9B.5 ARCHIVED SEVERE WEATHER WARNINGS FOR VIRTUAL GLOBE APPLICATIONS

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ABSTRACT

NOAA's National Climatic Data Center (NCDC) archives severe weather warnings in the Surface Record Retention System (SRRS) for all 124 National Weather Service (NWS) forecast offices. These data are available in text format from NCDC's Hierarchical Data Storage System (HDSS) Access System (HAS) dating back to April 2001 [6]. Open source Geographic Information System (GIS) software is used to parse the text data into the Keyhole Markup Language (KML) format [5]. KML is the primary input/output format for Google Earth, and is supported in other Virtual Globe applications such as NASA WorldWind and ESRI ArcGIS. Issue and expiration times for each warning are recorded in the KML file and allow animations through time. The full warning text is embedded in the file and both county and polygon based warnings are supported. Warnings are available in daily and monthly files and are updated nightly. This processing will be integrated into NCDC's Severe Weather Data Inventory, a geospatial database of severe weather data from multiple sources [1].

1. INTRODUCTION

The National Weather Service's (NWS) mission is to provide weather "warnings in the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy" [7]. Warnings are issued daily and provide public guidance for events such as tornadoes, severe thunderstorms, and flash flood warnings. Since 2001 NCDC has archived each warning as part of the Surface Record Retention System (SRRS). While these data are invaluable in real time for public warning and safety, the archive provides the potential for reanalysis, verification, and event querying.

2. PURPOSE

The public's interaction with archived severe weather warnings has been virtually unchanged since the archive was created. This sub-project of the Severe Weather Data Inventory was developed to facilitate interactive access and visualization of archived severe weather warnings. These warnings are processed into geographic features and exported in the KML format. KML provides an interactive means of viewing and manipulating these data in popular and user-friendly programs such as Google Earth, ArcGIS Explorer, and eventually NASA World Wind. These programs continue to add new features and information including: aerial images, time animation, location of schools and businesses, and telephone numbers. Coupling this added information with archived severe weather warnings provides a powerful way to examine a substantial amount of information concerning a severe weather event.

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3. RAW DATA

The raw data are the exact text information that is sent by the individual NWS forecast office at the time the warning is issued (Figure 1). The data received by NCDC in real-time are processed nightly.

The current period of record that can be used by our suite of programs is 1/1/2005 to the present. During the prior years, severe thunderstorm and tornado warnings did not include the Valid Time Event Codes (VTEC) and therefore those warnings currently cannot be actively processed [8].

4. PROCESSING

Once obtained, the raw data file is parsed and processed. A suite of Java programs, developed at the NCDC, parse warning information into individual warning objects called a "bulletin". The bulletin is made up of several parts: the feature id, geometry, message type, issue Weather Forecast Office (WFO), issue date, expiration date, bulletin text. Although all the parts of the warning are important, geometry is mandatory in order to view the warning spatially. The GeoTools [3] and Java Topology Suite [4] programming libraries are used for all GIS processing.

Warning area geometry is obtained one of two ways. Most modern warnings have a "LAT…LON" line, which contains the polygon coordinates as generated by the forecaster who issued the warning. If this line is missing, the program finds the counties that are in the warning by the Federal Information Processing Standards (FIPS) code [2] which is included on all warnings. The geometry of the county (or the resulting geometry from the combination of adjacent counties) is obtained by referencing this code against a detailed United States county Shapefile. The combined counties are used to decrease the file size and provide better visual presentation (Figure 2).

Verification and quality control (QC) are performed during processing to make sure specific parts of the

warning are in fact present. Verification QC include: missing required information (message type, issue WFO, World Meteorological Organization (WMO) ID, date/time, geometry), invalid date and test warning.

The bulletins are translated into KML, using either the warning polygon or county FIPS reference. Finally, the KML file, NOAA logo, legend and Severe Weather Data Inventory logo images are packaged into a KML zipped file (.KMZ) [5]. The KMZ file is then made available for public access via the internet.

5. FEATURES

KML data files include several important features:

1. Time animation – Allows the user in Google Earth to animate the warnings through time.
2. Color coded warnings which represent warning type. (Figure 3) – Colors are based on the NWS' web color standard [9] and semi-transparent to show overlap and information underneath.
3. Full warning text information. (Figure 4) – Full text is available to the user within their software.
4. Monthly or daily files – An entire month of warnings or a day can be downloaded.
5. Nightly updates. – Files are approximately ready for retrieval by 1AM eastern time for the previous day's warnings.

