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Ocean Properties [1]

Submitted by Dwight Owens Thu, 2013-09-26 15:20

Oceanographers and marine scientists measure or observe attributes or properties of the ocean that allow them to interpret water or component or organism behaviour. Although Ocean Networks Canada cannot measure all required parameters, many instruments are available to provide useful data.

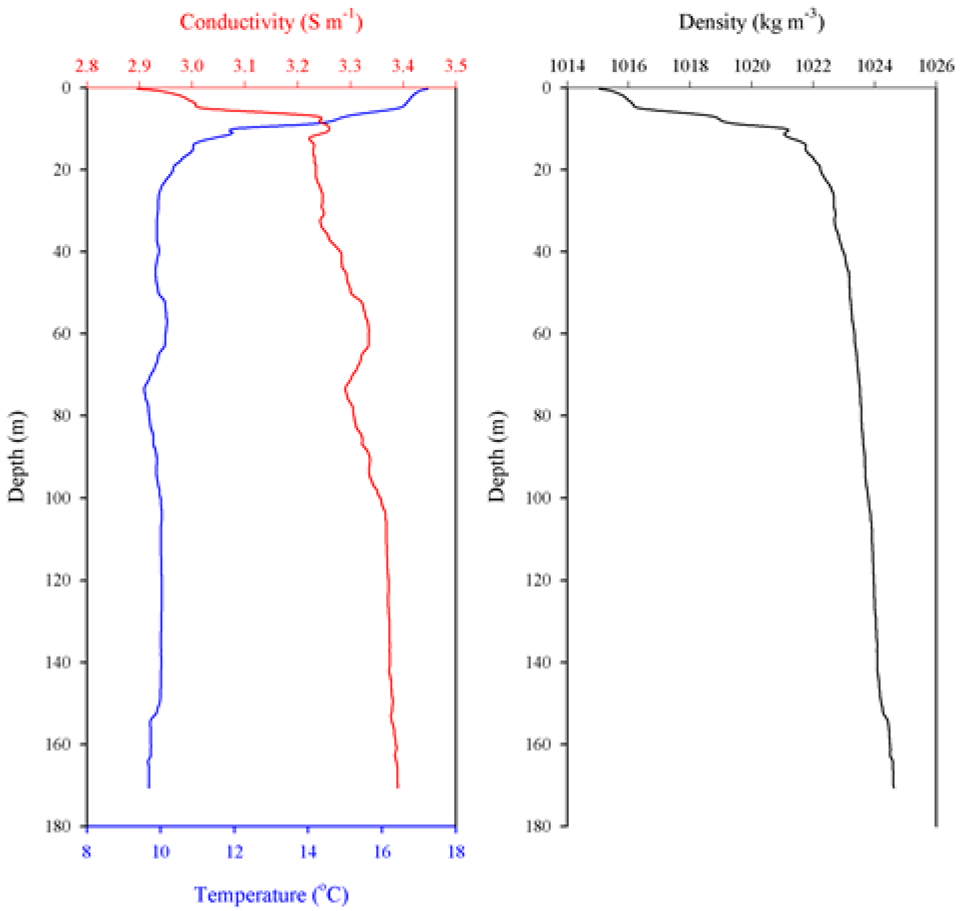
This section discusses the properties measured and provides links to the instruments that provide all or part of the information. Not all parameters are measured at all locations, and some locations have more than one instrument that will measure the same feature in different ways.

Bottom Animal Behaviour

Sometimes biologists have to see animals to understand their actions related to abundance, feeding, competition, and mating. Thus, a camera on the seafloor can often reveal phenomena that are not possible to measure with other means. With high-resolution lenses, the camera can see animals down to 1 mm in size on the seafloor. With a pan and tilt control, the camera can look up into the water column to assess fish and zooplankton. Visual cameras need light that is otherwise absent at most of our site depths. To minimize light pollution, which is unnatural to the deep-ocean environment, we limit lights-on time, scheduling it to descrete time blocks.

Conductivity

Unlike fresh water, saltwater contains free ions and can conduct electricity. We can use the conductivity as a means to calculate the salinity. Salinity is subsequently used, along with Temperature and Pressure, to calculate density. For a given temperature and pressure, fresher seawater is lighter (less dense) and saltier seawater is more dense. Salinity is also very important to marine organisms whose ability to regulate body salts can be limited. ?Average? seawater salinity for surface coastal oceans is about 32 parts per thousand. Conductivity is the C in the CTD instrument. The units of measure for Conductivity are Seamans per metre [S/m].



