J3.4 **Determining the “Optimum” Distribution of Cooperative Observer Network Stations to Support the National Weather Service Cooperative Observer Modernization Initiative**

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1. INTRODUCTION

The National Weather Service (NWS) is responsible for the operation and maintenance of a nationwide volunteer network of weather observation, known as the Cooperative Observers Network (COOP). It provides daily weather observations from 11,400 stations nationwide. The core network contains about 7,000 stations, which report maximum and minimum temperatures, daily precipitation, including liquid equivalent of frozen precipitation, snowfall and snow depth, and the occurrence of special phenomena such as thunder, fog, damaging winds, hail, etc. The remaining 4,400 stations report daily precipitation, evaporation, river stage levels, or some combination of these and other weather parameters. Under the current plans for modernization, COOP stations will use automated sensors to support seasonal, inter-annual climate forecasts, as well as short-range forecast verification. The new network will also provide a new source of real-time observations for use by the private sector. The movement of existing sites will be minimized, to allow overlapping observations between current and modernized network, in order to retain climatological homogeneity.

2. SCOPE OF WORK

The first objective under the NWS COOP Modernization Initiative is to determine the optimum distribution of COOP stations for the contiguous US, Alaska, Hawaii and Puerto Rico. The new network will be designed using a prescribed set of requirements that include using Geographical Information Systems (GIS) methodologies to depict station locations that are based on the following operational and climatology requirements:

* Include the presence of two sites (properly spaced) per NWS forecast zones (figure 1)

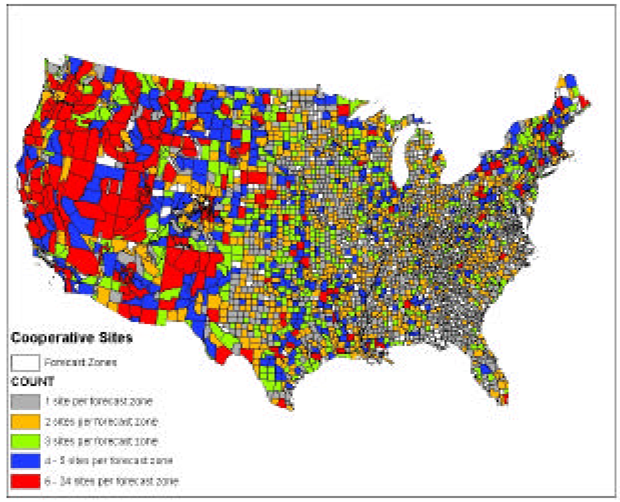

Figure 1. Color scheme number of current COOP sites per NWS forecast zones

* One site per 20 x 20 mile grid over the United States (figure 2)

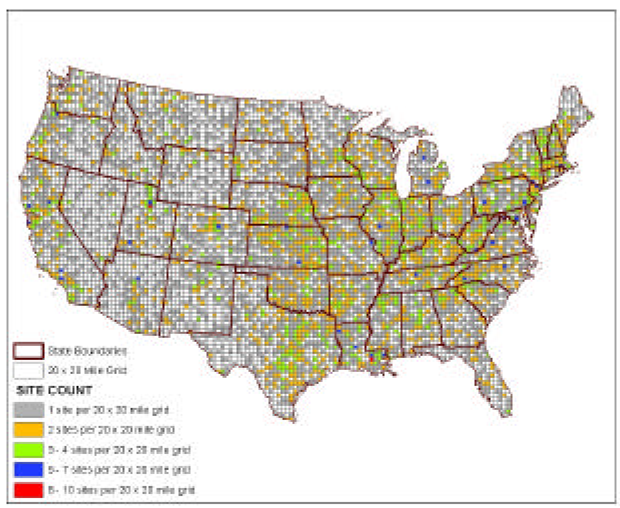

Figure 2. Color scheme number of current COOP site per 20 x 20 mile grid

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* Forty evenly distributed COOP sites per WSR-88D radar umbrella (radius = 124nm) (figure 3).

