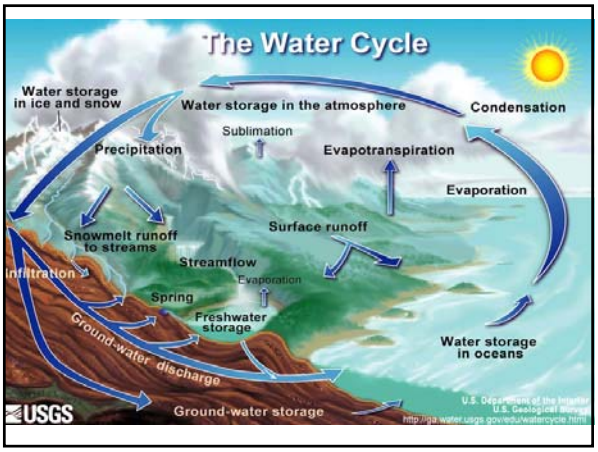
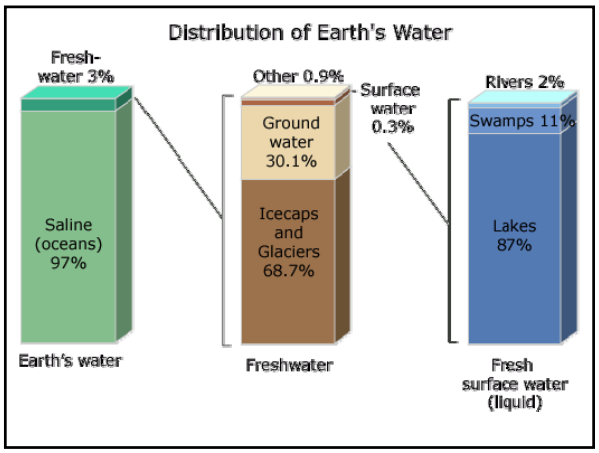
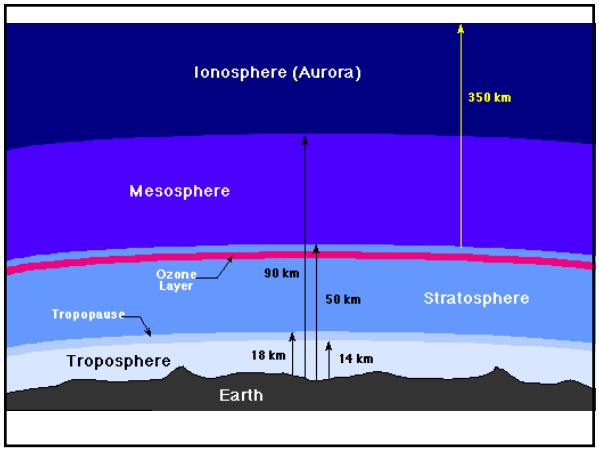
Weather

Hydrosphere and Atmosphere

- Hydrosphere
  - Consists of all of the water on earth:
    - Oceans, seas, rivers, underground water, ice, atmospheric water vapor (clouds)
- Atmosphere
  - Layer of gases surrounding the earth
    - 78% nitrogen, 21% oxygen, 1% other gases
    - No definite boundary between atmosphere and outer space





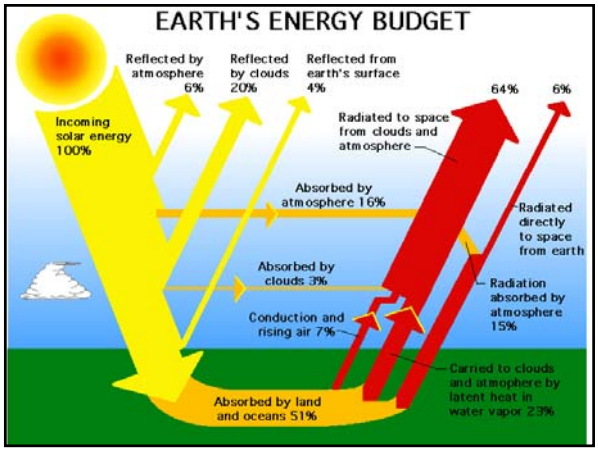


Troposphere

- The troposphere starts at the Earth's surface and extends 8 to 14.5 km high
- This part of the atmosphere is the most dense
- Climbing higher in this layer, the temperature drops from about 17 to -52 ^{o}C
- Almost all weather is in this region

Stratosphere

- The stratosphere starts just above the troposphere and extends to 50 km high
- This part of the atmosphere is dry and less dense
- The temperature in this region increases gradually to -3 ^{o}C
  - due to the absorption of ultraviolet radiation
- The ozone layer, which absorbs and scatters the solar ultraviolet radiation, is in this layer



- The Earth's climate system constantly tries to maintain a balance between the energy that reaches the Earth from the Sun and the energy that is emitted to space
- Scientists refer to this process as Earth's "radiation budget".
- Because of the tilt of the Earth's axis, incoming solar radiation is not evenly distributed on the Earth's surface and seasonal changes occur.

