J9.12 METEOROLOGICAL DATABASE MANAGEMENT SYSTEM AT THE USDA

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1. INTRODUCTION

The Joint Agricultural Weather Facility's (JAWF) primary mission is to monitor global weather and determine it's potential impacts on agriculture. JAWF meteorologists rely heavily on weather and climate data from international and U.S. sources. Consequently, one of JAWF's most critical tasks is to process large volumes of data in an efficient and timely manner, and to generate products and agricultural assessments that are meaningful to the user community. For over two decades, JAWF has developed techniques for the acquisition, processing, and archival of these data, creating a blend of "existing" and "newly-developed" methods and products used in agrometeorological data management and analysis. A new Database Management System (DBMS) is currently under development that will be driven by Oracle® software. Once fully implemented, the DBMS will replicate the capabilities of the existing operational system, while effectively handling larger volumes of available information.

2. METEOROLOGICAL DATA ACQUISITION

One of JAWF's primary responsibilities is to monitor global weather, and determine the impact of cumulative weather conditions on crop development. Consequently, timely, high-quality weather and climate data are the backbone of JAWF's analytical process. Most meteorological data used in JAWF's operational work are obtained from the NWS, which initially receives these data from the Global Observing System (GOS) and networks established within the United States.

The GOS, a worldwide network of over 7,000 meteorological reporting stations for surface and upper air data, is managed by the World Meteorological Organization (WMO). Figure 1 shows the global stations that are used by JAWF in worldwide weather monitoring and assessments. The NWS receives these data through the Global Telecommunications System (GTS) and redistributes these data domestically through a satellite broadcast system known as NOAAPORT.

In the United States, over 8,000 stations supported by the National Weather Service gather meteorological data (Figure 2). These stations include NWS field offices, cooperative observer stations (COOP), and automated stations (ASOS). In a process similar to that used by the GTS, data recorded by stations are transmitted to regional offices, which relay these data to the NWS data center in Silver Spring, Maryland.

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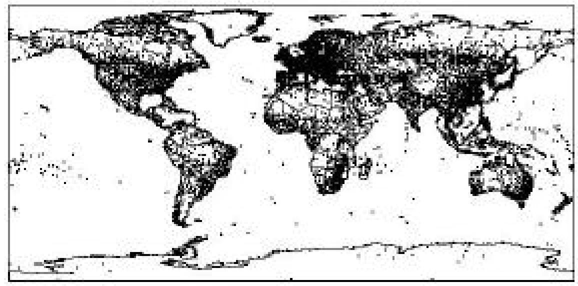

Figure 1. Global monitoring stations.

Currently, JAWF receives global and domestic weather data primarily through an established T-1 line connected to NCEP (Figure 3). The GOS data received at NCEP are decoded and summarized in a 24-hour data file that is sent to JAWF daily.

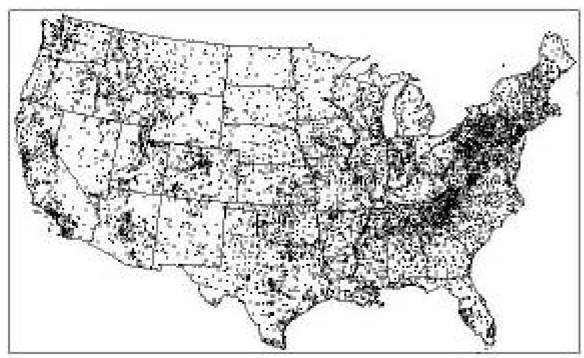

Figure 2. United States monitoring stations.

Each global reporting station in the data file contains station identifier information along with a value of maximum temperature, minimum temperature, total precipitation, 3-hourly weather codes, and snow cover. Files containing COOP data for individual parameters are also sent to JAWF each day.

Figure 3 also depicts a new method under development at JAWF, whereby meteorological data are directly acquired through NOAAPORT. In 1998, a satellite receiving dish and server were installed in Kansas City to receive NOAAPORT data. These data are automatically distributed to a server located at the main JAWF headquarters in Washington D.C., giving JAWF the capability to receive global and domestic surface data, upper air data, satellite images, and numerical model data. JAWF is currently developing a method to decode and process these data for inclusion into the operational database.

