

Introduction to Weather & Climate

PHYS 189

Fall 2017

Problem Assignment # 3

due 09-20-17

1. Obliquity

- (a) What is obliquity?
- (b) What is the most important factor in determining the seasons?
- (c) Draw the sun and earth in a side view plane of the orbit. Draw Earth's axis of rotation relative to the sun for a northern hemisphere winter.
- (d) Repeat part (b) for northern hemisphere summer.
- (e) Repeat part (b) for the equinox.
- (f) What is the significance of the tropics of cancer and capricorn?
- (g) What is the significance of the artic and antarctic circles?
- (h) Presently, Earth's axis is tilted at 23.5° . What would the latitude of the tropic of cancer be if the tilt was 50° ? What would the latitude of the artic circle be in this case?

2. Albedo

- (a) What is the definition of albedo?
- (b) What is Earth's average albedo?
- (c) Different surfaces have different albedos. The ocean has an albedo of about 0.06 when the sun is directly overhead. What does this imply about what happens to the incident solar radiation on the ocean?

3. Insolation

- (a) What is the definition of solar insolation?
- (b) At any given location on Earth, list at least 3 things that affect the solar insolation at that location.
4. What does it mean to take a *zonal average*?

5. The solar insolation at the top of the atmosphere is about 342 W/m^2 . The total radiation absorbed at the surface of the Earth is 494 W/m^2 . Explain how it is possible to absorb more radiation at the surface than comes in at the top of the atmosphere.

6. Global energy flows

- (a) Draw a figure equivalent to Figure 1.3 in your book. Include arrows that show what happens to the incoming solar radiation, what happens to terrestrial radiation, and energy coming into and out of the atmosphere.
- (b) Add up all of the radiation absorbed by the surface from all sources. Add up all of the energy leaving the surface of the earth. Compare these values; is energy balanced at Earth's surface?

- (c) Add up all of the radiation coming into the top of the atmosphere. Add up all of the radiation leaving the top of the atmosphere. Is energy balanced at the top of the atmosphere?
- (d) Add up all sources of energy absorbed by the atmosphere. Add up all energy emitted by the atmosphere. Is the atmosphere in approximate energy balance?