SIO 210 Problem Set 2
October 15, 2010
Due Oct. 25, 2010 (Monday)
Also due on Oct. 25: your paper topic and list of possible pair of papers – classic and modern. (You can change the pair later if you find something even better on the topic, or in consultation with me.)

1. Force balance and acceleration
Consider a very simplified current that is like the Gulf Stream. Assume that it is 100 km wide (west to east). Assume that that sea surface is 1 meter higher on the east side than on the west side. Assume the following: no rotation, no advection and no viscosity.

a) What force balance do you use to calculate the pressure at depths of 100m, 1000m, 4000 m, etc. underneath the Gulf Stream? __(simple answer – name it and write down the equation)___

b) Calculate the pressure on the west side and on the east side of the Gulf Stream, at a depth of 4000 m. Assume that g = 9.8 m/sec^2. Assume that the ocean density is constant, 1025 kg/m^3. (Ignore compressibility for this problem.)

c) What force balance do you use to calculate the east-west acceleration that would be due to this pressure difference between the west and east sides of the Gulf Stream? (Assume that there is NO rotation.) __(simple answer – name it and write down the equation)___

d) Assuming no rotation, no advection, and no viscosity, what would the east-west velocity be due to this pressure difference after 1 year?

2. Heat content change and transports
(a) Water flows into a marginal sea at a rate of $1 \times 10^9$ kg/s (mass transport). The mean temperature of the inflow water is 20°C. The marginal sea is a square box with sides of 100 km and depth of 5 km (see accompanying figure). The average heat loss over the sea is 90 W/m^2. Assuming steady state, calculate the temperature of outflowing water.

(b) For facility with units, what is the volume transport? Assume a uniform density to make an approximate conversion to volume. What special unit do we use for this transport, and how many of them are flowing into the marginal sea?

c) Suppose that the inflow into the marginal sea is also carrying oxygen with a concentration of 200 µmol/kg. What is the oxygen transport in moles/sec into the marginal sea?
3. Observations and data analysis
Suppose you want to observe the characteristics of planetary waves* that have periods of 4 months, by measuring the surface height at a fixed location from an altimeter.

(a) What is a satellite altimeter?

(b) Suppose the surface height excursion for a planetary wave is +5 cm. Is an altimeter a sensible instrument to use to measure this? Would it be a sensible choice for a permanent current with a 5 cm sea surface height difference across the current? Explain.

(c) What is the minimum time interval between observations at that location that you need in order to resolve this 2-month period? (What is the frequency associated with this time interval called?)

(d) What is the minimum length of the total record of altimetry that you need to measure this 2-month period? (What is the frequency associated with this time interval called?)

(e) If you want to have reasonably good certainty in your characterization of the 2-month wave, what length of data record would be useful? (Answer this in general by relating it to a concept/phrase defined in class; you don’t need for this class to be quantitative.)

(f) Satellite altimeters make measurements of a given location approximately once every 7 days. Give an example of an oceanographic phenomenon that deflects the sea surface that would be aliased by this sampling interval.

*(We have not described these waves yet; just for your information and not necessary for this question, particles in them mainly move horizontally with a small vertical excursion of the surface height as well, their wavelengths tend to be hundreds of kilometers, and they tend to propagate westward.)*

4. Water mass structures
Each subtropical ocean has a Central Water.

(a) In what part of the ocean’s “4-layer” structure does Central Water appear? _(short answer)_

(b) The Central Water includes the main thermocline and sometimes also thermostads. What is a thermostad?

(c) What are two radically different formation mechanisms for the thermocline?

(d) How do thermostads arise within the Central Water? (Where do they come from?)

(e) What generic water mass name do we often associate with permanent thermostads?