ADVANCED ENVIRONMENTAL DATA ANALYSIS
HOMEWORK #1

This first homework is to help you get started with MATLAB (or equivalent software) and some preliminary statistical analysis. Type your homework results using a text editing program and embed the figures in the text as you were writing a scientific article. At the end you will produce a .pdf file with text and figures included. All figures will need a caption and will have to be properly referenced from the text. Upload on the course website your homework file and a zip file containing the functions you wrote to produce the diagrams.

1) Consider the Lorenz Attractor equations:

$$\frac{dX}{dt} = -aX + aY$$
$$\frac{dY}{dt} = +rX - Y - XZ$$
$$\frac{dZ}{dt} = -bZ + XY$$

compute and plot the solution over the time interval $t = [0,100]$ subject to the initial conditions $X = 10$; $Y = 10$; $Z = 10$; and with $a = 10$; $b = 8/3$; $r = 28$; Now plot the solution obtained with a slight change in the initial condition $X = 10.2$; $Y = 10$; $Z = 10$; Make sure that all the axes are labeled properly in the figure. Include a title on each panel and briefly discuss the solution.

2) Reproduce the "phase space diagrams" shown in class, for XYZ and for XZ. What do these diagrams tell us about the system?

3) Compute and plot (a) the Probability Density Function (PDF) for X and Z, (b) the Joint PDF of XZ, and (c) the Joint PDF XZ conditional on $-1 < Y < 1$ and $8 < Y < 10$. Discuss the information contained in (a), (b) and (c). Discuss how the JPDFs in (b) provides a different kind of information from the phase diagram.

NOTE: All the figures you are asked to do are the same as the one shown in class during LECTURE 1. These figures are posted on the course website. To solve the Lorenz system you may want to use the MATLAB function `ode45.m`. Type `>> help ode45` in the MATLAB window to learn how to use it or search the web. You will also find a function `utl_contourfill.m` to make contour plots. The 3D phase diagram can be made using the function `plot3.m`