

## Introduction to the Hydrosphere

### I. INTRODUCTION

#### A. Hydrosphere - the water environment of the earth, includes

1. surface waters (oceans, lakes, rivers, swamps);
2. underground water (locked in soil pores, cracks fractures and openings in bedrock, and in unconsolidated sediment);
3. frozen water in form of ice, snow, and high cloud crystals;
4. water vapor in the atmosphere; and
5. moisture bound by organisms of the biosphere.
6. hydrosphere overlaps and is contained by the other environmental spheres of the earth.

#### B. Significance of Water

1. Essential for animal and plant life to exist, forms the medium in which biochemistry can take place.
2. Water solutions transport nutrients and elements to organic tissues, nourishing them. Carries waste products out of tissues.
  - a. Mass of living organisms comprised of water ranges from 65-95%
3. Surface water covers more than 70% of the earth's surface
4. Hydrologic Cycle
  - a. Water is neither created nor destroyed, the hydrosphere is essentially a closed system,
  - b. BUT water may be transformed from one form to another, and moved from one place to another.

### II. Physical Properties of Water

#### A. Can exist in all three physical states: liquid, solid (ice), and gas (water vapor)

#### B. Transformation Processes related to energy input and entropy of water: heating of water, > atomic activity of the water molecules, i.e. > vibrational energy of water atoms.

1. ICE -----HEAT----- WATER-----HEAT -----WATER VAPOR  
(<32 degrees) (32-212) (>212 degrees F)

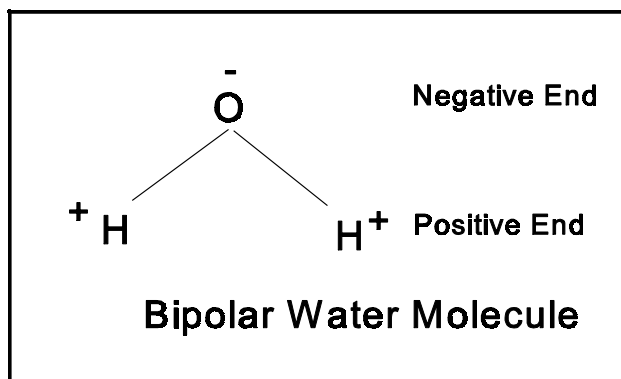
#### C. Water is one of few earth substances that remains in a liquid state at the operating surface temperatures of the earth.

1. The liquidity of water makes it a dominant and pervasive component of all earth processes

#### D. Water has High Heat Capacity- it has a capacity to absorb and hold energy with only a

small amount of temperature rise.

- E. Water expands in volume when it freezes/ becomes colder, in contrast to majority of substances (which contract when colder)
  - 1. Result Density of ice < Density of water: thus ice floats on water
  - 2. Also of importance for water playing the role of hydraulic press during process of frost wedging
- F. Water strongly influenced by the force of gravity, constantly driven downward, and can possess great erosive/ landscape carving force
- G. Water has property of high surface tension, ability to have strong molecular attractive forces (sticks to itself and electrostatically attracts ionic forms of elements)
  - 1. Capillarity- phenomena of water moving upward against the force of gravity, due to strong electrostatic adhesive forces, most notable in narrow, restricted pore spaces where surface to surface contact is high.
- H. Water acts as a "universal solvent" and can dissolve most any substance over time. Water + carbon dioxide forms a mild carbonic acid solution naturally in hydrosphere, as an acid can result in cationic exchange with positive ionic species, and result in chemical breakdown of substances.
  - 1. Bipolar Water Molecule H<sub>2</sub>O



### III. THE HYDROLOGIC CYCLE

- A. General Statement: 99% of all earth's water is held in storage in form of oceans, lakes, glacial ice or groundwater.
  - 1. The remaining 1% is involved in the continuous sequence of movement and change in the form of atmospheric moisture, precipitation, and subsequent runoff and drainage, perhaps temporarily stored en route.
- B. The Hydrologic Cycle: a circuit of water movement, with storage areas interconnected

by various transfer processes... water moves not only geographically, but through physical states as well.

1. Basic Model: Ocean Water----sun's energy---- evaporation -----atmospheric moisture----- condensation/precipitation-----land/continental waters-----downgradient flow due to gravity----- back to ocean-----and cycling through.
2. Surface to Air: Evaporation prime mechanism for transfer to atmospheric moisture.
  - a. Ocean Evaporation- heat and wind operate on oceans and result in evaporation of water from liquid to vapor form (especially effective in lower latitudes, areas with most direct heating from sun's rays)
  - b. Land Evapotranspiration- water is not only release to the atmosphere on land through evaporation, but also through transpiration of water vapor from plants/trees to the atmosphere.
  - c. Water Vapor Movement:
    - (1) Convection- vertical movement of moistureladen air masses through heat transferprocess
    - (2) Advection - horizontal transport of airmasses by wind currents.
3. Air to Surface: atmospheric water vapor is eventually condensed into liquid or sublimated into ice to form cloud particles = precipitation
4. Surface and Ground Waters: precipitation on land can run several possible courses:
  - a. accumulation/ponding on the continental surfaces (will subsequently be subject to high rates of evaporation).
  - b. surface runoff: in form of streams and rivers, eventually being subject to partial evaporation and final emptying back to sea.
  - c. Infiltration into the ground and uppermost strata comprising the lithosphere; forming "ground water"
  - d. Vegetative interception: the interception of precipitation by the vegetative canopy of the biosphere, may be subject to evaporation or eventually fall to ground.
5. Duration of Cycle: water may become temporarily stored and removed from the cycle from hours to days, to years to 100's of thousands of years...depending on the geohydrologic circumstance.

C. Moisture Inventory:

1. Oceans: contain 97% of earth's water
  - a. >70% of Earth's Surface Covered in Water
2. Glaciers: 2% of all moisture, comprising 75% of worlds fresh water
  - a. Continental Ice Sheets
    - (1) Antarctica
    - (2) Greenland
  - b. Ocean Ice
    - (1) Antarctic Shelf
    - (2) Arctic Sea
  - c. Glaciers = Savings Account of Fresh Water
  - d. Ice-Sea Water Budget
    - (1) Glacial Climates
      - (a) < Ocean Volume
      - (b) > Ice Volume
    - (2) Interglacial Climates
      - (a) > Ocean Volume
      - (b) < Ice Volume
3. Ground water: 0.5% of total
  - a. Surface Transfer
    - (1) Springs
    - (2) Anthropogenic Transfer
4. Fresh Surface Water: 0.2%
  - a. Lakes, Rivers
5. Soil Moisture: 0.1%
6. Atmospheric Moisture: 0.0001%
7. Biological Water: negligible