QUALITY ASSURANCE PROCEDURES FOR RECLAMATION'S AGRIMET WEATHER STATION NETWORK

Peter L. Palmer* and Jama L. Hamel†

ABSTRACT

Competition for limited water resources in the western United States continues to increase. In most western states, irrigated agriculture is the largest single consumer of water, so efficient irrigation water management can lead to considerable water savings. To this end, the U.S. Bureau of Reclamation (Reclamation) and Bonneville Power Administration (BPA) partnered to create a network of automated agricultural weather stations - called AgriMet - in the Pacific Northwest. These stations collect and telemeter the meteorological parameters required to model crop evapotranspiration (ET). The information is used by irrigation districts, farmers, resource conservation agencies, and agricultural consultants for irrigation scheduling and related purposes. The network consists of over 70 weather stations in the Pacific Northwest that telemeter weather data each hour via the Geostationary Operational Environmental satellite (GOES). Each station measures air temperature, relative humidity, solar radiation, wind speed, wind direction, and precipitation. Other stations have additional sensors, such as soil temperature, crop canopy temperature, leaf wetness, and diffuse solar radiation. Accuracy of the weather data is critical to successful crop water use modeling and other applications. Quality assurance for the AgriMet program consists of five interdependent components: laboratory sensor calibration, an annual maintenance and calibration visit to each weather station, automated data quality control procedures, manual data quality control procedures, and an annual review of weather and associated evapotranspiration parameters. These quality assurance efforts provide reliable meteorological and crop water use information for a variety of applications in the Pacific Northwest.

INTRODUCTION

In 1983, Reclamation partnered with BPA in an effort to promote efficient irrigation water use. This partnership resulted in the installation of a network of automated agricultural weather stations called "AgriMet" (for Agricultural Meteorology) in the Pacific Northwest. These stations collect and telemeter the meteorological parameters required to model crop evapotranspiration (ET). Since the initial installation of 3 stations in 1983, the network has grown to over 60 stations in Reclamation's Pacific Northwest Region, 22 stations in the Great Plains Region in Montana (east of the Continental Divide), and seven stations in the Mid Pacific Region. Reclamation has established partnerships with more than 25 entities, including other federal and state agencies, soil and water conservation districts, universities, public utilities, and private businesses to help fund the operation of the AgriMet network.

AGRIMET DATA COLLECTION AND TRANSMISSION

AgriMet stations are located in agricultural areas throughout Idaho, Montana, Oregon, and Washington, with additional stations located in northern California, western Wyoming, and Nevada (Fig. 1). The stations are typically located on the edge of irrigated fields so that the observed weather data approximates the meteorological conditions affecting the cultivated crops in the area (Fig. 2). Each AgriMet station is configured with a standard set of sensors, including air temperature, precipitation, solar radiation, wind speed and direction, and relative humidity. These standard sensors measure the meteorological parameters required for modeling crop ET. Some sites have special sensors, including soil temperature, diffuse pyranometers for special solar radiation studies, crop canopy temperature, leaf wetness, and evaporation pan sensors.

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[1] AgriMet Program Coordinator, U.S. Bureau of Reclamation, Pacific Northwest Region, Boise, ID PLPalmer@usbr.gov,

[2] AgriMet Program Technician, U.S. Bureau of Reclamation, Pacific Northwest Region, Boise, ID JHamel@usbr.gov