6. SOFTWARE

To use these data, the user needs to have visualization software that supports KML. As of August 1, 2007, the following list includes known virtual globe software supported and their functionality with regard to the archived warnings dataset:

1. Google Earth – all features coded into the KML i.e. animation, color polygons, legend and logo are fully functional.
2. ArcGIS Explorer – polygons are viewable in their correct color, and warning information, but with no animations or NOAA logo and legend.

An updated list will be kept on the virtual globe archived severe weather warnings website.

7. PUBLIC ACCESS

Access to all data is currently free via a webpage located at: http://www.ncdc.noaa.gov/oa/kml. This web page includes information about the data, a download form, tutorials, and frequently asked questions. The web form is continually updated with the nightly processing of the previous day's severe weather warnings.

8. FUTURE WORK

Future additions to this dataset include.

1. Extend the period of record available from 2001 to 2005.
2. Inclusion of Flash Flood Warning VTEC codes once they become operational.
3. Integration of warnings into NCDC's Severe Weather Data Inventory.

These important additions to the project will provide a longer period of record, more information about flood events, and geospatial query and analysis functionality present in the Severe Weather Data Inventory.

9. CONCLUSION

The Virtual Globe Archived Severe Weather Warnings provides a new interactive and functional way to analyze archived severe weather warnings.

With major media outlets and the general public using Google Earth, this dataset keeps NOAA in line with public demand for interactive visualization and expands the way archived warnings can be interpreted and viewed.

10. REFERENCES

1. Ansari, S., S.A. Del Greco, B. Nelson and H. Frederick, 2006: The Severe Weather Data Inventory (SWDI): Spatial Query Tools, Web Services and Data Portals at NOAA's National Climatic Data Center (NCDC). *86th AMS Annual Meeting, combined preprints CD-ROM, 30 January – 3 February 2006, Atlanta GA, 22nd Conference IIPS [International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology]*, American Meteorological Society, Boston, Mass., File 11.4, 9 pp. (February 2006).

2. Federal Information Processing Standards Website: http://www.itl.nist.gov/fipspubs/

3. GeoTools. Website: http://www.geotools.org

4. Java Topology Suite Website: http://www.vividsolutions.com/jts/jtshome.htm

5. KML Reference Documentation Website: http://code.google.com/apis/kml/documentation/

6. NOAA NCDC HDSS Access System Website: http://has.ncdc.noaa.gov/

7. NOAA National Weather Service Mission Statement Website: http://www.nws.noaa.gov/mission.shtml

8. NOAA National Weather Service Valid Time Event Code (VTEC) Message Dissemination Website: http://www.nws.noaa.gov/os/vtec/

9. NOAA National Weather Service Web Based Watch/Warning/Advisory Map Display Website: http://webdev1.weather.gov/wwa_colors/colors.htm

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WFUS53 KTOP 050827
TORTOP
KSC157-201-050915-
/O.NEW.KTOP.TO.W.0018.070505T0826Z-070505T0915Z/
BULLETIN - EAS ACTIVATION REQUESTED
TORNADO WARNING
NATIONAL WEATHER SERVICE TOPEKA KS
326 AM CDT SAT MAY 5 2007
THE NATIONAL WEATHER SERVICE IN TOPEKA HAS ISSUED A
* TORNADO WARNING FOR...
  SOUTHEASTERN REPUBLIC COUNTY IN NORTH CENTRAL KANSAS...
  WESTERN WASHINGTON COUNTY IN NORTH CENTRAL KANSAS...
* UNTIL 415 AM CDT
* AT 325 AM CDT...NATIONAL WEATHER SERVICE DOPPLER RADAR INDICATED A
  SEVERE THUNDERSTORM CAPABLE OF PRODUCING A TORNADO 4 MILES SOUTH OF
  AGENDA...OR ABOUT 14 MILES EAST OF CONCORDIA...MOVING NORTHEAST AT
  20 MPH.
* LOCATIONS IMPACTED INCLUDE...
  AGENDA...
  BRANTFORD...
  HADDAM...
  MORROWVILLE...
  WASHINGTON...
IF A TORNADO APPROACHES...GO TO A BASEMENT OR SEEK SHELTER IN A
HALLWAY OR CLOSET ON THE LOWEST FLOOR OF THE BUILDING. USE BLANKETS
OR PILLOWS TO COVER YOUR HEAD AND ALWAYS STAY AWAY FROM WINDOWS.
STAY TUNED TO WEATHER RADIO OR LOCAL MEDIA OUTLETS FOR THE LATEST
SEVERE WEATHER INFORMATION.
LAT...LON 3965 9749 3964 9731 3982 9703 3999 9735
$$
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Figure 1. Raw Warning Text

