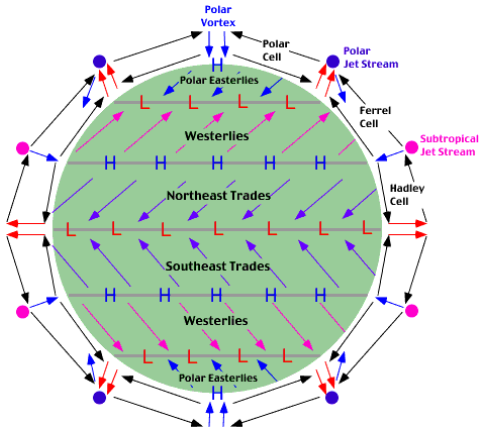
Lab 3. General Circulation of the Atmosphere



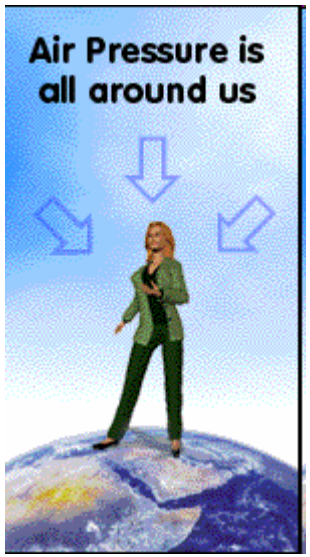
Topics to be discussed

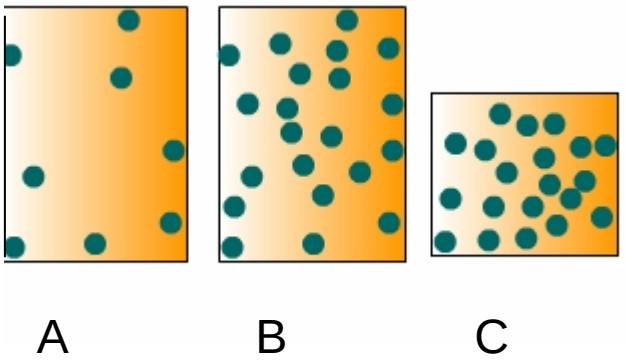
- Pressure
- Pressure Gradient Force
- Coriolis Force
- General Circulation Patterns

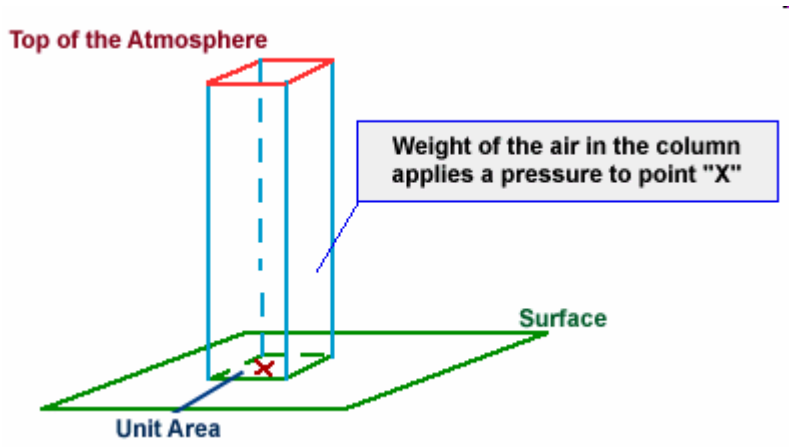
1. Pressure

- What is air pressure?

  Air pressure is the force exerted by the weight of a column of air above a particular location.



