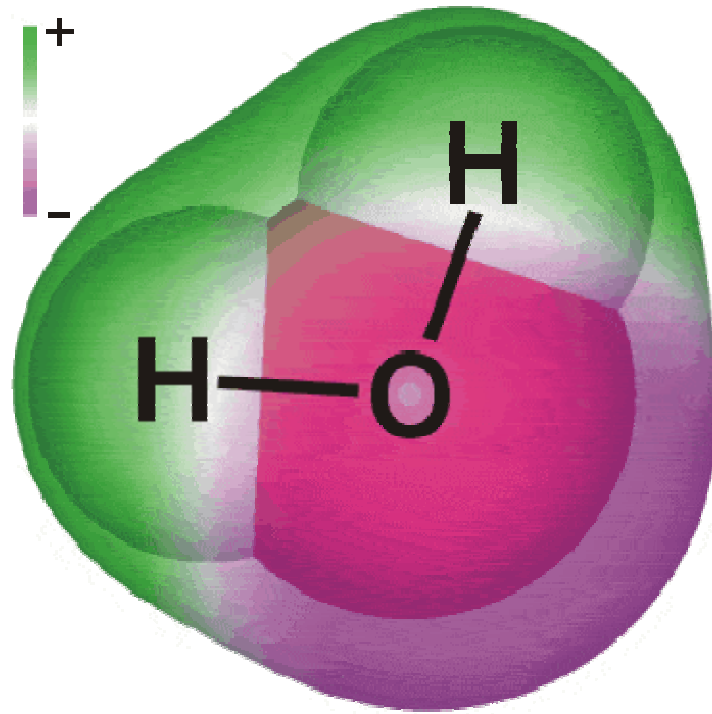


Chemical Oceanography

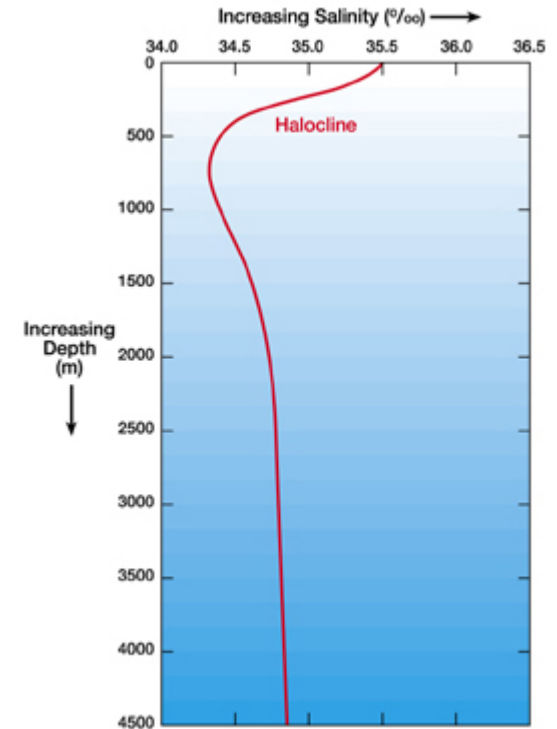
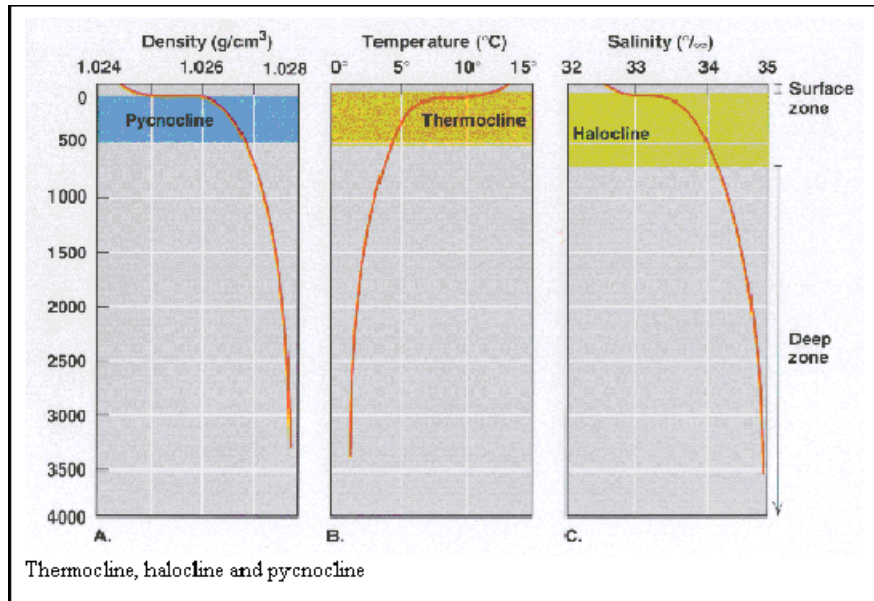


