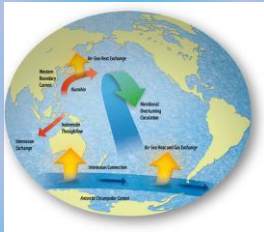


DISTRIBUTING THE HEAT

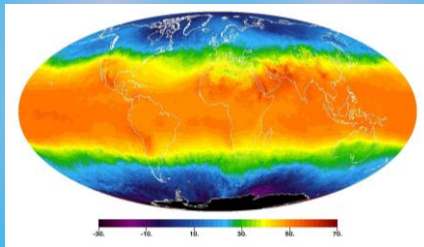


Every year, Prince Albert hosts a winter carnival where you can see really “cool” snow sculptures. During Prince Albert’s winter, ice sculptures are usually able to remain frozen. Meanwhile, only approximately 1700 km away, Vancouver’s winters are mild—too mild to maintain snow sculptures over weeks at a time.

Why?



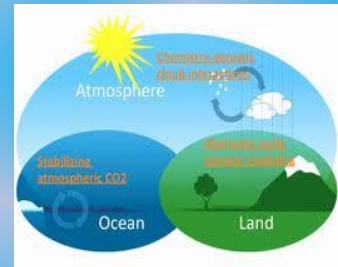
- The earth’s land & water absorb energy at different rates
- The earth is therefore **unevenly heated**



- The Earth’s Climate System needs to distribute thermal energy from areas that receive a lot to areas that receive little

- Systems affecting heat distribution:

- The Hydrosphere
- The Atmosphere
- The Lithosphere



1. THE ATMOSPHERE

➤ Atmospheric Pressure

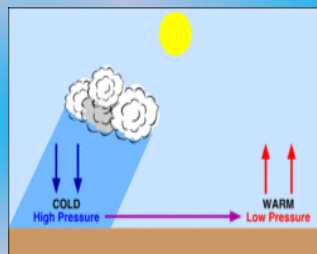
= pressure exerted by the mass of air on Earth’s surface.

Area of Low Pressure

Warm air expands, becomes less dense, rises from Earth’s surface

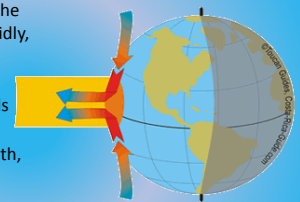
Area of High Pressure

Cold air contracts, becomes denser, descends to Earth’s surface



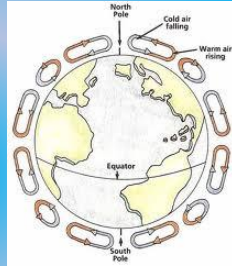
➤ Convection Currents

- They move thermal energy from the equator towards the North and South Poles
- Due to the Sun’s intense rays, the air at the equator heats up rapidly, becomes less dense and rises
- Once the warm air reaches troposphere, it spreads towards the poles and cools down
- The cooler air sinks back to earth, pushing the warm air into the atmosphere
- These convection currents are one of the main ways that energy is transported in the atmosphere



➤ Convection Cells

- Cold air descends at 3 separate latitudes:
30°, 60° and the Poles
- At the equator, warm air rises and loses its moisture.
- At 30°, dry air descends
= deserts occur at 30° latitude around the world.
- The movement of cool air from these areas of high pressure to areas of low pressure is **Wind**.



➤ Coriolis Effect

- Earth is constantly rotating and the atmosphere rotates with it
- The Earth rotates faster at the Equator than the poles.
- This uneven rotation causes the convection cells (and anything else in the atmosphere like airplanes, missiles, space shuttles) to veer to the sideways!
- This tendency is called the **Coriolis effect**.

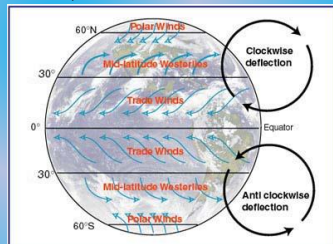
[Coriolis effect](#)



➤ Patterns of Wind Movement

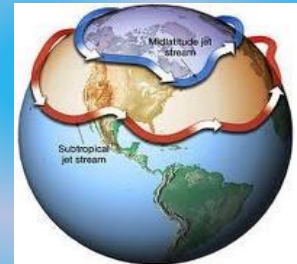
- There are 4 main wind belts on Earth.
- Winds are names based on the direction they originate from
- Due to the coriolis effect, the **Trade Winds** move from the northeast to the west in the Northern hemisphere, and from southeast to the west in the Southern hemisphere.
- The **Westerlies** move from the west, towards the east.

