1.2 MISSOURI'S TRANSITION TO A NEAR REAL-TIME MESONET

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1. INTRODUCTION

Sixteen years ago, the University of Missouri's Extension Commercial Agriculture Program established a small mesonet in Missouri named the Extension Commercial Agriculture Automated Weather Station Network. Environmental variables including temperature, relative humidity, wind speed, wind direction, solar radiation, soil temperature and precipitation were collected on an hourly and daily basis. The vision for these weather stations was to support high technology agriculture and preservation of the environment. Today, the mesonet has grown to 27 weather stations across the Show-Me state (Figure1.1) and the vision has exceeded all its expectations. In hindsight, the network has not only been successful in the agricultural realm, but its application has transcended numerous other vocations and interests and has become an important environmental data resource for the citizens of Missouri.

Recently, technological advancements in wireless communication and the acquisition of grant funds have provided the opportunity to bring near real-time weather monitoring to 15 of the 27 weather stations in the network. These 15 stations are providing the latest 5-minute weather conditions over the Internet and, with near real-time weather, the level of application increases significantly. Accordingly, near real-time monitoring has increased visibility of the network and earlier concerns of funding shortfalls in regard to weather station sustainability are beginning to wane as awareness increases and sponsorships are secured, mostly on a station by station basis.

2. NETWORK EVOLUTION

The Missouri mesonet was established in 1992 when four automated weather stations were installed across the state, 3 in the northwestern region and one in the south central part of the state. By 2000, the mesonet had expanded to 21 weather stations in the Show-Me state. They are comprised of hardware and sensors purchased through Campbell Scientific, Inc., including 3-meter towers and CR10(X) dataloggers. The initial variables mentioned in the introduction are still being monitored today. Additionally, some stations have acquired supplemental sensors to observe fuel moisture, soil moisture, leaf wetness and barometric pressure.

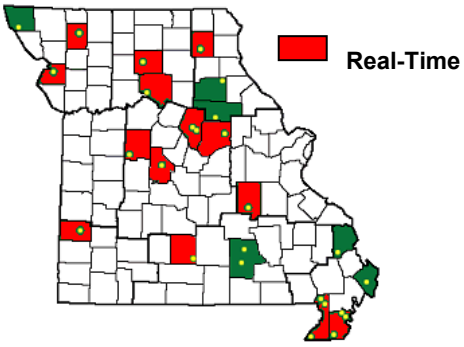

Figure 1.1 Extension Commercial Agriculture Automated Weather Station network

During this time data retrieval methods were limited to a landline telephone network interface located at the base of the tripod with a telephone modem housed inside the datalogger enclosure. Data was collected once a day, just after midnight. After various quality control procedures, data was submitted to an internet data server, generally by 8 a.m. Staff associated with the University of Missouri's Agricultural Electronic Bulletin Board (AgEBB) provided web support to host data display and archival:

http://agebb.missouri.edu/weather/stations/index.htm

AgEBB provides an effective weather and climate delivery information system for the network. Numerous products are available through AgEBB including hourly, daily, weekly, and year-to-date weather summaries. The historical archive incorporates a user friendly, menu-driven data selection and retrieval technique. Crop and insect models have also been developed using the network's data and are maintained on the AgEBB system.

The Commercial Agriculture Automated Weather Station network has provided data for a number of meteorological, agricultural and hydrological research projects. In addition, the network infrastructure is used to support field monitoring activities of the U.S. Department of Agriculture, the National Oceanic and Atmospheric Administration, and the University of Missouri.

Agricultural applications of Missouri's network include insect advisories, chemical application

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recommendations, irrigation scheduling, and planting. In addition to agriculture, the network has provided information for national, state, and local agencies, electric cooperatives, insurance companies, law firms, building contractors, university research and extension, K-12 education, media and the general public.

Network transition to real-time began in 2002 when a capital improvement proposal was funded to purchase telecommunication equipment for an existing weather station located on the University of Missouri-Columbia campus. Specifically, the telecommunication components were purchased through Campbell Scientific, Inc. and included two 900MHZ spread spectrum radios and two 3DBD omni-directional antennas. A 2003 grant acquired through the Environmental Protection Agency, and associated with manure management risk, provided resources to bring two more weather stations online in the network. These two stations, located in Morgan and Pettis counties, began providing real-time 5-minute weather conditions via the internet in April and October 2004, respectively.

Figure 1.2 Automated real-time weather station at the Greenley Research Center in Knox County, Missouri

The transition to real-time received a big boost during the fall of 2004 when a grant specifically dedicated to updating the network to real-time was funded by the University of Missouri's Integrated Pest Management Program. This grant provided $53,000 to upgrade 10 weather stations in the mesonet to real-time. Over the next few years, funds from this grant were used to real-time weather stations located in Barton, Boone, Buchanan, Chariton, Crawford, Dunklin, Gentry, Knox, Linn and Pemiscot counties.

A collaborative effort between the Missouri Department of Conservation, Missouri Prairie Foundation, and the University of Missouri's Department of Natural Resources provided resources in 2006 to bring an existing weather station located in Callaway County to real-time. The major premise behind providing the latest up to date 5-minute weather conditions was to aid in management decisions associated with controlled fire burns.

