Tropical Meteorology – Homework #4

Due Date: 7 April 2016

Whether a tropical cyclone develops/intensifies or dissipates/weakens is controlled in part by the atmospheric and oceanic conditions within its immediate environment. Of particular importance are the "necessary conditions" for tropical cyclone formation: warm sea surface temperature, high middle tropospheric relative humidity, large lower tropospheric cyclonic rotation, and small tropospheric-deep vertical wind shear.

In this assignment, you are to quantify the extent to which the "necessary conditions" for tropical cyclone formation are borne out by actual data from the environments of thirty developing and thirty dissipating Atlantic basin tropical cyclones. The data that are needed to do so are found at:

http://derecho.math.uwm.edu/classes/TropMet/assignments/hw4data

At this site, you will find two directories – strengthen and weaken – with thirty data files in each directory. You will also find documentation, 00README.txt, that describes the file format for the data files. Please read this file first before working with the data.

1. (20 pts) Testable hypotheses, relating the mean of one set of data (the 'strengthening' composite) to the mean of another set of data (the 'weakening' composite) are needed in order to accomplish the primary goal of this assignment. Please develop and list (on a separate sheet or the last page of this assignment) testable hypotheses for each of the four "necessary conditions" listed in the introduction to this assignment. Please also develop and list two additional testable hypotheses, one each for latitude and longitude.

2. (20 pts) In the table provided below, please list the mean values of each of the six variables described in Question 1 for both the strengthen and weaken composites. You will likely find it helpful to import the data for each composite into Excel (or similar) for this and all subsequent questions.

	Latitude (°N)	**Longitude (°W)**	**SST (°C)**	**RH (%)**	**ζ_{850} (10^{-7} s^{-1})**	**Shear Mag (kt)**
Strengthen						
Weaken						

3. (30 pts) To test each of the hypotheses that you developed in Question 1, you are to use a two-sided Student's *t*-test. There exist two versions of this test: one for use if the samples have equal variance and one for use if the samples have unequal variance.

In Microsoft Excel, whether or not two samples have equal variance can be determined using the F.TEST function. The result of this function is the two-tailed probability (as a fraction; multiply by 100 for a percentage) that two samples have *equal* variance. This hypothesis – that the two samples have equal variance – is rejected unless the probability returned by F.TEST is greater than or equal to 95%. In this case, the two samples are said to have equal variance to 95% confidence; otherwise, the two samples are said to have unequal variance.

For each of the six variables described in Question 1, please list in the table below the probability that the two samples have equal variance. List also whether the two samples have equal or unequal variance, as determined using the guidance given above.

	Latitude (°N)	**Longitude (°W)**	**SST (°C)**	**RH (%)**	**ζ_{850} (10^{-7} s^{-1})**	**Shear Mag (kt)**
Probability (%)						
Variances Equal?						

The values in the last row of this table determine which of the two-sided Student's *t*-tests that you are to use to test your hypotheses from Question 1.

4. (30 pts) In Microsoft Excel, the T.TEST function can be used to conduct the two-sided Student's *t*-tests described above. The result of this function is the probability (as a fraction; multiply by 100 for a percentage) that the means of the two samples are equal.

   To illustrate how this function can be used and how its output can be interpreted, consider the following hypothetical example. I have two samples, each with 31 elements: high temperatures from March 2015 and March 2016, both for Milwaukee. I wish to test the hypothesis that, at Milwaukee, the high temperatures for March 2016 are warmer than the high temperatures for March 2015. I have determined that the two samples have equal variance and applied the appropriate Student's *t*-test to the data accordingly. The T.TEST function returns the probability that the means of the two samples are equal.

   If the T.TEST probability is greater than 5%, the sample means are said to be equal. Thus, the hypothesis must be rejected, even if the mean high temperature is warmer in March 2016 than in March 2015. If the T.TEST probability is less than or equal to 5%, the sample means are said to be unequal. Whether the hypothesis is rejected or accepted hinges upon whether the mean high temperature is warmer in March 2016 than in March 2015: if so, the hypothesis is accepted; otherwise, the hypothesis is rejected.

With this example in mind, please list in the table below the probability that the two samples have equal means for each of the six variables described in Question 1. List also whether the hypothesis being tested for that variable is rejected or accepted. If it is rejected, please list why (i.e., is it rejected because the difference in the sample means is not statistically-significant or because the statistically-significant difference in the sample means is of opposite sign to that posed within your hypothesis?).

	Latitude (°N)	**Longitude (°W)**	**SST (°C)**	**RH (%)**	**ζ_{850} (10^{-7} s^{-1})**	**Shear Mag (kt)**
Probability (%)						
Hypothesis Rejected?						