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1. INTRODUCTION

The Management Information Retrieval System (MIRS) is a web-enabled database system designed to give National Weather Service (NWS) management and staff ready access to a wide array of systems acquisition, operations, and maintenance data through a centralized web portal. Currently under development by a team of personnel from QSS Group, Inc., and Raytheon Technical Services Company under contract to the NWS, MIRS will consolidate isolated and redundant legacy databases into one easy-to-use system. The goal of MIRS is threefold: to leverage the valuable data assets of the NWS, to provide NWS decisionmakers with reliable information in a timely manner, and to improve the efficiency and effectiveness of the administration of NWS services. Initially, MIRS will address the data requirements of NWS Headquarters. The system will then be expanded to encompass the requirements of NWS regional and field offices and, potentially, other offices within the National Oceanic and Atmospheric Administration (NOAA) and within the Department of Commerce.

MIRS has a flexible interface that will enable NWS personnel to view and interact with data sets via custom forms, reports, and maps. The forms module will allow users to view, query, and update raw data sets; the mapping and reporting modules will enable users to view and query multiple data sets simultaneously in an enhanced graphical format. In addition to its flexible user interface, the MIRS design includes strong controls to ensure data quality and secure access.

The focus of this paper is the MIRS mapping, or geographic information system (GIS), module. A significant portion of the data accessible through MIRS has a geographic component, making maps an ideal medium for viewing, querying, and interacting with MIRS data sets. Maps highlight patterns, trends, and relationships that are difficult, if not impossible, to discern from information in a tabular format. Thus, maps provide NWS management, the Congress, and the Administration with a valuable presentation and decisionmaking tool.

Currently, maps are created for NWS by request on an ad hoc basis. However, with the implementation of the GIS module's interactive web-based mapping system, access to NWS spatial data sets will become more efficient. The GIS module will allow users to directly ac-

cess and interact with spatial data sets through a web browser. As a result, many types of maps currently generated by GIS staff will be accessible to users with the simple click of a mouse. It is anticipated that the MIRS map portal, by facilitating access to NWS spatial data sets, will increase the usage and sharing of these data sets throughout the NWS.

2. DATA AND MAPS

The MIRS team currently generates maps from three NWS data categories: Infrastructure, Equipment Systems, and Service Areas. Each of these data categories has a spatial component, which allows the data to be tied to a specific geographic location or area. The data sets can be spatially displayed, queried, and overlaid with other related data sets for comprehensive analysis. Infrastructure data sets encompass NWS facilities and office locations. Maps created from these data sets are used to visualize the location of NWS facilities such as Weather Forecast Offices (WFO), River Forecast Centers (RFC), and Regional and National Centers. The Equipment Systems data set includes transmitter, sensor, and communication networks. The Automated Surface Observing System (ASOS), Next Generation Radar (NEXRAD), NOAA Weather Radio (NWR), and Advanced Weather Interactive Processing System (AWIPS) communication networks are all examples of NWS equipment systems included in this data set. Maps displaying the location and coverage areas of these systems, such as maps of the NOAA Weather Radio (NWR) network, are frequently generated for Congress to assess the quality of services provided to the public. Service Areas are geographic areas delineated by NWS for the purpose of generating weather forecasts and warnings. Service Area maps include Public Forecast Zones, Marine Forecast Zones, and County Warning Areas. Additional geopolitical data sets such as states, counties, congressional districts, and census information are also frequently integrated with the other data sets to fulfill requirements for additional or enhanced services.

Maps are delivered in both hard-copy and soft-copy formats, the latter often as PDF files or JPEG images. Additionally, some maps are available through the MIRS prototype Internet Map (IMAP) sites. These sites are currently accessible only to a select set of users. IMAP sites enable users to quickly access, view, and print maps. This capability is essential to the efficient distribution of spatial data through the MIRS web portal.

Although IMAP sites will automate access to many commonly requested maps, the NWS will still require a customized map capability. Accordingly, the MIRS team

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will continue using ArcView (ESRI's desktop mapping software) to create custom maps and perform spatial analysis. Custom maps provide NWS management with a powerful analysis and presentation tool. For example, these maps can help decisionmakers address and communicate answers to complex questions regarding site selection (*Where should the next NWR transmitter be located?*), coverage area analysis (*What natural or man made structures are impeding the radar signal?*), and distance analysis (*What Cooperative Observations sites are within 15 to 30 miles of an NWR transmitter?*).

