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Geog595 Ecological Modeling
Due: 5pm, Friday March 10, 2007.

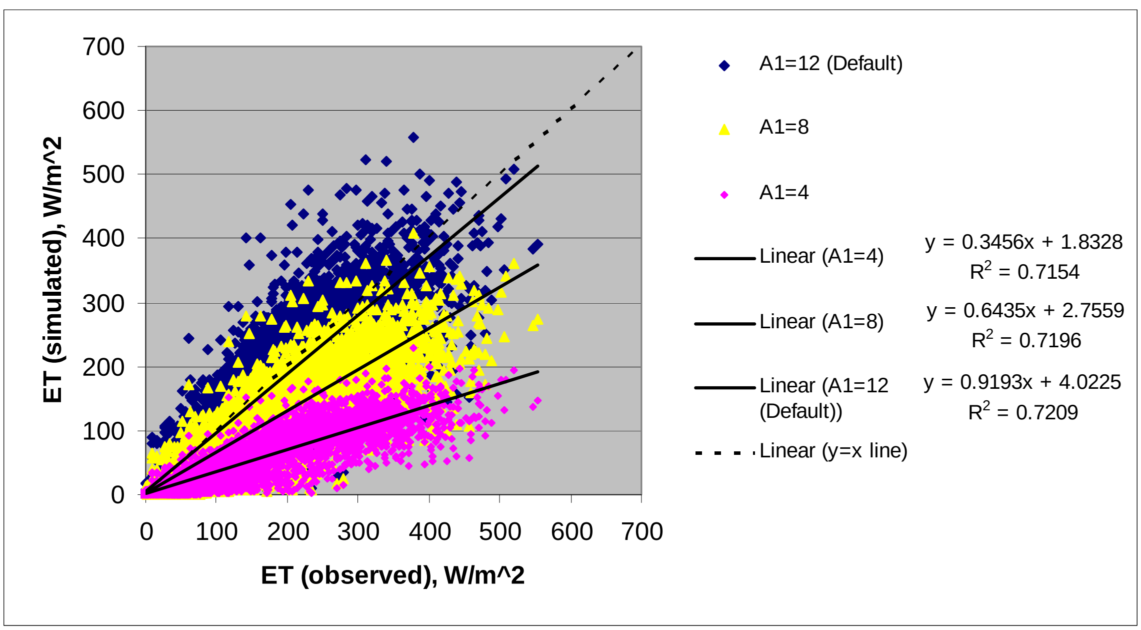
Lab 6 Modeling ET with Penman-Monteith Equation

(1) Run the model penman_monteith with default parameter values using WindLaiTaVpdAnRnet2001.txt as the input file. Save the output file and then compare the simulated LE with the measured LE.

(2) Do the same simulation as above and set a_1 as 4.0 and 8.0. Please compare the outputs with the observed data and describe how sensitive ET is to a_1.

Both questions 1 and 2 have been answered together below. The simulated values (ET) are on the x-axis, while the measured values (e) are on the y-axis. There are three series plotted, which are a_1=4.0 (pink), 8.0 (yellow), and 12.0 (blue), and the equations of the regression lines are next to their legend entries in case the lines aren't very visible. (a_1 = M in penman_monteith.c.)

ET is very sensitive to a_1. The simulated ET best agrees with the observed ET when a_1 = 12, though the simulation slightly underestimates the observed values. However, as a_1 decreases, the simulation further underestimates the observed values. Greater underestimation occurs with higher values of observed evapotranspiration than with lower values. This means that the Penman-Monteith equation does a good job in modeling evapotranspiration from the leaf surfaces only at higher values of a_1 and when values of evapotranspiration are low. There is also more scatter at higher values of a_1, as evidenced by the increase in R.



(3) Resume a_1 to its default value, and set C_a to 300 and 600 ppm, and compare the results. Discuss its implications to the rising CO_2 concentration in the atmosphere.

The Penman-Monteith model does the best job at simulating ET when C_a is close to its default value of 380. If C_a is higher, the model underestimates ET, and if it is lower, it overestimates ET. Perhaps the model agrees best with a C_a close to 380 because that was the concentration of CO_2 at the time the model was developed. The difference between simulated and observed values become higher with higher values of ET, so as long as evapotranspiration is low, C_a doesn't have much of an effect on the agreement between simulated and observed values.

As C_a increases from 300 to 600 ppm (blue to green to purple), from the Leuning (1995) model we notice that there will be less stomatal conductance. With lower conductance, plants will need to open their stoma for longer times to get enough CO_2. With stoma open for more time, plants will lose more water through the stoma, and evapotranspiration consequently will increase. This could lead to a wetter atmosphere and a lowering of the water table.

$$g_s = g_0 + \frac{a_1 A}{(C_a - \Gamma)\left(1 + \frac{D}{D_0}\right)}$$ (as C_a increases, this causes g_s to decrease.)