ENR

Illinois Department of
Energy and Natural Resources

State Water Survey Division

SWS Contract Report 355

DEMONSTRATION OF USE AND VALUE OF CLIMATIC INFORMATION TO GOVERNMENTAL AGENCIES

Final Report of COMM-NA82AA-D0041

The National Climate Program Office and the Climate Analysis Center of the National Weather Service

1 August 1982 – 31 December 1984

by

W. M. Wendland

and

S. A. Changnon, Jr.

Champaign, Illinois 61820

December 1984

TABLE OF CONTENTS

1. Introduction

Climatological records of data and information from first and second order stations and from special purpose networks have been gathered, archived, and/or published for decades by the NOAA, by state climatologists, and by private companies and individuals. These data are used for service and research purposes by a wide variety of users. Except for a few cases (Changnon, 1979; Pack et al., 1983; McKee and Doesken, 1983), neither the number of climatic parameters nor products used for specific decision-making purposes has been recorded. Nor has the potential need for data been assessed. Even the references above did not assess the purposes for which the data were requested, nor the value of the data or information in solving particular problems at hand. The very fact that the user community continues to request climatological data and information speaks to a need, but does not quantify the value of such data and information in decision making, scheduling, planning, management or other economic process.

In 1978, the National Climate Program Act was enacted and it included an Intergovernmental Climate Program (ICP). This portion of the Act paid particular attention to the need for improved climatological services to a myriad of users to ensure the proper translation of climate data and information, both existing and emerging, to the local, state, and national user community. Cooperative research between federal and state agencies under the guise of the ICP had been only nominally funded by 1981, presumably because federal agencies found it difficult to cooperate or direct research funded by them, but completed by, or completed in cooperation with state agencies. In addition, there was a reluctance to fund expansion of climate data and information dissemination because of insufficient data which demonstrated the value of such data to users.

The research reported herein was a project designed to demonstrate the value of near real-time climatic data and information to a variety of users, but primarily state governmental agencies. We initiated a computer-based near real-time climatic data archive, established a roster of authorized users from whom we would monitor data and information use, and investigated the value of such data and information in solving particular problems.

2. Objectives

The project objectives were created, and fulfilled in this research project. The first was to identify state and federal governmental agencies within Illinois to participate in this demonstration program. Knowing the general activities of many governmental agencies permitted us to list potential users, after which discussions were held with representatives of each to determine if they currently used or potentially could use climatic data and information. Second, to identify the climatic conditions of greatest impact to the governmental agencies participating in this study. Third, to obtain, prepare and maintain a climatic data base for various stations in the state from which conventional and new climatic statistics could be prepared. Fourth, to determine the probability of some given future condition based upon a number of prescribed initial conditions, from the historical record. Fifth, to establish a convenient means to present data and information to user's

terminals directly from the computer, via phone lines; and sixth, to evaluate the use of, the general benefits of, and the economic value of a continuing near real-time climatological data and information service to the various agencies participating in this demonstration program.

Each of the above six objectives has been fulfilled and results are reported herein. The computer-based climatological data system, known as the Illinois Climate Assistance Service (CLASS) is operational, and we are maintaining its operation because of the realization of improvements in climatological data service never before available to a state climatologist, because of savings from reduced personnel requirements, and because of recognized benefits (savings) to the user community.

2.1. Identifying State and Federal Governmental Agencies to Participate in the Program

Cohen and Wendland (1979) identified several Illinois governmental departments and agencies as potential users of climate data. This list was based upon prior experience as well as conversations with key personnel to discuss their climate-related problems. The initial list was expanded, primarily by contributions from Mr. David Farrell of the Illinois Commerce Commission. Discussions were held with representatives of each of these agencies to formulate a listing of potential products which could be beneficial to the participating agencies. More than twenty state and six federal governmental agencies in Illinois were contacted to discuss how near real-time climatic data could facilitate their operation. The state agencies included:

1. Illinois Commerce Commission
2. Division of Water Resources of the Illinois Department of Transportation
3. Illinois Department of Energy and Natural Resources
4. Illinois Environmental Protection Agency
5. Illinois Department of Agriculture
6. Illinois Emergency Services and Disaster Agency
7. Illinois Secretary of State's Office
8. Illinois Department of Conservation
9. Illinois Office of the State Attorney General
10. Illinois State Police
11. Illinois Crop Reporting Service
12. Illinois Department of Public Health
13. Illinois Department of Commerce and Community Affairs
14. Illinois Capitol Development Board
15. County Cooperative Extension Agents (funded by state)
16. Illinois State Natural History Survey

The following federal agencies in and around Illinois were invited to, or asked to participate:

1. D. S. Soil Conservation Service, Champaign Office
2. U. S. Army Corps of Engineers, Rock Island, Illinois
3. U. S. Department of Agriculture, Illinois Crop Reporting

Service, Springfield
4. National Weather Service Office, Chicago
5. U. S. Geological Survey, Champaign Office
6. Federal Emergency Management Agency, Chicago
7. NWS River Forecast Center, Minneapolis
8. NWS River Forecast Center, Cincinnati

A few non-governmental agencies were invited to participate because of our experience with each, suggesting they could use such data, including:

1. Illinois Farm Bureau
2. Illinois Municipal League
3. Department of Geography, Northern Illinois University
4. Department of Meteorology, University of Chicago

In addition to the above, the Climate Analysis Center (CAC) of National Weather Service, the National Climate Program Office, and the National Climatic Data Center were briefed on the data available on the computer system, and how such data could be accessed. CAC has called the Illinois system from time to time. The World Meteorological Organization (WMO) in Geneva, Switzerland was contacted to describe the data and information dissemination system because of conversations between ourselves and representatives of the National Climate Program Office. WMO is investigating several microcomputer climatic data systems that could be inaugurated in developing countries to permit them a means to acquire near real-time data. WMO is studying several systems (CLASS included) to identify one which could be easiest adapted or devised, with the least reworking.

Some of the above contacts flourished into frequent, continuing requests for data, whereas a few led to no usage contact because the data and information available were not perceived to be of benefit. Of the list of potential state users above, numbers 2 (water resource management), 3 (natural resources and energy), 5 (agriculture), 10 (police), 11 (crop reporting), and 15 (extension) evolved into frequent users. Of the federal agencies above, numbers 3, 6, 7, and 8 became the most frequent users. The Illinois Farm Bureau also became a very regular user from the short list of non-governmental agencies. The evolution and development of the list of users was also enhanced by word-of-mouth from present users to friends and colleqgues. This method was particularly noted amongst farmers and county cooperative extension agents.

2.2. Determination of Climatic Conditions of Greatest Interest and Heed to the Users

The products to be offered on the computer system were determined initially from conversations with potential users, as well as from our own experience with their operations, and from experience with requests coming to the Illinois State Water Survey. For example, conditions like mean monthly and weekly mean temperature, and daily weekly and monthly total precipitation were obvious needs, as were comparisons with similar data from the previous year and from the 30-year mean (normal).

Some users pointed out that they could most easily use time-series of climatic parameters for a given station, whereas others were more concerned with statewide distributions of a given condition for a particular time (yesterday) or period (last month). Both formatting systems (temporal and spatial) were therefore implemented into the system's products.

In addition to mean temperature and total precipitation, we included snow on the ground, and depth of ground frost (in winter). These were updated weekly and bi-weekly, respectively. These two parameters were found to be of particular interest to the River Forecast Centers.

The Illinois State Water Survey routinely measures soil moisture from the surface to a depth of 2 m at 17 sites within the state, bi-weekly during the growing season and monthly at other times. These observations were also entered in to CLASS because of agricultural interests.

As a result of interactions with the Illinois Crop Reporting Service a review of the statewide temperature, precipitation, and severe weather from the previous seven days was prepared each Monday. This narrative product is prepared expressly for further dissemination to over 6,000 agricultural recipients of the publication, Weekly Weather and Crops issued weekly by the Service and the Water Survey.

We divided the state of Illinois into 20 climatic regions based upon the distribution of temperature, precipitation and solar radiation. The 20 districts are shown in Figure 1 and each represents areas of 2 to 6 counties each. We accumulated the climate record for one of the National Weather Service Cooperative Stations (beginning in 1901) for each of these districts, against which recent observations could be compared.

Soil temperatures were obtained on a weekly basis at 22 sites in Illinois from the Agricultural Weather Service Office at Purdue University, West Lafayette, Indiana. Observations at the 4-inch level under grass were available for all sites and some data at the 8-inch depth, and/or under bare soil were available.

Growing-, heating-, and cooling-degree days were calculated for each of the 20 districts (in season), and summed from the beginning of the appropriate season. These daily degree days and seasonal sums were also compared against values calculated for the previous year, and the 30-year means.

Palmer Drought Indices for each of the nine crop reporting districts in Illinois were obtained from the Climate Analysis Center and displayed on CLASS. Also obtained and presented were the 30- and 90-day outlooks. The latter outlooks were offered in narrative form based upon the quantitative probabilities published by CAC.

