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Semi-Annual Progress Report fo the Period of May 1, 1994 to October 31, 1994 (HPCC Report 94-6)

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HPCC Report 94-6

High Plains Climate Center

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EXECUTIVE SUMMARY

This report covers the major activities of the High Plains Climate Center (HPCC) during the period of operation from May 1 to October 31, 1994. Your attention is called to the following highlights.

HPCC data updates from NCDC are now received on Exobyte (8mm tapes). Advantages include the smaller physical size of the 8 mm tapes and their larger data capacity. All SOD data is now formatted for the HPCC archive.

Self-service data requests are on the order of 6,000 per year and involve more than 12,000 data bundles. Full service requests have been running from 20 to 60 per month. Use of the FTP file server on Internet is increasing. HPCC is developing a marketing plan that includes highlighting of the new interactive (both Internet and dial-up modem) system, which is targeted for release by May 1995.

HPCC has stepped up its activities with respect to energy. Staff have met with representatives from public power companies and visited with load forecasters to establish linkages in this sector. HPCC will participate in a wind energy monitoring activity this coming year. Other topics now in progress underscore the attempt to bring more diversity to the research program including studies of aquaculture, livestock feed intake, urban lawn water use, and climate trends.

An advisory committee has been established; it includes experts from such sectors as information technology, broadcasting, transportation, consulting, energy, engineering, and hydrology. State Climatologists from the region met while in Wisconsin for the annual meeting of the American Association of State Climatologists.

A lawn water needs product was completed and furnished to the Weather Channel for broadcast on Friday and Saturday of each week. Plans are to examine the skill of the forecasts this winter and make any possible improvements before it is reintroduced next spring.

INTRODUCTION AND BACKGROUND

The High Plains Climate Center (HPCC) was formed in 1987 by charter members in the states of Colorado, Iowa, Kansas, Nebraska, South Dakota, and Wyoming. North Dakota became a member of HPCC in 1988. Headquarters of the HPCC are located in the Department of Agricultural Meteorology at the University of Nebraska in Lincoln.

The mission of the HPCC is to increase the use and availability of climate data in the High Plains region. To accomplish this, the HPCC staff carry on a variety of activities involving data collection, applied research, education, and services. HPCC personnel work closely with scientists from other regional and federal climate centers on objectives of the national climate program. HPCC personnel also provide a linkage mechanism for federal, state, and private sector climate activities to help bridge the gap between climate research and climate applications in the United States.

Data collection. Near-real time data are collected from a special network of 120 comprehensive weather reporting stations in the region. This network has provided the basis for climate information products needed in decision making situations. For example, "How much water has the crop used since the irrigation three days ago?" and "How much water can be added to the factory evaporation pond?" are typical questions that can be addressed on a timely basis. This has important economic ramifications with benefit to cost ratios estimated at 500 to 1 and above.

Applied Research. Research has focused on the use of existing networks for monitoring drought impacts on various sectors. Yield projection models have been developed and are being placed on a new interactive system. Soil water status models have been developed for the region and HPCC personnel have participated in studies on leaf wetness and evapotranspiration in the region. Recently, research has been refocused on wind energy, urban water use, and aquaculture to diversify the nature of HPCC-supported studies.

Education. HPCC is helping to organize and cosponsor educational workshops in the region. Staff participated on the planning committee for the Global Change Video Conference for Informal Educators to be held at downlink locations across the nation on November 14-16, 1994. HPCC staff also participated in the planning of Long-Lead Seasonal Climate Forecasts out ot a year as applied in the High Plains, a workshop to be held in Lincoln on November 29-30, 1994. Activities include making local arrangements, preparing presentations on applications of the new forecasts, and preparing demonstrations on how to access the new forecasts. In addition, HPCC provides outreach to clientele of the region on a variety of topics through timely news releases, radio and TV appearances, and public speaking.

DATA BASE DEVELOPMENT AND MANAGEMENT

The High Plains has a diverse climate ranging from subhumid along the eastern boundary to semiarid in the western half of the region. Justification for a climate data base lies in the fact that climate information is essential for management of resources in the region and for other decision-making opportunities. Decision making is a matter of choosing among alternatives in a given situation in an effort to produce an acceptable or desirable outcome. Often climate data is used to produce key information for the decision makers so that possible outcomes can be visualized and economic considerations can be addressed.

