The Transfer of Heat

Outcomes:

S2-4-03 Explain effects of heat transfer within the atmosphere and hydrosphere on the development and movement of wind and ocean currents.

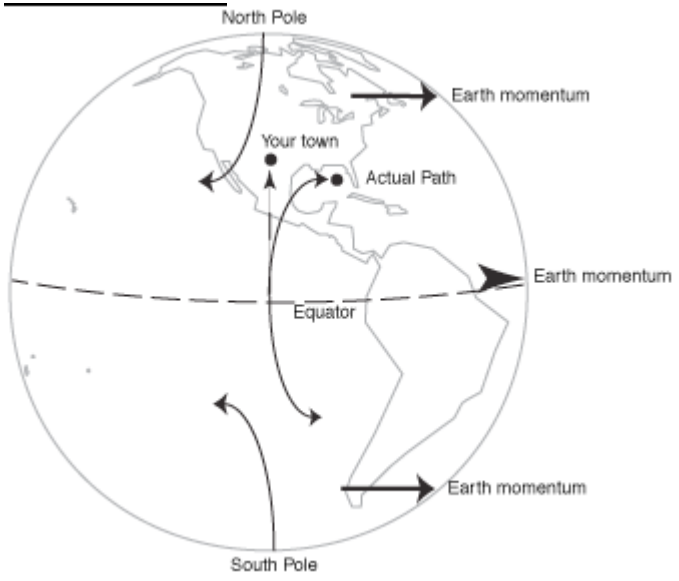
Coriolis Effect…

In our ecology unit we looked at the cycling of nitrogen, carbon and oxygen. The earth also cycles the **ENERGY** it gets from the sun with currents in the **ATMOSPHERE** and in the **OCEANS**.

Movement of Air in the Atmosphere

- The atmosphere is **NOT ATTACHED** to the Earth's surface, and can move at different **SPEEDS** or **DIRECTIONS**.
- Because of this, objects (like air, ocean currents, airplanes) **NOT ATTACHED** to the Earth will **APPEAR** to us to move along a **CURVED PATH** even though they may **ACTUALLY** be traveling in a **STRAIGHT** line.

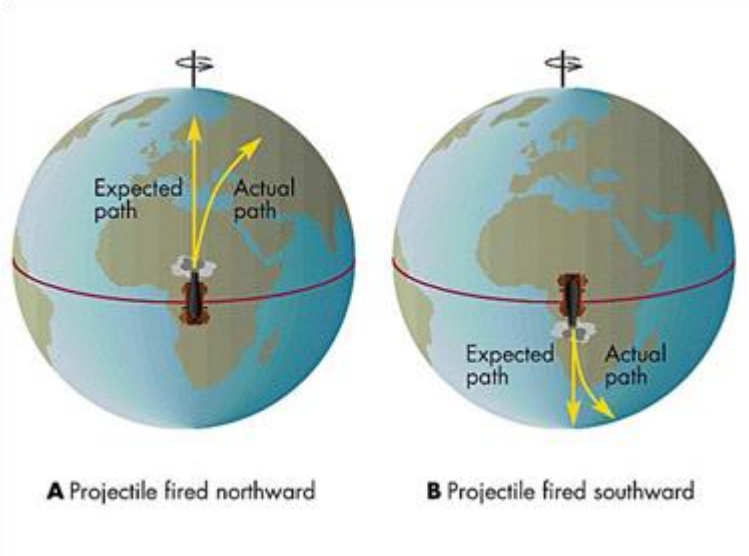
Coriolis Effect



Coriolis Effect…

- Consequently, moving objects always appear to **TURN** to the **RIGHT** in the **NORTHERN HEMISPHERE**.

- The reverse happens in the **SOUTHERN HEMISPHERE** because of the clockwise sense of our planet's rotation when looking down from above the South Pole. There, horizontally moving objects appear to **TURN** toward the **LEFT**.

