The Use of Grid System within National Weather Service

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Abstract

One of the ways National Weather Service (NWS) manages weather systems is by applying grid system technique within GIS software. The grid system helps to locate a point on a two-dimensional surface and gives its precise latitude and longitude values. Also, the grid system serves many other functions such as determining the coverage area, or specifying the location of particular weather equipment in relation to other equipment types and areas such as counties, congressional districts, or county warning areas. The grid data is part of a geographical database at the National Weather Service and is represented as square polygon each measured 20 by 20 miles. This dataset is produced using Spatial Analyst and ArcInfo 9x. The paper will take a closer look at how NOAA's NWS utilizes the grids to perform spatial analysis of its products and how they are related to one another.

Introduction

Weather data is geospatial and can be referenced to a 2-dimensional surface. If we imagine the Earth's surface as a grid frame, we can perform spatial analysis. Grid is a geographic representation of the world as an array of equally sized square cells arranged in rows and columns. Each individual grid cell is referenced by geographic x, y location. It helps forecasters to answer questions such as "How a good location for a site can be determined? Or how the interaction of various weather equipment can be utilized to make a prediction?" Spatial data analysis integrated into GIS has created a research tool that explores and analyzes spatial relationships. Grid system defines the link between locational and data value information and is a great useful analytical capability of GIS. There are several programs within NOAA's NWS that utilize grids for their predictions. Three of them will be covered in this paper and include Next Generation Weather Radar

(NEXRAD), Meteorological Assimilation Data Ingest System (MADIS), and Automated Surface Observing System (ASOS).

NEXRAD

NEXRAD is a network of approximately 159 Weather Surveillance Radar–1988 Doppler (WSR-88D) sites in the United States. The National Weather Service (NWS), Federal Aviation Administration (FAA), and Department of Defense (DOD) operate the Doppler Sites. Doppler is capable of detecting precipitation and atmospheric movement. During the modernization program that started in the late 1980s, the site locations were strategically chosen to provide the most overlapping coverage between radars in case one failed during a severe weather event. The term "coverage" means that the "lower edge of the radar beam, as determined from the radar horizon with standard atmospheric refraction and with due consideration of any blockage by intervening, terrain, would intercept any weather phenomenon reaching at least the altitude of 10,000 feet." Today's GIS capability allows predicting the favorable location by computing and collecting all the necessary information that is critical in determining whether a new site should be added or should it be relocated. For example, the integrating of terrain data into the NEXRAD coverage area gives a visual answer as to where the blockage is occurred, thus showing non covered areas. In some cases, if possible, the sites were to be located near Weather Forecast Offices so that to allow quicker access to maintenance technicians. Again, using the overlay analysis function of GIS we can add aggregate spatial units (congressional districts, states, counties or even urban areas) to illustrated the spatial autocorrelation of different data. The radar system collects raw atmosphere data and returns it the processed form that shows patterns of precipitation and its movement.

MADIS

In the last several years the need for frequent, densely spaced, real-time surface observations has significantly increased. NOAA's Forecast Systems Laboratory created Meteorological Assimilation Data Ingest System (MADIS) program. This program provides ingest, integration, automated quality control (QC), and distribution support for both NOAA and non-NOAA surface observations. MADIS collect raw data that comes from various sources, main of which is State Departments of Transportation, and combines it with NOAA data sets into a uniform format, converting all of the observations to standard observation units and time stamps. MADIS database also provides current and archived observational datasets including Road Weather Information Systems (RWIS) and MESONETs (groups of weather stations). RWIS are part of Environmental Sensor Stations (ESS) that is distributed along the highways in the United States. RWIS collects field data from ESS and provides road weather information in the easily understood format. Three types of road weather information include atmospheric data (pressure, temperature, humidity, wind speed and direction); pavement data (pavement temperature, freezing point, chemical concentration, and soil temperature); water level data (stream, river, lake, tide levels near roads).