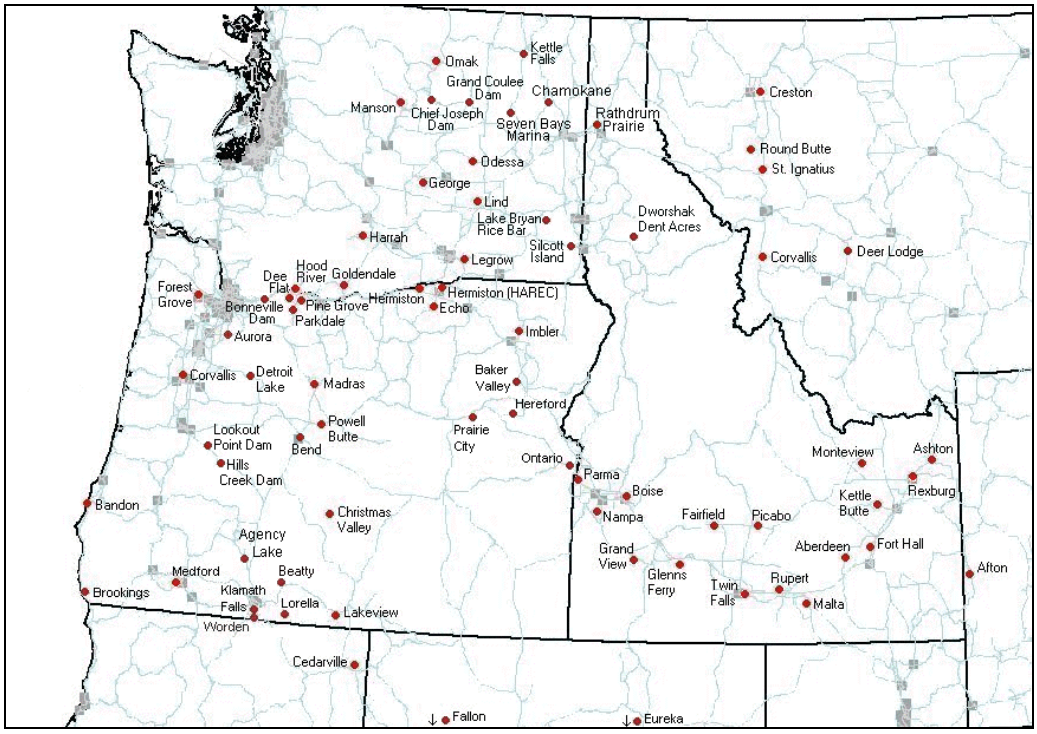

Figure 1. AgriMet weather station locations in the Pacific Northwest Region

All the weather station components, including sensors, solar panel, antenna, data logger, and transmitter are mounted on a sturdy aluminum tripod. Sensors are mounted at standard sensor heights for agricultural weather data collection requirements. Wind, air temperature, relative humidity, and precipitation are measured at 2 meters above the ground surface. Power for each weather station is provided by a heavy-duty lead acid storage battery that is recharged daily by a solar panel.

Figure 2. Typical AgriMet weather station

The data logger at the site monitors each of the sensors once every second. These readings are used to derive the final data parameters for subsequent transmission, such as 15 minute air temperature observations, total hourly precipitation, average wind speed, etc. These parameters are transmitted once an hour via the GOES satellite (Geostationary Operational Environmental Satellite) to a receive site at Reclamation's Pacific Northwest Regional Office in Boise, Idaho. The receive site also down-links data for other Reclamation programs, as well as for other cooperating federal agencies.

Evapotranspiration estimates, as well as any other product derived from meteorological data, are only as good as the data that goes into the computation. To ensure a high quality meteorological data set, the AgriMet

program has developed a stringent set of quality assurance procedures. These procedures have evolved over time as improved equipment and more powerful computers and graphics capabilities became available.

Quality assurance for the AgriMet program consists of five interrelated components: laboratory calibration of weather sensors, an annual maintenance and calibration visit to each weather station, automated data quality control procedures, manual data quality control procedures, and an annual review of weather and associated evapotranspiration parameters. Each of these components is discussed in detail below.

LABORATORY CALIBRATION OF WEATHER SENSORS

Good data quality begins with accurate, reliable sensors in the field. In order to minimize station downtime and to respond rapidly to sensor failures, vandalism, or other problems, the AgriMet network maintains approximately a ten percent overstock of spare sensors and components. These sensors and components are maintained in a calibrated state for use anytime during the year, or for sensor replacement during annual site maintenance and calibration visits.

Before each calibration season, an AgriMet technician calibrates a designated bench standard Vaisala HMP 45D relative humidity sensor using a two salt (LiCl and NaCl) calibration process. Each salt has a known humidity when mixed at saturation with water depending on surrounding air temperature (LiCl 11.3 percent and NaCl 75.3 percent, at 75°F). The Vaisala output for each salt solution is adjusted as needed to reach the desired output. The temperature output is also verified using an analog thermometer.

Several solar radiation sensors (Licor LI-200 pyranometers) are also pre-calibrated using the procedures detailed in the field calibration section below. These pre-calibrated spares are necessary in case field replacement is required when solar conditions are not conducive to an on-site calibration.

FIELD CALIBRATION AND MAINTENANCE OF WEATHER STATIONS

All AgriMet sites receive an annual maintenance and inspection visit by Reclamation technicians in the spring that includes calibration and maintenance of all sensors. All sensors are compared against laboratory calibrated standards and are adjusted or replaced as needed.

