Earth and Space Science

Unit 7 Lecture 2: Atmospheric Movement

and Its Role in Weather and Climate

Review Concepts

Specific Heat

- The amount of energy needed to raise 1g of a substance 1°C
- Materials with low specific heat will heat and cool faster than things with a high specific heat
- Water has a specific heat of 1 Cal/g●°C (this is high!)

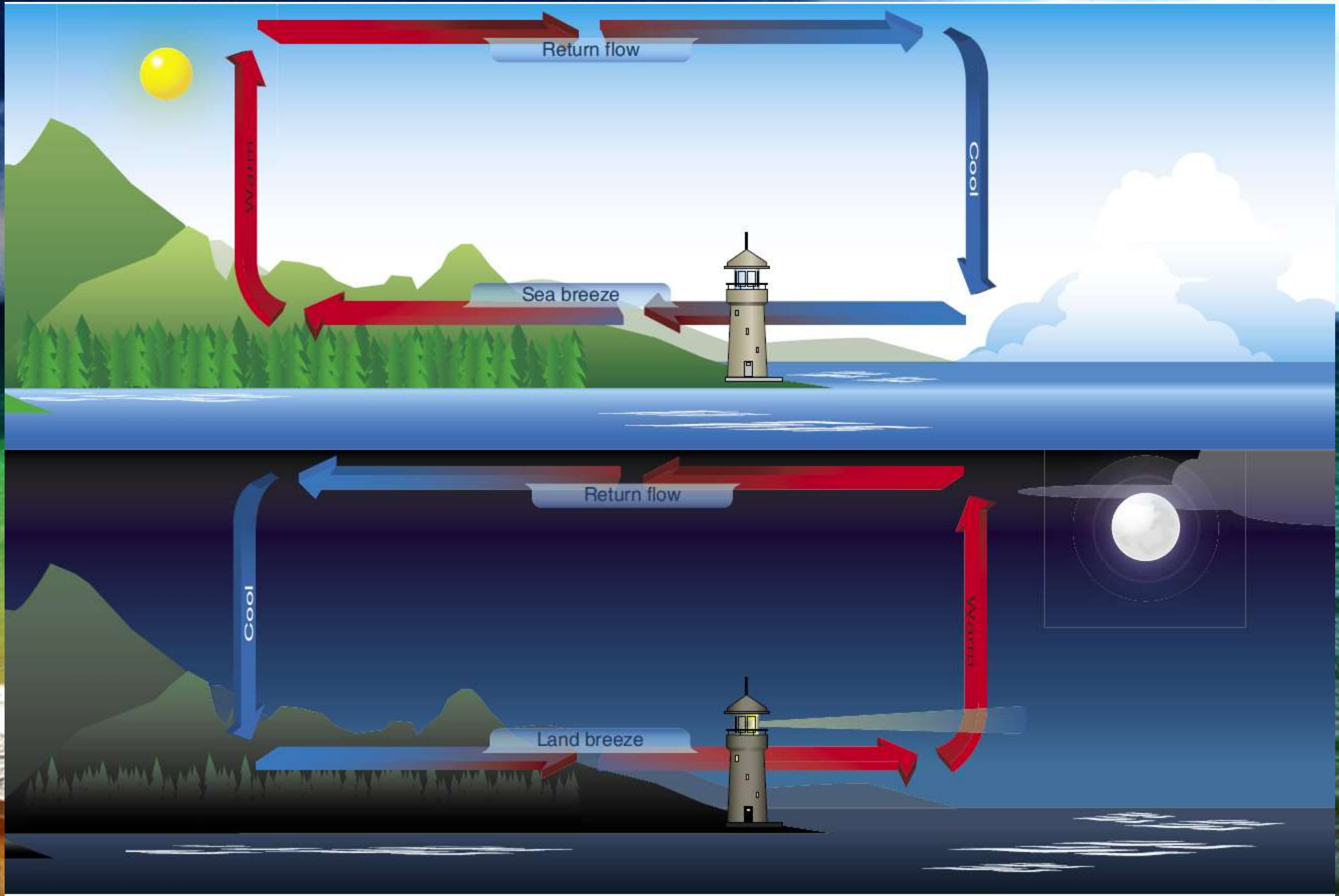
Kinetic Energy

- The Energy of moving particles
- The more Kinetic Energy in the air the more Heat we feel