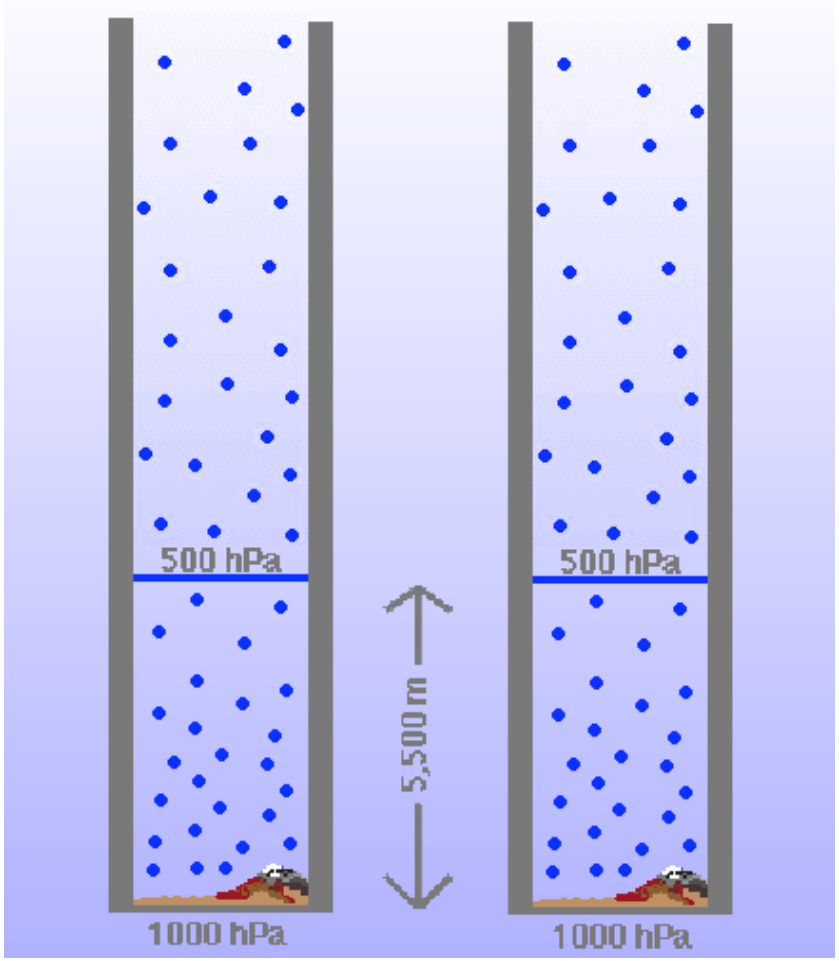




What causes pressure differences in the atmosphere?

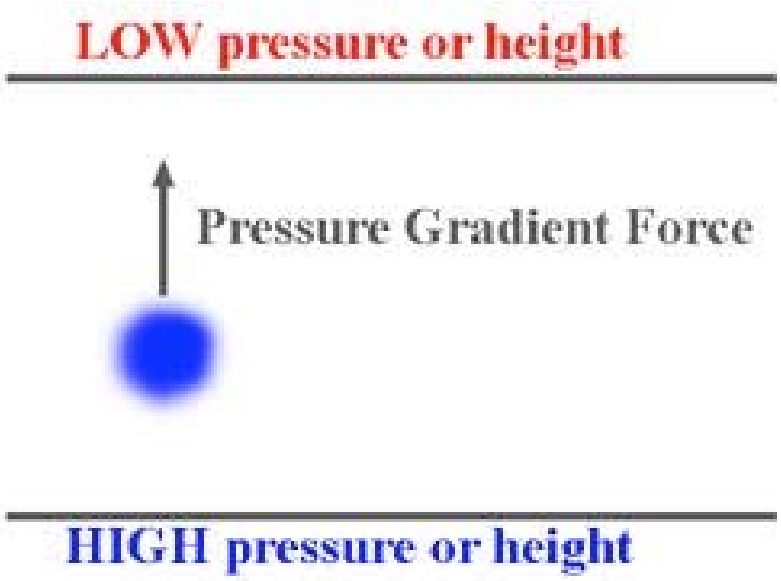
- **The heating effect of the sun**

- The warming effect of the sun varies with latitude and with the time of day. Warmer air is less dense than cooler air, and rises above it, so the pressure above the equator is lower than the pressure above the poles.
- The warming effect is greater over the equator as the sun is directly overhead. Nearer the earth's poles the angle at which the suns rays hit the earth is more acute, so the same amount of energy is spread over a greater area


500 hPa
5,500 m
500 hPa
1000 hPa
1000 hPa

2. Pressure Gradient Force

- This difference in pressure between two points is called the *Pressure Gradient Force*,
- and is ALWAYS directed from high pressure to low pressure.
- Wind



- Vertically in the atmosphere, we always have a pressure imbalance (remember that pressure decreases with height). If this is the case how come all of the air molecules don’t flow from high to low pressure and therefore out to space?

