ESYS 10: Introduction to Environmental Systems
Winter 2008
Midterm Review Questions

ESYS10 Students:
Here is a list of "representative" sample questions for the midterm on Thursday.

The 4 areas of emphasis will be on
a.) the concepts of a system
b.) the bulk characteristics of Earth and cycling of materials
c.) the best example of the workings of the Earth system: namely the carbon cycle
d.) the climate system

You will notice all of these areas in these representative questions. Some questions are much harder than others, so don't worry if the answers are not completely obvious to you immediately. Most of these questions derive from the lectures, but you will be able to find the answers in the reading as well (if you read carefully enough!).

Many of these questions are taken from previous years' exams, so they are very representative of the style of question that you will see this year. In fact, I promise to use at least one (and perhaps more) of the following questions on this year's exam.

A formatted version will appear on the website.

REPRESENTATIVE MIDTERM EXAM QUESTIONS

Next to each numbered feature/process, write the letter that best indicates the order-of-magnitude of the relevant timescale (the same letter can be used more than once).

1. Transit time of water around an ocean gyre	a. billion yrs
2. Total mixing time of the atmosphere	b. 100 million yrs
3. Age of the Atlantic Ocean	c. 10 million yrs
4. Building time of the Himalayas	d. 100,000 yrs
5. Buildup of significant oxygen in the atmosphere	e. 10,000 yrs
6. Total mixing time of the ocean	f. 1000 yr
7. Age of the earth	g. 100 yr
8. Usefulness of radiocarbon dating	h. 10 yr
	i. 1 yr

Next to each numbered feature, indicate the order- of- magnitude length scale that best describes it (the same answer can be used more than once).

1. Average height of the troposphere (from Earth's surface)	a. 10,000 km
2. Penetration of light into the ocean	b. 1000 km

3. Width of new Atlantic crust added in 1 year	c. 100 km
4. Typical vertical scale of coastal upwelling	d. 10 km
5. Horizontal extent of the intertropical convergence zone	e. kilometer (km)
6. Average thickness of the ocean's warm surface layer	f. meter
7. Sea level change for Virginia over the 20th century	g. centimeter
8. Average depth of the ocean	h. micrometer

The vertical mixing time of the oceans is significantly longer than that of the atmosphere. Think about why this is the case by indicating whether the following statements are true or false (circle the appropriate choice)

For both the atmosphere and the ocean, density decreases with height. (True or False)
The atmosphere (in the troposphere) is typically heated from top down. (True or False)
The ocean is being heated from bottom up. (True or False)
For any given mass, air and water both become less dense when warmed (True or False)

Water and air are deflected to the right in the northern hemisphere by the Coriolis effect. Suppose that the earth rotated in the opposite direction. Would water and air be deflected to the left in the northern hemisphere? Explain your answer (in a sentence or two).

What is the Intertropical Convergence Zone and how does it influence the salinity of the oceans?

What are the months of heavy monsoon rainfall over India and the rest of South Asia (Pakistan, Bangladesh, etc.)? What happens in the atmosphere to produce this intense rainy season?

What prevents the large polar ice caps from simply flowing out into the ocean and melting?

Explain the origin of magnetic "stripes" on the seafloor

Identify two differences between marine crust and continental crust, in either their physical or their chemical characteristics.

List the two main ways that continental rocks break down. Outline (in a sentence or two) the specific reason that the breakdown of continental rocks is related to the carbon dioxide content of the atmosphere.

Most earth scientists believe that the chemical breakdown of continental rocks ("weathering) is the primary negative feedback on Earth that keeps the climate from ever becoming too warm or too cold. Construct a systems diagram (with the components being atmospheric carbon dioxide, surface temperature, "weathering" and volcanic outgassing) that illustrates this concept of negative feedback. If you prefer, you may outline a chain of logic to explain the concept, instead of drawing a diagram.

How do we know anything about the carbon dioxide content of the atmosphere before 1958 AD (the year that flask measurements were first made on Mauna Loa, Hawaii)?

Why is there a seasonal cycle in the carbon dioxide concentration of the atmosphere? What is the typical magnitude (in parts per million) of this cycle?

Should there be a seasonal cycle in atmospheric oxygen concentration in the atmosphere corresponding to that of carbon dioxide? Explain.

What do oceanographers mean when they refer to the "conveyor belt" circulation of the ocean? What specific role does this circulation play in the uptake of fossil fuel-derived carbon dioxide?

The growth of an El Niño warm event represents a classic case of feedback in the ocean/atmosphere system.
Here's what happens: the trade winds that normally blow from east to west begin to weaken; the weaker winds then reduce the tendency for upwelling of cold water along the equator, and, as a result, the surface water warms in the eastern Pacific. The atmosphere responds to the warmer water, and the east to west trade winds weaken further still. Construct a systems diagram (with the components being trade wind strength, upwelling intensity, and ocean surface temperature) to illustrate this feedback loop. Indicate clearly the positive and negative interactions. Is this total feedback loop positive or negative? (use the other side of the page).

What is the current albedo (in %) of the Earth, and what aspect of the climate system is primarily responsible for this reflectivity?

How much has the strength of the sun varied over the course of the last 300 years. How do we know?

What are the three features of the climate system that can cause global temperature change?

The IPCC report predicts, by 2100, greater-than average warming of the earth in the high latitudes (polar regions). Explain the basis for this prediction.

Sketch the shape of the relationship between water holding capacity of the atmosphere and the temperature of air. Identify one way in which the predictions of future drought depend on this shape.

Explain the basis for water vapor feedback (either positive or negative). How does it influence the predictions of global temperature increase?

Explain briefly (two sentences or fewer) why the behavior of clouds might represent the biggest source of uncertainty in predictions of global warming.

Why does an El Niño warm event increase surface temperatures globally?

Researchers are now able to conclude with certainty that the pattern of warming of the last 25 years is the result of greenhouse gas increases. Explain how this conclusion can be reached.

We know that the warming and cooling of the ice age cycles was not triggered by changes in greenhouse gases (even though the ice core air bubbles show that greenhouse gases did in fact vary). Why is this observation largely irrelevant for understanding future climate.

Why do researchers believe that the melting of the Greenland ice cap might be especially likely over the next few hundred years? By how much would sea level rise globally if Greenland were to melt entirely?

What is the principal greenhouse gas in the present atmosphere?

The surface temperature of Venus is about 400°C higher than for the earth. Why does Venus appear to be colder than the Earth, when viewed from outer space?

Identify two regions of the world that experience drought during an El Niño warm event. Explain what is happening in the atmosphere to produce this drought.

Researchers worry about the stability of the "conveyor belt" circulation of the ocean. Identify the primary difference that it would make to the climate system if this circulation slowed (because of global warming).