12.12 THE OKLAHOMA MESONETWORK: TEN YEARS LATER

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1. INTRODUCTION

The idea for an Oklahoma Mesonetwork (termed 'Mesonet'; Brock ***et al.*** 1995) was conceived in 1982 by agricultural scientists at Oklahoma State University (OSU) in Stillwater, OK. In 1985, a similar plan was developed by meteorologists at the University of Oklahoma (OU) in Norman, OK. By 1987, the two universities had formed a partnership to establish the Oklahoma Mesonetwork (http://www.mesonet.ou.edu/) as a joint program of Oklahoma's comprehensive research universities, and established a Steering Committee of 6 individuals to guide the Mesonet into existence. The goal was to design, procure, install, and maintain an automated, statewide network of over 110 environmental monitoring sites. The task of administering and maintaining the Mesonet was assigned to the Oklahoma Climatological Survey (OCS; http://www.ocs.ou.edu/), a state agency.

Former Governor Henry Bellmon awarded $2.0 million of discretionary funds in 1991 to establish the Oklahoma Mesonet. The two universities provided an additional $700,000 for the network. Three years later, the Mesonet was commissioned as fully operational.

The enormity of establishing the Mesonet began with an idea and ended with a fully functioning network. During this three-year period, many tasks were accomplished: Mesonet's staff was hired, 115 sites were located (at least one site in each of Oklahoma's 77 counties), rent-free use of a plot of land was negotiated, the variables to measure were determined, appropriate sensors were selected, purchased and installed, the diverse parts were integrated into a system (~2100 sensors statewide linked by nearly 300 computers), a calibration, repair, and data quality assurance laboratory was developed, a data ingest system was streamlined, and relevant data products were developed. By the end of 2001, over 700 customers had been educated on how to apply the data to their particular job.

2. DATA ARCHIVAL AND NETWORK UPGRADES

Since 1994, the Oklahoma Mesonetwork has archived over 2 billion observations. The archiving efficiency during this 8-year period is 98.7%. Since 1997, the archiving efficiency has exceeded 99.5%. Equally as noteworthy, more than 98% of the Mesonet's observations have been available in near-real-time to a broad spectrum of customers.

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The Oklahoma Mesonetwork has been enhanced on two occasions since its commissioning. During the mid 1990s, the National Science Foundation (NSF) EPSCoR Program provided funds to add soil moisture sensors to the Mesonet (60 sites, four depths). Between 1997-2000, the NSF, under its Major Research Instrumentation program, provided funds to add additional soil moisture sensors (40 new sites, four depths) plus sensors capable of measuring sensible and latent heat fluxes. Between these two projects, 1100 additional sensors and over 100 million more variable observations per year were added to the Mesonet infrastructure.

3. APPLICATIONS OF THE MESONET

> ***"The Mesonet has grown over the past decade to an operation that reaches every county in Oklahoma, and impacts the economy of the state and the well-being of its citizens. The network itself has been constructed with careful attention to every detail. The management of the Mesonet should be applauded for continually identifying new end users, as well as working closely with all end users. This useful exchange has resulted in products that are specifically catered to the users' needs. This interaction has also resulted in a diverse clientele that is very satisfied with and highly supportive of the Mesonet. Mesonet is a model for the rest of the nation to admire and, if possible, emulate."*** — External Review Team, American Association for the Advancement of Science, Washington, D.C.

Although seemingly a simple innovation, the multi-purpose nature of the Oklahoma Mesonet has become its greatest strengths. From Day One, the Mesonet has been a multi-purpose network, designed to serve meteorologists, agriculturists, public safety officials, educators and students, government agencies, the media, and many other interests. Scientific quality is not sacrificed, nor is the task of moving the data from the remote station to the customer in a timely fashion. David L. Andra, Jr., Science and Operations Officer for the National Weather Service (NWS) Forecast Office in Norman, OK notes, "The Oklahoma Mesonet has quickly become a critical piece of information to make warning and forecast decisions at the National Weather Service. It has played key roles in situations ranging from the May 3rd tornadoes [of 1999] to forecast support during the Oklahoma City bombing recovery effort."

Mesonet's associated educational outreach programs have been instrumental in engaging scientists and engineers in workshops for teachers, college professors, public safety officials, electric utility workers, and agriculture industry professionals.