Data logger and transmitter parameters are checked for conformance to specifications. System battery voltage, solar panel output, and voltage regulator output are checked; these items are replaced or adjusted as needed. Batteries are replaced every 6 years to decrease the chance of mid-winter failure. All sensors are compared against laboratory calibrated standards and are adjusted or replaced as needed. Sensor replacement is tracked using a custom site visit database to identify possible repeat problems with sensors and sites. This special attention given to the sites during these annual calibration and maintenance visits provides early detection of problems and greatly reduces station or sensor failure during the year. Sensors deployed in the field require annual on site calibration, maintenance and cleaning as described below.

Solar Radiation Sensors

The AgriMet program uses a Licor LI-200 pyranometer for solar radiation measurement. Every 2 years, AgriMet sends 2-3 Licor pyranometers to the National Renewable Energy Laboratory (NREL) in Golden, Colorado for calibration against a NIST traceable standard. This is part of NREL's "Broadband Outdoor Radiometer Calibration - BORCAL" program (Myers et al, 2002). This provides AgriMet technicians with a solar radiation standard to use for field calibrations. In the field, a temporary mast is assembled on the station tripod and the lab standard pyranometer is mounted adjacent to the station pyranometer. A Campbell Scientific CR10x data logger with a custom calibration program is used to make paired measurements of the two pyranometers on a one second interval. After approximately 1 hour (3600 paired observations), the results of the calibration are entered into a spreadsheet which computes the output of the station pyranometer (in millivolts of output per 1000 W/m2 of solar input). The technician then compares the results of the calibration with the previous year's solar radiation values using the clear-sky solar radiation (R_{so}) method, described below in the "Annual Data Quality Control" section, to verify the accuracy of the calibration. Although every effort is made to conduct station specific field solar calibrations, AgriMet maintains a set of "pre-calibrated" pyranometers for replacement of failed or aged sensors during site visits where weather conditions are not conducive to a solar calibration.

Relative Humidity/Air Temperature Sensors

AgriMet uses a modified Vaisala HMP35A and HMP45D relative humidity/air temperature sensor in its weather station network. The factory thermistor has historically been replaced with a YSI Model 44030 thermistor for improved accuracy. In the field, the technician sets up two clean, dry radiation gill shields, one for the station sensor and one for the bench sensor. The technician then removes the filter cap of the station sensor and replaces it with a clean, dry filter. If the sensor is an HMP45D model, the o-ring sealing the two portions of the sensor is coated with high-vacuum grease to help resist corrosion on the pins. Both sensors are then placed in the provided shields and left for at least 15 minutes to equilibrate with surrounding conditions. The station shield is then cleaned to remove any dark spots or foreign substances that may absorb heat. The values of the station and bench sensor are then compared, and if the two are within 3 percent relative humidity, the sensor is returned to its original shield. If the two sensors are not within 3 percent of each other, the field sensor is replaced with a lab-calibrated sensor and again compared to the bench standard. In 2010, the AgriMet program intends to replace all existing humidity and air temperature sensors with new technology sensors (Rotronics Hygroclip2 S3). These sensors will be swapped out every 2 years and replaced with lab-calibrated sensors.

Wind Sensors

AgriMet utilizes the RM Young Model 05103 anemometer to measure wind speed and direction. The AgriMet technician removes the nose cone, checks the shaft play using a shim spacer, and the bearings using a torque disk. After listening for dirt while spinning the bearings, the nose cone is replaced and wind speed output verified using the RM Young Model 18802 Anemometer Drive. The motor in the drive rotates the anemometer shaft at a defined set of wind speeds ranging from 5 to 65 mph. If sensor output does not match the corresponding wind speed, the sensor is replaced (the sensors are extremely reliable and are yet to require replacement). These extraneous wind values are not included in the telemetered data through use of a special calibration flag. The technician then verifies wind direction by comparing sensor output with a compass reading set with the station's magnetic declination to measure true south. If the observed direction is greater than +/- 3 degrees, the technician realigns the sensor to match the output to the compass.

Precipitation Gages

AgriMet currently employs two types of precipitation gages, a tipping bucket (Hydrologic Services Model TB3) and a weighing device with a bucket containing an antifreeze/mineral oil mixture (24 inch load cell, 12 inch Belfort Instruments gage, and 20 inch Belfort Instruments gage). Tipping buckets are used where there is little frozen precipitation and high rainfall volumes; weighing gages are used where frozen precipitation is a significant portion of the total annual precipitation. Currently, the Belfort Instruments gages are in the process of being replaced with 24 inch load cell devices to increase storage capacity, dependability, and accuracy. Both types of sensors undergo a thorough cleaning of the mechanisms and a calibration check as described below.

