ATM 211 **Climate and Climate Change** **Fall, 2003**

Homework 4 assigned: Mon Nov 3 due: Wed Nov 12

Readings for Earth circulations and regional climates:
Atmospheric circulations: KKC Chap 4(all)
Ocean KKC Chap 5(p79-top82, p85 (last paragraph), p88-95, Key Figs 5-2, 5-3, 5-8, 5-14, 5-16)
Solid Earth: Chap 6(p97-98:Intro/Overview, p116-117:Plate Tectonics driven by radioactive decay, p123-125:Wilson Cycles of continental drift; Key Figs 6-19, 6-21, 6-26, 6-27)

1. *Energy distribution:* (a) Explain why more solar energy is absorbed at low (i.e. tropical) latitudes than at high (i.e. polar) latitudes. [6 pts] (b) Explain why more longwave (infrared) energy is emitted at low latitudes than at high latitudes. [4 pts]

2. *Layout of planet earth:* (a) Give the approximate latitudes that define the Tropics, the Midlatitudes, and the Polar Regions. [6 pts] (b) In which region does the weather tend to be more consistent from one day to the next? [2 pts] (c) What latitude band is essentially lacking in land? [2 pts] (d) What latitude bands in each hemisphere (not counting the polar regions) tend to have deserts? [2 pts] (e) What global-scale circulation pattern accounts for this tendency? Give its name and a brief description. [8 pts]

3. *Ocean circulation:* (a) What does "friction" have to due with the circulation of surface water in the global oceans? [4 pts] (b) Surface currents in the ocean (see Fig 5-3) are driven by the mean wind. Give two reasons why the ocean currents do not move in exactly the same direction as the mean wind. [6 pts] (c) Surface ocean currents in the Northern Hemisphere Atlantic Ocean (between North America and Europe) form a clock-wise rotating gyre. The water just cycles around and around. Yet these currents serve to transport energy from low latitudes to high latitudes. Explain how. [6 pts]

4. *Liquid water:* (a) List the four reasons why the ocean surface changes temperature more slowly than the land surface. State which is the most important reason. [10 pts] (b) What two factors control the density of ocean water. For each factor, state which way it changes in order for water density to go up. [6 pts]

5. *Water in the atmosphere:* Examine Figure 4-22. (a) The total removal rate of water from the atmosphere (that is, the "sink") is given by the sum of precipitation over the land and over the oceans. What is this total sink? [2 pts] (b) Using the relation: residence time = burden/sink, calculate the average residence time of a water molecule in the atmosphere. Give your answer in days. [6 pts]

6. *Three global pumps:* Chapters 4-6 describe three global-scale pumps, namely, (i) general circulation of the atmosphere and surface ocean, (ii) thermohaline circulation of the deep ocean, and (iii) plate tectonic cycle of supercontinent assembly and destruction (the Wilson cycle). For each of these, state the ultimate source of energy and the approximate time-scale associated with the circulation. [12 pts]

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