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THE GEORGIA MESONET: CONCEPTS AND SYSTEMS TO DEMONSTRATE A NEW COOPERATIVE CLIMATE NETWORK

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1. INTRODUCTION

The National Weather Service (NWS), as part of the National Oceanic and Atmospheric Administration (NOAA), oversees the operation and maintenance of the Cooperative Observer Network (COOP) - a network of meteorological observation stations scattered throughout the United States. This network is mainly operated by volunteers who dutifully record and report temperature and precipitation data each day. Because of the volunteers' diligence and because some of these observation stations predate the nation itself, COOP data have become a cornerstone of the United States climate record.

To preserve and enhance the climate record in the face of a declining number of volunteers, the growing costs in maintaining the quality and consistency of volunteer-based observations, and the ever-present goal of making government more effective and efficient, the NWS is seeking a modernized concept of cooperative observations. A new initiative, known as NOAA's Environmental Real-Time Observation Network (NERON), seeks to establish a national network of automated, real-time, high-quality, high-density, hydrometeorological monitoring stations. Because of its scope and far-reaching benefits, it is a project which must be achieved through multi-agency collaboration. One particular model is emerging in Georgia that redefines the meaning of the phrase "cooperative network." For the benefit of future COOP modernization efforts, this document describes the unique activities underway in Georgia.

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2. NERON AND THE GEORGIA MESONET

On 31 March 2004, Gen. D.L. Johnson (Ret.), NOAA's Assistant Administrator for Weather Services, approved the plan for the modernization of the cooperative observer network of the NWS. The plan for this NERON initiative sets the goal of establishing a national network of automated, real-time observation stations spaced approximately 32 km apart and abiding by strict quality standards.

The first efforts at prototyping a modernized COOP network occurred in New England where 103 existing and new COOP sites were modernized in late 2004 into mid 2005 (Crawford, et al. 2004). While this model of COOP modernization was largely successful, a less-costly, partner-based model was desired – one in which the NWS's COOP network was updated and supplemented with existing environmental monitoring networks operated by other government agencies and academic institutions. In this model, existing observation stations would be augmented as necessary and integrated into one shared system.

The state of Georgia was selected to test this concept due to the existence of several networks owned by federal, state, and local entities and the close working relationship between the NWS and some of these groups in earlier projects (e.g., weather support for the 1996 Olympic Games [Rothfusz, McLaughlin and Rinard 1998; Garza and Hoogenboom 1996]).

The NWS Weather Forecast Office in Peachtree City, GA hosted a meeting of interested parties in September 2004 at which the vision of the Georgia Mesonet (NERON, on the national scale) was presented. At least ten different organizations were represented at the meeting, each of which gave enthusiastic endorsement of the Georgia

Mesonet concept. The key catalyst for the project, however, was the prospect of some NOAA/NWS funding for mesonet equipment and operations. All attendees agreed the benefits of a coordinated "network of networks" would far surpass the sum of its parts and that NOAA/NWS "seed" funding was needed to set the project in motion. Thus, the concept of the Georgia Mesonet was born. The partners in this project now include the following (number of observation stations or contribution in parentheses):

- NOAA/NWS (160+)
- University of Georgia Automated Environmental Monitoring Network (67)
- Georgia Environmental Protection Division (4 full, 9 wind only)
- Georgia Forestry Commission (19)
- Georgia Department of Transportation (48)
- U.S. Geological Survey (360 stream flow and well sites)
- U.S. Forest Service (10)
- Georgia Bureau of Investigation (LETS communications)
- NOAA Atmospheric Research Lab (expertise)
- Georgia State Climatologist (guardian of climate record integrity)
- Georgia Emergency Management Agency (endorsement)
- Emergency Management Association of Georgia (endorsement)
- Georgia Institute of Technology Department of Earth and Atmospheric Sciences (endorsement)
- Centers for Disease Control, Radiology Department (endorsement).

