J3.3 AN END-TO-END QUALITY ASSURANCE SYSTEM FOR THE MODERNIZED COOP NETWORK

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1. INTRODUCTION

In late 2004, the Oklahoma Climatological Survey (OCS) began to prototype a modernized data ingest, quality assurance (QA), and monitoring system for the modernized cooperative observer (COOP) program of the National Oceanic and Atmospheric Administration (NOAA). Recently renamed NOAA's Environmental Real-Time Observation Network (NERON), the modernized COOP program has established about 100 automated sites in Maine, New Hampshire, Vermont, New York, Connecticut, Rhode Island, and Massachusetts. OCS personnel actively archive real-time observations from these NERON sites in New England, as well as perform rigorous quality assurance of the network data. The quality assurance system includes archiving site survey and site installation metadata in an online database, maintaining instrument and equipment information, performing both automated and manual quality control of the data, and providing detailed sensor problem reports to NERON maintenance personnel. The goal is to provide a research-quality data set that can be trusted by both real-time decision makers and research scientists alike.

2. SITE SURVEY AND INSTALLATION METADATA

To aid site selection in New England, the OCS team created a web site with access to the site survey metadata (Fig. 1). The website displays photos acquired during the surveys, site geographic information, and the subjective site rating provided by the surveyor. In addition, for NERON personnel with administrative access, the user can select whether or not a site will be installed at the surveyed location and what measurements will be acquired.

After stations were installed, OCS quality assurance (QA) staff entered the metadata into the official NERON database (Fig. 2). The NERON database contains metadata including sensor inventories, site information, manual quality assurance flags, sensor coefficient information, and trouble tickets. The database provides a seamless connection between the numerous metadata components (e.g., the resolution of a trouble ticket can result in an update of sensor locations, sensor residence times, and associated quality assurance flags).

3. AUTOMATED QUALITY ASSURANCE

The automated QA system for NERON provided by the OCS is adapted from that of the Oklahoma Mesonet (Shafer et al. 2000). Variables are tested first by a filter and second by a set of independent algorithms. The filter flags data that a) fail range tests, b) coincide with a technician visit, or c) have been flagged manually by a QA meteorologist. Data that pass all of the filter tests are then tested by a number of algorithms, each of which provides an assessment of the data. The independent algorithms currently consist of spatial tests, step tests, persistence tests, and step-to-normal tests. A decider algorithm combines the results of the various tests and provides a final flag for each observation. The flags are stratified as follows: a) "0" for a good observation, b) "1" for suspect, c) "2" for warning, and d) "3" for failure. Suspect flags are placed most commonly on observations via the independent algorithms, whereas warning flags are placed most commonly on observations via manual QA flags. Failure flags most often result from range test failures or from a combination of suspect and warning flags from the various algorithms. The data product generators prevent any data flagged as warning or failure from being displayed on the public website.

4. MANUAL QUALITY ASSURANCE

Each day, QA meteorologists review the results from the automated QA system. They analyze each observation that is flagged as

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erroneous by the automated QA. As a result of this assessment, "trouble tickets" are issued to NERON technicians so that sensors can be replaced or repaired. In addition, the QA meteorologists manually flag additional observations after they determine the true trace date/time of the problem.

Fig. 1. Details of a site survey, as compiled by the site surveyor. Site details include a list of the pictures taken at the site during the survey (in this case, at an existing COOP site), the ratings provided by the site surveyor (with 5 stars representing an excellent location), general site information, geographic location (in latitude/longitude), and contact information of the site owner. These data are password protected.

4.1. Identifying Erroneous Observations

The automated QA identifies potential data problems across the NERON network each day. For example, on 13 March 2005, the automated QA began to flag observations from the NERON site near Jonesboro, ME, because of a suspected cool bias. Jonesboro lies in a somewhat isolated area on the eastern coast of Maine. Because of Jonesboro's location, the QA meteorologist was unsure whether the cool anomaly was a real mesoscale feature or if it was caused by a sensor problem. Jonesboro continued to report 2-5°C cooler every day than its nearest neighbor (about 50 km up the coast at Eastport, ME). The QA meteorologist contacted the site host and verified that the cool readings were erroneous. The sensor bias was traced to 1 February 2005, and the data were flagged manually back to that date (Fig. 3). In addition, a trouble ticket was issued so that the sensor could be replaced.

