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The Arizona Meteorological Network: A Brief Overview

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For more than 17 years, the Arizona Meteorological Network (AZMET) has provided outreach and information to virtually anyone in the state who grows plants or uses water. Stakeholders include irrigation districts, managers of turf facilities and golf courses, cotton growers, fertilizer and pesticide companies, citrus growers, vegetable producers and other agribusiness organizations in southern and central Arizona.

AZMET services include daily updates of meteorological data and weather-based information and weekly reports of climatic conditions, such as evapotranspiration rates, which are relevant to farmers and other water users. In 2003, there were more than 137,000 visits to the AZMET website, with users accessing the data files more than half a million times.

AZMET, founded and maintained by the University of Arizona's College of Agriculture, has worked in partnership with Arizona communities, assisted state and federal agencies, provided education programs and has conducted many fundamental and applied research projects. A census of data-collection organizations indicates that AZMET is the only group that has been continuously monitoring evapotranspiration in Arizona.

The meteorological data collected by AZMET's automated weather data collection network include air and soil temperatures, humidity, solar radiation, wind speed, wind direction, and precipitation. AZMET also provides a variety of computed variables, including heat units (degree-days), chill hours, dew point, and evapotranspiration. Data are summarized in a variety of formats, including several ready-to-use summaries and text files that can be imported into most database and spreadsheet programs. Special reports generated by AZMET include daily Turf Water Use Reports and weekly Cotton Advisories.

Throughout its history, AZMET has worked with and provided data to many different organizations. These include the Arizona Department of Water Resources (ADWR), Arizona Municipal Water Users Association, U.S. Bureau of Reclamation, U.S. Geological Survey, university departments, water conservation programs, and city water companies. These cooperative partnerships have resulted in both applied research and beneficial outreach programs.

Logistics

The original start-up funds for AZMET allowed for the purchase of 10 weather stations and hiring of two people in 1987. Currently, the network has 27 stations operating in a variety of rural and urban production settings (Figure 1). Because AZMET currently is relying on private funding to support its operations, it might be necessary to remove or relocate stations as funding and logistical needs require.

Each station is a solar-powered, self-contained unit. A 10-foot tower supports the wind instruments and other sensors (Figure 2). The heart of the station is an electronic data storage module, known as a datalogger, which continuously reads the sensors. These measurements are stored in memory every hour.

Just after midnight, a computer in the AZMET offices on the University of Arizona campus automatically calls each station's datalogger and downloads the previous day's data. Within

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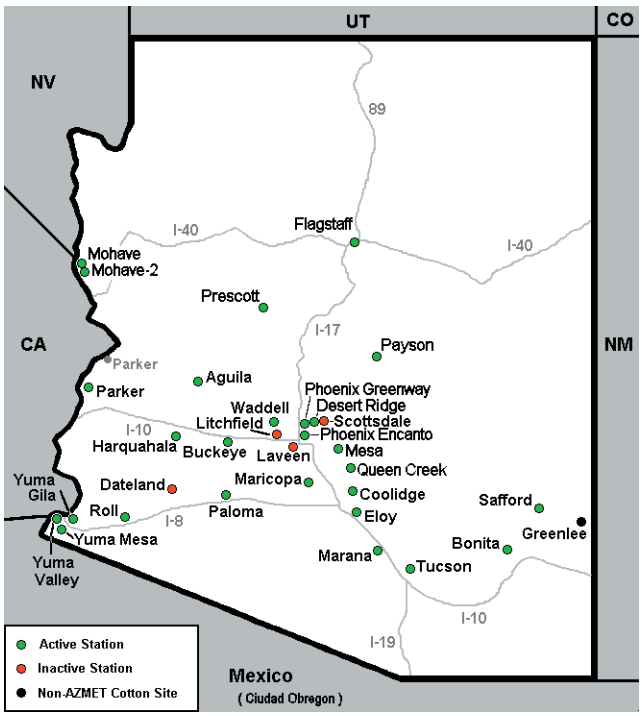

Figure 1. The Arizona Meteorological Network (AZMET) includes 27 active stations in Arizona.