The Illinois Natural History Survey (NHS), a sister agency, has developed agricultural pest models. As part of another state-funded project (known as the Climate and Pests Service, CAPS), personnel from NHS drove these models with the near real-time data from CLASS. The results were used to calculate and present updated advisories of several pests, as necessary, through the 1984 growing season, as well as develop new models from near real-time climatic data. As the growing season progressed, and different pests emerged, the advisories assessed the current and future potential for each pest (and treatment) in various sections of the state based on the current atmospheric conditions. CAPS products were developed for distribution to a wider audience

than that of CLASS. The increase in the number of total users of CLASS was adventageous since system exposure was greater than originally expected.

The ever-expanding climatic data base of CLASS was also made available to callers in the SHEF format. The following station conditions were included: 24-hr maximum and minimum temperatures, temperature at time of observation, 24-hr precipitation, snowfall, and snow on the ground. These time series began in early January 1984. Callers to the system could request the data for any or all stations, for specified days, or for the entire period of record.

Each of the above terminal-presented products was accompanied by a "help" page which described the source (derivation) of the observation at hand, and indicated from which station in Illinois the observations for each parameter originated.

The system was designed to be very user friendly. Callers to the system could type a "comment" on their terminal which was recorded on the CLASS computer, either directed to a given individual or to the system in general. These comments were invited to improve the system and to make the products more helpful in solving user problems. During the first nine months of operation, these comments were used to present new conditions or indices, and to rearrange the presentations to satisfy the needs of particular users. Such shifts were particularly attributed to the needs of the Illinois Crop Reporting Service, an agency that has need of climatological data for devised agricultural application.

2.3 Preparation and Maintenance of Appropriate Data Bases

The historic data base from 1901 to the present (1984) was collated from digitized card images originally produced by the Water Survey and updated with data from the National Climatic Data Center (NCDC) in Asheville. Daily card images containing maximum and minimum temperatures, temperature at the time of observation, precipitation (water equivalent), snowfall, snow on the ground and some "days with ..." data were used. Our data base was complete through 1983. As of January 1984, the data for each of the 20 state districts (Fig. 1) was routinely updated on a daily basis from the observations phoned directly to the computer by the NWS observers cooperating with the project.

Current (1984) observations input to CLASS were received from several sources, including 36 National Weather Service Cooperative Observers in Illinois, 22 stations inputting to the Midwest Agricultural Service Center at Purdue University, and the Climate Analysis Center. The NWS Cooperative Observers transmitted their temperature and preciptiation observations to CLASS on a daily basis by means of a touch tone telephone. The ISWS computer automatically received each parameter and ensured that the following 4 criteria were satisfied:

$$T_x \geq T_N \quad (1)$$

$$T^x \geq T^{yo} \quad (2)$$

$$T^n \leq T^{yo} \quad (3)$$

$$T_x \geq T^{yo}_o \geq T_n \quad (4)$$

where T_x is the maximum temperature during the last 24 hours, T_n is the

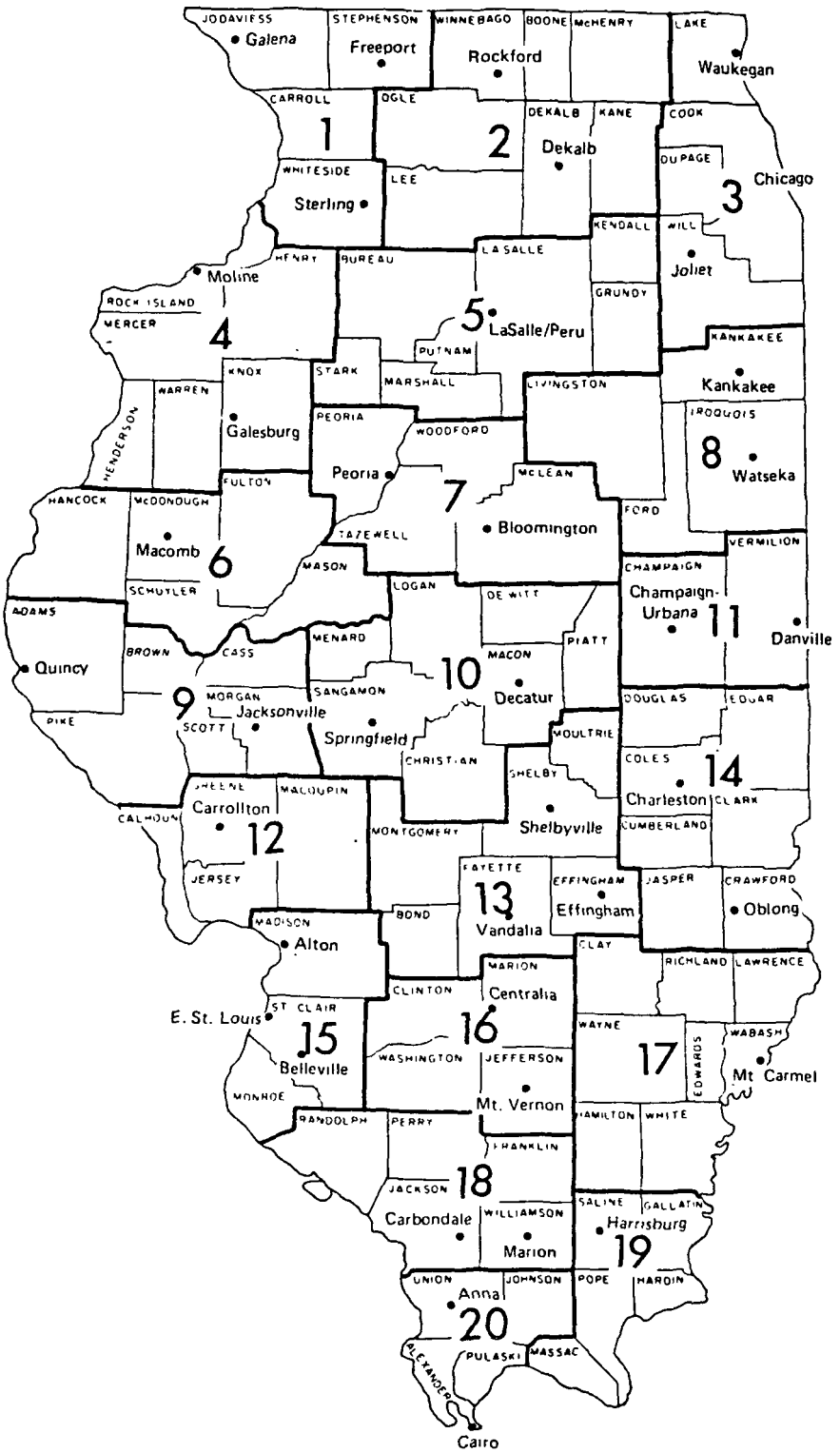

Fig. 1. Climate districts of Illinois used for CLASS, based on the distribution of temperature, precipitation, and solar radiation

minimum for the same period, T_{yo} is the temperature at the time of observation 24 hrs previous, and T_o is the current temperature (time of observation temperature). If any of the 3 observations failed the above criteria, the voice synthesizer on the computer requested the data to be retransmitted.

In addition to the above quality control determinations, the voice synthesizer in the ISWS computer repeated each entry over the phone so that the observer could verify that value or re-key a correct value. This method allowed the retrieval of digitized, verified observations within one or two hours of the time of observation.

In order to present specific data for various regions of the state, we divided Illinois into 20 climatic districts, based on the mean distribution of temperature, precipitation and solar radiation. Those districts are shown in Fig. 1.

We prepared several programs which were used to extract certain climatic data and information from a given station or all stations, and for particular times of the record or for the entire record. These programs are extremely helpful in comparing a recent anomalous event with the last 30, 50, or 80 years, a comparison not heretofore easily accomplished.

The computer-based data and information system which evolved at the Illinois State Water Survey was called the Climate Assistance Service (CLASS). The data base and managing software were housed in an ALTOS 8600 computer which maintained 8 ports, one being an 800 phone number available to our observers within the state and authorized users, another being a commercial phone number, the remaining port6 were connected to terminals within the Water Survey.

CLASS data were not quality controlled to a level equivalent to those maintained by NCDC for published data. The 4 equivalence determinations (equations 1-4, above) are similar to data tests at NCDC, but the latter agency goes further by correlating each station's observation with those of nearest neighbors, and replaces and flags errant data when necessary. It was not our intent to develop the CLASS data quality to that extent. The users of the CLASS are aware of this condition, but find the real-time data useful in their present state. Permit us to re-emphasize that 36 observations within Illinois become digitized, verified by the observer, and become available to users within 1 to 2 hrs of the time of observation. The density of stations, and timeliness of the observations is not equalled in any state.

2.4 Determination of Climatic Conditional Probabilities

Earlier research at the Water Survey had suggested that conditional probability outlooks could be used to predict climatic conditions for some future times and spatial ranges. In order to generate temperature and precipitation outlooks for Illinois, we used the digitized 80 years data base, for each of the 20 regions, to develop conditional probabilities for temperature and for precipitation for a given month (week), as a function of temperature alone, precipitation alone, or temperature and precipitation from the previous month (week). The verification of several tests determined which method would be implemented on a routine basis to generate monthly outlooks for the various

sectors of the state. The conditional probability outlooks were generated in categories of low, near, or above normal conditions, those three categories defined as having equal populations.

