

Water and Ocean Structure

- * Pure water is a compound- contains two different types of atoms
- * Individual water molecule is held together by covalent bonds
- * Water molecules form bonds between each other because of Hydrogen Bonding

Water's Properties

- * Water has special properties because of the hydrogen bonding (polarity)
- * Cohesion, Adhesion, Surface Tension are all properties that allow life on Earth to form

Density, Salinity & Temperature

Density of Water

- * Water has a density of 1 gm/cm^3
- * It is the only substance on Earth that has a solid state that is less dense than its liquid state

Density and Oceans

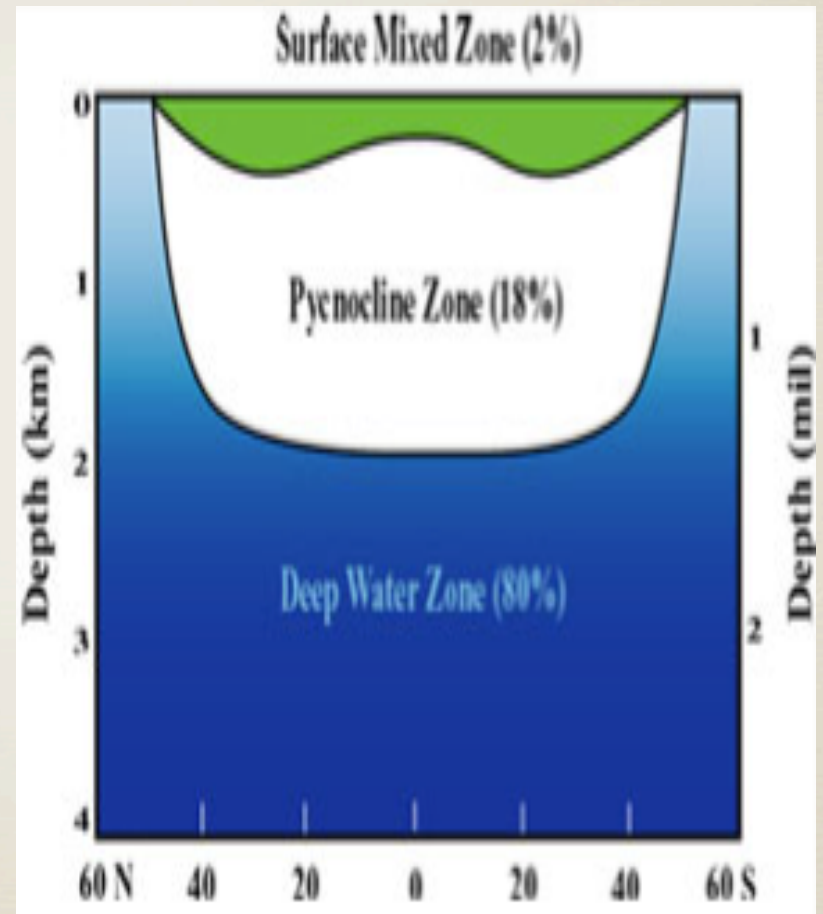
- **Density** is a measure of how much mass is contained in a given unit volume (*density = mass/volume*).
- Temperature, salinity and pressure work together to determine water density
- *Cold, salty water* is much denser than warm, fresher water and will *sink below* the less dense layer.

Surface Mixed Zone

- * The ocean waters can be divided into **three layers**, depending on their densities. Less dense waters form a top layer called the **surface mixed zone**. The temperature and salinity of this layer can change often because it is in direct contact with the air.
- * *For example, water evaporation could cause an increase in salinity, and a cold front could cause a drop in temperature.*

Density and Oceans

- The next layer is the *pycnocline*, or *transition zone*.
- The density here does not change very much. This transition zone *is a barrier between the surface zone and a bottom layer, allowing little water movement between the two zones.*