3. INTERNET MAPPING ARCHITECTURE

The MIRS web portal will contain a link directing users to the MIRS Maps and Data page. This will be the home page for users of IMAP sites, Static Maps, Spatial Data, and Viewers. IMAP sites will be accessible to users through a web browser or other ESRI desktop mapping client. Through a browser, users will view, query, and interact with the various map data layers. MIRS utilizes ESRI's ArcIMS (Internet Map Server) software to create and serve maps to the Internet. The Static Map page will allow users to view Service Area data such as Public Forecast Zones and Marine Forecast Zones in a PDF format. Adobe Acrobat Viewer software will be required to

display these data. The Spatial Data hyperlink will provide access to the AWIPS Map Database page. This page is maintained by the NWS Office of Science and Technology (OST) and contains shapefiles (ESRI spatial data format) that can be downloaded for Service Area and Geopolitical boundaries. Shapefiles are viewable using the following ESRI applications: ArcView 3.x, ArcGIS 8.x, or ArcExplorer. ArcExplorer is a free application that can be downloaded from a link on the Spatial Data Viewer page.

4. CURRENT IMAP SITES

The MIRS team has developed two IMAP site prototypes that are accessible through the MIRS GIS module. Features of these sites are addressed in the following subsections.

4.1 Public Forecast Zones

Public Forecast Zones define areas of WFO responsibility for issuing weather forecasts, watches, and warnings. Public Forecast Zone maps are accessible through the NWS web site as static PDF files. Static maps provide a useful reference but are functionally limited in comparison to IMAP sites. As shown in Figure 1, the Public

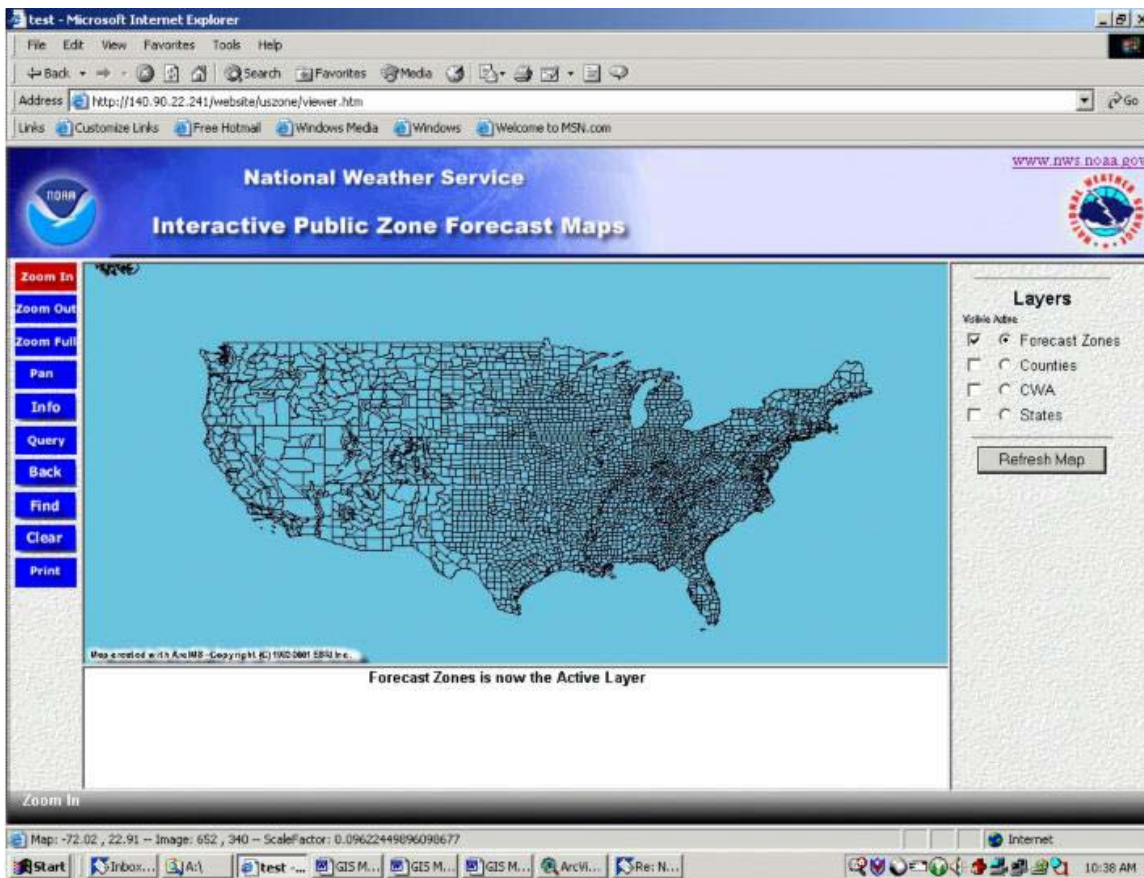


Figure 1. Initial Display (continental scale) of Public Forecast Zones.

