NAME:

December 10, 2008

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.

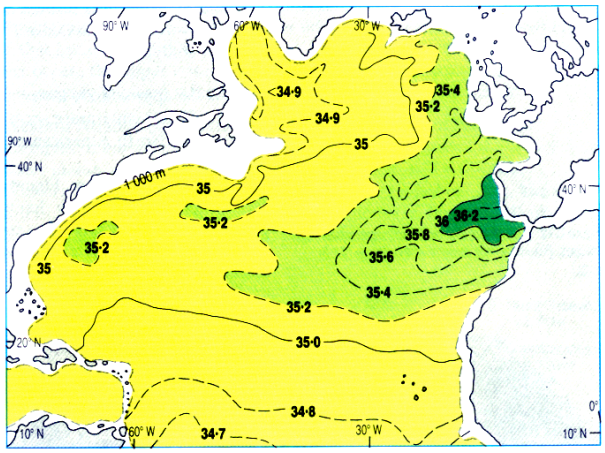
a) **Figure 1.** Label which image depicts the anomaly associated with El Niño and La Niña conditions and explain how you determined that (e.g. what is the role of the trade winds and Walker circulation). Label for each coast if it is downwelling or upwelling.

b) In the figure above draw the sea surface heigth anomalies (SSHa) and thermocline anomalies in the figure below panels (a) and (b) for both the Indian and Pacific Ocean. Explain how these anomalies are related to the atmosheric circulation.

c) What is the euqtorial undercurrent , where does it flow and what drives it? How does El Niño affect the equatorial current and why?

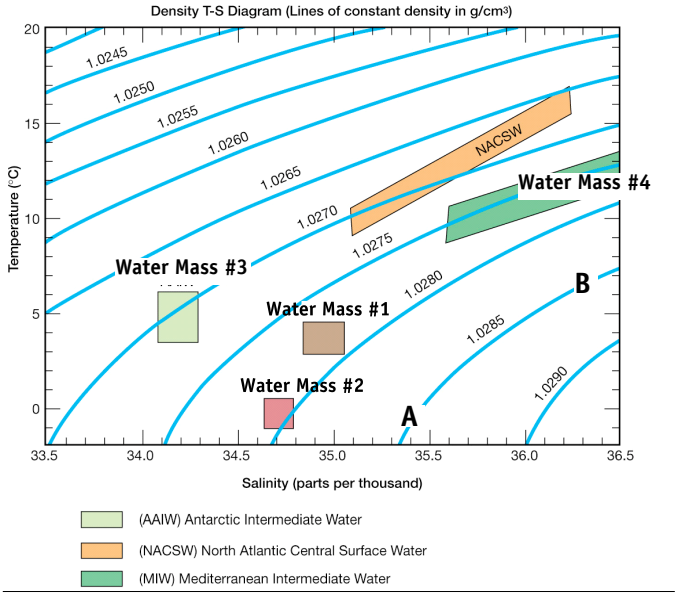
a) Below is a map of salinity at 1000 m depth. Can you explain why there is a higher salinity in the green area? Also label the spatial location where you may find deep water formation (based on your knowledge of North Atlantic circulation).

Map of North Atlantic Salinity at 1000 m depth



b) Can you explain how the higher salinity water mass is important in the formation of deep waters in the North Atlantic? How is the formation of the North Atlantic Deep Water (NADW) different from Antarctic Bottom Water (AABW)? (Hint: remember the Polynyas?)

c) In the diagram below which water masses are more dense between? Which one corresponds to NADW, AABW, AAIW and the MIW? How did you determine that? Is density a linear function of Temperature and Salinity in the diagram below (explain)? If you were to mix water from point A and B, is the density of the resulting water mass denser, lighter or the same as A and B? Explain.



a) The **Figure 2** gives a simple overview of the nitrogen cycle. Fill in the different nitrogen components and name the transformation processes

b) Two nitrogen-transforming processes act contrary to each other. What are the preconditions for them to occur? Where do they occur?

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) Chlorophyll concentrations are an indicator for the productivity of the ocean. Is high Chl-a value always indicative of oceanic regions where carbon dioxide is stored into the ocean for a long time? What determines if an oceanic region is a net sink of atmospheric carbon dioxide?

e) What is the role of bacteria in 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.

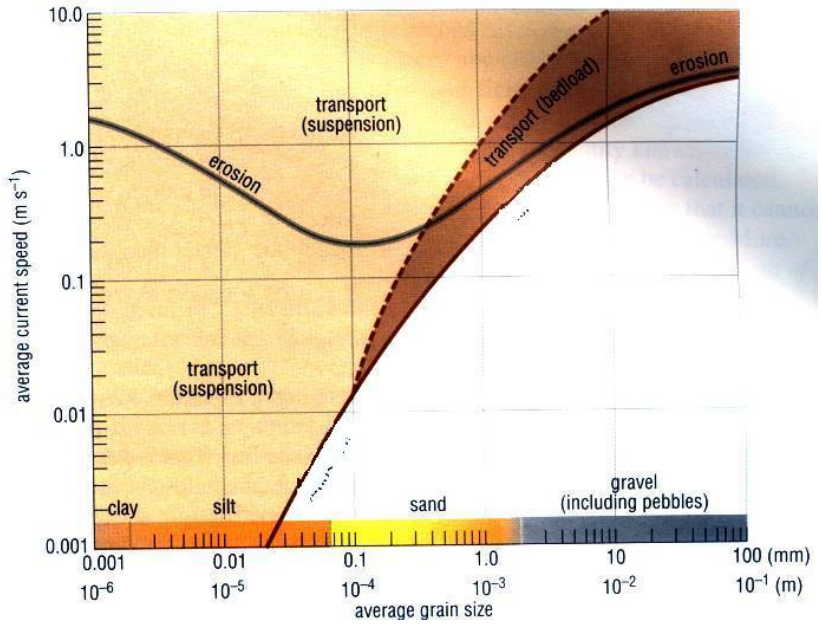
f) Draw the direction of propagation of the tide at Pt. 2? How can you tell from the chart.