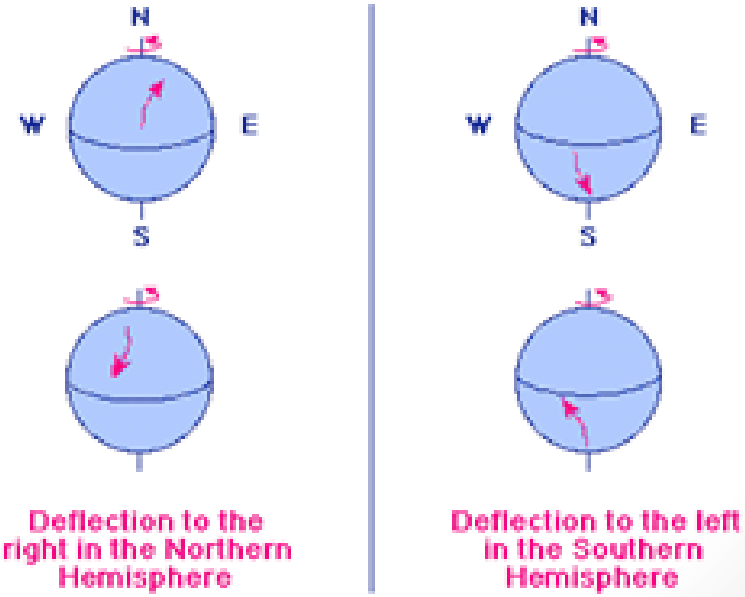


Coriolis Effect…

The Coriolis "Force"

- is defined as always acting **PERPENDICULAR** (90^0) to the **DIRECTION** of **MOTION**.
- Is **STRONGER** at **HIGHER** latitudes.
- Because the sense of the Earth's rotation as seen from above in the northern hemisphere is opposite to that in the southern hemisphere, it is further defined as always acting:
  - **TO THE RIGHT IN THE NORTHERN HEMISPHERE**
  - **TO THE LEFT IN THE SOUTHERN HEMISPHERE**