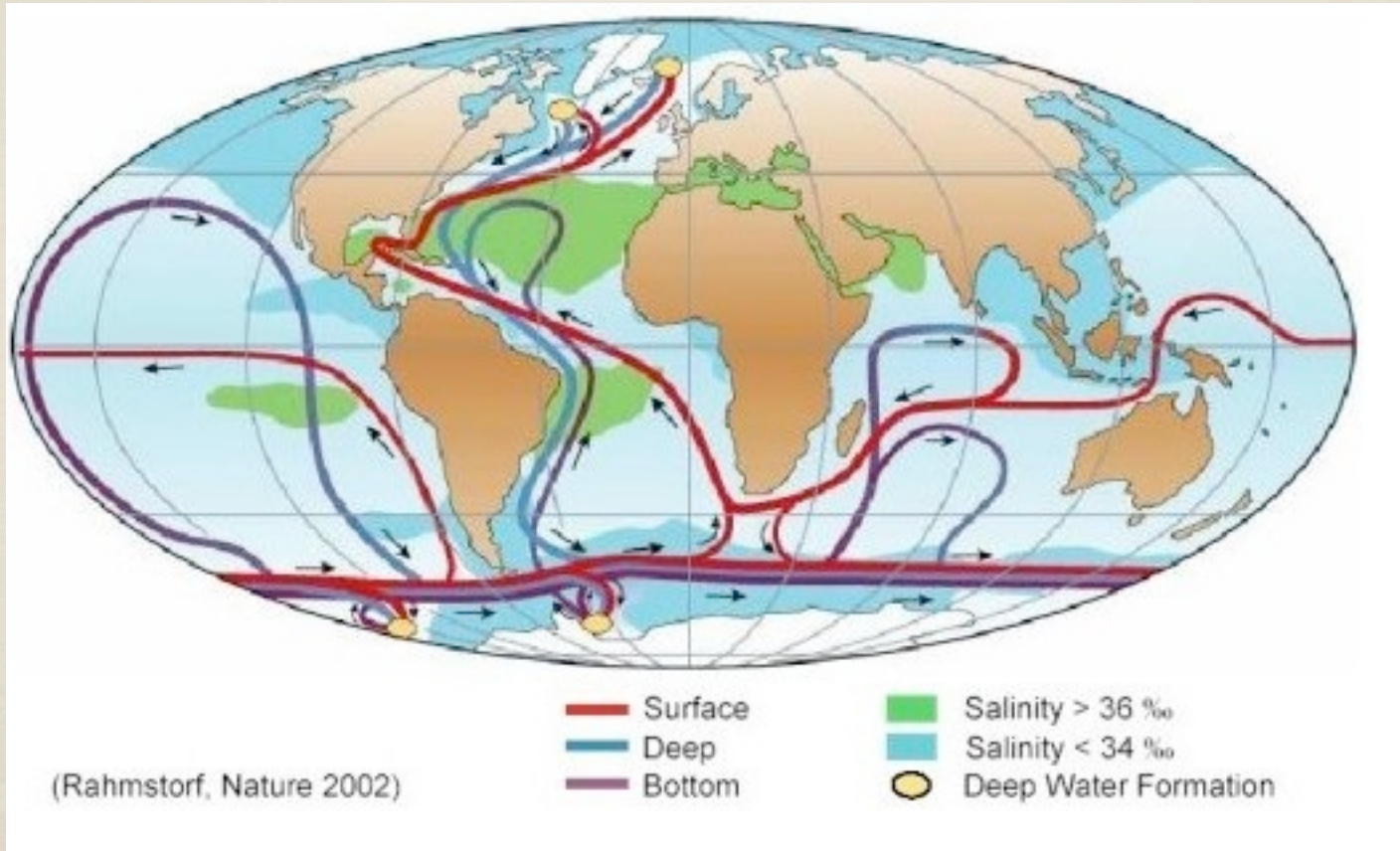


The Deep Zone

* The bottom layer is the **deep zone**, where the water **remains cold and dense**. The polar regions are the only places where deep waters are ever exposed to the atmosphere because the pycnocline is not always present.

