GEOG 401 Due 29 January 2015
HW #1

Earth's Energy Balance: Please show your work for maximum credit.

Questions

1. Calculate the *emission temperature* of the following hypothetical Earth's giving the following parameters. Emission temperature is the temperature at the "top of the atmosphere" or equilibrium temperature to balance incoming solar and outgoing longwave radiation. The Solar constant and albedo are provided for you. The Stefan Boltzmann constant $\sigma = 5.67 \times 10^{-8}$ W m^{-2} K^{-4}. Solar constant (S_0) and albedo (α) are given for you.

   a. **Asphalt Earth.** S_0= 1367 W/m2, α= 0 [2]

   b. **Snowball Earth.** S_0= 1367 W/m2, α= 0.95 [2]

   c. **Venetian Earth.** S_0= 2614 W/m2, α= 0.75 [2]

2. The solar minimum of 2009/2010 was the greatest in the last 50 years. During the previous solar maximum in 2002, S_0 was approximately 1367 W/m2, whereas S_0 in late 2009 was approximately 1365 W/m2.

a. Calculate the **change in the emission temperature** of the Earth associated only with changes in solar activity between 2002 and 2009. Assume global albedo is constant, α=0.3. [4]

b. (Extra credit) Since 1850 the global mean surface temperature has increased approximately 1C. Assume that the emission temperature was 1C cooler in 1850 than today. **Estimate S_0** in 1850 assuming that solar variability is the sole contributor to temperature changes. Also, assume that albedo remains unchanged at 0.3. [+3]

3.

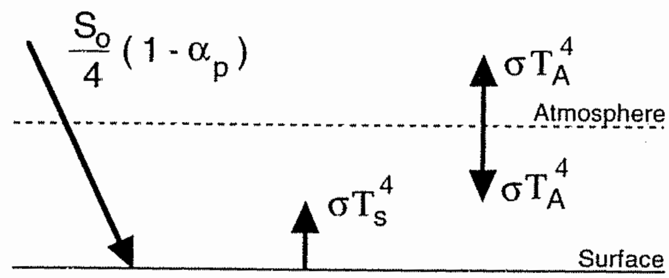

Fig. 2.3 Diagram of the energy fluxes for a planet with an atmosphere that is transparent for solar radiation but opaque to terrestrial radiation.

a. Calculate the difference between surface temperature, T_S, and emission temperature, T_A) in the simple 1-layer atmosphere shown above. Assume S_0= 1367 W/m2, α=0.3.

[4]

b. Why should the answer you derived be different than the observed surface temperature of Earth (15C)? [1]