More recently, in 2007, another grant, provided by the University of Missouri's Integrated Pest Management Program, provided resources to purchase and install a full-fledged real-time weather station located at the Missouri State Fruit Experiment Station located in Wright County, a part of the Ozark region.

3. BENEFITS AND UTILITY OF REAL-TIME DATA

With real-time weather, the level of application increases significantly. For example, real-time weather provides the latest wind conditions for spray applicators. Drift is an issue in Missouri with the Missouri Department of Agriculture's Pesticide Bureau receiving about a dozen *reported* drift complaints annually. Additionally, the Meteorological Assimilation Data Ingest System (MADIS), a product from the National Oceanic and Atmospheric Administration's Forecast Systems Laboratory, is retrieving the 5-minute data from the network. The purpose of MADIS is to improve weather forecasting by providing support for data assimilation, numerical weather prediction, and other hydrometeorlogical applications.

The following are other examples of derived benefits associated with having real-time weather data access.

- Agricultural producers could access the latest soil temperature data to aid in spring time planting decisions or autumn application of anhydrous ammonia
- Health hazard information could be provided for livestock producers
- Important decisions of whether to proceed with controlled fire burns can be made.
- The National Weather Service (NWS) could use the real-time information for surface analyses and flood assessments. The information could be used to issue immediate flood warnings as well as notify emergency managers and civil defense officials for flood response.
- The weather stations could monitor wind speeds and notify the NWS of damaging winds that warrant the issuance of severe weather warnings.
- Pilots would be informed of the latest weather conditions during take-off or landing
- If a homeland security threat appears imminent or has occurred, real-time weather conditions could play a vital role in the decision making process for emergency management and preparedness officials.
- Utility companies could stay abreast of the latest conditions related to temperature

extremes and adjust their power load supply accordingly, in addition to monitoring icing conditions.

- Transportation authorities could use the data to schedule sanding and salting road crews during freezing weather.
- The heat index and wind chill information could provide immediate awareness to health officials and the public of potential health hazards
- School teachers can link to the web site and help children learn about the weather and the importance of climate in our everyday lives and our work.
- News and radio media could use the real time data for local context and serve as outlets to help disseminate the real-time information for those who do not have internet access.

4. NETWORK SUSTAINABILITY

One of the challenges for any mesonet is sustainability. Annual recurring costs associated with travel, maintenance, sensor repair and replacement, web upkeep etc. require a constant funding allocation in order to sustain it. Not unlike other capital projects, mesonets may be funded with start-up monies but little financial consideration is applied toward sustaining the project. Attempts in Missouri to seek financial resources for viability of the network, as a whole, have been unsuccessful but progress has been achieved in securing sustainable funds by taking a one on one approach and securing sponsors one station at a time.

Admittedly, a sole mesonet sponsorship would be preferred and less time consuming, but there could be some risk involved if the sponsor decides to discontinue financial support, leaving the network "high and dry". Alternatively, a multiple sponsorship approach can increase administrative responsibilities concerning the mesonet.

In Missouri, success in securing sponsors for weather stations has been achieved through various channels including receiving funds or other means of support from K-12 schools, colleges, county extension offices, research farms, agri-business, internet service providers, conservation foundations, and state and federal agencies such as the Missouri Department of Conservation and the National Park Service.

For many of the real-time stations, the K-12 schools have provided wonderful opportunities for bringing weather instrumentation and observation into the science classroom and to educate students on the importance and application of it. Generally, the response has been very positive when school teachers and administrators were approached to see if there was any interest to sponsor or host a weather station. Currently, four of the real-time stations in Missouri are hosted by K-12 schools where a computer and internet access are provided at no cost. In fact, all real-time stations in the mesonet incur no monthly fee associated with internet access. Either the internet provider sees it as a marketing opportunity or the host of a weather station pays for the internet access. Additionally, the majority of real-time weather stations require a computer to capture the 5-minute data packages and all computers have been provided by either a host or sponsor.

Initially, when the weather stations began the transition to near real-time status, sponsors were charged $2,000/year for sustainability. These costs were split 50/50 between the mesonet curator, who took care of all the travel, maintenance, calibration, repair and replacement issues and AgEBB, who was responsible for web site development, updates and data archival. However, within the past couple years, rising costs associated with labor, gas and equipment has resulted in sponsors providing $3,000/year for sustainability.

The general approach taken in seeking sponsors for a weather station is to inquire with local extension folks or local K-12 faculty and staff who live in the region where the weather station exists or where it will be installed. Extension agents are excellent resources for providing names or acting as liaisons. Once a contact was provided, the mesonet director and/or AgEBB system administrator met with the potential sponsor(s). Depending on whom the sponsor may be, dialogue generally includes information about the network, benefits associated with having real-time data, marketing opportunities etc. Once a sponsorship is agreed upon, typically a verbal commitment, an invoice is either sent annually or semi-annually to the sponsor.

5. SUMMARY AND CONCLUSIONS

As the Commercial Agriculture Automated Weather Station network has evolved, it has not only been successful in the agricultural realm, but its application has transcended numerous other vocations and interests. The transition to near real-time status has not only increased application and awareness of the mesonet but it has become more efficient in providing beneficial and useful information.

The successful efforts achieved through securing sustainable sponsorships for real-time weather stations in the mesonet is testimony to the value and importance it provides for the citizens of Missouri.