The University of South Alabama Mesonet: Challenges and Opportunities for the Future

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History

The University of South Alabama (USA) built its first mesonet station in January 2005. By October 2006 four stations existed. A grant from the National Science Foundation allowed for the installation of these first four stations. Funding for more stations was received in 2006 through NOAA. Currently the network consists of 26 research quality weather stations (Figure 1) and is the only network of its kind on the north-central U.S. Gulf Coast. The USA Mesonet stretches about 325 km in an east-west direction, across three states. The north-south dimension ranges from about 100 km at the western end to about 30 km in southeast Alabama north of the Florida Panhandle. The spacing between stations ranges from 5.4 to 55.6 km with an average of about 30 km.

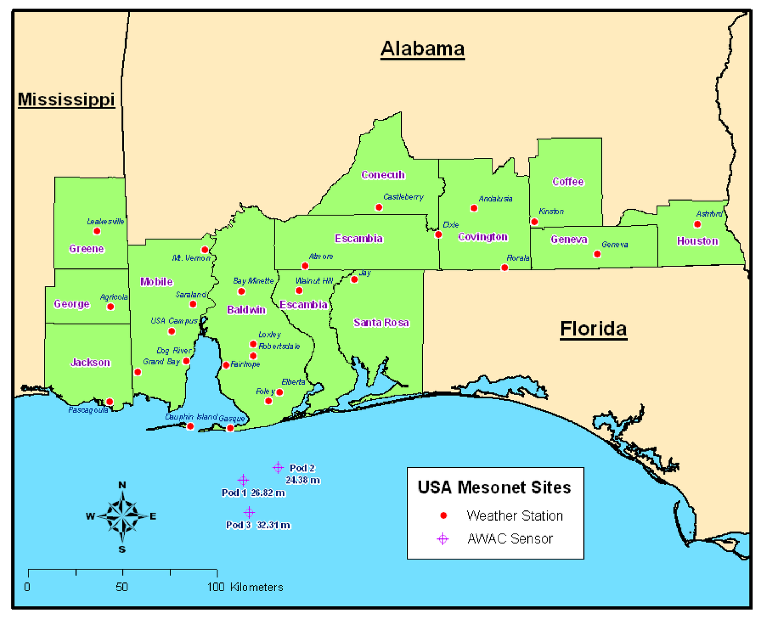

Figure 1: Map of USA Mesonet stations

The majority of station hosts are public schools which provide a safe, well-maintained environment with minimal vandalism and free access to the Internet. Additionally, they offer an important link for community outreach and K-12 education. Many stations are located in counties where previously no data were available at all. This is crucial to the Mobile National Weather Service Forecasting Office and local TV stations in fulfilling their mission of forecasting and issuing severe weather warnings.

Figure 2: Bird's-eye view of USA Mesonet weather station lay-out. Components are not drawn to scale.

Data Access:

Near real-time, archived, and meta-data are available online at:
http://chiliweb.southalabama.edu/

Station Configuration

All USA Mesonet stations are enclosed by a 9.14 by 9.14 m fence (Figures 2 and 3). The fence is 2.44 m tall including three strands of barbed wire at the top of a chain-link base. A 3.05 m wide gate is located on the north side of the enclosure. In the center of the enclosure is a 1.22 by 1.22 m concrete foundation that anchors the tower base plate (Figure 4). The concrete foundation is 0.61 m deep. Two smaller concrete pads measuring 0.46 by 0.46 m are located to the north of the tower foundation and form the base of the rain gauge supports. The tops of the rain gauge funnels are 82.5 cm above the ground. At a distance of 1.12 m south of the tower foundation is a "tower lift anchor pipe" that supports a winch used to raise and lower the towers (Figures 5 and 6) which are hinged at the northern end of the base plate. The towers are secured with three heavy duty (4.76 mm diameter) guy wires secured into the ground with 15.88 mm wide, 1.22 m long, earth anchors. This robust construction was chosen due to the relatively frequent occurrence of severe weather in the area, including tropical storms and hurricanes.