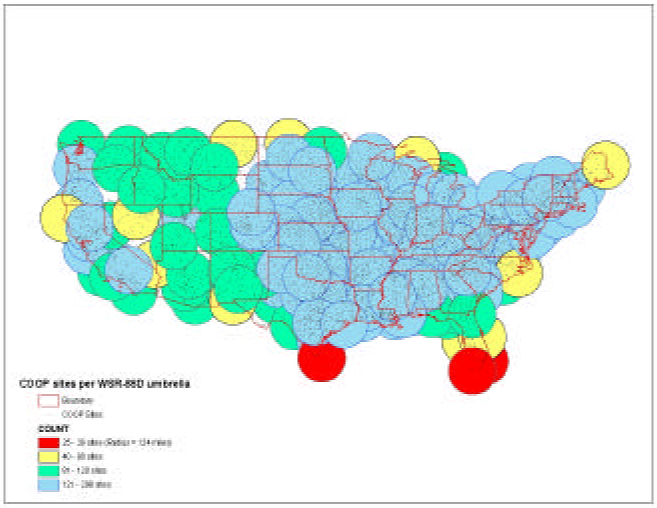

Figure 3. Color Scheme number of current COOP sites per WSR-88D radar umbrella

* COOP station placement for 5-degree climate resolution. The methodology used generates analyzed grid files of mean monthly temperatures for all months using the 30-year normals. A directional derivative algorithm (Figure 4) is applied to the mean monthly temperature grids to generate slope at grid points. This empirical method for creating slope was utilized instead of using physical methods such as elevation. Applying the 1st derivative to the 30-year normals monthly mean temperatures may account for other local climate effects as well as elevation. Figure 5 depicts areas with slopes that are greater than +5 (blue) or less than -5 (red). In these areas, station density must be closer than a 20-mile radius in order to resolve climate variability to within 5 degrees.

$$dZ/ds = Z_e - Z_w / 2\blacklozenge X * \cos(a) + Z_n - Z_s / 2\blacklozenge Y * \sin(a)$$

Figure 4. First derivative calculates slope along the direction line, where a is the user-defined angle. Using compass-based grid notation, the equation takes the above form.

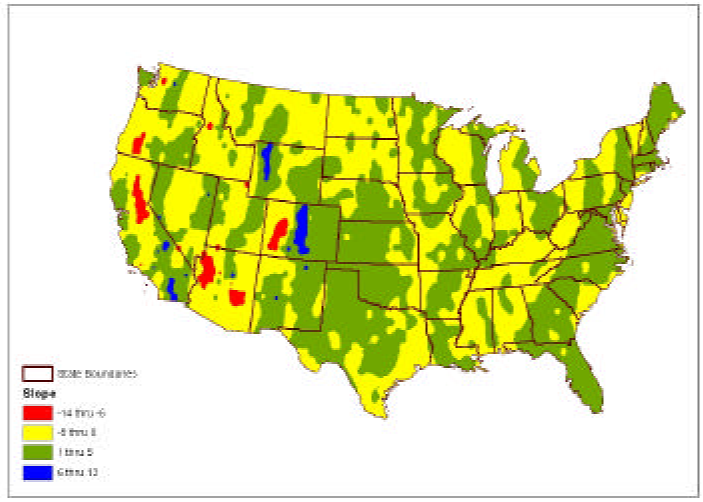

Figure 4. Slope for March 30-year normal mean temperature analyzed on 20-mile grid spaces

* To support agricultural requirements, there will be at least one site per 60 x 60 mile grid in agriculturally sensitive areas. Measurements will include soil temperature, soil moisture, temperature, precipitation, evaporation, wind, and radiation (figure 5).

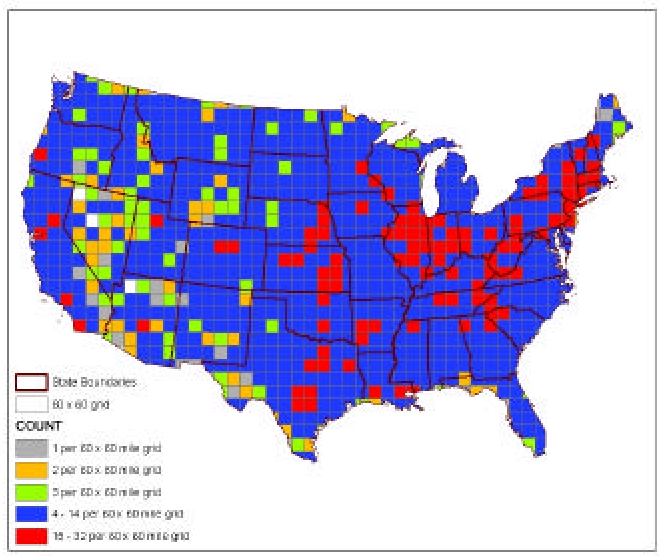

Figure 5. Color scheme number of current COOP sites per 60 x 60 mile grid

3. OTHER OBSERVING NETWORKS

The following existing observing networks are included in the spacing plan for comparison and potential use as a COOP site in areas where site gaps are determined:

* NWS Automated Surface Observing System (ASOS) (Figures 6, 10, 11 & Figure 12)

