NATS 1780 A (Summer 2016): Lab - Temperature, Radiation & The Ft. McMurray Wildfires (Version 0.9; May 16, 2016)

Purpose

Through use of the Ft. McMurray wildfires, the purpose of this lab is to investigate the relationship between temperature and radiation, as well as radiation processes in Earth's atmosphere.

Data Analysis and Interpretation

Data analysis and interpretation focuses on May 4, 2016, for Ft. McMurray, AB and the area that surrounds it.

1. Obtain the hourly data set of weather observables here.
2. Regarding the temperature data:
    a. Plot temperature (°C) vs. local time (hours) for the full 24-hour period.
    b. When (local time of day) are the minimum and maximum temperatures attained? How does the timing of these values in the data compare/contrast with the textbook example of Figure 1 below? (In reporting times, it is important to account for DST when applicable.)
3. UV index data serves as a proxy for incoming solar energy. Obtain hourly data for the forecasted UV index here; regarding this data:
    a. When (local time of day) are the minimum and maximum UV index values expected? How does the timing of these values in the data compare/contrast with the textbook example of Figure 1 below? (In reporting times, it is important to account for DST when applicable.)
    b. Which mechanism of heat transfer does the UV index represent?
    c. Why is a lag between maximum incoming solar energy and maximum temperature expected?
    d. Estimate the UV index at 7 pm local time.
4. The interaction between fuel, heat and oxygen are the 'fire essentials' modelled by The Fire Triangle. Suppose there is ample fuel (e.g., smouldering wood from partially burned forest) and oxygen, so that the only variable is heat.
    a. At the edge of the fire, fire responders are in close proximity with smouldering wood. In this location, how might they observe conduction and convection? Which types of processes are these?
    b. Heat is required to raise the fuel to its ignition temperature; suppose that this ignition temperature is 28 °C. When is this ignition temperature (of 28 °C) first reached according to the data?
5. Regarding the visibility data:

    a. Define visibility as a weather observable.
    b. Plot visibility (km) vs. time for the full 24-hour period.
    c. Based on the visibility data, when does smoke (from the wildfire) start to appear? For how long is this state of reduced visibility present? (Assume that this smoke is the only element responsible for decreased visibility. Also assume that once the fire reaches its ignition temperature, it burns, and continues to burn for the remainder of the day.)
6. Suppose that by 7 pm, the smoke from the wildfire has developed into a 1 km thick ‘cloud’.
    a. State the percentage of incoming solar energy that is reflected, transmitted and absorbed by this cloud. (Hint: Make use of Figure 2.) If this smoke cloud continues to thicken, how will the reflective, transmissive and absorptive radiative transfers be affected?
    b. Estimate the effective UV index. Assume that the forecasted UV index (answer 3(d) above) is reduced solely by reflective capacity of the smoke cloud. (Hint: If the reflective capacity of the cloud is 60%, then the UV index is reduced by 60% - i.e., only 40% of the incoming solar energy is available for transmission and/or absorption.)
    c. Why does this thickening smoke cloud have a relatively minor effect on the maximum temperature (answer 1(c))?
7. Using Google (or a similar search service), search for “satellite imagery ft. mcmurray alberta may 4 2016”, and then respond to the following questions:
    a. Why might evidence of the Ft. McMurray wildfires be expected in satellite imagery that focuses on the visible light portion of the EM spectrum? Illustrate with an image. (Be certain to reference your source.)
    b. Why might evidence of the Ft. McMurray wildfires be expected in satellite imagery that focuses on the infrared (IR) portion of the EM spectrum? Illustrate with an image. (Be certain to reference your source.)

Important Note: Retain your temperature and visibility plots as they will be required for a subsequent lab.

Your Submission

Submit your lab in the form of a written response to the questions online via Moodle.

Note: You are encouraged to work together on labs. However, your submission must be original. Translation: Write up your final lab submissions independently, using your own words.

Assessment: This is a pass/fail component of the course that accounts for 4% of your overall grade. Completing at least 75% of the lab appropriately will result in a “Satisfactory” assessment and a grade of 3 out of 4; an “Outstanding” assessment, and a grade of 4 out of 4, will be awarded to those who completed at least 90% of the lab appropriately.