Figure 3: North facing photo of USA Mesonet station

Two 3 m long, east-west oriented cross-arms are mounted on the tower to support instruments at 1.5, 2, 9.5, and 10 m elevation (Figure 7). Additionally, a 1.5 m long, north-south oriented cross-arm is mounted at the 10 m level. A solar panel is mounted on the tower at about 7 m AGL. All stations are grounded using a 2.44 m copper ground rod attached to the tower base by a copper wire.

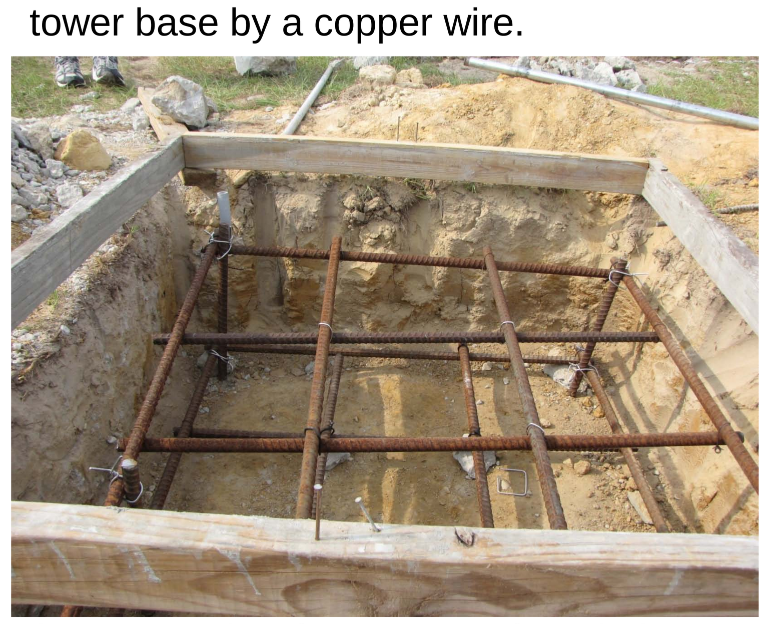

Figure 4: Rebar for concrete foundation.

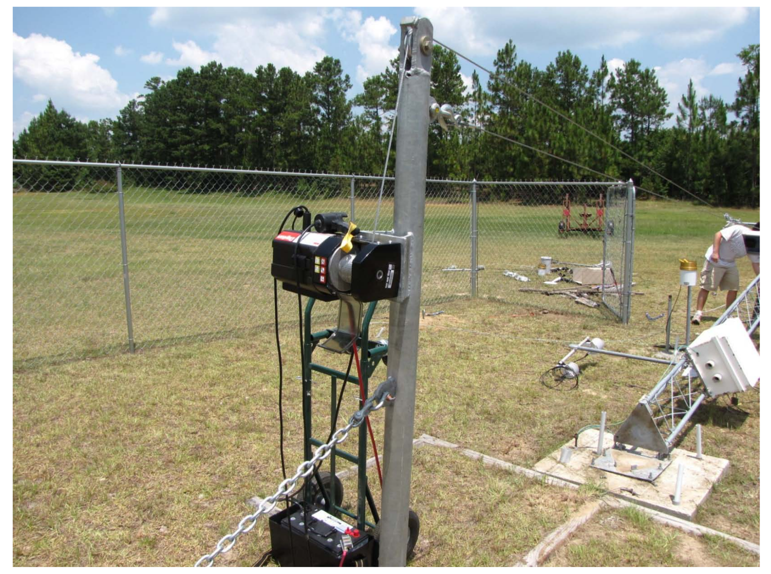

Figure 5: Winch mechanism secured on tower lift anchor pipe.

Figure 6: Raising and lowering of towers occurs with an electric winch mechanism.

Figure 7: Schematic of USA Mesonet station layout (components not drawn to scale).