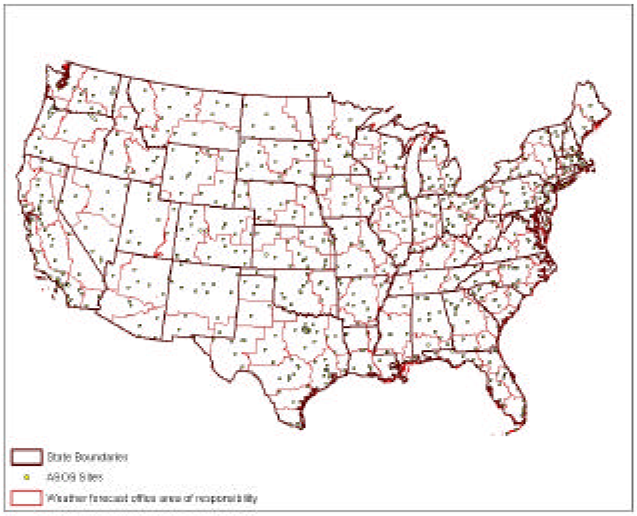

Figure 6. ASOS sites, potential candidates for the New COOP network

* United States Historical Climatology Network (USHCN) (Figure 7)

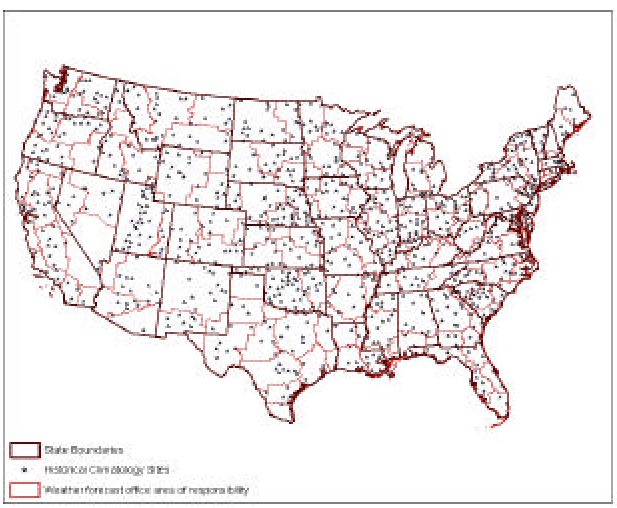

Figure 7. USHCN sites, potential candidates for the New COOP network

* Soil Climate Analysis Network (SCAN) (Figures 8 & 11)

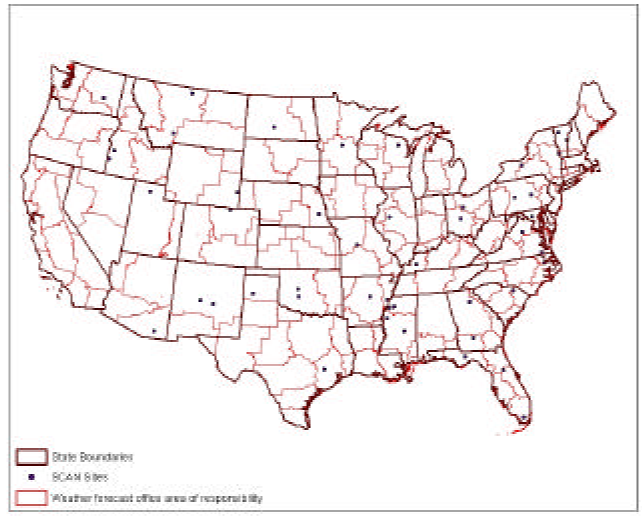

Figure 8. SCAN sites, potential candidates for the New COOP network

* Remote Automated Weather Stations (RAWS) (Figures 9, 10 & 11)

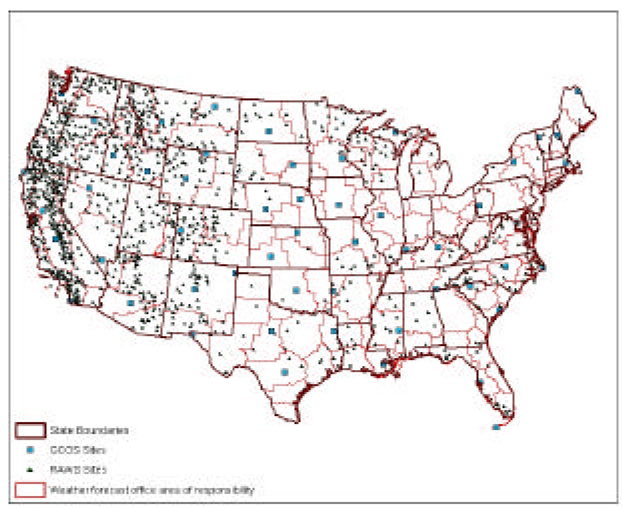

Figure 9. GCOS & RAWS sites, potential candidates for the New COOP network

* Global Climate Observing Systems (GCOS) (Figure 9 and Figure 10)

* USDA Surface Stations (SNOTEL) (figure 10)