Resources

Lumb, I. Lectures on temperature and radiation for NATS 1780. Available online via Moodle.

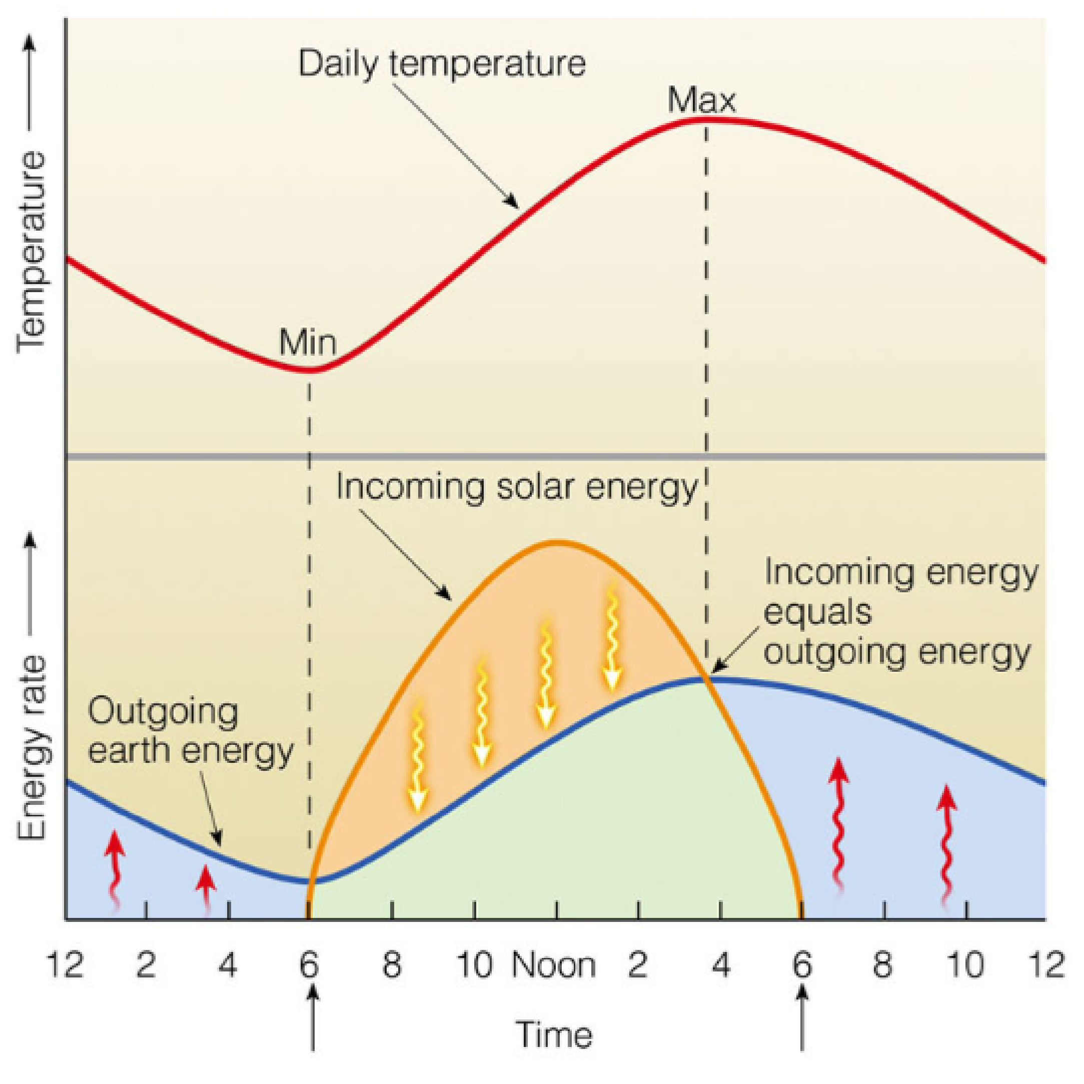

Figure 1. Diurnal radiation and temperature variations. (Source: Ahrens' textbook.)

