# A Comparative Analysis of Severe Weather Warnings in the Continental United States


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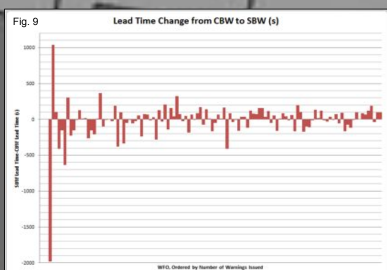
## Introduction

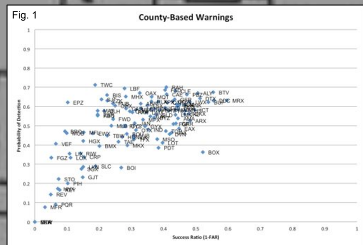
In the United States, the National Weather Service (NWS) is in charge of issuing warnings and advisories for the entire country. It achieves this by splitting the contiguous U.S. into 4 NWS regions and 116 different county warning areas (CWAs), each with their own Weather Forecast Office (WFO). Warnings issued by these offices are the primary way information is communicated to the public during life-threatening severe weather events.

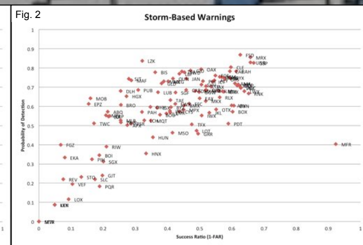
From their inception, WFOs issued warnings by county. These county-based warnings (CBWs) meant that if a storm was expected to cross into another county, the entire county was included in the warning, not just the part anticipated to be in the direct path of the storm. This changed in October of 2007, when the NWS began issuing storm-based warnings (SBWs). Unlike with CBWs, a SBW can warn particular sections of a county while leaving the rest of the county unwarned. Our project focuses on the changes this shift made in the issuance of warnings for different WFOs.

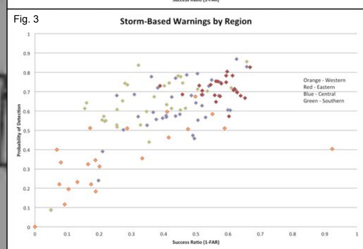
## Data/Methodology

- Analyzed severe thunderstorm and tornado warnings from January 1, 2005 to December 31, 2012 for the 116 WFOs in the contiguous U.S.
- Used IEM Cow website and CSV data files obtained from the Iowa Environmental Mesonet (IEM)
- Plotted results using Excel 2010 and Python scripts



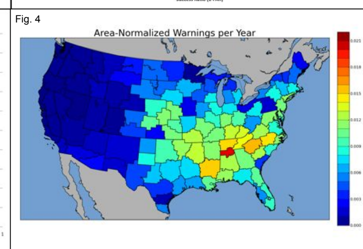




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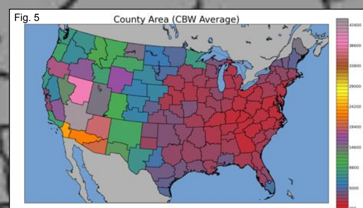
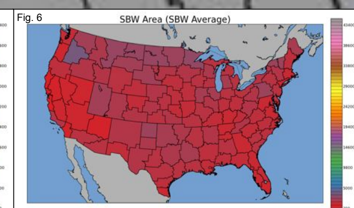
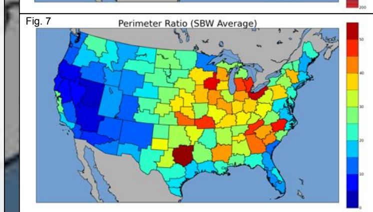
**Fig. 1 (upper left):** Performance diagram of WFOs during CBW verification period
**Fig. 2 (upper right):** Performance diagram of WFOs during SBW verification period
**Fig. 3 (lower left):** Performance diagram of WFOs during SBW verification period, grouped by NWS region
**Fig. 4 (lower right):** Normalized map of Warnings/Year for each WFO. The number of warnings/year was divided by the area of each WFO to take into account the variation in CWA sizes

**Fig. 5 (upper left):** Average county based warning area in km² from January 1, 2005 through September 30, 2007 (CBW era).
**Fig. 6 (upper right):** Average storm based warning area in km² from October 1, 2007 through December 3, 2011 (SBW era)..
**Fig. 7 (lower left):** The average perimeter ratio from October 1, 2007 through December 3, 2011. A value of 100 implies that the warning boundaries exactly align with political boundaries.
**Fig. 8 (lower right):** The average size percentage from October 1, 2007 through December 3, 2011. Percentage of reduction in size from the storm based warning to the county based warning. The closer the number is to 1.0 the bigger the reduction.