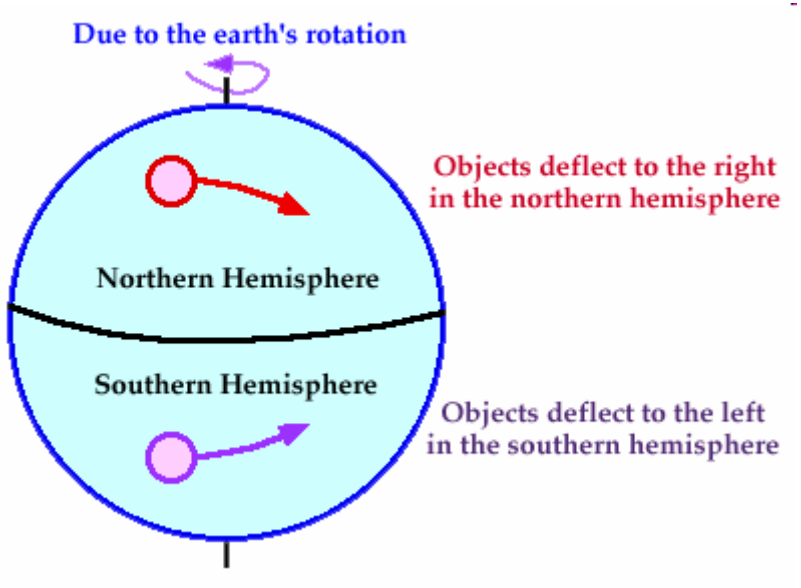
- If air always flowed directly from high pressure to low pressure, we would have air rising in the tropics and sinking at the poles (because there is more heating in the tropics than at the poles).
- However, this isn’t what happens, what are we missing?

Summary (1)

- Atmospheric **pressure** is caused by the mass of the air above us
- **Pressure** gradients are caused by the variable heating of the Earth by the sun, along with the rotation of the Earth.
- Air movement or wind is due to **pressure** gradients from place to place balancing out the **pressure**