- * Circulation of surface waters of the ocean are driven by winds, the circulation of the deep waters are driven by density differences.
- * Circulation in the depths of the ocean is referred to as thermohaline circulation.
- * The deep ocean is layered with the densest water on bottom and the lightest water on top.
- * Water tends to move horizontally throughout the deep ocean, moving along lines of equal density.
- * Vertical circulation is limited because it is easier to move along densities that are the same

Thermohaline Circulation



Salinity

- Most of the salt in the oceans came from land.
- Over millions of years, rain, rivers, and streams have washed over rocks containing the compound sodium chloride (NaCl), and carried it into the sea.
- Some of the salt in the oceans comes from undersea volcanoes and hydrothermal vents
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Salinity

- * When water evaporates from the surface of the ocean, the salt is left behind. After millions of years, the oceans have developed a noticeably salty taste.
- * Different bodies of water have different amounts of salt mixed in, or different salinities.
- * Salinity is expressed by the amount of salt found in 1,000 grams of water. Therefore, if we have 1 gram of salt and 1,000 grams of water, the salinity is 1 part per thousand, or 1 ppt.

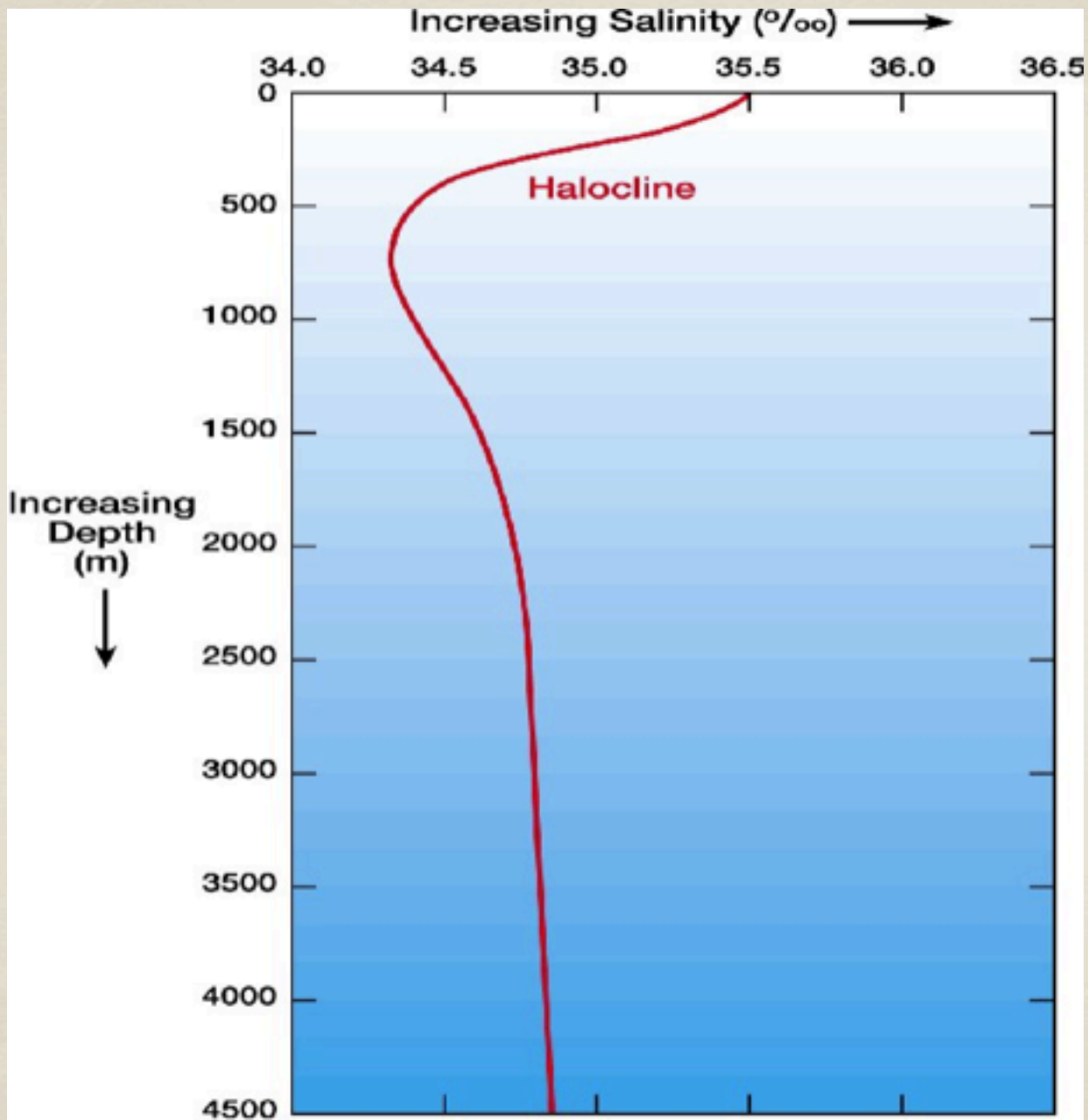
- The average ocean salinity is 35 ppt
- This number varies between about 32 and 37 ppt.
- Rainfall, evaporation, river runoff, and ice formation cause the variations. For example, the Black Sea is so diluted by river runoff, its average salinity is only 16 ppt.
- Freshwater salinity is usually less than 0.5 ppt.
- Water between 0.5 ppt and 17 ppt is called brackish. Estuaries (where fresh river water meets salty ocean water) are examples of brackish waters.

