Lab 5
Due 10/13/04

This week we are going to revisit several datasets we have already looked at and look at correlations. Make sure to address all questions asked, not just the numerical calculations. Make sure you support your arguments with evidence from the data.

Computing Correlations:
Correlation is computed by the following equation:

$$Correlation = \frac{1}{n}\sum_{i=1}^{n}\frac{(x_i - \bar{x})}{\sigma_x}\frac{(y_i - \bar{y})}{\sigma_y} = \frac{1}{n}\sum_{i=1}^{n} z(x_i)z(y_i)$$

You can use any method you like for computing the correlations but you should use some sort of equation calculation at least once before exploring Excel options. The steps suggested in lecture for computing the correlation between X and Y are provided for reference.
1. Compute mean of X and then mean of Y
2. Compute standard deviation of X and then of Y (in this case, divide by n instead of n-1)
3. For each case of x and y, compute z by subtracting the mean, and then dividing by the standard deviation
4. For all n cases of corresponding x and y members, multiply their respective z values, and add their products
5. Divide the sum of the products by n

Project 1: Spatial and meteorological correlation in NY State.
Climate scientists are always looking for relations between different variables and try to predict one from the other. For example, precipitation is a much more difficult quantity to predict than surface temperature. One is tempted to predict precipitation or reconstruct precipitation from surface temperature. There are many reasons that one would expect the two variables are related. For example, in the winter, the cold air is often associated with high pressure and clear weather, whereas warm air is located at where the precipitation occurs (Norwegian cyclone model). In the summer, precipitation falling through the atmosphere will lead to evaporation, thus cooling the air. On the other hand, warmer surface temperature can lead to stronger instability and thus more precipitation. You are asked to explore the temperature and precipitation relationship at Central Park station and compute correlation between Central Park temperature and West Point temperature in a) January and in b) July. Which season shows a larger correlation in temperature?

Compute the correlation between temperature and precipitation for Central Park
for a) January and for b) July. Which season shows a stronger connection between temperature and precipitation. Why do you think this is?

In a global climate model (GCM, or general circulation model), the grid points are approximately 200 to 300 km apart, thus not able to distinguish places like Central Park and West Point, which is on order 50 miles apart. By examining the relation between Central Park temperature and West Point temperature, can you justify the use of large grid size in these models? Why or why not?

Project 2:
Greenhouse gases such as Carbon dioxide are well mixed in the atmosphere due to strong winds. Thus observations of CO2 concentration in Hawaii may be representative of CO2 concentrations anywhere in the earth atmosphere. Compute correlation between Mauna Loa carbon dioxide concentration (in parts

per million or ppm) and several other time series. Notice that the two series need to be the same length, so you should only correlate corresponding years.

Compute correlation between Mauna Loa CO2 concentration and
a) the Year
a) Yuma temperature in January.
b) Central Park temperature in January
c) Central Park precipitation in January
c) Perth winter precipitation (remember that it is in the Southern Hemisphere!)

Can you explain the magnitude and sign of the correlations you have just calculated?

Project 3: Climatology of NY
You often hear people say this winter is the coldest on record, or this winter is the snowiest on record. When a winter is very cold, does that mean every month in that winter is cold? Or just one out of the three months is cold and others are just normal or even considered warm? To focus the effort, in this project, you are asked to design a way to examine the January and February temperature in Central Park to answer the question of whether winter tend to take on a similar character during the two coldest months. Do hot summers tend also to be dry summers in New York? Explain your method and results.

When January temperature is below normal in New York, does February temperature tend also to be below normal? That is, does winter tend to take on a similar character during the two coldest months, or could the two months differ from one another (in anomaly) just as easily? Devise a way to examine this relationship and explain your methods and results.