Components of Seawater

- Salinity
 - Total quantity of dissolved inorganic solids
 - Most inorganic solids have been separated into ions
 - Varies from 3.3 - 3.7% of water by mass
 - Discussed in parts per thousand ($^{\circ}/_{00}$)
 - Average salinity of water in the open ocean is $35^{\circ}/_{00}$
 - Dissolved solids can come from river input and hydrothermal vent activity

Variation in Salinity

- Halocline: Rapid change in salinity over a small depth range
 - Thermocline: rapid change in temperature
- Tropical areas are on average more salty than temperate areas
 - More evaporation in tropical areas
- Open ocean more salty than coastal areas
 - Runoff and river input near coast



Temperate areas:

Surface less salty due to runoff and precipitation

Tropical areas:

Surface more salty due to increased evaporation

Components of Seawater

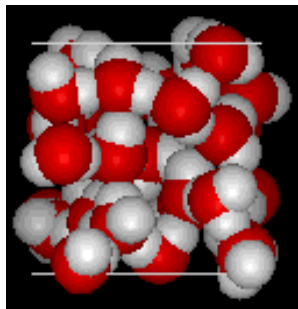
- Major Ions in Seawater (>99% of ions)
 - Chloride (Cl^-)
 - Sodium (Na^+)
 - Sulfate (SO_4^{2-})
 - Magnesium (Mg^{2+})
 - Calcium (Ca^{2+})
 - Potassium (K^+)
- Together make up over 95% of ions

Principle of Constant Proportions

- Total amount of dissolved solids may change
 - Different areas of the ocean have different salinities
- However, the proportions of the different ions remains constant
 - ex Chloride always makes up 55.04% of the ions in seawater regardless of the total salinity
- If you know the concentration of one ion you can determine the total salinity of the water

Density of Seawater

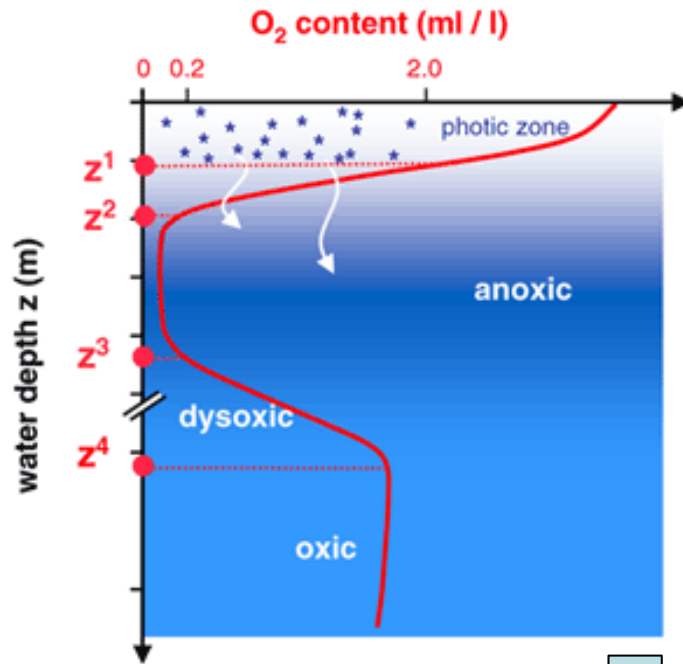
- More salt = more dense
- Colder = denser (down to 4C)
 - Water densest at 4C
 - Density of water decreases from 3-0C
 - Ice floats (less dense)



Dissolved Gases

- Dissolved gases are important for animals and algae living in the ocean
- Nitrogen
 - About 48% of gas in seawater (78% in air)
 - Must be fixed before it is useable to organisms
- Oxygen
 - About 36% of gas in seawater
 - Highest at the surface

