

Severe Weather Data for Siren Activation

National Weather Service Des Moines, IA

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Jeff Johnson, Warning Coordination Meteorologist, Karl Jungbluth, Science and Operations Officer and Craig Cogil, Climate Program Leader

Introduction

In recent years, several Iowa counties have updated their storm siren policy to include activation for strong straight-line thunderstorm winds and occasionally for large hail. The National Weather Service, Des Moines, IA in general supports efforts to expand the use of outdoor warning sirens because of the threat to life and property of significant severe thunderstorms.

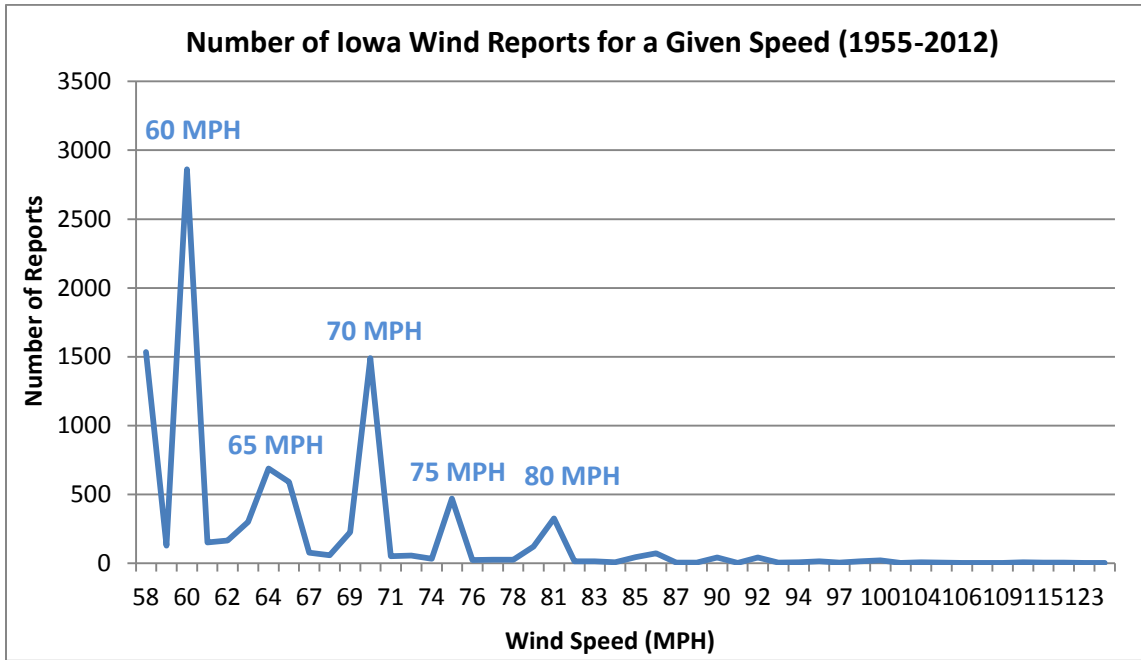
This paper is for emergency managers and other local officials who are responsible for siren activations. It is intended to provide an overview of severe thunderstorm straight-line wind climatology in Iowa, the National Weather Service, Des Moines, IA severe thunderstorm warning philosophy and verification statistics. Emergency managers and local officials are encouraged to refer to this paper when making siren activation policy enhancements or changes.

The National Weather Service, Des Moines, IA can provide detailed severe thunderstorm climatology for individual counties, including the frequency of wind speeds and/or hail size and a recent overview of severe thunderstorm warning statistics. Requests for county based data should be sent to Jeff Johnson at jeff.johnson@noaa.gov and Craig Cogil at Craig.Cogil@noaa.gov

