J2.6 Use of MIRS to Conduct System Density Studies

Joe Facundo, Office of Operational Systems,
Silver Spring, Maryland

1. INTRODUCTION

NOAA/National Weather Service (NWS) has developed the Management Information Retrieval System (MIRS) to perform a variety of mapping and reporting functions. MIRS uses the ARC© family of GIS products to portray both NWS and non-NWS metadata in new and innovative ways. When combined with information about NWS service areas and other characteristics such as population densities, MIRS can produce a host of graphics to be used in a wide variety of applications. This paper is centered on techniques for evaluating the geospatial distribution of surface-based networks with respect to hydro-meteorological and climatic applications. The techniques will show how geospatial techniques along with possible model outputs can be utilized to answer network density studies such as: Are there too many sites per unit area?

2. BACKGROUND

What Is MIRS? MIRS is both a database and GIS system providing NWS management, staff, and the public with an efficient means to access and interact with multiple NWS databases and GIS mapping through a centralized web portal. See Figure 1 for the web site.

Figure 1. MIRS website.

For the purposes of this paper, the only aspect of MIRS discussed will be its GIS capability, even though the data bases could easily support the density study as well.

2.1 MIS Mapping

MIRS uses the ARC© family of GIS products to organize and display a plethora of specific static graphics depicting a whole range of system and services offered by the NWS. The website URL for the interested reader is:

http://weather.gov/mirs/

Use Microsoft Internet Explorer © for best results.

2.2 Displaying Density Graphics

For the purposes of the study, NWS is considering three approaches including:

- A symmetrical 400 sq. mi. grid covering the entire CONUS
- Climate Regions/divisions as defined by the National Climatic Data Center (NCDC)
- Using the 5 mile/100 ft rule to replace sites

Figures 2, 3 and 6 illustrate examples of these types of mappings.

3. DENSITY STUDY ATTRIBUTES

Original work in density studies was conducted by Del Greco and Smith (see Section 7) and by Mr. David Mannarano in the 1990s. This work intends to leverage off of their ideas and expand the concept for conducting a process referred to in this paper as “thinning the herd.” The goal is to assess the density of the current climate network comprising: Cooperative Observer Program (COOP) network, U.S. Climate Reference Network (USCRN), selected Automated Surface Observing System (ASOS) sites designated as Local Climatological Data (LCD), and the new NOAA’s Environmental Real-time Observing Network (NERON). Thus, the purpose of the density study will be to look at areas where:

- There might be a dearth of climate sites and,
- Where there may be too many.

Note no decision has been made on what the proper density ought to be; rather, this study serves to develop the framework for performing the study when this and other aspects have been agreed to. The end-state network should consist of both new and old sites situated close to the idealized spacing, i.e., density, required to conduct operations.

3.1 Methodology

To determine where there is a dearth of climate sites, the sites defined under Section 3 were plotted under a 400 sq. mi. grid and then a color scheme was used to highlight those areas with no sites falling within the grid. Figure 6 shows grid areas in green where there are no sites. If this type of mapping density is approved, then these might be candidates for new NERON locations. Likewise, a density exceeding 3-4 sites per grid are shaded in a dark red color depicting too high a density of sites. In this case, a process based on both model output and subjective analysis needs to be conducted to reduce the number to a manageable level.

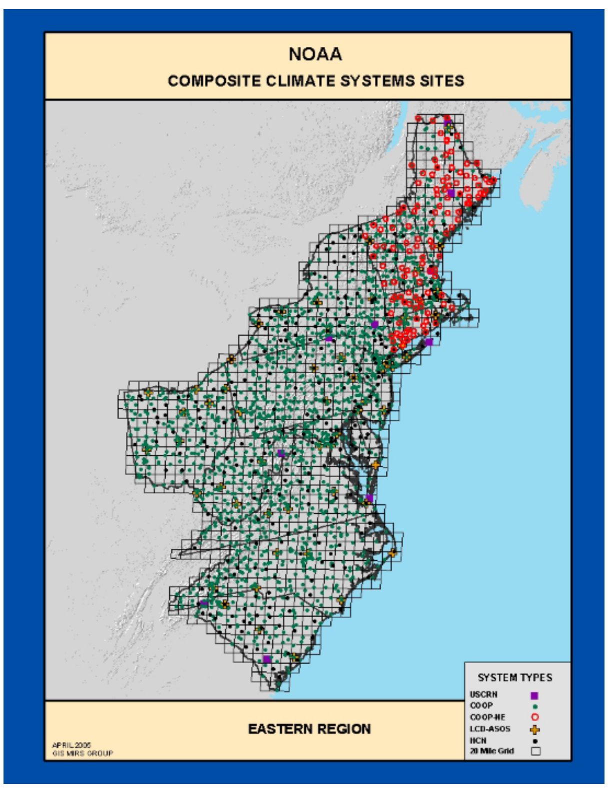

Figure 2. Example of Grid Overlay with Sites Plotted.

