

Density Driven Circulation and Water Masses

How do density differences in seawater drive deep ocean circulation?

Temperature and salinity are two of the most important properties of ocean water; together they govern the density (mass per unit volume) of seawater. Density differences drive the vertical and horizontal circulation of about 90% of the ocean. Surface seawater that is made denser by cooling, increased salinity, or mixing, sinks to depths where its density is the same as the surrounding water. From there the water spreads horizontally to great distances, leaving between waters of lesser density above and greater density below. It continues spreading outward, at a very slow pace compared to surface-ocean currents, as more water of the same density sinks from above.

The tendency of seawater to seek its own density level leads to the formation of distinctive water masses. A **water mass** is a body of seawater that is relatively uniform in density and is identifiable based on its temperature and salinity. The subsurface movement of water masses is called **Thermohaline circulation**. Heat transport by moving water masses, likened to huge conveyor belts, is an important control of global climate.

Water masses of different densities tend not to mix. This lack of mixing means that each water-mass layer retains its original properties, including temperature, salinity, % of dissolved gasses and trace elements, which in turn can be used to identify and track the water mass.

When compared to the approximately 1.0km per hour speed of most wind driven surface currents, the velocity of a density driven deep ocean currents is much slower, typically covering about 1.0 m per hour. The circulation of the deep ocean is driven by the increase in density of surface water due to changes in its temperature and /or salinity. A major mechanism whereby the density of surface waters at high latitudes is increased by cooling and the density of surface water at any latitude is increased by net evaporation.

Oceans influence on climate.

Water's exceptional capacity to store heat has important implications for weather and climate. A large body of water (such as the ocean or Great Lakes) can significantly influence the climate of downwind localities. The most persistent influence is on air temperature. Compared to an adjacent landmass, a body of water does not warm as much during the day (or in the summer) and does not cool as much at night (or in the winter). In other words, a large body of water exhibits a greater resistance to temperature change, called **thermal inertia**, than does a landmass. Air temperature is regulated to a great extent by the temperature of the surface over which the air resides or travels. Air over a large body of water tends to take on similar temperature characteristics as the surface water. Places immediately downwind of the ocean experience less contrast between average winter and summer temperatures. So in Oceanside, California, it will stay warmer in the winter and cooler in the summer than it will in San Marcos, California

which is 25 miles inland from the coast. These coastal areas are said to have a **maritime** climate.

(Insert diagram of cross section here)

This vertical cross section of the ocean goes from Papeete Tahiti (16.0'S) at the right to 62.0'S at the left and represents the line we are following and sampling for this cruise. This sampling is repeat of a previous cruise.