These outlooks were prepared in order to compare to the 30- and 90-day outlooks of temperature and precipitation prepared by the Climate Analysis Center of NWS, which are available for first order stations (Chicago, Rockford, Moline, Springfield, and Peoria in Illinois). Using the 80+ year daily maximum and minimum temperature and precipitation records of 20 cooperative NWS stations in Illinois, we investigated the category of temperature and precipitation (above, near, or below normal) for a given week as a function of the category of the same variable for a previous week(s). We developed two outlook models: (1) a one predictor model, i.e., where the temperature condition of a foregoing week was used as a predictor for the following week, and (2) the two predictor model, where the categories of both temperature and precipitation for one week were used to predict temperature and precipitation for a subsequent week. In most instances studied, the predicted categories exhibited spatial continuity, particularly during some seasons of the year.

Earlier research conducted at the Water Survey (reported in Changnon, 1985) produced techniques for monthly and seasonal outlooks of precipitation in Illinois which verified between 50% and 60%, where outlooks prepared by chance alone would verify at only 33% (based on a 3 category scheme). Obviously, these conditional probability outlooks verify substantially better than persistence. The monthly and seasonal precipitation outlooks were presented on CLASS.

Past climatological data for about 20 stations in Illinois were subjected to conditional probability analysis. Conditional probability verifications were calculated for several models and several period lengths as shown in Table 1, including the conditional probabilities of 1 month categories used as a predictor for the following month, the conditions of 1 month used to foreshadow the conditions for the second month in the future (1 month lag), and the category of the predictor(s) during 2, 3, and 4 months as a predictor of the category of later periods. Table 1 presents the verifications for seven sites in Illinois. The upper half of the table exhibits the verifications for precipitation outlooks whereas the lower half presents that for temperature, based on 1- and 2-predictor models. Although the 2-predictor model yielded better verification in only 19 of 56 cases for precipitation outlooks, the 2-predictor model yielded overwhelmingly better verification (54 of 56 cases) for temperature. In order to use the same procedure for both temperature and precipitation, the 2-predictor model was therefore implemented for the operational outlooks to be displayed on CLASS.

Each of the verifications shown in Table 1 was prepared by using conditional probabilities developed from 3 years of data, thence tested on the following independent year. Of the 80 yrs data, 60 yrs were used to develop conditional probabilities, with 20 independent years used for the verification. The outlooks for precipitation verified between 30% and 40%, whereas those for temperature verified between 33% and 47% (33% again expected due to chance alone). There was no systematic difference in verification statistics from station to station, and similar verification statistics were found for all stations using the same forecast model. Using the 2-predictor model for temperature outlooks, the best results were obtained at virtually all stations for a 4 week pre-period used to predict the following 4 weeks, and for one

Table 1. Verification (%) of weekly, monthly, and seasonal outlooks prepared from conditional probabilities for seven Illinois locations. Left-hand column indicates number of weeks (s indicates a season) in each period. Parameter category in pre-period used to predict category during outlook period with or without a lag period. The symbols T&P:P signify temperature and precipitation conditions from antecedent period used to predict temperature. The symbol P&P:P signifies precipitation used to predict precipitation. Verifications based on 80 years of data (1901-1980).

pre-period / outlook period / separation period	Anna		Decatur		LaHarpe		Moline		Quincy		Springfield		Urbana	
	P&P:P	T&P:P	P&P;P	T&P:P	P&P:P	T&P:P	P&P:P	T&P:P	P&P:P	T&P;P	P&P;P	T&P:P	P&P;P	T&P:P
1 . 1 . 0	33.2	40.0	35.8	34.1	33.0	33.9	33.6	32.5	35.3	32.4	32.0	34.8	30.5	31.9
1 . 1 . 1	34.8	32.9	34.4	30.3	35.1	35.9	34.9	31.2	42.6	34.9	33.4	31.0	34.9	34.8
2 . 1 . 0	35.2	33.4	35.0	34.6	33.1	34.7	35.8	31.7	35.7	34.6	32.5	35.0	36.0	34.3
2 . 1 . 1	34.0	35.1	35.5	34.9	35.4	34.5	36.2	32.5	37.5	35.4	33.4	29.1	34.4	32.5
4 . 4 . 0	34.8	32.3	35.0	32.3	36.2	34.9	32.5	38.2	33.2	34.0	41.6	33.3	31.7	34.4
4 . 4 . 4	32.1	31.0	32.6	33.9	31.5	32.5	35.3	34.9	29.4	36.6	31.8	33.2	35.2	29.9
s . s . 0	36.9	33.2	34.7	32.7	29.1	37.0	39.9	34.6	33.3	32.3	33.2	38.4	33.0	32.2
s . s . s	32.7	26.4	36.3	34.3	35.8	33.6'	37.2	36.0	36.3	33.1	31.8	33.7	37.4	32.5
	T&P:T	T&T:T	T&P:T	T&T;T	T&P:T	T&T:T	T&P:T	T&T;T	T&P:T	T&T:T	T&P:T	T&T:T	T&P:T	T&T:T
1 . 1 . 0	32.7	42.1	30.6	38.3	34.5	39.5	29.8	37.3	29.7	41.1	30.0	37.4	29.3	38.3
1 . 1 . 1	34.2	34.7	36.2	37.4	30.1	37.3	32.3	35.3	31.1	35.4	34.7	37.5	32.2	37.8
2 . 1 . 0	30.6	37.4	32.5	37.4	31.5	38.9	32.0	36.5	32.4	39.1	31.7	37.1	34.0	38.6
2 . 1 . 1	35.2	35.7	32.1	36.8	32.8	36.5	34.1	35.9	34.7	37.7	31.8	36.0	34.1	38.5
4 . 4 . 0	30.1	40.3	30.7	39.3	32.7	42.8	34.4	35.7	31.3	40.1	30.5	39.3	32.2	40.6
4 . 4 . 4	32.2	34.1	31.7	33.2	36.4	33.2	33.9	33.1	34.4	38.9	32.6	35.5	31.6	34.6
s . s . 0	34.1	46.8	35.8	39.2	34.6	44.0	33.7	36.1	32.6	47.1	33.7	39.7	28.8	40.9
s . s . s	34.1	43.2	31.9	36.2	34.3	41.4	35.1	36.8	30.8	44.7	32.9	40.3	31.9	37.2

season to predict the following season, and one season to predict the second future season (one season lag). In these instances, the two predictor model verified between 30% and 34%. Conditional probability outlooks for one week hence exhibited lower verification rates, but only by a few percent.

Precipitation outlooks did not verify as well as those for temperature. However, the best verification rates were found for a model based on a two week pre-period used to forecast the following week, the one week outlook lagging the one week pre-period, and one month predicting the following month.

Again, in order to use the same scheme for predicting temperature and precipitation, the 2-predictor model was used for both parameters, using the categories of temperature and precipitation for one given period to predict the category of temperature and that of precipitation for the following period. Periods refer to either one week, two or four weeks, or 13-week seasons. The verifications in 1984 are shown in Table 2 for each of the models and four sectors of Illinois, each sector representing the average of 6 or 7 individual stations. Clearly, the temperature verifications are better than those for precipitation. These verification statistics represent the results of 17 week long outlooks, beginning with 5 April 1984. The 0.5 increments shown in Table 2, occurred from those cases when two categories were predicted with equal probability. The verifications are given both for the number of cases verified as well as those which verify with conditional probabilities equal to or greater than 40%. The four sectors of Illinois verified at about the same rate. We expect that the disparate verification rates between the 80 years data and the 17 week studies was due to the limited sample size of the latter study. More data will be required to determine if this is indeed the case.

2.5 Establish a Means to Present Data and Outlooks to the Users

In order to present near real-time climatic data and information to a user, we designed and built a computer-based system, one which contained a number of tables, map-displays and narrative presentations, updated daily, weekly, monthly, or seasonally, as necessary and as new data became available. With the rapid increase in use of terminals and desk-top computers, we devised CLASS to be accessible by terminal and modem via a telephone. This arrangement also allowed us to monitor each caller, products requested, and total contact time.

In order to encourage people with little computer experience to use this system, and to make it as easy as possible for all users, a user friendly computer system, known as the Climate Assistance Service (CLASS) was developed. It was menu-driven, i.e., as soon as contact is made with the CLASS computer at the Water Survey (whether through a Water Survey terminal or from another terminal via phone), the CLASS program generates a title page, advising the user that contact has been made with CLASS. The computer requests the user to signon with their authorized signon code. Authorized codes permitted the sys-

Table 2. Verification of the weekly outlooks presented on CLASS
(17 weeks data, Feb-May 1984)

	T&T:T		T&P:T		P&P:P		T&P:P		Total %	
	Verify	Verify P ≥ .40	V	V P ≥ .40	V	V P ≥ .40	V	V P ≥ .40		
North	4	2	5	4	6.5	0	5.5	2.5	21	8.5
North Central	6	5	6.5	6.5	3.5	0	5	1	21	12.5
South Central	10.5	3	7.5	5.5	5	2	2.5	2	25.5	12.5
South	6	3	6	5	4.5	2	4.5	2	23	12
Total	26.5	13	25	21	19.5	4	17.5	7.5		
Percent	(39%)		(37%)		(29%)		(26%)			

tem to discriminate authorized users, for us to limit users, and to record caller use frequency.