Animals and Salinity

- * Most marine organisms keep the salinity inside their bodies at about the same concentration as the water outside their bodies.
- * If an animal that usually lives in salt water were placed in fresh water, the fresh water would flow into the animal through its skin. If a fresh water animal found itself in the salty ocean, the water inside of it would rush out. This is regulated by osmosis

Halocline

- * Vertical zone in the oceanic water column in which salinity changes rapidly with depth, located below the well-mixed, uniformly saline surface water layer.
- * Especially well developed haloclines occur in the Atlantic Ocean, in which salinities may decrease by several parts per thousand from the base of the surface layer to depths of about one km

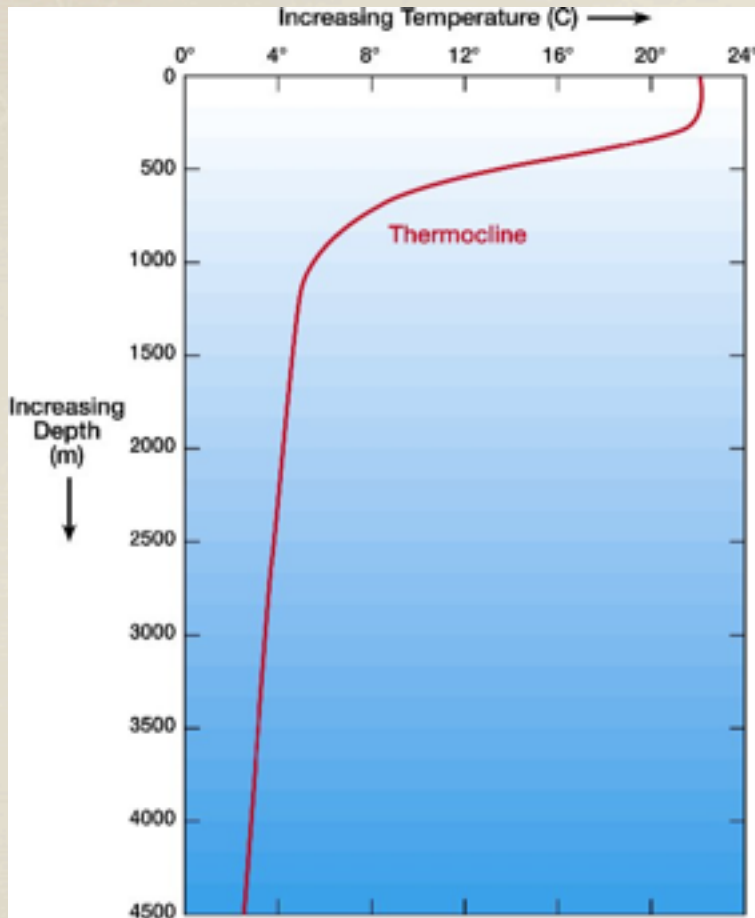


Composition of Sea Water

- * Dissolved salts in sea water (atoms):
- * 55.3 % Chlorine, 30.8 % Sodium, 3.7 % Magnesium
- * 2.6 % Sulfur, 1.2 % Calcium, 1.1 % Potassium

Temperature

- The Sun hits the surface layer of the ocean, heating the water up.
- Wind and waves mix this layer up from top to bottom, so the heat gets mixed downward too.
- The temperature of the surface waters varies mainly with latitude.
- The polar seas (high latitude) can be as cold as -2 degrees Celsius (28.4 degrees Fahrenheit) while the Persian Gulf (low latitude) can be as warm as 36 degrees Celsius (96.8 degrees Fahrenheit).
- Ocean water, with an average salinity of 35 psu, freezes at -1.94 degrees Celsius (28.5 degrees Fahrenheit). That means at high latitudes sea ice can form. The average temperature of the ocean surface waters is about 17



- Thermocline- a distinct zonation of waters based on temperature. In large bodies of water this is a natural process occurring between the air and wind influenced surface waters, which have relatively rapidly changing temperatures, with the colder, more constant temperature deeper waters.

Density, Salinity, Temperature & Organisms

Density, Temperature & Organisms

- Density of ocean water is about 1.026gm/cm^3 . Which means anything below this will float and anything above this will sink.
- What do you think is the density of most phytoplankton, why?

- As water becomes cold it sinks, which causes the under water currents in the oceans.