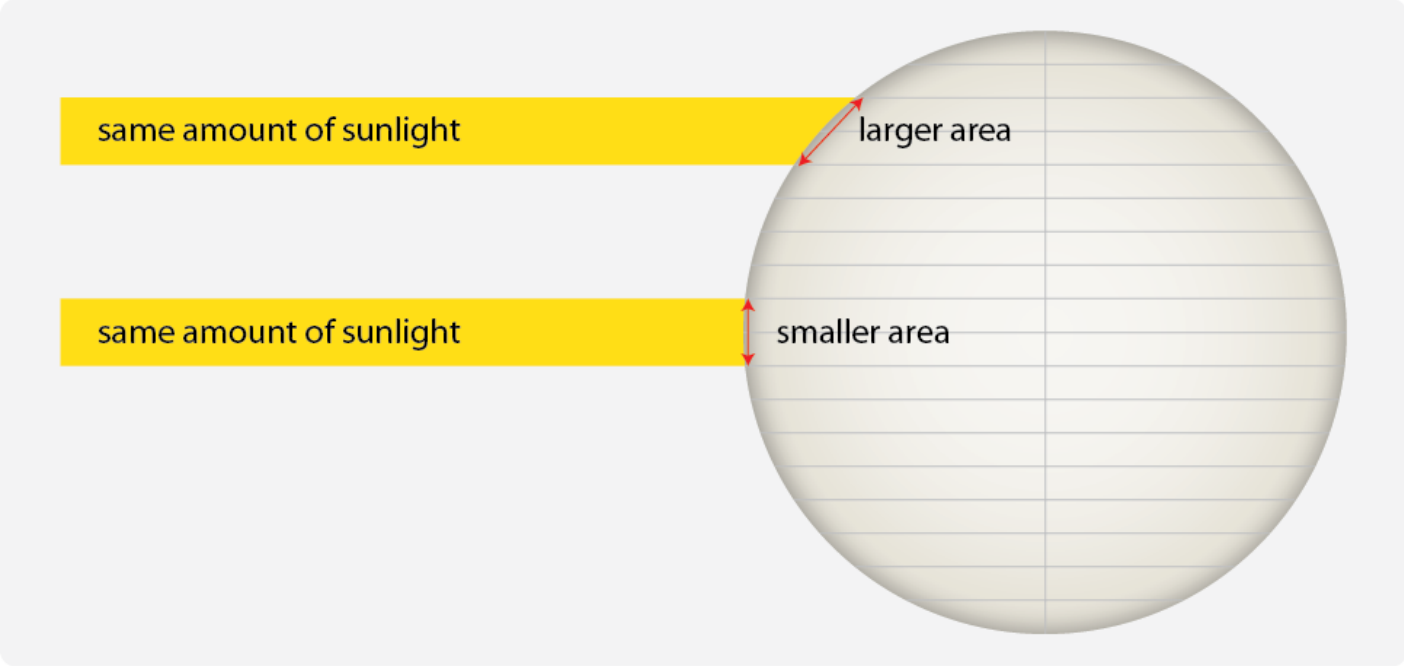
Coriolis, Toilets & Winds



Solar Heating & Convection…

SOLAR HEATING is most prominent at the equator because of the sun's **ANGLE OF INCIDENCE**.

EFFECT OF LATITUDE ON INSOLATION



The same amount of sunlight spreads over a larger area near the poles than near the equator. When spread over a larger area, the insolation per unit area is decreased, leading to cooler temperatures away from the equator.

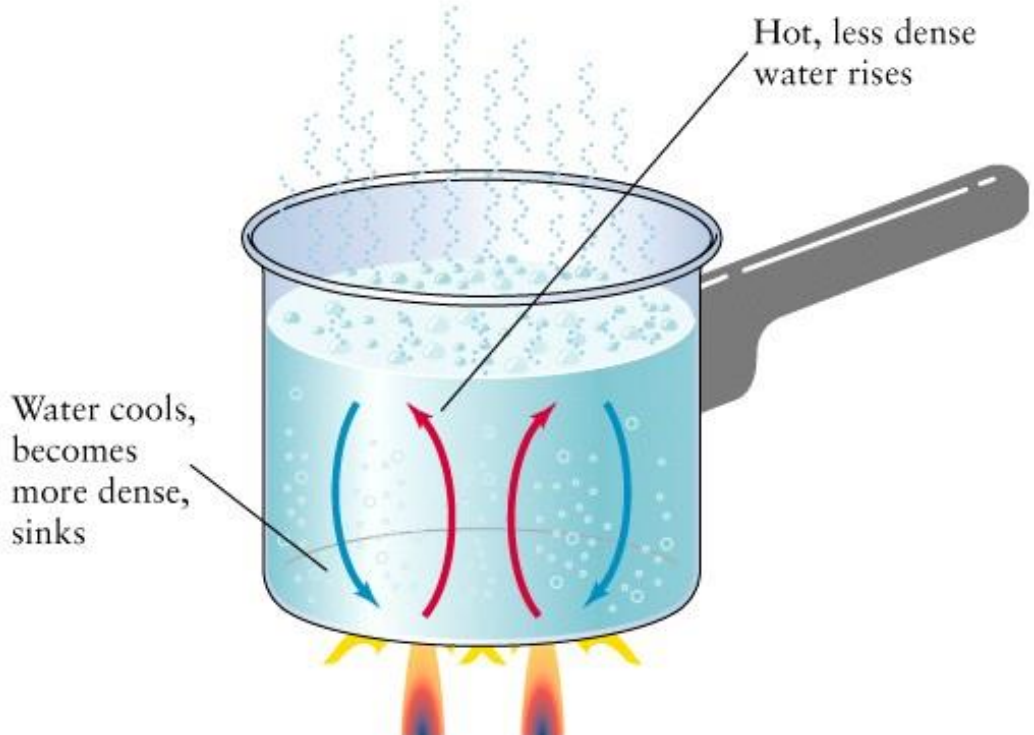
Solar Heating & Convection…

Heat from the sun can be absorbed by:

- **AIR** molecules (i.e. troposphere)
- **WATER** molecules (i.e. oceans)

The **HEATING OF AIR AND WATER** molecules causes a **VERTICAL** motion of these molecules.

