EART 254 PROBLEM SET #1

Due: Friday, April 10, 2009

In all the below problems, the answers are order-of-magnitude. Roughly speaking, get the value to within a factor of 3 ($=10^{1/2}$) and that's fine (and therefore all values used are reported to at most ONE significant figure). The method is more important than the answer, so be **very explicit** about assumptions and your thought process (i.e. *much more text* than in a normal problem set). Also, the more you estimate and the less you look up, the better.

1. Using Fick's Law, estimate the time scale for the diffusion of a molecule (e.g. tritium) from the surface to the bottom of the ocean.

2. Using the conduction equation, estimate the time scale for the diffusion of heat (e.g. global warming) from the surface to the bottom of the ocean.

3. Assuming the open-ocean vertical eddy diffusivity of $\kappa = 10^{-5}\,\mathrm{m^2\,s^{-1}}$, estimate the time scale for turbulence to transport heat or material from the surface to the bottom of the ocean.

4. Assuming a high-latitude sinking flow of 30 Sv represents the overturning circulation, calculate the time scale for ocean overturning.

5. Estimate the kinetic energy needed to *completely overturn* the *stably-stratified* ocean (by winds and tides according to Chris' lecture). If this overturning occurs on a time scale of 10^3 yr, estimate the power in units of $\mathrm{W\,m^{-2}}$ needed. How does this compare with mean solar input?

6. Estimate the *difference* in mean salinity between surface layers in the Atlantic and Pacific Oceans assuming that the net transport of water in the easterly trade winds across Central America is the primary mechanism for this difference.