

P2.6 SVRGIS: GEOGRAPHIC INFORMATION SYSTEM (GIS) GRAPHICAL DATABASE OF TORNADO, LARGE HAIL, AND DAMAGING WIND REPORTS IN THE UNITED STATES (1950-2005)

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1. INTRODUCTION

Severe weather report data is currently organized into graphical user friendly formats and in interrogation programs. An existing program called SeverePlot v2.0 (Hart 1993), is a graphical and table-based software package that is PC-based and examines attributes, or specific information, of a portion of the United States archived severe weather database. The implementation of Geographic Information Systems (GIS) into mainstream meteorology tasks has been increasing in recent years. SVRGIS is a GIS-based methodology developed at Ball State University that is based on a similar principle to SeverePlot's severe reports graphical database. In addition to SeverePlot's capabilities, the GIS user can access more advanced spatial and statistical tools which provide the user with data querying (data characteristic sorting) capabilities. Additionally, GIS functions include options to select and query large quantities of data and data types and extract user-specified data (e.g., type, quantity, time, space, etc.). A few options include querying the existing database in a tabular format and selecting files to be analyzed, (e.g., tornadoes with specified proximity sounding temporal and spatial criteria), converting classes or "fields" in the database (e.g., time from LST to UTC), or applying spatial or statistical functions to queried data. In addition to severe report data, other data such as geographic and archived meteorological data can be input into SVRGIS. The GIS user can select desired data by querying data by its attributes, location, or both. This is especially helpful when working with large datasets. One advantage of a GIS-based system is the ability to view data in layers. This feature enables the user to quickly examine different variables (e.g., severe reports, municipal areas, transportation routes, and meteorological data) and examine any relationships between the variables.

This study's purpose is to examine the methodology of importing severe report databases into a Geographical Information System (GIS) and highlight a few advantages and capabilities of using a GIS. Outlined are a few of the methods the author used to organize the severe report database into a GIS and include other data types (e.g., geographical) for comparison. A few severe report comparisons will be presented herein and will serve as examples to the many advantages and capabilities a GIS-based severe report database may have in analyzing severe data.

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2. DATA COLLECTION / DATABASE MANAGEMENT

2a. Severe Reports

The severe reports used in this study originated from the National Climatic Data Center (NCDC) and were downloaded as text files (.txt) from the Storm Prediction Center (SPC) Tornado/Severe Thunderstorm Database (Schaefer and Edwards 1999) located at the following web address <<http://www.spc.noaa.gov/wcm/>>. It must be noted that description of the severe report attribute format used is available for download from the previously listed SPC web address. The reports are associated with descriptive data such as date, time, state(s) affected, F-scale, latitude and longitude coordinates, and monetary damage to name a few. In order to input the large number of recorded reports in a database table, the .txt files were imported into MS Office Access. Access converted the data into tables within an ArcGIS personal geodatabase. Necessary file-converting and file creating steps, not mentioned here, were completed in ArcGIS to create severe report files for display. A visual basic (.bas) script file was used to create and display tornado tracks from tornado touchdown and endpoints in ArcGIS.

Once the files with spatial coordinates were created, they were overlaid on projected maps of the contiguous United States. Other geographic data was input into the GIS for visual purposes. Density files were used, which were determined by values originating from a central grid cell with a radius distance turned 360 degrees for values of other grid cells. Lastly, point density layers and line density layers were created for different variables and some of their associated magnitudes (e.g., baseball-sized hail, significant tornado tracks) using the ArcGIS spatial analyst extension. It is worth noting that there were a few error values found in the severe database. Because of these errors, (e.g., null data values, missing or incomplete latitude/longitude coordinate pair), a few minor data filtering methods were required.

2b. Miscellaneous Data

Various types of geographic data can be input into SVRGIS and examined in many ways. Free data from the internet originated from different sources including the U.S. government and National Weather Service. Most of the miscellaneous data was geographic-based. A few examples of data types include county and state maps, cities and towns, National Weather Service County Warning Areas (CWA's), orthoimagery, elevation and topographic data, and transportation routes.

3. APPLICATION

Meteorologists have investigated past severe weather report distribution (i.e. tornadoes, large hail, and severe convective wind reports) and have for many years qualitatively and quantitatively assessed areas where higher frequencies of severe weather have occurred (Brooks et al. 2003, Hart 2005, Hart 2006). More sophisticated studies are now possible. For example, tornado analysis indicates that nearly half of the tornadoes in the 1950-2005 archived database were either brief touchdowns or do not have a recorded tornado end point. Therefore, tornado track studies have inherent limitations to determining geographical distributions of tornado path length and associated tornado incidence as documented in *Storm Data*. Using this database, a simple plot of tornado tracks can be plotted over metropolitan areas (Fig. 1). A more advanced plot of violent tornado (F4-F5) track densities (Fig. 2) and significant hail (2 in. (5 cm.) or greater in diameter) (Fig. 3) can be calculated from grid cells and displayed with overlaying geographic data (e.g., municipal boundaries).