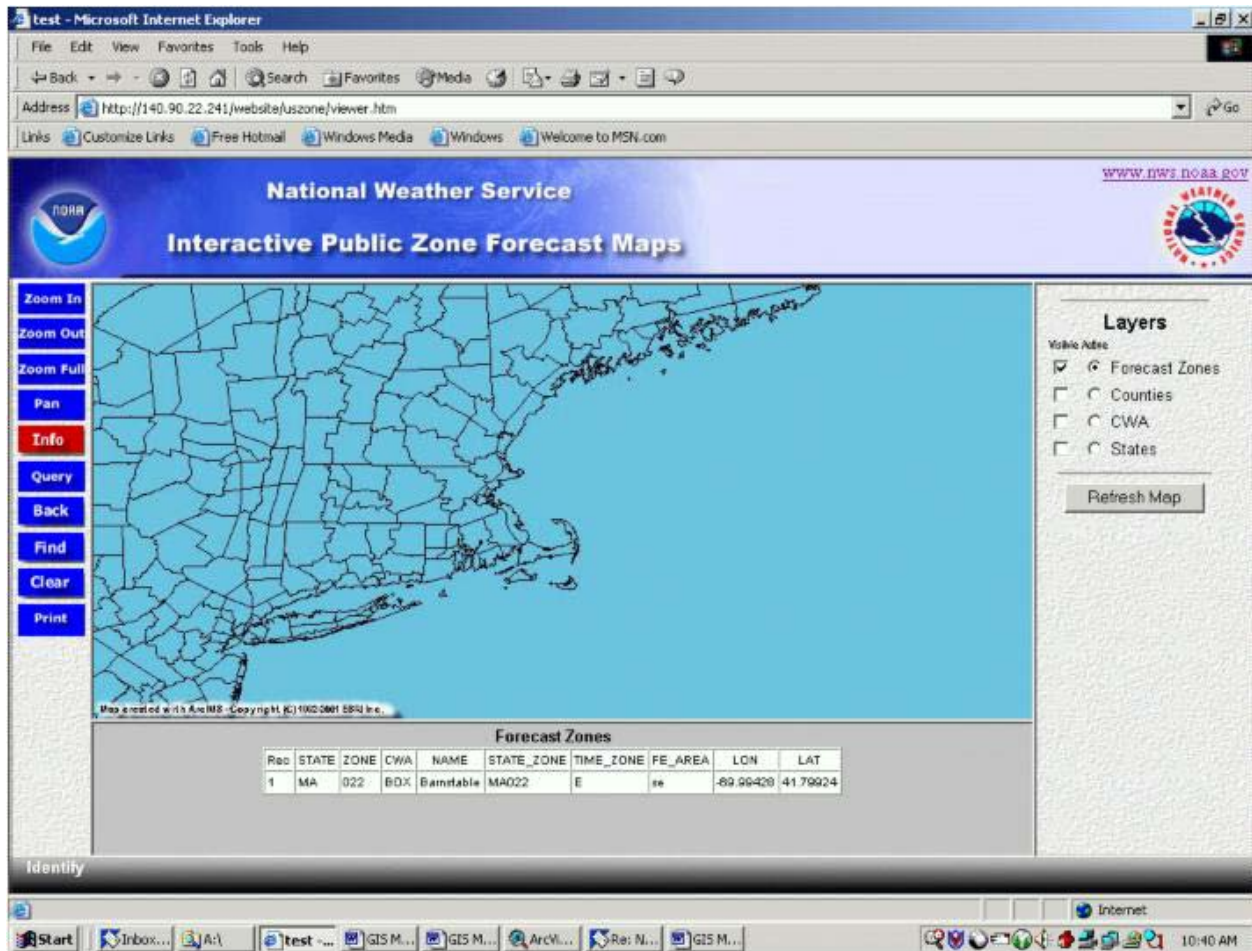


Figure 2. Zoomed Display With Use of Info Tool to Identify Zone Attributes.

