Environmental Systems 1
ESR 320
Problem Set 6
DUE: Thursday, 12/03/2009

Find the (quasi-)steady state temperature (equilibrium temperature) for Lake Boltzmann, an Oregon lake in late September, given the following information.

Shortwave Input:

Cloudless insolation (at " = 90E) I_c = 1050 W/m2
Average solar angle over the day " = 30E
Average daily cloud cover N = 0.25
Cloud base altitude = 1,700 ft, so use k = 0.22 for the effect of cloud cover (Eq. 3-56)
Day length = 12 h

Longwave Input:

Assume essentially all of this comes from a mix of clouds and humid air, so use approximate the value by using the "cloudy sky" formula (Eq 3.63 in reading) but do *not* apply the 0.25 factor.
Cloud base altitude of 1,700 ft has mean temperature of 5EC
The Stefan-Boltzmann coefficient (**F**) is 5.80 x 10^{-8} W m^{-2} K^{-4} (for all media)

Evaporative Heat Output:

Lake has a measure evaporation rate of 3 mm/d
Use a latent heat of vaporization of 2,400 J/g at this temperature range

Conductive Heat Loss:

Assume a "Bowen Ratio" value of 0.20, meaning that conduction is 20% of the evaporative heat loss value.

Longwave Output:

This is governed by the water temperature, which is the variable you are solving for. Assume that water has an emissivity for longwave light of 1.0. (Water is virtually a blackbody with respect to IR light in the relevant range of 10 µm wavelength.)

NOTE 1: Remember that shortwave insolation only occur for 12 h/d (half the day) while all the other fluxes operate continuously for 24 h/d. Factor this into your budget.

NOTE 2: The area, volume, depth of the lake are largely irrelevant to this heat budget with the information you are given. Just work in units of flux: W/m^2.