P14.1 POLYGON WEATHER WARNINGS – A NEW APPROACH FOR THE NATIONAL WEATHER SERVICE

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1. Introduction

This paper describes the current method of issuing short-term National Weather Service (NWS) warnings and a proposed mechanism to encourage a new polygon approach to target areas of threatening weather. It is expected that such a change will lead to improved service to the agencies customers.

2. Current State of NWS Warnings

The National Weather Service issues four different types of short-term warnings: tornado, severe thunderstorm, flash flood, and special marine warnings. These warnings indicate severe weather is expected within the next few hours after issue time for locations in the warned area. Warnings are issued for an entire county or cluster of counties. Dissemination of warnings is done using the NOAA Weather Radio (NWR) with encoded county codes using Specific Area Message Encoding (SAME). In addition, warnings are sent over the Emergency Alert System (EAS) to media outlets in the affected area. These systems are county-based and therefore when any one part of the county is threatened, the entire county essentially receives the warning.

Verification of warnings is also done on a "by county" basis. Verification is important for the agency as it is used as a performance measure. If an event such as a tornado or other severe weather occurs within the valid warning time within the county that is warned for, then it is considered a verified warning. Clearly, county size and shape can improve or worsen verification statistics – it is much more likely to verify a warning within a very large county rather than a small county.

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Since 1998 the NWS forecast offices have used a new computer system, the Advanced Weather Interactive Processing System (AWIPS), along with new warning software, WARNGEN, to produce short-term warnings. The WARNGEN software allows meteorologists to draw a polygon to outline the geographic area threatened. The software is then used to build a template of the text warning that can be used to transmit the warning. WARNGEN adds the latitude-longitude coordinates of the polygon to the end of the warning text. So, meteorologists have the opportunity with WARNGEN to delineate a polygon showing the area of threatening weather.

Although NWS meteorologists do have the capability to issue polygons with their short-term warnings, there is a noticeable tendency for forecasters to "crop" the polygon to existing county boundaries. This is likely due to concern about the effect of accidentally warning for more than one county at a time. The WARNGEN software has a tool that allows the warned polygon to be recreated to fit within one or more county outlines. This tends to create polygons with many vertices, matching the irregular shape of counties such as shown in Figure 1 below.

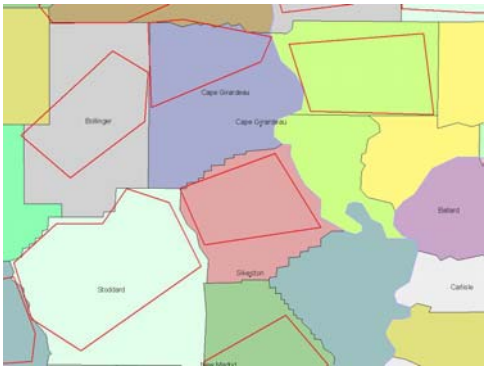

Figure 1. Example of tornado warnings issued during the May 30, 2004 tornado outbreak in southeast Missouri. Tornado polygons are

shown in red, overlaid atop a map of counties. Note the generalized polygon for Stoddard County (lower left) with additional vertices to conform to the shape of the county.

3. Polygon Warning Methodology

A new NWS team has been formed to try to guide the agency towards a true polygon-based approach to short-term warnings. The Polygon Warning Team was established in 2003 and will be conducting a test during the severe weather season in Spring 2004 with several forecast offices. Forecasters will be encouraged to issue warnings using polygons, disregarding geopolitical boundaries such as county and state lines, such as shown in Figure 2 below.

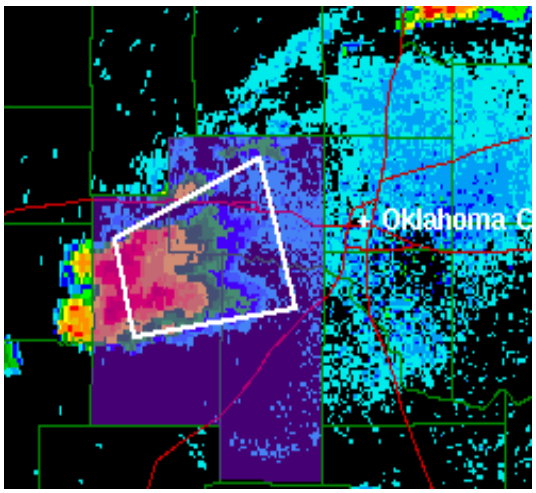

Figure 2. An example of a polygon tornado warning (white outline) overlaid on radar reflectivity. The polygon crosses county boundaries, shown in green. Note the blue shaded area; it is the warned area for the three counties combined. The white polygon greatly reduces the area that is covered by the warning.

