APPLICATION OF WEATHER DATA FOR MANAGEMENT OF COTTON PRODUCTION IN 2005

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Introduction

The year 2005 was a relatively dry year when compared to 2003 and 2004. Most of our weather observation sites had a negative water balance, demonstrating the need for supplemental irrigation. However, during the last five years the availability of water for irrigation has become a critical issue for Georgia farmers due to the requirements for minimum water flows in the major rivers set by the neighboring states of Florida and Alabama. The future is not very bright, especially for farmers located in the Flint river basin. In 2000, the Georgia legislature approved the Flint River Drought Protection act. This act was implemented during the Spring of both 2001 and 2002, when farmers were asked to bid for acreage that they were willing to remove from irrigation. Fortunately the drought mitigation act has not been implemented since 2003 as the weather outlook provided for a wetter growing season compared to the previous years. However, it is highly likely that these drought episodes will repeat in the future based on the past weather history.

Access to near real-time weather data is critical for cotton production. This weather information can be used in various computer programs to help producers with their daily management decisions. There is a need to develop and implement computer-based information technologies for decision making, using local weather data from Georgia, as well as other input conditions such as soil and crop management. Although weather and decision support system has not been listed as one of the research needs for the Georgia cotton industry, it directly or indirectly affects many issues and decisions that are made on a daily basis by producers. These decisions include planting dates, deficit irrigation, when to start and stop irrigation, replanting decisions, irrigation timing and crop water use, and applications of pesticides and herbicides. The strategic plan of the Georgia Cooperative Extension Service has identified Information Technology as one of the critical issues for the near future for dissemination of knowledge and information to farmers, producers, growers, consultants and other stakeholders.

Procedures

The College of Agricultural and Environmental Sciences of the University of Georgia has established an extensive network of automated weather stations that are located across the state of Georgia. There are currently 68 stations in operation in Albany, Arlington, Calhoun, Camilla, Cordele, Dublin, Newton, Statesboro, Vidalia, and many other locations (Figure 1). Several of these weather stations have been installed in farmers' fields, such as in Georgetown and Cordele, while in 2005 a weather station was also installed at the Sunbelt Agricultural Exposition Center in Moultrie. The weather variables that are collected include rainfall, air temperature, soil temperature, relative humidity, wind speed and direction, solar radiation, soil moisture and barometric pressure. The weather data are automatically recorded by the data logger that is the central core for operation of each weather station and storage of data. Each weather sensor is scanned at a one-second frequency and every 15 minutes summaries are calculated for the previous period. At midnight daily extremes, daily totals and other summaries are determined.

Each weather station is a stand-alone unit, powered by a battery, which is recharged by a solar panel. Communications are handled through a dedicated telephone line or cell phone, which is connected to the modem of each weather station. A computer located at the College of Agricultural and Environmental Sciences-Griffin Campus calls each station at hourly or more frequent intervals and downloads the data. After processing, error checking, and other procedures, all data are pushed to a web server. Users can retrieve various types of weather and climate data from the world wide web, i.e., www.Georgiaweather.net, including yesterday's conditions, weather conditions for the last 31 days, as well as historical data for temperature and rainfall. Weather data are also distributed to local news media, including television stations and newspapers, and to farmers and agribusinesses via electronic mail. Current weather conditions are now updated at least hourly for all sites and more frequently for some of the sites.

A key component for decision making by growers and producers is the suite of application programs that have been implemented on the web. Users can calculate degree days for any period of time until present. As part of the degree day calculator, users can define the base temperature as well as a maximum temperature, above which no degree days are calculated. During the winter, users can calculate chilling hours for any period of time until present. A third calculator is the water balance calculator. It calculates total precipitation received for any period of time, as well as potential evapotranspiration. Potential evapotranspiration is the potential amount of water that can be lost by a crop that is grown under well-watered conditions. The difference between total precipitation and total potential evapotranspiration reflects the need for irrigation to avoid water stress. Recent additions include simple calculators to summarize soil temperature, air temperature as well as rainfall. The newest tool has been the capability to graph daily weather data, as shown for maximum and minimum temperature and daily total rainfall for Moultrie in Figure 2 and Figure 3.

