SMS-204: Physics for marine sciences.
Homework week 9 - answer

1. (20pts) A dolphin is swimming towards a school of fish near the ocean surface at a speed of 18miles/hour. It emits a sound and the echo from a fish school comes back within 2s. Water temperature is 15C and salinity is 34psu. How long (in seconds) will it take the dolphin to arrive to the fish school after it got the echo? (To compute the sound velocity use one of the equation in: http://resource.npl.co.uk/acoustics/techguides/soundseawater/)

The dolphin swims 8.05 m/s. The median sound speed from all the equations was 1505.5 m/s. In two seconds the sound would have traveled 3011m. During that time the dolphin moved 16.1m.

Taking as a reference point the original location of the dolphin, the distance to the fish is = (distance sound as traveled + distance the dolphin swam)/2 = 3027/2= 1513.75m. Since the dolphin swam for 2s, the distance to the fish after two seconds = 1513.75-16.1=1497.65m

Assuming the fish school is stationary it will take 1497.65m/8.05m/s=186s.

2. (20pts) A whale emits a song in the water as he swims fast towards an island. How does the sound a fish near the island hears compares to that heard by a Remora attached to the whale in terms of frequency and amplitude?

Due to the doppler effect, the stationary fish on the island hear a fainter (but increasing in amplitude with time) and higher frequency sound relative to the remora, that hears no change in amplitude and a lower frequency sound.

3. (60pts) We have learned that waves tend to refract towards where the speed of the wave decreases. Go to http://www3.mbari.org/chemsensor/floatviz.htm. Choose a float and download the data from its last profile of temperature, salinity and pressure. Note its latitude and longitude (use the text button on the left side). Use the equation provided in https://rbr-global.com/speed-of-sound-in-water/ (or from https://www.tsuchiya2.org/soundspeed/unesco.htm) in a spreadsheet where you have the temperature, salinity and depth data to compute the sound speed as a function of depth.

I worked this problem up on a google spreadsheet (here)

1. Plot temperature and salinity (x-axis) as function of depth (z axis, with negative value so that deepest is on the bottom of graph).

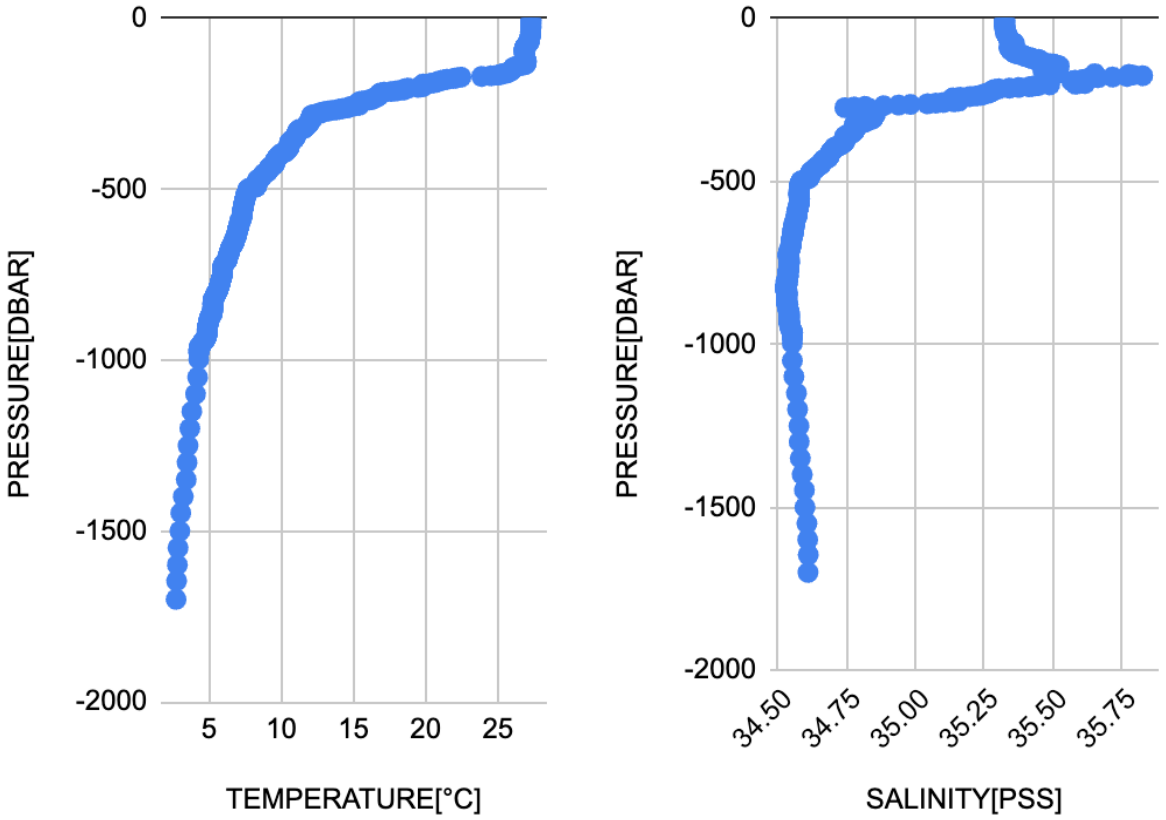

Figure 1. Temperature and salinity as a function of pressure.

2. Plot the sound speed (x-axis) as a function of depth (z axis, with negative value so that deepest is on the bottom of graph).

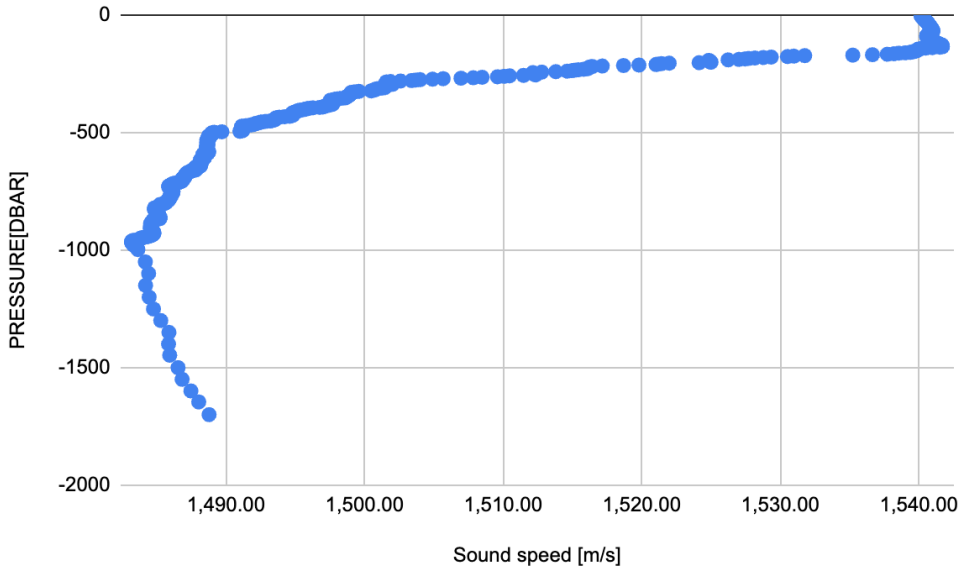

Figure 2. Sound speed as a function of pressure.

3. Where should a whale position itself if it wanted its song to propagate the furthest?
   At a 1000m, the position of the minimum sound speed. Sound emitted there will refract back to it.

Boss, 2024
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