

Water, Energy, and Climate

I. Water cycle

A. A model of water movement

B. Source of most water is the **OCEANS**

C. 4 things that can happen to precipitation:

1. Storage on the surface - ice/snow/glaciers on land and water
2. Evapotranspiration - as water vapor back into atmosphere
3. Run-off - flows on surface (rivers and streams)
4. Infiltration - water soaking into the ground to become groundwater (until it hits **impermeable bedrock**)

D. Factors affecting infiltration

1. **Slope** - a steep slope means **LESS** infiltration
2. **Saturation of ground** - a more saturated soil means **LESS** infiltration
 - a) **Zones underground**
 - 1) **Zone of aeration** - **ABOVE** the water table (**DRY**)
 - 2) **Zone of saturation** - **BELOW** the water table (**WET**)
3. **Porosity of ground**
 - a) **porosity** - percent of **air space** in material
 - b) Porosity of material is determined by:
 - 1) **particle shape** - rounder particles have **MORE** porosity
 - 2) **packing** - loose packing means **MORE** porosity
 - 3) **sorting** - sorted particles have **MORE** porosity than mixed

BUT: The **SIZE** of the particles does **NOT** affect the porosity !!!
(only mixing the particles affects porosity)

One cup of big beads has the **SAME** porosity as one cup of medium or small beads.

4. **Permeability of ground**
 - a) **permeability** - ability of water to pass through something
 - b) The larger the particle size, the **GREATER** the permeability (water passes through faster).
5. **Capillarity of ground** - attractive force between water and soil molecules that “pulls” water uphill, like a paper towel does.
 - a) is called capillary water, and also **RETAINED** water (on beads)
 - b) The smaller the particle size, the **GREATER** the capillary migration (movement), and the **GREATER** the retained water.

E. Run-off

1. Run-off occurs when
 - a) precipitation *exceeds* (is more than) **permeability** of ground
 - b) the ground is already **saturated**
 - c) the slope is **great**
2. **Stream discharge** - volume of water flowing in a stream
(usually greatest in the **spring**)
3. Run-off *INCREASES* in populated areas
(more paving = more run-off)

II. Climate

- A. Is the **average** weather conditions for an area, especially temperature and moisture.
- B. Global climate is determined by the interaction of solar energy with the earth's surface and atmosphere. This energy transfer is influenced by the dynamic processes of:
 1. cloud cover
 2. earth rotation
 3. positions of mountain ranges and oceans
- C. Average **temperatures** on earth result from total amount of insolation absorbed by the earth's surface and atmosphere *AND* the amount of long-wave infrared energy radiated back into space.
 1. Ice ages indicate that this average has dropped at times in the geologic past.
 2. Average earth temperatures were much warmer in distant geologic past.
 - a) These suggest earth had long periods of imbalances of its heat budget.
- D. Climate types:
 1. humid - moist
 2. sub-humid
 3. semi-arid
 4. arid - dry, like a desert

III. Climate patterns

- A. Seasons are “opposite” in the Southern Hemisphere.
- B. The climate is most moderate (even) at the **equator**, but is most extreme (wide variation from winter to summer) at **high latitudes** (near the poles).

IV. Factors affecting climate

A. Latitude and climate

- 1. As latitude increases, average **temperature decreases**.
- 2. Moisture - is determined by planetary (global) winds
(see Ref. Tables, p. 14)
 - a) At 0° and 60°, zones of **low** pressure are common, cyclonic storms develop, and precipitation is plentiful.
 - b) At 30° and 90°, zones of **high** pressure due to sinking air cause arid (dry) conditions.

B. **Large bodies of water** have a **MODERATING** affect on climate.

- 1. **marine climate** - cooler summers, and warmer winters
(like Long Island)
- 2. **continental climate** - hotter summers, and colder winters
(like N. Dakota)

C. **Ocean currents** (see Ref. Tables, p. 4)

- 1. “Pushed” by the **global winds** and affected by the Coriolis Effect.
- 2. **Cold** ocean currents (from the poles) bring cold, dry climates.
- 3. **Warm** ocean currents (from equator) bring warm, moist climates.
- 4. Can affect type of vegetation that can grow in an area.

D. **Mountains and climate**

- 1. The side prevailing winds hit (**windward side**) is **WET**.
- 2. The side opposite from winds (**leeward side**) is **DRY** (desert).
- 3. Windward side (wet side) has more vegetation.
- 4. For all mountains, as altitude increases, average temperature **decreases**.

E. **Land and Sea breezes**

- 1. **Sea breeze** occurs during day, when low pressure (warm air) is over land. (wind blow in toward land from sea)
- 2. **Land breeze** occurs during night, when low pressure (warm air) is over the ocean. (wind blows out to sea from land)

F. Planetary wind belts (see Ref. Tables, p. 14)

1. Can influence the affect of ocean currents on nearby climates (US feels little warming affect of Gulf Stream since global winds blow from west to east.)

G. Monsoons - continental winds in Asia that bring rainy weather to S. Asia in the summer months.

1. In Arizona, monsoon weather is caused by summer thunderstorms fed by a moist summer inland flow of air.

H. Storm tracks - paths that storms follow due to global winds

1. For the U.S., generally **west to east**
 - a) Seasonal changes in global wind patterns affect the jet streams and also storm tracks.

I. Natural events

1. Volcanic eruptions - add dust to atmosphere which causes **less** insolation to reach the ground (**cooler temps**)
2. El Nino - warmer than usual ocean current off west coast of S. America every 5 years or so.
 - a) triggers atmospheric disturbances that result in more storms in parts of the U.S.

V. Human affects on climate

A. "Heat islands" - major cities are warmer than outlying areas

1. more carbon dioxide (CO₂) to hold heat
2. pavement/buildings hold heat

B. Global warming - due to the "greenhouse effect"

1. Increased carbon dioxide in atmosphere from burning fossil fuels absorbs more infrared radiation (heat) that is reradiated from the earth's surface.
2. CO₂ cycle - the earth maintains the level of carbon dioxide at an even rate, but human activities can disrupt this equilibrium.
 - a) photosynthesis and sea water removes CO₂ from atm.
 - b) respiration (breathing) and volcanoes, and burning fossil fuels adds CO₂.