→This motion is called **CONVECTION**.



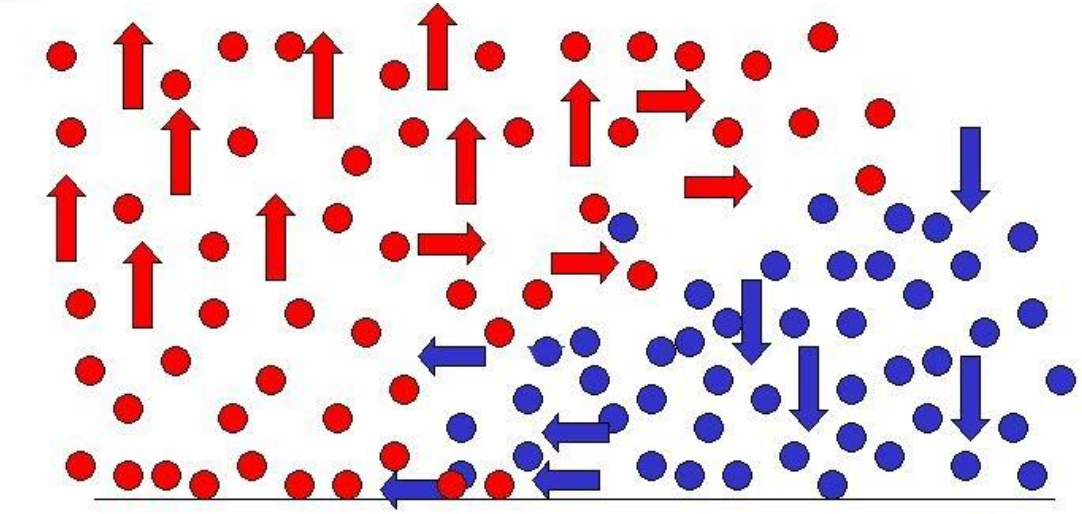
Solar Heating & Convection…

HOT AIR RISES because the molecules are moving faster (have more energy) and are more spread out (i.e. less dense so they rise)

→ This creates an area of **LOW PRESSURE**!

COLD AIR FALLS because the molecules are moving slower (have less energy) and are closer together (i.e. more dense so they fall)

