



The Correlation between Radar Velocity Profile Data and Wind Advisory Verification



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INTRODUCTION

Wind events are weather phenomena that some people don't take seriously, although they are known to cause damage to nature and property. This is why the purpose of this study is to make future wind advisories more accurate by collecting past wind advisories that covered the Rio Grande Valley and setting some new parameters for a wind decision tree. Iowa State University Agricultural Mesonet, National Climate Data Center and University of Wyoming Department of Atmospheric Sciences data were used to examine these new parameters out of total of 134 wind event days from January 2007 to June 2012 in the Rio Grande Valley.

The National Weather Service (NWS) in Brownsville, Texas defines a wind event when wind speeds exceed 13 m s^{-1} and wind gusts exceed 18 m s^{-1} for 2 hours or more. The Rio Grande Valley typically sees stronger wind events from February to May, mostly during day time hours.

During the winter months, the jet stream climatologically extends across the Rockies and induces surface lee troughing in the Central Plains. When this occurs, the stronger jet stream winds will induce deeper surface low pressure. After a front passes across the eastern United States, strong polar high pressure (behind the front) will typically settle across the eastern United States or the northern Gulf of Mexico. The gradient between these two features sets up gusty southeast winds across of most south Texas.

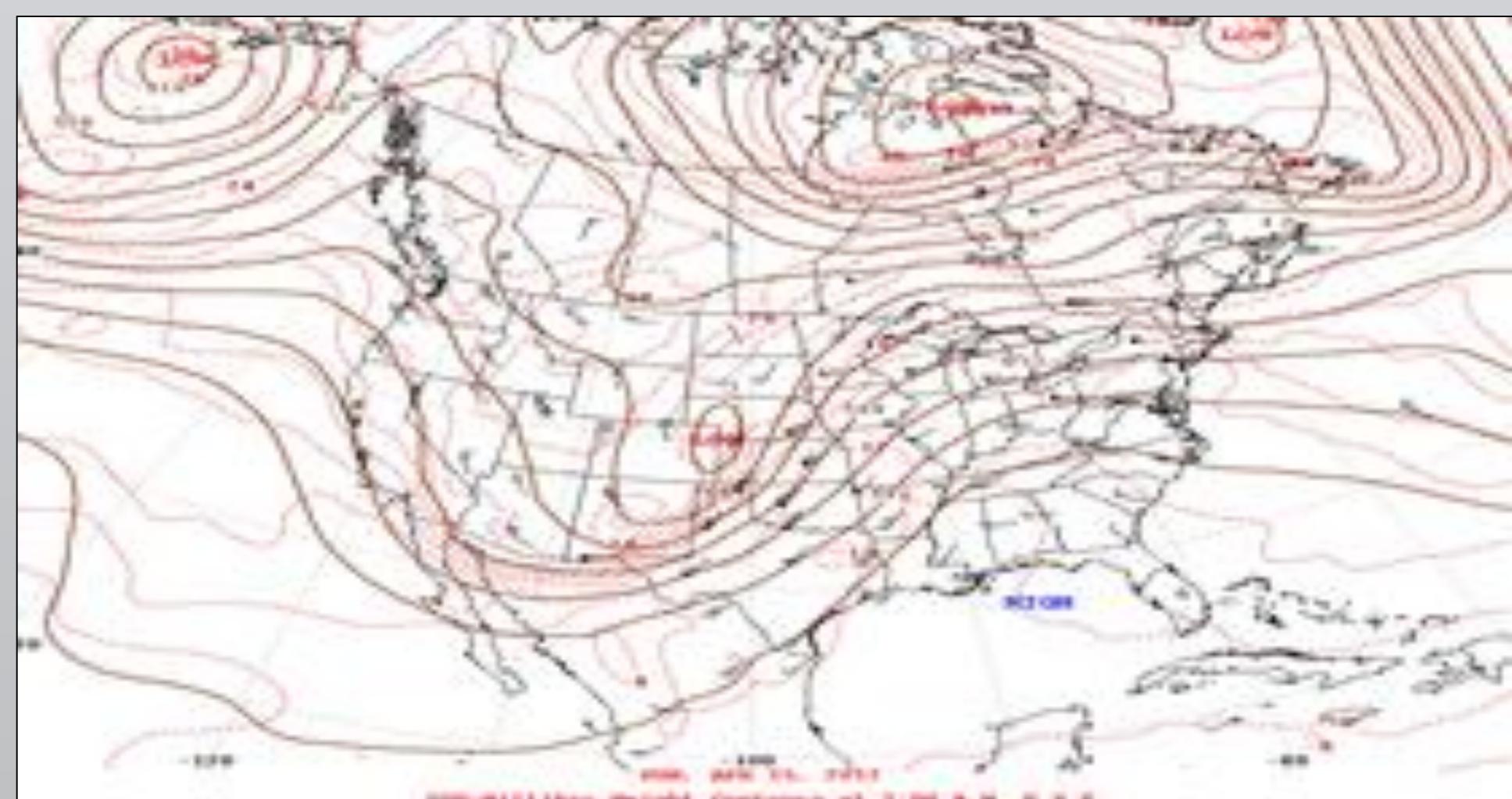


Figure 1. An example of a 500 hPa map.

During the night-time hours, winds will decouple from the surface, forming a tight low-level jet streak. Usually, this is located above the nighttime inversion. Daytime heating will weaken the inversion, allowing wind speeds associated with the jet stream to be pulled down to the surface by mechanical mixing. This explains why there are more wind events during the day.

This study will determine the correlation between the strength of the low level jet during the predawn hours and the maximum surface winds observed during the day. The scenario described happens exclusively with southeast wind events.

