Tropical Meteorology – Homework #4

Due Date: 5 April 2018

Learning Objectives: In this assignment, you will use relatively simple data analysis techniques to *evaluate* whether the "necessary conditions" for tropical cyclone formation are supported by an analysis of environmental data for 60 developing and dissipating Atlantic tropical cyclones.

Whether a tropical cyclone develops/intensifies or dissipates/weakens is controlled in part by the atmospheric and oceanic conditions within its immediate environment. These can be summarized by the "necessary conditions" for tropical cyclone formation: warm sea-surface temperature, high middle-tropospheric relative humidity, large lower-tropospheric cyclonic vorticity, and weak 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. (30 pts) Testable hypotheses, here relating the mean of one dataset (the 'developing' composite) to the mean of another dataset (the 'dissipating' composite) with a physically based rationale to underpin this relationship, are needed in order to accomplish the primary goal of this assignment. Please develop and list testable hypotheses for each of the four "necessary conditions" listed in the introduction to this assignment, as well as one each for latitude and longitude. Please pose each in terms of an inequality; i.e., "the _____ for the 'developing' composite is >/< that for the 'dissipating' composite because _____."

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

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

3. (20 pts) To test the hypotheses you developed in Question 1, we will assume that all data are normally distributed, allowing us 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. If the probability returned by F.TEST is ≤ 5%, the null hypothesis that the samples have equal variance is rejected and the two samples are said to have unequal variance (to 95% confidence); otherwise, the two samples are said to have equal 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. (20 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 *p*-value for the test of the null hypothesis that the sample means are equal. If the T.TEST *p*-value is < 0.05, the null hypothesis is rejected and the sample means are said to be unequal. If the T.TEST *p*-value is ≥ 0.05, the null hypothesis cannot be rejected and the sample means are said to be statistically equal.

   With this example in mind, please list in the table below the *p*-value that the two samples have equal means for each of the six variables described in Question 1. List also whether the null hypothesis being tested for that variable is rejected or accepted.

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

5. (10 pts) We now wish to use the results from #2, in which you found the sample means for each variable, and #4, in which you determined if a given pair of means were statistically equal, to evaluate the hypotheses posed in #1. There are two reasons why a hypothesis in #1 might be rejected:

   - The two sample means are statistically equal.
   - The two sample means are statistically unequal, but the inequality between them is of opposite sign to that in your hypothesis.

   Given this, please list whether each of your hypotheses from #1 is accepted or rejected and, if rejected, which of the two reasons above is why it is rejected.

Please turn in your Excel worksheet or code, preferably by email, with your completed assignment.