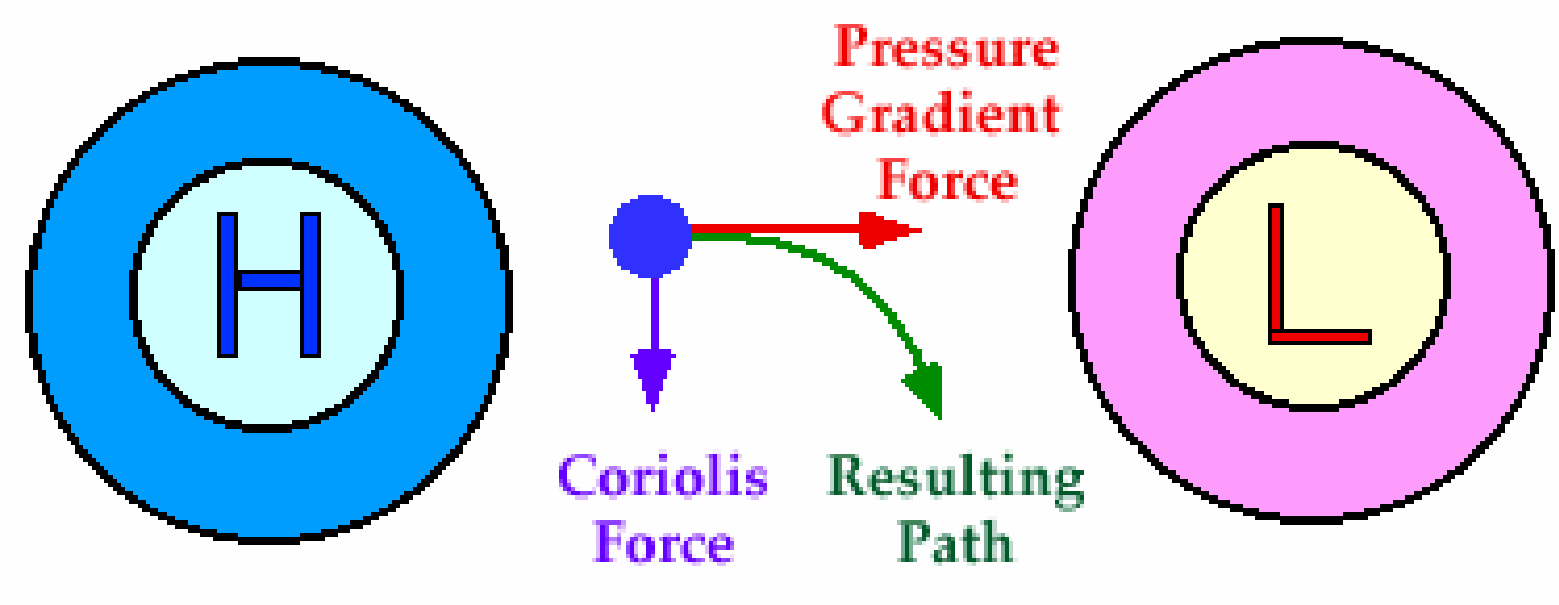
3. **Coriolis Force**

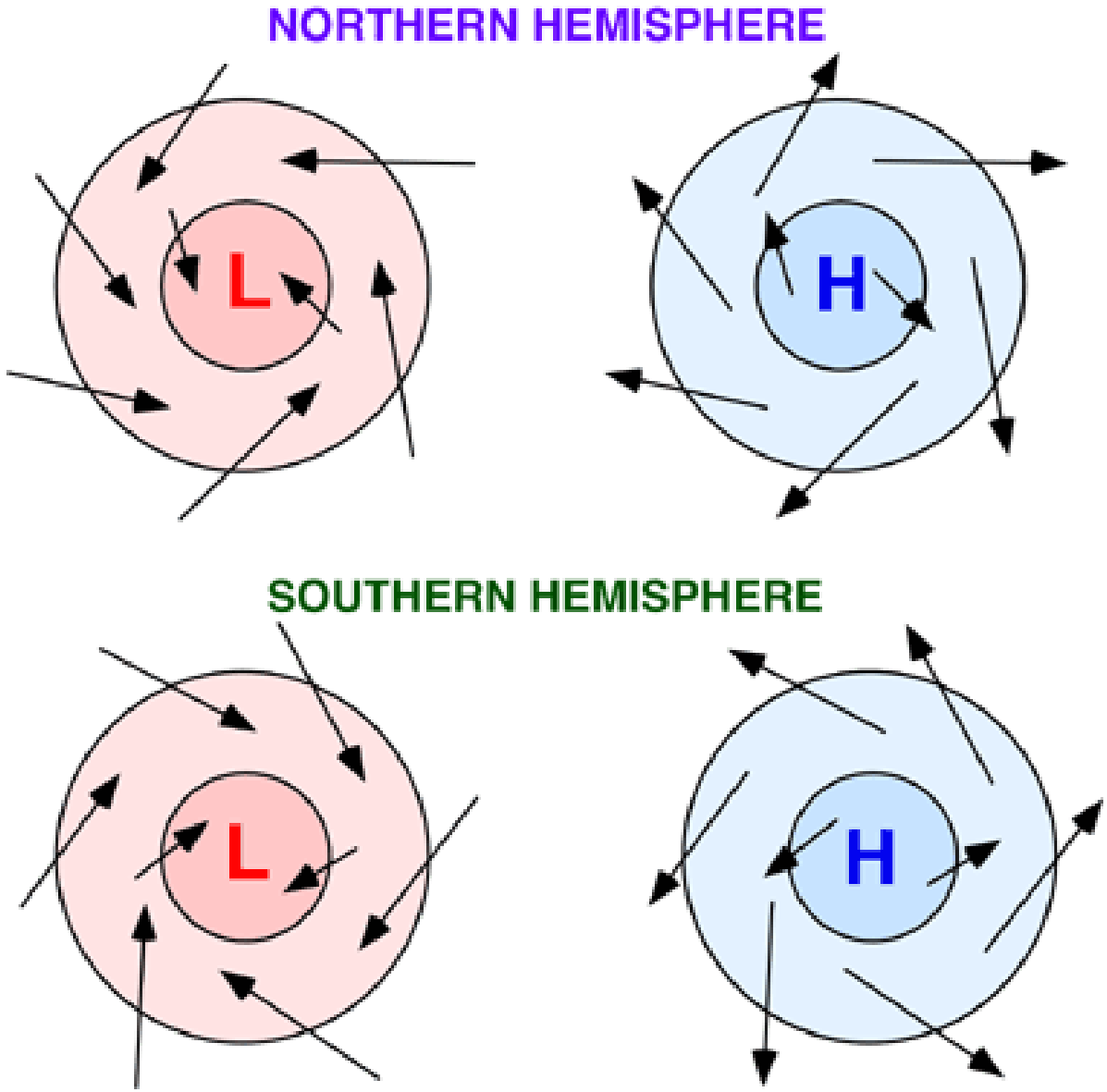
- Once air has been set in motion by the pressure gradient force, it undergoes an apparent deflection from its path, as seen by an observer on the earth. This apparent deflection is called the "Coriolis force" and is a result of the earth's rotation.
- http://donald.phast.umass.edu/~arny/quiz/images/coriolis.mov