ASOS

In the 1980s, NWS in cooperation with the Federal Aviation Administration (FAA) and the department of Defense (DOD) decided to automate the process of surface weather observation and thus, developed Automated Surface Observing Stations (ASOS). Currently, there are more than 850 ASOS locations throughout the country. The majority of them are located in the airports. These monitoring systems work non-stop and provide an hourly updated surface weather information to forecasters and aviation community. ASOS sensors measure and report sky conditions (cloud height and amount), temperature, dew point, and wind speed and direction. All this information is disseminated hourly and is sent to a processing computer that uses basic coding called algorithms to process the raw data. Cloud height is measured by Ceilometer Sensor, also called Cloud Height Indicator (CHI) Sensor. It is a laser beam ceilometer that measures vertical visibility, sky coverage, and cloud height up to 12,000 feet above ground level. A vertically pointed laser beam reflects off any clouds directly overhead, and the time for the beam to return to the sensor is measured. The sampling is taken once every 30 seconds. Another important to the aviation weather information that ASOS provides is that it determines the visibility in foggy conditions. ASOS visibility is reported in varying increments from less than ½ to 1 statute mile, and the total coverage visibility area can be up to 10 miles. ASOS combined with the older Automated Weather Observing Systems (AWOS) and Automated Weather Warning Systems (AWSS) provide important data for meteorologists, pilots and flight dispatchers by preparing and monitoring weather forecasts and flight routes. Using the buffer tool, provided by GIS, the only sites that are located within two miles of the interstates are selected. Knowing the number of sites and coverage area, the forecasters determine whether a new site needs to be established or not. The following image shows the location of Aviation Sites in relation to RWIS and MESONET Sites.

Conclusion

The future systems are being developed to enable more efficient enhancements. On the part of the NEXRAD program, Radar Data Acquisition (RDA) upgrade is on its way and it is being installed at all WSR-88D sites across the country to improve the Doppler's' performance. As we saw from the examples above, GIS is very powerful tool and it provides important features for spatial analysis. It is a great advantage for the forecasters to make their predictions and to ensure safety of the community. Future research will lead to more forecasting applications.

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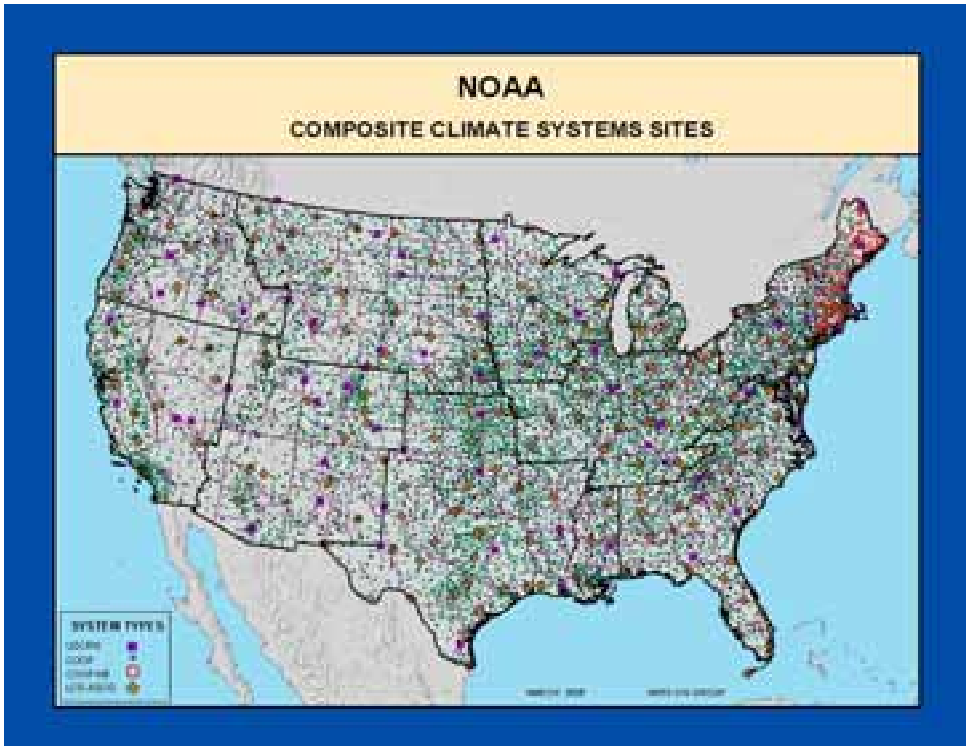