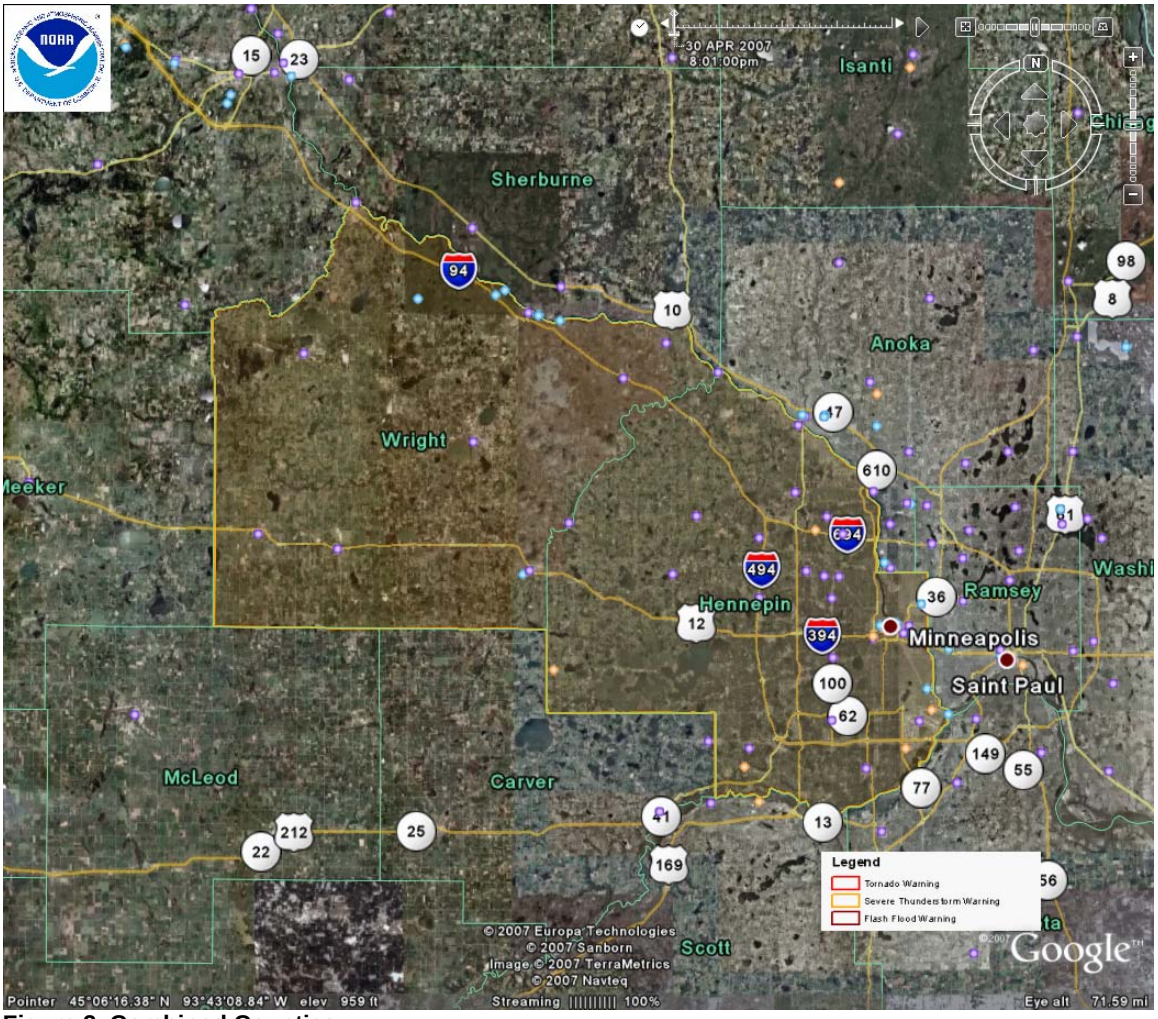

Figure 2. Combined Counties

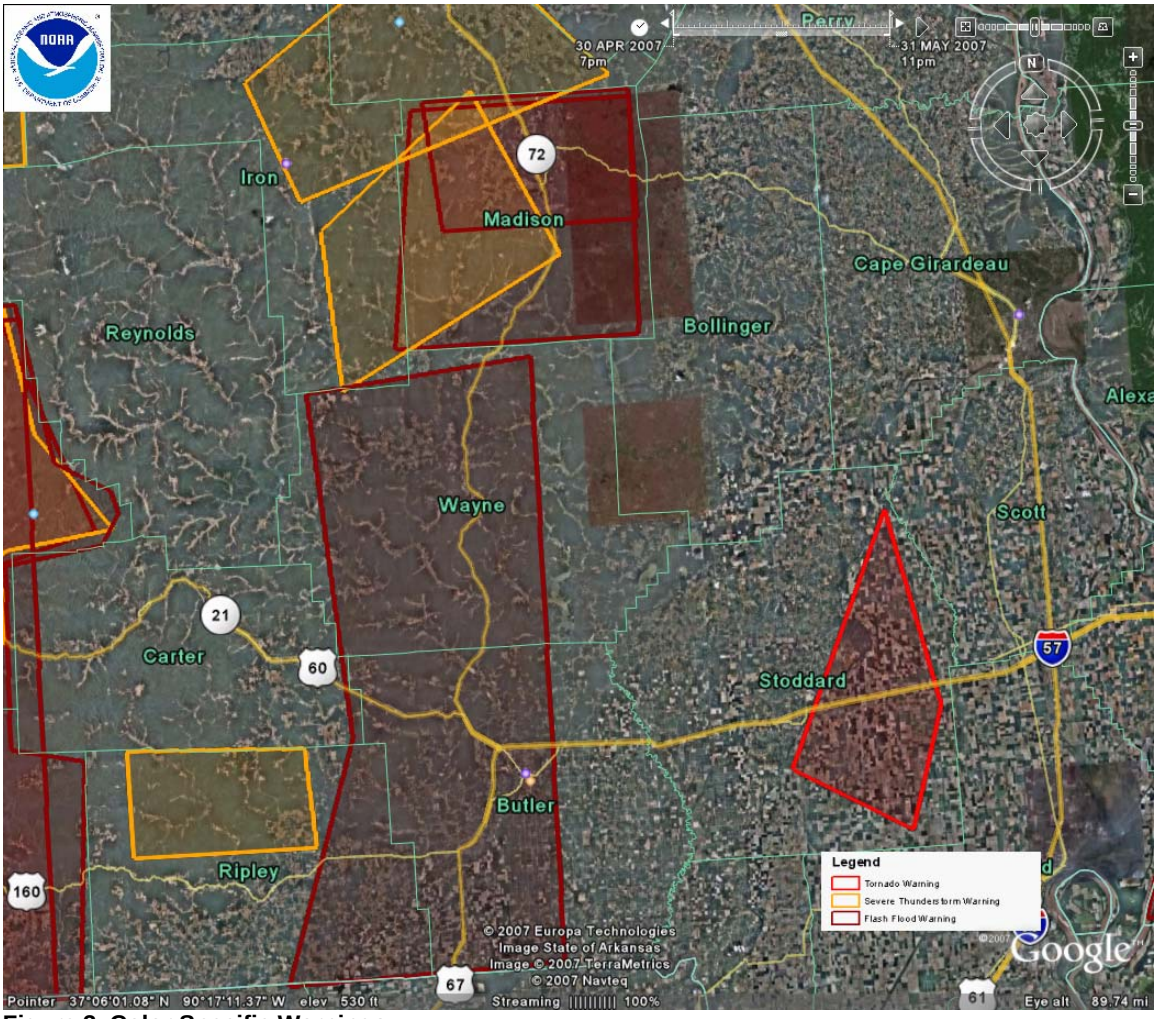

Figure 3. Color Specific Warnings

Tornado Warning Issued By NWS Office: KPAH

Warning: Starts: 05/03/2007 At: 2133Z , Ends: 05/03/2007 At: 2200Z

Warning Text

WFUS53 KPAH 032135
TORPAH
MOC207-032200-
/O.NEW.KPAH.TO.W.0012.070503T2133Z-070503T2200Z/
BULLETIN - EAS ACTIVATION REQUESTED
TORNADO WARNING
NATIONAL WEATHER SERVICE PADUCAH KY
433 PM CDT THU MAY 3 2007
THE NATIONAL WEATHER SERVICE IN PADUCAH KENTUCKY HAS ISSUED A
* TORNADO WARNING FOR...
EASTERN STODDARD COUNTY IN SOUTHEAST MISSOURI...
* UNTIL 500 PM CDT
* AT 432 PM CDT...STODDARD COUNTY EMERGENCY MANAGEMENT REPORTS
SIGHTINGS OF A ROPE LIKE TORNADO...2 MILES SOUTH OF ESSEX OR 6
MILES EAST OF DEXTER. THE STORM WAS MOVING NORTHEAST AT 25 MPH.
* LOCATIONS IN THE WARNING INCLUDE ESSEX
IF YOU ARE CAUGHT OUTSIDE...SEEK SHELTER IN A NEARBY REINFORCED
BUILDING. AS A LAST RESORT...SEEK SHELTER IN A CULVERT...DITCH OR LOW
SPOT AND COVER YOUR HEAD WITH YOUR HANDS.
LAT...LON 3674 8997 3665 8978 3681 8972 3707 8979
$$

Figure 4. Full Text Warning Information