APPLICATION OF WEATHER DATA FOR MANAGEMENT OF COTTON PRODUCTION IN 2006

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Introduction

The year 2006 was a very dry year when compared to 2005 and especially 2003 and 2004. All our weather observation sites showed a negative water balance, demonstrating the need for supplemental irrigation. However, during the last six 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, the spring of 2006 was initially also relatively dry compared to previous years. 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 and other input conditions such as soil and crop management. Although weather and decision support system have 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 relate planting date selection, deficit irrigation management, when to start and stop irrigation, replanting in case of establishment failure, 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 71 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. In 2006, three new weather stations were installed in Ty Ty at the Ponder Farm of the Tifton Campus of the University of Georgia to help support cotton research, in Tennille at the Washington County Farm Bureau Ag Center, and in Blue Ridge at Mercier Orchards. 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 data logger is the central core for operation of the weather station and storage of the data and it automatically records the weather data. Each weather sensors 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 Griffin Campus of the University of Georgia 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 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 every 30 minutes 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 site (www.Georgiaweather.net). 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 months, users can calculate chilling hours for any period 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 the capability to graph daily weather data, as shown for maximum and minimum temperature and daily total rainfall for Vienna in Figure 2 and Figure 3, and local temperature predictions up to 12 hours ahead.

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 2006 were compared with the previous growing seasons for 2001 through 2005. 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 Albany, Tiger, and Clarks Hill, South Carolina in 2004, Moultrie, Unadilla, Vienna, and Woodbine in 2005, and Ty Ty, Tennille, and Blue Ridge in 2006. We defined the start of the growing season as May 1 and the end of the growing season as December 31. In reality, this can vary from location to location. Cumulative degrees days for the 2001 through 2006 growing seasons are shown in Table 1. The maximum number of degree-days for 2006 was found in Valdosta at 3384, Albany at 3253, and Moultie at 3136. The minimum number of degrees in 2006 was found in Rome at 2444, Watkinsville at 2487, and Pine Mountain at 2491. The same sites also had maximum and minimum values for degree-days in 2004 and 2005. For all sites, except for Alapaha, the cumulative total number of degree-days was very similar for 2005 and 2006. For the six-year period from 2001 through 2006, both 2001 and 2003 had the lowest number of degree days, except for a few sites, while the number of degree days for 2002, 2004, 2005, and 2006 was very similar.

Cumulative precipitation for May 1 until October 1 is shown in Table 2. Similar to the previous years, rainfall varied significantly across the state and among weather stations for this period. Fort Valley and Moultrie were the driest locations, with respectively 12.2 and 12.6 inches. Arlington, Attapulgus, and Plains had the highest amount of precipitation, with respectively 28.6, 27.8, and 27.1 inches of rain. When comparing the period 2001 through 2006, the growing season of 2006 was relatively dry and for some sites the driest for the past six years.

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. All sites had a negative water balance that ranged from -3.8 inches for Arlington to -25.6 for Vidalia. During the period from 2000 through 2005, four sites had a negative water balance for all six years. These include Cairo, Camilla, Dearing, and Fort Valley, while eight sites had a negative balance during five of the six years, e.g., Arlington, Attapulgus, Cordele, Dublin, Eatonton, Plains, Rome, and Valdosta. This is somewhat of concern and could mean that for these sites an investment in supplemental irrigation should be recommended. Unfortunately, the water balance does not provide much information with respect to both the rainfall distribution and intensity, and only provides a seasonal summary. Recent reports show that late rains really help boost cotton yields compared to the early estimates based on drought and heat stress, as shown in Figure 3 for Vienna during late August and early September.

