NAME:

December 10, 2009

EAS-4300 Oceanography FINAL Exam

There are 6 questions and you have up to 2 hours and 40 minutes.

The questions may have more than one answer so it is important that you explain when asked to do so. However try to be brief and succinct.

If you have questions during the exam, ask TA.

a) **Figure 1**. Label which image depicts the anomaly associated with El Niño and Nomral conditions. In the normal condition panel label the Walker Cell. Explain how you determined that (e.g. what is the role of the trade winds and Walker circulation). Label for each coast (blue boxes) if it is downwelling or upwelling.

b) In the same figure draw the sea surface heigth anomalies (SSHa) for each basin in panels (a) and (b). Label the regions where the you expect the thermocline depth anomalies to be deeper in both panels (a) and (b) for both the Indian and Pacific Ocean. Explain how these anomalies are related to the atmosheric circulation.

c) At each round circle numbered 1-5 indicate if you expect the atmosperic pressure to be higher or lower than the sorrounding pressure at that altitude. Explain how you determined your answer.

a) Briefly explain (in the space below) the phyiscal basis for global warming.

b) What is the paleoclimate evidence (discussed in class) that higher values of carbon dioxide in the atmosphere are associated with higher global temperature in past climates?

c) If we were to stop emitting greenhouse gases today would the rate of change of temperature in future decade be postive, negative or zero? Explain your answer.

d) What is the evidence that recent increases in global average temperature are connected to humans activities?

a) **Figure 2** is a schematic of the major biological transformations of nitrogen in the ocean. Label three very important reactions/transofrmations of nitrogen at the location of the questionmark. In the space below also write down the chemical composition of the following:

nitrate: _____ nitrogen gas:_____ ammonia:_____ nitrite:_____

b) Which of the transformations/reactions of nitrogen that you labeled in the previous question rapresent a lost of nitrogen for the ocean and which one a source? According to current estimates discussed in class, is the ocean nitrogen budget in balance or is one of these reactions gaining or loosing nitrogen at a higher rate? Where do the major losses of ocean nitrogen occur in the ocean (e.g. in the upper ocean, open ocean, sediments, etc.).

c) Phytoplankton gains its energy by using sunlight and CO2. What is this process called (give an equation)? Certain other macronutrients and micronutrients are necessary for phytoplankton growth. Which are those and what are there sources?

d) What is the ocean biological pump? If there where no bacteria in the ocean, do you expect to find a more efficient sink of atmsospheric carbon dioxide through the ocean biological pump? Explain.

Figure 3 shows a map of global amphidromic systems associated with the lunar tide.

a) Label one amhidromic point. Clearly label one cotidal lines.

b) What is a Corange Line in tidal charts? Draw one corange line for the amphidromic system in the North Atlantic.

c) Do wave crest travel faster at Pt. 1 or Pt. 2 in Figure 2? Explain.

d) Where are the tidal elevations expected to be higher at Pt. 1 or Pt. 2? Explain why.

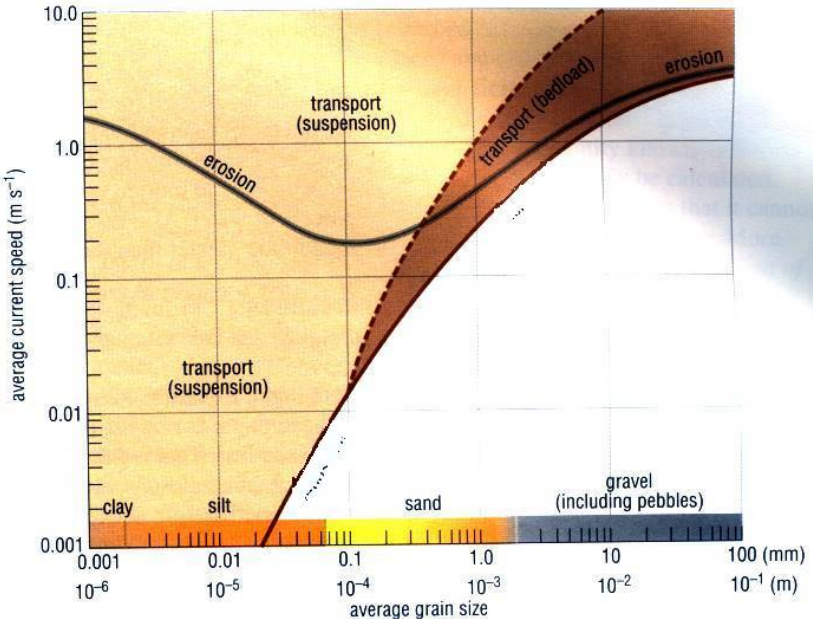
f) Draw the direction of propagation of the tide at Pt. 2? How can you tell from the chart.

g) How many high tides do you expect in 1 day? If the sun did not exert any graviational pull on the earth, how many tides would you exect x day?

e) We have learned about the differences between the equilibrium and the dynamical model of tides. If the planet was not rotating and there where no continents, would you expect these two models to give the same answer. Explain.

f) Say you have a sailboat in a marina and you want to sink it to gain money from your insurance company. Here is your chance to use the power of tides to do so! Suddenly you are called as an engineer to decide if you want to do some dredging or replenishment of sand at the bottom of the marina. How could this help you make the wave condition very hostile in the marina? (hint: the waves in the marina travel at the speed of shallow waves $c = \sqrt{gd}$).

a) On the graph below, label the behavior of the sediment grains in each of the three boxes.
b) What are the two factors that explain the type of transport a sediment undergoes?



c) Explain the shape of the erosion line in the figure below (Why isn't it linear?)

d) Why isn't bedload transport evident in smaller grain sizes?

Figure 4. As a coastal engineer, you have been hired to prepare a plan for the area shown on the coastal chart. The main goals are to protect the town on Mitchell Point and the harbor facilities in Herman Bay. The land area consists of easily eroded sediment, mainly sand and silt. A study of wave and wind records for the past ten years indicates that from October through May the wind and waves are primarily from the southwest. From June through September they are from the Southeast.

e) Draw in red the longshore currents during the summer. Draw in blue (or dashed line) the longshore currents during winter. Remember to allow the refraction around headlands.

f) In figure 4, locate where you expect the formation of rip currents with the label RP and a circle. Do rip currents occupy the same location year round or do they change location with season? Explain.

The **Figure 5** shows a map of sea level pressure anomalies.

a) Draw the directions of the winds associated with the centers of high and low pressure in the Pacific and over the North American and Asian continent.

b)Draw the direction of the surface winds at the equator (inside the box where it says “Equatorial latitudes”) for both the Indian and Pacific Ocean. Keep in mind that Coriolis effect is zero at the equator in the box.

c) **Figure 6** shows to maps of sea surface temperature anomalies. Which of these two maps is associated with the sea level pressure pattern of Figure 5? Explain your answer.

d) **Figure 7** shows a map of mean ocean temperatures at 150m depth. This is a good proxy also for pressure the pressure field at 150m and hence of the geostrophic circulation. With this in mind, label approximately the centers of the subtropical gyres. Are these region of upwelling or downwelling?

e) Label 4 regions where you expect the strongest currents based on the map in Figure 7. Tell me to what large-scale circulation system these currents belong to.

f) What is the differnece between Ekman and Geostrophic Currents? If tomorrow there was suddenly no friction between the ocean and atmosphere, which of these currents would disappear? Explain.

g) Are ocean upwelling regions characterized by surface convergence or divergence of water masses?