After user recognition, the CLASS system automatically presented comments concerning recent system changes, new data products, changed procedures, etc. Following the comments, this system presented the first menu, permitting the user to choose either 1) district of the state for which data could be requested (temperature, precipitation, or agricultural data), or 2) maps of Illinois or tables with various means or summed conditions.

If data were requested for 1 of the 20 districts, the district had to be chosen by the user. This was accomplished either by district number, or by typing a city, town or county of interest.

After this initial area choice, the system generated a second user menu with the specific choices under each of several major categories. For example, if the user specified that temperature data were desired, the system presented the following choices: (a) daily temperature summary (which showed the daily maximum, minimum, and mean temperature for the last 14 days, as well as those for last year, and for the past 30 years); (b) soil temperatures (same format as daily temperature); (c) heating- and cooling-degree days (same format); and (d) growing-degree days (same format).

If district precipitation information was chosen from the first menu, the second menu presented offered (a) daily precipitation for the past 14 days; (b) monthly and annual precipitation; (c) soil moisture (most recent available); and (d) Palmer Drought Index information (from CAC).

The system also offered information on agricultural pests which were currently known to be, or suspected to be, active in the state when agricultural data and information are specified. For example, the presence of the corn borer was summarized throughout the 1984 season for the state. Critical concentration of borers was noted and control suggestions were offered.

The largest number of choices were offered under the second main menu, the statewide menu. It included maps of Illinois showing the distribution of temperature or precipitation for the current month to date, last month, the last 7 days, yesterday's rain (and snow in season) and maximum and minimum temperature. Frost depth presented in the cold season, and heating- or cooling-degree days summed for the current season. The 30- and 90-day outlooks prepared by the Climate Analysis Center were presented in narrative form, and appear as one of the choices on this menu, as does a statewide review of the previous week's temperature, precipitation and severe weather. This narrative summary was prepared each Monday, primarily for use by the Illinois Crop Reporting Service. The weekly, monthly, and seasonal precipitation outlooks generated by the Survey's techniques were also available.

Each give the user the opportunity to make a comment on the system by merely typing a message, either specifically addressed to an individual or to the system in general. We found these comments to be helpful in that they pointed errors in current data bases; suggested a specific change to make the data more useable; or prompted us to restudy a data base and perhaps offer a different integration time or format of presentation.

The computer system, available to users via phone line, was put into service in late January 1984; however, potential user briefings continued through the next several months. As expected, the use of the system increased with

time as shown in Figures 2 and 3. Figure 2 exhibits the total number of calls per week. For the first eight weeks, between 10 and 20 calls per week were made to the system. After that time, the usage dramatically increased until about mid-May (about 90 calls per week), during July, but increased 80 to 100 calls per week in latter August. The decline in number of calls during June and July is supported by the hours per week of CLASS usage (Fig. 3). Interestingly the total products requested per week (Fig. 4) did not decline substantially, but remainded rather even during June and July. This suggests that there were fewer users (from earlier values) but each requested more products than earlier, but because of their increasing familiarity with the system, accomplished this in less time than earlier. Calls declined to about 30 to 40 per week. Figure 3 shows the total number of hours per week that CLASS was in use for data or information requests, either by Water Survey personnel or by outside users. Usage during the first eight weeks averaged between 2 and 4 hours. Time dramatically increased to about 13 hours by mid-May, decreasing to between 4 and 6 hours in June and July, (as with number of products requested, Fig. 4), and increased to 450 to 500 products per week in late August.

Further analysis of the phone calls from the end of February through mid-April clearly shows that although the number of calls varied considerably from week to week, the mean duration of calls (not shown) increased with time, suggesting that users became acquainted with the various climate products available on CLASS, and after initial usage, more quickly requested their data of interest.

3. Users of CLASS

After the CLASS system had been operational for 7 months (February-August 1984), the number of users had grown to about 130. About 40 of these were one-time users, either having signed on for the first time in the middle or end of August, or had signed on earlier but had apparently found little of interest. Some of these may return to the system again next growing season, being primarily interested in pest advisories and time specific agricultural data. The affiliations of the principal users, as of 31 August 1984, are shown in Table 3.

In order to determine how the users evaluated, and perceived the value of CLASS at the end of 7 months of operation, a telephone survey of the most frequent users was conducted. Phone calls were made between 1 August and 10 October 1984. A standardized questionnaire, consisting of 13 questions, was composed with contributions from Charles Guse and Paul Risser of the Illinois State Natural History Survey, Steven Sonka of the University of Illinois Agricultural Economics Department, and the authors of this report. The topic of the questions is broader than would be expected for this project because we were able to query users concerning their need for the Climate and Pests Service as well as that related to CLASS. The questions were designed to identify the strong and weak characteristics of CLASS, as well as to define the real and perceived values of the system by the various users.

4. Results of Telephone Survey of Users

The affiliations of surveyed individuals are shown on Table 3, as well as the affiliations of all authorized users. Table 4 shows the user categories for 5 state climate centers published within the last few years for comparison to CLASS. Dissemination from the state climate centers was accomplished by phone, letter, and personal contact, whereas that of CLASS was by electronic means, and for real time data. Therefore the results may not be directly comparable. Private business and agriculture comprise the largest components of users in all states except Arizona and Illinois. The minimal agricultural interest in Arizona is understandable due to the small agricultural component in the state. Many of the "media" requests (see Table 4) in Illinois are known to be of agricultural concern. Government agencies generally comprise about 15% of the total users and university researchers from 10 to about 25%.

Most of those contacted by a phone survey had had prior computer experience, although even those without prior experience claimed to have little or no difficulty using CLASS.

The first question of the Survey was: "Did you receive climate information prior to the existence to CLASS? If so, did you incur a cost for this service?" Thirteen respondents (37%) had not received climate information prior to their contact with CLASS; whereas 22 (63%) had received such information. Of the latter, 9 had received "Illinois Weather & Crops" from the Illinois Crop Reporting Service or the "Weekly Weather and Crop Bulletin" prepared by USDA, both received by mail. Four of the respondents had access either to data from the Midwest Agricultural Weather Service at Purdue University, or maintained their own teletype or facsimile facilities. These few individuals were consulting meteorologists or individuals who are in the business of providing marketing advice. Two of the positive responders had received the weekly summaries prepared by the National Weather Service office at O'Hare Airport, and one seed company had subscribed to one of the meteorological data services commercially available.

The second question was worded: "Do you have an alternative means to obtain the information which is currently offered on CLASS? If so, why do you use CLASS?" The responses to this question were virtually identical to the distribution of answers to the first question, i.e.., most users would again rely on-the mailed bulletins prepared by the Illinois Crop Reporting Service, and a few would subscribe to special data services available by teletype, facsimile or computer terminal. CLASS was chosen over the other possible data sources by these individuals for three primary reasons. First, the data were available much sooner after the time of observations; second, the data were at a density greater than any other source; and third what was deserved was available at the request of the user. CLASS was also preferred because it was at no cost to the user.

The third question: "How do you use the data you receive from CLASS?" was responded to in several different ways. The most frequent response (7 times) was that the data were for general interest or used for background material for newspaper or magazine articles, or for radio releases (indicated by 5 individuals). Four cooperative county extension agents primarily used CLASS data to respond to inquiries made to them by farmers, most often being precipitation and temperature information. A few of the respondents specifically,

Table 3. The affiliations of principal CLASS users as of 31 August 1984 and those who participated in telephone survey in August and September 1984.

	Total Users		Telephone Survey Participants	
	Number	Percent of Total	Number	Percent of Total
Private business, small:	20	(19.0%)	8	(16.7%)
Private business, large:	17	(16.2%)	8	(22.2%)
Farmers:	18	(17.1%)	8	(22.2%)
Cooperative extension agents:	21	(20.0%)	9	(25.0%)
Bank representative:	1	(0.9%)	1	(2.8%)
State government representative:	13	(12.4%)	3	(8.3%)
University researchers:	11	(10.6%)	1	(2.8%)
Federal government representative:	3	(2.9%)		---
High school agriculture teacher:	1	(0.9%)		---
	105		38	

Table 4. Percent of all users of data of CLASS by category during first 9 months of operation, and that of 5 state climate centers. Percents do not necessarily total to 100% due to differences in category choices.

	CLASS	Arizona (Brazel, 1981)	Iowa (Waite, 1981)	Oklahoma (Eddy, 1981)	Illinois (Changnon, 1979)	Colorado (McKee, 1983)
Private Business	35	16	25	12	10	47
Farmers	17		25			
Coop County Extension Agents	20					
State Government Representatives	12	16	20	10	2	8
Federal Government Representatives	3			7		10
University Staff	11	26	10	28	12	22
Media				7	71	7
Individuals		30		19		10

and of their own accord, listed Palmer Drought Index and the 30-day outlooks as being products of great interest. One respondent used CLASS to study its menu structure, as well as the arrangement of the data products. He used it to generate ideas for the development of a system under consideration in another state (Missouri). Two farmers and two consultants (individually) accumulated the data to develop a crop-yield model as a function of climate. Five farmers specifically indicated that the insect advisories prompted action on their parts, i.e., the population of insects in and around their counties prompted them to monitor populations on their farm and take appropriate action. Three farmers said that they used the climate information on CLASS to help their hedging decisions in the futures market. Many of the farmers using CLASS hedged their crops by means of the futures market and were sensitive to the fact that day-to-day prices fluctuate in response to recent precipitation and temperature, as well as the national and international economy. Two individuals from computer dealer companies used CLASS merely to demonstrate the availability of a data base to prospective buyers. They had essentially no interest in the information of CLASS itself, merely the unique system.