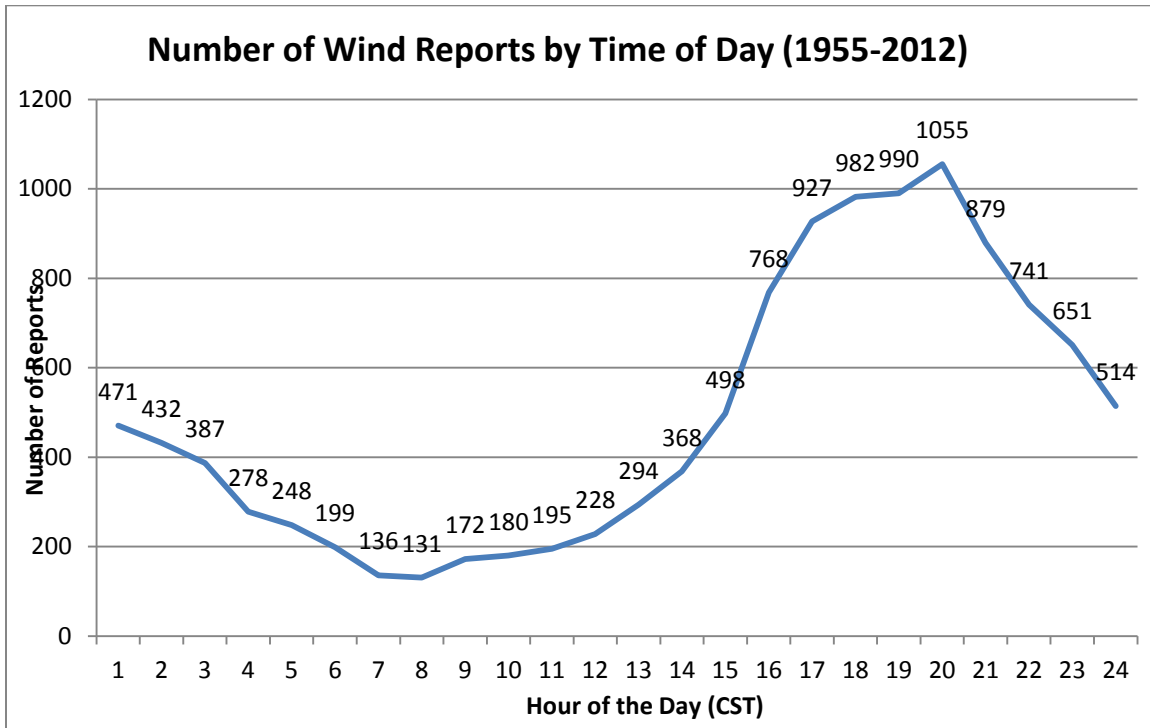
Overview of Severe Thunderstorm Wind Climatology

The following wind climatology consists of reports obtained from the Storm Data publication which lists severe weather data for the United States. This data extends from 1955 to the present and provides information regarding the placement, timing and intensity of severe wind events across the state of Iowa. Please be aware of the fact that much of the wind data is provided by storm spotters, law enforcement and similar spotter networks and not from calibrated wind instruments. However, these reports can be correlated to reasonable wind speed estimates via the severity of the damage and given damage indicators.

Number of reports associated with severe thunderstorm wind damage.



