Assignment #1 ATM S 211: Climate and Climate Change

Due Tuesday, Jan 11, 11:30am

1. Using the relation °F = (9/5) °C + 32, find the temperature where °F=°C; i.e. where Fahrenheit and Celsius temperatures are the same. *Show work.* [0.5 pt]

two equations: F = (9/5)C + 32 and F = C - where do they intersect?

C = (9/5)C + 32
-(4/5)C = 32
C = -40 =F

2. Climate measurements. Please refer to figures in Chapter 1 of the text.

a. About how far back in time do **direct** measurements of Earth's surface temperature extend? [0.5 pt]

~150 years

b. By what percentage did the concentration of carbon dioxide (CO2) in the atmosphere increase between 1850 and 2000? *Show your work*. Why did it increase? [0.5 pt]

(370 ppm – 290 ppm) / 290 ppm = 0.28 or about 30%.

The increase is due to humans burning fossil fuels, which releases CO_2 *to the atmosphere.*

c. By what percentage did the average surface temperature increase over this same time period? Assume that the average over the entire period is 15°C. *Show your work.* [0.5 pt]

Need to do this in Kelvins. Over this period the Earth warmed about 0.8°C, which is the same as 0.8K. Thus the fractional temperature change is 0.8K / (15+273) = .003 or 0.3%.

d. Briefly explain the seasonal oscillation (ups and downs) in the observations of CO2 from Mauna Loa. [0.5 pt]

'Breathing' of the northern hemisphere forests, i.e. seasonal cycle of plant growth.

3. Feedbacks. $\Delta T = \lambda \Delta F$

a. Explain in words what this equation means, including what each variable represents. [1.5 pt]

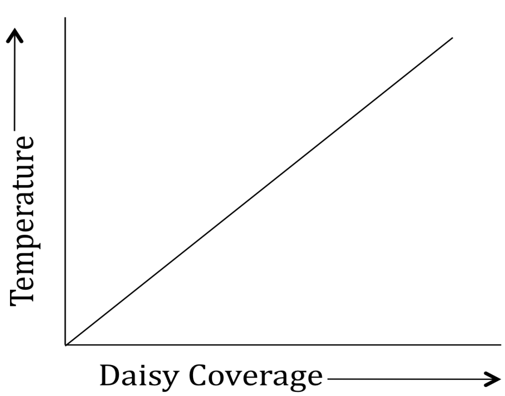
ΔT is the equilibrium change in temperature due to the change in radiative forcing, ΔF. We usually express F in W/m^2, which is a heating rate (W) that is occurring over a certain surface area. The magnitude of the temperature change is related to the change in radiative forcing by the climate sensitivity parameter, λ. If the climate has a high sensitivity, a small forcing can cause a large change in temperature, while for a climate with low sensitivity, even large changes in forcing result in only small temperature changes.

b. Give three examples of ΔF that are relevant for Earth's climate. [1.5 pt]

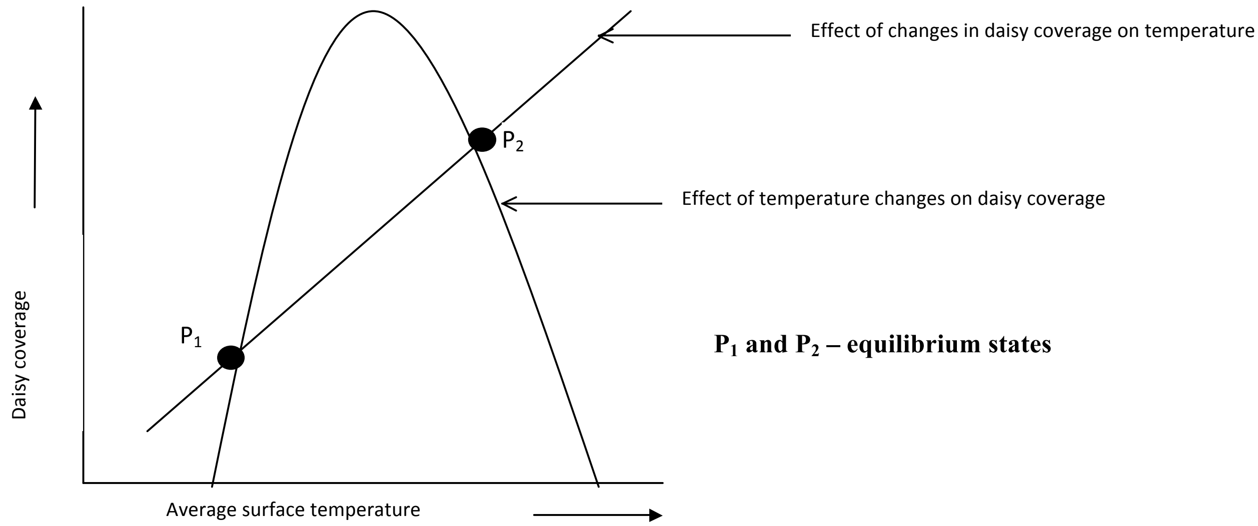
1. Changes in incoming solar radiation due to variations in solar luminosity
2. Changes in the greenhouse effect due to changes in CO_2 concentration
3. Changes in the amount of aerosol particles in the atmosphere, which reflect incoming solar radiation

4. Daisyworld has a companion planet that is similar in all ways except that the daisies are black and are growing in white sand.

a. What is the effect of an increase in black-daisy coverage on planetary temperature? Express your answer graphically and label your axes. [0.5 pt]



b. Assuming that the effect of temperature on daisy coverage is the same on black-daisy Daisyworld as on white-daisy Daisyworld, draw a stability diagram – a diagram analogous to Figure 2-10a – for black daisy Daisyworld. [0.5 pt]



i. Are these equilibrium states stable or unstable? *Label each*. [1 pt]

Equilibrium state P_2 is stable, P_1 is unstable.

ii. If the temperature is less than the optimum temperature for daisies, explain what happens if the surface temperature is increased slightly. [1 pt]

Surface temperature increases → daisy coverage increases → surface temperature increases → daisy coverage increases. This process continues until the surface temperature exceeds the optimum temperature. For temperatures beyond this point, increasing surface temperature leads to decreased daisy coverage. Between the optimum temperature and that at P2, the daisies continue to force the temperature to rise, even though their coverage is decreasing with temperature. If the temperature rises above that at P2, the decrease in daisy coverage causes a reduction in surface temperature, which forces the temperature back to that at P2. In summary, a positive feedback between daisy coverage and temperature takes the system from a temperature below the optimum to the temperature at P2. Negative feedbacks then tend to maintain the system at P2.

5. Write a 200 word description of the climate of an area that you have lived (ideally besides Seattle). [1.5 pt]