Solar Radiation and Rising Air

- When air is heated by Solar Radiation it become less dense and rises
- In areas of the Earth that receive more Solar radiation than others (like around the Equator) this creates areas where air is constantly rising
- Usually when air rises it takes moisture with it
- This moisture will condense as the air rises and cools at higher altitudes.
- This makes the clouds and gives us rain

Sea Breeze vs. Land Breeze

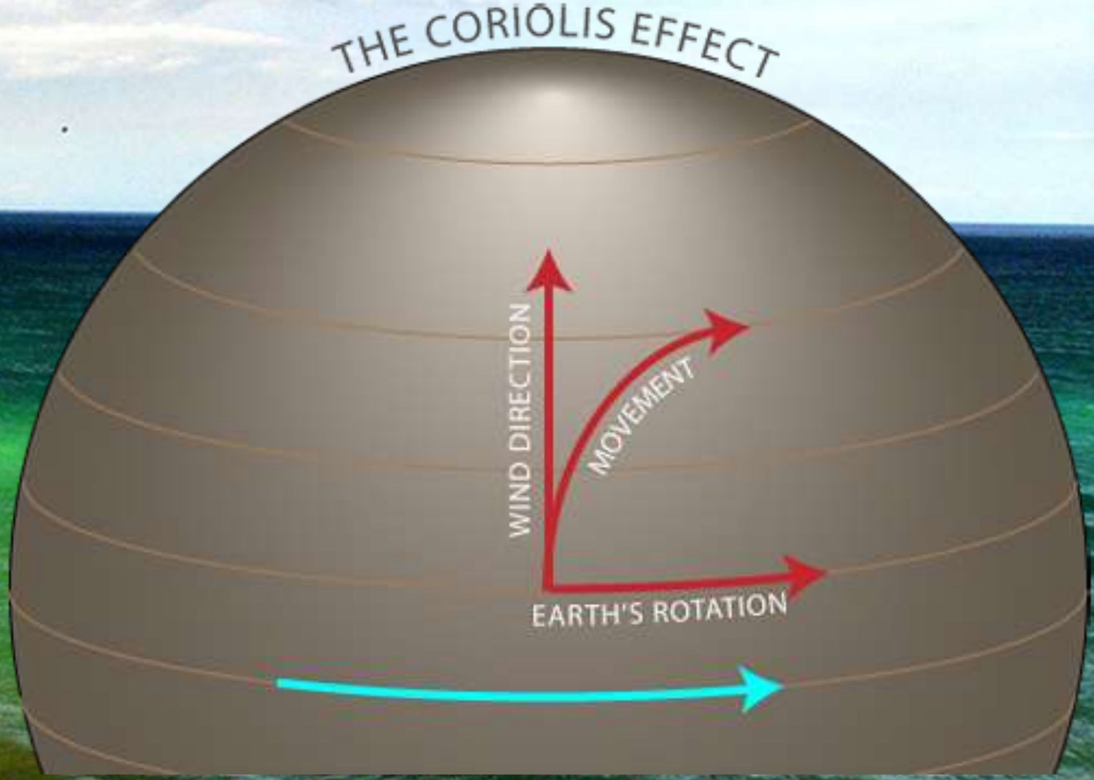


Solar Radiation and Rising Air (cont.)

- We know that the tilt of the Earth means that at different times of the year different parts of the Earth are receive more (or less) direct Sun light
- This can have a dramatic effect not only on the temperature but on the weather and wind patterns.