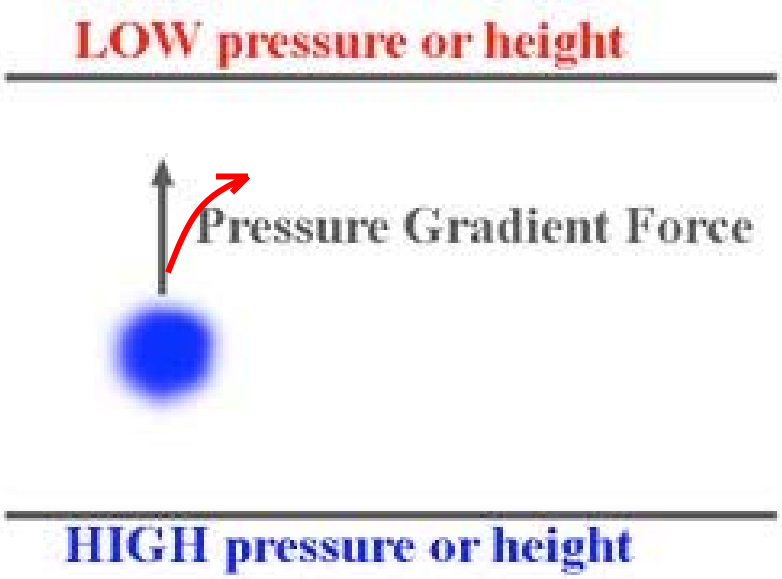
- The amount of deflection depends upon

1. The rotation of the Earth
2. The latitude
3. The object’s speed
4. It only affects wind direction and never wind speed.


H
Pressure
Gradient
Force
L
Coriolis
Force
Resulting
Path


NORTHERN HEMISPHERE
L
H
SOUTHERN HEMISPHERE
L
H

- In the figure above (in the previous section) where we have high pressure on the bottom (towards the south), and lower pressure towards the north, which way will the wind actually blow if we are in the northern hemisphere?