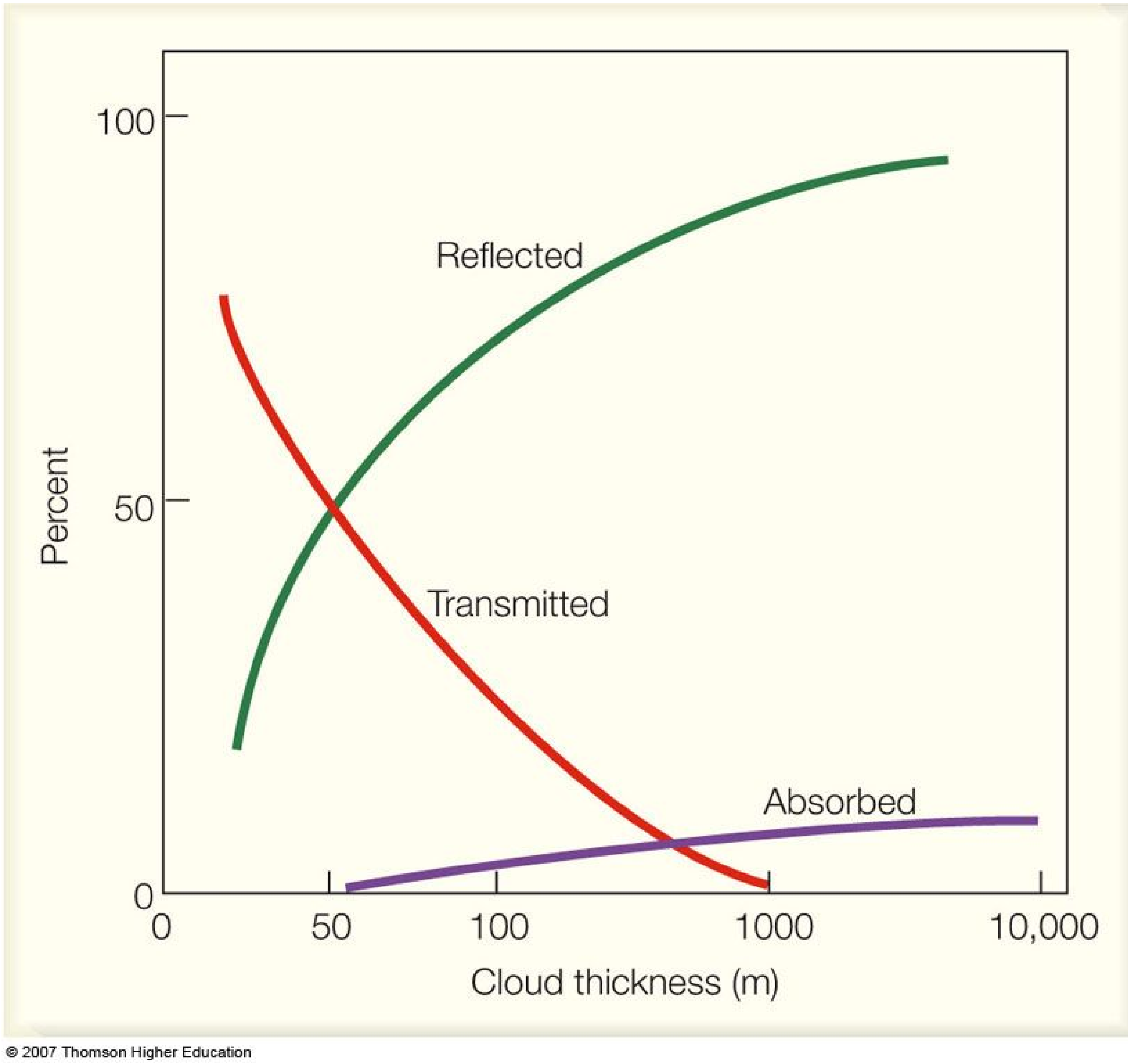

Figure 2. Radiative transfer as a function of 'cloud' thickness.