STUDY REGION

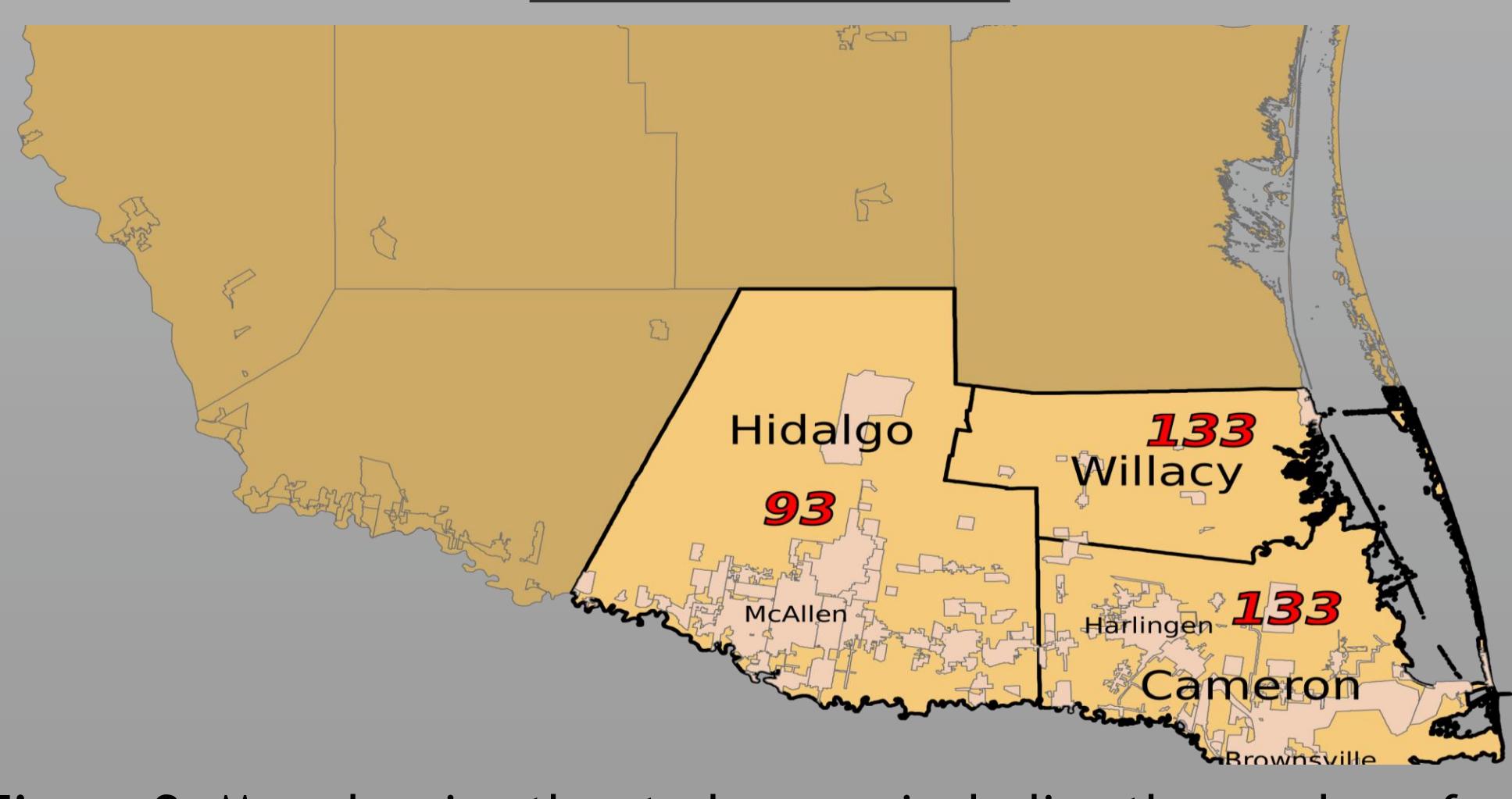


Figure 2. Map showing the study area, including the number of wind advisories by county. The study area is outlined in black.

METHODOLOGY

Past wind advisories from January 2007 to June 2012 were collected from the archives at Iowa State University Agricultural Mesonet (ISU 2012a)(ISU 2012b). These advisories allowed the authors to better assess the areas where advisories were issued and for what time period. Radar data from the Brownsville, Texas WSR-88D was collected from the National Climatic Data Center (NCDC)(NCDC 2012) to analyze velocity azimuth display wind profile (VWP) information. Sounding data from the NWS Brownsville upper-air site were collected from the University of Wyoming Department of Atmospheric Sciences(UW 2012) and analyzed using commercially available software. These data were used to confirm VWP data and compute the surface inversion level.

The wind advisories were organized by year and the dates and times in which they were in effect. Wind speed, maximum wind speed, maximum gust speed and wind direction for each advisory was acquired at the Weather Underground (WU 2012) website. From January 2007 to June 2012 there were 134 wind events. These events were then separated into northerly and southerly groupings based upon the predominant wind direction, as shown in Figure 3.

A total of 21 northerly events were acknowledged, which were not caused by the southeast low-level jet mechanics studied here. Thus, these 21 events were excluded from the study.

Next, advisories related to the remaining events (including those which were canceled) were organized by month. The data were further stratified by month (Figures 4 and 5). This was done to know in order to aid in the determination of the peak months for wind advisories.