- As the Sun's electromagnetic radiation penetrates the Earth's atmosphere it is selectively absorbed and scattered by molecules of gases, liquids, and solids.
- The energy coming from the Sun to the Earth's surface is called solar insolation or shortwave energy.
- Energy goes back to space from the Earth system in two ways: reflection and emission.

Reflection

- Part of the solar energy that comes to Earth is reflected back out to space
- The percentage of solar energy that is reflected back to space is called the ***albedo***
- Different surfaces have different albedos
  - Deserts have a higher albedo than oceans
- Over the whole surface of the Earth, about 30 percent of incoming solar energy is reflected back to space

Emission

- Part of the energy going back to space from the Earth is heat emitted by the Earth
- The solar radiation absorbed by the Earth increases the planet's temperature
- Heat energy is emitted into space, creating a balance

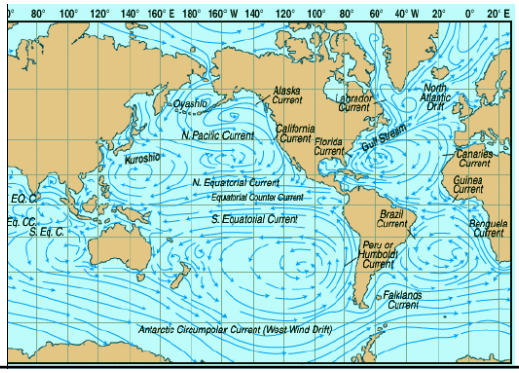
Clouds

- Clouds have a higher albedo than the ground beneath them
  - More heat is reflected and therefore less heat makes it to the ground
- Clouds can absorb heat radiating from the surface of the earth and radiate it in all directions
  - Heat is radiated to the earth, heating it up

“Green House” Effect

- Energy emitted from the surface of the Earth and absorbed by the atmosphere results in an increase in the ambient temperature
- This absorbed energy is then emitted both to space and back towards the Earth's surface
- The greenhouse effect is due mainly to water vapor in the atmosphere (clouds)

Wind and Ocean Currents



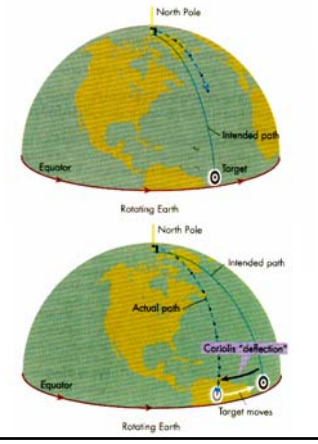
Wind

- Air moves from areas of high pressure to low pressure.

Coriolis Effect

- Air in motion undergoes an apparent deflection from its path, as seen by an observer on the earth.
- This apparent deflection is called the Coriolis effect and is a result of the earth's rotation.
- In the northern hemisphere, wind is deflected to the right.
- In the southern hemisphere, wind is deflected to the left.

- The amount of deflection the air makes is directly related to both the speed at which the air is moving and its latitude.
  - Slowly blowing winds will be deflected only a small amount, while stronger winds will be deflected more.
  - Winds blowing closer to the poles will be deflected more than winds at the same speed closer to the equator.
  - The Coriolis effect is zero right at the equator.



The Coriolis Effect

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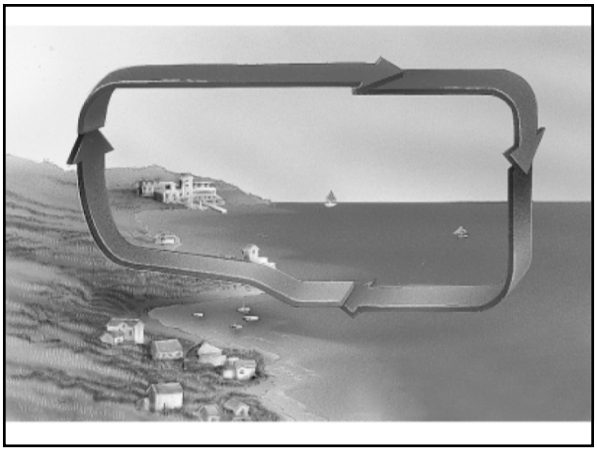
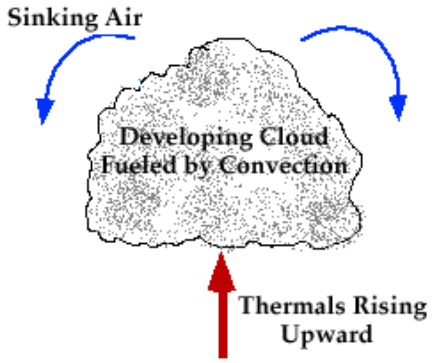
Convection Currents