4.2. *Over-riding Automated QA Flags*

In some situations, the automated QA may inadvertently flag good observations as erroneous (Fiebrich and Crawford 2001). When this occurs, the QA meteorologist enters a manual QA flag in the database indicating that the observation is "good." One such example, depicted in Figure 4, occurred during a sea breeze across Long Island, NY. Note that the NERON sites on the eastern side of Long Island are much cooler (e.g., 14.4°C at Fire Island CS Coast Guard Station and 18.8°C at Jones Beach Coast Guard) than those on the western side (e.g., 27.7°C at Planting Fields Arboretum and 28.7°C at Vanderbilt Museum). The cold anomaly at the two eastern stations caused the automated QA algorithm to flag the observations as erroneous. When the QA meteorologist inspected the data (along with ASOS wind observations), it was determined that the cold anomaly was caused by onshore flow. The observations at Fire Island CS Coast Guard and Jones Beach Coast Guard were then manually flagged as "good" in the QA database.

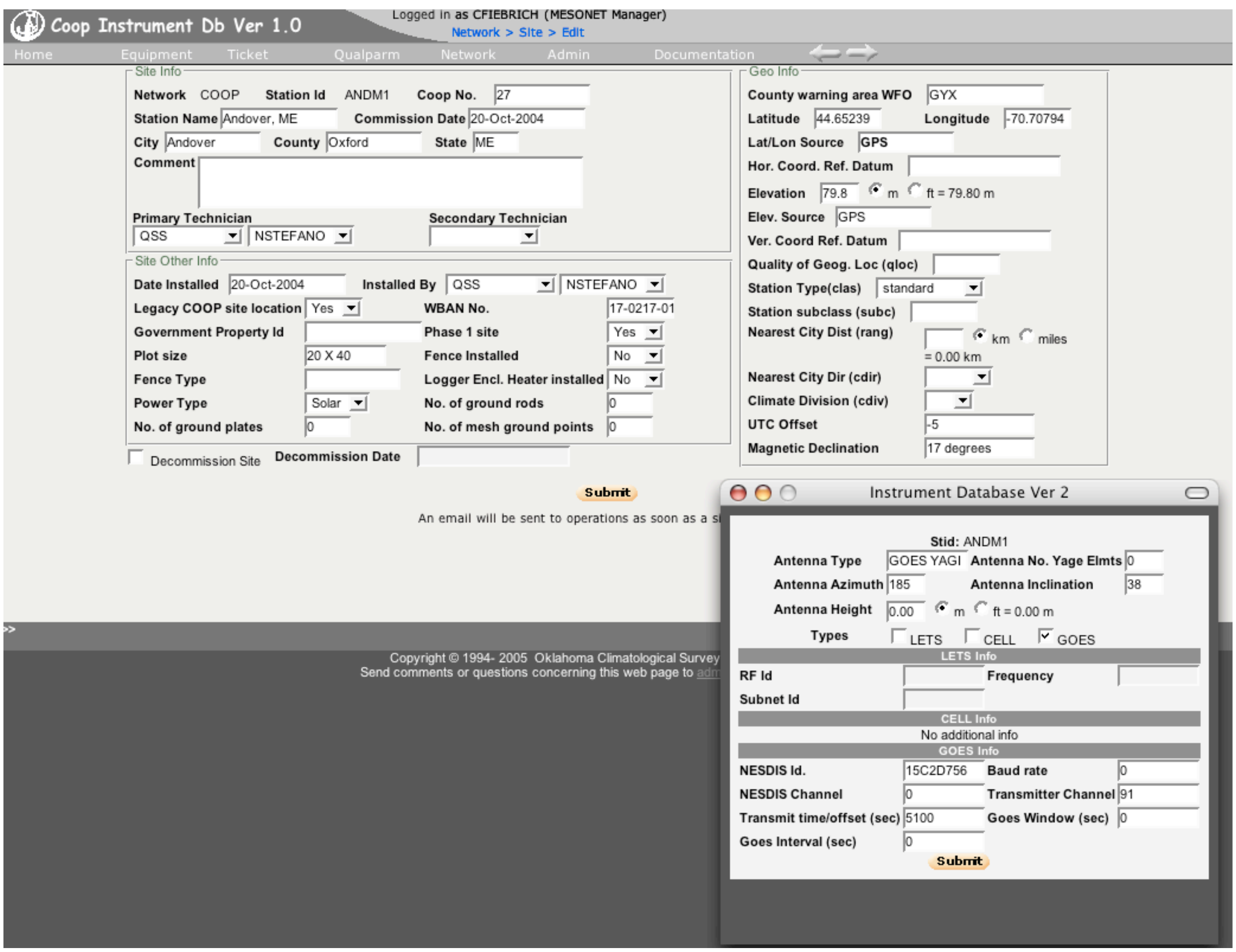

Fig. 2. Portion of the NERON metadata database that lists station information for the Andover, ME COOP site.

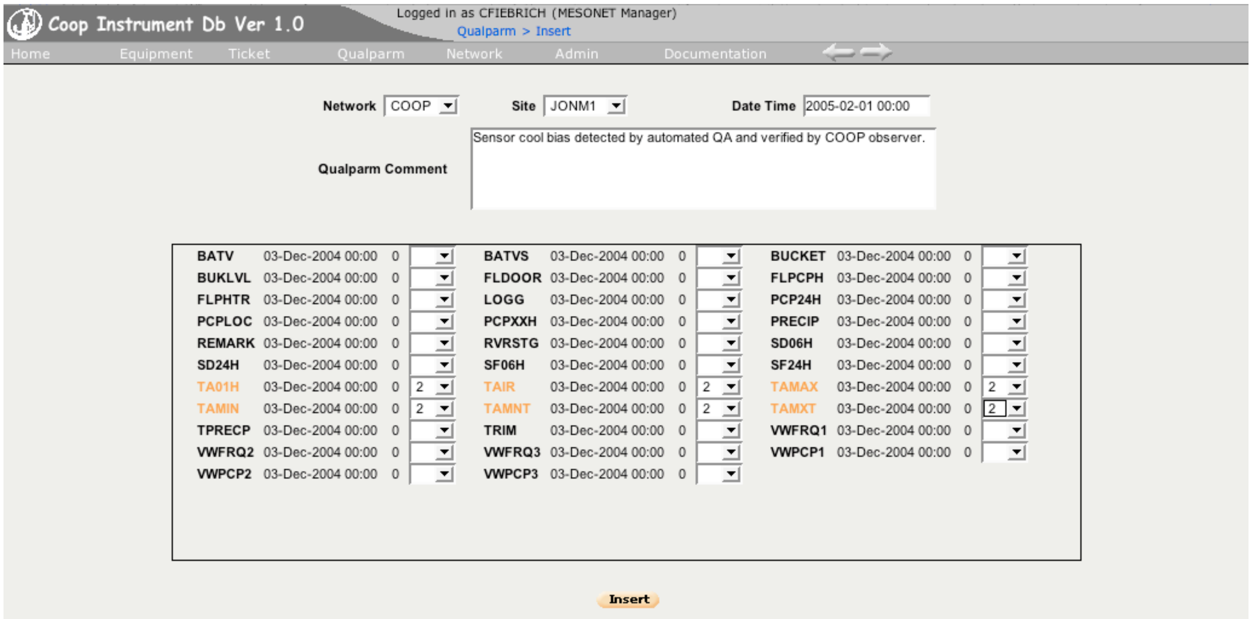

Fig. 3. Portion of the NERON metadata database which allows the QA meteorologists to manually flag observations. In this case, the QA meteorologist flagged the Jonesboro, ME (JONM1) air temperature observations with a warning flag back to 1 February 2005 because of a sensor cool bias.