Time of occurrence for Wind Damage

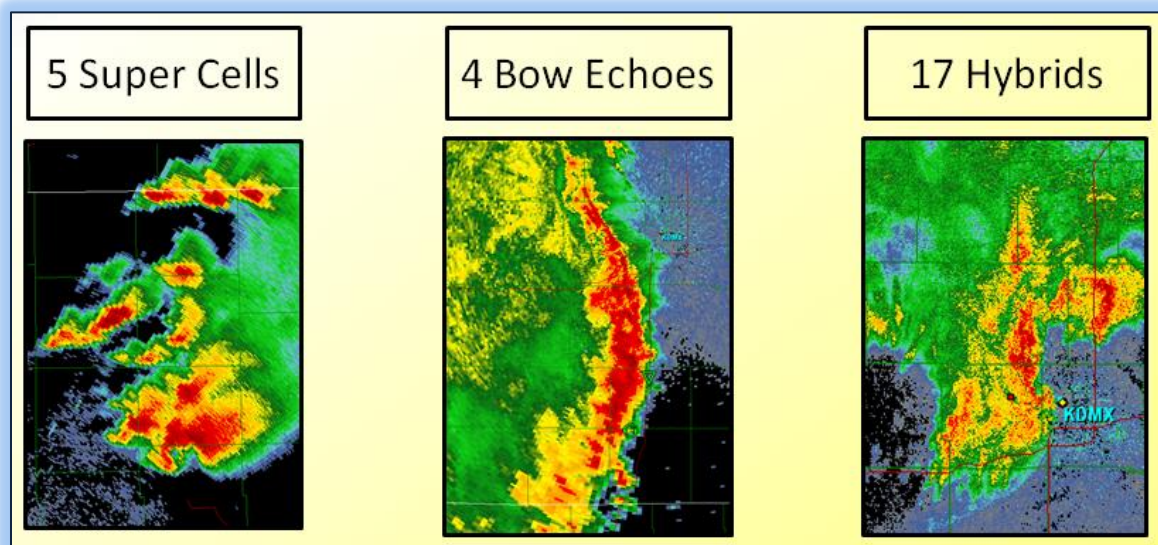


Peak activity occurs in the mid to late evening.

Thunderstorms Producing Winds of 70 mph or Greater – What Do They Look Like?

The National Weather Service received nearly 400 reports of severe thunderstorms winds of 70 mph or greater from 2007-2011 across the Des Moines Forecast Office's area of responsibility. Of these reports, 302 were associated with events that produced at least two reports of 70 mph or greater and at least 10 minutes apart. The total number of events that meets the above criteria during the study timeframe was 26. From these events, the characteristics of long-lived storms with the highest damage potential can be illustrated.

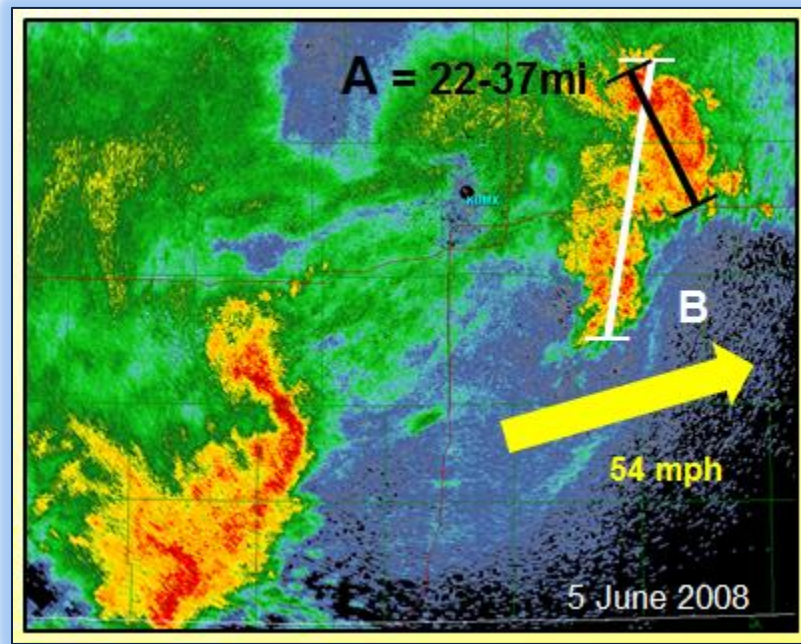
The radar signatures of the longer-lived wind storms were typical of well-organized severe thunderstorms, but a *wide variety* of storm coverage, configuration and evolution were observed. 19% of the events were supercells (usually isolated rotating storms), 15% were large scale bow echo lines of storms, and 65% were hybrids exhibiting characteristics of both (rotation along with bowing/accelerating segments).



Storms or clusters of storms that were growing larger in areal coverage and gaining in forward speed, were more likely to produce 70 mph or greater winds. Not every event was a big bright red monster on radar, so don't be fooled. Also, even though bow-shaped line segments are characteristic of these events, the worst of the winds may already be occurring by the time the bow shape is observed.

The width of the damage swath associated with these wind events is typically NOT huge. The width of the radar signature is typically only about 30 miles wide (the width of an Iowa county) and the worse damage is much narrower than that. However, the

potential damage swath is still much larger than the biggest tornadoes. Also, these features move rapidly, on average at 54 mph, covering much ground in a short time.