AZMET, continued

an hour, this raw data is evaluated by a program that processes the values into various user-friendly reports and generates derived values such as heat units, dew point and reference-crop evapotranspiration. These files are then transferred onto a web server and are usually available to the public by about 1 a.m. each day.

Preventive maintenance of the station instrumentation is essential to collecting accurate data. An AZMET technician visits each station at least every three months to compare existing equipment with a set of laboratory-standard sensors. Wind speed and solar sensors are removed and recalibrated once a year, while the sensor that measures temperature and humidity are recalibrated every two years.

These data and others are used to compile values and reports useful to a variety of stakeholders. Evapotranspiration, for example, can supplement precipitation data to allow farmers and golf course managers to keep their crops watered at the optimal level.

Figure 2. A 10-foot tower supports instruments that measure air and soil temperatures, humidity, solar radiation, wind speed, wind direction, and precipitation at an AZMET station in Tucson.

Similarly, temperature values help yield frost reports during critical growing times. AZMET's services are used by many different agriculturalists, but cotton farmers and turf and lawn growers are particularly targeted with special advisories, as described in more detail below.

Evapotranspiration

Evapotranspiration is the water that is lost to the atmosphere from surface evaporation and from plant transpiration (i.e., water evaporated from a plant surface). This process is largely driven by solar energy and wind speed.

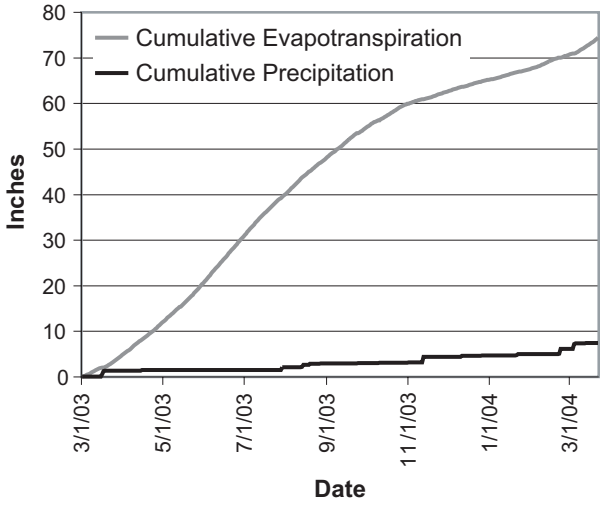

Figure 3. Annual evapotranspiration far exceeds precipitation in Arizona, including at the Phoenix Greenway AZMET station. Above, the lower line illustrates values for cumulative precipitation while the upper line illustrated cumulative evapotranspiration from March 1, 2003, through March 22, 2004.

Evapotranspiration is a major component of the earth's water cycle. In most continental areas, evapotranspiration accounts for about 60 percent of the hydrologic activity in a basin. Here in the Southwest, due to the lack of cloud cover, evapotranspiration has an even larger role in the hydrologic budget.

However, because it is less tangible than other meteorological parameters, evapotranspiration often is not given proper attention in water budgets, if it is included at all. The monitoring of precipitation, snowpack, lakes, streams, reservoirs and groundwater levels tells us how much water is entering and being held in a basin. Evapotranspiration gives us the other side of the hydrologic cycle—it tracks the amount water that can potentially be lost from a basin and returned to the atmosphere.

In southern Arizona, an open body of water such as a lake, canal or uncovered swimming pool, can lose about 80 inches of water to evaporation each year. Normal rainfall during the same period only averages about 8 to 10 inches. Figure 3 shows a comparison of evapotranspiration and precipitation for the Phoenix Greenway.

During periods of drought, the significance of evapotranspiration in the hydrologic cycle is further accentuated as the available precipitation decreases. Each species of plant has its own unique water requirements, so evapotranspiration rates must be adjusted for different crops. By using AZMET reference crop water-use values, a grower can apply just the right amount of water to meet a plant's demand. Underwatering will stress the plant and cause low yields, while overwatering would waste a limited resource.