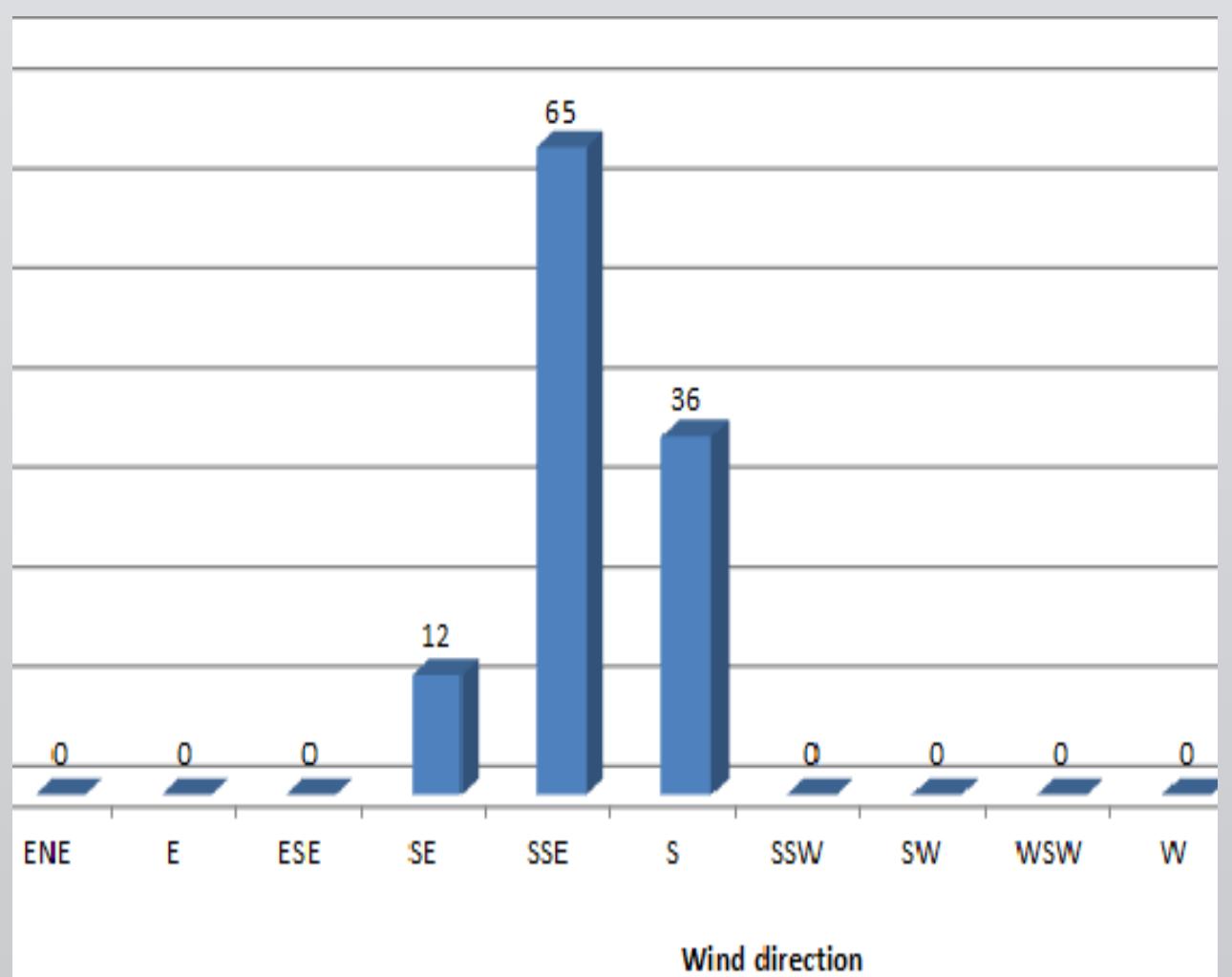


Figure 3. Events grouped by wind direction.