[global wind patterns](#)



➤ Jet Streams

- Currents of extremely fast-moving air about 10-15 km above Earth's surface are called **Jet Streams**.
- Jet Streams form at the boundaries of cold and warm air.
- The intense winds within jet streams influence precipitation and thunderstorms.



2. THE HYDROSPHERE



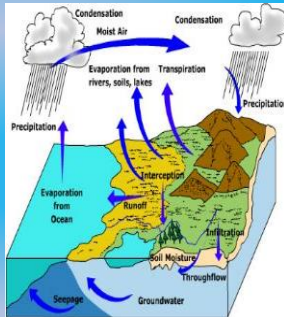
- Earth has been given the nickname "The Blue Planet". This is because Earth's surface is covered with 70% water.
- The hydrosphere is made up of water from the Earth's oceans, rivers, streams, lakes, ground water, glaciers and water in the atmosphere.
- Water plays a very important role in the movement of energy through the biosphere.

➤ The Hydrologic Cycle

- Earth's hydrosphere undergoes a constant cycle involving transport and transformation called the **water cycle**.
- The water cycle is one way that the climate system moves **energy** from one place to another
- The hydrologic cycle distributes water by **evaporation, condensation & precipitation**.
- <http://earthguide.ucsd.edu/earthguide/diagrams/watercycle/>

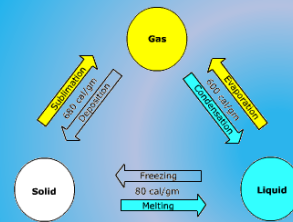
❖ The Water Cycle

1. Heat from the sun causes water in oceans & other water sources to **evaporate**
2. Rising air currents cool the water filled air forming clouds (**condensation**)
3. Clouds release **precipitation** (snow, rain, etc.)
4. Precipitation can **runoff** into bodies of water or be **absorbed (groundwater)**
5. Water is then able to **evaporate** again



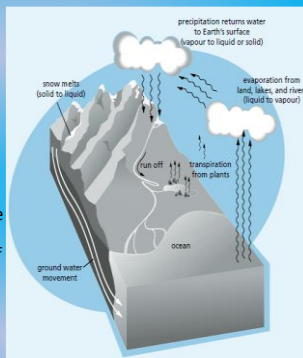
****NOTE:** water can be **stored** in such areas as glaciers and groundwater (aquifers). Water may also be **transpired** from trees.

➤ Energy Transfer in the Hydrologic Cycle



- At various stages in the **hydrologic cycle**, water molecules undergo change in **state**, from **solid to liquid** to **vapour**, and back again.
- Because of water's high specific heat capacity it takes a lot of energy to change its temperature or phase.

- Energy is absorbed when water evaporates from lakes and oceans.
- Energy is given off when water condenses into clouds in the atmosphere.
- Because of these phase changes, the hydrologic cycle moves not only lots of water, but it moves vast amounts of thermal energy.



❖ How do water's phase changes influence climate?



- In Spring, days become longer = more solar energy
- Much of the Sun's energy is used to melt the snow and ice so the air temperature does not rise as much as it would in their absence.
- As winter sets in, shorter days = less solar energy and therefore less heat
- However, liquid water releases heat as it freezes = less of a drop in air temperature.



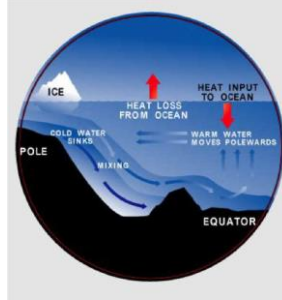
➤ Oceans



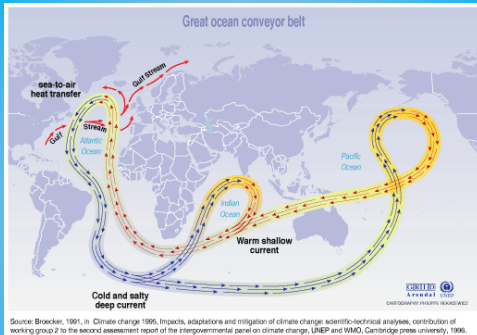
- Water has a low albedo and absorbs more than 90% of the solar energy striking it.
- the energy absorbed by the oceans is distributed around the globe due convection currents, winds and topography.

