

**NAME:**

October 8, 2009

**EAS-4300 Oceanography MIDTERM Exam**

**There are 3 questions and you have up to 55 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 the TA Andrew.**

**You have about 15 minutes for each question.**

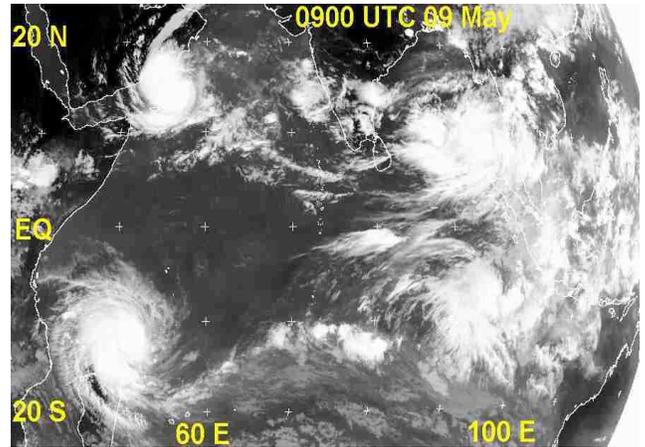
Question # 1

ATMOSPHERIC CIRCULATION

A) On the right is a map of water vapor over the Indian Ocean. Identify the cyclones with a letter C and anticyclones with letter A. For each cyclone/anticyclone draw an arrow indicating the direction of the pressure force from low pressure to high pressure.

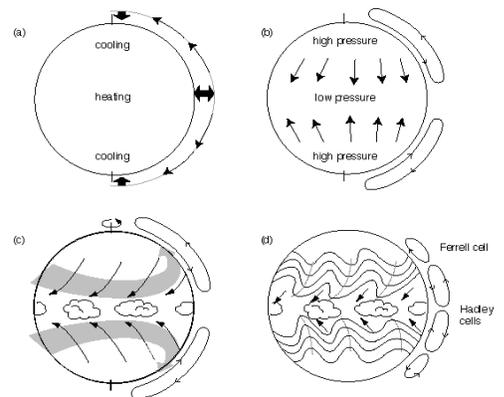
Why are the storms evident in this water vapor map?

Would this map be different if there were no surface friction? (Explain)



B) Explain briefly the Greenhouse effect and list the major gases that contribute to it? If during global warming the sea surface temperature became cooler because of deeper vertical mixing in the ocean, how would that affect the greenhouse effect? (would it become stronger or weaker - why?).

C) Briefly describe the four conceptual steps needed to explain the mean circulation of the atmosphere as we discussed in class (see diagram on the right for help a,b,c,d). Careful: not all steps include rotation. As you list the 4 steps indicate when and how the trade winds and westerly winds are established. (Write on the back of the page if needed).



A) Figure 1 Panel A shows a diagram with two axes, the timing and the amplitude of sea level changes. List at least 4 processes that contribute to sea level corresponding to the black markers (label the diagram). Indicate also if these changes are Eustatic. For each process give a brief description.

B) Figure 1 Panel B shows how sea level has changed in the geologic past. Can you explain what process caused the peak at location Time X. Please explain why sea level went up and then why it went down.

C) What is Post Glacial Rebound (PGR)? How are changes in sea level associated with PGR different from those associated with 'steric' effects? Will global warming affect these two types of sea level change? If yes, how and with what speed?

D) What is the range of projections for global sea level rise by 2100AD, according to the IPCC? Explain why the IPCC may drastically under-estimate 21st century sea level rise?

*Surface circulation*

Figure 2, shows a map of sea surface temperature anomalies during El Niño.

A) Assume that instead of temperature this map was showing contours of pressure in the ocean surface. Sketch the direction of geostrophic currents in the Pacific Ocean at the locations of the black dots.

B) Figure 3 shows a map of an open ocean basin that covers both Northern and Southern Hemisphere, including the Equator (red line in the middle). The red arrows indicate the direction of the wind stresses at the ocean surface. The black filled rectangles are islands. (NOTE: this is an hypothetical basin with hypothetical winds).

C) In correspondence of each red arrow draw the direction of the corresponding upper ocean current (=mass transport in the first 0-100 meters).

