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Use of MRMS Mosaics to Analyze the Frequency of Pop-Up Windstorms

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Problem Statement

Many have heard of the phrase, "If a tree fell in a forest when nobody witnessed it, did it ever really happen?". From an objective standpoint, the tree still fell despite the lack of witnesses. However, the same occurrence often happens with air mass thunderstorms. What may have begun as an air mass thunderstorm can quickly develop into an enhanced wind event (i.e., a so-called "pop-up windstorm") due to a variety of factors, especially due to topography such as mountain ranges. These storms can become hazardous to people in the area, and even more so due to sparse reporting of these events. One specific issue is that Automated Surface Observation Stations (ASOS) and first-person reports tend to disagree and be spread out. ASOS stations are typically located at airports and consist of various instruments that record weather data (barometers, anemometers, etc.). This sounds great in theory, however, many of these stations are in open spaces on level ground. They are also typically in populated areas. This can lead to an inaccurate reflection of weather events since more factors such as terrain and temperatures tend to change in surrounding areas. This discrepancy is very noticeable when comparing ASOS reports to first-person reports of wind events.

Previous research from 2003 depicts this discrepancy in maps that show the frequency of severe (>= 50 kt) wind reports via both ASOS and first-person accounts across the US [4]. It is interesting to note that on the east coast, the number of ASOS reports greatly disagrees with the number of first-person reports, with the frequency of ASOS wind reports being less than frequency of first-person reports. The opposite seems to occur over the Rocky Mountains. The goal of this project is to identify radar as a third source of wind report information to begin to unravel the actual frequency of wind reports for a number of case studies, along with ASOS and first person reports. To help further this research, a case study will also be conducted on a severe wind event the student researcher experienced in the southeastern Appalachian Mountains. This area is known to have many discrepancies between ASOS and in-person reports (with in-person reports suggesting more severe wind events than ASOS does). It would be useful to use radar to see which reports were more accurate. These three resources can actually be combined to analyze the location and intensity of severe wind events by combining ASOS and first-person wind reports, and then by comparing these reports to the available radar data.

Resources

The first tool that will be used is the Multi-Radar Multi-Sensor (MRMS) project. MRMS was developed by the National Oceanic Atmospheric Administration (NOAA) National Severe Storms Laboratory (NSSL). According to the NSSL MRMS website, the project, "integrates data from multiple radars and radar networks, surface observations, numerical weather prediction (NWP) models, and [climatology] to generate seamless, high spatio-temporal resolution mosaics" [1]. This product integrates far more data than radar alone, making it a very useful tool in analyzing weather patterns. A second tool that will prove useful in locating pop-up wind events is a software called mPING. mMPING was also developed by the NOAA NSSL and is designed to collect first-person weather reports from the public. Once it receives input, it archives it in the University of Oklahoma database and indicates the data on a map visible to the public [2]. This app can even be installed on a mobile device for report submission and viewing. Both MRMS and mPING can be used to compare real time storms and data that extends back to October of 2020. A couple of other tools that may be useful to this project are archived radar data and MMM-Py by Timothy Lang. Archived radar data, such as that from the KGSP – the Greer South Carolina WSR-88D – would be needed to analyze past wind events like what the student researcher experienced, which was in Asheville, North Carolina. This sort of data can also go back further than MRMS, making it useful for pattern analysis. A last tool that would be useful is Timothy Lang's MMM-Py software. This software is intended to, "read any version of the MRMS radar mosaics, past or present, and you can analyze, plot, subsection, and output custom mosaics of your own, which MMM-Py can ingest later" [3]. This means that a researcher is not limited to the MRMS mosaics, but they can also download the data and create unique mosaics of their own. This may be applicable to creating a map to reflect the frequency of wind events via radar data. MMM-Py may require a bit of Python experience, but this would also be a useful skill for the student researcher to learn.

Proposed Research

The project will begin on Tuesday, May 31 and continue through Friday, August 5, 2022, in accordance with the ten-week University of Alabama in Huntsville (UAH) summer semester. The first week will be spent becoming familiar with MRMS and mPING softwares. This will involve learning how they were created, how to download and work with data, and how to interpret the mosaics or report maps. The following two weeks will be spent looking at past radar data to find signatures of wind events in air mass thunderstorms. These signatures will be compared to ASOS station reports as well as first-person reports. It would also be interesting to compare MRMS mosaics to local radar data. Once a pattern for the wind events is found, the following weeks of the project will be spent using MRMS and mPING to locate real time wind events from air mass thunderstorms. This is a common occurrence during the project period, and thunderstorm hotspots such as Florida may be particularly useful.

Research will be conducted in the SWIRLL building in either the SWIRLL OPS or a SWIRLL student office. This will allow the student researcher to use computer resources provided by the NSSTC IT as well as to have weekly meetings and discussions with the project mentor, whose office is also in the SWIRLL building.

If the ongoing COVID-19 pandemic were to render in-person work impossible, coordination with the NSSTC IT department will allow remote access to the necessary software. Zoom meetings will also be arranged at least once a week in order to ensure the project continues as planned. Progress throughout the project will be recorded as to whether MRMS mosaics are accurate in locating pop-up wind events. This may be useful for future researchers in locating and forecasting these events. If time allows, MMM-Py software will be used to learn Python coding skills as well as to create unique mosaics to display wind events via MRMS.

Conclusion

This research will both help the student researcher to better understand a severe wind event they experienced in the southeastern Appalachian Mountains as well as to help the public stay safe and informed. Since pop-up wind events are underreported by ASOS stations, which conflicts with first person reports, MRMS may be a useful alternative resource for locating and reporting wind events from air mass thunderstorms. This research will assist in identifying these storms and protecting people as they go about their day, especially in the socially active and storm ridden seasons of spring and summer.

References:

[1]

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