In addition, don't wait for a neighboring county to report 70 mph or greater winds to become concerned. Over one quarter of the events studied, the first wind report was 70+ mph!

Given fast movement, a significant damage swath that is small compared to the thunderstorm system, and that a good percentage of events start out at 70+ mph, it is difficult to get adequate warning lead time while maintaining a low false alarm rate.

How is the Decision Made to Include Winds of 70 mph or Greater in a Severe Thunderstorm Warning?

National Weather Service meteorologists make warning decisions based upon three main inputs, but in reality, there are a myriad of factors. Input number one is Doppler radar data alongside other observations like satellite, lightning activity and surface observations. Number two is the temperature, moisture and wind shear environment through which the storms are moving- this helps the meteorologist narrow down which outcomes are the most likely. Third, but certainly not least are spotter reports. These help the meteorologist know if the severe radar "signature" is actually producing damage, if the storm is intensifying or weakening. Spotter reports also help to calibrate how severe an event is or might become compared to other observations and radar.

The decision to include 70 or 80 mph wind tags is not made lightly, knowing that such events are uncommon to rare. Intensity of all factors, including radar data and reports, are weighed and reweighed against classic shapes and conceptual models of wind storms, elevations of features, interaction with neighboring storm cells, speed of movement and acceleration. Sometimes the speeds, shapes and radar intensities evolve in a classic fashion matching previous storms or idealized models of high wind producers. Sometimes long swaths of severe damage are produced, like the derechos of 11 July 2011 and 29 June 1998 in Iowa, and the 29 June 2012 in the eastern U.S. In those events, advance lead time can be provided in NWS Severe Thunderstorm Warnings or Severe Weather Statements. In other events, the high winds develop much more suddenly or unconventionally. In such cases warning lead time may be short, or the warning could be based upon spotter reports. As a result, it is essential that spotter information is relayed quickly to the NWS in order to warn people downstream.

Verification Summary

The National Weather Service (NWS) tracks verification of severe thunderstorm and tornado warnings. Verification information can be useful in helping decision makers understand how accurate NWS warning services are.

In 2010, the NWS started using wind and hail tags in severe thunderstorm warnings and statements. The “tags” show the highest expected hail and/or wind speed expected in the warning and they are very useful for those who make decisions based on the severity of a storm.

Here is the NWS Des Moines verification statistics for tornadoes and severe thunderstorms for the period 2010-2012. The severe thunderstorm verification was presented for all severe thunderstorms, or winds of 58 mph or stronger and/or hail 1 inch diameter or greater for all of the NWS Des Moines County Warning Area (51 Iowa counties).

We computed the number of warnings and reports which considered warnings which contained 70 mph winds or stronger in the warning vs 70 mph wind reports. This data did not use the wind/hail tags, but was obtained by searching all of the warnings for 70 mph wording. It is useful as a general trend of NWS Des Moines warnings which contain 70 mph wording and their accuracy.

Severe thunderstorm warning verification was also presented for winds of 70 mph or greater and for hail 1.75 inches or greater for the county of interest.

Official NWS StormData was used to compute the verification scores for tornado and overall severe thunderstorm warnings.

National Weather Service Verification

False Alarm Ratio (FAR):

(0 is best) $\text{Unverified warnings} / \text{total warnings} = 0.000 \text{ to } 1.000$ (multiply by 100 to express as a percent)

The FAR is the ratio of unverified warnings to the total number of warnings issued. The higher the FAR, the more the NWS is over warning the public, or “false alarming”.

Probability of Detection (POD):

(1.00 is best) $\text{Warned severe events} / \text{Total severe events} = 0.000 \text{ to } 1.000$ (multiply by 100 to express as a percent)

The POD is the ratio of warned severe events to total severe events. A high POD is important since it shows the skill in warning for severe weather events in advance. This is core to the NWS mission of protection of life and property.