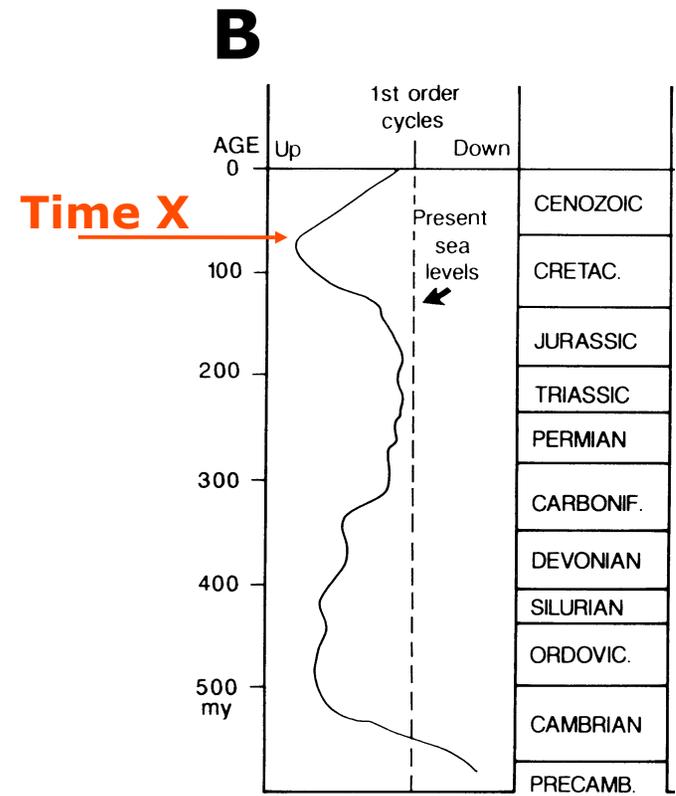
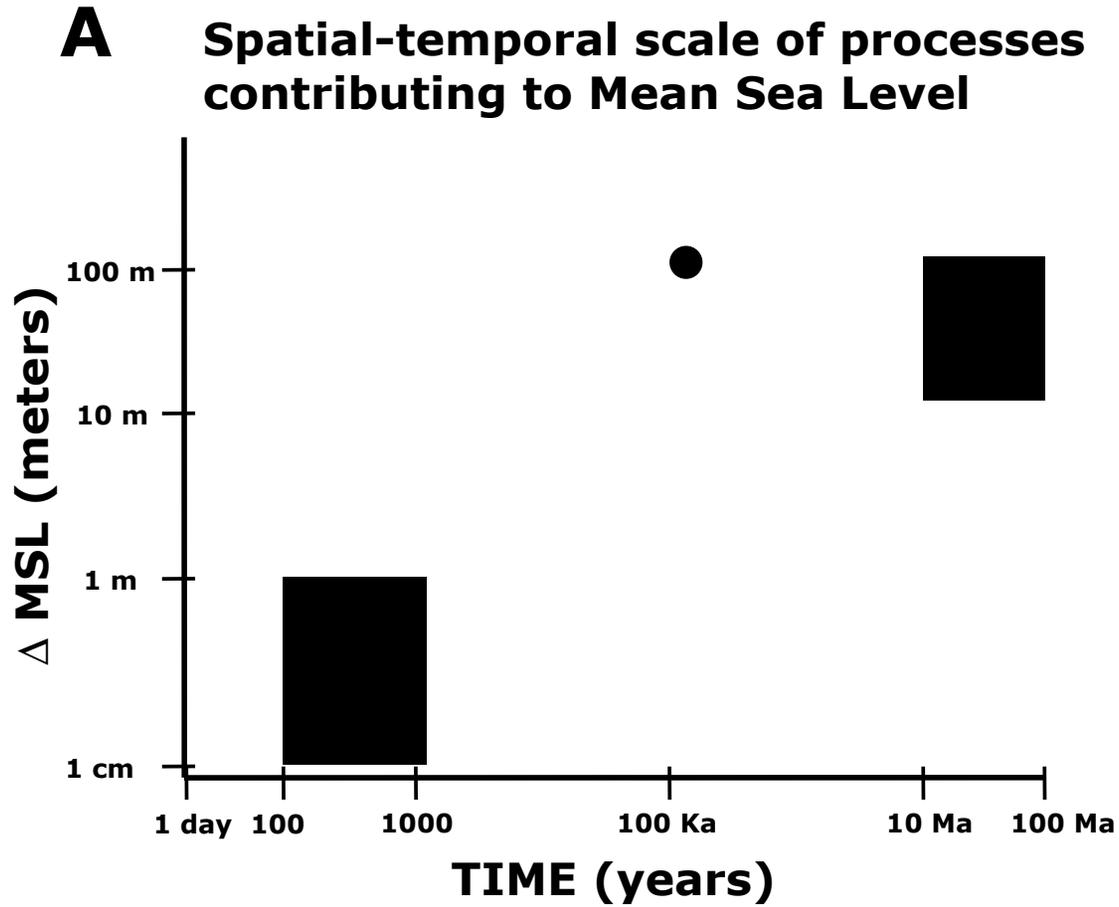
D) For each green dot on the map indicate if it is upwelling with a letter U and if it is downwelling with a letter D.