It should be recognized that the Illinois Crop Reporting Service, an agency of the Illinois Department of Agriculture and USDA, began gathering most of the climate information from CLASS for the weekly publication "Illinois Weather & Crops". It is distributed to 6500 users in Illinois. Products acquired included the narrative summary of the past 7 day temperature and precipitation, a map of Illinois showing the last 7 day precipitation, and a map of Illinois showing available soil moisture in the upper 2 meters of soil. The latter product alternated with a map of Illinois showing the distribution of accumulated growing degree days from 1 May to the present. A table showing accumulated precipitation and average temperature by crop reporting district for the state during the past seven days was also extracted from CLASS.

The Pioneer Seed Company used temperature, precipitation and degree day information from CLASS in the preparation of articles reviewing the agricultural scene in Illinois. Their newsletter was disseminated to about 20,000 recipients at no cost. Similarly, the publication Farm Week (published by Illinois Farm Bureau) used data available on CLASS as background information in the preparation of stories assessing the impact of current climate on agriculture in Illinois.

The fourth question "Should additional climatic parameters or indices be added to CLASS?", generated a wide variety of responses. Eleven users of the system responded in the negative, but by their own admission, had not given much thought to new product development. Nine (26%) asked for inclusions of data from states surrounding Illinois. This comment was reinforced by repetition. These proponents of regional real time data recognized that future crop prices, in part, respond to climate over the entire crop-producing region, not necessarily a political region.

Six individuals (17%) suggested developing a greater data density within Illinois. This comment particularly applies to poorly measured areas in the northeast, the west central and southwestern Illinois. Three individuals (9%) suggested that presentation of 24- to 72-hour forecasts would be helpful to their operation. Such information lies outside the objectives of CLASS, as now supported.

The remainder of the responses were suggested by one respondent only. A consultant suggested that daily updated degree days would be valuable. We agree, and expect to have degree days (growing-, heating-, and cooling-) updated on a daily basis the future. Another suggested that evaporation data would be valuable. Of the reporting stations in Illinois on CLASS, only Urbana has evaporation pan observations. In the absence of an evaporation model, we could only provide data for that one station. One individual each suggested that growing season precipitation and soil moisture should be presented in map format as well as a narrative, rather than tabular form in which it is presently available. This program change can be accomplished.

Geographic displays of various parameters were the most frequently requested products. It was suggested that the weekly climate outlooks currently prepared for four sections of Illinois by ISWS could also be presented in narrative form. One user suggested that NWS first order stations in and around Illinois ought to be included in our data base. We currently have no access to such data on a daily basis although hourly data could be obtained from the Midwest Agricultural Weather Service at Purdue after which daily maximum and minimum temperatures and total precipitation could be found. The writer from Prairie Farmer suggested that he would prefer soil moisture given in soil layers, rather than moisture contained within the total (2 m) layer. We will discuss the format of soil moisture data at the beginning of the 1985 growing season.

One consultant expressed an interest in hourly precipitation, but such data are not possible unless transmitted by phone to ISWS. One of the county extension agents expressed an interest in receiving estimates of drying conditions, particularly during the fall. In the absence of a model to calculate potential drying, we cannot fulfill such a request.

The fifth question: "How might you use these data in the future?" did not prompt a particularly useful array of responses. Twenty-four individuals responded that they would most likely continue to use the data as they had in the past. As found earlier, the users generally had little/no experience with information systems, and therefore had limited suggestions. The limited responses to this question suggest that our user group's needs were adequately assessed, at least for the present. Of the remainder of respondents, one farmer and one cooperative extension agent planned to use the pest advisories to a "greater degree" next year relative to this year. One seed company representative said they would be using soil temperature information to guide next spring's planting schedule, as did one farmer.

The sixth question: "Do you use NWS 30- and 90-day outlooks?" was negatively answered by 10 individuals (29%). Their use was limited primarily because of little perceived need, or because of little faith in the credibility of outlooks. Twenty-five (71%) responded positively, claiming that the information was of general interest and either was usable in planning long-range marketing strategies, or was necessary to them because they further disseminated the outlooks via radio or media articles. No one used the information in a quantitative fashion. This is not to say that long range outlooks are necessarily of little value, but that these users did not perceive a method whereby the temperature and precipitation outlooks could be used in any obvious way to help in their business decisions.

The seventh question: "Do you use the Palmer Drought Index (PDI) soil moisture information?" received 17 negative answers (50%); 7 who said that they requested it occasionally; and 13 (35%) responded that they followed it rather regularly. Those who expressed a positive response, used PDI to assess the impact of recent precipitation on soil moisture, to satisfy their general interest in the distribution of soil moisture at the present time, or used the PDI information in the preparation of news releases (county extension agent). The summer of 1984 included a very dry period in July and August which should have generated interest in the PDI.

The eighth question: "Do you obtain as much pest and weather information from a computer as you did calling an individual at the Natural History Survey?" received only 6 negative responses. Ten others also responded in the negative because they had not called anyone for this information prior to CLASS. A clear majority of respondents thought that the pest information available on CLASS was clear and as easy or easier to obtain and understand as that from an individual. There was some concern expressed by several individuals that CLASS pest advisories, at times, were not updated as frequently as they might have been, and that more timely advice was obtainable only by calling an individual at the Natural History Survey. Two writers (one who prepared written news releases, and another who prepared audio releases for radio) said that they would continue to use voice recordings from individuals because of the timeliness of that medium, and that particularly for radio releases, a voice recording was better than a statement prepared from data from CLASS.

Concerning changes that individuals would like to see in the CAPS/CLASS pest information (question 9), nine individuals (36%) requested more tree fruit crop pest information while 16 individuals (64%) expressed no interest in this information. Whereas 9 (36%) desired more small fruit crop pest information, 16 (64%) did not. Sixteen individuals (64%) would use more vegetable crop pest information, whereas nine (36%) expressed no interest. Fifteen individuals (60%) claimed interest for more ornamental tree and shrub pest information, and 10 did not (40%). Twenty-five individuals said that they would be interested in more forecasts of pest damage. There were no negative responses to that component of the question. Twenty-one (84%) expressed a desire for more information on pest sampling procedures, whereas four were not interested. Twenty-one (84%) were desirous of more information on pest control practices, whereas four were not. Twenty-one (88%) expressed interest in economic threshold information (3 negative response), and 18 (86%) expressed an interest in more information on pest life cycles (also 3 negative responses). Many of the negative responders said that they simply had no need for such information because of their present row crop enterprises.

It must be remembered that certain types of information should not be deleted from the system if only a few have need of it. There are instances when a particular product is sought or needed by only one or two users (in a limited sample), but those users depended upon that product for decision making, or in the preparation of information which they prepare for dissemination to others, e.g., the Illinois Crop Reporting Service and several cooperative extension agents.

Twenty-two individuals (96%) responded positively (with one negative respondent) to being desirous of surveys of general pest conditions throughout Illinois acquired by Extension Entomology (question 10). Twenty-one (88%)

were desirous of information from the surrounding states as well (3 negative responses). Ten users (50%) were interested in pest surveys from all of the United States, whereas ten expressed no interest.

Sixteen individuals (64%) did receive "Insect, Weed and Plant Disease Bulletin" from the Cooperative Extension Service (question 11) whereas eight did not, and one individual was uncertain. Thirteen of the users (81%) accessed CAPS information before they received the Bulletin, whereas two did not, and again one was uncertain. Thirteen thought that the information from the Bulletin should be included on CAPS, whereas three did not, and two were uncertain. Thirteen of the responders received "Home, Yard, and Garden Pest Newsletter" from the Cooperative Extension Service, whereas twelve did not. Seven responded positively and another seven negatively to the question as to whether CAPS should include the information of this Newsletter.

The twelfth question; "Are there other general types of natural resource data that would be useful?" received 20 negative responses (71%). Of those responding positively, two expressed an interest in having CLASS/CAPS containing information on the present crop conditions and state of crop development around the state of Illinois. One user suggested that the material of the weekly publication "Illinois Weather & Crops" of the Illinois Crop Reporting Service be included on CLASS. Although this information could probably be obtained from Illinois Crop Reporting Service, it does not fall within the purview of the present objectives of CLASS. One respondent expressed an interest in temperature and humidity forecasts for the next 24 to 48 hours to be used for spraying decisions. Another requested whether erosion potential information could be presented on the system for various soils, slopes, and aspects. As with some other requests, without a model in existence we are presently unable to prepare such a product. One individual expressed an interest in wind and solar observations from around the state. These parameters are currently measured at the 14 sites of the Illinois Climate Network, but these data are not available in digital form on a current basis because of delays in data reduction. One individual expressed an interest in the evaporation potential. Another expressed interest in percent possible sun observations. This information is available only from first order stations, the data of which are not currently available to the Water Survey. One respondent wondered whether we were able to estimate the area receiving various precipitation amounts during the previous 24 hours. With our present data density, such estimates would be crude indeed. Radar data could be a source if it were digitized and summed.