❖ Thermohaline Circulation

- *Thermo* means heat and *haline* means salt in Greek
- Warmer water is less dense than colder water & a current is formed when water is unevenly heated



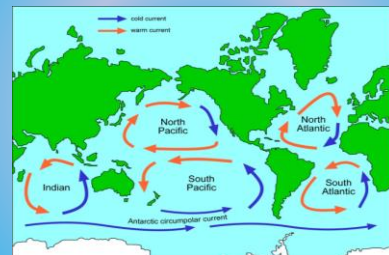
- 1) The sun warms equatorial water starting convection currents
- 2) As water travels to the poles, it gets colder and saltier
- 3) This denser, saltier water at the poles sinks to the ocean floor & warmer surface water from the equator then flows to take its place



Source: Broecker, 1991, in: Climate change 1995, impacts, adaptations and mitigation of climate change scientific-technical analysis, contribution of working group 2 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge press university, 1996.

= giant rivers within the sea that act like "conveyor belts" transporting the energy stored in water from warm parts to cold parts of Earth
[Thermohaline Circulation](#)

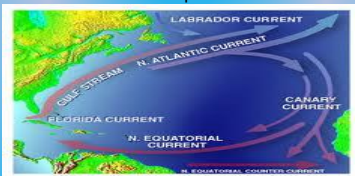
- these currents are started by surface winds
- their patterns of flow are affected by:
 - a) earth's rotation = coriolis effect
 - b) shapes of the continents



Result = **gyres**: almost circular currents which flow clockwise in the Northern Hemisphere & counterclockwise in the Southern Hemisphere

❖ Surface Currents

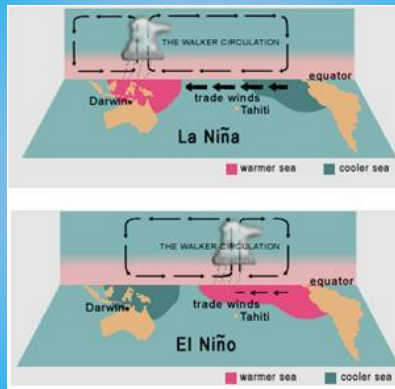
- Ocean currents have a strong effect on the climates of nearby land.
- Warm ocean currents heat the air above them and when the air reaches land, it warms it and produces rain
- Cold ocean currents cool the air above them and when this air reaches land, it cools the land and creates desert areas
- The Gulf Stream is a large surface current that starts in the Caribbean and follows the coastline of the United States and Canada.
- It transports warm water from the tropics to the eastern coast of North America and across to Europe.



➤ El Nino and La Nina

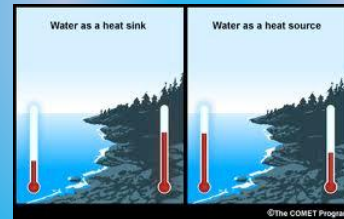
- El Niño is a disruption of the ocean-atmosphere system in the tropical Pacific that typically occurs every three to seven years.
- During an El Niño year, the wind reverses direction over the South Pacific & flows eastward causing an increase in the sea-surface temperature
 - result = heavy rains in South America & droughts in Asia & Australia.
- La Niña is the opposite of El Niño
- An increase in the strength of the westward moving winds.
- La Niña produces wetter than normal conditions in Australia and Asia while North America becomes warmer and drier.

[el nino / la nina](#)
[Science Cast](#)



❖ The Ocean as a Heat Sink

- The ocean is an important heat sink because it can absorb more energy than air
- It absorbs a great deal of solar radiation, keeping the region cooler during the day, and it slowly reradiates the heat at night
- Areas around large bodies of water do not experience extreme weather changes like areas that are continental interiors
 - i.e. British Columbia and Saskatchewan

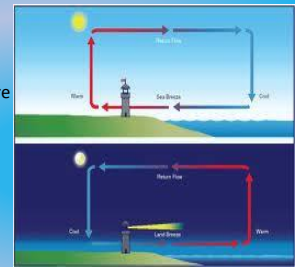


3) THE LITHOSPHERE

- The part of the climate system made up of solid rock, soil and minerals of Earth's crust
- It extends under the oceans
- The Lithosphere absorbs higher-energy radiation from the sun, converts it into thermal energy and then emits energy back as lower-energy radiation
- Sea and land breezes form as a result of the vastly different specific heat capacities of water and land. Water heats and cools at a slower rate than land. This results in a temperature differential between the two bodies.

❖ Sea Breeze vs Land Breeze

- Daytime: land heats up faster than water, sets up convection current, air blows towards shore = "sea breeze"
- Nighttime: water cools more slowly than land, air blows towards ocean = "land breeze"



❖ Land Formations

- Land formations such as mountains affect climate zones by disrupting air flow over an area
- Warm, moist air cools, condenses as it rises against the mountains resulting in precipitation on the windward side and a dry leeward side = the Rain Shadow Effect

i.e. Alberta & Saskatchewan are much drier than Vancouver