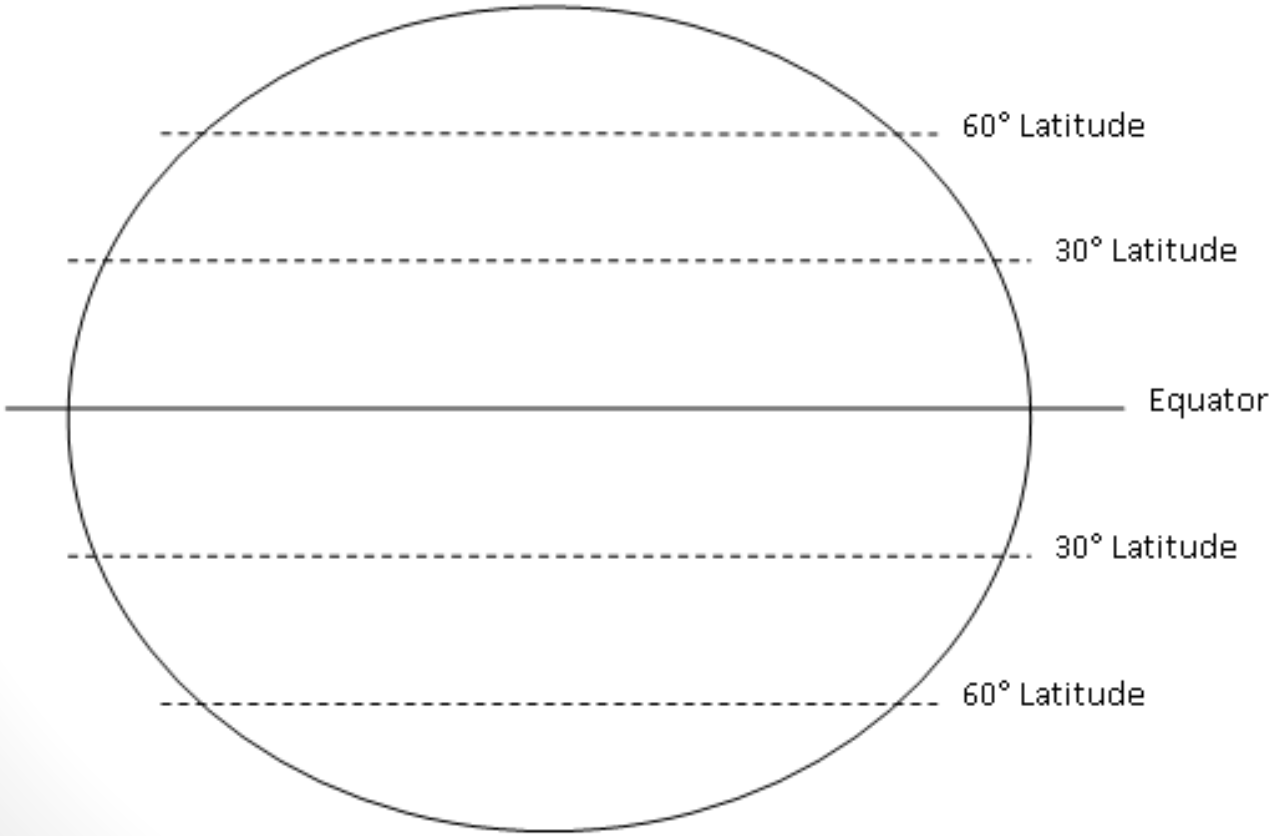
→ This creates an area of **HIGH PRESSURE**!