Forecast Zones site integrates additional data layers and map interaction tools, allowing users to explore the data and leverage information from other related data sets.

The Public Forecast Zones IMAP site prototype consists of the following data layers: Forecast Zones, County Warning Areas (CWA), and Counties and State boundaries. Additional data layers can be added to this site as needed, but for now the site's purpose is to provide WFOs with an efficient tool for viewing the latest Public Forecast Zone data. The site utilizes the standard ArcIMS HTML viewer template and returns client requests as a JPEG image. The MIRS team customized the ArcIMS template to create a "look" and "feel" consistent with NOAA NWS web site standards. The viewer page contains the standard NWS corporate banner, a simplified toolbar, and a floating button bar. The toolbar was modified to provide users with the following functionality: Zoom In, Zoom Out, Zoom Full, Pan, Info, Query, Back, Find, Clear, and Print.

Users can access any of these functions by clicking the corresponding blue button on the toolbar. When selected, the button turns red and the cursor becomes enabled with the functionality of the button. Figure 2 illus-

trates changes to the map extent and display scale invoked with the Zoom In tool. Users can also determine which data layers display by turning layers on and off using the layer menu on the right side of the page.

4.2 Cooperative Stations

Cooperative Stations (COOP) are sites where weather observations and/or other services are performed by non-NWS employees, such as volunteers or contractors. There are currently 11,700 COOPs scattered throughout the United States. Meteorological data such as temperature, snowfall, precipitation, and evaporation are collected at these stations. The COOP network has been recognized as the most definitive source of information on U.S. climate trends for temperature and precipitation.

The COOP IMAP site prototype is currently used by NWS personnel responsible for managing the COOP program. This site is composed of Forecast Zone, County, CWA, and State boundary layers. With three COOP layers, seven additional equipment layers, and a 20- by 20-