Tipping Bucket. Using a graduated cylinder, the technician measures out 798 ml of water into a special bottle designed to release the water at a slow, steady flow rate. The bottle is placed upside down in the precipitation catch portion of the sensor until the bottle is drained. The number of tips is then read from a special calibration location in the data logger and the device is adjusted if needed. If adjustment is required, the procedure is repeated. This "artificial" precipitation is not included in the actual station catch through use of a special calibration toggle flag.

Weighing Device. Calibrating the load cell and Belfort gages both require removal of the outer shroud and weighing bucket. The technician places precision weights, equaling 1 inch of water each, one at a time on the weighing mechanism until the maximum water equivalent is reached (12, 20 or 24 inch). The output of the sensor is read with each plate and should show a one inch increase. If the error over the full range is greater than 3 percent, the sensor is adjusted and the procedure repeated.

The following sensors are non-standard sensors, installed at selected AgriMet stations depending upon local need:

Soil Temperature Sensors. A YSI Model 44030 thermistor soldered to a two conductor wire, and potted in potting compound measures soil temperature at various standard depths. The technician digs a hole in an area representative of where the station sensors are located, and inserts a digital thermometer into the soil at the appropriate depth to compare temperatures. Soil temperatures can be highly variable due to slight differences in vegetative cover, ground shading, depth, or other environmental factors. Because of this variability, the technician also graphically reviews previous data to ensure the sensors are behaving as expected (e.g., in the summer,

temperature and diurnal fluctuation decrease with depth). Large temperature differences or other anomalies require replacement of the sensor.

Shelter and Canopy Temperature Sensors. Shelter and canopy temperature sensors are essentially identical to the soil temperature sensor and are similarly calibrated. The digital thermometer is placed next to the sensor and the values compared. The technician also looks at previous data compared with the station temperature to ensure they are closely plotting together. Anomalous readings also require sensor replacement.

Leaf Wetness Sensors. AgriMet uses an unpainted Campbell Scientific Model 237 leaf wetness sensor. At the site, the technician wets the face of the sensor and verifies the output drop from 6999 (completely dry) to about 0 (completely wet). The sensor is then wiped off and the technician verifies the return to 6999 output. Previous humidity data is also plotted against the leaf wetness values to verify response to humidity changes. Malfunction requires sensor replacement.

Barometer. To measure barometric pressure, AgriMet uses a Vaisala Model PTB 101B barometer. Onsite calibration is not feasible; therefore, barometric pressure values are plotted against values of proximal sites to verify similar responses to changes in atmospheric pressure. On initial installation and occasionally thereafter, station barometric pressure readings are verified against nearby National Weather Service reported values when barometric pressure values are consistent over large areas.

AUTOMATED DATA QUALITY CONTROL PROCEDURES

Weather data transmitted via the GOES satellite is subjected to a variety of automated quality control procedures immediately upon receipt. These validation tests include a check of satellite transmission data quality parameters, upper and lower value limit tests, and rate of change tests. If the incoming data fails any of these checks, it is marked with a flag indicating the nature of the failure before being added to the database. These flagged values are not used in subsequent calculations, such as computation of average daily temperatures or daily ET rates. After these automated quality control processes are completed, the 15 minute (and hourly) data are stored in a “dayfiles” database. Standard AgriMet dayfile parameters include instantaneous air temperature and relative humidity, computed dew point, peak wind gust, and average wind speed and wind direction -- all on 15 minute intervals. Hourly data includes accumulated wind run, accumulated solar radiation, and accumulated precipitation.

Between 5:00 and 5:30 am each morning, several automated processes run on the dayfiles data, producing summary parameters for the previous day, including daily maximum, minimum, and average air temperatures, total daily wind run, average wind direction, peak wind gust, total daily precipitation, total daily solar radiation, mean relative humidity, mean dew point, and reference ET. For stations with special sensors, other summary parameters are generated, such as mean 4-inch soil temperature. These data are stored in an “archive” database. All of the historical weather information (both hourly/15 minute and daily summaries) is available on the AgriMet website for the period of record.

MANUAL DATA QUALITY CONTROL PROCEDURES

In addition to the automated checks, a manual quality control review is performed on the data each working day. These procedures include review of satellite transmission quality parameters that may point to data quality problems not detected by the automated procedures. Other checks include graphical review of sensor data by groups of sites that have similar climatic characteristics. Apparent anomalies are examined for possible data quality problems, and bad data are removed or estimated. Archive parameters and ET values are then recalculated using the revised data. These changes are reposted to the AgriMet website. AgriMet’s quality control procedures result in a very complete, accurate, and timely database of meteorological information, easily available on the Internet.