E) For each green dot draw an arrow indicating the direction of the surface currents.

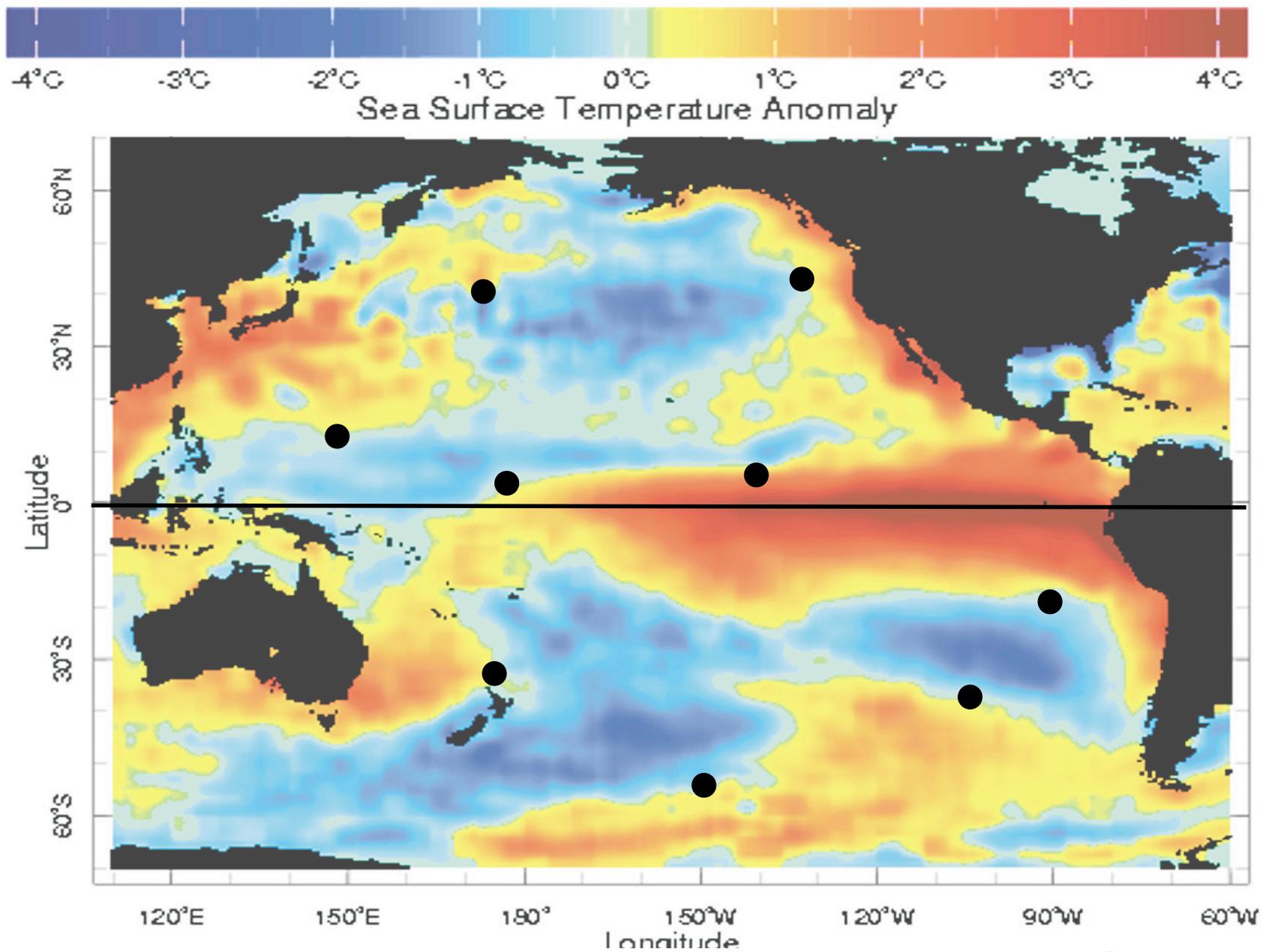
*Thermohaline circulation*

F) Explain the steps important in the formation of North Atlantic Deep water and of Antarctic Deep water and point out there differences.

