

Name:

MSC 409 Final May 3, 2007

(10 pts each, 130 pts total)

1. Clear air scatters the visible blue wavelength (more, less, is not sensitive) than the red wavelength. Explain.
2. The optical depth of clear air for blue light is (more, less, the same as) for red light. Explain.
3. The rate of energy emitted by the Sun at a wavelength near 20 microns is (less than, comparable to, greater than) the rate emitted by a unit area of the earth at the same wavelength. Explain your choice, Hint: it may help to think of Planck's law.
4. Draw, show or explain how sunlight is scattered by air molecules for the two polarizations sunlight can be decomposed into.
5. Explain the relationship between radiation and convection in a one-dimensional energy balance model.
6. Last week the discovery of a new planet was announced. It experiences a flux density of radiation from its own Star that is similar to ours: assume  $1370 \text{ W m}^{-2}$ . It is 14X closer to its Star than the Earth is to our Sun and its Star has a radius one-half that of our Sun. our Earth-Sun distance  $D_s$  is  $1.496 \cdot 10^8 \text{ km}$ , the radius of the Sun is  $R_s = 6.96 \cdot 10^5 \text{ km}$ , the Sun's emission temperature is  $5970 \text{ K}$ .
  - a) What is the Star's emission temperature ?
  - b) What is the wavelength of maximum emission of the Star ?

7. Miami has been under a layer of smoke recently from brush fires to the west of us, a picture of which is shown below

- a. Explain the halo around the Sun that is evident in the picture. What is a representative size for a smoke particle ?
- b. Why was it possible to look directly at the Sun when I took this picture ? Assume an optical depth of 3 and calculate the direct transmittance. Estimate the solar zenith angle.
- c. Why does the sky look dark ? Estimate the single-scattering albedo of the smoke layer.
- d. Would you expect the atmosphere to heat up as a result of this smoke layer ? Using a daily-averaged flux of  $500 \text{ W m}^{-2}$  estimate the temperature change a smoke layer 500 m thick will have experienced over the course of the day. Explain any assumptions you make (if any).
- e. The smoke layer also decreases the amount of solar radiation reaching Biscayne Bay, ultimately by the amount absorbed by the smoke layer. Assuming an average depth of 1 m, calculate the warming of Biscayne Bay waters over a 12-hour time period with and without the smoke layer using your answer to part d. Disregard any infrared effects.