Summary and Conclusions

Temperature and rainfall display a very strong annual variability, as well as among 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 via 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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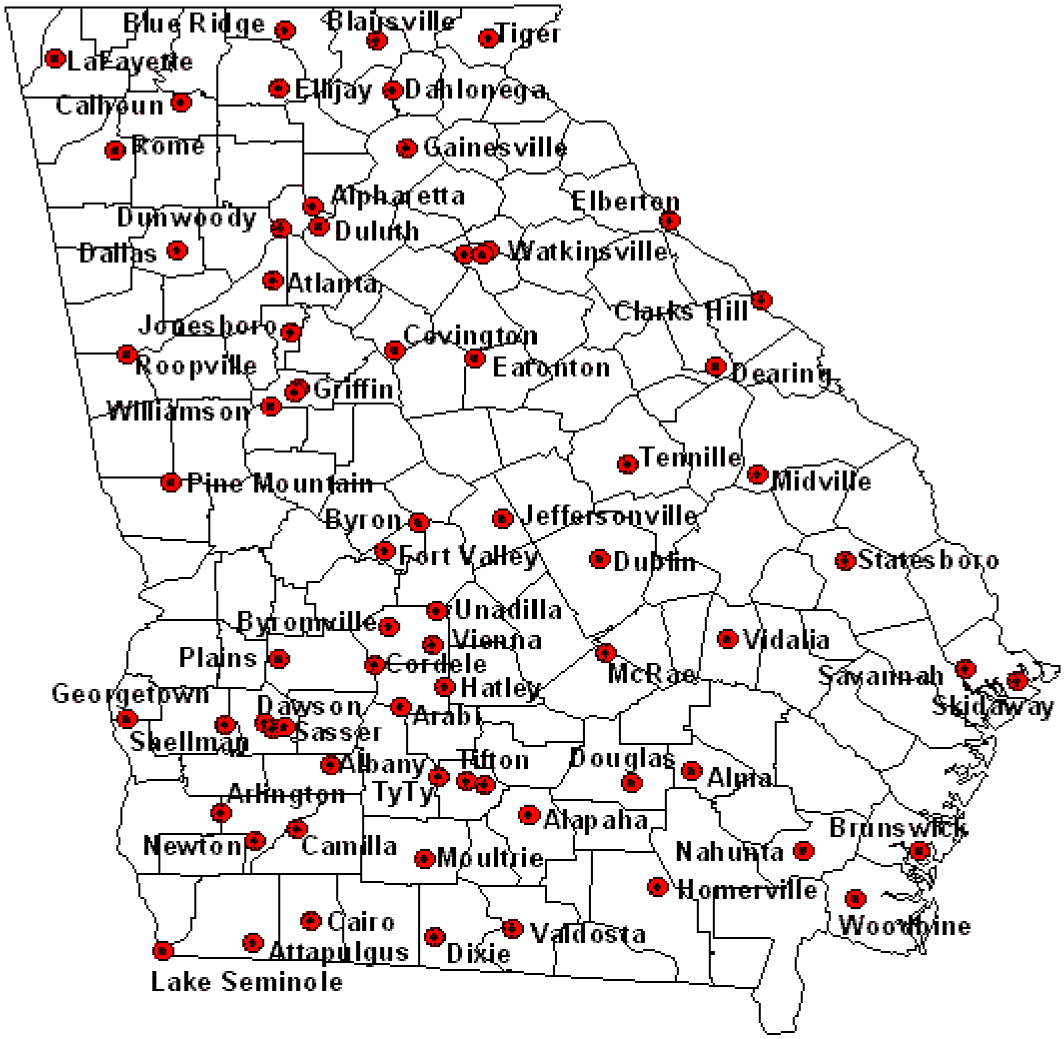

Figure 1. Location of the weather stations of the Georgia Automated Environmental Monitoring Network.

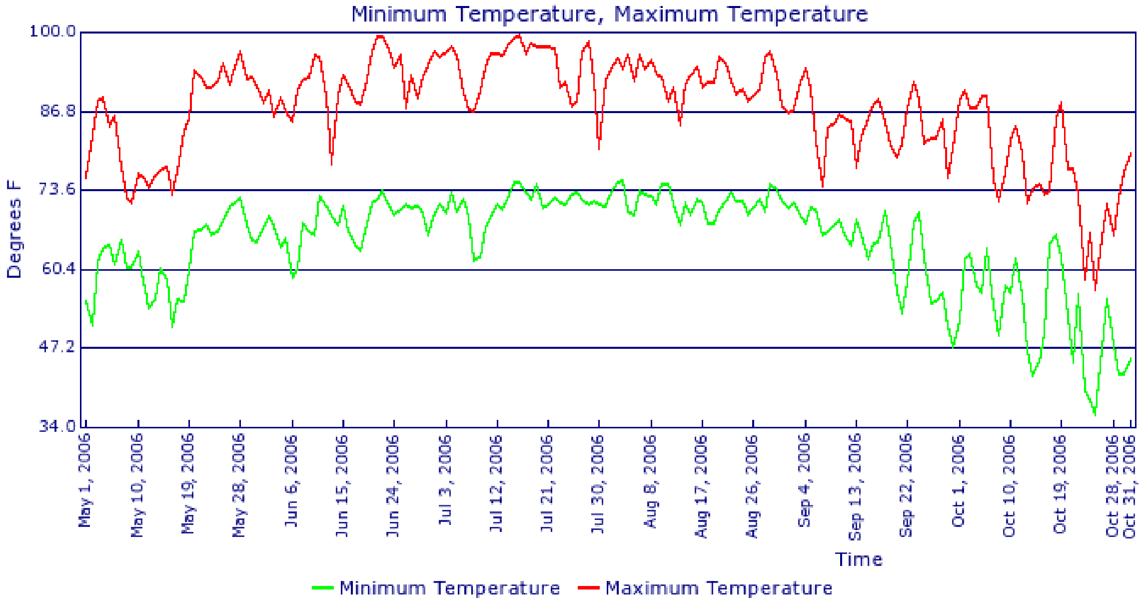

Figure 2. Daily maximum and minimum temperature for May 1 through October 31, 2006 for Vienna, Georgia.