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Currents

Tidal currents are a dominate factor influencing water behaviour along the BC coast, while winds and topography can also influence local flow characteristics. Changes in flow rates and directions are vital in determining exchange rates of water properties and habitat conditions. Advanced computer models can be used to predict flow patterns into the future, or during unusual circumstances (e.g., pollutant release from a sunken vessel).

Today, oceanographers use Acoustic Doppler Current Profilers (ADCP) to look at flow patterns through the entire water column. This bottom-mounted instrument looks upward and uses weak high-frequency acoustic signals that bounce off particles to determine the flow rates in layers throughout the water column.

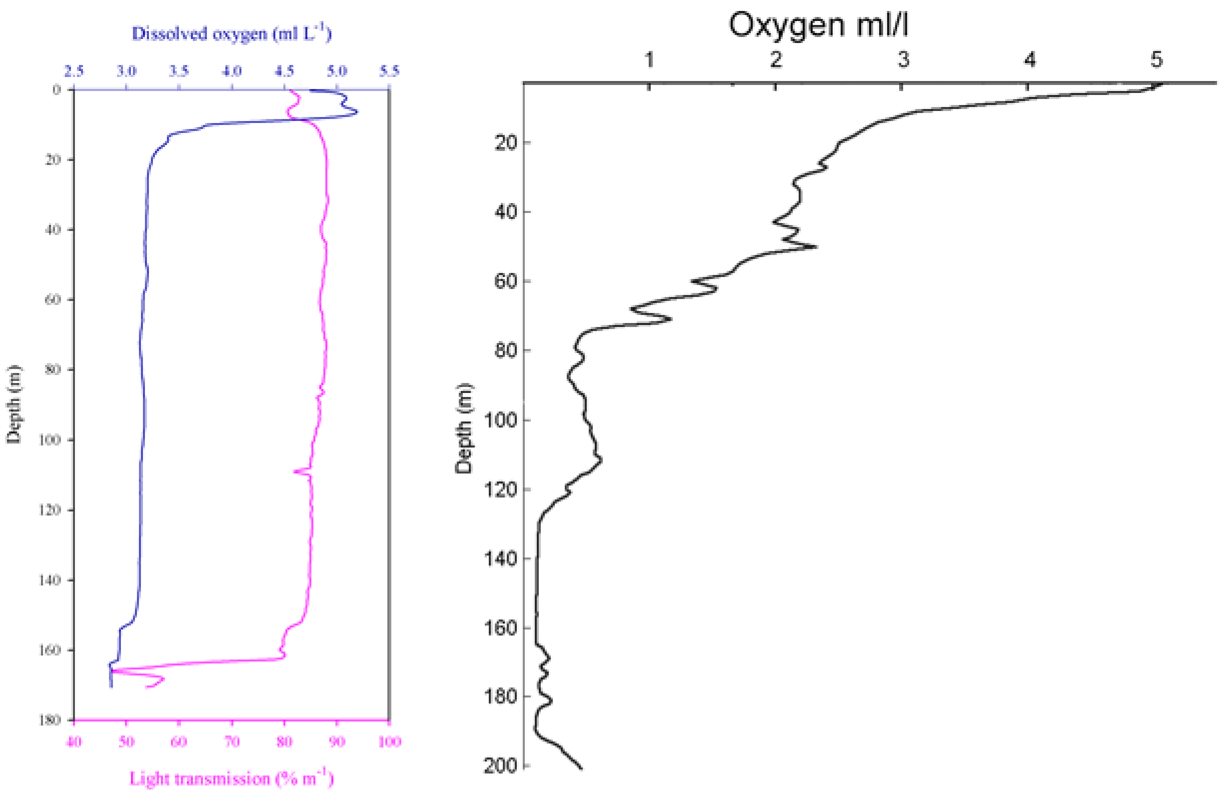
Density

A key measure in oceanography is the seawater density. Adding heat makes the water lighter (less dense), adding salt make it heavier (more dense). Conversely, colder water is heavier and fresher water is lighter. Combinations in between can have various densities. Seawater is also very slightly compressible, and at large ocean depths (i.e. >1000 m) seawater is slightly compressed to higher densities. Denser seawater always sinks underneath lighter seawater, so that at any one location, the lightest seawater is at the surface and the densest is at the bottom. Density is measured in units of kilograms per cubic metre, or kg/m^3. Typical values in the ocean range between 1024-1030 kg/m^3. Often the pressure contribution is small and we are interested in local changes that might only show up in the first few decimal places, so a quantity called sigma-t is considered that is the seawater density calculated from the in situ temperature and salinity, but at zero (atmospheric) pressure, minus 1000. Therefore sigma-t values range between 23 and 28 kg/m^3.

