Lab Assignment #1
ECE 597UU/697UU, Fall 2009
(Posted on the course website on Thu, 5 Nov; due in class on Thu, 12 Nov)

Estimation of the surface flux of sensible heat

The sensible heat flux at a height \( z \) is defined as

\[
H(z) = c_p \rho \langle w'(z) T'(z) \rangle,
\]

where \( \langle \cdot \rangle \) stands for "expected value of", \( c_p \) is the specific heat of dry air at constant pressure, \( \rho \) is the air density, and \( w'(z) = w(z) - \langle w(z) \rangle \) and \( T'(z) = T(z) - \langle T(z) \rangle \) are the fluctuations of vertical velocity and of temperature, respectively.

**Task 1:** Download the .mat file and the .m file from the Lab #1 webpage. The .mat file contains 24 hours of 5-Hz data of vertical velocity \( w \) and of temperature \( T \). The two time series were measured in Amherst on 15/16 September 2009 with an ultrasonic anemometer/thermometer ("sonic") about 1 m above ground level. The .m file contains a Matlab code that (a) loads the data file into the Matlab workspace, (b) performs some basic data processing to estimate the sensible heat flux \( H \) at the level of the sonic, and (c) plots time series of \( H \).

**Task 2:** "Transcribe" the Matlab code into a sequence of "textbook-style" mathematical equations (as opposed to Matlab code) embedded in explanatory text.

**Task 3:** Interpret the plots generated by the processing code that I provided. Consult Chapter 5 of Garratt, *The Atmospheric Boundary Layer* (1992). Compare the \( H \) time series with that shown in Garratt’s Figure 5.5 (p. 126). What is similar, what is different? Why?

**Task 4:** Refine the data processing such that you obtain a \( H \) time series that has as little scatter as the one in Garratt’s Figure 5.5. Explain.

**Grading:** The Lab #1 report will be graded according to the following criteria: (a) readability, conciseness and logical flow of the text, (b) neatness, clarity and correctness of figures including axis labels, choice of colors and symbols, and readability of the figure captions, (c) correctness and completeness of mathematical equations including the verbal definitions of the symbols in those equations, (d) qualitative and quantitative understanding of the measurements. – I will grade each of the four items on a scale from 5 (very bad) to 10 (excellent) and sum them up. A total of 20 is equivalent to a numerical grade of 50% (very bad), and a total of 40 is equivalent to a numerical grade of 100% (excellent).