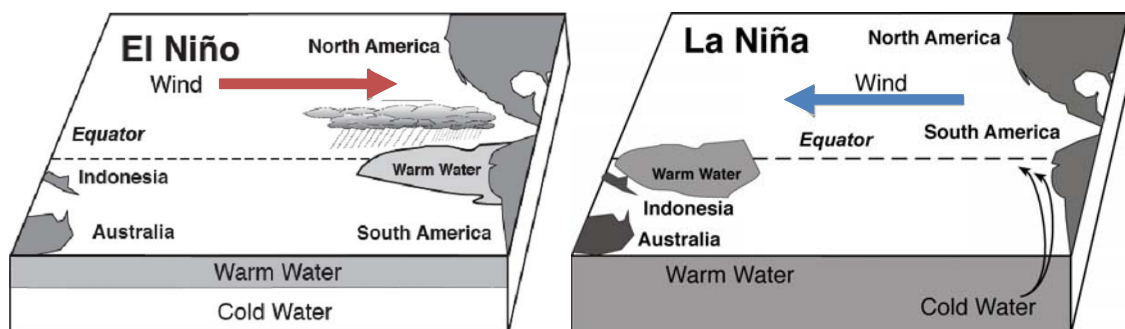
A. Normal conditions



B. El Niño

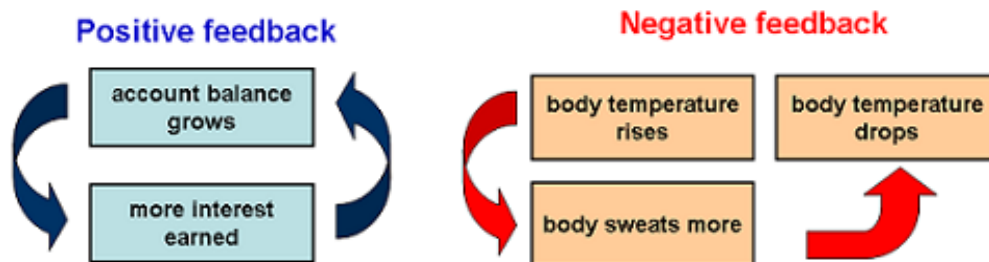
La Nina

- 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

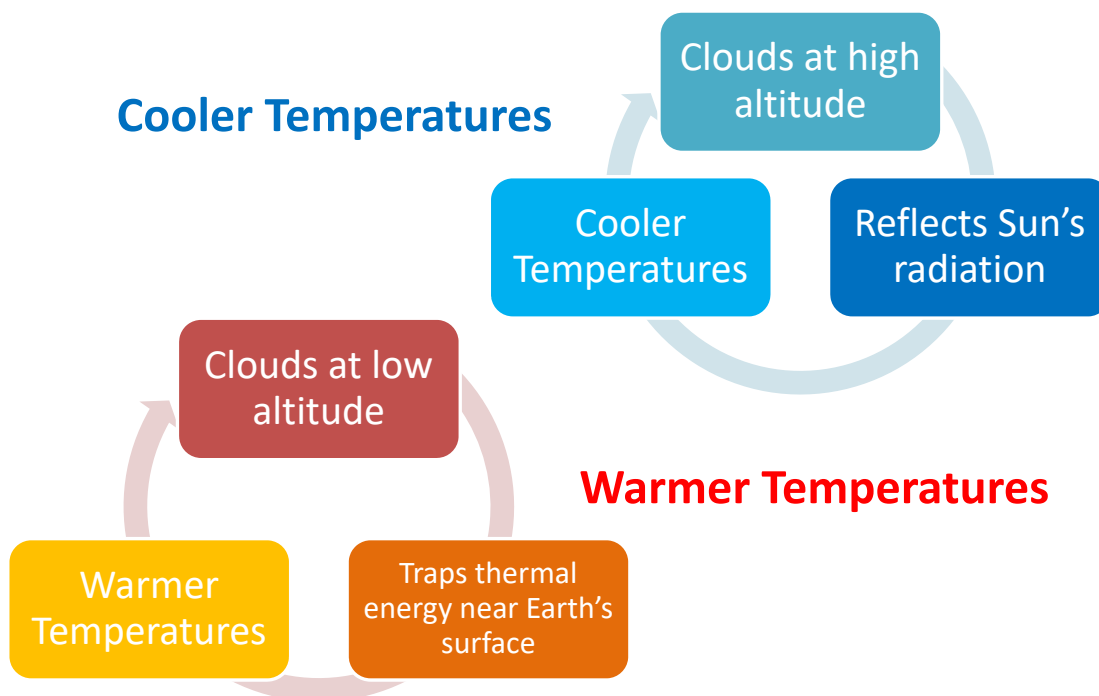


Feedback Loops and Climate

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

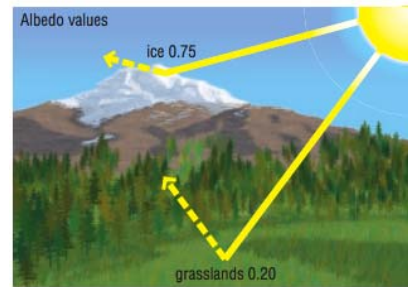


- **Water Vapour Loop (Positive Feedback)**

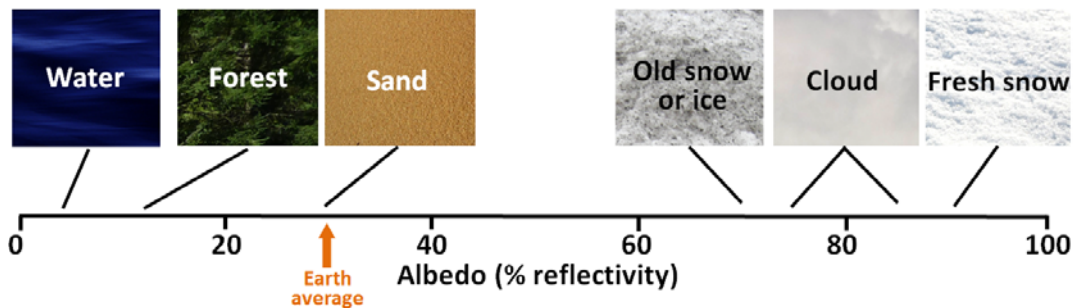


The Albedo Effect

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



Albedo values for Earth surfaces



- Albedo Effect (Positive Feedback Loop)**