The 13th question: "Would you pay for access to a service such as CLASS? If so, how much?" received 26 firm (79%) positive responses, five (15%) responding probably positive, and only 2 clearly negative responses, one from a bank representative (farm manager), the other from a representative of a grain company. Only a few individuals opted to suggest charge rates, in most cases based upon their experience with other controlled data bases. Four individuals suggested that a charge of about $100 per year was appropriate for the system as is. Two suggested a charge of between $200 and $400 per year. Two individuals suggested $600 per year, whereas one individual suggested that the charge be based upon usage. Several individuals who suggested a CLASS subscription fee also suggested an additional charge for time used or products requested. Experience with the charge rates of other data systems and the

results of the above survey suggests that an annual charge between about $300 and $600 would be acceptable to commercial users.

5. Demand for CLASS Products

Weekly request demand for CLASS products is shown in Fig. 2, beginning with the week ending 17 February 1984. An increase in the number of calls through May is apparent, after which the weekly calls decrease, increasing again in late July. The mean use for the recent four months was about 50 hrs/wk. During these first few months of operation, use was greatly affected by the increasing number of users, their fsimilarity with the products, and the changing products themselves. Because of changes in the latter factors, little significance should be placed on the week-to-week changes. In addition, a telephone survey of users began in August, and some of the questions of that survey may have prompted users to "browse" the products, which may account for the increase during August in Figs. 1, 2, and 3.

Figure 3 shows the total number of hours per week that CLASS was in use, i.e., total time during which someone was requesting data and information from the on-line system. The trends are similar to those shown in Fig. 2. The average use of the recent 4 months was 8 to 9 hrs per week.

Figure 4 presents the number of products requested per week. The upper curve shows the total number of requests, while the lower curve shows the number of pest (CAPS) requests. The longer scale trends of the 2 curves track each other. The number of weekly CAPS requests was about 10% of the total requests. The mean number of products requested during the last 4 months was 250-300 (CAPS being 25 to 30).

Table 5 shows the average weekly number of requests for each month (April-August, 1984) for each of the several products available on CLASS. Several conclusions are readily apparent from these data. First, of the 29 non-pest categories, all except three (heating degree days, and choices B and E of Water Resources) exhibited substantially greater use during August than during April or June, whichever was the first month in which those data were available on the system. The greatest growth was exhibited by the precipitation parameters, particularly precipitation that fell during the last 14 days, the monthly and annual precipitation, the current month to date, the last 7 days, the weekly summary, "yesterday's" precipitation and the seasonal and annual summary. Whereas requests for precipitation information increased by about a factor between 4 to 10, the increases in temperature data were all less than a factor of about 3.

The substantial increases in requests during August may be due to the dry conditions or to the telephone survey of users which we began in August. In the process of those telephone interviews, the broad categories of CLASS data were reviewed at least once with each of the users, and it is possible that this review prompted some of the users to preview the various products available which they may have forgotten, or perhaps never had seen before.

It is interesting to note that the number of "help" requests for all categories also increased dramatically in August (48.5 requests per week) as opposed to earlier months (a maximum of 29.2 requests per week in June). This increase suggests that the users of CLASS were still not fully aware of all of

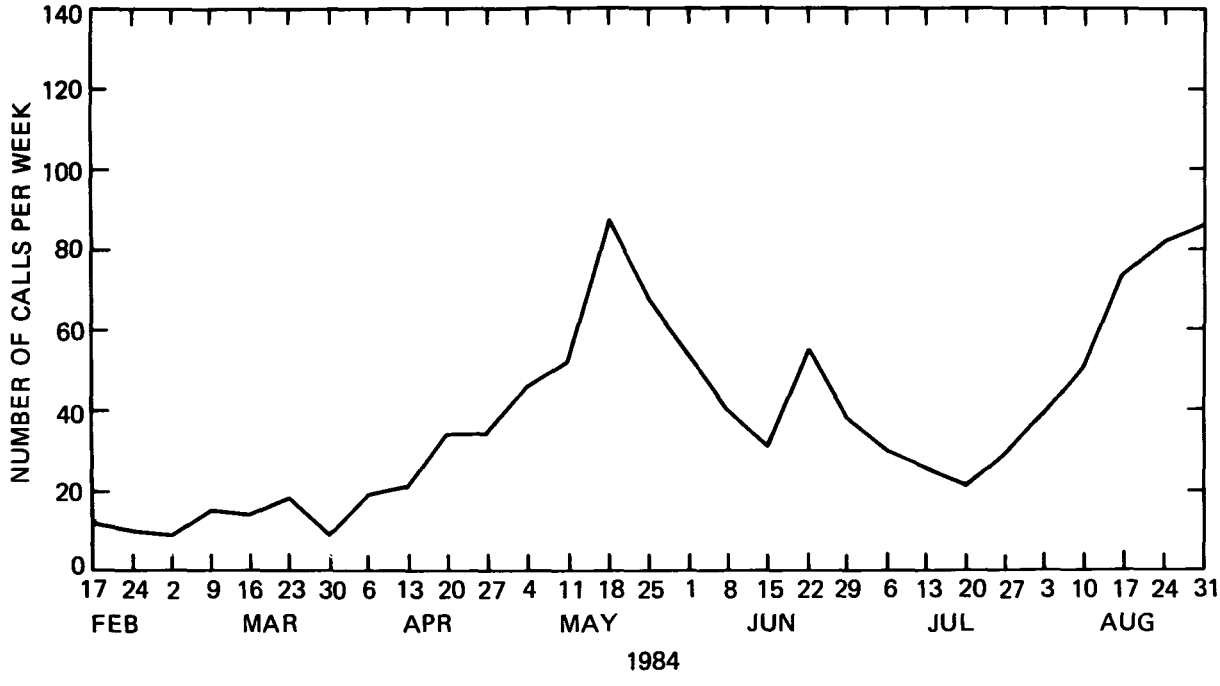

Fig. 2. Number of phone calls per week to CLASS to request data and information

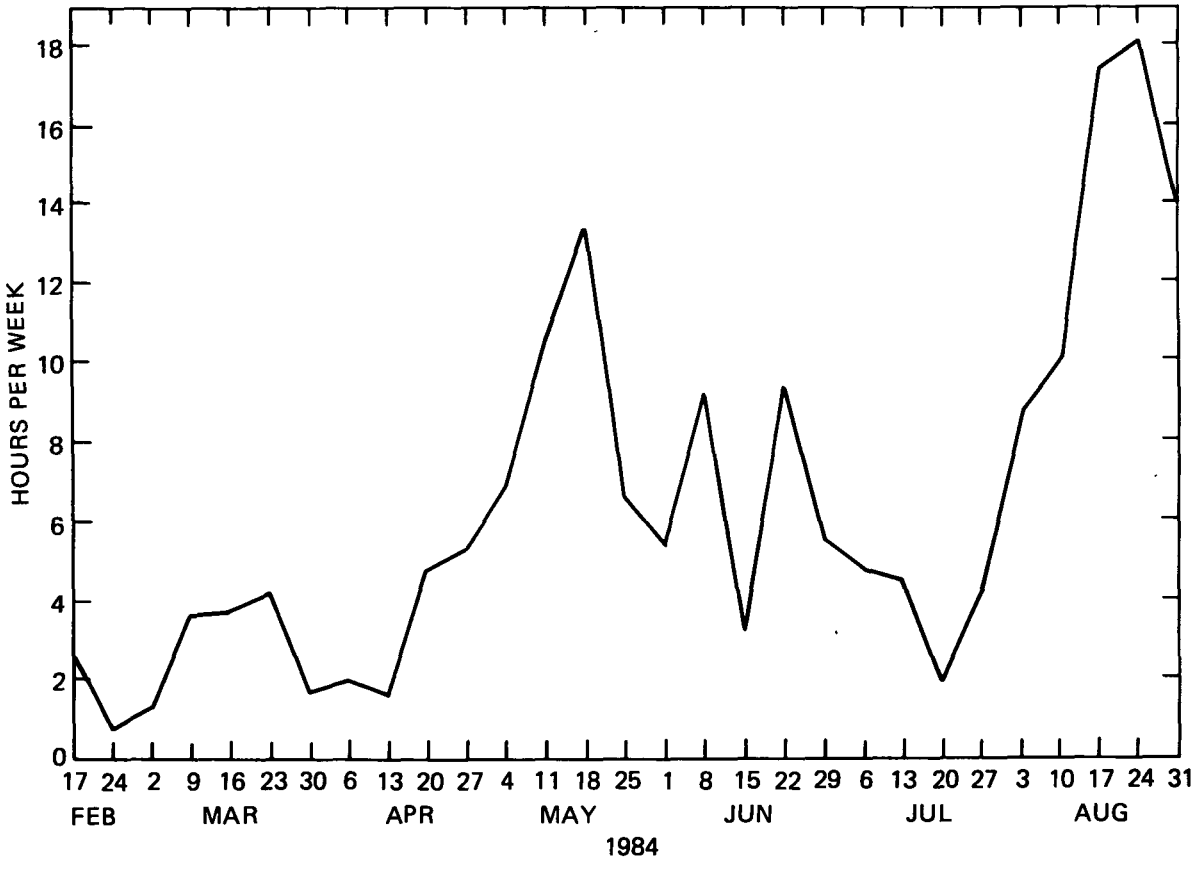

Fig. 3. Number of hours per week that CLASS was being used for data or information retrieval via phone line.