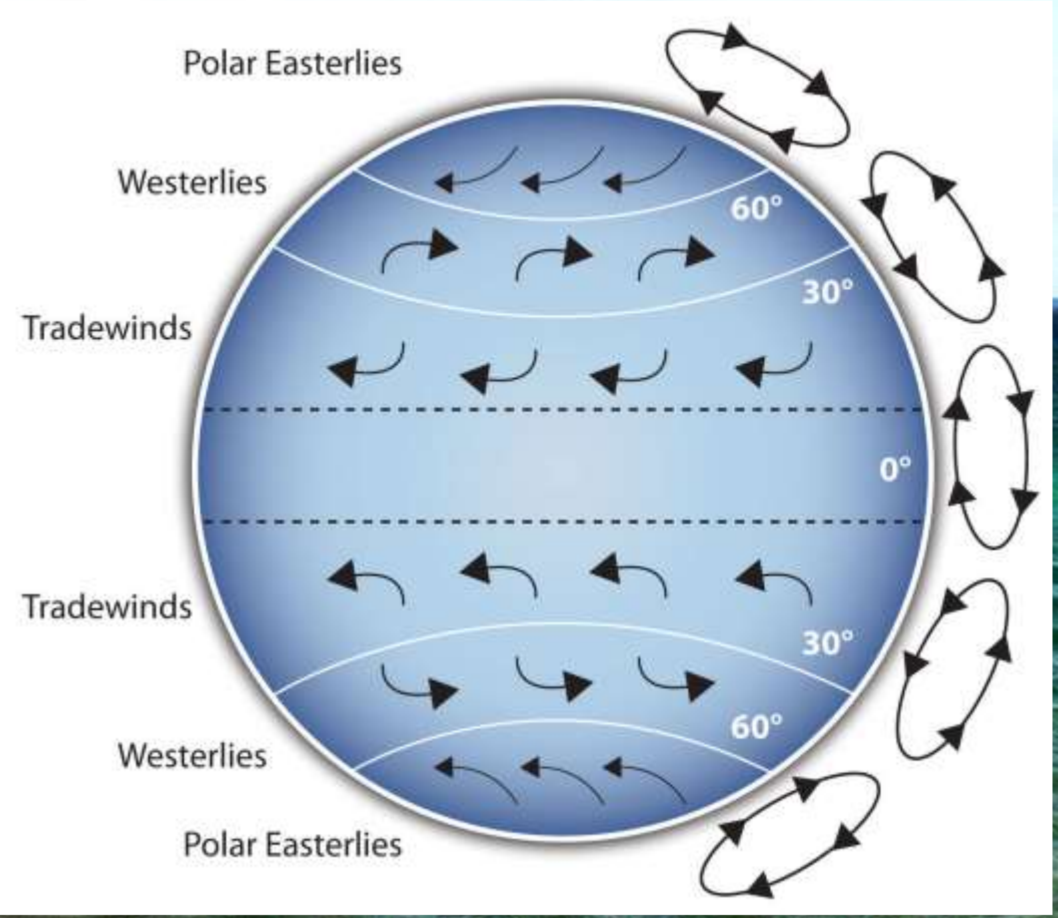
The Coriolis Effect

- https://www.youtube.com/watch?v=i2mec3vgeal
- Simple put, it is the deflection of objects viewed in a rotating frame.



