PROJECT on TROPICAL CYCLONES AND CLIMATE CHANGE

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This is a semester-long project assigned to senior undergraduates majoring in meteorology; this is their only class in tropical meteorology

This five-part project is worth 40% of the students' final grades

Note on referencing relevant to all projects

A separate, complete list of references is required for every paper you hand in. *When quoting a paper in your text, use the form "author (year)" or "(author year)."* References should be listed alphabetically in the format used in the American Meteorological Society journals. A collection of these journals is housed in the Department's Blackadar Library (Room 529 Walker) or they may be found online at http://ams.allenpress.com/amsonline/?request=index-html

Website references alone are not acceptable. Hard copy materials must also be used. Only University or government websites relevant to the topic are acceptable as one form of reference source. Should you choose to use a site like Wikipedia, you must find a second, corroborating source.

Context

Students have generally completed required courses in dynamical meteorology and physical meteorology (2 semesters of each) as well as required synoptic meteorology. They have not had any prior tropical meteorology classes and very few have taken a climate or climate change class.

Learning objectives for this class

1. Develop broad based skills in scientific problem solving;
2. Develop the ability to review and synthesize the scientific literature;
3. Demonstrate knowledge of the current theories for tropical cyclone genesis, intensification and motion;
4. Demonstrate knowledge of the role of the tropics in the general circulation;
5. Demonstrate the ability to synthesize diverse data and model sources to provide a comprehensive picture of the evolving atmospheric flow;
6. Demonstrate the ability to forecast tropical cyclone track and intensity.

Outline of this project

The project has five components

1. Initial short opinion paper
2. In-class exercises on data sampling, trend analysis, extrapolation, filtering and data quality
3. Group presentation (30 minutes plus questions) on a relevant journal article agreed with the instructor
4. Individual data analysis project on a topic agreed in advance with the instructor
5. Final opinion paper presenting their perspective on the topic. In contrast to the first opinion paper (which is very informal) students are expected to put this paper in context based on the class exercises and lectures during the course of the semester, as well as any relevant external materials.

Specific goals for this project

1. Encourage students to think critically about their science with the goal that they will critically assess the information presented based upon their professional training. The choice of this hotly and publically debated topic provides ample motivation to engage them.
2. Develop the students' abilities to read and evaluate the scientific literature. Engender an awareness of the need for continuing professional education, even among those who intend to be practitioners and don't think of themselves as researchers.
3. Develop the students' awareness of data quality and data sampling issues.
4. Create a variety of learning and teaching environments, where students help each other learn through group work (with group configurations changing for different subprojects).
5. Develop students' public speaking skills: this includes interactive classroom discussions, formal and informal presentations.
6. Develop students' writing skills through short opinion papers and a longer data project.
7. Synthesize all of these tools through the individual data analysis project.
8. Synthesize the variety of knowledge gained via both the data analysis project and the final term paper.

PROJECT ONE: TROPICAL CYCLONES AND GLOBAL WARMING

Part 1: Position paper #1

The purpose of this component of the project is to inspire each class member to review their perspective on the role of climate in modulating tropical cyclones; in particular, whether any change might be expected to the characteristics (e.g. annual frequency, range or distribution of intensities, mean tracks) of tropical cyclones due to global warming. Class members are *not* required to provide any attribution for the observed historical warming.

The paper may be as short as 1–2 pages (including figures, tables and references), or as long as it takes to completely support the arguments presented. It must be submitted online and is due no later than 2:30pm (the start of class) on Friday, 12 September.

Part 2: In class exercise

This will be a team exercise, designed to explore the effects of sampling on analysis of a dataset. More details will be provided at the beginning of class on Monday, 22 September. See below for more details.

Part 3: Data and model analysis group presentation

This will be a team exercise to familiarize the class with the most recent journal articles analyzing the historical record or climate models for climate signals or possible signs of climate change. A list of potential journal articles will be provided.

You may choose your groups for this in consultation with me. Groups should be different from your forecasting group for Project #2.

All group presentations will be due at 2:30 pm (the beginning of class) on Wednesday, 15 October.