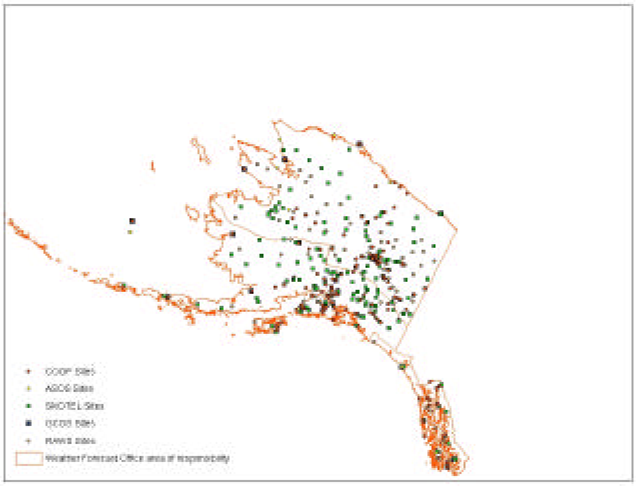

Figure 10. COOP, ASOS, SNOTEL, GCOS, RAWS & sites, potential candidates for the New COOP network

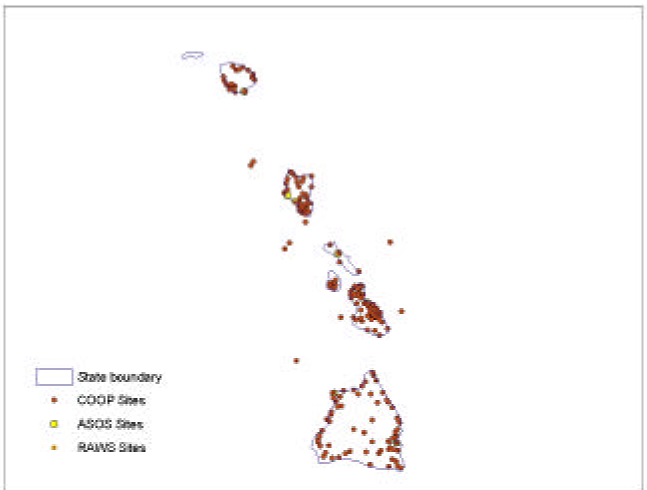

Figure 11. COOP, ASOS & RAWS sites, potential candidates for the New COOP network

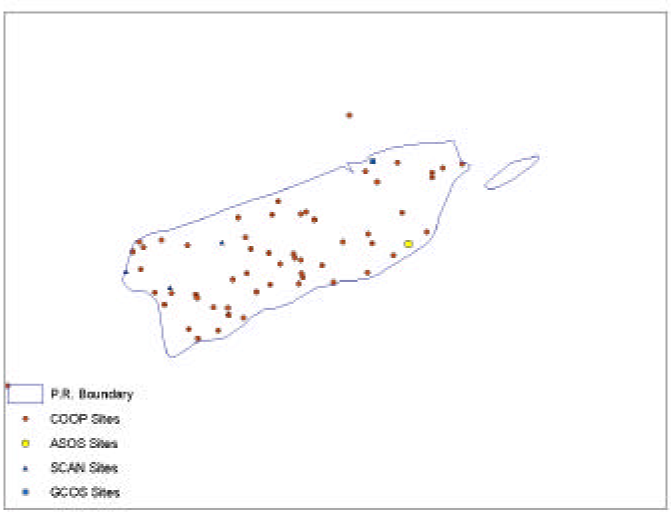

Figure 12 COOP, ASOS, SCAN & GCOS sites, potential candidates for the New COOP network

* Incorporate the Climate Reference Network (CRN) density study overlays/information into the COOP Spacing Plan. The U.S. Climate Reference Network (CRN) is a network of climate stations now being developed as part of a National Oceanic and Atmospheric Administration (NOAA) initiative. The primary goal of its implementation is to provide future long-term homogeneous observations of temperature and precipitation that can be coupled to past long-term observations for the detection and attribution of present and future climate change.

5. FINAL PRODUCT

The objective of this project is to create a Geographic Information System (GIS) product on CD-ROM. This product will be used by the NWS Weather Forecast Offices to strategically establish observing sites to fulfill NWS COOP Modernization Initiative. Product delivery to the NWS and other participating agencies is scheduled for October 2001.

5. References

Del Greco, Stephen A., Mannarano, David., Leffler, Robert., Nelson, Cynthia and Rippey, Brad: A Spatial Approach to Determining the Optimum Density of the Cooperative Observers Network. Preprints, 16th International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography and Hydrology, 511-512, Long Beach, CA

NOAA. 1993. Project Development Plan: Modernization of the National Weather Service Cooperative Observer Network. National Weather Service Office of Systems Operations, Observing Systems Branch. Silver Spring, MD., U.S. Department of Commerce.

Weather Bureau. 1953. Multiple Address Letter No. 37-53. Climatological Data Substation Network Plan. Washington, D.C., U. S. Department of Commerce.