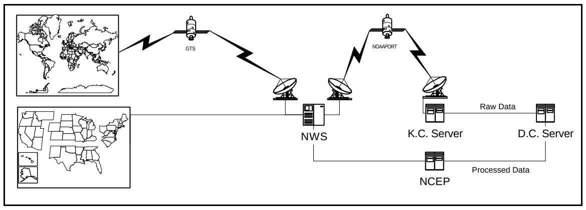

Figure 3. Transport of domestic meteorological data to NCEP and K.C. Server.

JAWF also maintains a historical database, consisting of monthly historical data obtained from the National Climatic Data Center (NCDC) and CPC. The database is often used by JAWF agricultural meteorologists in climate studies and analog year comparisons.

3. DATA PROCESSING AND MANAGEMENT

Meteorological data at JAWF is made accessible to the agricultural meteorologists through an internally developed data management system that links personal computers (PCs) through a Local Area Network (LAN). This system is the result of many years of development, and, whenever possible, takes advantage of the newest technological innovations.

3.1. History

During the 1980's, operational weather data and products were mostly obtained by courier from NCEP on computer tapes that contained daily data for the 6000-8000 stations reporting through the GOS. These data were processed and stored at JAWF on a WANG mini-computer system.

Due to cuts in computer staffing by the early 1990's, a system was introduced by which data were downloaded to a PC through a dedicated telecommunication circuit and distributed to users using standard floppy disks or higher capacity Bernoulli disks. Initally, in-house data processing was slow, taking nearly 3 hours to run on a then state-of-the-art IBM compatible 286 PC. In addition, daily data were ingested at a rate of about 500,000 Kilobytes (KB), or 0.5 Megabytes (MB), per day, requiring an efficient method of external archival. As processing speeds and storage space of the PC increased, so did JAWF's ability to process and store meteorological data. Data could now be processed into agriculturally important geographic regions chosen for daily weather monitoring. Daily normals were generated from the standard 30-year monthly normals, using an algorithm developed by Epstein (1991). Furthermore, data for more than 350 subregions were archived for the purpose of crop-specific, historical weather comparisons under the current archival system. Both daily and weekly averaged time series were saved, as were station library and other operational files, necessitating the maintenance of nearly 800 files for these applications alone.

By the end of the 1990's, file maintenance and overhead had become a problem. Although newer computer hardware and the introduction of LAN technology made processing and dissemination easier, no formalized Database Management System (DBMS) had been purchased or developed. Consequently, the agricultural weather database was a combination of raw and processed ASCII text data files formatted to meet specific user needs. In addition, the processing programs, which had been developed in Microsoft DOS, were not fully compatible in a Microsoft Windows environment. Finally, since the programs and software packages JAWF was using to process and analyze data often required different formats for the same data, multiple files had to be created, each with it's own unique format.

3.2. The New Oracle â Database

A more efficient agricultural weather DBMS is being developed using Oracle, a high-ended software package capable of maintaining an extensive database. However, specific hardware requirements were necessary for JAWF's data needs. They are:

- A high end server capable of containing multiple physical drives with expansion flexibility;
- Linkages between the physical drives to form individual disk arrays for the operating system and DBMS;
- Creation of a recovery system in the event of a disk failure.

To provide effective management of the database, a middle tier architecture was instituted. Middle tier architectures typically consist of:

- A Database Server;
- Administration Server; and

The database server consists of the hardware (as mentioned above) and database software. The administration server is the communications link between the client and the database. Oracle uses Oracle Management Server (OMS) software to handle the administration of the database. The OMS acts like a queue for requests to the database. The hardware for the OMS consists of a computer with over 100 MB of RAM and a processor over 100MHz. Also, the OMS requires server side software (i.e. Microsoft NT) as the operating system.

4. References

Epstein, E.S. 1991. On Obtaining Daily Climatological Values from Monthly Means. *Journ. of Clim.* **4:** 365-68.