In the early days of the AgriMet program (the mid-1980s), data quality assurance procedures were rudimentary and limited to manual review of tabular archive data. The sheer volume of dayfile data prevented close inspection of this data set (e.g., there are 96 temperature, humidity, and wind speed observations for each station each day). With only a few weather stations in the network, this methodology was fairly effective, although tedious. As more stations came on line and the volume of data increased, new procedures were developed. Automated techniques were implemented to scrutinize weather data based on upper and lower limits and rates of

change between successive observations. Customized graphics programs were developed to plot archive weather data from climatically and geographically similar weather stations.

Early each workday morning, an AgriMet technician reviews the results of the automated data quality control procedures that were generated for the previous calendar day, paying particular attention to the satellite transmission statistics. Items that are reviewed include:

- Number of transmissions received (24 hourly transmits are expected)
- Message length (truncated or interfered transmissions may contain data errors)
- Parity bit check (a technique to insure correct decoding of data)
- Evaluation of transmit power and frequency (to insure compliance with GOES policies)
- Evaluation of station battery voltage (for early warning about potential power supply problems)
- Difference between expected and actual data transmission time (indicates clock drift)

After the satellite statistics are reviewed, the technician then reviews a list of various weather parameters, sorted by magnitude for all weather stations in the network, to quickly find potential outliers. Parameters reviewed include evapotranspiration, total solar radiation, and 24-hour wind run. At any point in the review of satellite and weather data parameters, the technician may "dig deeper" into any potential anomaly to correct any errors.

Next, the technician reviews a list of files that are generated on the AgriMet database system for publishing on Reclamation's web server. The time and date stamps and number of files provide assurance that all the various weather and crop water use products are generated according to an expected schedule. Process log files are automatically searched for key words that could indicate problems. The system queue is reviewed to insure that all required processes are correctly scheduled for execution. Finally, a quick spot check of web site content is conducted to insure that the publication of time sensitive products is up to date.

The final step in the quality control procedure is the graphical review of daily and selected hourly weather parameters. In previous years, AgriMet used a set of custom developed graphics to plot and review weather data from a group of stations that were climatologically and geographically similar. For example, maximum daily air temperature for the last week for seven stations in the Upper Snake River Plain in Idaho would be graphed together. This technique allows for rapid identification of outliers or potential anomalies.

In 2008 AgriMet developed a new set of graphical procedures using an Excel spreadsheet and visual basic programming. Previously, custom graphic programs were loaded on computers requiring Virtual Private Network (VPN) or direct network access, resulting in limited use away from office workstations. An Excel spreadsheet, developed by the AgriMet technician, mimics the basic concepts of the previous software. The new spreadsheet process incorporates data previously not reviewed on a daily basis, improving data quality assurance. The spreadsheet only requires Excel and internet access, allowing for easy accessibility to this portion of the quality control procedures. Visual Basic programming commands import data into a spreadsheet from the AgriMet web site, calling various sub routines based on the site and parameter. The spreadsheet includes date, station and parameter references, a worksheet for each region, and imported numerical data and graphical procedures for each worksheet (Fig. 3). A command button loads date specific data into the spreadsheet, updating both the numerical data and associated graphics. The graphs of the different weather parameters

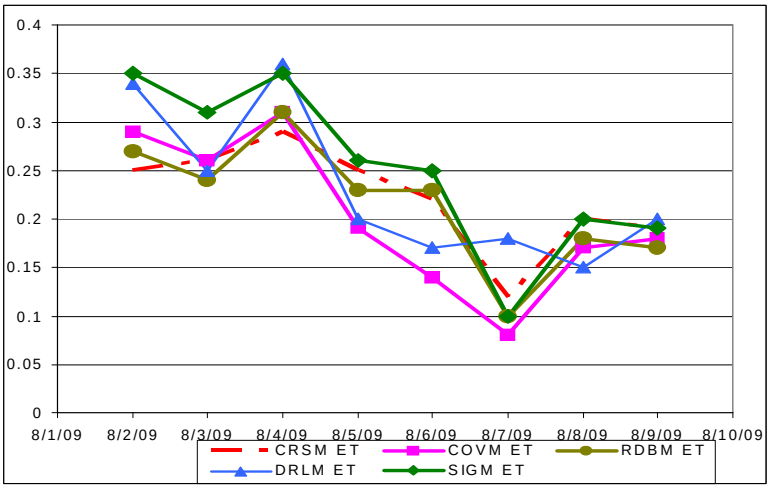

Figure 3. Example of graph for daily review of weather parameters.

for each group are viewed on the same worksheet, resulting in better comparison of data in a shorter amount of time.