Acknowledgements

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Instruments

Table 1 lists the instruments installed on USA Mesonet stations. Sensor redundancy exists to maximize data collection during severe weather events. World Meteorological Organization (WMO) instrument siting standards are followed as much as possible. In some cases, minor compromises were necessary such as accepting nearby obstructions in order to secure a safe, no-charge lease of land with free Internet access.

Variable	Instrument
Wind speed and direction (2 and 10 m)	Campbell Scientific 05103 wind monitor
Vertical wind speed (10 m)	RM Young 27106T Gill propeller anemometer
Total solar radiation	Li-Cor LI-200S pyranometer
Photosynthetically active radiation	Li-Cor LI-190S quantum sensor
Barometric Pressure	Vaisala PTB101B
Air temperature and relative humidity (2 and 10 m)	Campbell Scientific HMP45C temperature/humidity sensor
Air temperature (1.5 and 9.5 m)	Campbell Scientific 107 thermistor
Soil temperature 5, 10, 20, 50, 100 cm	Campbell Scientific 105T thermocouple
Primary precipitation	Hydrological Services TB3/Campbell Scientific CS700 rain gauge
Backup precipitation	Texas Electronic TE525-L20 rain gauge
Surface temperature	Apogee SI-111 infrared radiometer
Soil moisture 5, 10, 20, 50, 100 cm	Stevens/Vitel Hydra Probe 70030-002 25' soil moisture probe
Datalogger	Campbell Scientific CR 3000
Radio/Modem	Campbell Scientific RF401
Battery	Campbell Scientific BP-24 12V sealed battery
Internet link	Lantronix UDS 1100
Yagi Antenna	Maxrad Corporation, BMOY8905
Omni directional antenna	Laird Technologies Antenex FG9023
Tower antenna	Antenna Factor ANT-2.4-CW-RCT-xx
Window antenna	Antenna Factor ANT-DB1-HDP-xxx
Multiplexer	Campbell Scientific AM16/32
Solar Panel	BP Solar SX30U
Datalogger enclosure	Campbell Scientific EN 50298
Radiation shields	Campbell Scientific 41305-5A 6-plate radiation shield Campbell Scientific 41003-5 10-plate radiation shield

Table 1: List of USA Mesonet instruments and hardware

Data

Data are collected at 1-minute intervals using a Campbell Scientific CR 3000 datalogger. A Campbell Scientific AM16/32 multiplexer is used to accommodate the large suite of sensors. All stations are powered by solar energy using a BP Solar SX30U solar panel which charges a 12 V battery. A fully charged battery will operate the station for approximately six days before discharging to the critical dysfunctional level of 10 volts. Data is sent to a nearby building using line of sight transmission via 900-MHz spread-spectrum radio. An antenna inside the datalogger enclosure communicates with a directional glass-mount dipole antenna on the inside of a window in clear line of sight view of the tower. These antennas have a range of 1 mile. At some sites two 10-mile range antennas were needed; an Omni-directional antenna was placed on the tower and a directional Yagi antenna was mounted at the building. Both of these antennas are placed outside. The data flow to the Internet via a Lantronix UDS1100. The Campbell Scientific Inc. software package Loggernet is run on a data server at USA and polls all mesonet stations at 5-minute intervals.

Opportunities

The primary motivation for establishing the USA Mesonet was hurricane and tropical storm landfall monitoring. Valuable data have been collected during Hurricanes Katrina, Ike, Gustav, and Ida, and Tropical Storm Fay, but the network has a lot more to offer.

Besides being an invaluable resource to local forecasters, the USA Mesonet should be a key player player in addressing local, regional, and national challenges including possible climate change and renewable energy concerns. Farmers use weather data to make decisions about planting, harvesting, and spraying of pesticides, civil engineers use rainfall data for the design and planning of drainage systems and roadways, ecologists use weather information to help protect the area's unique ecosystem (crucial to the tourism and seafood industries), local chemical plants require wind data for dispersion modeling, and private citizens can use weather data to plan outdoor activities. Last but certainly not least, the Mesonet is a wonderful tool for science education at the K-12 level, and for university education and research.