Critical Success Index (CSI):

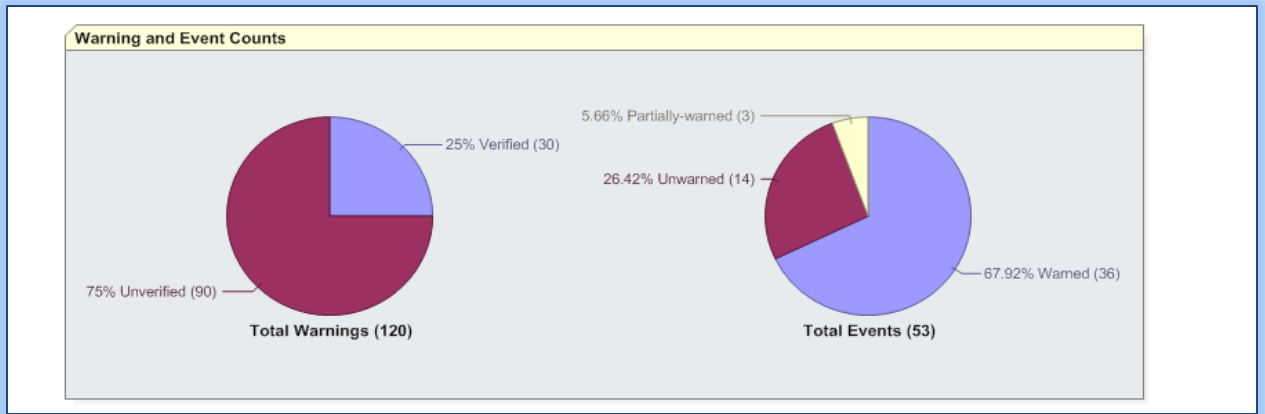
(1.00 is best) $\text{Warned severe events} / (\text{Total severe events} + \text{unverified warnings}) = 0.000 \text{ to } 1.000$ (multiply by 100 to express as a percent)

The CSI takes both FAR and POD to account to give a measure of performance. The higher the CSI is the better.

Lead-time is the amount of time between when the warning was issued and the event occurred.

Tornado Verification

Group	Counts							Statistics							
	Warnings			Events				Scores			Lead Time (min)		Warning Area (sq. mi)		
	Total	Verif	NOT Verif	Total	Fully Warned	Partially Warned	NOT Warned	POD	FAR	CSI	Mean	Initial	Total	Average	County Reduction
National	120	30	90	53	36	3	14	0.717	0.750	0.228	16.26	16.32	42972.53	358.10	0.85