Another useful application of a GIS permits the user to query severe report data relatively quickly. The following two query examples used methods that queried by location, then by attributes, and finally a combination of both querying steps. In the first example, cool season (October-March) tornadoes that affected portions of Ohio Valley states from 1995-2006 were selected (Fig. 4). Then tornado touchdown reports were further queried to be within rawinsonde launches defined by temporal/spatial criteria (i.e. 200 km and +3 hr) (Fig. 5). In the second example, useful features such as buffering enable users to query wind reports around a 25 mi. radius of Minneapolis, Minnesota (Fig. 6) and then perform statistical summaries of the data (not shown). The previously mentioned examples are a few of the many possible ways to analyze the severe report database.

4. SUMMARY AND DISCUSSION

Building on the capabilities of SeverePlot and other graphical interface programs, a GIS severe report graphical and statistical database was constructed to complement existing severe weather graphical databases. SVRGIS is not meant to replace Severeplot and other existing programs, but rather complement these user-friendly programs in situations where more in-depth analysis is necessary. SVRGIS is much more than a tool to query only severe weather because its utility is far-reaching and cross disciplinary. SVRGIS is unique from other graphical databases because it allows the GIS user to import other data types (e.g., geographical data) and analyze the data by its attributes by means of both spatial and statistical methods in layer formats. There are countless ways to investigate severe reports and more analysis possibilities exist within a GIS. It is not new to qualitatively and quantitatively assess regions of the contiguous U. S. with key elements, such as dollar loss,

population areas at risk, et cetera. By using a GIS, it is now possible to assess these variables and many more through examination of a plethora of possible relationships between variables all in one database.

The possible users of a GIS severe report database include governmental organizations, researchers, academic professionals and students, the emergency management community, and private sector concerns such as insurance companies and private weather firms.

4. SOFTWARE

The software used for completing the GIS-based database included ESRI's ArcGIS 9 and Microsoft Office Access.

It is recommended that SVRGIS data files be viewed using the latest ESRI ArcGIS version. However, free downloadable GIS software applications such as ESRI's ArcExplorer can be run on the following supporting platforms: Windows, Macintosh, Solaris, AIX, HP-UX, and Linux.

Acknowledgements. The author would like to thank Dr. Kevin Turcotte, Ball State University, for his help in computer script writing and encouragement and enthusiasm towards seeing the completion of this study. Also, thanks to John Kwiatkowski (NWS Indianapolis, IN) and Dr. Kevin Turcotte for providing valuable comments about how to improve this manuscript.

5. REFERENCES

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6. ILLUSTRATIONS AND TABLES

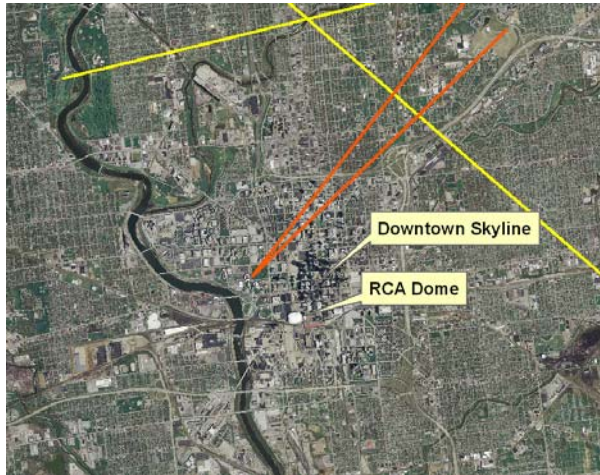


Fig. 1. Tornado tracks overlaid on orthoimagery near downtown Indianapolis, Indiana (1950-2005). (F1-yellow, F2-orange).

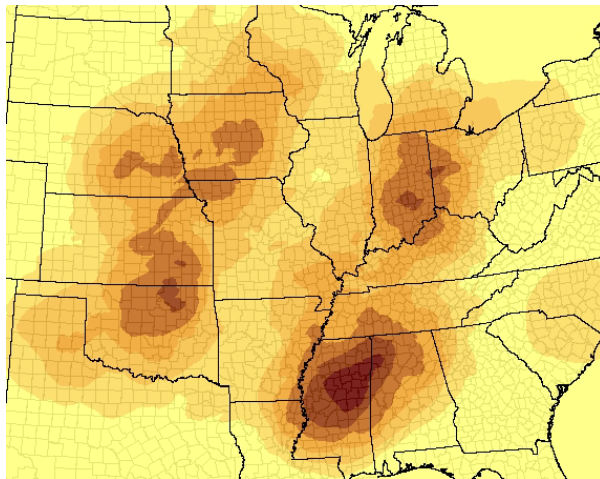


Fig. 2. Violent tornado track density (1950-2005). (1 km horizontal grid cell resolution and 200 km area radius). Darker (lighter) colors indicate higher (lower) density.

