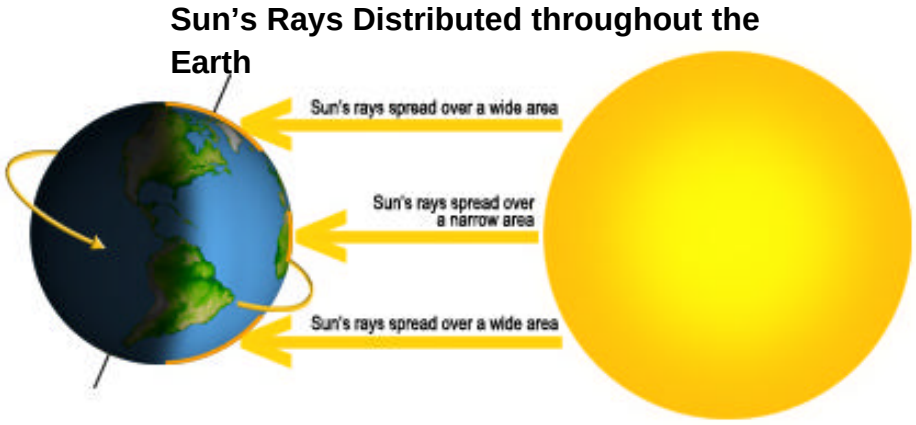
Energy Transfer within the Climate System

By: Lisa Bui

Textbook Reference: Section 8.8 page 344-347

Energy Transfer within the Climate System: Air and Ocean Circulation

As a recap, we all know that the Sun's radiation approaches the earth with different levels of concentration depending on its latitude. (Section 8.3)

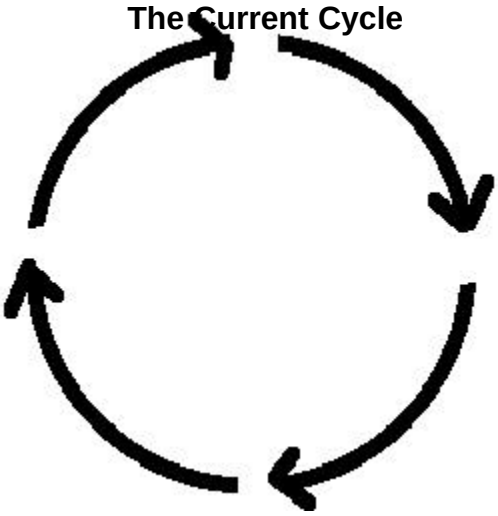


In this given diagram, we are able to see that the North and South Pole both receive less light in comparison to the equator; as the ray of light directly hits the earth.

The curvature of the earth's structure, does not allow it to be at a consistent temperature or be provided with a consistent amount of heat. In addition to the intensity of heat provided by the sun's rays, the water and land absorb energy at varying speeds. The climate system transports **thermal energy** also known as heat energy through the air (atmosphere) and ocean (hydrosphere) in order to neutralize the earth's temperature, and to reduce the temperature difference around the earth.

Both the atmosphere and hydrosphere are crucial in order to regulate the earth's temperature because they act as heat sinks. **Heat sinks** are reservoirs that absorb and stores thermal energy. The hydrosphere has a more dramatic affect on its surrounding regions then the atmosphere because it is capable of absorbing greater amounts of thermal energy. The ocean surface releases thermal energy when the air above it is cooler, and absorbs thermal energy when the air above it is warmer. The majority of the thermal energy circulation remains dependant and consists of the hydrosphere and atmosphere.

Thermal energy transfer is possible because of the presence of currents. Currents are formed because of present energy sources emitting heat. Particles hit by the energy source will begin to move faster and farther apart, and affect the surrounding particles. The colder, denser air will sink as the warmer air continues to rise. Ocean currents and air currents both emerge when its particles are unevenly heated.



