ESYS10 Mid-term examination

Tuesday, February 10, 2004

1:00 - 3:20 PM

No notes, no books.

I. Fill in the blank (10 points each)

1. The very long records of carbon dioxide in the atmosphere are measured from _____ collected in Antarctica.

2. The two most abundant greenhouse gases are _____ and _____.

3. The maximum size of a population in which birth and death are in equilibrium (balanced) is called the population's _____.

4. The atmospheric circulation in which air rises near the equator and sinks at about 30°S and 30°N is called the _____.

5. The fraction of incoming energy that is reflected (from the earth or another planet) is called the _____.

II. Short answer (20 points each)

1. Plants convert CO_2 into oxygen through photosynthesis. The rate of photosynthesis increases with the amount of CO_2 in the atmosphere and also with the global temperature. The global temperature depends on the amount of CO_2 through the greenhouse effect.

a. Draw a systems diagram with the three components: plant numbers, atmospheric CO_2, and temperature. Make sure to include arrows or circles on the lines connecting the components.

b. Are the feedback loops positive or negative?

c. Describe the response of the system to an increase in atmospheric CO_2.

2. Use sketches to describe the processes that drive the seabreeze. When does a seabreeze usually occur?

3. The Planck function gives the radiation flux as a function of the wavelength of electromagnetic waves emitted by a black body.

a. Describe (in very general terms) how the wavelength at the peak (highest point) of the Planck function depends on the temperature of the black body.

b. Describe how the total amount of energy emitted by the black body depends on the temperature of the black body (the Stefan-Boltzman Law) . (This total amount of energy is equal to the area under the Planck function curve.)

b. Draw a schematic Planck function for the sun. On the same graph, draw a Planck function for Earth. Make sure that the function for Earth is in the proper general relation to the function for the sun.

Some random and possibly useful expressions.

$A = \pi r^2$

$A = 4\pi r^2$

$\text{Volume} = \frac{4}{3}\pi r^3$

$\lambda\nu = c$

$E = h\nu$

$T(K) = T(C) + 273.15$

$F = \sigma T^4$

III. Essay (30 points). On November 12, 2003, Senator Dianne Feinstein "*delivered a speech on the Senate floor in opposition to a measure which would prohibit states from setting their own emissions standards for small engines*." She includes the following associated text on her website.

Washington Report from U.S. Senator Dianne Feinstein
(http://www.senate.gov/~feinstein/03november-newsletter.htm)
November 19, 2003

Small Engines

".... the Senate is considering a second provision which would prohibit California and other states from imposing air quality standards on emissions from lawn and garden equipment.

In fact, a midwestern lawn-mower manufacturer has used its influence to insert a provision deep within a Senate spending bill which would prohibit California and other States from placing ground-breaking pollution standards on off-road engines of 50 horsepower or less.

This may seem like a minor issue, but with 130 million portable generators, lawn mowers, backhoes, forklifts, boat engines, and other small engines in existence in America today, the impact of this provision could be devastating

These small engines produce more than 100 tons of smog-producing chemicals per day - just in California. This is equal to the emissions from 4 million cars.

The target of this provision is clearly California, which has the toughest air quality standards in the nation. California currently has in place standards that have significantly reduced emissions from small engines over the past decade - by 70 percent. And the State has proposed landmark regulation to cut pollution from these engines in half.

But if Congress approves the prohibition on limiting emissions, California may not be able to meet federal air quality guidelines, putting in jeopardy $2.5 billion in new transportation projects statewide.

The measure, however, would not just affect California. It would be binding on other states as well. If Texas or Maine, for instance, wanted to adopt California's standards, they would not be able to.

The measure was included in the VA/HUD Appropriations bill by Senator Christopher "Kit" Bond (R-MO) on behalf of Briggs and Stratton, a company that has operations in Missouri, which is pursuing their narrow interests at the cost of clean air across the country.

This is a simple issue in our view. California should be allowed to take the lead in setting tough air pollution standards. And if other States want to follow California's model, then they should be allowed to do that as well....."

Write an essay commenting on Senator Feinstein's report. Consider the following issues: Why have Californians historically been concerned about emissions? Why must Californians be concerned about emissions today? Why is Senator Feinstein so concerned about federal limits on regulation at the state level? Which emissions are especially of interest for air quality? Which emissions are of importance for global warming? Why is this problem worse for California than for other states?

How might the midwestern manufacturer be impacted by California's proposed regulations? How might users of small engines be impacted by California's proposed regulations?