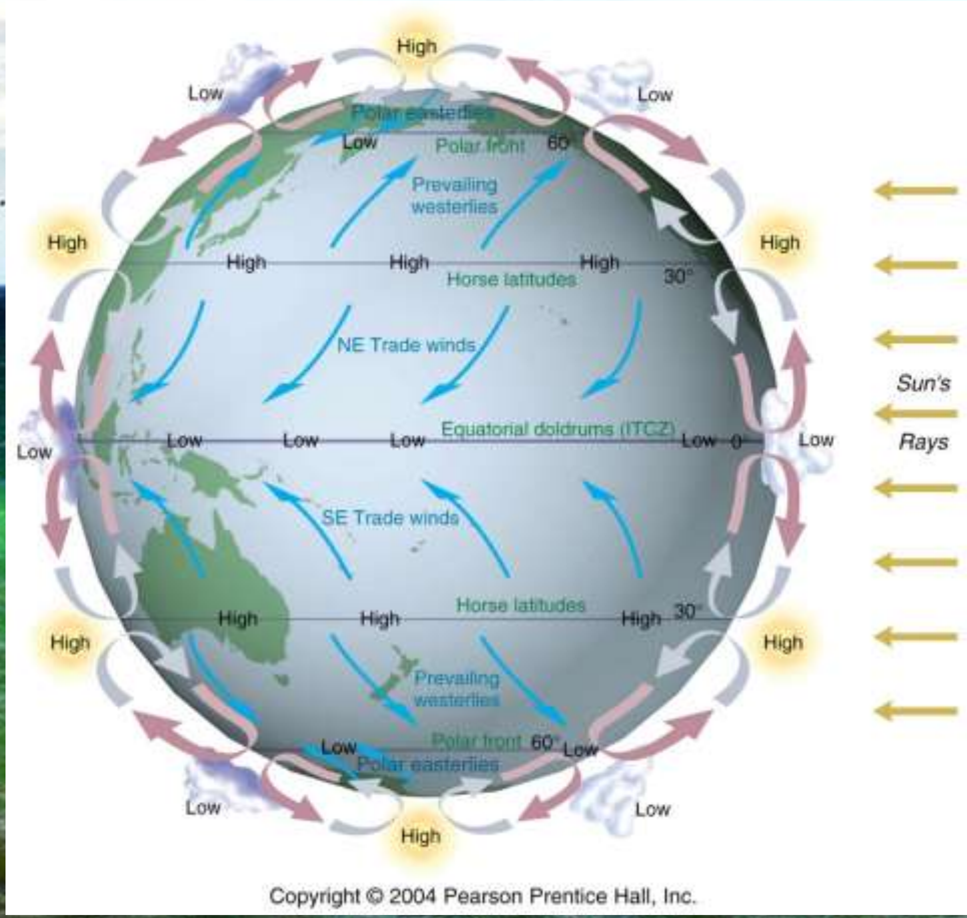
Global Winds

- Tradewinds
- Westerlies
- Polar Easterlies
- https://www.youtube.com/watch?v=WXuGYSM2D8k