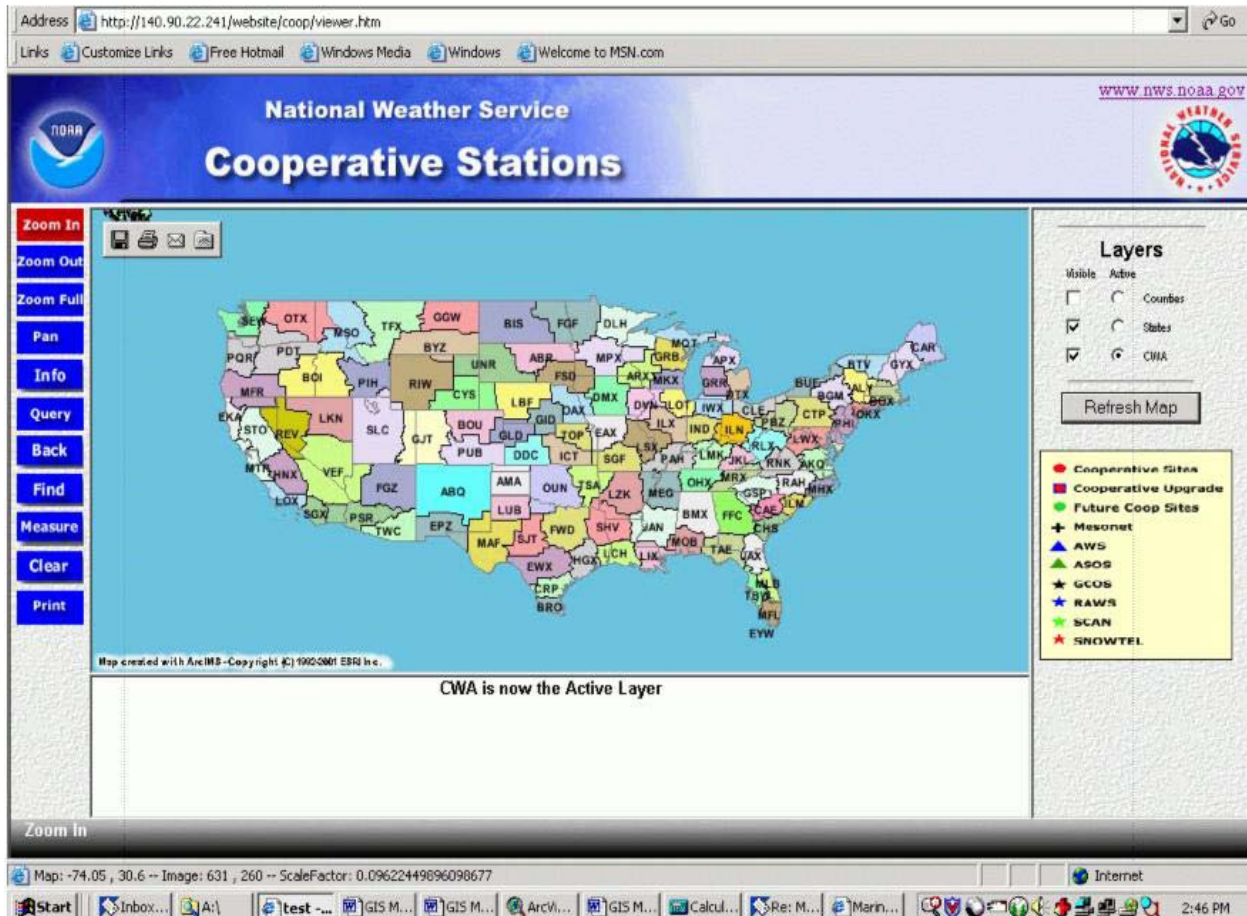


Figure 3. Initial Display (Continental Style) of the Cooperative Stations IMAP Site. (Only counties, states and CWAs are viewable at this scale.)

mile grid, this site provides a vast amount of information. Site users can visualize the coverage areas of the various equipment systems in relation to the boundary layers noted above and the coverage areas of other equipment systems.

The COOP IMAP site was created with ArcIMS utilizing the standard HTML viewer template. This site is identical in “look” and “feel” to the Public Forecast Zones IMAP site. The toolbar functions and rendering are the same except for the “measure” tool, which was added to determine distances between various equipment systems. A customized legend provides unique symbols for each of the ten equipment layers, and the scale-dependent display option ensures these equipment layers display at a useful viewing scale.

Figures 3 and 4 are screen shots from the COOP site. Note the floating button bar in Figure 3, which allows the user to save the image, print the image, or send the image in an e-mail.

5. FUTURE IMAP SITES

The GIS module will eventually include other IMAP sites, as described below.

5.1 Marine Forecast Zones

Marine Forecast Zones are over-water areas used in various NWS marine forecasts. There are three categories of marine zones: coastal, offshore, and high seas. Each of these zones will be included as a layer in the Marine Forecast Zones IMAP site. Additional layers will include land-based boundary data (States, Counties, CWAs, Public Forecast Zones), WFO office locations, and buoy locations. This site will be updated regularly to provide NWS staff with an efficient means of referencing the latest Marine Forecast Zones and buoy data.