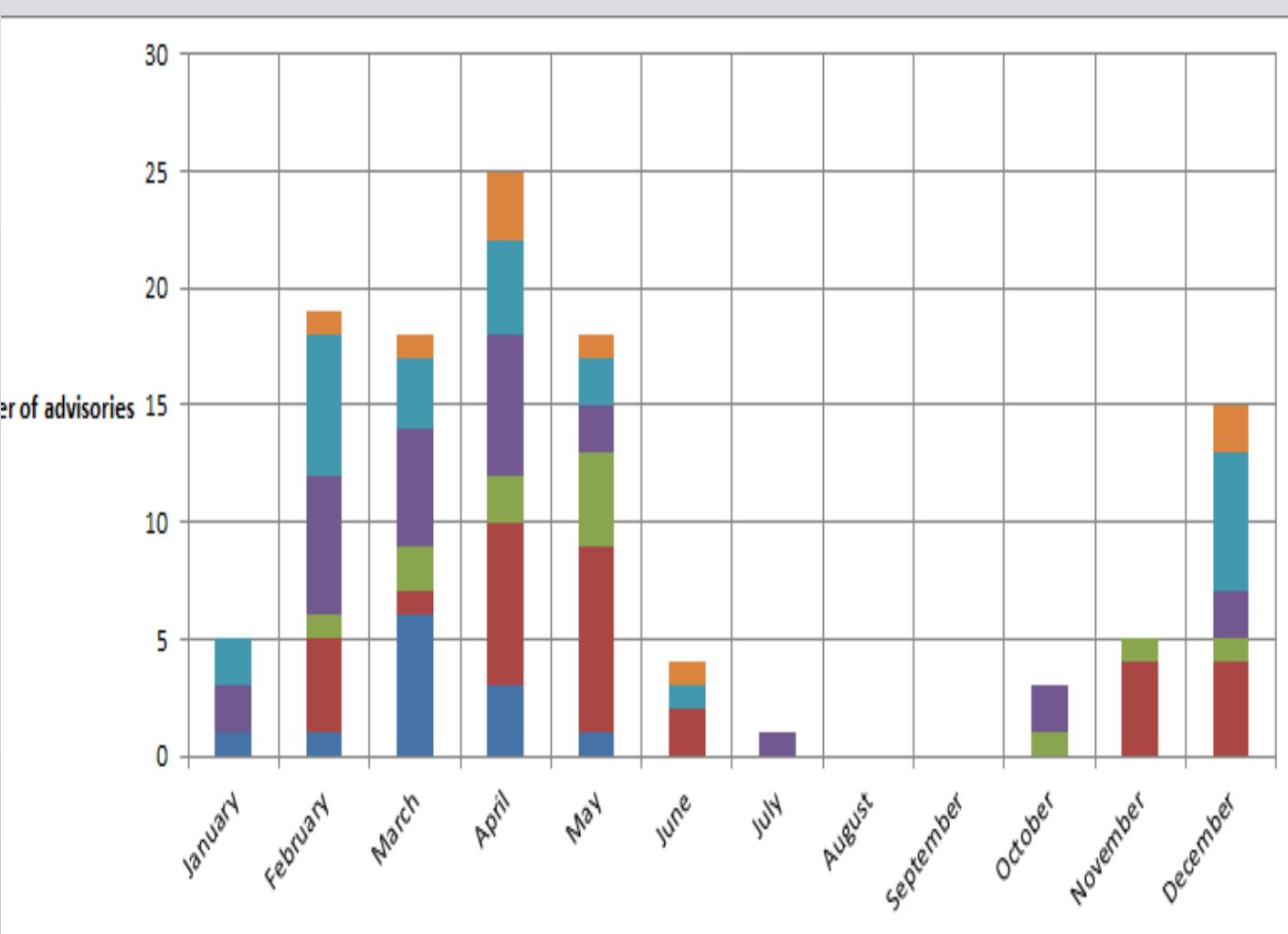


Figure 4. Southerly wind advisories grouped by month.