3.1 Education

Probably the least measurable but one of the greatest long-lasting influences that the Mesonet has had on Oklahomans is in the area of scientific literacy for the next generation of citizens, decision makers, scientists, and engineers. For the first time, Oklahoma's rural (and urban) schools were involved significantly in a statewide science initiative that provided direct access to current data, new technology, scientific mentorship from world-renowned scientists, software and information to encourage the development of higher-order thinking skills, and a curriculum focused on scientific discovery. "Using the Mesonet, we now work in a laboratory without walls," said Comanche Public Schools teacher JoAnn Ball. "Rural areas are at a disadvantage no longer."

In 1992, as the Mesonet was being implemented, scientists at OCS were awarded ~$760,000 from the NSF to establish an educational outreach program designed to educate Oklahoma K-12 teachers to apply Mesonet data in their classrooms (McPherson and Crawford 1996). The program became known as 'EarthStorm' (http://k12.ocs.ou.edu/). Today, ~200 public and private schools actively use Mesonet data.

Roberta Chance, Gage Jr. High teacher in Gage, OK, states, "I have seen a significant increase in the skills and abilities of my students with gathering, analyzing and interpreting data. Interest in science has increased while discipline problems have decreased. My students have gained a better understanding of scientific methods because Mesonet has realistic data.... Many of my students who may somewhat struggle in other aspects of science seem to thrive on the computer using Mesonet data."

> ***"Never in my 14 years of teaching have I had students begging to come and stay at school for any other curriculum."*** — Lori Painter, 6th Grade Teacher, Presidential Awardee for Excellence in Mathematics and Science Teaching, Monroe Elementary, Enid Public Schools, Enid, OK

3.2 Public Safety

Based upon successes with EarthStorm and the growing experience base at OCS, the U.S. Department of Commerce awarded ~$550,000 in 1996 to OCS to establish an educational outreach program focused on public safety (Morris ***et al.*** 2001). The program became known as 'OK-FIRST'. Today, more than 140 public safety agencies (police, fire, and civil emergency management) are active users of Mesonet data via OK-FIRST (http://okfirst.ocs.ou.edu/).

OK-FIRST participants use Mesonet data to prepare for and respond to severe weather events (including tornado outbreaks, flooding, flash flooding, droughts, heat and cold waves, and ice storms). In addition, these data have been proven useful in solving homicides, preparing for local events, and responding to wildfires. For example, Tommy Thornton, Emergency Management Director for the City of Burkburnett, TX noted that on September 19, 2000: "We had a wildfire west of Burkburnett, and then along the Red River south of Grandfield. Using the Mesonet and your fire weather products, I was able to relay to the first fire truck that was en route to the scene how fast the fire should burn and what the winds, soil and air temperatures would be at the fire scene. Because the spread component was quite high, we dispatched two more trucks to the scene even before the first truck arrived. The three trucks had the fire out within 30 minutes, quite possibly saving property and lives."

Emergency managers now can share their experiences with K-12 students who use the same data in their classroom activities. For example, in Enid, OK, 6th grade students at Monroe Elementary serve as the Garfield County Junior Emergency Managers. These students monitor the weather during the day and can page weather updates to the local emergency management director, who serves the county on a volunteer basis.

3.3 Electric Utilities

In 1998, with Oklahoma and other states facing deregulation of the electrical utility industry, OCS developed an educational outreach program targeted at the rural electric cooperatives (RECs) of Oklahoma. Now, ~25 RECs, including a power generation facility, make extensive use of real-time weather data for critical decision making. These services (and all other data services of the Mesonet) are provided via the World Wide Web.

> ***"Information from the Oklahoma Mesonet is proving to be a tremendous resource for the Electric Cooperatives of Oklahoma. Up-to-the-minute weather data are absolutely critical for our Electric Cooperatives, which transmit and deliver electricity via powerlines in all 77 counties of the state. Not only is the information from Mesonet accurate and timely, but other services, such as the OK-FIRST program with its access to real-time weather radar, afford our electric co-ops the opportunity to enhance their abilities to deliver competitively priced electricity in a safe and reliable manner."*** — Sid Sperry, Director of Marketing & Member Relations, Oklahoma Assoc. of Electric Cooperatives

3.4 Agriculture

The outreach activities of OSU focus on the agricultural community. Mesonet data are essential to assess conditions for the issuance of state burn bans, verify the quality of the state's weather modification effort, and establish justification for county-by-county disaster declarations. The latter use of Mesonet data has been instrumental in obtaining

federal relief funding for localized disasters, especially for farmers in drought-stricken regions.

