Effects of Environmental Factors on Speed of Sound

# Temperature

* Temperature affects the speed of sound by changing the density of the medium in which a sound wave travels. In most cases, when the temperature of a medium increases so does the speed of sound through that medium.
* Temperature is the dominant variable affecting sound speed in the upper few thousand feet (few hundred meters) of the ocean.
* The speed of sound in the sea is a function of water temperature, pressure, and salinity. Of these three variables, temperature is the most important. It is the primary controller of sound speed, and therefore direction, in the upper 300 meters (1,000 feet) of seawater. In general, sound speed increases 2.4 m/sec for every 1C increase in temperature.

# Salinity

* Salinity is the total amount of salt dissolved in seawater; the units most often used are parts per thousand (ppt) but practical salinity unit (psu) is now the accepted standard in oceanography. An average salinity value for seawater is 35 ppt (psu) or 35 parts of salt in 1000 parts of water.
* The effect of salinity on sound speed is slight in the open sea because salinity values are pretty much constant. The effect of salinity on sound speed is greatest where there is a significant influx of fresh water or where surface [evaporation](http://armyordnance.tpub.com/OD1620/OD16200027.htm) creates high salinity. A one part per thousand (1%) increase in salinity increases sound speed 1.4 m/see.
* Salinity has a much smaller effect on sound speed than temperature or pressure at most locations in the ocean. This is because the effect of salinity on sound speed is small and salinity changes in the open ocean are small. Near shore and in [estuaries](https://dosits.org/glossary/estuary/), where the salinity varies greatly, salinity can have a more important effect on the speed of sound in water.

# Pressure

* In most of the ocean except for the polar regions where salinity varies more than temperature, temperature controls the sound speed. Pressure is important in the deeper ocean where temperature is more uniform.
* The effect of pressure on sound speed is a function of depth. The greater the depth, the greater the pressure; the greater the pressure, the greater the sound speed. Sound speed increases approximately 1.7 m/sec per 100 meters of depth. Pressure is the dominant sound speed controller below 300 meters, because below 300 meters, the temperature is relatively constant.

Diagram

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Figure Here are the basic profiles of temperature, salinity and pressure for a mid-latitude location in the deep ocean.

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[Ocean Acoustics (nps.edu)](https://www.oc.nps.edu/~bird/oc2930/acoustics/ssp.html)

[Technical Guides - Speed of sound in sea water - Underlying Physics (npl.co.uk)](http://resource.npl.co.uk/acoustics/techguides/soundseawater/underlying-phys.html)

[Technical Guides - Speed of sound in sea water (npl.co.uk)](http://resource.npl.co.uk/acoustics/techguides/soundseawater/index.html)

[(PDF) On equations for the speed of sound in seawater (researchgate.net)](https://www.researchgate.net/publication/242442965_On_equations_for_the_speed_of_sound_in_seawater) – Contains equations to calculate speed of sound from pressure, temperature, and salinity

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