Chemical compostion of sea water

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Sea water

- Seawater, water that makes up the oceans and seas, covering more than 70 percent of Earth’s surface.
- Seawater is a complex mixture of 96.5 percent water, 2.5 percent salts, and smaller amounts of other substances, including dissolved inorganic and organic materials, particulates, and a few atmospheric gases.

Componds

- Seawater constitutes a rich source of various commercially important chemical elements.
- Much of the world’s magnesium is recovered from seawater, as are large quantities of bromine.
- In certain parts of the world, sodium chloride (table salt) is still obtained by evaporating seawater.
- In addition, water from the sea, when desalted, can furnish a limitless supply of drinking water.
- Many large desalination plants have been built in dry areas along seacoasts in the Middle East and elsewhere to relieve shortages of fresh water.

source and mixing

- The chemical composition of seawater is influenced by a wide variety of chemical transport mechanisms.
- Rivers add dissolved and particulate chemicals to the oceanic margins.
- Wind-borne particulates are carried to mid-ocean regions thousands of kilometres from their continental source areas.
- Hydrothermal solutions that have circulated through crustal materials beneath the seafloor add both dissolved and particulate materials to the deep ocean.
- Organisms in the upper ocean convert dissolved materials to solids, which eventually settle to greater oceanic depths.
- Particulates in transit to the seafloor, as well as materials both on and within the seafloor, undergo chemical exchange with surrounding solutions.
- Through these local and regional chemical input and removal mechanisms, each element in the oceans tends to exhibit spatial and temporal concentration variations.
- Physical mixing in the oceans (thermohaline and wind-driven circulation) tends to homogenize the chemical composition of seawater.
- The opposing influences of physical mixing and of biogeochemical input and removal mechanisms result in a substantial variety of chemical distributions in the oceans.

Seawater Composition

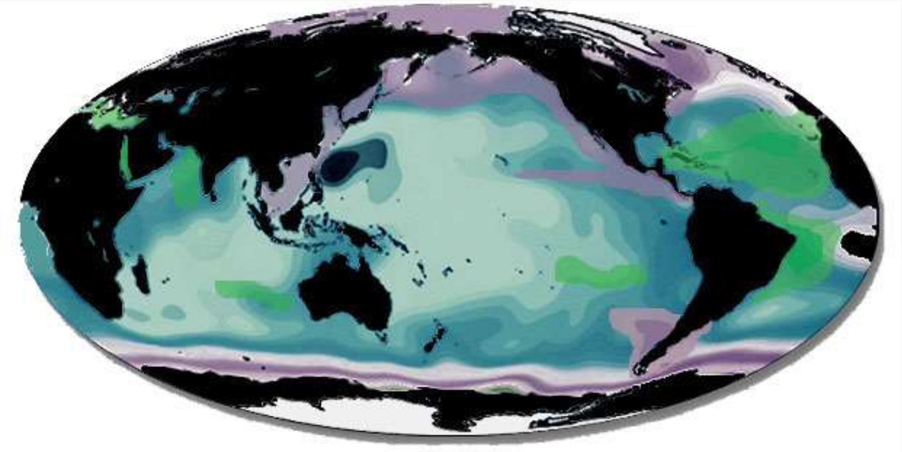
- Almost anything can be found in seawater. This includes dissolved materials from Earth's crust as well as materials released from organisms.
- The most important components of seawater that influence life forms are salinity, temperature, dissolved gases (mostly oxygen and carbon dioxide), nutrients, and pH. Each of these is discussed below along with how it varies (or does not vary) and its influence on marine life.

Salinity

- ✓ The salinity of seawater is usually 35 parts per thousand (also written as o/oo) in most marine areas.
- ✓ This salinity measurement is a total of all the salts that are dissolved in the water.
- ✓ Although 35 parts per thousand is not very concentrated (the same as 3.5 parts per hundred, o/o, or percent) the water in the oceans tastes very salty.
- ✓ The interesting thing about this dissolved salt is that it is always made up of the same types of salts and they are always in the same proportion to each other (even if the salinity is different than average).
- ✓ The majority of the salt is the same as table salt (sodium chloride) but there are other salts as well.