Results

For this study we compared the cumulative number of degrees days, using a base temperature of 60 degrees Fahrenheit. We did not use a maximum temperature cutoff in our calculators. The results for 2005 were compared with the previous growing seasons for 2000 through 2004. Please note that the automated weather station network is continuously being expanded and that we, therefore, do not have complete weather records for all sites. Recent installations include Elberton, McRae and Alapaha in 2003, Albany, Tiger and Clarks Hill, South Carolina in 2004 and Moultrie, Unadilla,Vienna and Wootbine in 2005. We defined the start of the growing season as May 1 and the end of the growing season as November 1. In reality this can vary from location to location. Cumulative degrees days for the 2000 through 2005 growing seasons are shown in Table 1. The maximum number of degree days for 2005 was found in Valdosta at 3272, Albany at 3108 and Savannah at 3092. The minimum number of degrees in 2005 was found in Rome at 2313, Eatonton at 2368 and Watkinsville at 2379. The same sites also had maximum and minimum values for degree days in 2003 and 2004. For all sites, except for Savannah, the cumulative total number of degree days was very similar for 2004 and 2005. For the five-year period from 2000 through 2005, both 2001 and 2003 had the lowest number of degree days, except for a few sites, while the number of degree days for 2000, 2002, 2004 and 2005 was very similar.

Cumulative precipitation for May 1 until November 1 is shown in Table 2. Similar to the previous years rainfall varied significantly across the state and among weather stations for this period. Rome and Vidalia were the driest locations, with respectively 15.3 and 15.75 inches. Savannah, Valdosta and Griffin had the highest amount of precipitation, with respectively 31.0, 31.1 and 31.7 inches of rain. When comparing the period 2000 through 2005, the growing season of 2004, in general, was still the wettest, except for Camilla, Dublin, Midville, Rome, Statesboro, Vidalia and Watksinville.

The water balance for the same period is presented in Table 3. The water balance represents the difference between incoming water through rainfall and outgoing water lost through potential evapotranspiration for a well-watered crop. Twenty-two out of the 25 sites shown had a negative water balance, while only four sites had a positive water balance, ranging from 0.27 to 3.45 inches. Unfortunately the water balance does not provide much information with respect to both the rainfall distribution and intensity, and only provides a seasonal summary. During the period from 2000 through 2005 six sites had a negative water balance for all six years. These include Cairo, Camilla, Dearing, Eatonton, Fort Valley and Valdosta. This is somewhat of concern and could mean that for these sites an investment in supplemental irrigation should be recommended.

Summary and Conclusions

Temperature and rainfall display a very strong variability between years, as well as between sites. Although this is not a new observation, it shows that the availability of local weather information is critical for day-to-day decision making by farmers. This weather information can be integrated in management and decision support tools, such as models, to provide alternate management options and solutions for farmers. Especially schedulers for irrigation management are needed if water for agricultural use will become restricted.

The automated weather station network will continue to collect local weather data as long as financial support will be provided by industry, government, and others interested in weather data to support their operation and management decisions. Weather information can be retrieved at no-cost from the world wide web at www.Georgiaweather.net and specific web pages have been developed for cotton producers to be able to quickly retrieve degree days (www.griffin.uga.edu/aemn/degreedays.htm) and cumulative rainfall (www.griffin.uga.edu/aemn/rainNOV.htm) for the main cotton producing areas in Georgia. The degree day and water balance calculators can also be run interactively on the web, using local weather data as input. We feel that the combination of near real-time weather data and decision support systems is critical to maintain an economically sustainable farming operation.