3. PROJECT GOALS

The primary goal of the Georgia Mesonet, like that of NERON, is two-fold – to maintain and enhance a long-term, climatological record for the state and to provide real-time, mesoscale data. To achieve these goals, the network will have the following characteristics:

- Data collected must be of sufficient quality to match or exceed the existing COOP network of the NWS.
- Sensors will be located every 32 km, which is roughly one station per county in Georgia.
- At a minimum, temperature and precipitation data will be reported at hourly intervals, although, 15-minute reports are preferred.
- Primary communications will be through the National Law Enforcement Telecommunications System (NLETS), which will forward the data to a central collection point. In Georgia, the LETS is operated by the Georgia Bureau of Investigation (GBI) and is known as the Criminal Justice Information System (CJIS). Where LETS communications prove insufficient or redundant, Data Collection Platform (DCP) sites operated by the U.S. Geological Survey (USGS) may be used. Data from these platforms are already collected by the NWS and USGS.
- A yet-to-be-determined central facility will collect data from the Georgia Mesonet, provide quality-control services, and make the data available to all partners and the public.

Two categories of Georgia Mesonet stations have been defined. "Basic Sites" measure and report temperature and precipitation only. This is the minimum operating requirement of NERON. "Enhanced Sites" are intended to capitalize on the dense coverage of stations and the NLETS communications backbone. These sites will include sensors unique to the particular requirements of participating organizations (e.g., relative humidity, atmospheric pressure, wind speed and direction, soil moisture, air quality, biochemical, stream flow, and sensors at non-standard heights, etc.).

Many existing network stations that become part of the Georgia Mesonet will be Enhanced Sites from the very start because they already have more than temperature and precipitation sensors. Basic and Enhanced Sites, along with the NLETS communication backbone, will serve as the foundation for expansion and adaptation as new mesonet stations/sensors are acquired and installed.

Strict standards for sensor accuracy, placement, and exposure were established for the project. Mesonet sensor heights, for example, will follow the standards recommended by the American Association of State Climatologists (1985). A rating system for sensor exposure was developed and only those sites with exposure deemed "Pristine" or "Very Good" will be accepted. The standards for sensor accuracy, resolution and range are shown in Table I.

4. SITE SELECTION PROCESS

The process of selecting sites began with each Mesonet partner using guidelines established by

Table 1

Sensor	Accuracy	Range	Resolution
Temp	± 0.28° C	-65° to +60°C	0.1°C
Precip	±0.5 mm or 4% of hrly amount	0 to 254 mm/hr	0.25 mm
Wind Spd*	±0.27 m/s	0 to 60 m/s	.45 m/s
Wind Dir.*	±3 degrees	1 to 360	1 degree
Pressure*	±5 hPa	600 to 1060 hPa	.25 mm Hg
RH*	±3%	.8 to 100%	1%

*Enhanced site equipment.

the NWS' ISOS office to rate their respective observation sites as Pristine, Very Good, Acceptable, Marginal or Unacceptable. A list of all prospective (and rated) NERON observation sites and their capabilities was compiled. This list included over 600 potential observation sites. These sites were plotted on a 32 x 32 km grid for proximity comparison (Figure 1).

Once this list of initial candidate sites was created, a Site Selection Committee (SSC) comprised of representatives from each participating group was formed. This SSC met periodically to evaluate candidate sites on a grid-by-grid basis and identify the sites with the best exposures, history, and

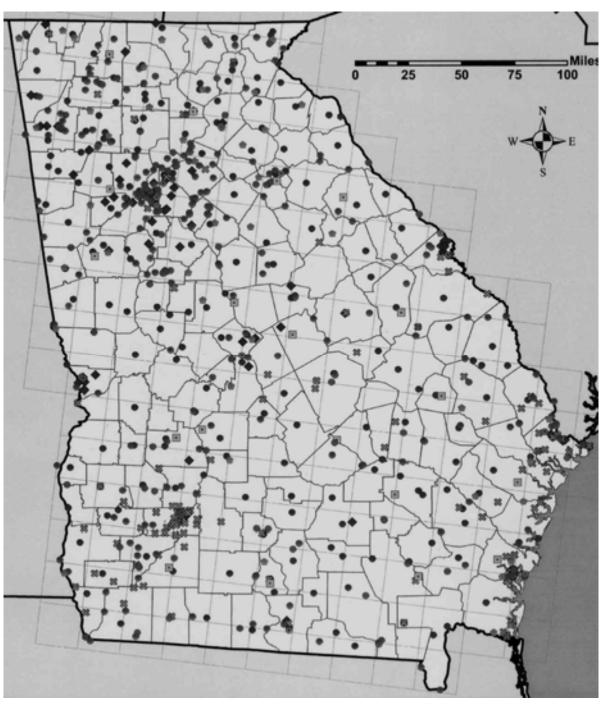

Figure 1. Candidate observation sites of the Georgia Mesonet with grid overlay.

long-term stability. These sites were earmarked for a visit by a Site Survey Team (SST) member.