Factors affecting salinity

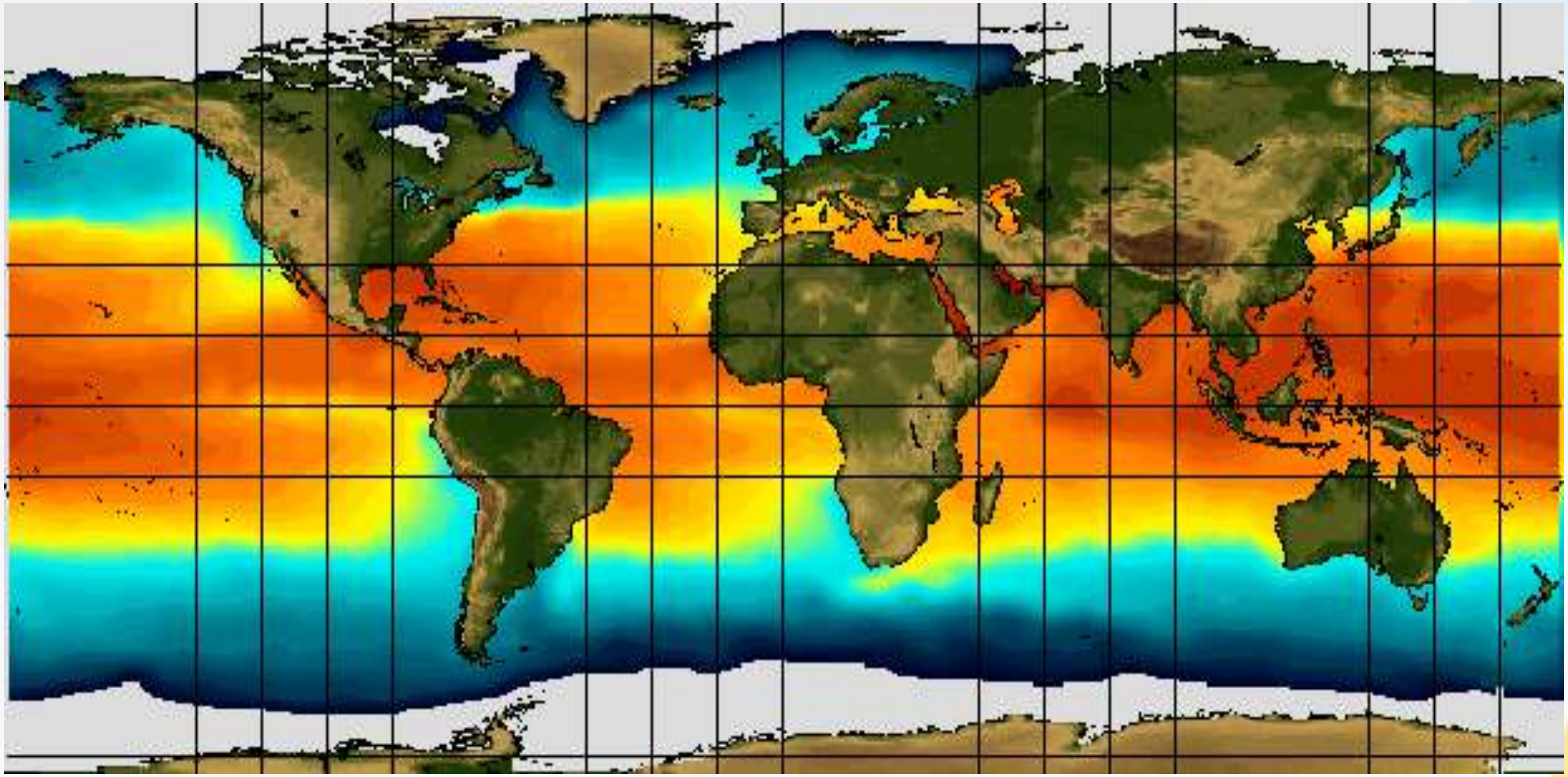
- The most common factor is the relative amount of evaporation or precipitation in an area.
- If there is more evaporation than precipitation then the salinity increases (since salt is not evaporated into the atmosphere).
- If there is more precipitation (rain) than evaporation then the salinity decreases.



Salinity map showing areas of high salinity (36 o/oo) in green, medium salinity in blue (35 o/oo), and low salinity (34 o/oo) in purple. Salinity is rather stable but areas in the North Atlantic, South Atlantic, South Pacific, Indian Ocean, Arabian Sea, Red Sea, and Mediterranean Sea tend to be a little high (green). Areas near Antarctica, the Arctic Ocean, Southeast Asia, and the West Coast of North and Central America tend to be a little low (purple). (NOAA image edited by GA)

Temperature

- The temperature of seawater varies with the amount of sun that hits that area.
- This includes the length of time as well as the angle of the sun's rays.
- The longer the time and the more direct the rays of the sun fall on the ocean, the greater the temperature of seawater.
- Thus, tropical areas that get more year-round sun and more direct sun (almost 90 degrees, straight down for most of the year at noon) have warmer surface waters than polar areas that may have no sun at all for several months each year and then very steep angles of the sun's rays (never directly overhead at noon).
- Knowing this about ocean water helps us understand that surface ocean temperatures are warm in the tropics (up to 30 or more degrees C) and cooler at the poles (down to -2 degrees C).
- But, when we look below the surface we find that the oceans are also vertically stratified and marine scientists recognize a basic three layered ocean - the upper mixed layer, the main thermocline, and deep (bottom) water.