Oxygen Minimum Zone



Decomposition of sinking dead material uses up the oxygen

No photosynthesis to replenish the oxygen

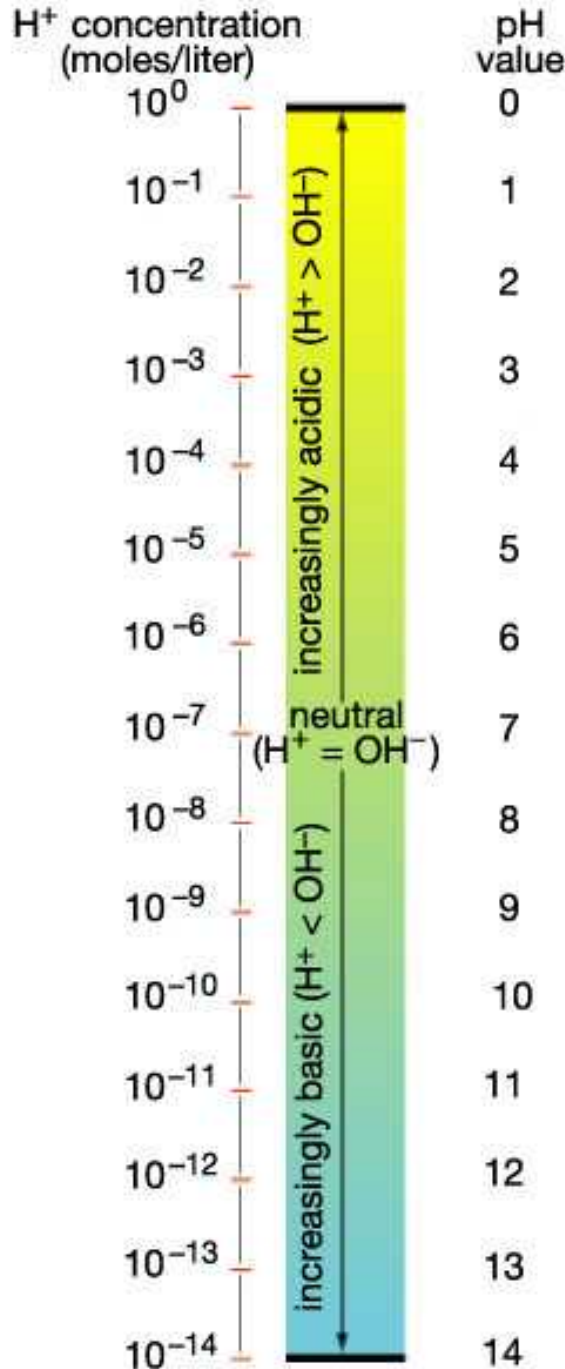
Deep water denser and thus does not mix with the above layers

Dissolved Gases

- Carbon dioxide
 - About 15% of gas in seawater (0.03% in air)
 - Combines with water to form carbonic acid
 - Means the ocean can hold (store) a lot of carbon dioxide

pH of Seawater

- Water can be separated into H^+ and OH^- ions
 - In pure water $H = OH$
 - Acids have more H ions
 - Bases have more OH ions
- Average pH of seawater is 8.0
 - Why is seawater basic if carbon dioxide combines with water to form carbonic acid?



1-molar hydrochloric acid (HCl)

stomach acid, lime juice

lemon juice

“acid rain” (2.5-5.5), vinegar, cola, orange juice, tomatoes

beer

**black coffee, tea
normal rain (5.6),
urine (5.7)**

**pure water (7.0), saliva, blood,
sweat (7.4)**

seawater (7.8-8.3)

baking soda

**phosphate detergents
chlorine bleach, milk of magnesia
household ammonia, some
detergents (without phosphates)
washing soda**

oven cleaner

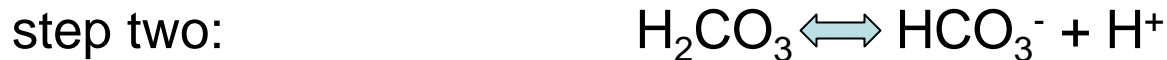
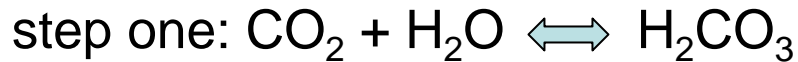
1-molar sodium hydroxide (NaOH)