Prevailing Winds & Jet Streams…

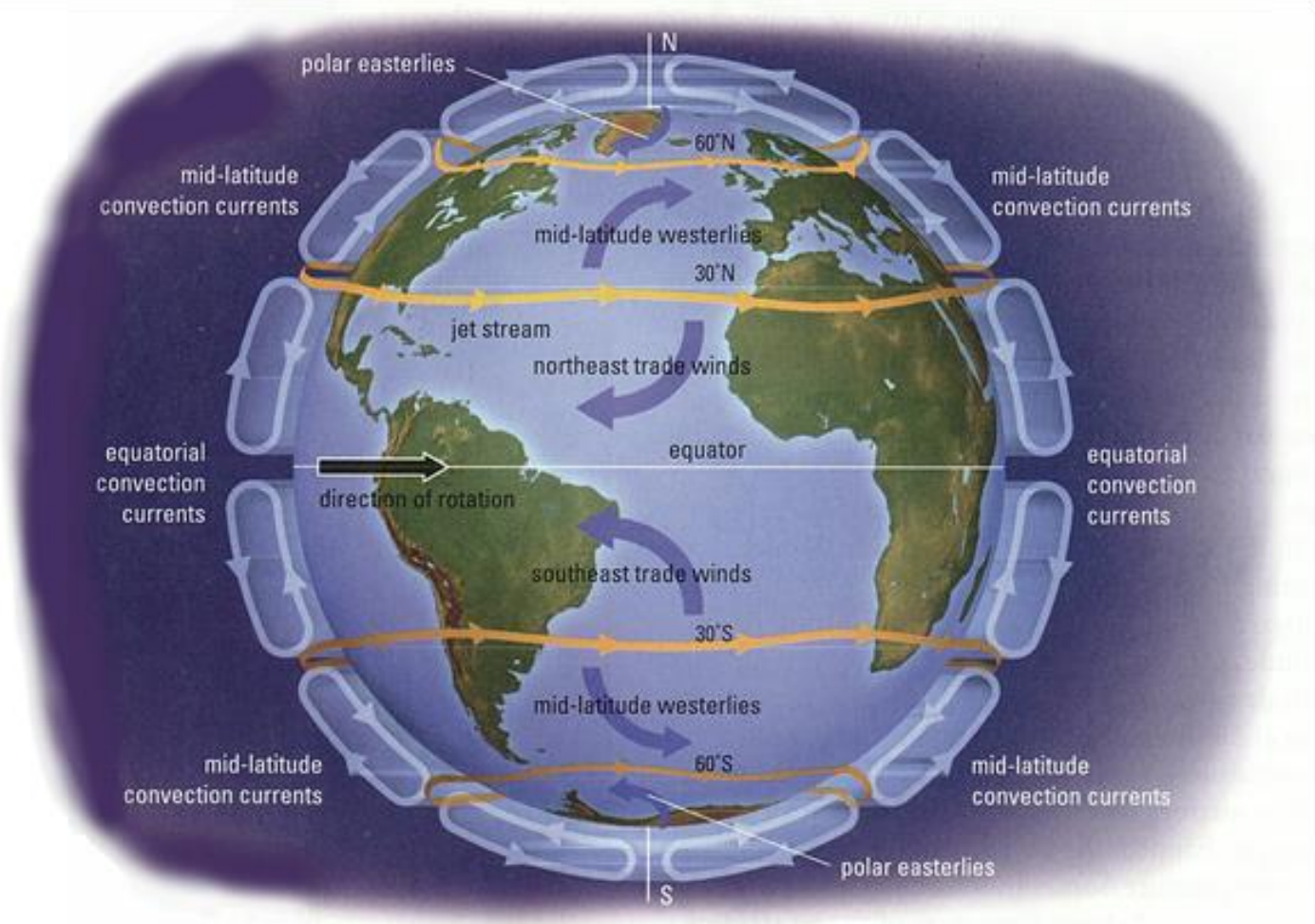
Since **WINDS** are just molecules of air, they are **SUBJECT TO** solar **HEATING** (convection) and to the **CORIOLIS** effect.

As the image below indicates, solar heating on the Earth has the effect of producing **THREE MAJOR CONVECTION ZONES** in each hemisphere.



Prevailing Winds & Jet Streams…

Notice how the convection zones act like **GEARS**, with the equatorial convection currents affecting the mid-latitude convection currents, and the mid-latitude convection currents affecting the polar convection currents.



Prevailing Winds & Jet Streams…

Prevaling Winds

- **IF SOLAR HEATING** were the only thing influencing the weather, we would then **EXPECT** the **PREVAILING WINDS** along the Earth's surface to either be from the **NORTH** or the **SOUTH**, depending on the latitude.

- However, the Coriolis force **DEFLECTS** these wind flows to the **RIGHT** in the **NORTHERN** hemisphere and to the **LEFT** in the **SOUTHERN** hemisphere. This produces the prevailing surface winds as illustrated.