Acknowledgments

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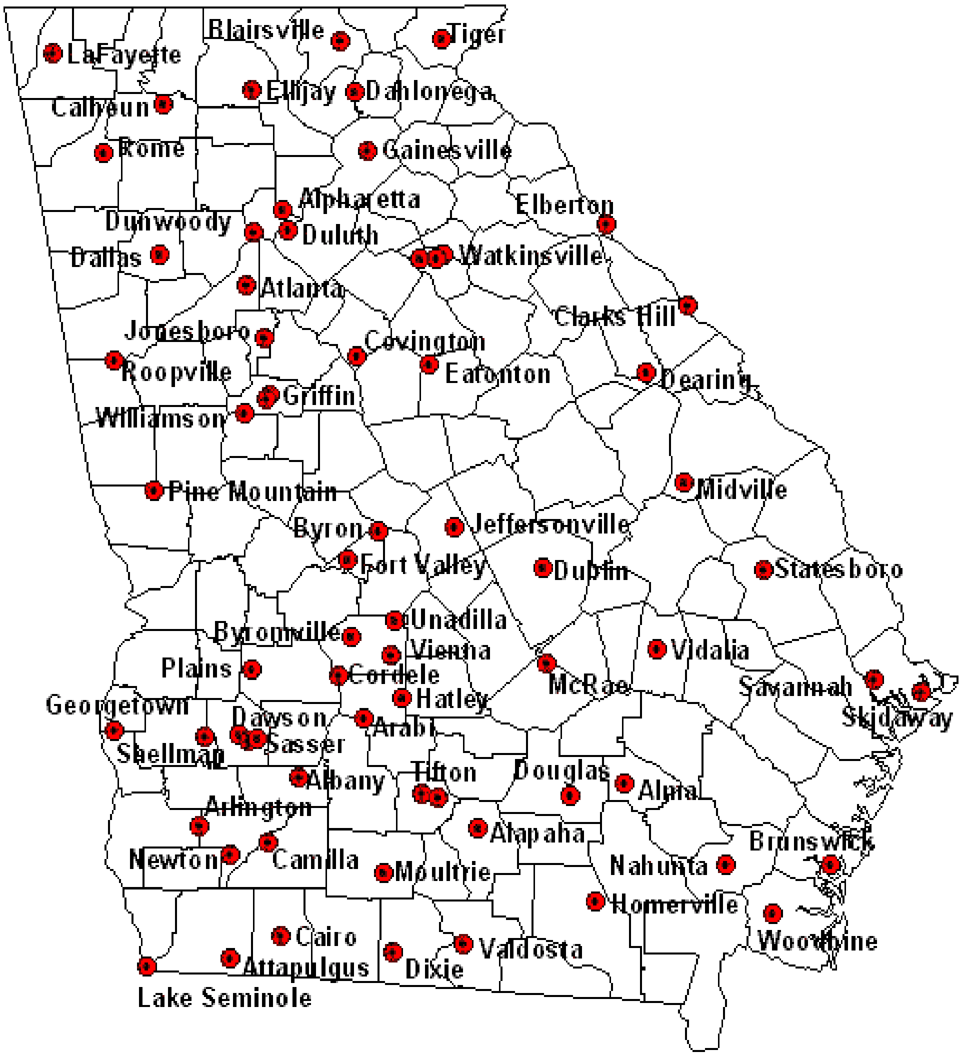

Figure 1. Location of the weather stations of the Georgia Automated Environmental Monitoring Network - College of Agricultural and Environmental Sciences.

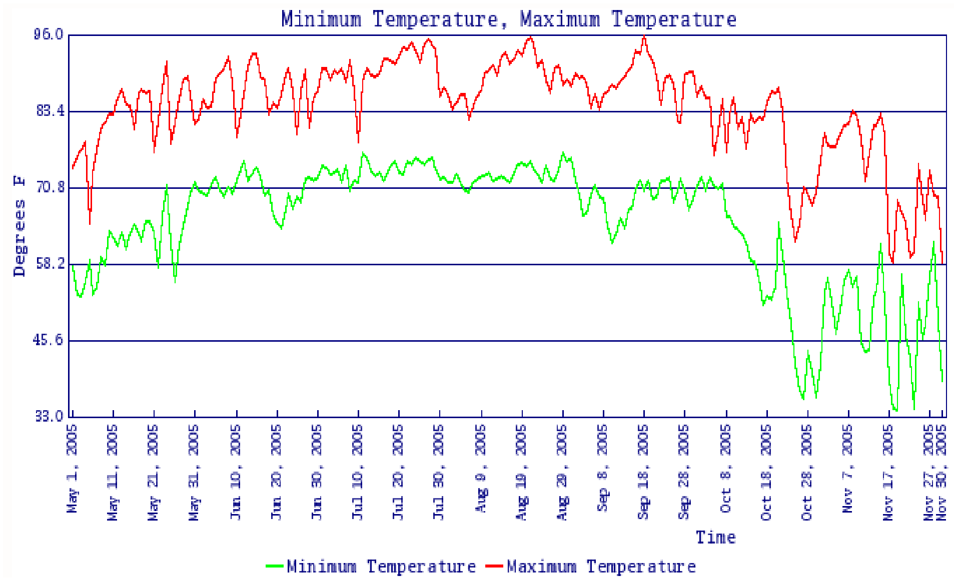

Figure 2. Daily maximum and minimum temperature for Moultrie, Georgia for May 1 through November 30, 2005.