pH of Seawater

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Acid-Base Balance

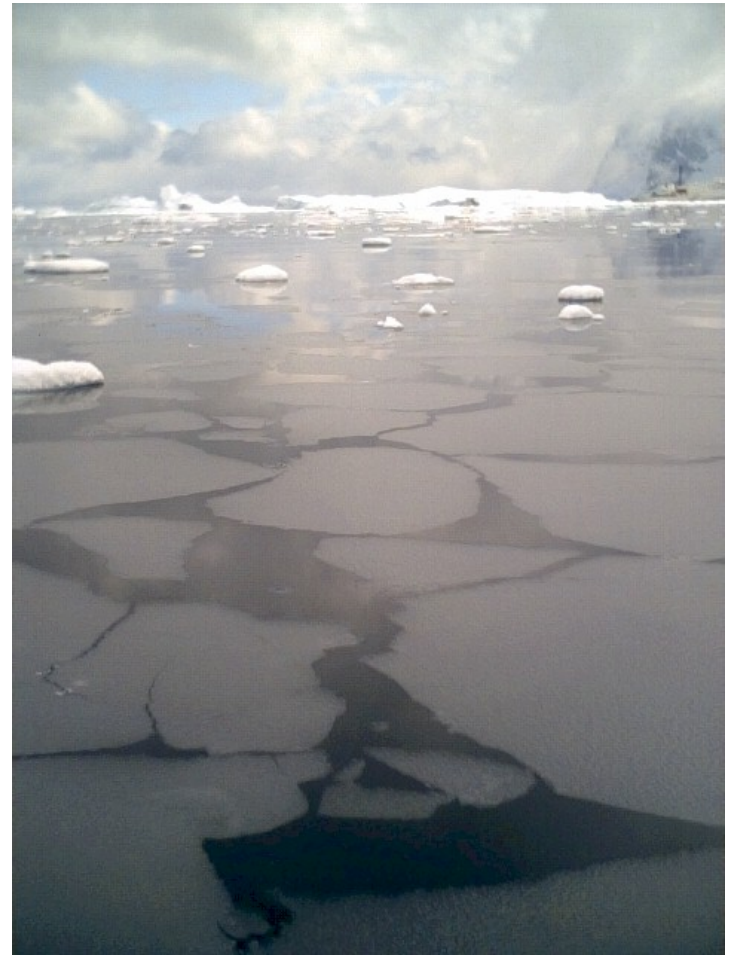
- Carbonic acid gets converted to bicarbonate (HCO_3^-)



