THE USE OF DIVERSE SURFACE WEATHER DATA COLLECTION SYSTEMS IN SUPPORT OF THE 1996 OLYMPIC GAMES

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INTRODUCTION

The National Weather Service's support of the 1996 Olympic Games was, according to many sources, a huge success. Much of this success was attributed to the utilization of highly sophisticated modernization-era tools and equipment which could run the latest technologically-advanced analysis and fore- casting models available at the operational level (Rothfusz, et al. 1997). State-of-the-art computer workstations and software were brought into the two weather offices responsible for providing detailed "spot" forecasts during the Games (Johnson, J.T., et al. 1997a).

The overall success of the entire effort, though, hinged on obtaining large amounts of weather information that could be ingested by the models to produce the most accurate and detailed forecasts possible. Upper air observations at several locations in the southeastern U.S. were increased from two-a-day to four-a-day. Doppler radar informa- tion from over ten sites in and surrounding Georgia was fed into the Olympic Weather Support Office (OWSO) in Peachtree City, GA. And, surface weather data (temperature, pressure, moisture content, wind speed and direction, and rainfall amounts) availability to the OWSO increased considerably due to the integration of various sources of data from universities, state agencies, and other federal agencies. The assimilation of the additional surface weather data by the forecast models proved to be a key factor in improving the accuracy of the forecast products and achieving the NWS's goal of providing both real-time weather information and "spot" forecast products in support of the Summer Games.

DESCRIPTION OF MESONETWORK(S)

Surface weather parameters provided by the diverse group of monitoring equipment included temperature, moisture content (humidity or dewpoint temperature), wind speed and direction, rainfall amounts and occurrence time, and atmospheric pressure. In addition, soil temperature, solar radiation, and atmospheric pollutant informa-tion was available from several selected sites.

The several systems used to provide the environmental parameters included the University of Georgia's Automated Environmental Monitoring Network, the Georgia Forestry Commission's Weather Monitoring Network, the University of Auburn's Agricultural Weather Monitoring Network, and the National Weather Service's ASOS sites. Several other sites around the southeast were polled; these included sites from Florida, Tennessee, and South Carolina (Garza, C., and G. Hoogenboom, 1996). Each individual network had a unique weather format. In addition, there were some stations within an individual network that were also different from the rest of the monitoring stations within the network. For example, a network could conceivably provide measurements of temperature, moisture content, wind, and precipitation from most of the stations. Yet other stations within the network could also take and provide solar radiation and/or soil temperature conditions. The Systems Manager was faced with making sure that 13 unique data formats were "reformatted" into a standard format that could be fed into a common database. This was further complicated by the changeover within the NWS from an SAO format to the international METAR code.

NWS ASOS Monitoring Sites

The National Weather Service had approximately 35 Automated Surface Observing System (ASOS) sites that fed information into the OWSO on a nearly continuous basis. Fourteen (14) of these were in Georgia. The ASOS observations provided the core of the information used in the Local Analysis and Prediction System (LAPS) and the Regional Atmospheric Modeling System (RAMS). The observations consisted of sky conditions, visibility, temperature, dewpoint temperature, pressure, wind speed and direction, and rainfall amounts.

ASOS observations were received via satellite and long-line communications directly into the AFOS. These then were sent to a serial port in a Hewlett Packard (HP) computer, run through a decoder and converted into the database ingest format (common database).

UGA Automated Environmental Monitoring Network Sites

In the early 1990s, the University of Georgia began installing a weather monitoring network in support of the state's agricultural program. The weather stations were purchased from Campbell-Scientific, Inc and installation began in 1991 with about five (5) units installed that year (Hoogenboom, 1996). The choice to go with the C-S equipment was based on the reliability of the sensors, the ease of installation at remote sites, and the ability to interrogate these units not only via regular telephone lines, but by use of radio, cellular systems, or even satellite interrogation (Tanner, 1990). Due to the excellent relationship between the NWS in Georgia and the UGA at that time, the UGA became the other early player in supporting the 1996 Olympic Games. Active participation by the UGA College of Agriculture's Department of Biological and Agricultural Engineering in 1990 and 1991 in the Olympic support ensured having an adequate database for "climatology" and other weather requests encountered in 1996.

In 1993, at the request of the NWS's Area Manager for Georgia, the UGA acquired eight (8) additional units for the specific purpose of helping the NWS in supporting the 1996 Olympic Games. By 1995, there were thirty-one (31) UGA Automated Environmental Monitoring Network (AEMN) sites. All of these were used in support of the 1996 Olympics.

The location of the AEMN sites afforded a great opportunity to fill in data gaps that existed throughout the state. Thirty (30) of the C-S units were located in Georgia and one (1) was installed at the Ocoee River near Ducktown, TN. Six (6) of these were at the Olympic venues and included two (2) at the Georgia International Horse Park in Conyers, GA, one (1) at the yachting venue in Savannah, GA, one (1) at the white water canoeing venue at the Ocoee River in Tennessee, one (1) at the rowing venue at Lake Lanier, near Gainesville, GA, and one (1) at the beach volleyball venue at the Atlanta Beach area in Jonesboro, GA. All of these units were programmed to measure air temperature and relative humidity at 2 meters, wind speed and direction at 3.5 meters, along with precipitation, solar radiation, and soil temperature at three points (0.05, 0.10, and 0.20 meters) below ground level.

These monitoring stations were also programmed to scan/monitor conditions at a 1-second interval and store the data at 15 minute intervals. They were then interrogated automatically by telephone four (4) times per hour from the OWSO.

