ATSC 545 - Hydrometeorology-Fall 2018
Homework Assignment 1
Due September 25

Complete each problem with a clear narrative explaining the physical relationships used, your assumptions, your sources for any required constants or other inputs to your calculations, and your assessment of the accuracy of your results.

1. Estimate the total solar energy that could be received at Grand Forks, ND, on a cloudless sunny day for two dates. These will be October 1, 2018, and December 1, 2018. Discuss the reasons for the differences in your estimates of total possible solar energy on these two days. Discuss the biggest uncertainties in your estimates.

2. Consider a rainstorm occurring over Goodland, Kansas, on March 15, 2019. The rain fills a depression 8 ft long by 4.25 ft wide to a depth of 6 inches. Suppose subsequent days are absolutely clear. Estimate the number of days it will take to evaporate the water in the depression. Assume there is no water loss by infiltration into the ground, or any other mechanism except evaporation.

Suppose the same scenario occurs on August 15, 2019. How many days will it take for the water to evaporate on this date?

3. Estimate the net daily average longwave radiation for September 16, 2018, for Grand Forks, ND. Utilize the weather observations available from the ezLMS course site as a supplement to this assignment. Describe the role of clouds and humidity in your computation and how you dealt with them.

Notes:

(1) For computing daily averages and estimating cloudiness, use only observations "on the hour".

(2) The METAR codes for cloudiness are defined by "octas", or eighths of the sky covered by clouds:

CLR - 0
FEW - 1/8 to 2/8
SCT - 3/8 to 4/8
BKN - 5/8 to 7/8
OVC - 8

(3) To convert from dewpoint temperature T_d to vapor pressure, use eq. (2.17) on p. 19 in the text, or another relationship from among the many curve fits available for $e_s(T)$. Please give the source of the relationship you use if it is not the one in the text.

(4) For estimating solar radiation at the ground, use $a_s = 0.25$ and $b_s = 0.5$.

4. Compute the 4 AM local vertical soil heat flux at a depth of 1 m in dry clay soil of 40% porosity where the soil temperature at 0.5 m is 28°F and the soil temperature at 1.5 m is 34°F. In what direction is it, up or down?

Next, compute for the same time the local soil heat flux at a depth of 2 m in the same soil if the temperature at 2.5 m is 38°F. In what direction is it?

In both cases, assume the heat capacity and thermal diffusivity are constant over the entire range of depths.

An hour later, at 5 AM, describe how the temperature at 1.5 m depth will differ from its value at 4 AM.

5. The daily maximum soil-surface temperature is 40°C and the minimum is 10°C. Assume the diurnal temperature wave is symmetrical, that the mean temperature is equal throughout the profile with surface temperature equal to the mean value at 6 AM and 6 PM, and that the "damping depth) is 0.10 m. Calculate the soil temperatures at noon and midnight for depths 0.05, 010, and 0.20 m.