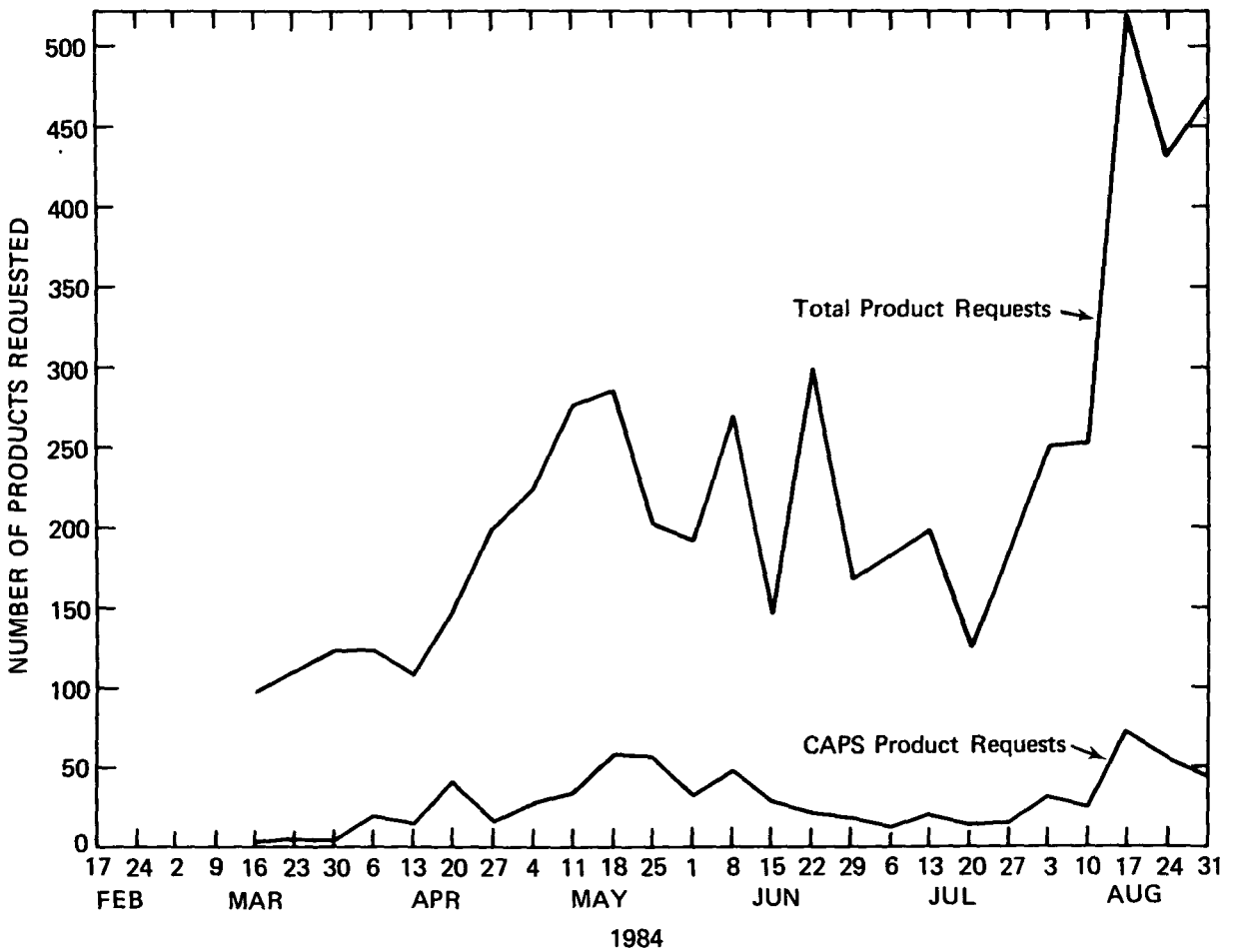

Fig. 4. Number of all products per week requested of CLASS (upper curve), and number of pest advisory requests per week (lower curve)

Table 5. Mean number (per week) of requests of various CLASS products by month.

	April	May	June	July	August
Forecast Info					
30- & 90-day (CAC)	5.5	7.6	7.5	7.0	12.8
Weekly (SWS)	10.0	11.8	14.6	13.4	28.0
Precipitation					
Last 14 days	4.0	10.8	8.3	9.4	24.3
Monthly & annual	3.0	2.5	3.8	4.2	22.5
Current month to date (map)	3.3	5.5	7.2	12.6	19.0
Last month (map)	1.3	2.0	2.4	5.2	6.3
Last 7 days (map)	3.5	7.5	7.6	12.6	15.5
Weekly summary	---	1.8	3.2	5.8	10.8
Yesterday	3.5	5.5	7.0	11.6	17.5
Seasonal annual	0.8	2.3	2.2	4.8	9.0
Temperature					
Last 14 days (map)	6.8	7.8	10.2	4.8	17.3
HDD & CDD (maps)	3.8	0.8	2.6	1.6	4.8
Current month to date (map)	3.5	3.3	5.4	4.6	10.0
Last month (map)	1.5	2.5	0.8	3.4	3.3
Last 7 days (map)	3.3	6.8	5.4	2.6	7.5
Yesterday hi/lo	7.3	2.5	7.0	5.4	12.5
Heating Degree Days	3.5	5.5	4.4	2.2	2.8
Cooling Degree Days	---	---	2.4	1.0	3.3

Table 5 (cont). Mean number (per week) of requests of various CLASS products.

	April	May	June	July	August
Agricultural Info					
Soil temperature	4.8	8.0	4.4	1.8	6.3
Growing degree days	3.3	27.8	4.8	4.0	7.5
Soil moisture	6.5	3.5	4.4	5.0	11.5
Station					
Info & names	4.3	2.5	3.6	5.0	10.5
Data transfer	3.5	10.3	9.0	3.0	14.3
Help					
All categories	20.3	24.5	29.2	16.6	48.5
Water Resources					
Lake & reservior summary	2.3	0.3	2.0	1.8	3.3
Peak river stages	1.8	1.0	0.4	0.6	1.5-
Mean river flow	0.5	0.8	0.8	0.4	1.0
Shallow groundwater levels	3.3	1.0	3.0	3.0	1.6
Current river stages	3.3	0.8	1.6	0.2	2.3-
Pest Advisories					
General statement, pest conditions	11.3	11.5	12.0	8.8	12.8
Bean leafhopper	6.5	15.2	11.3	0	5.3
Grasshopper	5.0	9.5	6.7	6.7	0.6
Wheat leaf rust	---	7.0	---	---	---
European cornborer	---	---	3.0	5.3	5.5
Spidermite	---	---	---	4.3	8.5
Corn rootworm	---	---	---	---	6.0
Comments to the System	3.3	7.0	4.2	2.8	10.0

the system components, and that a growth potential exists with the present users, in addition to that which may be generated by new users.

Outlook information (CAC- and ISWS-generated) was requested about as often as any other product (8 to 15 requests per week), except for 5 precipitation parameters and the general statement of statewide pest conditions (during August). In spite of the fact that this information was not quantitatively used, it was none the less desired.

Although about half of the users were farmers or individuals associated with agri-business, information on soil temperatures, growing degree-days and soil moisture was generally requested between 2 and 8 times each week (except for requests for growing degree days in May: 28), with little growth exhibited during the five months of operation.

The water resource information realized moderate growth during the 5 months, up to between 1 and 5 calls per week in August. These data were only updated monthly during these months, and were available in state newspapers as well, which may explain the relatively small demand.

The pest advisories typically realized continued growth during those months when active, with weekly demand being between 5 and 15 calls per week.

6. Use of CLASS by User Category

The hours of system use per week are shown in Table 6 by user category, and are summarized of the entire period of record in Table 7. About half the total time (45.4%) was used by farmers, and primarily during the 7 weeks from 13 July to 31 August 1984. Although the total use of the system grew rather regularly during that period (shown in Table 6), the growth in each of the categories was erratic, probably in response to user sensitivity to local problems of drought, temperature stress, or pest problem potential.

The second most frequent user by duration of calls were large private businesses (17.7%), followed by university researchers (9.9%) and service personnel. Cooperative county extension agents accounted for 9.4% of the total use, followed by state governmental agencies, small private businesses, all using 5% to 6.5% of the total time.