Long-term historical records. The large variability of climate on the Plains requires that long historical records be digitized as part of the historical data base so that probabilities and other statistical properties can be accurately assessed. HPCC has acquired the daily cooperative weather station data as well as the first-order weather station data for the region and updates this data annually in the computer archives. The most recent acquisition of data is the daily data for the Historical Climate Network for the U.S. The following formats are obtained from the National Climatic Data Center:

TD3200 Summary of the Day-Coop
TD3210 Summary of the Day-1st Order
TD3280 Surface Airways-Hourly

HPCC has updated the TD3200 data on Exobyte 8 mm tapes. HPCC is also implementing ClimProb, which requires extraction of the SOD data.

An updated CD-ROM for the streamflows (1874-1988) has been added to the HPCC collection. Other CD-ROM data sets include the ISMCS (ver. 2.0), WWD, National Climate Information Disk (vol. 4), NOAA National Environmental Watch, and Hydrosphere NCDC Hourly and Daily Data.

Near-real time comprehensive network. In addition to the long-term records, near-real time information is required to address decisions that hinge on recent weather conditions. HPCC has developed a regionwide network to collect hourly temperature, humidity, wind speed and direction, soil temperature, precipitation, and solar energy data. These variables are needed to address energy and water balance questions that come into play in water-related decisions like irrigation scheduling. HPCC's network of automated stations has been expanded to 120 in nine states. North Dakota is proposing to sugar beet growers that more stations be added in the main cropping areas of that state. Several weather stations are being moved to avoid conflicts with planned land use (e.g., new tree plantings or new irrigation).

OPERATIONS AND SERVICES

Services are provided to interested parties through a variety of mechanisms. These mechanisms fall into two broad categories: self-service (computer accessible) and full service (personnel centered). In the area of full service requests, several actions have been taken. The one telephone number for data requests, (402) 472-6709, is now answered by Mathew Werner, Shellie Henneman, or Allen Dutcher. Shellie Jo Henneman has been hired to assist in preparation of materials for data requests and publication. In addition, she performs quality assurance tasks on the data collection system. Threee student workers, Heather Muir, Megan Salyards, and Dana Loewenstein were hired on a part-time basis to key-enter historical weather observations.

Full service activity. There are many contacts between HPCC staff and potential clients through the course of a month. These may involve answering a question or giving advice on what direction a climate-related issue should take. Brief interactions of this type when limited to conversation, whether by telephone or in person, are not tracked. When an information bundle is prepared and disseminated to a client, this action is tracked. These requests for full service require staff to run computer programs, create graphs or maps, or make copies of resource materials to satisfy the need. The time and effort associated with the preparation and delivery of each information packet ranges from part of an hour to several days. The number of full service requests is shown below in Table 1.

Table 1. The number of full service requests handled by the High Plains Climate Center.

Month	1992	1993	1994
January	25	18	43
February	15	37	21
March	23	43	40
April	26	56	25
May	21	49	28
June	19	74	54
July	20	110	57
August	23	87	56
September	16	53	44
October	23	63	
November	24	60	
December	23	50	

An analysis of the data for June through September indicate that the total requests come from the following sectors.

Sector	(%)	Sector	(%)
Agricul. & Forestry	6	Legal	16
Construction	4	Manufacturing	4
Consulting	8	Media	4
Education	6	Recreation	4
Energy	1	Retailing & Service	4
Engineering	4	Transportation	3
Government	24	Water Resources	5
Insurance	7	TOTAL	100

The full service requests are divided according to use of information as follows: operational planning 14%, long-range planning 57%, specific past event analysis 18%, research 6%, and personal interest 5%.

Self-Service Accesses. A system that automatically responds to data and information requests greatly expands our capability to serve users. The Weather Effects Analyzer for Tracking Heat, Evapotranspiration, and Rainfall (WEATHER) is the primary system through which users access weather and climate data electronically at the HPCC. In addition, users may bypass WEATHER and process their requests on our INTERNET file server. It is not possible to track the number of accesses on this file server. The state climatologists in cooperating states also operate dial-in computers from which many of our WEATHER products are redistributed. In addition, private companies also distribute HPCC products on their in-house networks. No formal tracking of the secondary dissemination has been achieved, but it is thought to multiply the original accesses by a large factor.

Although many of the alternate paths to the HPCC data and information products are not monitored to assess usage, the direct accesses to WEATHER are recorded. These accesses are shown below on a monthly basis.

Table 2. Total accesses and files downloaded from the WEATHER system on a monthly basis.