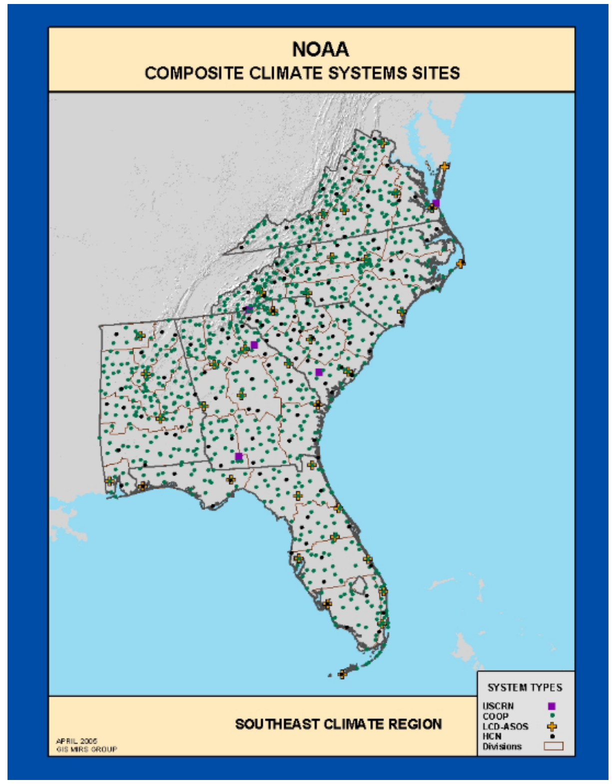

Figure 3. Climate Region and Divisions.

3.2 "Thinning the Herd" Process

Although reducing the number of sites is a much more complicated activity than identifying gaps, it could be conducted through the use of a model. For any site in the network, a numbered score can be derived based on a set of criteria organized into matrices or tables. For example, separate tables can be established for the following:

1. Metadata characteristics
2. Parameters measured or derived
3. Applications they are used in, i.e.; climate, hydrology, weather and water, etc.
4. Data products issued from the site
5. Transmission rates and characteristics
6. Post-transmission products generated by NOAA

One example from above is the *Parameters* table/matrix, which might include the following possible parameters:

Precipitation Amount
Surface Temperature and Max/Min
Wind Speed
Wind Direction
Relative Humidity
Precipitation Type
Snowfall/Depth
Snow Water Equivalent
Barometric Pressure
Incoming Radiation
Soil Moisture Profile (50 cm)
Precipitation Presence
Soil Temperature Profile
Surface Water Stage Height
Evaporation
Net Radiation
Ground Water
Water pH
Dissolved O2
Turbidity

Similar types of entries pertaining to the other categories above could be done in this way. For example, under Metadata, one criterion could be the length of record, i.e.; Historical Climate Network sites having greater than 80 years, ones with *Normals* established for 30+ years, and those that do not have *Normals* yet established. Each criterion could be weighted differently meaning the longer the record the more "points" it would receive. Another attribute would be its location. Here a site might lose "points" because it is poorly sited under a tree or next to a building, or gain points because it's perfectly situated.

When all the required data is captured, the plan would be to derive and execute a model integrating all factors into an equation and generating the results in an automated manner. The output would be a score based on total points on a site-by-site basis reflecting its relative value within the network. Below are certain outcomes which are possible from this process.

4. POSSIBLE MODEL OUTCOMES

There are several anticipated outcomes from the prospective model. Sites designated as USCRN or ASOS-LCD should be ranked very high because they produce higher-quality observations and more parameters than traditional COOP sites. For this latter group, the HCN network should score higher than other COOP sites, except at locations where sensor siting has become problematic. Likewise, sites having *Normals* should have higher scores than those without them assuming they have similar sensor suites.

4.1 Process of Elimination

No matter how the country is divided -- grid or climate region/divisions -- eliminating sites can be accomplished by executing the model, then ranking all the sites within its grid or division domain, and finally identifying sites for possible eliminating based on the lowest ranked sites within the grid or division. Figure 4 illustrates how this concept might work. Sites colored green would be those with the highest score, and therefore, would either be modernized or remain in the network. Red sites are obvious contenders for elimination and yellow ones might remain or be eliminated after some further subjective evaluation, possibly due to some mitigating circumstances such as the site might serve some other purpose not well delineated by the model.

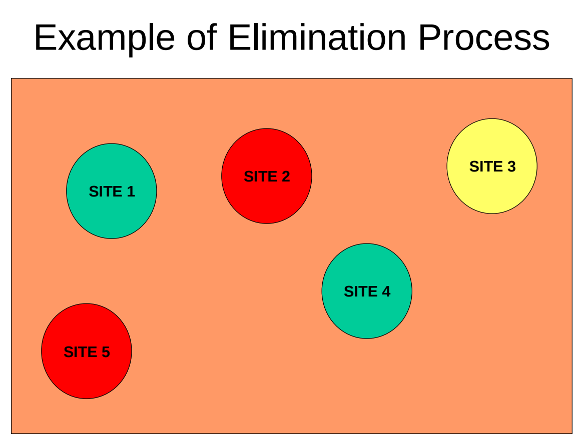

Figure 4. Color Scheme from Model Output.