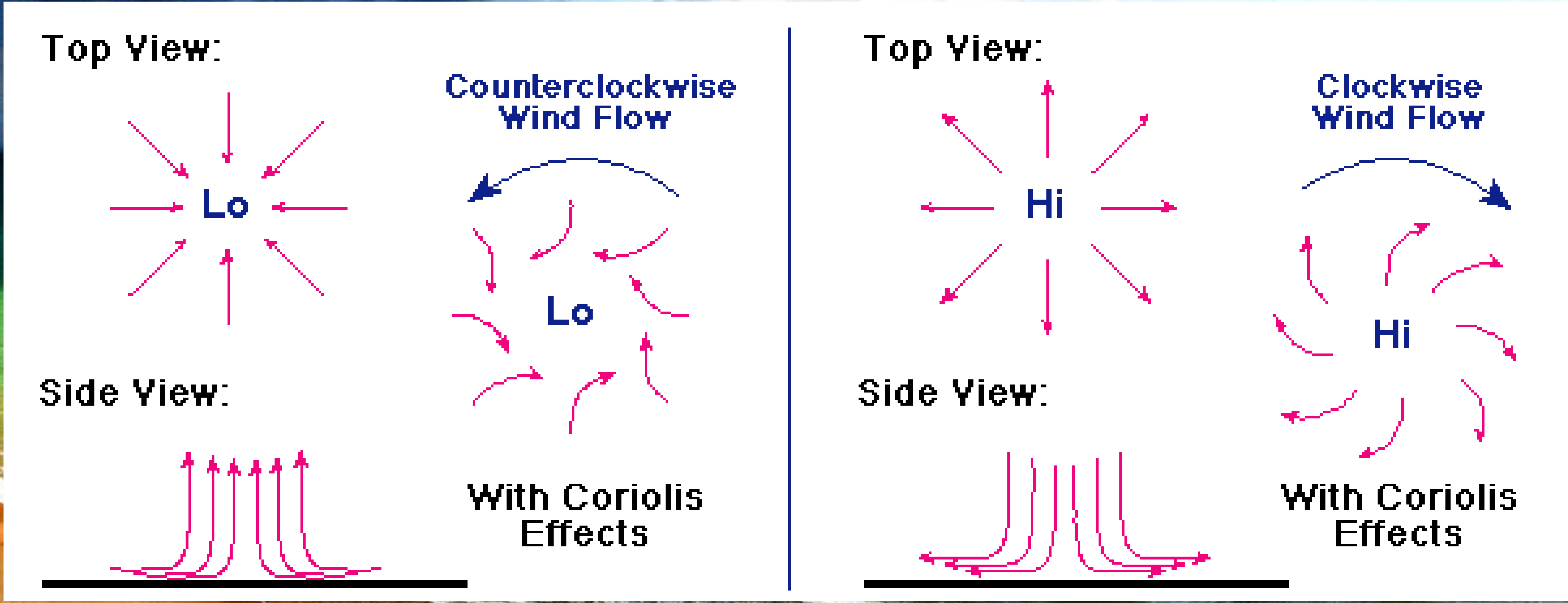


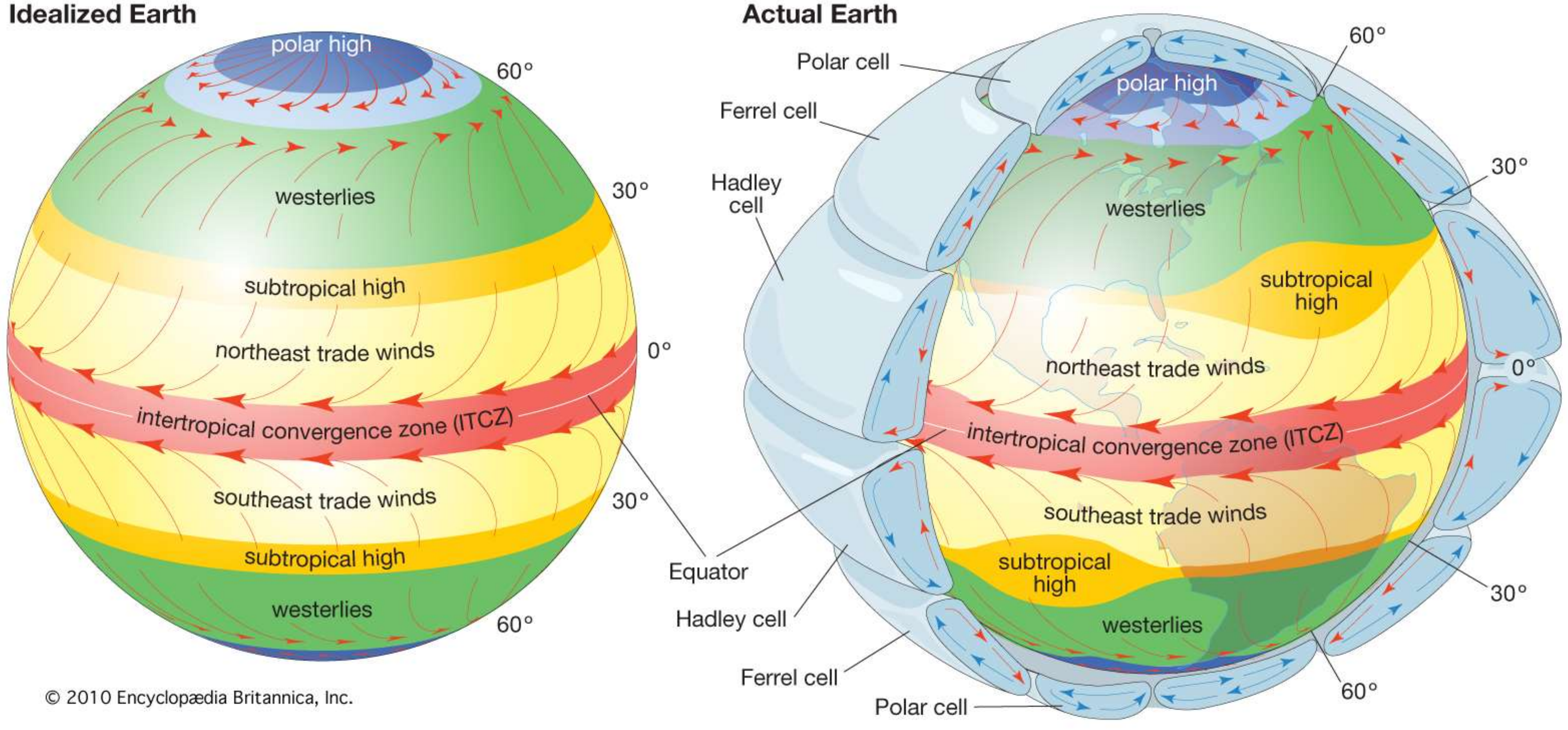
Global Winds & Pressure Systems

- Driven by the warming of the air around the equator
- The rising air at the equator is like the cog in a machine that drives the other cogs
- Areas where converging area is rising creates **Low pressure systems**
- Areas where converging air is sinking creates **high pressure systems**



High and Low Pressure System




Idealized Earth
polar high
60°
westerlies
30°
subtropical high
northeast trade winds
0°
intertropical convergence zone (ITCZ)
southeast trade winds
30°
subtropical high
westerlies
60°
Actual Earth
60°
Polar cell
Ferrel cell
polar high
Hadley
cell
30°
westerlies
subtropical
high
northeast trade winds
0°
intertropical convergence zone (ITCZ)
southeast trade winds
Equator
subtropical
high
30°
Hadley cell
westerlies
Ferrel cell
60°
Polar cell

Equatorial Low

Equatorial Low-Pressure - Intertropical Convergence Zone (ITCZ) The equatorial region is the most strongly heated area on the Earth. It is there that we find the most vigorous upward convection.

Low pressure is found all along the equator. Winds converge on the intertropical convergence zone from the northeast ***(northeast tradewinds)*** and the southeast ***(southeast tradewinds)***.

The trades are fairly strong and consistent. Right at the ITCZ winds are weak and variable. Sailors in the days of sailing ships called this ***the doldrums.***

Subtropical High

Subtropical Highs At latitudes around 25° to 30° north and south of the equator there are several more-or-less continuous and stationary centers of high pressure.

For example the ***Bermuda High*** (or Azores High) in the north Atlantic Ocean, the ***Pacific High*** (or Hawaiian High) in the north Pacific, and highs over the south Atlantic, south Pacific, and south Indian oceans.

Winds diverging from these highs toward the equator form the tradewinds. Winds diverging from the highs towards the poles are deflected to the east in northern and southern hemispheres forming the prevailing ***westerlies*** in midlatitudes.

Subpolar Low

Subpolar Lows A series of low pressure centers encircle Antarctica summer and winter.

