MSC409 Spring 2009 FINAL May 6, 2009 NAME:

attempt all questions, if you are having trouble with one, move on and come back to it.

1.write down the radiative transfer equation and explain the terms. explain how it reduces for terrestrial and solar radiative transfer.

2. explain the significance of the 2 components to the index of refraction

3. define the 3 main radiative parameters describing a cloud or aerosol layer.

4. the transmission through a liquid layer of depth 10 cm is measured to be 70% for an overhead Sun. what is the volume extinction coefficient?

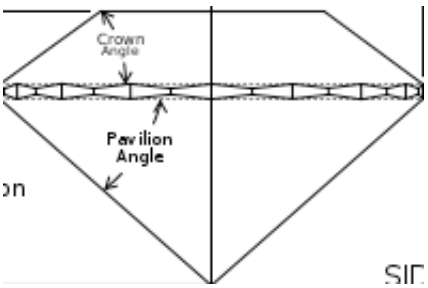
5. estimate the temperature of the filament of a 100 W electric light bulb. State all assumptions. (Stefan-Boltzmann constant=$5.67*10^{-8}$ W m^{-2} K^{-4})

6. At a beach in Miami, the net flux of solar energy absorbed by the sand is 500 W m^{-2} over a period of 12 hours while the 12-hour-mean sand temperature is 303 K (86F). Assuming a sand heat capacity of $2*10^6$ J $m^{-3}K^{-1}$ and a conductivity depth of 4 cm, how much does the temperature of the sand increase? If all the heat is transferred to a boundary layer of depth 300 m (air density=1 kg m^{-3}, c_p=1004 J/(kg*K)) how much does the air temperature rise? what would you expect to see happen to the depth of the boundary layer?

7. suppose the sun were hotter, with maximum emission occurring at 0.4 rather than 0.475 micron. what would that imply for the earth's equilibrium temperature?

8. the net (longwave+shortwave) radiative forcing of a cloud - whether or not a cloud warms or cools the climate relative to clear-sky conditions - depends strongly on the properties of the cloud. comment on differences in the radiative forcing of low and high clouds, include some rough estimates of the clouds' (3 main) optical properties.

9. a diamond's cut is meant to maximize light return*. The shape of a classic diamond cut is shown below. given a real index of refraction of 2.42, trace the path of light entering the diamond directly from above. include one sample calculation at one interface - how does the "pavilion angle" figure into the light's trajectory? where does the light go if the cone is cut too deep (ie the pavilion angle is too large)?



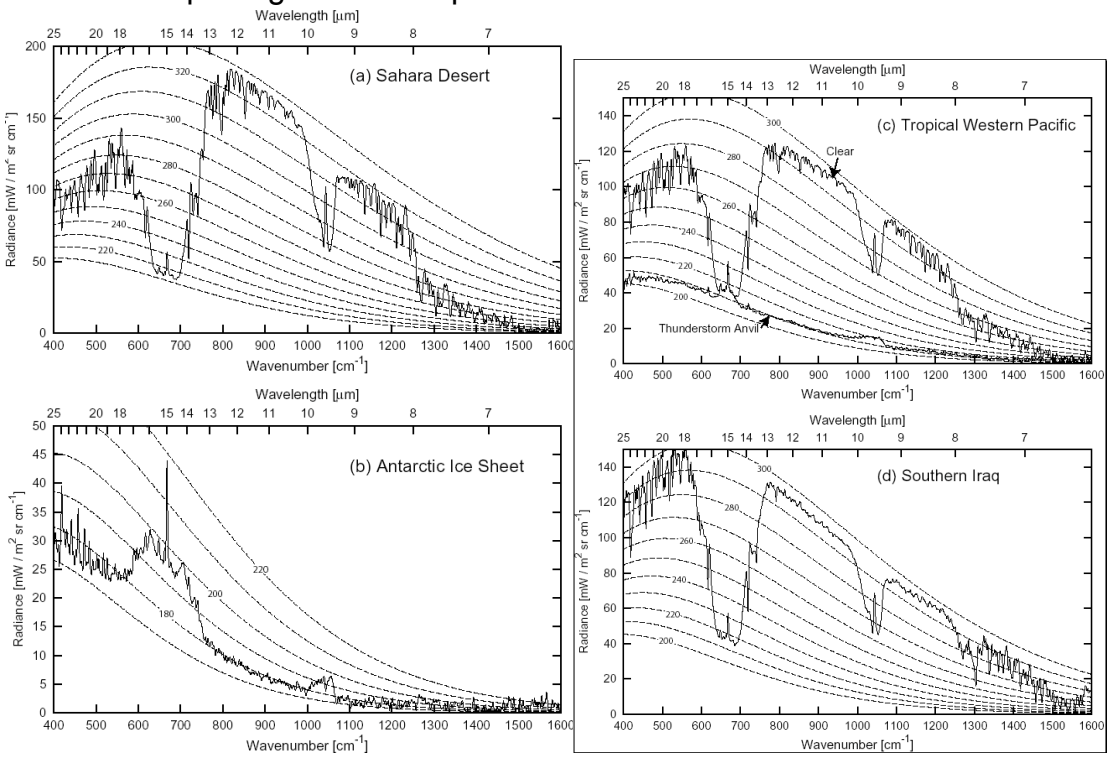
*early diamonds, lacking such cuts, often appeared black to the eye

MSC409 Spring 2009 FINAL May 6, 2009 NAME:

10.AERONET sites measure 5 or more transmitted direct solar spectral radiances (wavelengths between 0.34-10 micron), as well as the diffuse solar radiation. How is this used to estimate aerosol radiative properties?

11.What does aerosol “reddening” refer to and how does it also impact the AERONET aerosol optical depth retrievals?

12. the 4 plots below show the top-of-atmosphere clear-sky infrared spectra for 4 locations on earth: Sahara Desert, Antarctica, tropical western Pacific, southern Iraq. the dashed lines correspond to the Planck’s function for the indicated temperatures. for each of the 4 scenes, provide an estimate of the surface temperature. for which scene does the surface appear to be significantly colder than any other level in the atmosphere? identify the location of each scene. how does the drier atmosphere above southern Iraqdistinguish its IR spectra from that of the TWP?



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EXTRA CREDIT: what is the solid angle at point O of the sphere in the following diagram as a function of the distances d_c and r_s?