The National Research Council recently published a report entitled "Observing weather and climate from the ground up: A nationwide network of networks" addressing the urgent need for the establishment of Mesonets throughout the entire U.S. Others also recognized this urgency and established the "National Mesonet Pilot Program". The USA Mesonet will take part in this effort.

Figure 8a and b: Kudzu at Atmore AL – the importance of frequent site maintenance.

Challenge 1: Funding

Currently, the biggest challenge facing the USA Mesonet is securing stable, long term funding. Federal appropriations have kept the project going for the past 4 years, but this funding source remains uncertain for the future. Unfortunately, traditional research funding agencies like the National Science Foundation do not support operation and maintenance of existing observing systems or research equipment. It costs approximately $12,000 per year to keep one weather station operational. This includes staff salaries, operation and maintenance of a service vehicle, building rental, calibration and replacement of sensors, and maintenance/replacement of computer equipment. Several avenues of funding are actively being pursued.

Figure 9: Bird's nest under datalogger enclosure

Figure 10: The Loggerhead shrike (a) impales dead animals on the station fence (b) including birds its own size.

Challenge 2: Flora and Fauna

As Figures 8 through 11 show, the warm, humid climate of the north-central U.S. Gulf coast supports fast growing plants and wide variety of animal species. The removal of Kudzu, cutting the grass, and cleaning up animal debris needs to occur on a regular basis. Our weather station technician visits each site at least once per month to do so. In addition to the above, fire ants, owl droppings, large birds on the 10 m cross arm, and chewed wires have been encountered.

Figure 11: Wasp nest under TB3 tipping bucket rain gauge.

Challenge 3: Weather

In August 2005 Hurricane Katrina's outer eyewall passed directly over the Pascagoula, MS station (Figure 12). The storm surge brought in debris that can be seen on the south-facing side of the fence, but fortunately did not reach as high as the datalogger enclosure. Shortly after the peak 10 m windspeeds were measured, the tower leaned over, causing the 10 m anemometer wires to become unplugged (Figure 13).

At 0412 CST on 27 March 2009 a wind gust of 38.25 m s^{-1} was recorded at Robertsdale, AL. An outbreak of severe weather and associated bow echo passed directly over the station. A house about 1300 m to the west-southwest of the tower incurred significant roof damage (Figure 14) with debris strewn to the east and east-northeast of the house. The station tower incurred no damage.

Figure 12: Leaning tower and debris at Pascagoula MS after Hurricane Katrina

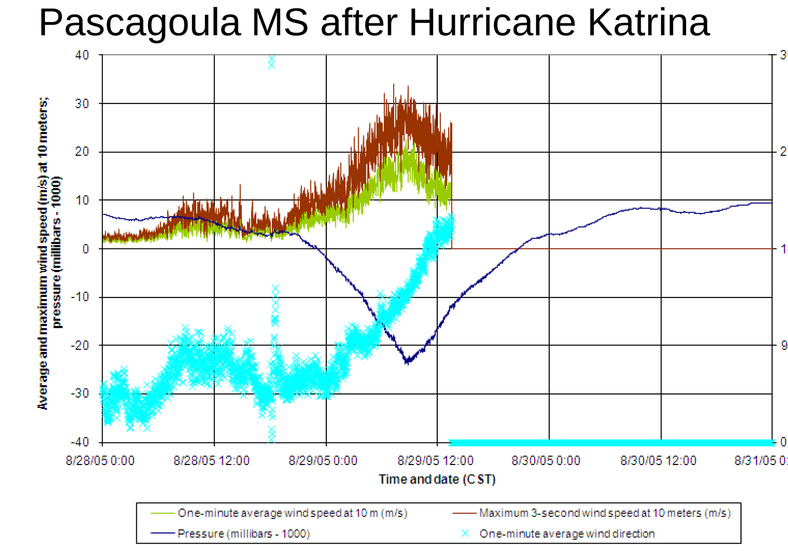

Figure 13: Hurricane Katrina measurements at Pascagoula, MS.

Figure 14: Damage to home at Robertsdale AL in March 2009.