Figure 1

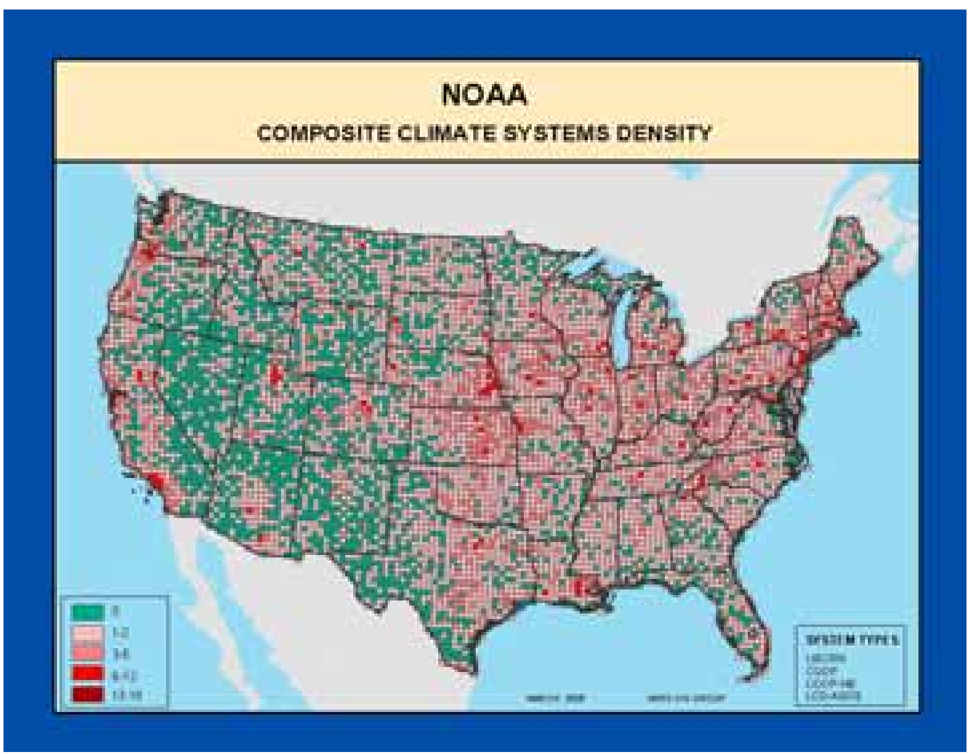
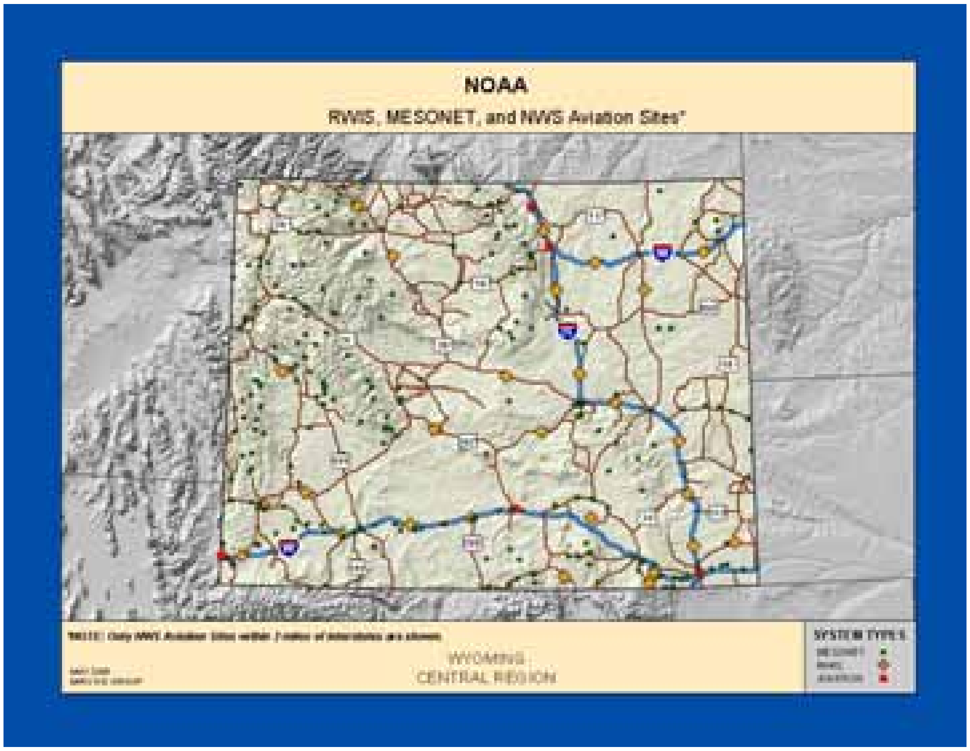