Though it may not be too meaningful at this stage of the CLASS system, average length of each call to the computer was about 12 minutes (calculated from the totals of Table 6). Longest duration calls were initiated by consultants and small private businesses (about 26 and 21 minutes per call, respectively) followed by about 15 minutes each from large private businesses, about 11 minutes from both farmers and university researchers, 9 minutes from cooperative extension agents, and about 8 minutes from representatives of state government.

As of 31 August, there were about 150 users on the system including State Water Survey and State Natural History Survey personnel, who both use the system to receive information as well as to input data and information. By 14 September 1984, the total users numbered about 175, with the greatest increase being farmers. By the end of October, users numbered in excess of 250. With the growth of micro computers within the farming community, and the growth among farm users in the last weeks of this use survey, it appears likely that a strong potential for continued growth exists among the Illinois farm

Table 6. Number of minutes of CLASS time used by user category for the week ending (month, year).

User Category	7/13	7/20	7/27	8/3	8/10	8/17	8/24	8/31
Farmers	353	99	387	118	185	508	486	160
Large private business	28	22	171	229	201	139	93	18
University personnel	--	35	192	20	63	15	107	72
Cooperative Extension Agents	31	14	74	69	61	111	55	61
State governmental agencies	43	6	7	36	21	76	85	57
Consultants	--	51	--	--	40	--	162	30
Small private business	--	--	--	--	7	134	40	107

Table 7. Time use of CLASS by categories during April through August 1984.

User Category	Total Time (minutes)	% of Total	Number of Calls	% of Total
Small private business	288	5.5%	14	4.9%
Large private business	901	17.7%	59	13.8%
Farmers	2307	45.4%	200	46.6%
Cooperative County Extension agents	476	9.4%	51	11.9%
State governmental agencies	331	6.5%	41	9.6%
University researchers	504	9.9%	46	10.7%
Consulting Meteorologists, Engineers and Agriculturalists	283	5.6%	11	2.6%

Total: 5083 minutes 429 calls

Mean duration of each call: 11.8 minutes

community. Although use of CLASS for agricultural purposes is expected to diminish during the winter months, we think it likely that total users during the growing season of 1985 will be greater than 350. The user research in 1985 will continue to monitor the use of a controlled number of users, however, there will be additions due to unforeseen circumstances. The number of calls would therefore grow from about 25 to 50 calls per week by the growing season of 1985, and if the average duration of the calls remains at about 11.8 minutes, the farm community would account for about 9.5 hours per week of CLASS time which represents about 24% of a 40 hour week, the hours during which most of the calls are received.

On 8 October 1984, the 800 phone number was reserved only for NWS cooperative observers to transmit observations to the system. CLASS users were given access to two toll phone numbers (two ports of the ALTOS computer). The impact of this additional cost to users is not possible to assess at this time because of the short duration of this new condition, and because this change was instituted at the end of the growing season, a time when calls are expected to decrease.

7. Summary and Conclusions

The establishment of Illinois CLASS represented a substantial step forward in providing near real-time climatic data and information to users in government and industry, and to private individuals. The incoming weather observations were screened and verified in a preliminary manner, although no spatial correlations with nearest neighbors were made, nor were erroneous data "corrected." The Illinois data network is sufficiently dense to allow preliminary estimates of parameter distribution in the state. The growth in use, and the increase in the spectrum of users in 1984 strongly suggests that near real-time climatic data and information are very useful.

The concept of an Illinois microcomputer-based climatic data acquisition and dissemination system evolved to proposal status in 1981. The proposed Illinois CLASS called for the establishment of a microcomputer system to both receive and disseminate near real-time climatic data. Observations were to be received via touch tone phone from National Weather Service Cooperative Observers located in the state, and from the Midwest Agricultural Weather Service station at Purdue University. Climatic normals (1951-80) for each of the 20 districts of Illinois were developed from the Water Survey data base.

CLASS served both service and research interests, although more products are service-oriented than research. CLASS provides maps, tables, and narratives which summarize the state of the climate as of the present time, or for the most recent one or two weeks, month, or growing season, etc. This information was made available to a limited audience having a terminal and modem. In addition, users could request a data transfer of daily observations of maximum and minimum temperature, and precipitation, thereby developing their own data base.

Incoming observations were screened while the observer is yet connected to determine whether temperature values are reasonable (e.g., $T_x > T_n$, etc.). If the temperature observations did not satisfy the test criteria, the voice synthesizer of the computer requested the data to be retransmitted. Immediately after each parameter was transmitted to the computer, the voice

synthesizer repeated the value, so that the observer could verify that the numbers were received as transmitted. These procedures eliminate most errors which may materialize in the digitization of data. However, these data are not of similar quality to those provided months later by NCDC, the latter having been subjected to more extensive quality control procedures.

Potential users of the system were identified within state government and federal government agencies (in Illinois), and within private businesses and individuals. The system was described to users at briefings in late 1983 and early 1984. At these briefings, products and potential products were demonstrated, and suggestions received as to how products might be improved for more immediate application. After the initial briefings, word of mouth carried information about CLASS to a wide variety of users, including individual farmers, consulting engineers and meteorologists, university researchers, and farm managers.

Individuals and agencies with farm and agribusiness interests represented 43% of the total users, cooperative extension agents represented another 20%, and representatives from state and federal governmental offices another 15%. As of early fall 1984, the system received between 60 and 80 calls per week, each with an average duration of about 12 minutes. The system fulfilled requests from users from 10 to 18 hours per week, and between 300 and 500 products were viewed by users per week.

The system received strong support from the limited body of regular users. Indeed, most commercial users claim that the data and information now contained on CLASS is of sufficient value to their operation that they would pay an annual subscription rate of several hundred dollars. Farm magazine writers and editors and county cooperative extension agents generally use the data and information of CLASS in the preparation of articles which they disseminate further to the public. Similarly, the Illinois Crop Reporting Service uses several products of CLASS for inclusion in their weeklky publication entitled "Illinois Heather & Crops." Farmers monitor recent precipitation, and (secondarily) temperature, to assist in cultivation, fertilizer and spray applications, and irrigation decisions.

Of the more than 250 "pages" of information available on CLASS, most requests received for precipitation were for (a) the current month to-date, (b) the last 14 days, (c) the last 7 days, and (d) for yesterday. The most for temperature were for (a) the last 14 days, (b) for the current month to date, and (c) for yesterday. Many requests were for soil moisture observations; station location and data transfer information; and pest conditions.

Individual farmers constituted about 45% of the total time demand to the system, followed by large private businesses (18%), university researchers (10%), county cooperative extension agents (9%), state governmental representatives (7%), consultants (6%), and small private businesses (6%).

Acknowledgements

The successful completion of this project required the input of a number of individuals. Without the commitment and devotion of the National Weather Service Cooperative Observers who participate in this program, CLASS would not exist. Their willingness to transmit temperature and precipitation

observations on a daily basis enables CLASS to function. Their continuing service to the Illinois State Water Survey and to CLASS is greatfully acknowledged and appreciated.

The financial support required for the development and maintenance of CLASS was greater than that available from this grant. Partial financial support was realized from the State of Illinois for the development and preparation of weekly and monthly temperature and precipitation outlooks for Illinois. The conditional probability outlooks were developed and are routinely prepared under the direction of Robert Scott and John L. Vogel. John Vogel provided considerable assistance to the project.

All decisions relating to (a) procurement of equipment, (b) development of virtually all of the software to enable the microcomputer to receive, verify and automatically incorporate new observations into the existing data base, (c) preparation of geographic maps and tables displaying the various parameters, (d) development of a method to account for all requests, and summarize product use were accomplished under the expert guidance of David Brunkow, with contributions from Carl Lonnquist.

The development and updating of current pest advisories was coordinated by Charles Guse, Illinois State Natural History Survey. Paul Risser offered useful comments on the system and the user assessment.

Data routinely gathered from the Midwest Agricultural Weather Center at Purdue University and the Climate Analysis Center (NOAA) were routinely accomplished by Marsha Conover. She and Rebecca Runge typed the draft and final copy of this report, and much of the correspondence required for the implementation of Illinois CLASS. The figures were prepared by Linda Riggin.

The authors offer their sincere thanks to each of the above persons for their contributions. Without any of their services, the project could not have reached its present state.

REFERENCES

Brazel, A., 1981: Unpublished manuscript.

Changnon, S. A., Jr., 1979: The Illinois Climate Center. Bull., Amer. Meteor. Soc, 60:1157-1164.

Changnon, S. A., Jr., 1985: Assessment of operationally-issued long-range outlooks for Illinois. Submitted to J. Clim. Appl. Meteor.

Cohen, S. J., and W. M. Wendland, 1979: Illinois State Agencies: Potential Users of Climate Information Provided by the Illinois State Water Survey. Champaign, M.S. 6 p.

Eddy, A., 1981: Unpublished manuscript.

McKee, T. B., and N. J. Doesken. 1983: Lessons from the Colorado Climate Center. In: National Climate Program Office, Washington, 125-144.

Pack, A. B., B. E. Dethier, and T. Schmidline, 1983: Northeast Regional Climate Program. In: Proceedings of the Conference on Cooperative Climate Services, National Climate Program Office, Washington, 115-123.

Waite, P., 1981: Unpublished manuscript.