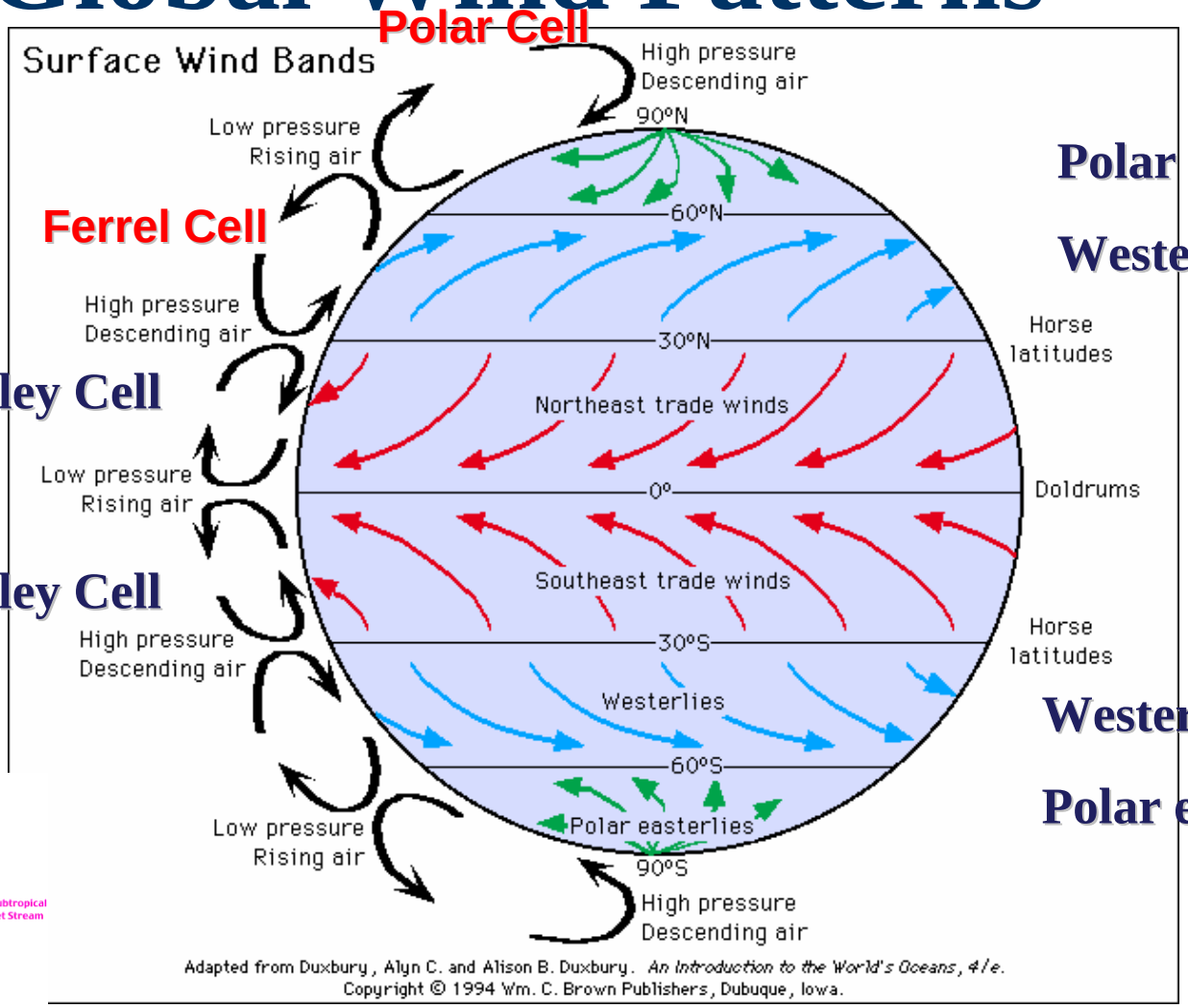
4. General Circulation

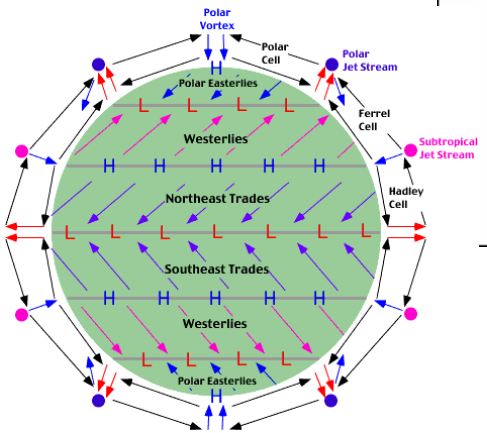
- The worldwide system of winds, which transports warm air from the equator where solar heating is greatest towards the higher latitudes, is called the general circulation of the atmosphere, and it gives rise to the Earth's climate zones.
- Atmospheric circulation is the large-scale movement of air by which heat is distributed on the surface of the Earth.
- The general circulation of air is broken up into a number of cells, the most common of which is called the Hadley cell.

Steps to draw the general winds on Earth

- Sunlight is strongest nearer the equator.
- Air heated there rises and spreads out north and south.
- After cooling the air sinks back to the Earth's surface within the subtropical climate zone between latitudes 25° and 40°.
- This cool descending air stabilizes the atmosphere, preventing much cloud formation and rainfall. Consequently, many of the world's desert climates can be found in the subtropical climate zone.
- Surface air from subtropical regions returns towards the equator to replace the rising air, so completing the cycle of air circulation within the Hadley cell.

