EAS372 Assignment 3 (15%) Due: 11 April, 2017

The accompanying data file 'stalbert2011_timeseries13.csv' (1.2 MB) contains a time series of wind components, temperature, carbon dioxide concentration (ρ_c) and absolute humidity (ρ_v), registered at 10 Hz and covering 30 min, from a sonic anemometer at height $z = 2.55$ m over a wheat field at St. Albert (16 Aug. 20011, 13:30–14:00 MDT). The data are arranged in columns in the order $u, v, w, T, \rho_c, \rho_v$, where u is the westerly component, v the northerly component and w the vertical component. The number of entries (N) in each column is $N = 10 \times 1800$. The velocity components are in $\mathrm{m\,s^{-1}}$; the temperature in °C; carbon dioxide concentration is in $\mathrm{mg\,m^{-3}}$ *and is expressed as the deviation from* $600\,\mathrm{mg\,m^{-3}}$; and the absolute humidity is in $\mathrm{g\,m^{-3}}$.

Write a program (or use a Spreadsheet) to compute the following statistics:

- mean velocity components U, V, W and mean wind direction $\beta = \arctan(V/U)$
- the evapotranspiration rate in the flux density unit $E = \overline{w'\rho_v'}$, and as a velocity [$\mathrm{mm\,dy^{-1}}$]
- the carbon dioxide flux density $F_c = \overline{w'\rho_c'}$
- Reynolds stress tensor

$$\mathbf{R} \equiv R_{ij} \equiv \overline{u_i' u_j'} = \begin{pmatrix} \sigma_u^2 & \overline{u'v'} & \overline{u'w'} \\ \overline{u'v'} & \sigma_v^2 & \overline{v'w'} \\ \overline{u'w'} & \overline{v'w'} & \sigma_w^2 \end{pmatrix}$$

- the velocity standard deviations $(\sigma_u, \sigma_v, \sigma_w)$ and the turbulent kinetic energy $E = (\sigma_u^2 + \sigma_v^2 + \sigma_w^2)/2$
- the friction velocity u_*, defined by

$$u_*^4 = \left(\overline{u'w'}\right)^2 + \left(\overline{v'w'}\right)^2$$

- the turbulent temperature scale $T_* = -\overline{w'\,T'}/u_*$
- the Obukhov length

$$L = -\frac{u_*^3\, T_0}{k_v\, g\, \overline{w'T'}}$$

  where $k_v = 0.4$ is the von Karman constant and T_0 [K] is the mean air temperature. (Note: L is negative in unstable stratification)

- heat flux density $Q_H = \rho c_p\, \overline{w'T'}$ (to compute the density, assume the local pressure was $p = 91$ kPa).

In addition to the above computations, plot scatter diagrams of w' versus ρ'_v and w' versus T'

Format: Please submit the results of your calculations, along with some interpretation as to meaning of the calculated quantity, as a PDF file, double spaced with font size 12 pt; the page limit is **four**, not counting any figures or tables. Images should preferably be integrated into your PDF; however if your software does not permit that step, please submit them as images, each with a suitable title (instructor will integrate them into a single PDF).