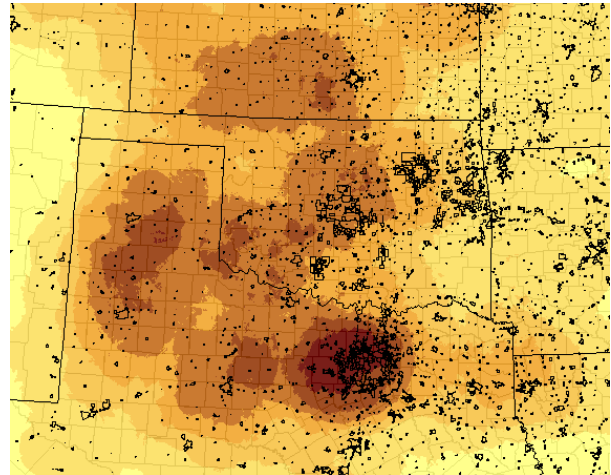


Fig. 3. Significant hail (2 in. (5 cm.) in diameter or larger) point density in the south central Plains (1980-2005). (1 km horizontal grid resolution and 100 km area radius). Darker (lighter) colors indicate higher (lower) density and outlined city areas (black).

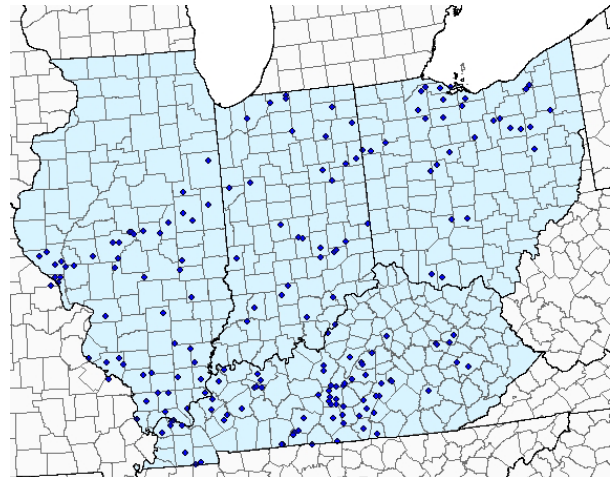


Fig. 4. Tornado touchdown points within the Ohio Valley cool season (Oct.-Mar.) during the 1995-2006 period. Tornado touchdowns (blue) and Ohio Valley states (light blue).

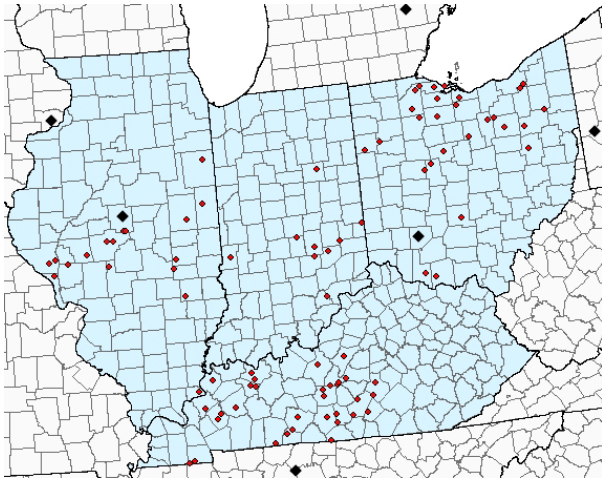


Fig. 5. Same as Fig. 4 but with temporal and spatial restrictions (± 3 hr and 200 km) of a rawinsonde. Tornado touchdown points (red) and rawinsonde locations (black).

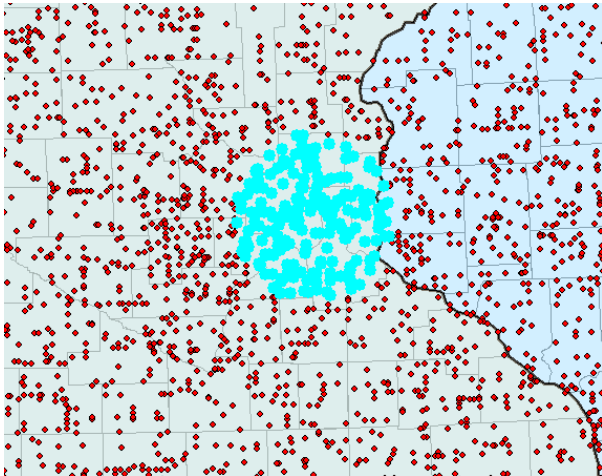


Fig. 6. Wind reports (red dots) in southeastern Minnesota and western Wisconsin (1980-2005). Selected wind reports (blue dots) within 25 mi. radius of Minneapolis, Minnesota.