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INTEGRATION OF MESONET STATIONS INTO THE NEW HAMPSHIRE ROAD WEATHER INFORMATION SYSTEM

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1. OVERVIEW

In 2006, the New Hampshire Department of Transportation (NHDOT) established a Road Weather Information System (RWIS) in an effort to provide road maintenance engineers with atmospheric and surface conditions during winter weather events. The RWIS includes 12 Environmental Sensor Station (ESS) sites distributed throughout the state. Each ESS provides data such as air/surface/dewpoint temperature, wind velocity, visibility, and precipitation type/intensity. The majority of the ESS sites were positioned along heavily traveled freeways (such as Interstate 93 & 89), so as to maximize the value of the RWIS investment for both NHDOT personnel and the motoring public. The data from the RWIS is provided to a number of entities, including the Meteorological Assimilation Data Ingest System (MADIS), and is made available to the public via a "511" website which contains other real-time highway traffic and construction information.

Also in 2006, the NHDOT initiated a separate study to develop a methodology to determine the beginning and duration of the spring thaw period. The techniques developed provide guidance in determining when to place and remove load restrictions for secondary roads during what is commonly known as the frost heave season. The study examined environmental data at a variety of geographic locations at nine sites in central New Hampshire. One of the data components of this study was the establishment of a collection of atmospheric sensors at each site, resulting in the creation of a mesonet. The configuration, manufactured by Davis Instruments, included sensors for air/dewpoint temperature, wind velocity, and precipitation rate/intensity, as well as probes modified to provide pavement surface temperature. The data from each site was manually obtained by physically visiting each site.

An additional location with existing atmospheric sensor data unaffiliated with the spring thaw study was also identified and included as part of the mesonet.

2. INTEGRATION PROCESS

Figure 1 shows the location of the four sites selected and utilized for this study. These sites were selected primarily due to their co-location with existing NHDOT maintenance facilities. Each location featured the capability for the existing console from the weather station to be connected with an existing computer located at the facility. Atmospheric sensor data from the four sites selected were integrated with NHDOT RWIS data.

The automatic data upload software provided by Davis Instruments with each weather station was configured to run as a service on each computer. This allowed for the computer to continue to be used for normal day to day operations by NHDOT personnel, while data transfer occurred in the background without interference by the user.

The data was pushed from each remote location to a central server via secure File Transfer Protocol (FTP) approximately every five minutes. Due to stringent NHDOT security requirements, data was then transferred to a second server located on a perimeter (DMZ) subnet. A final data transfer allowed the flat files containing the data to

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Figure 1. Mesonet site locations integrated into New Hampshire RWIS.

be sent to a server which serves as a central transfer point for all RWIS data. Figure 2 shows a schematic diagram of the transfer process.

After the transfer of the mesonet data was complete, each observation was parsed and converted to conform to the existing text format utilized by other RWIS ESS site observations. The mesonet data was then merged with the existing main text files, creating two master files of all observations, one with atmospheric data, the other with surface data. Each of these files was then processed using a series of quality control algorithms. The resulting enhanced data files were then made available to NHDOT clients, including MADIS, through existing protocols. Each client was provided with metadata for each mesonet site, allowing the client to add stations to existing database structures as appropriate. Figure 3 shows an example of the mesonet data appearing on the NHDOT 511 website.

3. DATA AVAILABILTY & QUALITY

In order to determine the reliability of the transmission of mesonet data to the central RWIS data transfer server, a simple methodology was developed. A valid observation hour was defined as an hour where more than half of the available 12 observations were available in the data files obtained from the central RWIS server. An analysis of the data was then performed, examining the total number of hours of data available. Based on the methodology, three of the stations performed adequately with between 82% and 94% of valid observation hours available. One station (Enfield) only had 40% of observation hours available.

Data availability was also examined based on the hour of the day as well as the day of the week. Enfield showed higher availability during mid morning hours (12Z-14Z), while other stations showed no distinct hourly biases. The Enfield station did perform consistently each day of the week, while the other three stations generally showed a trend towards less data availability during weekend periods.

Reasons for different data availability rates are varied. Since the computers at each site were used by NHDOT personnel for daily operations, it is possible that systems may have been inadvertently powered down in an effort to save energy during non-working hours. Also, the network configuration varied among sites, presenting additional security issues and possibly preventing data uploads in some circumstances. In some cases, reboots of the computer at each site resolved connectivity issues.