- This process acts as a buffer to prevent large pH changes in the ocean

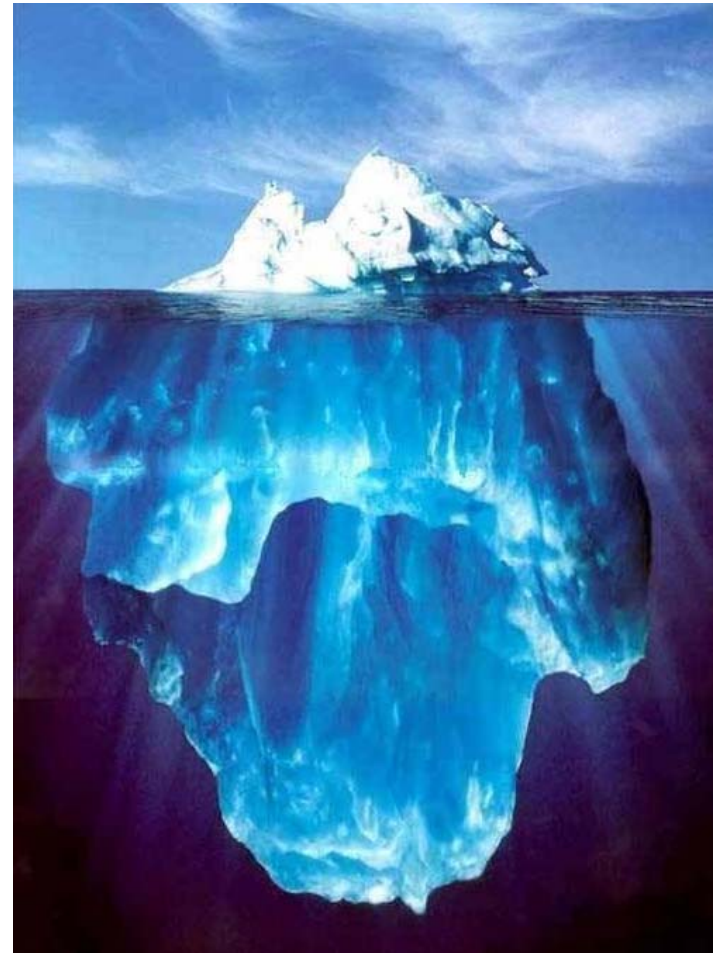
Sea Ice

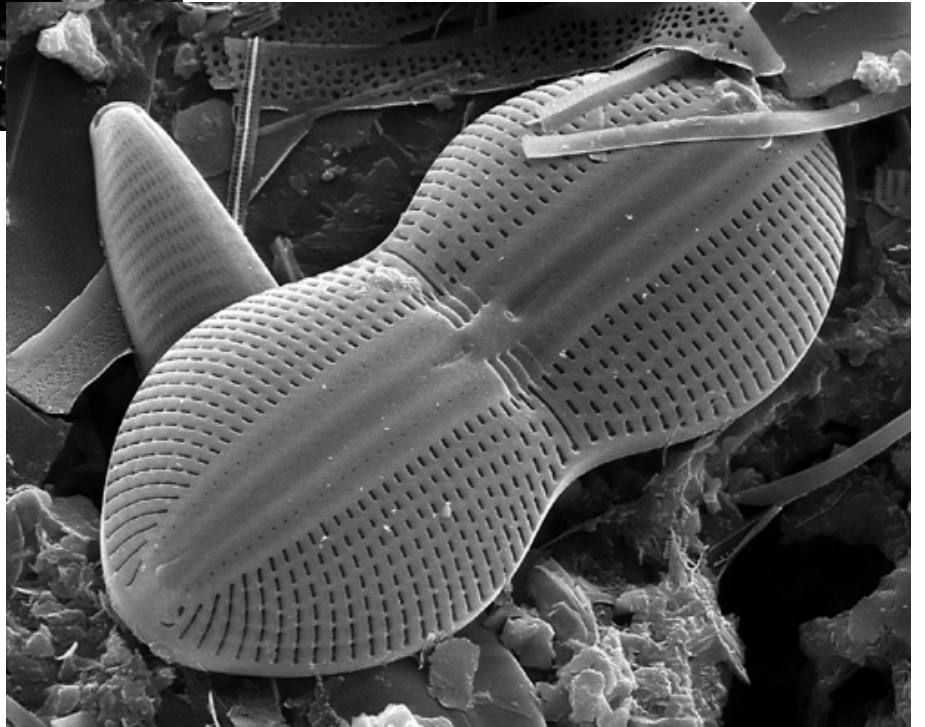
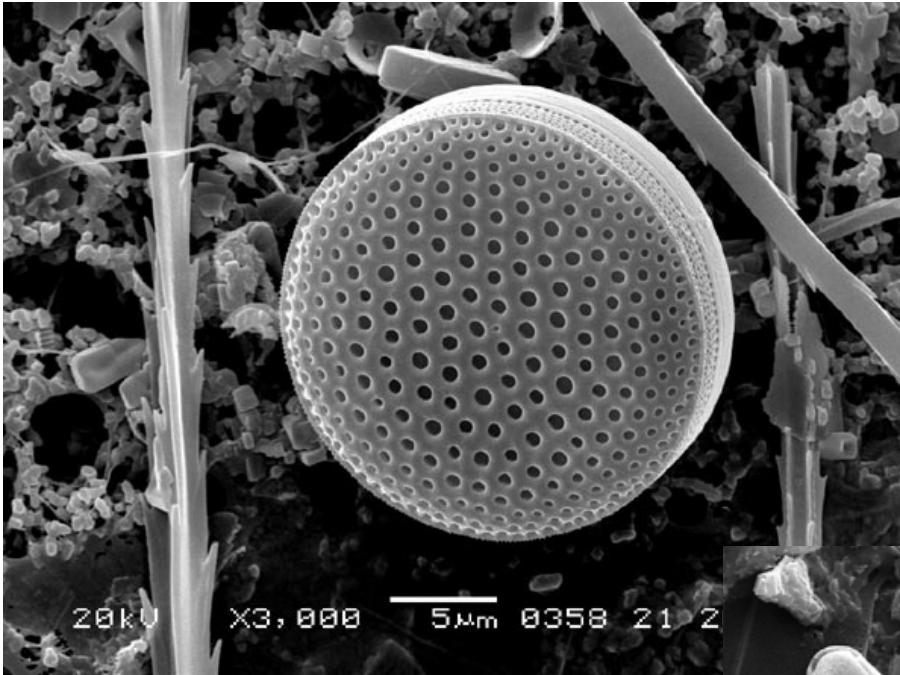
- Sheet of ice that forms over the ocean
 - Salt is left behind
 - Thus, formation of sea ice increases the salinity of the surrounding water
 - Found in polar areas
 - Sea ice cover has been decreasing in recent years



Icebergs

- Form from chunks of ice that break off glaciers
 - Derived from land based glaciers





Chemical terms

- Latent heat: amount of energy required for a material to undergo a phase change
 - Vaporization (evaporation)
 - Fusion (freezing)
- Heat capacity: amount of energy required to raise a substance by 1C.