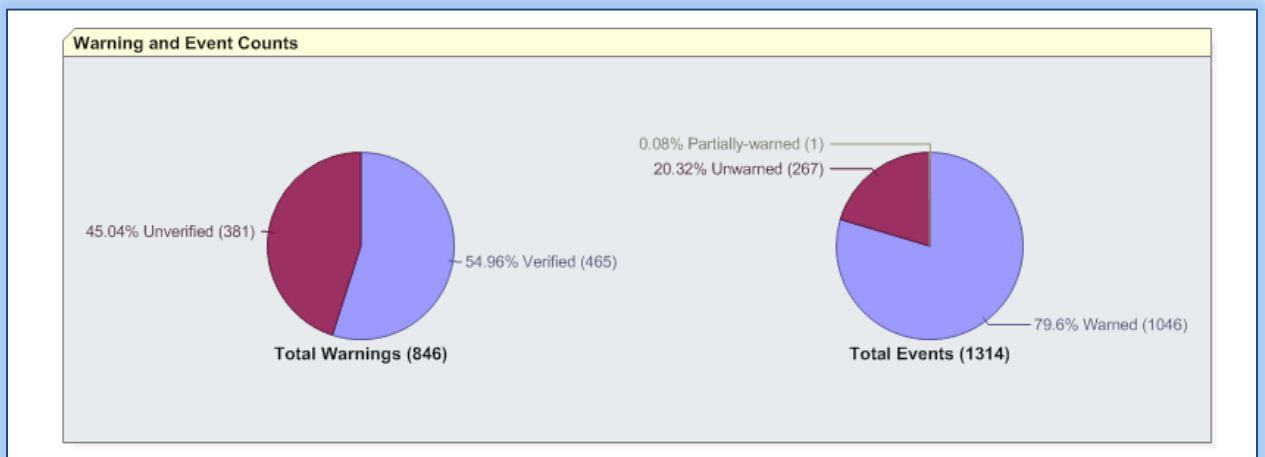


The tables show the NWS Des Moines tornado warning verification scores for 2010-2012. Notice 3 out of every 4 tornado warnings are NOT verified. The POD was just .717, or nearly 72% of tornadoes were preceded by a warning.

Severe Thunderstorm Verification – All events vs warnings

Summary Statistics

Group	Counts							Statistics								
	Warnings			Events				Scores			Lead Time (min)		Warning Area (sq. mi)			
	Total	Verif	NOT Verif	Total	Fully Warned	Partially Warned	NOT Warned	POD	FAR	CSI	Mean	Initial	Total	Average	County Reduction	
<u>DMX</u>	846	465	381	1314	1046	1	267	0.797	0.450	0.482	17.34	17.26	583396.59	689.59	0.78	



The tables show the NWS Des Moines severe thunderstorm warning verification scores for 2010-2012. Notice that the volume of warnings is significant more than tornado warnings (846 vs 120). Almost 80 percent of severe events (58 mph winds or stronger and/or 1 inch hail or larger) were warned. The FAR was also lower than tornadoes (45 % for severe thunderstorm vs 75 % for tornado).

70 mph or greater winds in the warning vs 70 mph wind reports

	2005	2006	2007	2008	2009	2010	2011	2012
Total Severe Warnings for the Year	312	338	368	509	194	360	303	183
Total Severe Warnings with 70 mph tags (SVR70)	63	88	102	114	49	58	15	14
SVR70 Verified (by any severe criteria)	42	53	50	74	36	41	13	11
SVR70 Verified by 70 Wind	12	16	14	37	16	27	7	5
SVR70 Verified by Wind reports 58-69	26	29	28	25	15	11	6	2
SVR70 No wind reports - verified by hail	2	7	6	10	5	3	0	2
SVR70 No wind reports - verified by tornado	2	1	2	2	0	0	0	2
SVR70 Not Verified by 70 Wind	51	72	88	77	33	31	8	9
SVR70 Not Verified by any reports	21	35	52	40	13	17	2	3
Number of Days 70mph Tag was Issued	16	17	26	24	8	16	9	8
SVR70 Percent Verified (by any severe criteria)	66.7	60.2	49.0	64.9	73.5	70.7	86.7	78.6
SVR70 Percent Not Verified	33.3	39.8	51.0	35.1	26.5	29.3	13.3	21.4
SVR70 Percent Verified by 70 mph	19.0	18.2	13.7	32.5	32.7	46.6	46.7	35.7
Percent SVR70 tag warnings vs All warnings issued	20.2	26.0	27.7	22.4	25.3	16.1	5.0	7.7

Important things to consider when viewing this table:

1. 2005-2012 for all 51 NWS Des Moines Counties.
2. Total NWS Des Moines Severe Thunderstorm warnings for each year followed by the number of warnings which contained 70 mph wording under "Total". Notice the significant drop between 2007 and 2012. At this time, counties started using 70 mph winds for siren activations and NWS Des Moines warning meteorologists became more conservative using the 70 mph wind tag.
3. Notice the verification of 70 mph wind warnings in 2012. 15 warnings contained a 70 mph wind tag in which 13 verified and 7 verified with winds at 70 mph or above.
4. Notice the percent of warnings containing 70 mph wind wording fell from 28% in 2007 to just 8% in 2012. The FAR fell from 51% in 2007 to just 21% in 2011.
5. As the number of 70 mph wind tag warnings decreased due to increased forecaster confidence needed to generate such a tag, the FAR also decreased significantly.
6. Almost half of the 70 mph wind warnings issued verified with at least 70 mph winds.
7. No study has been completed concerning hail size vs hail tags for NWS Des Moines warnings.