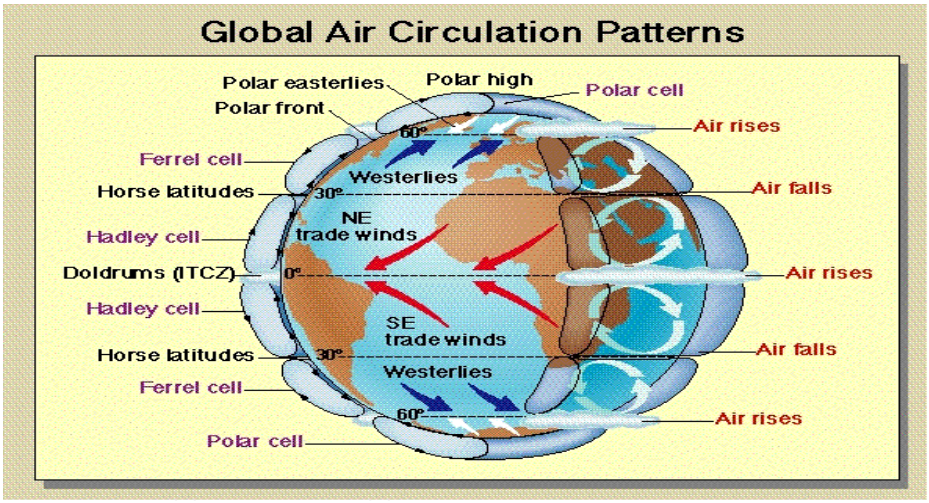
Rising current of warm air

Warmer air gets pushed upwards as cool air sinks

Warm air sinks as it cools

Energy transfer is a never-ending cycle of which warm air rises and cool air falls. As the warm air rises it creates an area of low pressure below. Once the warm air has moved high enough into the troposphere, it diffuses and moves towards either poles pending its current location, and as the air cools it sinks back into the earth it creates an area of high pressure. This never-ending cycle is referred to as a **convectional current**.

As we approach the poles the convection current begin to repeat itself more frequently and thus creates permanent bands of high and low pressure parallel to the equator allowing energy to be transported through the atmosphere as it moves towards the North and South Poles.



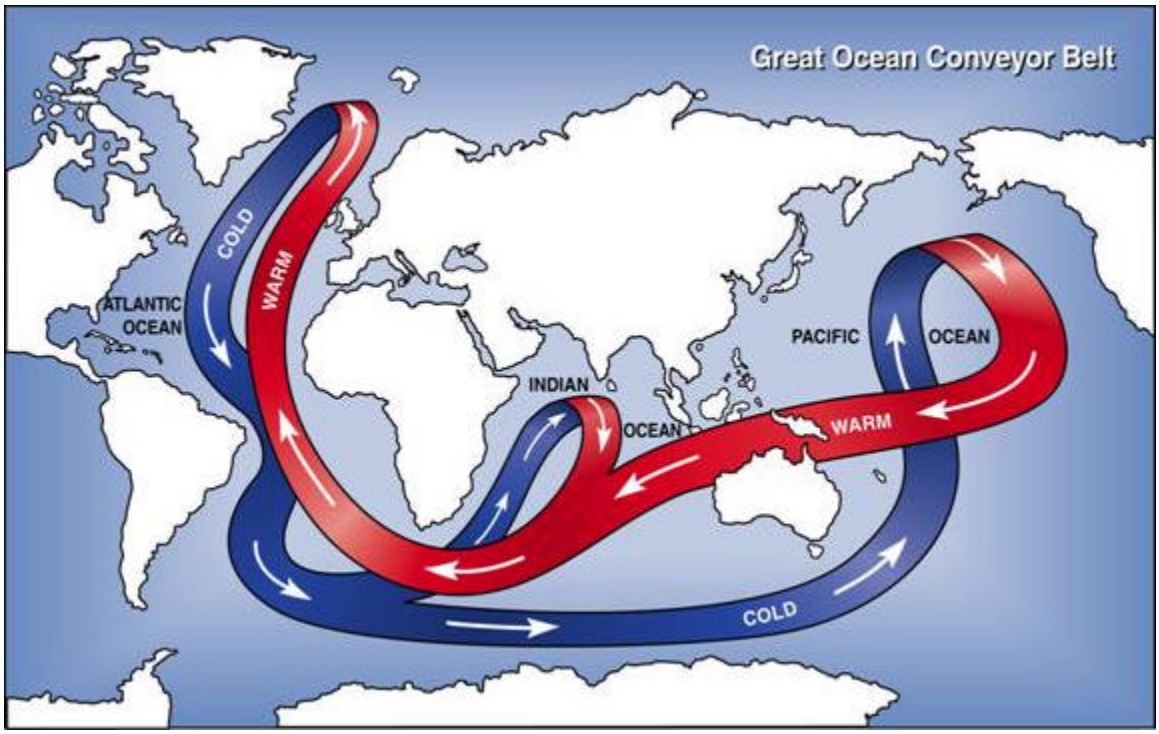
Global air circulation as described in the three-cell circular model. As in simpler circulation models, air rises at the equator and falls at the poles. But instead of one great circuit in each hemisphere from equator to pole, there are three. Note the influence of the Coriolis effect on wind direction.

