Problem Set #1. (Due in two weeks from assignment date)

1) On the attached page from COA, the definition of transmission loss is presented. One also sees, in Figure 1.6, what the geometrical spreading laws are for a free space source and one inside an ocean waveguide with (perfectly reflecting) top and bottom boundaries.
   a. The spherical case is a TL=20 log R spreading law, and the cylindrical case is a 10 log R law. But this TL law coefficient varies with range R. Derive a simple expression, based on geometry, of how the coefficient varies with range R.
   b. There is actually a TL= 0 log R case (no loss) for a certain type of geometry. What would this be? And can this arise in the ocean?
2) The plane wave reflection coefficient is another basic quantity one need to know how to compute.
   a. Compute the reflection coefficient from water with c=1500 m/s and rho=1 with a sediment of c=1700 m/s and rho=1.7. Show a magnitude and phase plot.
   b. Ocean fronts can reflect sound horizontally, which produces 3D, out of plane acoustic propagation. Show the reflection coefficient, magnitude and phase, for a front going from water with c=1500 m/s to water with c=1546 m/s, which represents a 10 degree C temperature front.
   c. What are the significant differences between the two cases? Compare.
3) In ray theory, one often breaks an ocean soundspeed profile into linear gradient segments.
   a. Show that sound travels in a circular arc through such a linear gradient region. This is a very useful practical result.
4) Problem 1.1 in COA.
5) Oil exploration is often done with airgun arrays that are within 7m of the ocean surface, and produce broadband signals. The pressure field at given frequencies shows distinct Lloyd's mirror beams, typical of a dipole radiation pattern.
   a. At what angle do you expect to see beams for 125 Hz, 250 Hz, and 500 Hz.
   b. Do your simple predictions agree with the (real case) beams seen in the Parabolic Equation calculations attached?

2.682 Acoustical Oceanography
Spring 2012