Depth

Why measure depth when the instrument never moves from one place on the bottom? The pressure sensor measures the water column height as tides go up and down. Although tidal height predictions are very useful, weather and wind conditions can also affect the real height of the water level. Tidal height can influence water movement and bottom currents. Also, pressure near the bottom of the ocean can vary as the density of the overlying water above varies. Colder and saltier seawater is more dense than warmer and fresher seawater, and will result in a higher pressure for the same water depth.

The pressure sensor is part of the CTD instrument (the D, for depth, in CTD). The average depth of the ocean is 3750 m; the deepest Ocean Networks Canada instrument is 2660 m in the Cascadia Basin [2].



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Left: A September oxygen profile of Saanich dissolved oxygen. Levels are very low below 70 m and near anoxic below 120 m. Courtesy I. Beveridge. Right: A ship-based cast in the Strait near the Fraser Ridge shows dissolved oxygen (the purple line) and water clarity with depth (the pink line). The slightly lower clarity near the surface is caused by the Fraser River sediments. At the bottom, however, currents are resuspending bottom sediments and water clarity is much lower.

Salinity

What distinguishes the ocean from all other water bodies on Earth is that it is salty. When salts are added to water, the dissolved ions actually allow the water molecules to compact more closely together, thus increasing the water density. The dissolved compounds in seawater are remarkably well mixed over the entire globe, and have been present since the ocean was formed some 4 billion years ago. The dissolved minerals in seawater cover, although sometimes in minute quantities, nearly all the elements of the periodic table. The key ingredients include Chlorine ions (55% by weight), Sodium ions (30.6% by weight), and Sulphate ions (7.7% by weight), representing already 93% of the dissolved compounds in seawater by weight. The Salinity of water is measured by the total weight in grams of dissolved compounds per kilogram of seawater, which translates to about 35 gm/kg, or 35 parts per thousand. Rather than measure the actual dissolved elements, we now measure the conductivity, temperature, and pressure using electronic sensors, and using standard formulae, calculate the salinity assuming a ?standard? oceanic composition. Like temperature (heat), changes in the salt concentration only occur near the ocean surface. Rain or river run-off adds fresh water, which dilutes the salinity, whereas in hot regions, evaporation takes fresh water away into the atmosphere in the form of water vapour, thus increasing the salt concentration. The modern units for Salinity are ?practical salinity units? [psu], which are equivalent to the number of grams of dissolved compounds per kilogram of water.

Temperature

The two most important properties that help oceanographers understand the physical structure of the water column are temperature and salinity. Along with pressure, they determine the density of seawater. For a given salinity and pressure, warmer seawater is lighter, whereas colder seawater is more dense. Denser seawater always sinks beneath lighter seawater, thus density differences alone can cause water to move. Heat content also influences many organisms ? often triggering phytoplankton to grow faster and animals to reproduce. Except for conditions near volcanic activity, changes in water temperature occur at the ocean surface. In the summer, surface water is heated, while in the winter, surface water is cooled. Away from the surfact, changes in water temperature are caused by mixing volumes of water with differing temperatures. The CTD instrument also measures temperature (the T in CTD). Surface waters in British Columbia range from 6 to 20ºC. The unit of measure for Temperature is degrees Celsius [ºC].

Water Clarity

Coastal waters can be very cloudy. The clarity gives oceanographers an idea of the suspended particulate level in the water. Many things can cause high particulate load, but river runoff and plankton blooms are the major sources. Ocean Networks Canada measures the particulate load with a Transmissometer that shoots a narrow beam of light through about 20 cm of water to a receptor; particles will bounce the light away from the receptor, yielding a lower transmission level. Because the Ocean Networks Canada transmissometer is on the ocean floor, we will also see the resuspension of sediments from the bottom.

Zooplankton Behaviour

The tiny animals that eat phytoplankton are a vital source of food for most larger animals in the ocean, including fish and corals. ?Zooplankton? is a term that includes a wide variety of species, ranging from tiny copepods to krill to jellyfish. Ocean Networks Canada uses acoustic methods to detect zooplankton with the Zooplankton Acoustic Profiler (ZAP). Very low strength, high-frequency (200 kHz) acoustic pulses from the bottom are directed upward and bounce off zooplankton in the water. To access food, most zooplankton migrate to the photic zone near the surface to feed on phytoplankton. But during the day, zooplankton can be detected by visual predators such as fish, so they hide at depth while the sun is up and rise only at dusk. The ZAP therefore detects a dense band of acoustic reflectors that moves vertically through the water column twice a day.

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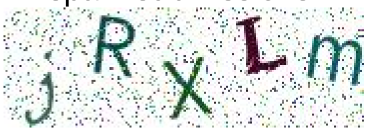

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