

METEO 466: Homework #7

(Due Thurs., Oct. 25)

1. Kepler's first law says that the planets move around the Sun in elliptical orbits with the Sun at one focus. Earth's present orbit has a semi-major axis of 1 AU (astronomical unit) and an eccentricity of 0.017. The point of closest approach to the Sun is termed *perihelion*; the point farthest away is termed *aphelion*. Given these definitions, how much closer is the Earth to the Sun at perihelion than at aphelion? Express your answer in AU.
2. The Milankovitch theory of the ice ages holds that the most important forcing factor is the difference in solar heating at high latitudes when northern hemisphere summer occurs at perihelion as opposed to aphelion. What is the solar flux at perihelion and at aphelion? Recall that the solar flux at 1 AU is 1370 W/m^2 . How much higher is the solar flux at perihelion than at aphelion today? Express your answer in percent. (Hint: If you keep your answer in algebraic form until the last step, it will save you time on the rest of the assignment.)
3. The eccentricity of Earth's orbit varies with time as a consequence of gravitational perturbations caused by the other planets. What is the answer to question (2) when e is at its maximum value of 0.06?
4. Mars' current eccentricity is 0.093, and it is predicted to occasionally get as high as 0.2. What is the answer to question (2) for these two values at Mars?
5. Mars' obliquity varies chaotically and occasionally reaches values as high as 60 degrees. What is the solar flux at the pole during summer solstice? (Neglect the eccentricity of the orbit for this calculation.) How does it compare to the average solar flux received by Earth (that is, the flux at some average point on the Earth's surface)? What would be the local effective radiating temperature if the planetary albedo was the same as Earth (0.3)? Would you expect that liquid water would be present at the surface? Note: Mars' semi-major axis is 1.52 AU.