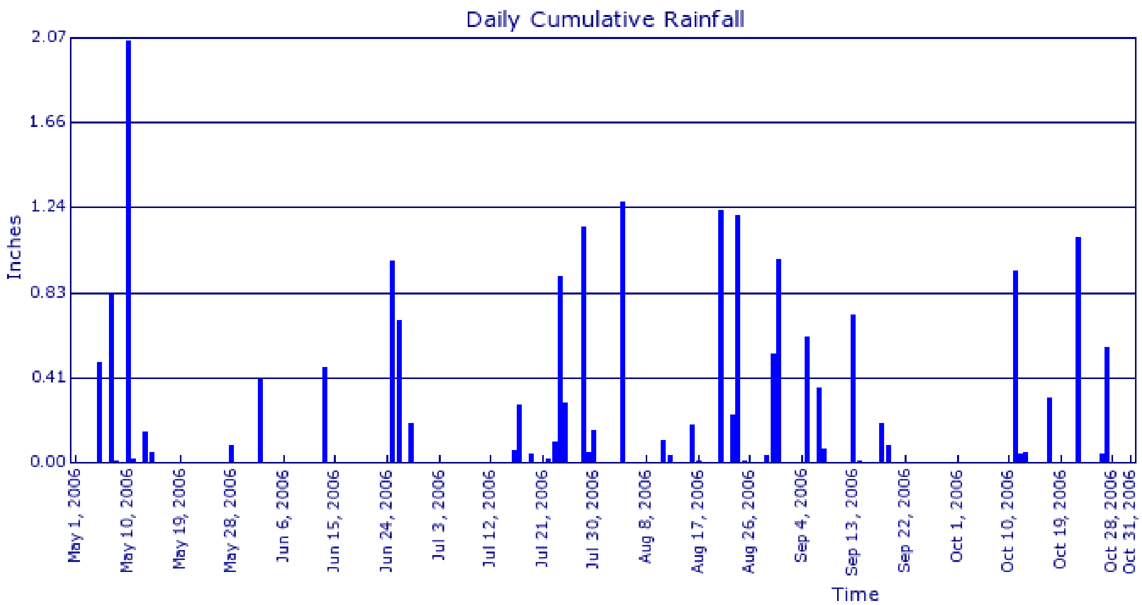

Figure 3. Daily total precipitation for May 1 through October 31, 2006 for Vienna, Georgia. (The weather station at Vienna is supported by AgAmerica Empowerment Agency, Inc.)

Table 1. Degree-days from May 1 until October 31 with a base of 60 degrees Fahrenheit.

Site	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Alapaha	N/A	N/A	2941	3052	3025	2600
Albany	N/A	N/A	N/A	3279	3250	3253
Alma	2904	3296	3030	3182	3162	3056
Arlington	2658	3207	2923	3067	3086	2985
Attapulgus	2852	3297	3023	3096	2850	3046
Cairo	2601	3327	3043	3275	3185	3120
Camilla	2886	3354	3026	3225	3133	3096
Cordele	2789	3210	2946	3124	3102	3020
Dearing	2694	2983	2676	2984	2898	2837
Dublin	2682	3127	2818	3077	3048	2993
Eatonton	2233	2601	2277	2540	2507	2553
Ft. Valley	2571	2893	2610	2889	2895	2910
Griffin	2213	2571	2269	2515	2495	2540
Jeffersonville	N/A	N/A	2597	2845	2780	2779
McRae	N/A	N/A	N/A	2934	2916	2798
Midville	2783	3097	2758	3010	3019	2904
Moultrie	N/A	N/A	N/A	N/A	3105	3136
Pine Mountain	2128	2615	2381	2534	2533	2491
Plains	2479	3016	2741	2938	2924	2847
Rome	2074	2610	2182	2430	2475	2444
Savannah	2631	3111	2936	2983	3251	3001
Statesboro	2506	3106	2818	3029	2724	2689
Tifton	2811	3252	2950	3196	3080	3025
Valdosta	3117	3437	3224	3467	3456	3384
Vidalia	2850	3147	2935	3129	3143	3082
Watkinsville	2269	2594	2294	2548	2497	2487

Table 2. Total Precipitation (Inches) from May 1 until October 31.