Some initial studies (Browning, et al, 2002) have been done to examine the efficacy of using polygons for warnings. However, these studies have been limited to small areas. The Polygon Warning Team will be working towards adopting the polygon approach nationally.

4. Geographic Information Systems

Use of polygons to describe threatening weather fits in well with the use of Geographic Information Systems (GIS). GIS are accustomed to dealing with 2-dimensional objects described with latitude and longitude and allow interactivity with other themes such as radar reflectivity, county borders, roads,

A mechanism (Waters, 2004) was devised to automatically capture the text of short-term warnings issued on AWIPS and database the resultant polygon information on a real-time basis. From that information, GIS shapefiles are created and made available over the Internet. This data sharing also conforms with the Open Geospatial Consortium guidelines which encourage open sharing of data between agencies and GIS users worldwide.

Also, the generation of GIS shapefiles allows for the development of interactive web-based applications. The advantage of such Internet Mapping Systems (Waters and Settelmaier, 2004) is that users can manipulate views of warning polygons overlaid with other geographic data to build the desired view. Such a prototype Internet Mapping System has been developed using the real-time warning shapefiles. In the future, other weather data such as radar reflectivity, satellite imagery, and point weather observations can be added to this system.

Use of GIS technology also lends itself well to produce verification of weather events. Such an example is shown below in Figure 3.

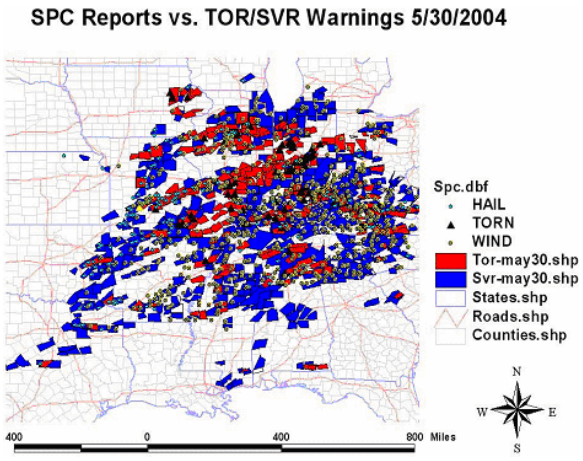

Figure 3. Plot of all warnings issued in a 24-hour period, May 30th, 2004. Red polygons

denote tornado warnings, blue polygons are severe thunderstorm warnings. Overlaid atop the warnings are point locations for actual severe weather, as collected by the NWS Storm Prediction Center for the same period.

Using GIS to produce verification statistics is a very viable use of GIS software tools and is only limited by possible delays in receiving storm reports which often need to be verified in person.

5. Future Goals

Encouraging meteorologists to warn using polygons rather than counties is only the first step for the Polygon Warning Team. To fully adopt this paradigm shift several other areas must be addressed.

First of all, a new verification mechanism will be required. This would verify warnings based on weather occurring within the polygon rather than within county boundaries. Verification statistics such as Probability of Detection (POD) and False Alarm Ratio (FAR) would be quite different for this new approach and a new baseline of performance would likely be required based on the new values. One advantage of changing to a polygon verification system is that verification results could be delivered almost immediately using automated GIS techniques. The Polygon Warning Team will be looking at ways to transition to this new method of verification.

Another impacted area is dissemination. In the future, the NOAA Weather Radio system could be modified to allow targeted areas by polygon rather than counties. This could lead to much reduced warned areas and therefore provide better service. Dissemination systems can include newer technologies that are becoming available, such as cellular phone alerts, pagers, and web-enabled Personal Data Assistants.

References

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