Summer Research Fellowship Proposal

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Page 1

Summer Research Fellowship Proposal (no more than 4-pages double-spaced = 1,200 words in length).

Summer Undergraduate Research Fellowship

Comprehensive Analysis of Tornadic Daily Cycles from 1979 to 2013. Student Investigator: S Mentor: M

Introduction:

Tornadoes can occur at any time throughout the diurnal cycle; however, the probability of them occurring is not constant throughout that cycle. Historical records show the peak tornado activity in the United States is around the mid-afternoon between noon and sunset (Kelly et al. 1978). While this peak appears to be constant across space and time, there seems to be changes in the diurnal cycle based on season and location throughout the United States. While the severe storms event data set for the United States, which dates back to 1950, still has some inherent errors associated with it (Doswell et al. 1988) it is the best data available for analyzing tornado occurrences. The objective of this research is to: (1) create a modern extension of Kelly et al (1978) work by repeating some of his methods for the most recent 35 years (1979-2013) of tornado data across the United States; and (2) examine the diurnal shifts in the conditions that lead to tornadoes to further understand why a mid-afternoon peak occurs. Specifically, I will analyze the daily and seasonal patterns of tornadoes and the associated meteorological conditions for the United States and then by various physiographic regions..

Data and Methods:

The proposed study will entail a comprehensive analysis of tornadic activity from 1979-2013 across the United States. This 35-year period is ideal because the time frame creates consistent, compatible, and stabilized patterns of tornado occurrences in the United States (Schaefer et al., 1993). The tornado data collected for the 1979-2013 time period will come from the Storm Prediction Center (SPC; www.spc.noaa.gov). An important aspect of determining the diurnal effects of tornadoes is to convert the time of occurrence from local standard time to a sun time **(Kelly et al. 1978)**. This process uses the local time of tornado initiation from the SPC dataset and the latitude and longitude coordinates for initiation. From that data, a sun time value can be determined which sets sunrise as the 0600 hour and sunset as the 1800 hour of the 24 hour day. The SPC data will allow us to analyze when the tornadoes transpired and if they match the diurnal cycles and mid-afternoon peak pattern from Kelly et al. (1978).

In addition, I will be analyzing the hourly intervals as a whole and also by seasonal variations. I will look at the f**our meteorological seasons** to determine if the diurnal pattern of tornado occurrences changes throughout the seasonal cycle. Another facet of this research is comparing the daily cycles in **different physiographic regions**. I specifically want to observe known tornado prone regions. However, I will let the **spatial pattern of occurrences** dictate the defined regions and determine appropriate names for each region.

After the tornado data is analyzed across the multiple spatial and temporal scales, the meteorological conditions (on the days in which

Reviewer 2: Nowhere in this proposal did I see acknowledgment of how the student will acquire new skills or experiences. In addition, no reference to how the research will be carried out during the next academic year.

Reviewer 2: Title matches the content in the proposal. Also note that proposal is dived into sections. Every proposal should have section headings.

Reviewer 3: This statement bridges the gap between what is known (the diurnal pattern of tornado occurrence) and what remains to be studied (a more comprehensive understanding of tornado distribution across space and time). It is important to establish that the research project will address an important question, as the author has done here.

Reviewer 4: Solid statement of purpose and intent.

Reviewer 2: Excellent Introduction. It presents a short overview of the topic to be studied and explicitly states the research questions early on. I would add one more sentence that states what the rest of the proposal will included. Let the reader know what to expect in the rest of the proposal.

Reviewer 1: Clear objectives

Reviewer 4: Like to see this narrative "broken up" into smaller sections dealing procedure, universe, variables (definition and measurement), data analysis, etc. or whatever categories you deem most appropriate.

Reviewer 1: Might want to explain why this is an important aspect of the study as not everyone who reads this may be as familiar with the topic as you are.

Reviewer 2: Excellent citations. Too often students fail to cite correctly. This is something that the mentor has surely instilled in the student.

Reviewer 3: This description is concise, but still follows a logical order and explains the method in such a way that it can be understood by specialists and non-scientists.

Reviewer 2: Explain what these are.

Reviewer 2: Physiographic regions already have names and geographic boundaries. Your spatial pattern of tornadoes will fit into or span multiple physiographic regions. Something here is a little off.

Reviewer 1: Such as? Some examples might help

tornadoes occurred) will be analyzed to see if there is a diurnal cycle pattern in atmospheric conditions. For this study, I will focus on the large synoptic-scale conditions that most often lead to severe thunderstorms producing tornadoes. The parameters will include convective available potential energy (CAPE), wind shear, mid-tropospheric trough axes, and low level jets (LLJ).

CAPE is a measure of the amount of energy available for convection. The higher the CAPE value the greater the probability for severe thunderstorms to occur. Wind shear is the rate at which wind velocity change vertically either by direction, speed, or a combination of the two. Vertical wind shear is important in tornado formation because it creates a rolling effect in the atmosphere that can be ingested by a thunderstorm to create a mesocyclone, which can later in the lifecycle of the storm produce to a tornado, or a tornadic circulation. Troughs are an extended area of low pressure which leads to further enhancement of rising motion in the atmosphere needed to intensify a thunderstorm. LLJ are a region of strong winds in the lower atmosphere which in the United States provide additional heat and moisture to a thunderstorm thus enhancing the energy available. All of these components aid in the development of severe weather and tornado initiation (Doswell 2001).