Site	2001	2002	2003	2004	2005	2006
Alapaha	N/A	N/A	40.79	35.70	18.98	20.74
Albany	N/A	N/A	N/A	33.40	30.68	25.78
Alma	19.68	26.17	35.23	33.45	23.39	19.46
Arlington	16.23	28.36	23.49	32.61	28.56	28.62
Attapulgus	30.54	27.82	25.39	28.83	28.28	27.79
Cairo	26.23	19.99	27.29	28.11	27.85	19.76
Camilla	24.86	25.70	25.71	23.77	24.71	25.65
Cordele	18.47	19.40	27.71	34.72	19.81	17.16
Dearing	17.15	23.02	22.22	28.32	28.31	21.20
Dublin	16.55	22.95	32.42	31.73	17.93	17.06
Eatonton	18.46	17.48	25.11	32.95	23.33	15.96
Ft. Valley	14.04	24.40	17.04	20.56	23.94	12.20
Griffin	12.86	21.75	32.80	35.52	31.71	16.52
Jeffersonville	N/A	N/A	28.80	29.00	22.52	16.85
McRae	N/A	N/A	N/A	35.79	17.30	19.62
Midville	12.89	18.52	35.20	30.45	28.71	14.37
Moultrie	N/A	N/A	N/A	N/A	28.37	12.63
Pine Mountain	16.48	18.67	34.56	38.87	24.11	17.32
Plains	24.37	19.50	26.00	32.07	29.53	27.07
Rome	18.59	26.23	31.85	24.12	15.30	19.71
Savannah	22.54	38.28	24.52	37.85	31.00	18.48
Statesboro	13.89	25.67	36.34	24.37	28.86	19.28
Tifton	19.33	17.21	31.78	33.62	18.97	15.78
Valdosta	26.31	24.93	25.97	31.96	31.12	22.93
Vidalia	18.07	28.06	40.37	35.87	15.75	13.03
Watkinsville	22.39	19.48	34.27	30.36	29.02	17.70

Table 3. Water balance (inches) from May 1 until October 31. **(**The calculation of the water balance is based on [total seasonal rainfall - total seasonal evapotranspiration]).

Site	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Alapaha	N/A	N/A	14.35	9.69	-6.60	-6.13
Albany	N/A	N/A	N/A	1.40	-0.89	-7.72
Alma	-7.44	-3.29	5.82	2.50	-7.83	-14.13
Arlington	-14.11	-2.68	-5.22	2.62	-1.27	-3.80
Attapulgus	9.82	-2.54	-2.92	-2.08	-1.80	-12.85
Cairo	-3.22	-9.71	-1.16	-2.17	-1.80	-12.85
Camilla	-5.17	-7.21	-4.04	-8.08	-7.20	-7.76
Cordele	-12.92	-14.28	-3.64	1.21	-14.21	-16.82
Dearing	-8.93	-6.79	-5.67	-2.10	-0.89	-10.45
Dublin	-14.49	-8.83	3.04	-0.51	-12.72	-14.51
Eatonton	-10.81	-11.99	-1.16	3.91	-3.42	-14.98
Ft. Valley	-16.57	-4.28	-6.92	-3.90	-0.18	-20.15
Griffin	-17.48	-7.30	5.27	7.18	3.51	-15.21
Jeffersonville	N/A	N/A	2.21	-1.11	-8.10	-15.61
McRae	N/A	N/A	N/A	5.44	-12.28	-11.84
Midville	-18.74	-11.83	7.25	3.59	1.22	-18.93
Moultrie	N/A	N/A	N/A	N/A	-3.12	-21.43
Pine Mountain	-10.90	-8.58	9.24	13.42	-1.29	-8.95
Plains	-5.19	-9.70	-1.04	2.87	-1.27	-6.96
Rome	-7.36	-0.93	7.19	-1.41	-11.21	-9.07
Savannah	-7.28	7.06	-4.06	9.02	1.82	-13.34
Statesboro	-14.70	-2.70	8.59	-5.31	0.35	-12.29
Tifton	-12.48	-15.43	0.90	2.70	-12.02	-17.61
Valdosta	-4.49	-5.40	-2.85	0.06	-0.75	-10.32
Vidalia	-11.56	-2.41	11.35	2.47	-15.40	-25.64
Watkinsville	-7.48	-9.72	7.47	1.24	1.02	-11.44