Figure 2



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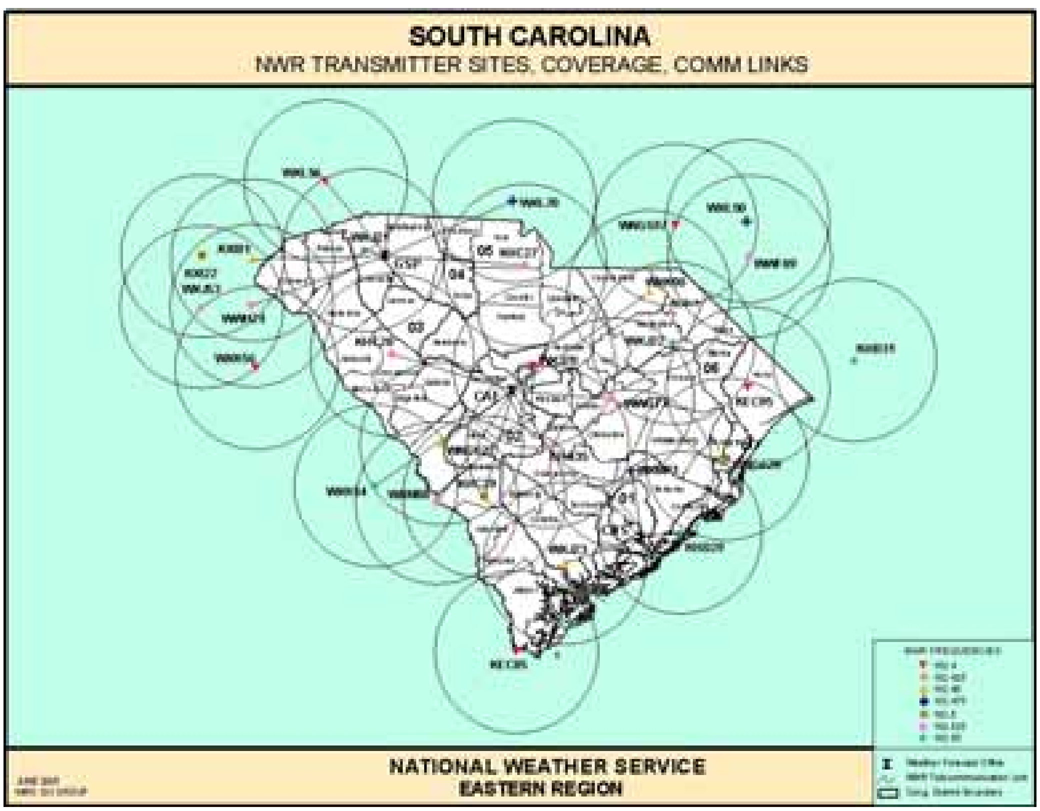

Figure 4

Figure 5

Figure 6