ANNUAL DATA QUALITY CONTROL PROCEDURES

At the conclusion of each year, an AgriMet technician reviews annual graphs of weather data and crop consumptive water use in both climatologically and geographically similar groups, as well as individually. Reviewing historical data provides an overall picture of how a particular year compares to other years and allows for quick identification of data errors that may have been previously overlooked.

Yearly Data Analysis

Excel spreadsheets import weather data for the entire period of record and display the data graphically (Fig. 4). Outlying data points are investigated and edited if needed, or a note is made within the spreadsheet with an explanation of each outlier. For example, the 107 degree day in Figure 4 would stand out as a suspect data point for a coastal location like Brookings, Oregon. However, field technicians calibrated the station on that day and verified the temperature values. Had they not been present, the technician would review the 15 minute values for that day for a gradual increase to that temperature and then also verify it with other local observations.

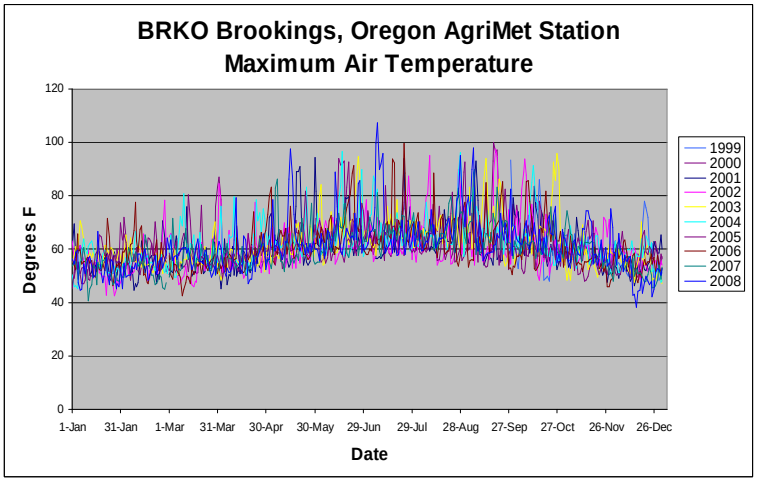

Figure 4. Example of annual graph for review of maximum air temperature.

Crop Consumptive Water Use

Total annual crop consumptive water use is also entered in a spreadsheet and the complete historical record is graphed (Fig. 5). All the crops that are modeled for each station are displayed on the graph. This technique quickly identifies any errors in annual totals of crop water use, and also allows for a quick comparison between years.

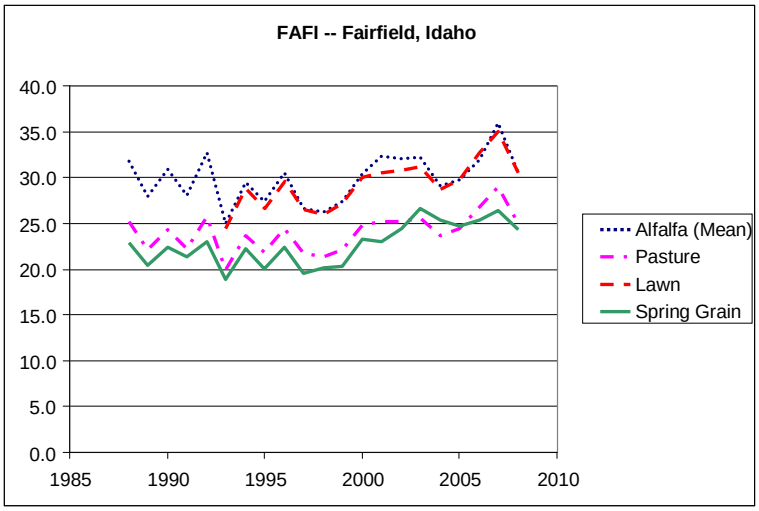

Figure 5. Example of annual graph of crop consumptive water use.

Clear-Sky Solar Radiation (R_{so})

After completion of the annual solar calibration (described in the Field Calibration and Maintenance of Weather Stations section), the technician compares the solar calibration results with computed clear-sky solar radiation. Clear-sky solar radiation is an estimate of the radiation the site would receive under cloud free conditions for any given day of the year. It is computed using the site elevation and latitude, as well as mean dew point temperature that provides an indicator of solar attenuation due to water vapor in the atmosphere (EWRI 2005).