- This mixes the layers of water which allow food from the surface to reach the bottom. This along with **upwelling** and **downwelling** (the upward and downward motion of sub-surface water toward the surface and bottom of the ocean. This is often a source of cold, nutrient-rich water.
- Strong upwelling occurs along the equator where easterly winds are present. Upwelling also can occur along coastlines).
- This increases the **productivity** (the amount of carbon available to the system as a result of photosynthesis) of the marine ecosystem.

Affect of Climate Change

- Increasing temperatures will cause distinct layers to form in the water, reducing the mixing and in turn lower productivity.
- Introduction of new species as a result of warmer water. Which compete with local species for space and food. (invasive species).

Salinity & Organisms

- All aquatic organisms must deal with the problem of maintaining internal homeostasis, a constant internal chemical environment in which that organism's enzymes can operate efficiently. This is largely a matter of osmoregulation- ability to move water in and out.
- Many marine organisms can get by with minimal osmoregulation since the oceans, are already a good environment; other marine organisms maintain their body fluids at ionic concentrations different from the surrounding ocean and must actively regulate ions. Freshwater also calls for active measures to maintain proper osmotic balance.

- One method to avoid having to deal with osmotic balance is to cover the body with an impermeable membrane. Many aquatic organisms do just that, but this protection is necessarily incomplete, because three other processes involve intimate contact between a water-permeable body membrane and the surrounding fluid. In addition, these three other processes demand large surface areas in order to occur at sufficient rates to satisfy bodily needs.
- These three processes are, of course, respiration, absorption of food, and nitrogen excretion.
- Well, actually, only respiration is required of all aquatic organisms; plants do not ingest food (although they do need to take up plant nutrients), and plants do not have to excrete nitrogenous wastes, since they possess the chemical machinery needed to incorporate N into amino acids.