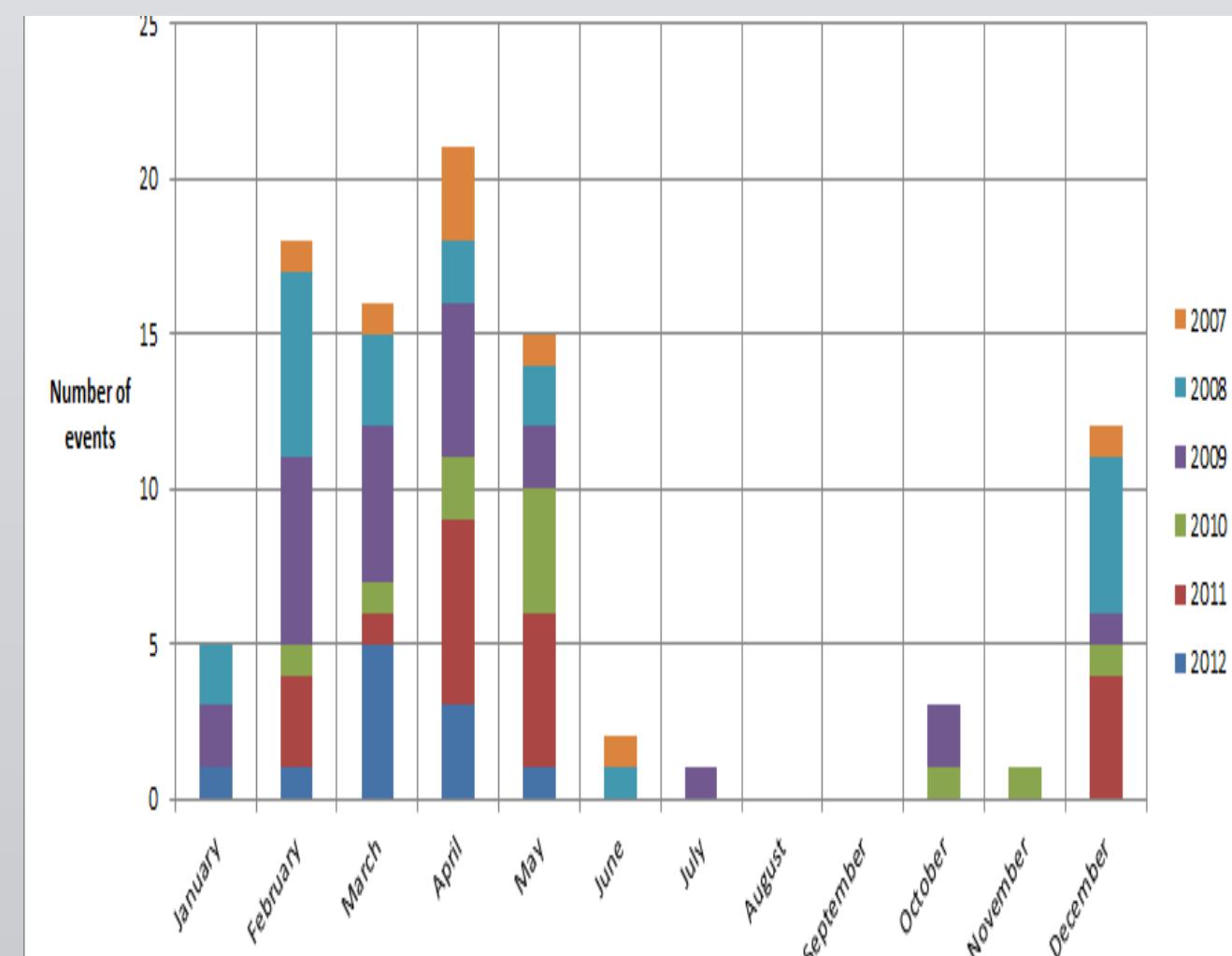


Figure 5. Verified southerly wind events by month.

Wind advisories were also separated by hour. This was completed in order to know at what time of the day they were the most likely to occur. Based on the data, the peak event time occurred between 1700 and 2359 UTC. This is coincident with maximum solar insolation. Nighttime events did occur, but were much rarer.

For each wind event, the corresponding low-level jet height and maximum wind speed were added. Data was collected between 1300 and 1800 UTC, because jet stream wind speeds are strongest during this period. This makes it easier to diagnose.