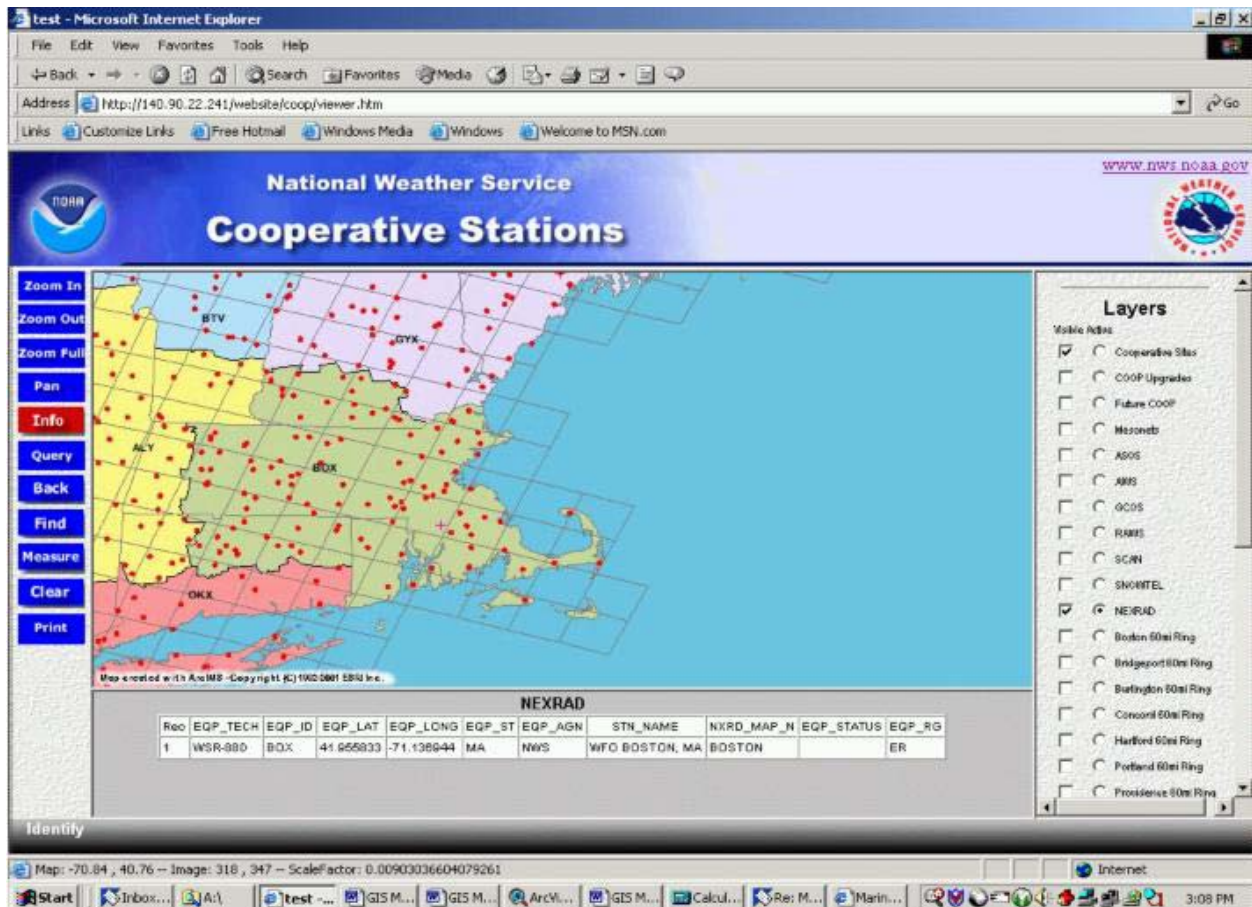


Figure 4. Example of Zoom Tool Application. (The zoom tool allows additional layers to become viewable at specifically defined.

5.2 NOAA Weather Radio

There are currently 749 NWR transmitters scattered throughout the United States, Puerto Rico, the U.S. Virgin Islands, and Guam. NWR transmitters broadcast NWS warnings, watches, forecasts, and other hazard information 24 hours a day. This site will incorporate the following data layers: NWR sites, NWR coverage rings, land-based boundary data, congressional districts, census population data, and additional equipment systems data. This site will allow users to visualize and spatially relate NWR locations and coverage areas with the other specified data layers. Additional query and feature identification functions will be associated with this site.

5.3 TWEB Routes

Transcribed Weather Broadcasts (TWEB) are forecasts for more than 300 selected short-leg and cross-country aviation routes over the contiguous United States. Terminal Aerodrome Forecasts (TAF) are weather forecasts for airport locations. The TWEB IMAP site will in-

clude the following map layers: TWEB Routes, TAF Sites, U.S. States, and some U.S. Territories. This site will provide users with a visual reference of the most up-to-date TWEB network.

5.4 AWIPS Network

AWIPS is a network of high-performance workstations and national communications systems. AWIPS integrates satellite imagery, radar data, and ground observations with numeric weather models to display and analyze the rapidly changing state of weather. The AWIPS IMAP site will allow users to visualize the AWIPS communications network, which links various operational offices together. This site will include the following map layers: NWS Facilities, AWIPS Network, NWS Regions, U.S. States, and U.S. Territories in the Caribbean.

5.5 Equipment Systems

Several IMAP sites will be created to display the location and coverage areas of various NWS equipment sys-

tems. These sites will provide content similar to that of the congressional briefing maps and will include ASOS, NEXRAD, NWR, and Upper Air equipment systems. The sites will also include a mix of Geopolitical, Facilities, and Service Area data. Figure 5 is a map depicting the location and elevation of ASOS and COOP observation stations in Wyoming.