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 on the next page shows a map of precipitation and water vapor.

a) Label the Trade winds and Westerlies.

b) Label the ascend and descent locations of the Hadley Cell and Polar Cell (AH = Ascending Hadley, DH = Descending Hadley, AP=Ascending Polar, DP=Descending Polar). Also indicate if these location correspond to low surface pressure of high surface pressure.

c) Where are the winds expected to be stronger and why?

d) Where do you expect convection to be the strongest in the figure (next page)? Explain. Would this be a region of low level convergence or divergence?

e) Isolate a mid-latitude cyclone with a label MLC and it correspondent cold front.

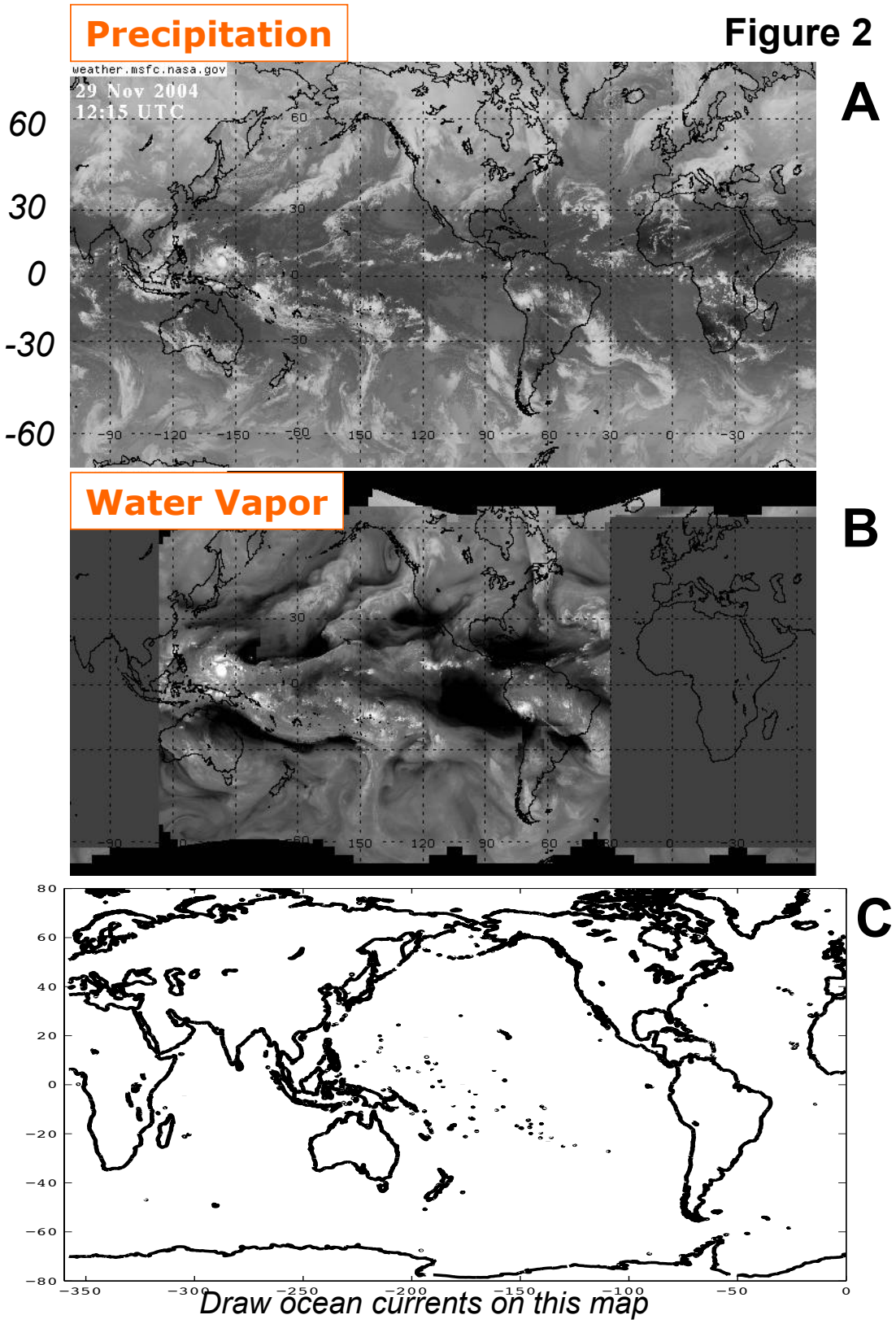
f) Identify the location of a tropical cyclone with the red pen and the label TLC. What are the conditions needed for formation of a tropical cyclone?

c) Why do most mid-latitude areas only rarely experience a hurricane?

d) Why are there no hurricanes at the Equator?

e) Draw the ocean circulation on panel C of figure 2 for the Pacific, Atlantic and Southern ocean. Make sure to include the gyres, the currents at the equator and label the major upwelling systems with UPW and a circle.

Figure 2


Precipitation
weather.msfc.nasa.gov
29 Nov 2004
12:15 UTC
A
Water Vapor
B
C
Draw ocean currents on this map