The Forestry Division of the Oklahoma Dept. of Agriculture relies on the Mesonet-based Fire Danger Model to assess fire danger levels across the state. "I use it at least daily and some days I'll use it three or four times. The data are very helpful, in fact I don't know how we managed in 1995-96 without it," says Patrick McDowell, Forestry Division Assistant Director.

> ***"The Mesonet has proven to be one of the most valuable production and marketing tools available to Oklahoma producers.... Mesonet data will play an increasing role in pesticide and fertilizer applications, prescribed burning, confined animal operations, and irrigation scheduling, to name a few."*** — Mark Hodges, Exec. Director, Oklahoma Wheat Commission

4. DATA QUALITY AND SCIENTIFIC RESEARCH

> ***"The Oklahoma Mesonet's Quality Assurance/ Quality Control methodology is certainly visionary for ensuring high quality meteorological data from a large network. I think it is important to understand that as state and national networks are developed that similar procedures should be utilized. In the field of meteorology, long term QA/QC at the network level has traditionally been an unattainable goal. I commend the individuals that are involved with the Oklahoma Mesonet for having the foresight to incorporate this aspect into their operational network."*** — Bruce Baker, Meteorologist, Climate Data Division, National Climate Data Center, Asheville, NC

The need for transferring Mesonet data quickly to local decision makers does not preclude this high-quality dataset from being used to discover new scientific knowledge.

Scientists are using Mesonet's unique data set to investigate problems that previously could not be studied thoroughly because of the lack of adequate data. For example, OSU is using Mesonet data to manage an automatically-controlled, geothermally heated, bridge deck to eliminate preferential icing on highways. Zoologists are using Mesonet climatological data to study ant and grasshopper populations across microclimates. Meteorologists are examining the impact of Oklahoma's winter wheat crop on the near-surface atmosphere. Five-minute measurements of isolated episodes of dramatic, nocturnal increases in air temperature have led to a better understanding of the climatology of "heat bursts" and to the documentation of their intensity. In addition, coupling seven years of Mesonet wind data with terrain models has pinpointed preferred locations for establishing wind turbines. The multi-year, statewide dataset of the Oklahoma Mesonet is crucial for all of these studies.

The Mesonet's impact extends beyond the borders of Oklahoma. New measurements of land-air interaction using Mesonet sensors provide a unique dataset that will be used to improve forecast models. Dr. Ken Mitchell, Land and Hydrology Team Leader, states, ***"The National Center for Environmental Prediction (NCEP) and its Environmental Modeling Center regards the land-surface energy flux measurements from the state-wide [Oklahoma Mesonet] as a critical and fundamental resource for improving the physics and prediction skill of NCEP numerical weather and climate prediction models."***

With its operational network of 330 soil moisture sensors and with the measurement of sensible and latent heat fluxes at many sites, it appears that the Oklahoma Mesonet is well positioned to make additional contributions to the solution of fundamental problems in atmospheric and hydrologic modeling.

Finally, the Oklahoma Mesonet has been part of the infrastructure of two programs examining global change and its impact on public policy: the U.S. Dept. of Agriculture's 42-station Micronet in the Little Washita River Basin and the U.S. Dept. of Energy's Atmospheric Radiation Measurement Program.

5. CONCLUSION

Over the span of a few years, OU and OSU have moved the Oklahoma Mesonetwork from a dream to a state-of-the-art information infrastructure serving the citizens of Oklahoma. The Mesonet customer base has grown from an isolated group of scientists to a far-reaching assembly of state and federal agencies, educators, decision makers, agriculturalists, non-profit agencies, the media, businesses, scientists, and engineers. During that same time, the number of data files downloaded by Mesonet's customers has increased exponentially – from fewer than 50,000 files during 1994 to greater than 5 million files during 2000.

The Mesonet has played a key role in bringing products of the information age to rural and urban areas of Oklahoma. It has served to jump-start and harmonize working relationships between numerous and diverse agencies with mission statements that involve our environment.

Finally, OU and OSU have become highly visible across Oklahoma — from the smallest community to its largest city. As a result, the perception of higher education being a bastion of 'ivory tower thinkers' has changed. Now, higher education in Oklahoma is being seen as a servant of its citizens.

6. REFERENCES

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