

Homework–Module 1

Name:

- 1) Warning signs such as the one to the right are common before bridges. And they are put there for good reason.

Why does the bridge get icy before the pavement on the ground when air temperatures drop below freezing? Use heat transfer concepts of Chapter 4 to explain your answer. Assume calm winds to simplify the discussion.

There is a 600-character limit for all questions.

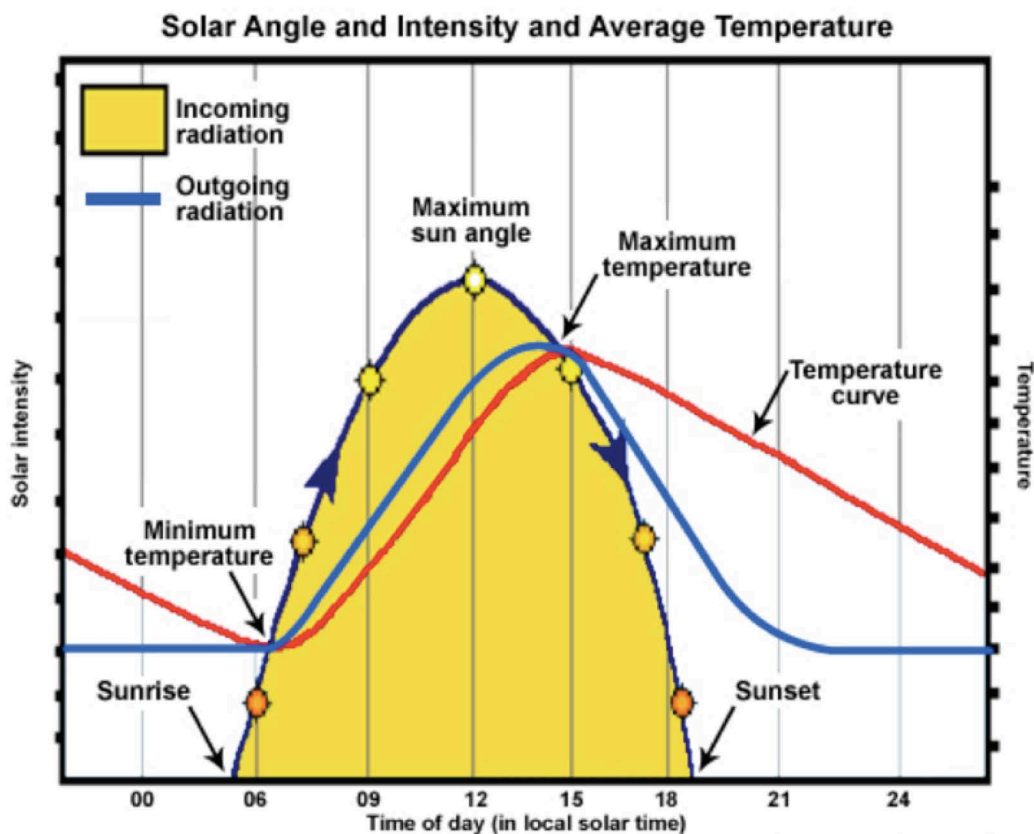


- 2) One of my most humbling experiences as a young meteorologist (a.k.a. early learning experiences) occurred for Corvallis, Oregon during the winter of 1979-80. I forecast clear, calm conditions overnight with a low near freezing (33°F). It was indeed calm all night with cold air trapped in the Willamette Valley. And it was clear too...most of the night. Unfortunately for my forecast, low-clouds (stratocumulus) began to drift overhead after midnight, at which time the temperature warmed to 45°F and stayed there through the rest of the night. My forecast low ended up 8°F too cold, a major bust!

Use heat transfer concepts to explain why the surface temperature increased as the low clouds moved overhead. (Hint: subsection 4.5.4 and Fig. 4.15 of H&P on how clouds impact radiative heat transfer.)

- 3) I used to show in lecture sections the schematic to explain the diurnal cycle of temperature in terms of radiative balance. Unfortunately, the diagram has a conceptual error (that I intentionally omitted during the narrative for pedagogic reasons) where two of the curves are not consistent with the laws of radiation. Which two curves are in error? Use the laws of radiation to explain what the inconsistency is between the two curves and what changes need to be made to correct the diagram. (Note: The COMET Program has since corrected the figure.)

(Hint: Radiation Laws of Box 4.1 and subsection 4.5.3 of H&P.)



Black curve-incoming solar radiation
Blue curve-outgoing IR radiation
Red curve-temperature

- 4) Every thermometer of the National Weather Service is placed inside a standardized weather shelter that is painted white, provides shade at all times, is ventilated, and is placed two meters above ground level (AGL). See picture to the right. Answer the following questions regarding differences in the daily MAX and MIN temperatures if the thermometer placement is changed as described. Assume clear, calm, cloudless weather for each question.

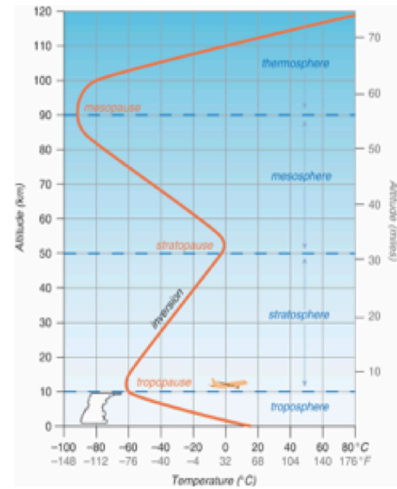


*Thermometer in a shelter.
(Hakim & Patoux. 2018).*

- a) How would MAX temperature readings change if the thermometer was not placed in the shade?
- b) How would MAX and MIN temperature readings change if the shelter was painted black instead of white?
- c) How would MAX and MIN temperature readings change if the shelter was airtight, not ventilated?
- d) How would MAX and MIN temperature readings change if the shelter was placed only two inches AGL?

- 5) Pressure (with rare exceptions beyond the level of this course) always decreases with elevation gain. Explain why temperatures increase with altitude in the stratosphere when the troposphere is mainly heated from below by the earth's surface.

(Hint: section 3.5 of H&P.)



*Average vertical temperature profile
(Hakim & Patoux, Fig. 3.3)*