Georgia Forestry Commission Monitoring Sites

The Georgia Forestry Commission has also had a weather monitoring network since the early '90s. The instrumentation and software was purchased from Forest Technology Systems, Inc. and installation of these units began in 1992. At the present time, eighteen (18) units have been installed throughout Georgia. The environmental parameters (temperature, dewpoint, wind speed and direction, and fuel stick index) are stored in a data logger and can be retrieved in a similar manner to the ones used by the University of Georgia.

In 1994, the National Weather Service entered into an agreement to access these sites in support of the Olympic Games. However, because of the time needed to call and poll each station, a "bottleneck" developed at the polling site. Therefore, only an average of ten (1) units were actually used throughout the Games.

Alabama Weather Observing Network

The Alabama Weather Observing Network (AWON)had a total of eighteen (18) sites that were made available for interrogation by the NWS. Initially, this was done by the Agricultural Weather Service Center (AWSC) in Auburn, AL and provided to the OWSO via INTERNET once an hour. The AWSC was closed in May, 1996 and the information was lost except for a monitoring unit in Union Springs, AL that was interrogated directly by the OWSO.

Several weeks before the start of the Games, the AWON data was again made available to the NWS through the University of Auburn. However, it was found that it would have been necessary to call each station (thus adding to the "bottleneck") and additional reformatters would have had to be developed to accept the data in the format needed by the OWSO computers. There was no time available to do this and the AWON monitoring sites were only interrogated infrequently and, when interrogated, the procedure was manual and quite cumbersome.

Additional Observing Networks

Additional surface weather information was also made available by the South Carolina Forestry Commission, the Florida Forestry Commission and the U.S. Fish and Wildlife Service. Weather monitoring stations similar to those used by the Georgia Forestry Commission and the University of Georgia provided forecasters with an additional 20 sites that could be interrogated on an as-need basis. For the most part, these were left off the data fed into LAPS only because of the time factor involved in polling these stations.

The location of the South Carolina Forestry Commission sites provided a unique look at sea-breeze development and pointed to a need of having those stations polled on a routine basis.

NWS Campbell-Scientific Monitoring Units

In late 1994, the National Weather Service took one last look at the distribution of weather monitoring units and found that gaps still existed within the consolidated network being used. An additional 12 units (identical to those used by the UGA) were bought and installed at the remaining venues and throughout Georgia (one was installed in Union Springs, AL). These units were also polled every 15 minutes using the same technique as used in polling the UGA units and the Georgia Forestry Commission sites.

Several units were placed at or near venues to provide the observational data needed by the venue managers, participants, and media. One (1) was placed in the immediate vicinity of the Aquatic Center at Georgia Tech University and gave an excellent reading of conditions in the center of the Olympic Ring, including the Olympic Stadium. Another was located at Clark-Atlanta University, also in the Olympic Ring, and the site of wrestling and field hockey events. One (1) was installed at the shooting venue at Wolf Creek and two (2) were installed at Stone Mountain to support the tennis and cycling events.

DATA COLLECTION

As indicated earlier, the LAPS required a large amount of surface weather data (Stamus and McGinley, 1997). In addition, these data were fed into the RAMS, which was set to run every three hours from morning through the evening (Snook, et.al. 1997). It was crucial to have not only the quantity of data but to have high quality data to produce accurate forecast products. Thus the LAPS became not only the final model produced by the mesonet data but a quality control tool that could provide forecasters a quick look at temperature, wind, and moisture fields every 15 minutes and allowing enough time to detect and correct erroneous data before the 3-hourly RAMS runs.

The bottleneck encountered was at the OWSO's server which polled and decoded all observations coming into the system.

Although two telephone lines were available, the fact that polling each unit required 30 seconds limited the number of sites that could be polled in order to produce a LAPS output every 15 minutes. Additional problems or time delays would also occur if the software used in calling the units or the telephone system would fail to allow connection to a particular unit. Thus, the number of stations called during each 15-minute period was normally between 50 to 60.

EXPERIENCES

There is no doubt that the additional data from the various mesonetworks contributed to more accurate forecast and warning products. In fact, there were several documented instances where the wind information retrieved from several of the units located at the venues reinforced and contributed to the decision of issuing warnings for those sites. Large data gaps within the state that would have caused extremely "course" analysis of weather conditions were completely eliminated by the careful placement of weather monitoring equipment by the NWS and the UGA.

Calibration and maintenance were of utmost concern to forecasters and administrators alike. The need to have a reliable data base that would supply not only information to be used by numerical models but also used as observations at venues led all agencies involved to increase the number of maintenance visits to each site. Several quality control measures were put in place. Not only did each agency poll and check their monitoring stations from their respective central polling computer but the OWSO provided near real-time checks that were readily visible with each LAPS run. LAPS generated quality control information was then relayed to each agency manager so that any perceived problem be corrected as quickly as possible.

While the importance and utility of continuing such a combined mesonetwork was realized by all concerned, the cost of polling each station at 15-minute intervals and the requirement to have "supercomputers" running the models at such frequency is, at this time, cost-prohibitive. Much of the equipment that made all this possible for the Olympics was "on loan" from sister agencies and/or private companies (Johnson, J.T., et. al. 1997b). No doubt in time these costs may be able to be cut through cost-sharing between agencies and will enable the numerical models to be utilized in an operational setting as was done during the 1996 Olympic Games.

SUMMARY

The opportunity to provide weather information for the XXVIth Olympiad proved to be not only interesting and important in the immediate sense but vital to the development of the way future weather services will be provided. Hardware was tested and recommendations made on how to make it "workable" in NWS offices. Software was tweaked and enhanced with the hopes of making it "operationally-friendly."

The legacy left includes a myriad of environmental data collected and archived from Georgia and the surrounding southeastern states. The cooperative ventures between the NWS and several universities, agencies and the private sector also showed that there can indeed be a partnership between concerned parties to provide the best meteorological service in this country.

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