4.2 Gap Analysis

Figure 5 illustrates how the gap analysis could be conducted. The green shaded squares, in this case, are areas of the country where no climate sites currently exist. These might receive priority for new systems as they are deployed to fill these gaps. There may be other reasons preventing a new site ever being installed in the empty (green-colored) grid space, such as the area is inhospitable by terrain or is deemed private property, e.g., an Indian reservation or military complex.

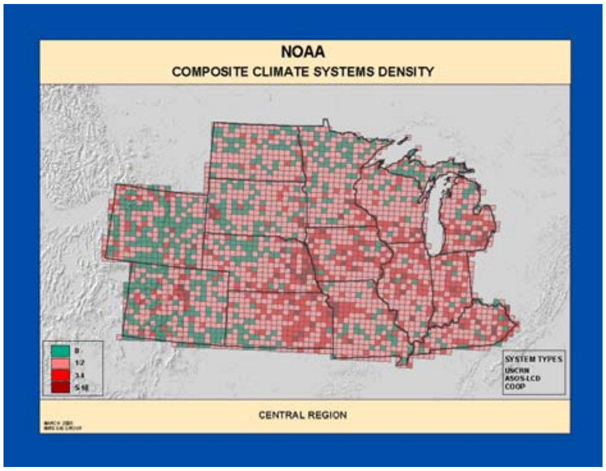

Figure 5. Density of Climate Sites in the Mid-West.

4. TRANSITIONING COOP SITES

One of the challenges for NWS will be deciding which COOP sites remain and which one can be decommissioned as part of the transition to NERON. One approach is to use the 5 mile-horizontal/100 feet – vertical rule when deciding. GIS lends itself to this analysis by displaying both the current and new sites as well as displaying a 5 mile ring around the new site. Note, additional software is needed to display geographical contours for determining if sites are displaced 100 feet vertically of each other. Figure 6 illustrates an example of displaying the 5 mile rule for new NERON sites in Maine.

5. FUTURE WORK

If NWS decides to move forward with this work, the plan is to compile the necessary information into the matrices and run the model to ascertain which sites will continue to be modernized and which ones can be eliminated as the transition is conducted. Also, more complex mapping tools may be used to depict the 5-mile/100 foot rule for determining which sites to transition. Elimination would be carried out in a sensitive manner, meaning through attrition or through mutual agreement with those currently performing the human observing function.

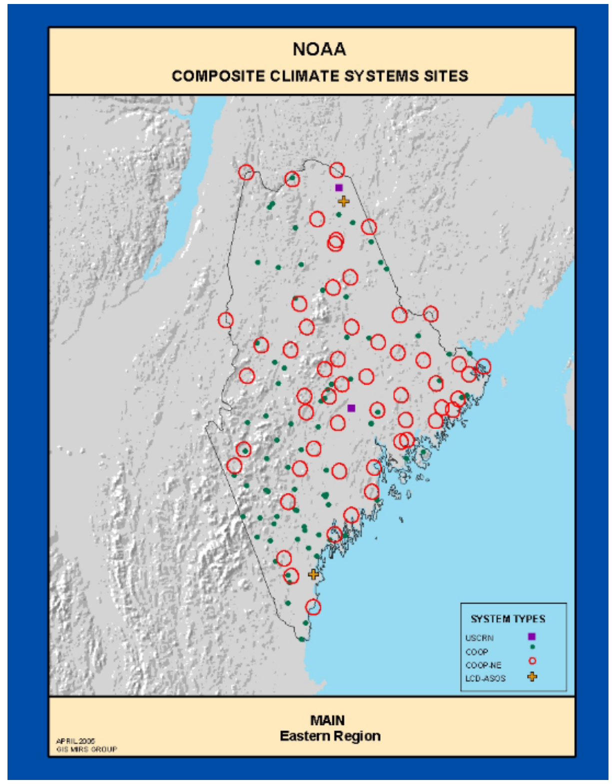

Figure 6. Display of the 5-mile rule "rings."

6. CONCLUSION

The purpose of this paper was to inform the climate community about the methodology which could be employed to define the density of the composite climate network within the CONUS. The goal was to illustrate a method by which gaps in the U.S. climate network could be identified, and where too many sites exist within a defined area, a process could be developed to determine candidates for possible elimination. Lastly, the use of the 5 mile/100 foot rule can be depicted through GIS technique to identify possible candidates for decommissioning. When decisions are made to define the type of polygon and the desired density of sites within it, the model can accurately place the best candidates within each grid space and determine its value through a ranking scheme.

7. Reference

AMS Extended Abstract, J3.4 Determining the “Optimum” Distribution of Cooperative Observer Network Stations to Support the National Weather Service Cooperative Observer Modernization Initiative, Stephen A. Del Greco, David P. Smith, National Climatic Data Center, Asheville, NC