Accesses	1992	1993	1994
January		508	428
February		536	378
March		483	368
April		799	578
May		638	606
June	810	837	661
July	846	841	640
August	710	692	584
September	465	545	369
October	1364	441	
November	448	468	
December	485	396	
Files	**1992**	**1993**	**1994**
January		1595	790
February		1506	602
March		1332	543
April		3045	988
May		2087	1217
June	2602	3716	1931
July	2642	3398	1620
August	2112	2078	1376
September	1997	1353	809
October	1900	772	
November	1584	1144	
December	1131	706	

In the year ending May 30, 1994, there were more than 6,500 calls to the WEATHER system. For the year ending September 30, 1994, there were more than 5,900 calls to WEATHER and more than 12,500 data bundles were downloaded by users. This does not include access to the system by HPCC staff. A portion of the decrease in calls is thought to be attributable to the relatively benign weather of the past year, especially summer and fall. Another factor possibly responsible for part of the decline may be the number of users who have switched from dialing-up WEATHER to Internet access via our FTP file server. Although this leads to an increase in accesses through Internet, we cannot track the use of this access point at present. The new interactive system planned for May, 1995 will have more capabilities for tracking.

Other Activities. This summer a user's survey was mailed to all clients who used HPCC services in the past six months. An analysis of the responses is nearly finished and a report summarizing the survey is 75% complete. Preliminary findings include: most users are happy with the services that they have received; the RBBS needs to be more user-friendly; and users do not have much interest in new products. These findings are no surprise to HPCC. In fact, the new interactive system for the SUN is being designed as a friendly interface and will offer clients more documentation messages during their interactive sessions. Also, the lack of interest in new products is consistent with our previous experiences. Several factors are at work here. Clients, from their perspective, find it difficult to imagine new products and all the possible uses of these products. We have found that "if you build it, they will come" applies to the development and release of new products.

David Stooksbury hosted a visit to HPCC by Phil Clark and John Ball of the WSFO in Valley, NE. HPCC and departmental staff hosted the Wind Energy Display and Information Exchange at the Nebraska State Fair. David Stooksbury's other activities in wind energy were a presentation on Nebraska climate to the Nebraska Power Association on October 25, a radio tape on wind energy potential in Nebraska for IANR News on September 1, and a wind energy display at the Nebraska Public Power District Wholesalers Meeting on September 21.

The HPCC now routinely prepares a climate impact statement for release on AFOS. This statement is released on about the 15th of each month. Steve Meyer prepares a monthly climate impacts newsletter, which is sent out the tenth of each month to clients across the region.

HPCC is also preparing an annual summary of evapotranspiration for the High Plains region. The report for 1993 has been finalized and the 1994 report is currently being prepared.

The spring edition of TRIPOD, a newsletter for automated weather station managers, was mailed. This newsletter remains one of the few coordination mechanisms for a movement that is nationwide but independently developed by states and other sponsors.

Data for another year from the regional network has been requested by the GEWEX project as that study gets underway. GEWEX scientists will again perform quality assurance tests on the HPCC network data using a model/grid process.

The HPCC staff are working on the new SUN workstation with UNIX operating system. An effort is underway to develop an interactive system for dial-in users of climate data. Ken Hubbard, Jim Hines, and Soheil Ameri have developed a prototype menu system consistent with the uniform system concept. Menus dealing with NWS products are about 90 percent complete while menus dealing with historical climate data are about 20 percent complete. HPCC continues to work with staff from the other regional climate centers and the Climate Prediction Center in coordinating the development of this new system so that it builds on existing techniques and represents a standard or uniform RCC system.

APPLIED RESEARCH

HPCC monitored the progress of all funded projects in the region. The projects are listed below and the interim reports are attached in the appendix.

Data documentation project. S.J. Meyer and K.G. Hubbard.
A user-interactive approach to determining probabilities of climatic events. S.J. Meyer and K.G. Hubbard.
Soil water storage and plant water use efficiency in dryland agroecosystems. G.A. Peterson.
Use of climate data to evaluate key fish species for aquaculture development in the High Plains region. T.B. Kayes and K.G. Hubbard.
Evaluation and development in intake prediction and model for feedlot cattle. T.L. Mader, A. Parkhurst, G.L. Hahn, K.G. Hubbard, and D.E. Stooksbury.
Reactive management of surge irrigation using evapotranspiration data. G. Hoffman, D. Eisenhauer, J. Cahoon, and C.D. Yonts.
Research initiation and improvement funds for the High Plains Climate Center. K.G. Hubbard.

Other applied research studies to which HPCC staff dedicate time and effort but that do not derive major operating funds from the RCC budget are as follows.