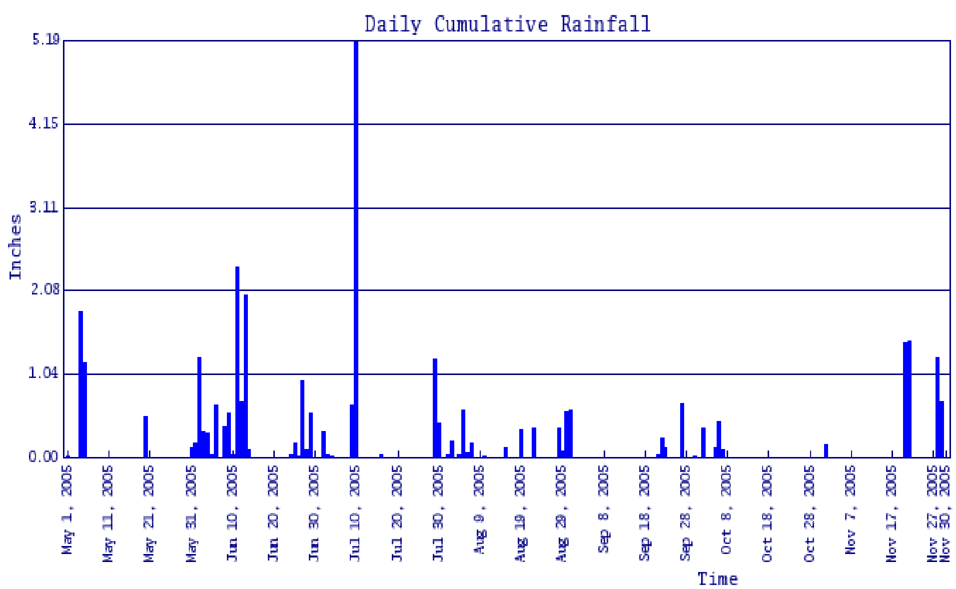

Figure 3. Daily total rainfall for Moultrie, Georgia for May 1 through November 30, 2005.

Table 1. Degree Days from May 1 until November 1 with a base of 60 degrees Fahrenheit.

Site	2000	2001	2002	2003	2004	2005
Alapaha	N/A	N/A	N/A	2728	2863	2882
Albany	N/A	N/A	N/A	N/A	3123	3108
Alma	2875	2766	3089	2820	2978	2987
Arlington	2823	2544	2966	2699	2826	2857
Attapulgus	2827	2687	3064	2789	2911	2704
Cairo	2836	2512	3112	2811	3050	2990
Camilla	3031	2765	3176	2836	3043	2990
Cordele	2966	2692	3034	2745	2927	2939
Dearing	2795	2597	2817	2501	2811	2736
Dublin	2739	2587	2923	2581	2850	2848
Eatonton	2566	2245	2516	2203	2431	2368
Ft. Valley	2741	2484	2743	2435	2695	2727
Griffin	2506	2222	2489	2202	2386	2386
Jeffersonville	N/A	N/A	N/A	2403	2663	2616
McRae	N/A	N/A	N/A	N/A	2747	2761
Midville	2830	2666	2916	2569	2829	2827
Moultrie	N/A	N/A	N/A	N/A	N/A	2926
Pine Mountain	2375	2107	2471	2248	2343	2393
Plains	2637	2351	2831	2531	2722	2739
Rome	2309	2053	2443	2090	2276	2313
Savannah	2591	2548	2940	2738	2749	3092
Statesboro	2567	2420	2936	2628	2840	2565
Tifton	2928	2692	3075	2766	3024	2940
Valdosta	3061	2933	3193	2986	3239	3271
Vidalia	2892	2706	2949	2703	2915	2966
Watkinsville	2512	2220	2509	2173	2407	2379