Four University of Georgia physical sciences students conducted surveys at each identified location. After a two-day training session, the surveyors visited over 150 potential mesonet sites during the summer of 2005, mostly in southern Georgia. At each location, they followed a set procedure to collect digital photographs, diagrams of surrounding terrain, information on coordinates, site history, site stability, construction issues and contact information. A numerical score was calculated for each site based on characteristics of exposure for temperature, precipitation, wind and soil temperature. The data were recorded on paper forms and transferred to spreadsheets. These "metadata" were uploaded to an ftp site within two days of the survey. The online data were checked for consistency and then transferred to a restricted online database for review by SSC members.

Once all the surveys of potential sites within a grid were completed, the SSC met to review the surveys for each grid. Based on numerical scores, knowledge about site ownership, long-term stability, historical record, and other factors, the committee either chose a final candidate site for each 32x32 grid or sent the grid back for additional work if no acceptable site was identified. If no surveyed site was suitable, the NWS was requested to identify potential new sites. Once these new sites were surveyed, the grids could be reevaluated for a final candidate site.

5. CURRENT STATUS & LESSONS LEARNED

While the site selection process was underway, four sites were chosen to operate as "prototype" stations. These sites are selected to test the LETS communication viability in Georgia. Because of their excellent exposure and high likelihood of selection as official NERON sites, four Automated Environmental Monitoring Network (AEMN) stations operated by the University of Georgia were selected for this test. On 30 September 2005, two of these stations successfully began transmitting data via NLETS to a central collection point at the Oklahoma Climate Survey in Norman, Oklahoma. The third site began transmitting a week later. All three have been transmitting flawlessly, with total access by the site's owner, since their initiation. The test succeeded and the Georgia Mesonet is on the verge of becoming a reality, thanks to the cooperation, support, and encouragement of all partners involved.

The more significant "lessons learned" are shared below but, because the project is still in its relative infancy, there are far more lessons to come.

Lesson 1: A cooperative "network of networks" appears feasible and practical. Partners must be willing to adapt to meet the ultimate goal, but all appear to gain far more than they contribute individually.

Lesson 2: Clear communication and face-to-face interaction at the local level is crucial for success. The LETS communications equipment for the fourth prototype site was not activated because key local contacts were not clearly identified, were not interested in the project, or the IT system configuration was not as expected. The legwork necessary to achieve a statewide network is the most daunting aspect of the future Georgia Mesonet.

Lesson 3: Because of the wide diversity of partner interests, missions, locations, and resources, a single point of contact is required at the state level to coordinate the activities and vision of the project. The National Weather Service was the logical agent for this coordination, but the role could have been filled by any of the partners.

Lesson 4: Because COOP volunteer recruitment has been so difficult, NWS relationships with observers sometimes trumped the quality of the sensor exposures in the past. As the COOP modernization process ensued in Georgia, it became clear such relationships needed to change (or end) for the sake of the climate record. This was not an easy paradigm shift for some NWS program managers to make.

5. THE FUTURE

With the successful installation and testing of the prototype sites, the implementation of the Georgia Mesonet/NERON will proceed. Based on the decisions of the Site Selection Team, over 170 stations are planned in Georgia, many of which will be augmented and updated from existing networks. Maintenance responsibilities are in the process of being finalized at this writing, as are the final responsibilities for data collection, quality control, archival and dissemination.

6. SUMMARY

The NERON and Georgia Mesonet projects are in full swing in Georgia. Three early prototype sites are operating and communicating through NLETS channels, proving this low-cost, highly-reliable concept is feasible. The site selection process has also proven successful, in that representatives from several agencies have been meeting routinely for over a year to identify and select the mesonet stations. Their continued commitment to the success of this effort testifies to the potential the network has. It is becoming clearer that modernizing the COOP network by establishing a network of partner networks has great merit and potential. The Georgia Mesonet project can change the meaning of a "cooperative network."

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