The meteorological data will be collected from the Earth System Research Laboratory's (ESRL; www.esrl.noaa.gov) archive of the North American Regional Reanalysis (NARR) data set (Messinger et al. 2006). This data set contains gridded atmospheric and surface data at a 32-km spatial resolution and 3-hour temporal resolution across most of the North American continent and surrounding bodies of water from 1979 through present (Messinger et al. 2006). From ESRL's website, the specific dates and times of events can be entered to create average conditions of any atmospheric or surface parameters contained within the dataset. Maps can either be produced through the website or the gridded data can be downloaded for plotting in other visualization software. At this time, I am not sure which method will best suit this project and will decide as this step in the research is reached.

Conclusions:

This research can also be extended in the future to investigate the intensity of storms in relation to the Enhanced Fujita (EF) scale. Is there a pattern occurring with the time of day and the intensity of the tornado? I will investigate this question by comparing the times the tornadoes occurred with their intensities to see if each damage level, as rated by the EF-scale, follows the same diurnal curve.

While I believe this is important it will only be attempted if time allows after completing all of the work above. **If a pattern emerges from the proposed research** or this future research it would be useful in helping forecasters make better predictions of the severity of storms.. One of the mysteries of meteorology is being able to better predict how destructive a storm might become and thus any recognizable pattern could help meteorologist predict and prepare communities about to be struck by these violent storms. If I can successfully explain why the majority of tornadoes every year tend to arise in this time frame maybe it will help meteorologists better understand the formation and development of tornadoes. Once science understands what leads to a thunderstorm cloud forming a tornado versus one that won't we can possibly better predict when they will occur or not. **This is important to better prepare communities and individuals to lead them to safety**..

Bibliography

Doswell, C.A., 2001: Severe Convective Storms. Published in Meteorological Monograph No. 50: Severe

Reviewer 3: It can be helpful to have the steps outlined, with a clear order that they should happen in.

Reviewer 1: As not everyone reading this is as familiar with the topic as you, you might want to briefly explain what these are

Reviewer 1: It is good that you included a description of this

Reviewer 2: Nicely defined.....up to this point the proposal is reading very well.

Reviewer 3: These definitions are helpful to bring people up to speed who are not experts in the field. They also are helpful because each term has a component that could be used for modeling where and when tornadoes occur.

Reviewer 2: I would have liked to see what potential statistical analyses will be used in the analysis.

Reviewer 3: In this paragraph the student outlines how they will collect data. Knowing that the data are publicly available means that there will be no obstacles or delay in getting data for the study.

Reviewer 4: Not really at the point of conclusions yet.....a more appropriate heading might be "Significance"

Reviewer 3: This is one way of phrasing the hypothesis, as a question that already supposes an answer (i.e., that there is a pattern).

Reviewer 2: This is not conclusion material. It should have been included in the data and methods section.

Reviewer 3: This sentence and the rest of the paragraph explain how the results of the study could be more widely useful for the general public.

Reviewer 4: Like to see much more on direct benefits to student both short-term and long-term, especially with regard to career orientation.

Reviewer 2: This is conclusion material.

Reviewer 4: Overall, a reasonable proposal with a need for information on benefits to student. Try to minimize use of first-person writing throughout.

Convective Storms, Edited by C.A. Doswell, American Meteorological Society, 1-26.
Doswell, C.A. and D.W. Burgess, 1988: On Some Issues of United States Tornado Climatology. Monthly Weather Review, 116, 495-501.
Kelly, D.L., J.T. Schaefer, R.P. McNulty, C.A. Doswell, and R.F. Abbey, 1978: An Augmented Tornado Climatology. Monthly Weather Review, 106, 1172-83.
Messinger, F. et al., 2006: North American Regional Reanalysis. Bulletin of the American Meteorological Society, 87, 343-360. Schaefer, J.T., R.L. Livingston, F.P. Ostby, and P.W. Leftwich, 1993: The Stability of Climatological Tornado Data. Published in The Tornado: Its Structure, Dynamics, Prediction, and Hazards, American Geophysical Union, p 459-466.

Reviewer 2: Well done.

Applicants may upload one additional file containing an image, graphic, and/or diagram germane to the proposal. Applicants are encouraged to label their image, graphic,and/or diagram in the file upload as well as the narrative text in order to facilitate review. This is an optional attachment and not required for proposal submission.

Applicants may not upload any other file nor may applicants use this upload feature for additional text/information related to the proposal narrative. Files uploaded that include additional text as part of the narrative will not be forwarded to the reviewers.

Timetable

Reviewer 2: Well defined. Week 3 seems a little early to start GIS maps.

Week 1: (June 2nd -6th) Conduct background research on recent tornado climatology papers similar to Kelly et al. 1978.

Week 2: (June 9th -13th) Collect tornado data from Storm Prediction Center and also conclude background research. Create an annotated bibliography of all sources that can be included in research portfolio.

Week 3: (June 16th -20th) Begin analysis of tornado data and creation of maps using ArcGIS.

Week 4: (June 23rd -27th) Continuation of tornado data analysis and begin to view meteorological seasons and regional break downs.

Week 5: (June 30th -July 4th) Collect meteorological conditions data from North American Regional Reanalysis.

Week 6: (July 7th -11th) Analyze patterns between meteorological conditions and tornado data.

Week 7: (July 14th -18th) Continue to analyze patterns between datum.

Week 8: (July 21st -25th) Finalize research and finish maps, along with beginning poster

creation.

Week 9: (July 28th -August 1st) Finish poster, report and portfolio.

Week 10: (August 4th -8th) Edit, proofread, make revisions, and finalize all written work as well as make final touches to the poster presentation.

KEY TERMS: tornadoes, diurnal effects of tornadoes, tornado activity, tornado occurrence sun time