Air continually moves from an area of high pressure to an area of low pressure and creates air currents which are recognised as prevailing wind. **Prevailing wind** are winds that are present throughout the year and travel the majority of the time in the same direction. As the earth rotates the prevailing winds move relative to the earth's structure, curving their routes rather than heading directly north or south.

Prevailing winds also contribute to a climate zone. These wind currents pass over the ocean and picks up water vapour, of which possesses thermal energy. As the wind continues to pass over the region these water droplets condense and cause rain. Based on the volume of the body of water areas situated with prevailing winds and a large body of water will have induced rainfall. Likewise, prevailing winds from cold and dry regions such as the North Pole will carry cold and dry air causing uncomfortable conditions.

Energy transfer occurs regularly in oceans. As we approach the poles the water begins to get saltier. Once ice forms at the poles the salt gets rejected and remains in the water whilst warm water evaporates. The concentration of salt present in the water causes the water to become denser and because of this forces the salt water down into the ocean floor, then resulting in warmer surface water from the equator to flow into the poles to take its place. The process in which the flow of water continues around the world based on temperature and salinity is called **thermohaline circulation** *(thermo meaning heat, and haline meaning salt)*. The thermohaline circulation is greatly affected by strong winds, which can affect the speed at which the wind travels and the direction it travels in.

Analogy: Ocean currents act like a conveyor belt transferring water around the world.



Ocean Current affects the climate of surrounding areas. Warm ocean currents heat the air above them, and then continue being carried off onto the land where it will produce rain. Cold ocean currents cool the air above them and when the cold air reaches land it creates desert areas.

Assignment

Match up the definitions with the vocabulary.

1) Thermal Energy	a) winds that are present throughout the year
2) Heat Sinks	b) the process of flowing water continuing around the world based on temperature and salinity
3) Convection Current	c) never ending cycle of warm air rising, cool air falling
4) Thermohaline Circulation	d) reservoir that absorbs thermal energy
5) Prevailing Winds	e) warm air particles
6) Hydrosphere and Atmosphere	f) part of the earth, air and water

7) Draw a diagram of the Convection Current Cycle:

8) How do prevailing winds affect climate?

(a. Prevailing winds affect climate by picking up water vapour as it passes over oceans. Depending on the body of water it passes over, it will determine the moisture in the atmosphere; really cold and dry, or really moist and wet...etc)

9) Explain the process of thermohaline circulation.

(a. Thermohaline circulation is the process in which water continually flows around the world in order to regulate the water temperature. This process works through the temperature of the water and salinity, as salt water sinks, warm water from the equator moves in to take its place.)