Mesonet data was also analyzed and validated using a buddy check system. Each mesonet site was compared with data from a nearby airport. Plymouth Municipal Airport (K1P1) was used for Bristol, Rumney, and Wentworth locations while

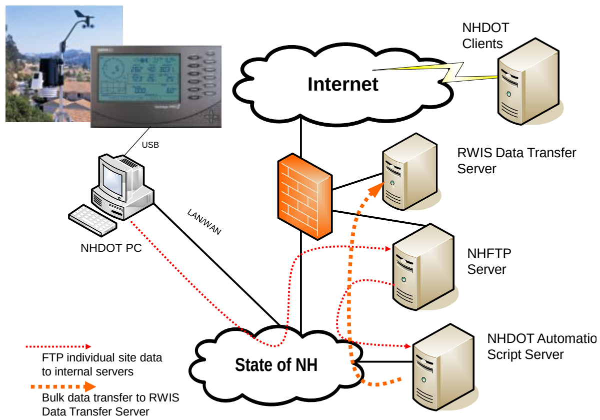

Figure 2. Data flow schematic showing transfer of mesonet data for integration with other RWIS data.

data from Lebanon Municipal Airport (KLEB) was used for comparison to the Enfield site. Absolute error and bias was computed for air/dewpoint temperature, relative humidity, mean sea level pressure, and wind speed, with a slightly modified calculation performed for wind direction.

Atmospheric sensor data quality was generally acceptable with the exception of pressure data, which tended show a positive bias between 10 and 25 mb. Further analysis showed a strong linear correlation between sensor data and data from AWOS/ASOS stations, suggesting that the pressure sensors may not have been properly calibrated.

4. FUTURE DIRECTIONS

Standardizing and isolating the computer platform for each mesonet station is envisioned to stabilize data flow and increase data availability rates. Testing is currently underway on the use of a plug computer capable of running software designed to be coupled with the mesonet station data console. The configuration features a small form factor suitable for use in remote settings, low power consumption (~5 volts, potentially usable with solar panel installations), and is inexpensive (< $1000). The potential also exists to couple the unit to a cellular modem, allowing for mesonet station placement in a wider variety of rural areas. Figure 4 shows the current hardware test configuration.

With the underlying data flow infrastructure already in place, adding additional stations at existing NHDOT facilities is relatively straightforward. Mesonet stations located at

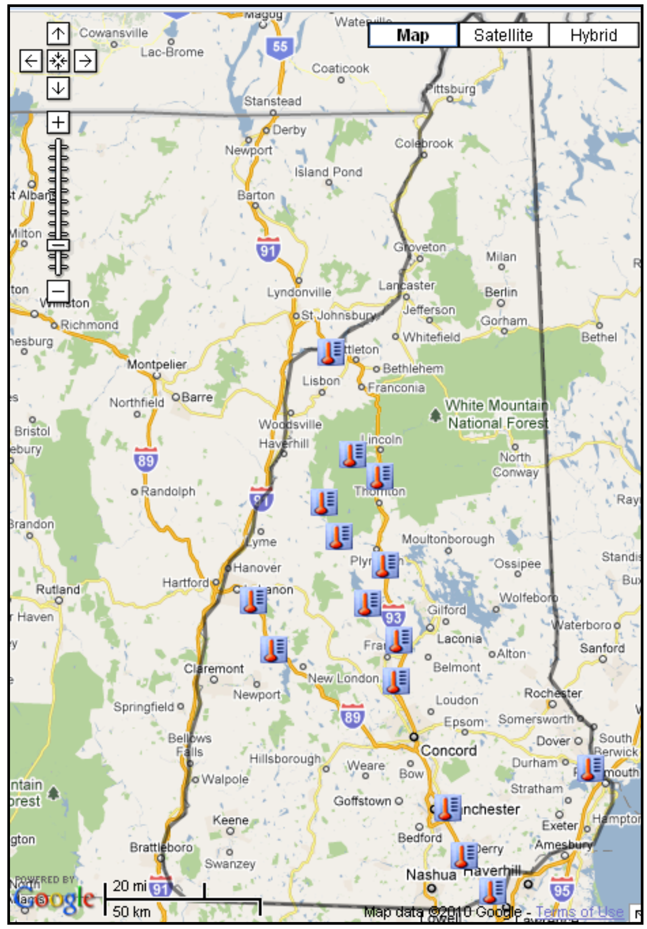

Figure 3: Image from NHDOT 511 Website showing both original RWIS data sites and mesonet station sites.

Figure 4: Data logger console connected to a plug computer capable of data relay.

remote locations would require internet access through dial-up, broadband or satellite provider. Further simplification of the data flow would also eliminate potential failure points in the upload process.

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