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Global Change, GEOS 4787/578
Fall 2006 FINAL EXAM

Please answer all questions, except in the essay section, in which we ask you to choose one of two. Be sure to read the questions carefully so that you know what is being asked. Please also try to follow the guidelines for answer length; it helps us to see what you know if you can answer the questions without too much extraneous information.

Good luck, and have a great holiday and coming semester! We enjoyed having you in class!

A. Very short answer: Please answer with just a number and units.

1. (2 points) How fast is sea level rising today (in the past 10-20 yrs)?

2. (2 points) By how much has Earth's temperature risen in the past 150 years?

3. We are in the midst of one of the major extinction events of earth history, which in the class presentation was divided into two stages: an initial phase that occurred in the Pleistocene, and a current phase, expected to continue into the future.
 - (a). (2 points) About how long ago did the initial phase take place?

 - (b). (2 points) Name two species that went extinct during the Pleistocene extinctions.

B. Short answer (4-5 points each) Please answer in no more than a few sentences.

1. (4 points) In model projections of future food supply, what is the single biggest difference among countries that emerges?

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2. (5 points) If we stopped burning fossil fuels today, sea level would continue to rise for centuries, even a millennium. Why?

3. (5 points) (a) Is the frequency of hurricanes in recent years changing? (b) Is hurricane intensity changing? (c) Where are changes most clearly supported by observations, and what are these changes? (i.e. in what variables or datasets)

4. (5 points) (a) What is oceanic iron fertilization? (b) Why and where (in what types of regions) does it work?

5. (5 points) What single pattern of change that is projected for future climate is expected to impact both water availability here in the Southwest and Southern Ocean carbon uptake?

6. (5 points) (a) Will the stratosphere warm or cool in the future? (b) How does this affect stratospheric ozone depletion?

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7. (5 points) You read in your local paper that in the future, climate will be warm enough that malaria-bearing mosquitoes will be able to live and breed for the first time near your home in Minneapolis. Should this be cause for major concern regarding malaria spread? Explain.

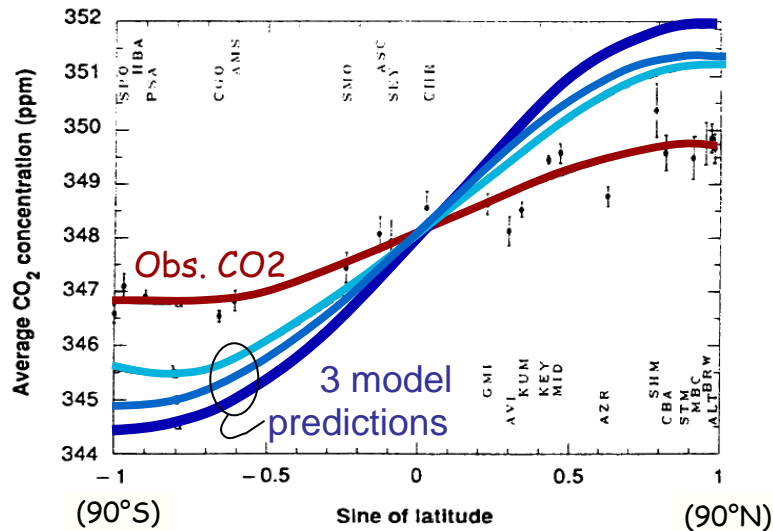
8. (5 points) (a) What effect does calcification have on CO₂ in the surface ocean? (b) How will calcification by marine organisms likely change in the future? (c) Why?

9. (5 points) How might greenhouse gases (on their own) be expected to change the strength of the Asian monsoon? (Your answer should reveal that you know the basic cause of the monsoon.)

10. (5 points) (a) Why might thermohaline circulation weaken in the future? What would be the main effects (b) on the ocean carbon sink and (c) on climate?

11. (5 points) This question refers to Figure 1 (next page), which highlights 2 features of spatial patterns of atmospheric CO₂: higher observed values in the northern hemisphere, and a discrepancy between observations and the pattern predicted if the land biosphere is assumed to be carbon-neutral (neither source nor sink).

Fig. 1. Meridional (from south on the left to north on the right) profiles in atmospheric CO₂ in the 1980s. Single line through points with error bars: average of observations. Set of 3 lines: modeled (accounting for fossil fuel emissions, and using 3 different scenarios of ocean uptake), assuming a carbon-neutral land biosphere.



Source: Tans, Takahashi, and Fung (1990)

- (a) (2 points) What is the reason for the overall pattern seen in both observations and models (i.e., why are average CO₂ values higher in the north)?
- (b) (3 points) What is the implication of the discrepancy between predictions (which account for only fossil fuel burning and ocean fluxes) and observation (which are the consequence of all processes influencing carbon)? Specifically, what does it say about two features of the carbon cycle that were discussed extensively in class: (i) about the northern hemisphere carbon cycle, and (ii) about the southern hemisphere carbon cycle?

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12. (4 points) Until recently, atmospheric methane concentrations were increasing at a rate of about 0.6% per year, reaching about 1700 parts-per-billion (ppb) in 1990.

(a) (2 points) What has happened to the rate of methane increase since then?

(b) (2 points) What are some of the reasons for why this might be?

13. (4 points) Biomass ethanol is widely discussed as near-term possible option for lessening reliance on fossil fuels. What is the distinction, in terms of (a) net energy balance (e.g., amount of net biomass energy available for end uses per area of land used), and (b) reduction in CO₂ emissions, between corn ethanol (the most widely produced form of ethanol in the U.S. today) and “cellulosic” ethanol (from grass and trees)?

14. (5 points) This question concerns “the dead zone” in the Gulf of Mexico, a phenomenon in which deep water or bottom dwelling organisms die off. Describe this phenomenon, specifically:

(a) (1 point) what is thought to be the main contributory cause?

(b) (1 point) what is its effect on phytoplankton and zooplankton,

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(c) (2 points) how does the effect on photoplankton and zooplankton cause “hypoxia” (a shortage of what compound in the water column?), and,

(d) (1 point) how does this effect lead to the die-off?

15. (5 points) In class we discussed several different ways that climate change is *already* affecting ecosystems and organismal communities. Name two of these effects, and cite one example that has been observed for each.

16. (5 points) One of the potential *future* effects of climate change is a reduction in biodiversity through extinction. (a) What is the name of the ecological rule has been used to estimate the extent of extinctions that may occur under climate change? (b) what is the mathematical form of this rule (either write down the equation or sketch the shape of the function)?, and (c) what fraction of species does this rule suggest may be committed to extinction by 2050, based on the Thomas et al (2004) reading discussed in class?

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Essay. (15 points) Please choose one of these two questions to answer. Your answer should be in reasonably well organized and well written paragraphs.

1. The ocean is currently a major sink for anthropogenic CO₂. Describe in detail how this is expected to change in the future. Your discussion should include the general types of processes that are important for evaluating the future of the ocean carbon sink and specific examples of each. What is the largest uncertainty in projecting the future strength of the ocean carbon sink?

2. The Pleistocene extinctions wiped out large numbers of mammalian species everywhere in the world but Africa. Write a concise, two-part essay, along the following lines. Part I: Discuss (a) the two main hypotheses for what caused these extinctions, and (b) two body characteristics of many of the species that went extinct, and how these characteristics tend to suggest a role for at least one of these hypotheses. Part II: discuss how these extinctions are relevant to (c) current discussions about restoration ecology and conservation, and (d) understanding the combined potential effect of climate change and human activities on future extinctions?

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