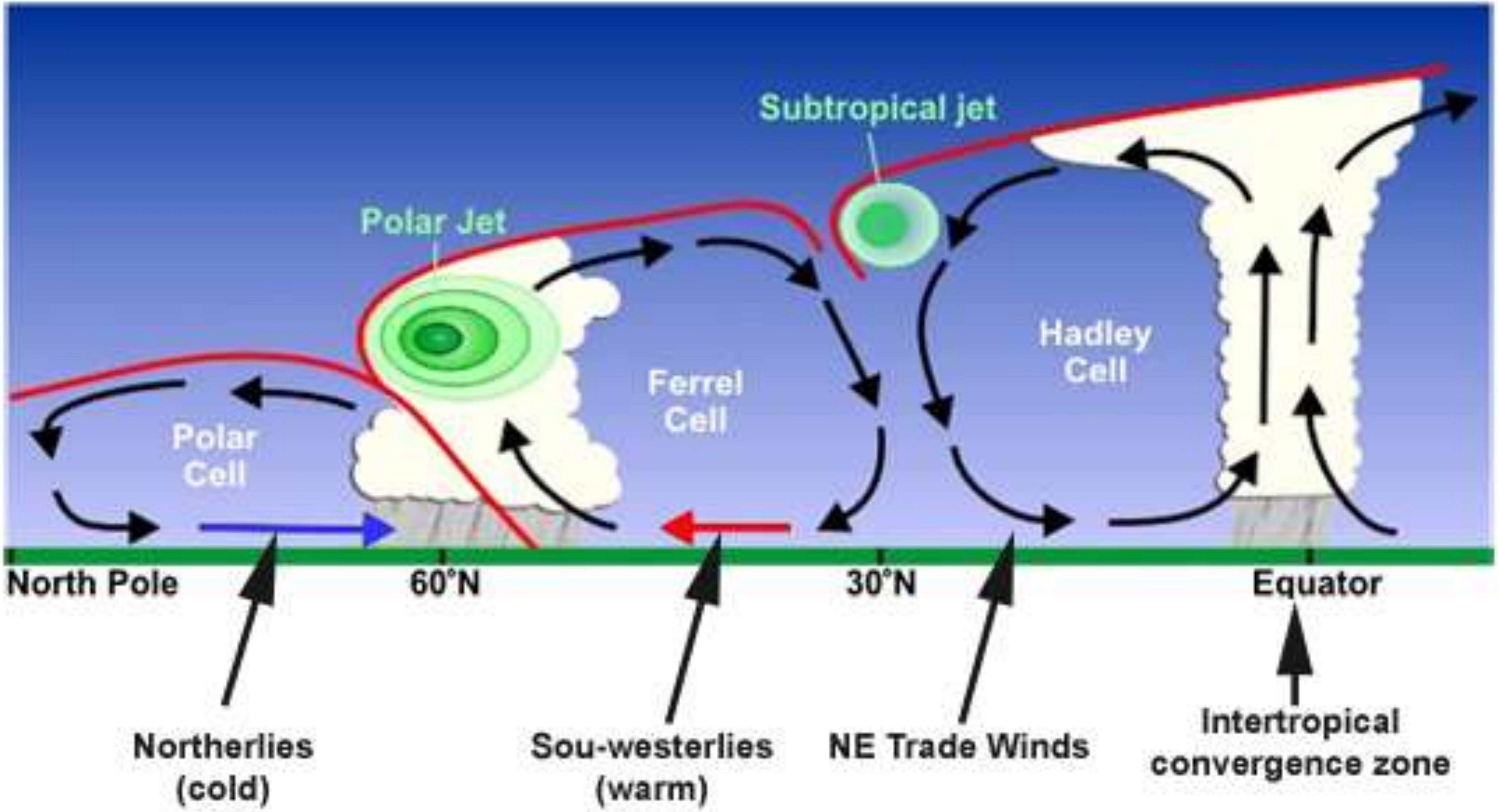
In the northern hemisphere, the ***Icelandic Low*** in the north Atlantic and ***Aleutian Low*** in the north Pacific spawn cyclonic storms in winter but weaken or die out in summer as the subtropical highs strengthen in the north Atlantic and north Pacific.

Polar High

Polar Highs High pressure dominates in the polar regions because the air is very cold and dense. Antarctica is the coldest place on Earth because it lies over the south pole, because it is continental, and because the ice sheet is very thick and so the surface elevation is also high.

