5.4 THE VALUE OF ROUTINE SITE VISITS IN MANAGING AND MAINTAINING QUALITY DATA FROM THE OKLAHOMA MESONET

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1. INTRODUCTION

Technicians at the Oklahoma Mesonet (Brock et. al, 1995) perform three scheduled station maintenance passes annually. During a pass, each of the 116 stations is visited. Each pass is completed over a period of three months. The Mesonet employs four technicians who each maintain the stations in a quadrant of the state. The purpose of a maintenance pass is to: 1) standardize maintenance procedures at each site, 2) document the site characteristics with digital photographs, 3) provide proactive vegetation maintenance, 4) clean and inspect sensors, 5) test the performance of sensors in the field, 6) inspect the station's hardware, and 7) perform sensor rotations.

2. STANDARDIZATION

A new form is created for each pass that outlines the maintenance objectives. This form lists standard maintenance procedures as well as special tasks that must be completed at each station. Upon completing a site visit, the form is submitted to the Quality Assurance meteorologist (Shafer et al. 2000, Martinez et al. 2004) for analysis and inclusion into the station's metadata file. While a technician is at a station, all data is automatically flagged as erroneous in the event sensor operation is compromised by maintenance activities.

3. DIGITAL PHOTOGRAPHS

Digital photographs are one of the most important pieces of metadata obtained during a site visit. Fourteen standard digital photos are taken at each station to document the condition of the site and its surroundings. Photographs are taken of the soil temperature plots, the soil moisture plots, the soil heat flux plots, the net radiometer footprint, the full 10 x 10 m site enclosure, and the outside vegetation view both upon the technician's arrival and departure. Vegetation height gauges are included in appropriate photographs (Fig. 1). Vegetation conditions have been shown to have a dramatic effect on land surface physics (Marshal et al. 2003) and soil temperature measurements (Fiebrich and Crawford 2001). Over the period 1 January 2000 – 31 July 2003, the Mesonet archived approximately 10,000 digital photos to aid in the documentation of its stations.

FIG. 1. One of 14 digital photographs taken during a station visit. The vegetation gauge indicates the height of the vegetation surrounding the station.

4. VEGETATION MAINTENANCE

A wide range of vegetation conditions exists across Oklahoma and it is important that vegetation inside the station enclosure match the surrounding area as closely as possible. Meeting this requirement has been challenging. The rapid growth of vegetation in some areas can adversely impact many of the Mesonet's measurements. In addition, wildfires are possible in many areas of the state and care must be taken to minimize fire damage to stations. From 1992 through 1998, subjective decisions by field personnel resulted in a wide range of vegetation height conditions across the network. Hence, the decision was made in 1999 to apply the same vegetation maintenance criteria to all stations. On each scheduled visit, vegetation must be cut and removed so that it matches the surrounding area with a height limit of 18 inches. A firebreak (maximum of 2 inches in height, Fig. 2) is cut in a swath that extends from the tower base to the rain gauge. This firebreak provides an access path for field personnel. Vegetation height changes are

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documented with before-and-after digital photographs.

FIG. 2. Example of the firebreak vegetation cut around the rain gauge and instrument tower.

5. SENSOR CLEANING AND INSPECTION

Each sensor is inspected and cleaned during a routine site visit (Fig. 3). It is not uncommon for insects to construct nests in the temperature and relative humidity shields. Therefore, it is important to clean those sensors of any debris. Mold and dust can also accumulate on radiation shields, so they must be cleaned or replaced if needed. Wind speed sensors are checked for signs of worn bearings. Radiation sensors are cleaned and leveled. The depth of subsurface sensors is checked and the soil surface is leveled if necessary. Lastly, the technician removes all vegetation from the bare soil temperature plot and a soil sterilant is applied if required.

FIG. 3. Mesonet technician inspecting and cleaning sensors at the 9 m level.

6. RAIN GAUGE TESTS

Before any rain gauge maintenance is performed, the gauge is tested. During the test, the technician dispenses a specified volume of water at a known rate into the gauge and verifies that the correct number of bucket tips is recorded. While the test is in progress, a switch is set on the data logger that prevents test tips from being counted as rainfall in the transmitted data. After the initial test, the rain gauge is cleaned and inspected (Fig. 4). A second test is then performed to determine if any changes in gauge performance occurred during the cleaning process.

FIG. 4. Mesonet technician cleaning the rain gauge after the initial drip test.

7. FIELD SENSOR COMPARISON

The Oklahoma Mesonet's instrument laboratory ensures that each sensor is properly calibrated. However, it is also very important that sensor accuracy in the field be verified (Brock and Richardson, 2001). A portable system (Fig. 5) was designed and manufactured by the Oklahoma Mesonet to perform field comparisons in a standardized manner. Observations from the air temperature, relative humidity, solar radiation, and pressure sensors are compared to calibrated reference sensors (Table 1). The system includes an integrated 5 ms^{-1} aspirator to provide a homogeneous air volume for the reference and station temperature and humidity sensors. These comparison observations are collected and analyzed by software on a PalmOS PDA. In addition to displaying comparison data for on-site evaluation, the software also generates a report for analysis by the QA meteorologist. The system is designed to require minimal technician interaction and to communicate automatically with the station data logger when connected. The system is also expandable so that other station sensors can be compared as needed. Wherever possible, the reference sensors are of a different type and/or measurement interface to guard against systematic errors.

FIG. 5. Portable reference system used to verify field performance of various sensors.

TABLE 1. Station and reference sensors used in field comparisons.

Station Sensor	***Reference (Calibrated Accuracy)***
Air Temperature - Vaisala HMP35/45C	Rotronics Pt100 RTD (± 0.1 °C) Vaisala HMP35C (± 0.3 °C) Thermometrics Thermister (± 0.2 °C)
Air Temperature - Thermometrics	Rotronics Pt100 RTD (± 0.1 °C) Thermometrics Thermister (± 0.2 °C)
Relative Humidity - Vaisala HMP35C/45C	Rotronics MP-100H (± 1%) Vaisala HMP35C (± 3%)
Barometric Pressure - Vaisala PTB 202/220	Vaisala PTB 220 (± 0.1 mbar)
Solar Radiation - Licor LI-200SZ	Licor LI-200SZ (± 5%)

8. HARDWARE INSPECTIONS

Several checks of the tower hardware and power system are made during each visit. The integrity of the tower and guy wires is checked and the tower is leveled if necessary. The battery terminals and fuse connectors are checked for corrosion and are cleaned if needed. A load test is performed on the battery to verify its operation (Fig. 7). To ensure optimal operation, the solar panel is cleaned of any debris. Due to the large seasonal range of temperatures experienced across Oklahoma, all wiring connections must be checked and tightened (Fig. 8). Finally, all electronics enclosures receive a fresh package of desiccant to minimize the data logger's exposure to moisture.

FIG. 7. Mesonet technician performing a battery load test.

9. SENSOR ROTATIONS

The Oklahoma Mesonet strives to provide proactive sensor replacements by following a sensor rotation schedule. Sensor residence times are tracked at every station via an instrumentation database, and any sensor that is due for a scheduled rotation is replaced and returned to the Mesonet calibration facility. The three seasonal station visits provide an efficient schedule for routine sensor replacement.

10. ORGANIZING THE METADATA

Metadata gathered during each pass are organized on a website for easy access for researchers and other data users. The website provides links to the digital photographs, the technician's forms, and any unique findings from the pass. Any data quality problems identified during the pass are also listed on the website.

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