Observed daily solar radiation and mean dew point temperature for each AgriMet station are automatically loaded into a spreadsheet using the Visual Basic procedure described in the Manual Data Quality Control Procedures section. The spreadsheet calculates an estimate of clear-sky R_{so} using two methods (Method A and Method B). Method A only considers extraterrestrial radiation and elevation, while Method B also includes mean dew point temperature as a water vapor parameter. Method A, Method B, and the observed solar radiation values are each plotted and compared on a graph to determine if an adjustment to the solar calibration scale factor is needed (Fig. 5). The clear-sky R_{so} method is extremely effective for both annual review of calibration results and investigation of suspect solar radiation values found during the manual data quality assurance routine.

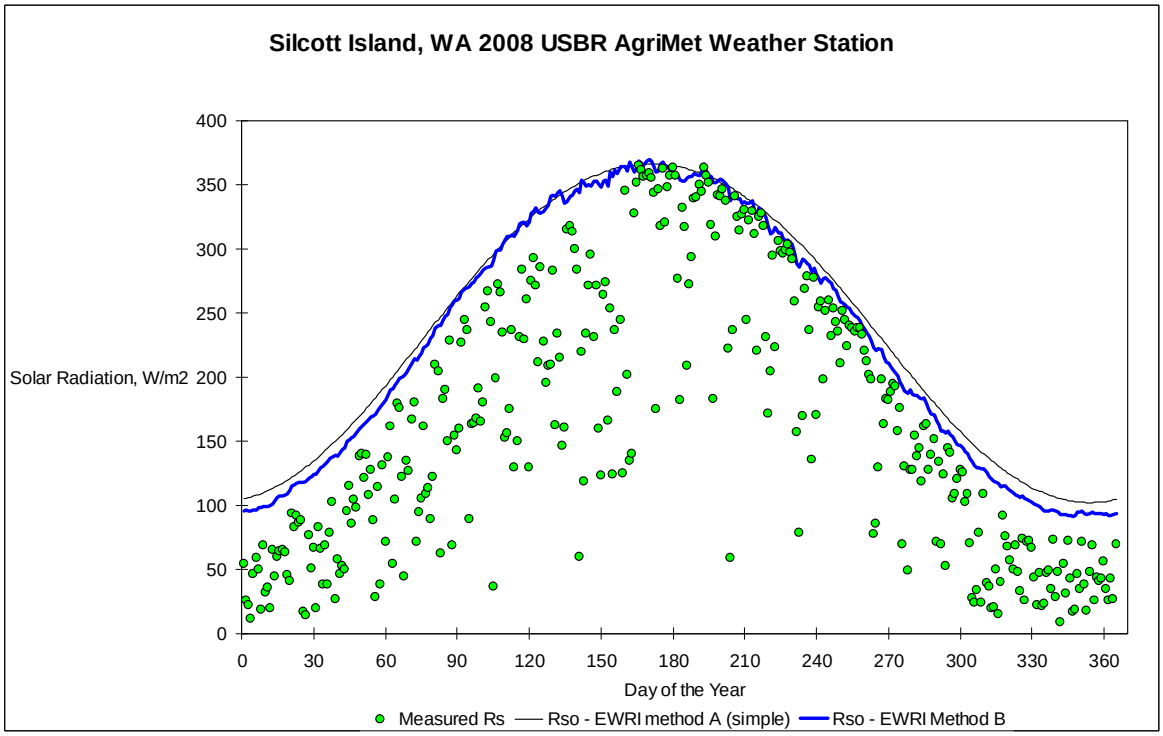

Figure 5. 2008 R_{so} plot for Silcott Island, Washington shows results of a solar calibration adjustment at approximately day 160. Prior to the adjustment, all of the observed solar readings were below the calculated clear-sky solar radiation. Observed readings after the adjustment fit the predicted curve much better. Observed values that lie well below the clear-sky curves are for days with varying amounts of cloud cover.

USES OF AGRIMET PRODUCTS AND INFORMATION

AgriMet crop water use information is integrated into various on-farm technical assistance programs by local agricultural consultants, the Cooperative Extension Service, and the USDA Natural Resources Conservation Service. As competition for limited water supplies increases - as well as the cost of pumping for irrigation - farmers are turning more and more to scientific irrigation scheduling.