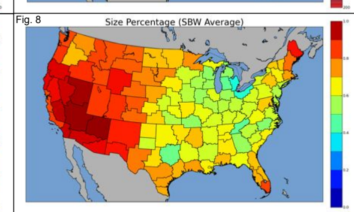
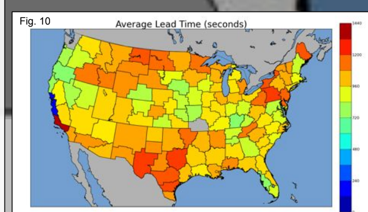
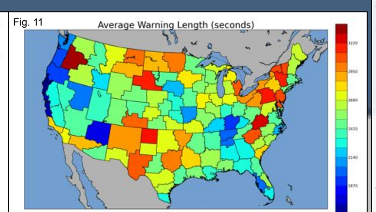




**Fig. 9 (above):** Change in lead time from the CBW time period to SBW, ordered by number of warnings issued. Positive values are an increase in lead time.
**Fig. 10 (right):** Average warning lead time for all warnings (2005-2011) with local storm reports (LSRs). Note that Springfield, MO (SGF) had erroneous LSR data for the time period, and that Seattle, WA (SEW) had no LSRs at all.
**Fig. 11 (far right):** Average warning length for all warnings for both CBW and SBW eras.




## Implications

- In general, the probability of detection (POD) increased and the false alarm ratio (FAR) decreased with the switch from CBWs to SBWs.
- Eastern Region WFOs are clustered together and overall have the highest POD and success ratio (SR), while western Region WFOs are the most spread out and have the lowest POD and SR.
- The differences in forecast quality between NWS regions are potentially attributable to factors such as population variance or differences in warning strategies for severe thunderstorms and tornadoes.
- For consistency, offices near one another should have a similar normalized number of warnings per year; however, there are a few instances where one office issues a significantly higher number of warnings than its neighboring offices.
- Average overall lead time is 16:23. Generally, the NWS Western Region seems to have the smallest average lead time. The most significant lead time discrepancies occur in offices that have few warnings issued and even fewer LSRs.
- Average overall warning length is 42:33. Western Region tends to have shorter warning lengths and Eastern Region longer ones.
- Offices without many warnings issued tended to have greater lead time changes after the switch, while offices with more warnings had smaller changes. 58 offices increased their lead time, while 54 decreased.
- The switch from CBWs to SBWs was intended to warn a smaller area more localized to the storm rather than a whole county. Across the board warnings got smaller, but the noticeable difference is in the Western Region where counties tend to be rather large (warning size reduced by 70 to 95%.). In the other regions the change was much less evident (30% to 60% reduction) due to warnings already being small due to the smaller county size.
- Even after the switch to SBWs many WFOs still used political boundaries as guides for their warnings. The WFOs with the highest perimeter ratios tended to have large metropolitan areas. The Dallas/Ft. Worth WFO has the highest Perimeter Ratio. After consulting with the office it was learned that they tend to draw warnings using political boundaries for the benefit of the county emergency managers (Fox 2013, personal communication).


## Acknowledgements

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## References


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## Future Work

POD and FAR measure accuracy of warnings, but currently the human response to warnings is not part of warning verification. Peter Wolf (2009) puts it best, that a warning is "essentially a meaningless product if it is not received, understood, and properly responded to by the target audience." Warnings are local decisions and these decisions vary based on local needs, so comparing WFOs that have different needs to determine warning success may not paint the full picture (Fox 2013, personal communication).