For example, between 30 degrees and 60 degrees North latitude the solar convection pattern would produce a prevailing surface wind from the South. However, the Coriolis force deflects this flow to the right and the prevailing winds at these latitudes are more from the West and Southwest. They are called the **PREVAILING WESTERLIES.**

Prevailing Winds & Jet Streams…

Jet Streams

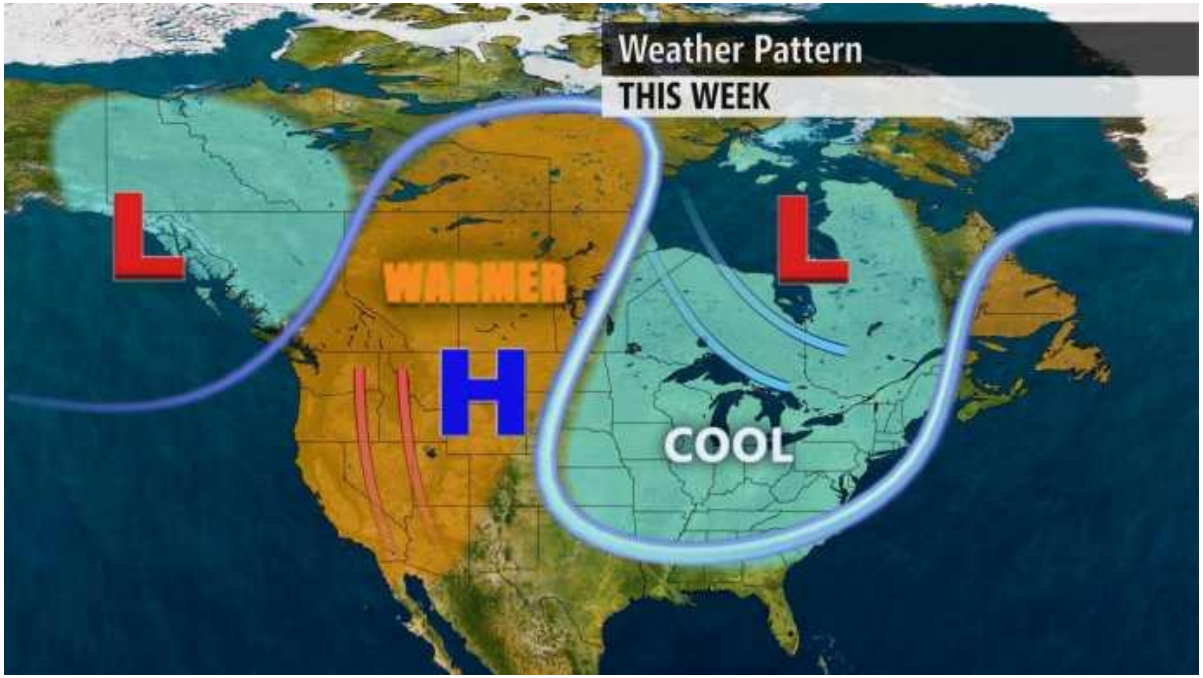
- Are **HIGH SPEED WINDS** in the **UPPER** regions of the **TROPOSPHERE**, often around **30^0** and **60^0** of **LATITUDE**.
- They move from **WEST TO EAST** and **STEER** most of the major **WEATHER SYSTEMS** (low-pressure and high-pressure systems).

- Jet streams are **THOUSANDS** of kilometers **LONG**, and they can be a few **HUNDRED** kilometers **WIDE** and usually two or three kilometers thick.

Prevailing Winds & Jet Streams…

Jet Streams

- Jet streams do not flow along one particular latitude but **WANDER** above and below the latitude **SEPARATING** the boundaries of **COLD** air masses and **WARM** air masses



- It is important to remember that **PREVAILING** winds occur along the **SURFACE** and the lower part of the troposphere, while the **JET STREAMS** occur in the **HIGHER PARTS** of the troposphere.

Prevailing Winds & Jet Streams…

Effects of Prevailing Winds

- Help **DISTRIBUTE** large amounts of **SOLAR ENERGY** **FROM** the **EQUATOR** to the **COLDER** poles.
- Because convection currents are involved in many of these winds, there is also a **RETURN** flow of **COLDER** air **SOUTHWARD**.
- The prevailing winds also carry **MOISTURE**, helping to cause a variety of **PRECIPITATION** such as snow and rain.