Seawater temperature map showing areas of warmer water in red and areas of cooler water is blue. White areas represent ice. Notice the upward finger of cold water in the South Pacific off of South America and the downward finger of cold water in the North Pacific off of the West Coast of the USA. The reasons for these become apparent when you learn about the major ocean currents (lesson 2.1.2). (NOAA image)

Density

- Temperature, salinity and pressure affect the density of seawater.
- Large water masses of different densities are important in the layering of the ocean water (more dense water sinks).
- As temperature increases water becomes less dense. As salinity increases water becomes more dense. As pressure increases water becomes more dense.
- A cold, highly saline, deep mass of water is very dense whereas a warm, less saline, surface water mass is less dense.
- When large water masses with different densities meet the denser water mass slips under the less dense mass.
- These responses to density are the reason for some of the deep ocean circulation models.

Dissolved Gases

- The concentration of dissolved oxygen and carbon dioxide are very important for marine life forms.
- Although both oxygen and carbon dioxide are a gas when outside the water, they dissolve to a certain extent in liquid seawater.
- Dissolved oxygen is what animals with gills use for respiration (their gills extract the dissolved oxygen from the water flowing over the gill filaments).
- Dissolved carbon dioxide is what marine plants use for photosynthesis.
- The amount of dissolved gases varies according to the types of life forms in the water.
- Most living species need oxygen to keep their cells alive (both plants and animals) and are constantly using it up.
- Replenishment of dissolved oxygen comes from the photosynthetic activity of plants (during daylight hours only) and from surface diffusion (to a lesser extent).

Dissolved Nutrients

- ✓ Fertilizers, like nitrogen (N), phosphorous (P), and potassium (K), are important for plant growth and are called 'nutrients.'
- ✓ The level of dissolved nutrients increases from animal feces and decomposition (bacteria, fungi).
- ✓ Surface water often may be lacking in nutrients because feces and dead matter tend to settle to the bottom of the ocean.
- ✓ Most decomposition is thus at the bottom of the ocean.
- ✓ In the oceans most surface water is separated from bottom water by a thermocline (seasonal in temperature and marginal polar regions, constant in tropics) which means that once surface nutrients get used up (by the plants there) they become a limiting factor for the growth of new plants.
- ✓ Plants must be at the surface for the light.
- ✓ Nutrients are returned to surface waters by a special type of current called 'upwelling' and it is in these areas of upwelling that we find the highest productivity of marine life.

pH

- pH is a measure of the acidity or alkalinity of a substance and is one of the stable measurements in seawater.
- Ocean water has an excellent buffering system with the interaction of carbon dioxide and water so that it is generally always at a pH of 7.5 to 8.5. Neutral water is a pH of 7 while acidic substances are less than 7 (down to 1, which is highly acidic) and alkaline substances are more than 7 (up to 14, which is highly alkaline).
- Anything either highly acid or alkaline would kill marine life but the oceans are very stable with regard to pH. If seawater was out of normal range (7.5-8.5) then something would be horribly wrong

Carbondioxide as bicarbonate

Carbondioxide binds loosely with water to form bicarbonate:

- $CO_2 + H_2O \Leftrightarrow H_2CO_3 \Leftrightarrow H^+ + HCO_3^- \Leftrightarrow H^+ + H^+ + CO_3^{2-}$

in the ratios CO_2 & carbonic acid H_2CO_3 = 1%, bicarbonate HCO_3^- = 93%, carbonate CO_3^{2-} =6%.

- These variants of CO_2 (species) add up to the total amount of Dissolved Inorganic Carbon (DIC), which also includes a smaller amount of Dissolved Organic Carbon (DOC) that passes filtration techniques

The <=> symbol means 'in equilibrium with'.

- These forms of carbon are always in close equilibrium with the atmosphere and with one another. When one talks about dissolved carbondioxide, it is the slightly acidic bicarbonate. When the concentration of CO_2 in the atmosphere increases, presumably also the concentration in the ocean's surface increases, and this works itself through to the right in above equation.