The most common method for irrigation scheduling is known as the "checkbook method," accounting for deposits and withdrawals to the soil moisture balance. For this procedure, the farmer must first know the plant root depth and water holding capacity of the soil. This information is typically available from detailed soil surveys of the area, or from site specific soil tests. After each irrigation during the growing season, the farmer tracks the daily crop specific ET, available from AgriMet. When the cumulative water use equals the Management Allowable Depletion (MAD) for that crop, it's time to irrigate again. Specific knowledge of the irrigation system, combined with ET information from AgriMet, allows a farmer to apply the right amount of water at the right time for optimum crop production. Not only does the farmer realize savings in water and pumping costs, but reduced leaching results in reduced costs for fertilizer, herbicides, and pesticides. Various agricultural consultants have reported water and power savings ranging from 15 to 50 percent through the use of AgriMet supplied ET data (Dockter 1996). Some irrigators have reported real savings of as much as $25 per acre in pumping costs after using AgriMet ET data to schedule their irrigations (Palmer 2004). Indirect benefits of scientific irrigation scheduling include reduction in non-point source surface water pollution (through reductions in nutrient and chemical laden irrigation tail water) as well as protecting groundwater supplies through reduced leaching of agricultural chemicals.

AgriMet ET information is being extensively used by irrigators for on-farm irrigation water management. In a study conducted for the BPA, "on-line services, primarily AgriMet, are the most commonly used source for obtaining this (ET) information and account for 45 percent of cases. These figures, however, under-represent the actual use of ET information, particularly from AgriMet, since they do not take into account cases where commercial irrigation service providers provide this data" (Kema-Xenergy Inc. 2003).

Through scientific irrigation scheduling, AgriMet offers significant opportunities for irrigators to reduce their use of limited irrigation water supplies. There are financial incentives to do so, beyond just the costs of water and the power required to move it. For example, in a case study conducted by Oregon State University (English 2002), an economic analysis was conducted on a 125 acre center pivot of potatoes in Washington supplied by a pump with 700 feet of total lift. Assuming 19 percent excess water use (a typical value, according to the study), and a low sensitivity to the excess water (resulting in a 3 percent yield loss), the extra costs to the farmer included:

Energy Cost:	$ 1,490
Nitrogen Leaching:	$ 5,625
Yield Reduction:	$ 10,890
Total Cost:	$ 18,005

In the Lake Chelan area of Washington, the local irrigation district uses AgriMet data for site-specific irrigation scheduling (Cross 1997). Manual soil moisture measurements are taken weekly at 2-4 sites per orchard in over 60 fruit orchards in the area. Daily AgriMet data is used to monitor the crop water use between field measurements. The soil moisture is plotted on a time series graph, showing soil moisture content at several depths through the growing season. When the AgriMet ET data indicates that the soil moisture has dropped to the management allowable depletion level, the producer irrigates the orchard. The next field measurement shows the new soil moisture levels, and the daily consumptive use values from AgriMet are systematically subtracted from the soil moisture levels until the next irrigation is scheduled. This process is repeated throughout the growing season, and updated information is provided to each producer on the same day the soil moisture measurements are taken.

AgriMet weather data are used for a variety of applications in addition to ET computation, and requests for current and historical weather information from the AgriMet network are common. Agricultural producers depend on wind speed and direction for scheduling practices such as field burning and pesticide applications. Weather data is used by state agencies for investigating pesticide application and ground water contamination issues. The National Weather Service uses AgriMet weather data for short-term forecasting and forecast verification. Several electric utilities use the weather information to forecast daily energy requirements, including peaking power. University researchers frequently use AgriMet data for a variety of applications, ranging from regional consumptive water use modeling to locating new orchards. ET information is being used by other agencies, such as the National Resources Conservation Service, to document compliance with irrigation water management practices on individual farm tracts. Increasingly, ET information from weather station networks is being used in water rights management by state water resource agencies.

SUMMARY

In the early 1980s, Reclamation, in partnership with BPA, developed a network of automated agricultural weather stations in the Pacific Northwest. From the original three sites installed in 1983, the AgriMet system has now grown to almost 90 sites in Idaho, Oregon, Washington, Montana, Wyoming, and California. Reclamation has cultivated partnerships with over 25 federal, state, and private interests to help fund the operation of the network.

AgriMet stations collect the weather data required for modeling crop ET and transmit this information via satellite to Reclamation's Regional Office in Boise, Idaho. Every day during the growing season, crop water use charts are developed for crops grown in the vicinity of each AgriMet station. This information is available daily through the Internet and is also published in many local newspapers throughout the region. The information is used by federal and state agencies, conservation districts, irrigation districts, extension agents, agricultural consultants, corporate farms, and individual irrigators for water management purposes. The weather data collected is also used for a wide variety of other applications. A rigorous field calibration and maintenance program, and data quality assurance program ensures a high-level of data quality and integrity.

Competition for limited water resources is increasing, cost of irrigation water and pumping is rising, and concerns for surface and ground water quality are heightening. In response to these factors, scientific irrigation scheduling is becoming more commonplace. AgriMet is providing the information required to meet these challenges in the Pacific Northwest.

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