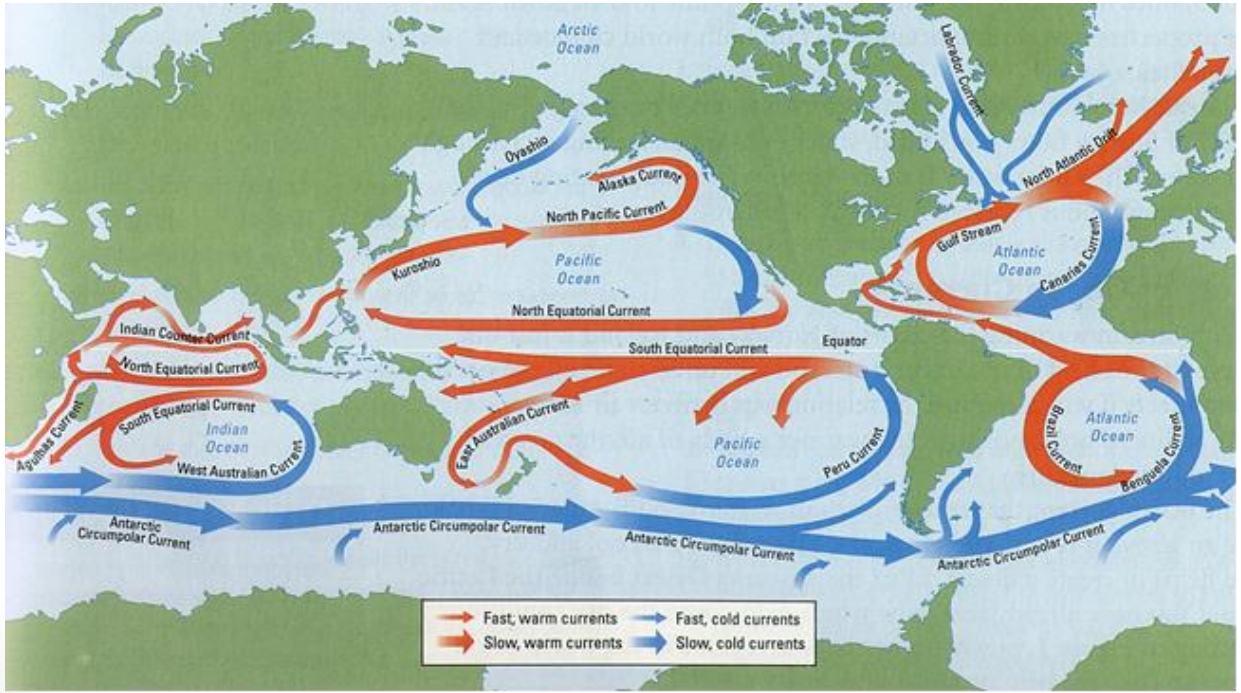
RISING air tends to be **WARM** and **MOIST**, creating **CLOUDS** and **RAIN** (creating low pressure systems). **FALLING** air tends to **COOL** and **DRY** (creating high pressure systems)

Ocean Currents…

Help **DISTRIBUTE** large amounts of solar **ENERGY** from the **EQUATOR** to the **COLDER** poles.

- Ocean water at the **SURFACE** near the **EQUATOR** absorbs the **DIRECT INTENSE** solar energy.
- The **PREVAILING WINDS** and the **CORIOLIS** effect **MOVES** the warm water **AWAY** from the **EQUATOR**.

Notice that the Equatorial currents are straighter than the currents towards the poles.



Ocean Currents…

Ocean currents also affect the pressure of the air above them.

- For example, **AIR ABOVE WARM** ocean currents becomes **WARMER**, more **MOIST** and **LESS DENSE**, forming **LOW-PRESSURE** systems.

- **AIR ABOVE COLD** ocean currents becomes **COOLER**, **DRIER**, and **DENSER**, forming **HIGH-PRESSURE** systems.