Note on referencing relevant to all projects

A separate, complete list of references is required for every paper you hand in. *When quoting a paper in your text, use the form "author (year)" or "(author year)."* References should be listed alphabetically in the format used in the American Meteorological Society journals. A collection of these journals is housed in the Department's Blackadar Library (Room 529 Walker) or they may be found online at http://ams.allenpress.com/amsonline/?request=index-html

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Part 4: Historical data analysis of climate signals
Individual class members will explore climate signals in the tropical cyclone record. Each person must agree their proposed topic with me and provide information on their data sources no later than Monday, 22 September.

A number of class periods (dates to be advised) will be devoted to this project.

This must be submitted online and is due at the start of class on Monday, 1 December.

Part 5: Position paper #2
The purpose of this component of the project is to revisit the question of the potential role of global warming in modulating tropical cyclone characteristics (e.g. annual frequency, range of intensities, mean tracks).

The paper may 3–5 pages of text (plus figures, tables and a formal reference list), or as long as it takes to completely support the arguments presented. Once again, the paper must be submitted online and is due at 2:30 pm on Wednesday, 10 December.

Project 1.2, In-Class Exercise: The Historical Tropical Cyclone Record

Objectives: To analyze a historical database and to make inferences about long-term changes in this record from differing samples of data. To evaluate the characteristics and limitations of a given dataset and to assess how data availability and quality may impact your conclusions.

You are given an Excel spreadsheet containing almost 160 years of tropical cyclone frequency data for a basin of my choice (these need not be the North Atlantic).

Phase 1

Each team will plot ten randomly selected datapoints from the historical record of tropical cyclone activity (frequency of storms per year). These data will be drawn randomly from the list given in Excel using the built-in random number generator.

a. Plot the 10 data points on a scatter plot. The graph has years on the abscissa (x-axis) and frequency on the ordinate (y-axis). Use the example graph to set your size for the datapoints. Make sure that more than one person in the group is involved in preparing and checking the graph.
b. Draw a linear trend line on your graph. Based on these data, what is the average number of tropical cyclones per year? What are the maximum and minimum? Record your results in a table.
c. Based on this slope, how many hurricanes would you expect to see in 2010? In 50 years from now? 100 years from now? Record your results in a table.
d. Based on this slope, how many hurricanes would you have expected to see in 1931? 1933? 1956? 2001? How did your numbers compare with the historical records for that year? Record your results in the table.
e. Think: do your results from the predictions and hindcasts surprise you? Why or why not? This will be a discussion point in the class, so be prepared.

Phase 2

Each team will plot an additional ten randomly selected data points from the historical record of tropical cyclone activity (frequency of storms per year) for the same basin (draw from the same data records used in part 1 of this exercise). Once again, use the Excel random number generator to draw 10 samples from the possible observations. If you sample a year drawn in your first round, take an additional sample. You should end up with 10 **new** years worth of data.

At this stage, we will only work with the new data. Repeat each of the steps for Phase 1 comparing your results.

Phase 3

We will now consider the entire 20 years worth of historical data sampled. Repeat each of the steps for Phase 1 comparing your results with the two individual samples.

Phase 4

We will now consider the entire historical data record. Repeat each of the steps for Phase 1 intercomparing all of your results.

Phase 5

Consolidate your graphs and tables of results for the four completed phases into an Excel file labeled with your team name and the exercise # e.g. *Team 1-Initial.xls*. Email this to me and I will share the results with the class.

Phase 6

First assign a group "recorder" to document the discussion and a group "reporter" to summarize these discussion notes back to the class. Discuss:

a. Potential reasons for any differences you may have observed between the two subsets of data;
b. Sources of any differences between the subsets and the complete dataset;
c. Assumptions you have used implicitly in determining your slopes;
d. The effect of considering a shorter record on your conclusions;
e. Criteria for an ideal dataset to answer the question "How is tropical cyclone frequency changing through time?"

Phase 7

Create three randomly generated series of 100 numbers. They should be scaled so that the first column represent tropical cyclone activity in a basin ("0-25 storms"), the second column symbolizes SST ("22-32°C") and the third column is an ENSO index (-1, 0 and 1).

Take linear correlations of each variable with the others.

Now run a "5-year" running mean filter across each column and calculate correlations

Now run a "20-year" running mean filter across each column and re-calculate the correlations.

Phase 8

We will meet in a full class discussion to review your responses.