Frost

During the spring of each year, AZMET generates a twice-daily frost report for the apple producers in the Bonita area north of Willcox. One of the casualties of the 1995/96 federal budget crisis was the closing of the National Weather Service office in Yuma. When citrus growers and related agribusiness interests were left without any source of local information, AZMET stepped forward and

filled the gap, supplying critical frost updates several times per day.

In addition, AZMET provides "chill hours" data to an experimental farm in Yuma for its research on citrus trees, which require a certain number of winter hours below 68 degrees to properly bud and produce fruit.

Cotton
During the 2002 season, the value of cotton production in Arizona was more than $167 million dollars. Due to inconsistent yields and limited water, the state's cotton industry has had several rough years recently. However, cotton remains a major segment of Arizona agriculture and an important part of the state economy, and AZMET information helps keep this industry viable.

Every Monday from March through August, AZMET generates 19 different advisories for various Arizona regions that can help cotton growers use water and agro-chemicals conservatively. AZMET's heat-unit calculations allow growers and researchers to track the stages of development in cotton plants and help predict the outbreak of pests such as the infamous pink bollworm. Preventive pesticides can then be targeted at specific time, saving money and limiting the amount of chemicals released into the environment.

Early in the season, the AZMET Planting Advisory provides information about soil temperatures for seed germination. By adjusting the planting date, growers can avoid having the crop reach a susceptible stage of development during a projected hatching of pink bollworms.

After planting, the advisories use heat units to track the cotton plants through their life cycle. The advisories compare the current year's temperatures, dew point and rainfall to historical data, and report present conditions as being ahead or behind past climatic conditions. A brief forecast describes the possible effect of weather systems that are entering the state. The advisories also include crop water-use estimates and crop stress values. This information is critical for maintaining cotton boll retention and producing a marketable crop.

Turf and Lawn
Although it is not considered as traditional agriculture, turf horticulture plays an important role in the state's economy. A recent study of the Arizona golf industry provides some interesting statistical insights. There are more than 330 golf courses in Arizona. More than 2 million visitors play golf in Arizona. Golf produces $45 million in state taxes and another $24 million in local taxes.

Since its inception in 1987, AZMET has worked closely with the turf industry in an effort to conserve water. Three stations in the Phoenix area are located on golf courses and are supported by the City of Phoenix Water Conservation Department. AZMET has done extensive research to determine the water requirements of both warm and cool season grasses in Arizona's desert environment.

Each day, AZMET generates Turf Water Use Reports for the Tucson and Phoenix areas. These reports track the water requirements over the most recent seven days and include values for total precipitation in these areas. By using this information, an irrigation manager can apply the correct amount of water on a turf surface.

AZMET also provides lawn-watering values to homeowners in the Phoenix area. In November 2003, three new stations were added to the network. These stations are located on turf facilities in Flagstaff, Prescott and Payson to support the water conservation efforts of these northern Arizona communities.

Other Crops
AZMET has provided data and information to assist agriculturalists growing other crops as well. In the spring and summer, AZMET reports water-use recommendations for corn and alfalfa. A special corn heat-stress report is provided when needed.

A small grains advisory uses AZMET data to track the development of wheat and barley crops. These reports also provide current and projected water use. The efficiency of melon and vegetable harvesting has been increased by the use of heat units. Grapes are a crop that is susceptible to extreme temperatures, and AZMET offers recommendations based on climate to the vineyard industry.

Dairies have utilized AZMET data to reduce heat stress on cattle and thus increase milk production. The growing aquaculture industry has requested information on temperature, humidity, wind speed and wind direction. AZMET data have even been used for non-agricultural purposes, including calculating environmental cooling-system design, building alignment, and automotive engineering.

Outlook
The ongoing drought and population growth will necessitate close monitoring of the limited water resources throughout the Southwest. Due to the changing role of agriculture and increasing degree of urbanization, AZMET has an obligation to modify and expand its mission in an effort to meet the evolving needs of our state. By strengthening past partnerships, forging new allegiances, and addressing future problems through applied research, AZMET will continue to be important and reliable source of weather data and information for the people of Arizona.

All available AZMET weather data and more information about the Arizona Meteorological Network can be found on the website:

http://ag.arizona.edu/azmet