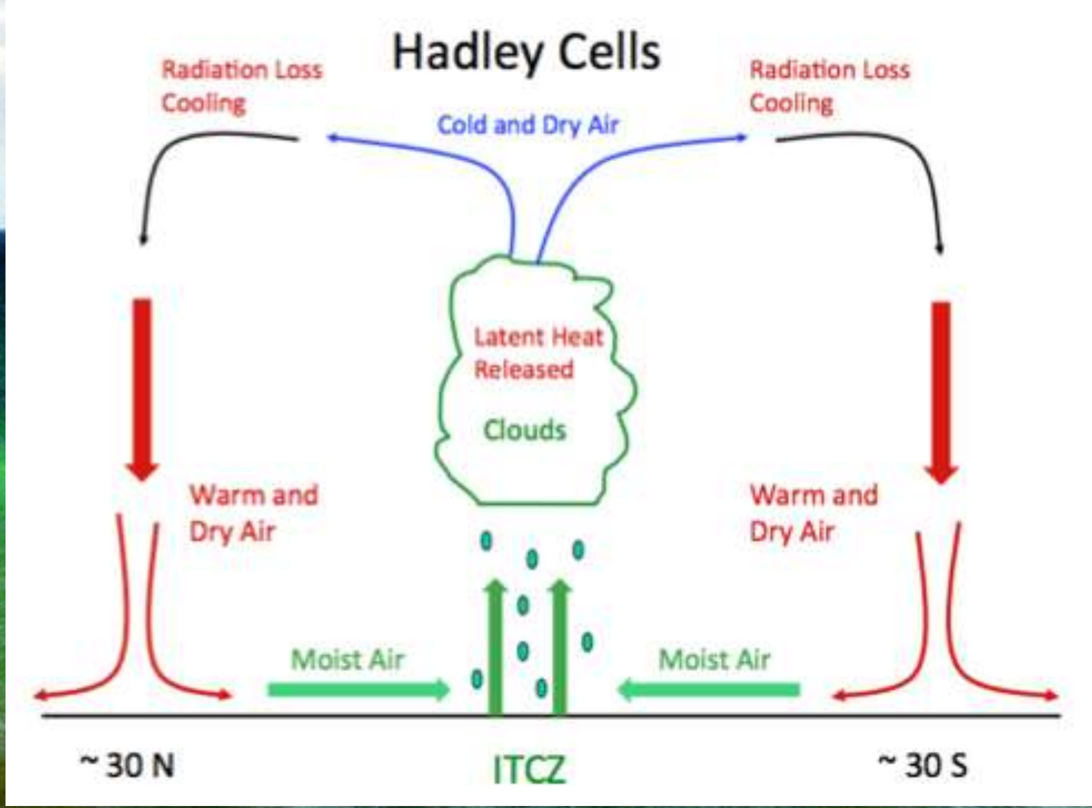
High pressure dominates Antarctica year-round. The north pole, however, lies in the Arctic Ocean. The ocean has a moderating effect on the arctic.

High pressure is less well developed in the north polar summer, but devlops over land as the ***Canadian and Siberian Highs*** in winter.


Subtropical jet
Polar Jet
Hadley Cell
Ferrel Cell
Polar Cell
North Pole
60°N
30°N
Equator
Northerlies (cold)
Sou-westerlies (warm)
NE Trade Winds
Intertropical convergence zone

Hadley Cell

- As heat rises around the equator, it takes with it moisture
- As the air cools and the moisture condenses clouds form and rain falls
- The now cool dry air sinks and now goes North or South
- Thermally Direct



Ferrel Cell

- The cell between the Polar Cell and the Hadley cell
- Cool air falls around 30° Latitude (warmer regions) and is forced towards the poles then rises again around 60° Latitude
- The air at the top can go towards the poles or back towards the equator
- Thermally Indirect

Polar Cell

- Cold air at the poles sinks and moves towards the equator.
- The air is warmed and rises; at this point air can return to the poles or go towards the equator
- The air that goes back to the poles is cooled again and sinks back to the ground towards the equator
- Thermally Direct

Thermally Direct / Thermally Indirect

- Thermally Direct Cells (Hadley and Polar Cells)
  - Both cells have their rising branches over warm temperature zones and sinking braches over the cold temperature zone. Both cells directly convert thermal energy to kinetic energy.
- Thermally Indirect Cell (Ferrel Cell)
  - This cell rises over cold temperature zone and sinks over warm temperature zone. The cell is not driven by thermal forcing but driven by eddy (weather systems) forcing.