Comparing the data, it was found that the strongest low-level jet stream winds occur in the months in which wind events are the most common (February through May). Both the number of events and wind speeds significantly diminish between June and November. This is because the jet stream moves north to Canada during the summer. As a result, low pressure moves with it, so the low level jet will lose strength and largely diminish until winter starts.

The results were then re-analyzed, based on varying thresholds. These demarcations were selected based on how the POD, FAR, and CSI were positively or negatively affected. The five highest-scoring thresholds are displayed in Table 1.

RESULTS & ANALYSIS

Figures 4 and 5 show the main peak of the wind advisory season falls between February and May, then diminishes abruptly in June as the northern jet stream retreats into Canada. This indicates the peak strength of the local low-level jet streak also happens during those months. Table 1 shows the results of all 113 wind advisory events with south winds from 2007 through the first half of 2012. Of the 113 southerly wind advisory events collected from January 2007 to June 2012, 79 verified without being canceled and 15 advisories were canceled but still verified. This yields an initial probability of detection (POD) of 0.904. Nineteen events were analyzed and did not verify, equaling a false alarm ratio (FAR) of 0.168. This results in a critical skill index (CSI) of 0.764. An additional ten events met advisory criteria, but did not have wind advisories issued for them.

	POD	FAR	CSI
28 m s⁻¹	0.505	0.037	0.495
26 m s⁻¹	0.699	0.100	0.649
28 m s⁻¹/23 m s⁻¹	0.689	0.113	0.634
26 m s⁻¹/23 m s⁻¹	0.777	0.121	0.702
23 m s⁻¹	0.825	0.133	0.733

Table 1 shows the analysis of five scenarios to find which, if any, threshold can accurately be used to solely trigger the issuance of a wind advisory. The four scenarios used either a 26 or 28 m s^{-1} threshold for the entire year, or used a separate, stronger threshold for the peak months of March through May. If a separate threshold was used, 26 or 28 m s^{-1} were used for the peak months, while 23 m s^{-1} was used for the off-peak months.

Table 1, when compared to the pre-analysis results, shows that even with a lower initial threshold, the FAR improvements do not appear to adequately offset the losses in POD for any scenario.

Table 1. Illustration of the probability of detection, false alarm rate and critical success index for five wind thresholds

	Verified	Not Verified	Cancelled verified	Cancelled not verified	Total
Jan	5				5
Feb	15	1	3		19
Mar	14	1	2	2	19
Apr	19	2	2	1	24
May	12	1	3	2	18
Jun	2	2			4
Jul	1				1
Aug					
Sep					
Oct	1		2		3
Nov	1	1		3	5
Dec	9	3	3		15
Total	79	11	15	8	113

Table 2. Results of all southerly wind advisories from 2007 to 2012 separated by month.

CONCLUSIONS

Finding a specific threshold usable for determining the viability of issuing a wind advisory was not attainable in this specific case. While using the VWP from the KBRO radar alone did not attain improvements, other, ongoing research combined with these results, may provide a useful decision tool for further improvement of wind advisory detection and improvement of verification scores in the region.

REFERENCES

- Iowa State University (ISU), cited 2012a: Iowa State University Archives. [Available online at <http://mtarchive.geol.iastate.edu/>]
- Iowa State University (ISU), cited 2012b: Iowa Environmental Mesonet. [Available online at <http://mesonet.agron.iastate.edu/wx/afos/>]
- National Climatic Data Center (NCDC), cited 2012: Radar Data Archives. [Available online at <http://has.ncdc.noaa.gov/pls/plhas/HAS.FileAppSelect?datasetname=7000>]
- University of Wyoming (UW), cited 2012: Upper Air Archives. [Available online at <http://weather.uwyo.edu/upperair/sounding.html>]
- Weather Underground (WU), cited 2012: Daily Metar Archive. [Available online at <http://www.wunderground.com/cgi-bin/findweather/hdfForecast?query=78520>]

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