- As the air above the surface of the earth warms it becomes less dense and rises
- The rising air leaves a “hole” (low pressure) that is filled by surrounding air
- As the air rises it cools and becomes more dense causing it to fall
- The falling dense air increases pressure in the area where it is falling

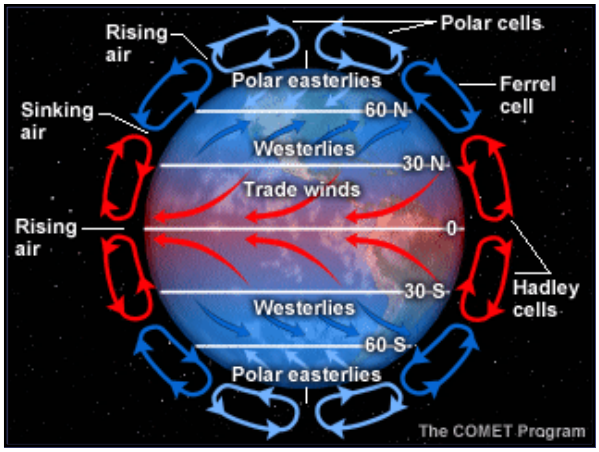


- Clouds are formed the same way.



Prevailing Winds

- The prevailing wind is the wind that blows most frequently across a particularly region
- Different regions on Earth have different prevailing wind directions



Jet Streams

- Jet streams are fast flowing, relatively narrow air currents found in the atmosphere around 10 km above the surface of the Earth
- They form at the boundaries of adjacent air masses with significant differences in temperature
  - such as the polar region and the warmer air to the south.

- The major jet streams are westerly winds (flowing west to east) in the Northern Hemisphere.

- These winds not only steer storms, but also help determine the locations of areas of high and low air pressure at the Earth's surface.

The Ocean

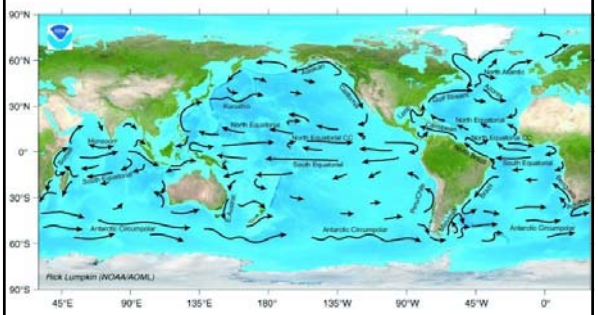
- There are two main sections of ocean water
  - the surface layer
  - the deep waters
- The surface layer is the layer at the top of the ocean that is well mixed by waves, tides, and weather events like rain or a hurricane.

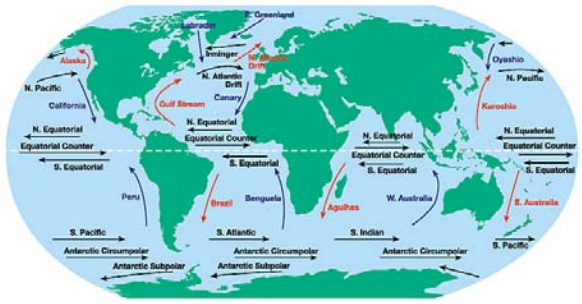
Currents

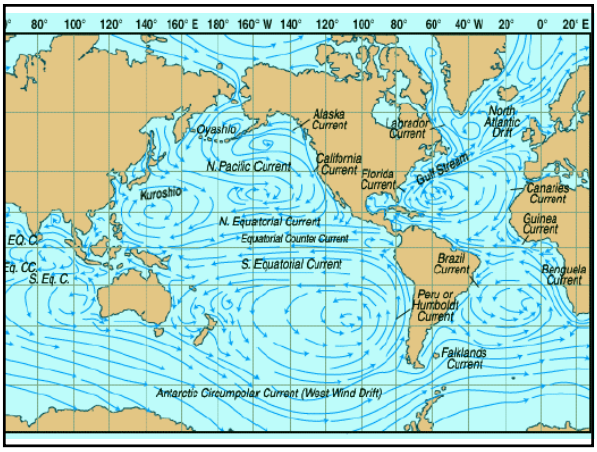
- Surface water movement takes place in the form of currents
- Currents move ocean water horizontally at the ocean's surface
- Surface currents are driven mainly by the wind
- Other forces such as the Coriolis effect and the location of land masses do affect surface current patterns

Gyres

- Huge circular patterns called current gyres can be seen when looking at the world's ocean currents
- They flow clockwise in the northern hemisphere and counter-clockwise in the southern hemisphere







El Niño

- Refers to the extensive warming of the central and eastern Pacific that leads to a major shift in weather patterns across the Pacific
- In North America, temperatures in the winter are warmer than normal in the North and cooler than normal in the South

La Niña

- Characterized by unusually cold ocean temperatures in the Equatorial Pacific
- In North America winter temperatures are warmer than normal in the South and cooler than normal in the North