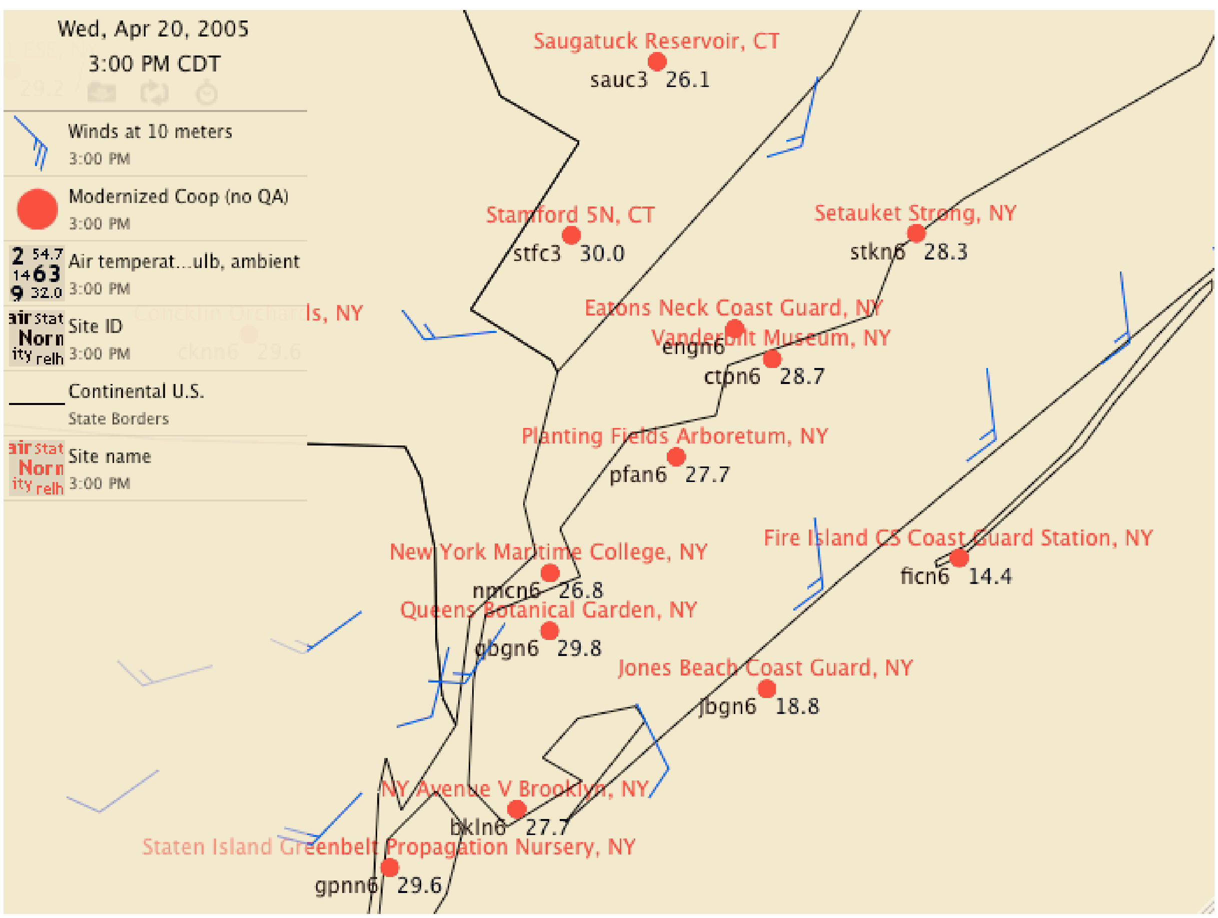

Fig. 4. Station plot of the surface temperature (°C) and wind field (m/s) across Long Island at 3:00 PM on 20 April 2005. An onshore flow created a temperature gradient of more than 10 °C across Long Island.

5. NETWORK MONITORING

A number of OCS network administrators and student operators monitor the NERON network seven days per week. Personnel monitor the communication status of each station in real-time via a number of websites. In addition, scripts automatically generate daily reports of battery voltages, tech visit status, and other diagnostics. These reports are emailed to the NERON managers, technicians, and QA personnel.

6. FUTURE WORK

Between now and the end of FY06, OCS will continue to prototype a modernized data ingest, quality assurance, and monitoring system for NERON. The metadata database will continue to evolve and grow as routine maintenance passes begin at the NERON sites across New England. In addition, the QA techniques and tasks will expand as NERON sites begin to receive wind and soil sensors. Research currently is underway to implement a real-time storm-total precipitation tool for providing automated assessments of the New England rain gauges. As some sites begin to migrate to a VHF 2-way communications infrastructure (using the backbone of the National Law Enforcement Telecommunications System), new tools for monitoring and data collection will be developed. Likewise, as NERON sites are surveyed and installed in other parts of the nation, the scalability of the end-to-end QA system will continue to mature. As FY06 ends, the prototype system will be transferred into an operational system whose details are still to be determined.

7. REFERENCES

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