Terms and Concepts ATMS 211 March 2011

A. First half of course

1. weather vs. climate
2. temperature vs. temperature anomaly
3. surface temperature record: magnitude of changes over last century
4. seasonal cycle, diurnal cycle
5. anomaly, interannual variation, trend
6. Gaia hypothesis
7. Daisyworld
8. Feedback loops – negative, positive
9. energy, conversion of energy, conservation of energy
10. calories, Joules, Watts
11. temperature scales: Kelvin, Celsius, Fahrenheit
12. radiation energy spectrum: shortwave (UV, visible, near-IR), longwave (thermal IR)
13. the Sun: solar luminosity, solar constant, sunspot cycle
14. Inverse square law (radiation and distance from Sun)
15. emission of radiation: hotter objects emit at shorter wavelengths
16. Stefan-Boltzmann law: emission is proportional to the fourth power of temperature
17. albedo (surface albedo, cloud albedo, planetary albedo)
18. planetary radiation balance
19. effective temperature
20. effective radiating level
21. atmospheric molecules: O_2, N_2, H_2O, CO_2, O_3; their abundances, their vertical distributions, their absorption properties for shortwave and longwave radiation

21a. Mars-Venus-Earth comparison

22. troposphere vs. stratosphere
23. greenhouse effect: requires longwave absorptance greater than shortwave absorptance; results in surface temperature warmer than effective temperature.
24. radiative forcing
25. climate sensitivity = temperature response / radiative forcing
26. why high clouds warm the earth and low clouds cool the earth
27. why clouds cause cooling in the day and warming at night
28. geometry of Earth-Sun relation: eccentricity, tilt, declination, solstice, equinox, aphelion, perihelion

29. solar zenith angle
30. radiation received on a surface: the cosine law
31. atmospheric circulation driven by pressure differences, which are in turn driven by temperature differences
32. Hadley Cells, ITCZ, locations of deserts, timing of wet and dry seasons

B. Second half of the course

The following topics were not covered on the midterm exam and will therefore be stressed more heavily on the final exam.

33. water: molecular structure, hydrogen bonds, latent heat, density, vapor pressure
34. cycle concepts: reservoirs, flux, residence time
35. residence time = volume/flux or mass/flux (in general, "burden"/flux)
36. hydrological cycle (water cycle): evaporation = precipitation (what goes up must come down)
37. thermal inertia
38. the seasons: temperature lags behind the sun by how many days?
39. thermal structure of the oceans (mixed layer vs. deep ocean)
40. Carbon cycle
41. Natural regulation of CO_2
42. Chemical reactions of photosynthesis and respiration
43. CO_2 variations and their causes: annual cycle, anthropogenic increase, ice age cycle, plate tectonics
44. Venus (runaway greenhouse) and Mars (frozen)
45. Burning rate of fossil fuels: 1 ton carbon per person per year (5-6 tons per person per year in U.S.)
46. Fate of current CO_2 emissions: 2.5 gigatons per year to ocean, 2.5 to land plants, 3 to atmosphere
47. CO_2 removal processes in the distant future
48. cryosphere
49. Ice ages: 20,000 years ago the North American Ice Sheet was as large as the Antarctic Ice Sheet today
50. variation of sea level during ice ages
51. glacial cycles
52. Pleistocene, Holocene
53. isotopes of O and H

54. oxygen isotopes in ocean tell ice volume
55. oxygen isotopes in ice cores tell air temperature
56. Milankovitch theory: orbital configuration leading to cool NH summers favors NH glaciation
57. ice age positive feedbacks: snow albedo, water vapor, CO_2
58. bedrock depression and rebound
59. rapid climate change: Ice-age climate fluctuations, ocean "conveyor"
60. Snowball Earth: Feedback mechanisms, escape from snowball Earth
61. sea-glaciers
62. Walker Circulation
63. El Niño and the Southern Oscillation (ENSO): El Nino (warm phase), La Nina (cool phase)
64. Factors affecting CO_2 emissions
65. Fossil fuels: reserves, resources, additional occurrences, potential contribution to atmospheric CO2.
66. Major uses for coal, oil, natural gas
67. Evidence for global warming: temperatures, glaciers, sea ice, . . .
68. Pacific Northwest climate impacts with global warming
69. Ozone: tropospheric ozone, stratospheric ozone, ozone as a pollutant, protective role of ozone against UV light.

Sample questions for final exam:

1. Why would there be no significant rise in sea level if sea ice were to melt?

2. Earth's tilt, eccentricity, and time of perihelion vary on time scales of 10^5-10^6 years. What causes this variation?

3. The mass of carbon in the land biosphere is estimated to be about 2200 gigatons of carbon. The global total rate of production of biomass by photosynthesis is estimated to be about 60 gigatons C per year. What is the average residence time of carbon in the land biosphere?

4. You bring a pot of water to boil on the stove, then boil all the water away. Which takes longer, bringing the water to a boil, or boiling the water away? Why?

5. Describe the seasonal cycle of CO2.

6. Describe the radiative forcing caused by aerosols.

7. Which resource is expected to be used up first, coal or oil? Which is preferable as an energy source from the point of view of its CO_2 emissions? Why?

8. Describe El Nino using the words temperature, sea level, precipitation, South America, and Indonesia.

9. Which has the highest energy output per CO_2 emitted: natural gas, coal, oil, or wood?

10. During an El Nino the Walker circulation (weakens / strengthens).

11. For constant fluxes, a large reservoir interacts with climate (more slowly / more quickly) than a small one.