6. CONCLUSION

MIRS will enable authorized users to access multiple NWS databases through a centralized web portal. The MIRS web portal will include a GIS module that will allow users to view and query MIRS data sets as maps. The GIS module includes links to IMAP sites that will automate access to commonly requested map data sets and provide users with tools for interacting with these data sets in a direct, intuitive manner. In summary, the GIS module will provide NWS with a powerful visual analy-

sis capability that will facilitate timely deployment of NWS resources and maximize the effectiveness of NWS services to the public.

7. ACKNOWLEDGMENTS

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Wyoming ASOS and COOP Locations (Elevation in Meters)

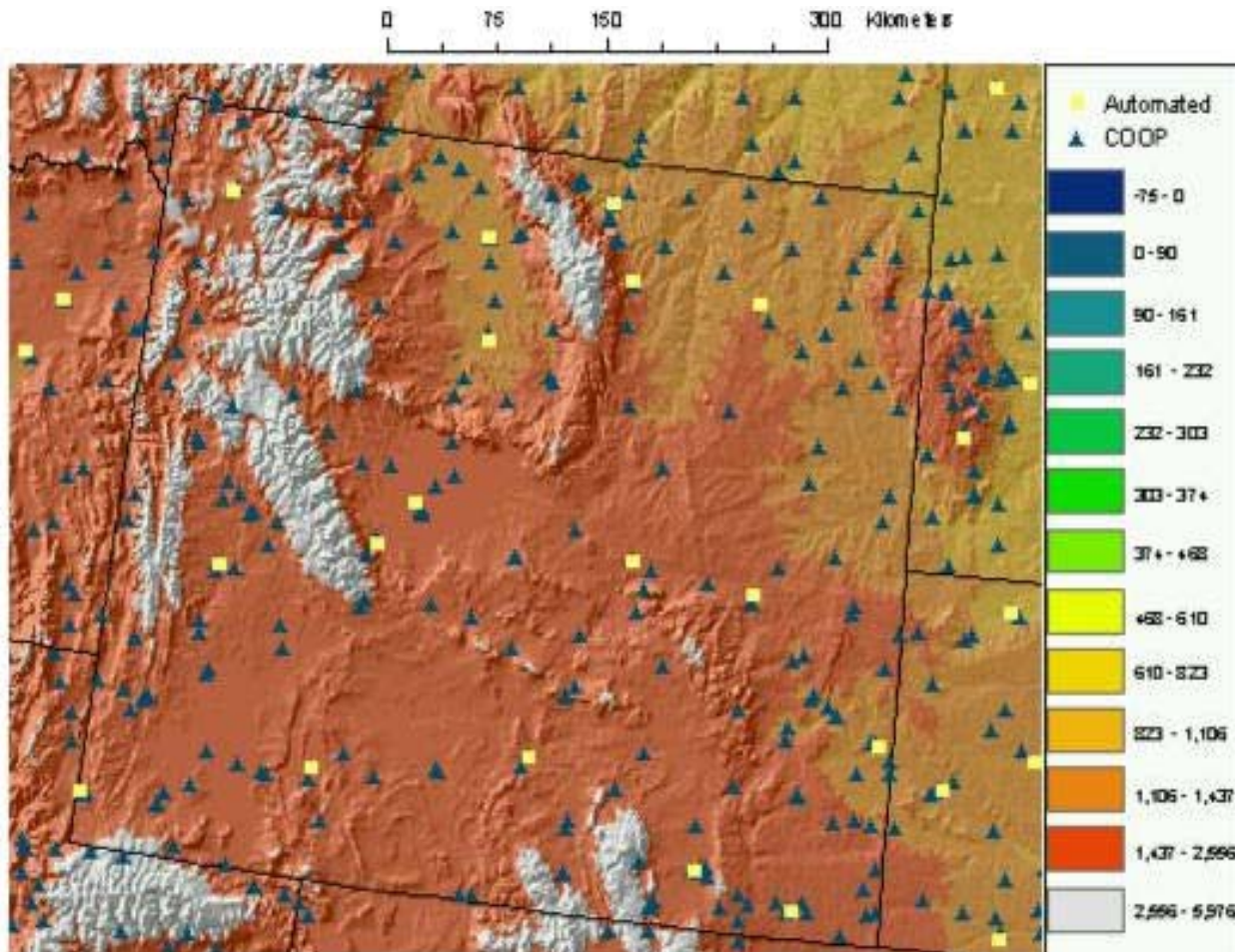


Figure 5. Wyoming ASOS and COOP Locations.