Table 2. Total Precipitation (Inches) from May 1 until November 1

Site	2000	2001	2002	2003	2004	2005
Alapaha	N/A	N/A	N/A	40.79	35.70	18.98
Albany	N/A	N/A	N/A	N/A	33.40	30.68
Alma	23.74	19.68	26.17	35.23	33.45	23.39
Arlington	18.66	16.23	28.36	23.49	32.61	28.56
Attapulgus	20.20	30.54	27.82	25.39	28.83	28.28
Cairo	20.84	26.23	19.99	27.29	28.11	27.85
Camilla	22.59	24.86	25.70	25.71	23.77	24.71
Cordele	11.19	18.47	19.40	27.71	34.72	19.81
Dearing	17.84	17.15	23.02	22.22	28.32	28.31
Dublin	17.70	16.55	22.95	32.42	31.73	17.93
Eatonton	14.24	18.46	17.48	25.11	32.95	23.33
Ft. Valley	16.30	14.04	24.40	17.04	20.56	23.94
Griffin	16.09	12.86	21.75	32.80	35.52	31.71
Jeffersonville	N/A	N/A	N/A	28.80	29.00	22.52
McRae	N/A	N/A	N/A	N/A	35.79	17.30
Midville	15.60	12.89	18.52	35.20	30.45	28.71
Moultrie	N/A	N/A	N/A	N/A	N/A	28.37
Pine Mountain	14.09	16.48	18.67	34.56	38.87	24.11
Plains	18.11	24.37	19.50	26.00	32.07	29.53
Rome	16.58	18.59	26.23	31.85	24.12	15.30
Savannah	20.27	22.54	38.28	24.52	37.85	31.00
Statesboro	15.33	13.89	25.67	36.34	24.37	28.86
Tifton	18.31	19.33	17.21	31.78	33.62	18.97
Valdosta	23.43	26.31	24.93	25.97	31.96	31.12
Vidalia	16.95	18.07	28.06	40.37	35.87	15.75
Watkinsville	16.30	22.39	19.48	34.27	30.36	29.02

Table 3. Water balance (inches) from May 1 until November 1. (The calculation of the water balance is based on [total seasonal rainfall - total seasonal evapotranspiration]).

Site	2000	2001	2002	2003	2004	2005
Alapaha	N/A	N/A	N/A	14.26	9.61	-6.61
Albany	N/A	N/A	N/A	N/A	1.37	-0.43
Alma	-5.26	-7.52	-3.38	5.72	2.40	-7.93
Arlington	-13.20	-14.29	-2.77	-5.32	2.52	-0.88
Attapulgus	-5.48	9.75	-2.62	-3.03	-2.17	-2.38
Cairo	-10.59	-3.31	-9.79	-1.26	-2.26	-1.53
Camilla	-9.73	-5.26	-7.30	-4.13	-8.18	-6.80
Cordele	-22.58	-13.01	-14.36	-3.74	1.10	-14.25
Dearing	-12.07	-8.99	-6.85	-5.76	-2.18	-0.95
Dublin	-15.58	-14.58	-8.91	2.94	-0.60	-12.80
Eatonton	-17.53	-10.88	-12.05	-1.24	-3.87	-3.48
Ft. Valley	-15.33	-16.66	-4.35	-7.00	-3.97	-0.24
Griffin	-16.82	-17.56	-7.38	5.18	7.10	3.45
Jeffersonville	N/A	N/A	N/A	2.12	-1.20	-8.18
McRae	N/A	N/A	N/A	N/A	5.35	-12.36
Midville	-17.45	-18.82	-11.90	7.17	3.52	1.16
Moultrie	N/A	N/A	N/A	N/A	N/A	-3.02
Pine Mountain	-15.34	-10.96	-8.64	9.17	13.37	-1.17
Plains	-13.19	-5.27	-9.77	-1.13	2.79	-0.91
Rome	-11.41	-7.41	-0.97	7.12	-1.47	-11.23
Savannah	-11.05	-7.36	6.98	-4.16	8.94	1.74
Statesboro	-14.50	-14.78	-2.78	8.50	-5.40	0.27
Tifton	-15.66	-12.58	-15.52	0.80	2.61	-11.97
Valdosta	-8.91	-4.59	-5.48	-2.96	-0.04	-0.86
Vidalia	-14.96	-11.65	-2.49	11.26	2.38	-15.49
Watkinsville	-12.79	-7.54	-9.78	7.39	1.17	0.95