Energy Balance and Climate

2023-01-13

Contents

Reading:

Required Reading (everyone):

- Understanding the Forecast, Ch. 2–3, pp. 9–23.

Reading Notes:

Note: There is an error in Table 3.1 on p. 23 of *Understanding the Forecast*: The observed temperature of the earth (T_{observed}) is 288 K, not 295 K.

As you read *Understanding the Forecast*, focus on pp. 13–23 . You need to understand the calculations of the "bare-rock" model on pp. 19–23. The intermediate steps are not as important as two equations:

$$F_{\text{out}} = F_{\text{in}} \quad \text{at equilibrium,}$$

and equation (3.1), which describes the bare-rock model:

$$T_{\text{earth}} = \sqrt[4]{\frac{(1-\alpha)I_{\text{in}}}{4\varepsilon\sigma}}$$

(Helpful hint: to take a fourth root easily with your calculator, just press the square root key twice.)

Questions to think about (**not** to write up and turn in):

- What is blackbody radiation? What is a "blackbody" anyway?
- Why is it that the sun gives off visible light, but the earth does not?
- When the earth absorbs energy from sunlight, where does the energy go initially? Where is the final destination of that energy?
- What is the Stefan-Boltzmann equation, and why is it important?
- What does the Stefan-Boltzmann equation tell us would happen if the sun got hotter? What would happen if the Earth got hotter?
- Study table 3.1 on p. 23 of *Understanding the Forecast* (ignore the column "$T_{\text{1 layer}}$" because we don't get to that until later in the chapter.):
  - Why is the sunlight brighter on Venus than on Earth, and dimmer on Mars?

  - Why is the "bare-rock" temperature of Venus lower than Earth, even though it gets more sunlight?
  - Why do you suppose the actual observed temperature at the surface of Venus is so much hotter than the "bare rock" temperature?

- At the top of p. 20, why does Archer write, $F_{\text{out}} = F_{\text{in}}$? What would happen if $F_{\text{out}} \neq F_{\text{in}}$
- Without getting bogged down in the details of the numbers, why are the areas used to calculate the incoming and outgoing energy fluxes different? (Figures 3.1 and 3.2 explain this)
- If the sun got 5% brighter, approximately how many degrees warmer would the earth become?