G) If the strait of Gibraltar was closed, how would it affect the heat transport of the Atlantic ocean? Would air temperature in greenland become colder or warmer? Explain.



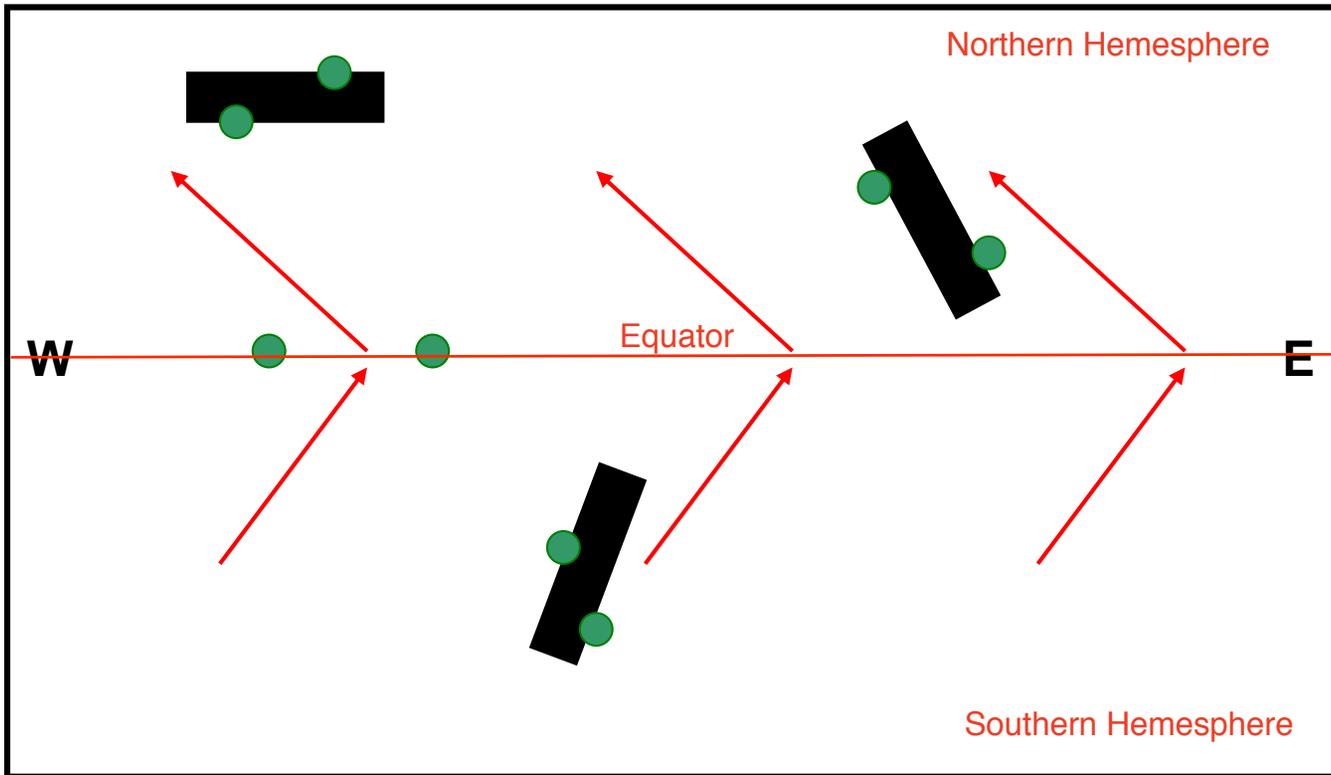
**Figure 1**



**Figure 2**

→  
**Red arrows on map are  
Surface Wind Stresses**

Open Ocean Basin



**Black rectangles are islands**

**Figure 3**