Global Wind Patterns

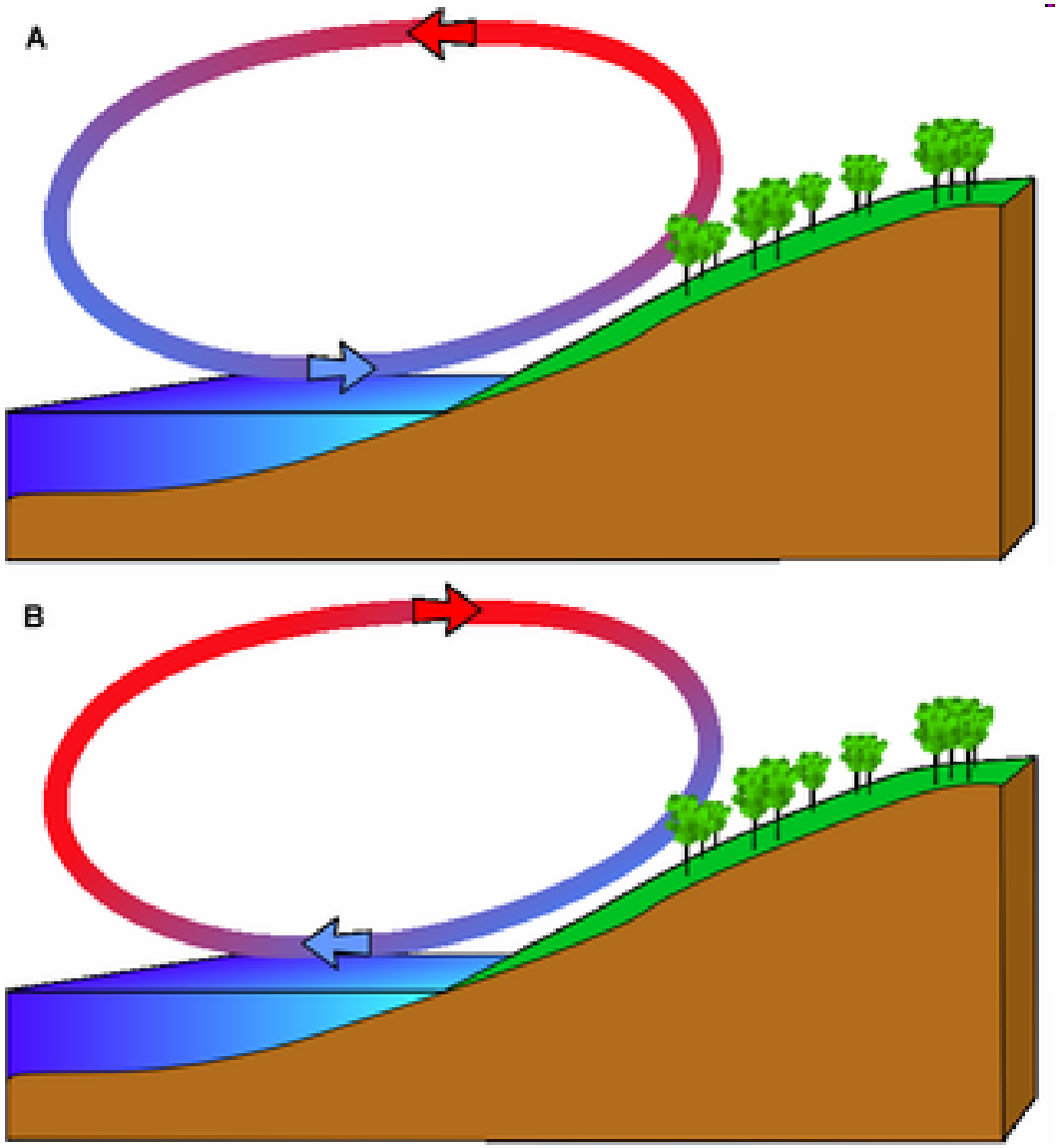




Hadley cell

- The Hadley cell is a circulation pattern that dominates the tropical atmosphere, with rising motion near the equator, poleward flow 10-15 kilometers above the surface, descending motion in the subtropics, and equatorward flow near the surface. This circulation is intimately related to the trade winds, tropical rainbelts, subtropical deserts and the jet streams.

Land Sea Breeze



Sea Breeze

Land Breeze