ETp estimation and prediction by zone and city. Dr. Ken Hubbard worked with Ray Ban of the Weather Channel, Atlanta GA; John Pollack of the NWS, Omaha, NE; Glenn Hoffman, Biological Systems Engineering, University of Nebraska; the directors of the other regional climate centers; and others to produce a lawn water use product for use in weekly broadcasts. The possibility of furnishing information on ETp to the Weather Channel was discussed at the AMS meeting in Nashville in January, 1994. Subsequently, programs were written to produce maps for the Weather Channel. Interest in this product has been high. During the summer, the product aired two to three times per hour between 10 am CST Friday and 10 am CST Saturday. The product will be restarted in spring 1995. The directors have submitted an extended abstract on this study for the January AMS conference in Dallas, TX. Weather observations from around the nation are being collected at this time to estimate the lawn water use (after the fact) and to compare it with last season's predictions. This phase of the study should improve next year's product.

Soil temperature relation to air temperature. Dr. David Stooksbury is investigating the warm-up and cool-down of soil temperature at the 4 inch (10cm) depth as it relates to air temperature in the region. There is a need for a climatology of soil temperatures in the region, particularly for planting and chemical application decisions in the agricultural sector. This study will provide the basis for generating "pseudo" normal soil temperature for the region.

Time series analysis of annual climate extremes. Dr. David Stooksbury is studying the statistics of the time series of annual climate extremes using data from the HCN/D data set. This study can furnish baseline information on the variability of climate extremes across the region and contribute in the future to filling requests on such information. The initial study is nearing completion and an extended abstract has been submitted to the January 1995 AMS Applied Climatology Conference to be held in Dallas, TX.

Wetlands weather monitoring in support of water quality studies. Dr. Ken Hubbard, Mr. Jerry Schmidt, and Mr. Karl Blauvelt modified an automated weather station for use in a wetlands environment in 1993. A separate water quality datalogger/sensor package was integrated with the existing weather sensors. Communication with the station was by cellular phone. The study demonstrated the feasibility of monitoring parameters for evaporation and water quality at remote sites. This system is being considered for use in a global change study conducted by researchers at the University of Nebraska.

Soil temperature bibliography. David Stooksbury, with the help of Christopher Curtis (a student intern), prepared a soil temperature bibliography. A report on this information has been prepared and is now undergoing final review at the University of Nebraska.

Other proposals. Drs. David Stooksbury and Ken Hubbard submitted a proposal to the Nebraska Power Association to establish eight monitoring sites for monitoring the wind power of Nebraska. This proposal was partially funded. R. Lynnette and Associates will install and maintain the sites and HPCC will perform teleconnections and archive functions for the project.

Dr. Hubbard submitted a Project Earthlink proposal to the USDA Climate Change Program. This proposal has been funded and Lynn Mortensen is the project consultant, with primary responsibility for addressing the goals of the project.

Dr. Meyer submitted a 4-H proposal to the Nebraska Weather Related Youth Program. This proposal has been funded. Weather instruments were purchased and the elementary students will be trained to make measurements.

MANAGEMENT AND PROGRAM ACTIVITIES

Deborah Wood took the lead in developing a brochure to describe the activities of the HPCC. This brochure is now given to visitors and to participants at meetings by HPCC staff.

HPCC continues to work with NWS personnel from the Nebraska WSFO in Valley and from the Central Region Headquarters in Kansas City. Janice Bunting (Central Region Headquarters) helped to coordinate the dissemination of HPCC announcements to NWS personnel in the region. This resulted in participation by NWS personnel in plans for the Global Change Video Conference to be held October 14-16 in Lincoln and in the Long Lead Climate Forecasts workshop to be held October 29-30 in Lincoln. HPCC continues to work with various WSFO offices to furnish ClimProb software.

Outreach. The staff have participated in the following:

Allen Dutcher. Annual meeting NE Crop Consultants. Lincoln, NE. May 1994.
Steve Meyer. Combined 4th graders. Omaha, NE. May 1994.
Ken Hubbard. Feedlot researchers. Concord, NE. June 1994.
David Stooksbury. Feedlot researchers. Concord, NE. June 1994.
Steve Meyer. Expovision. Lincoln, NE. July 1994.
Steve Meyer. Lincoln area boy scouts. Lincoln, NE. July 1994.
David Stooksbury. NE State Fair. Lincoln, NE. August 1994.
Ken Hubbard. NE State Fair. Lincoln, NE. August 1994.
Steve Meyer. NE State Fair. Lincoln, NE. August 1994.
David Stooksbury. NE Public Power District Wholesalers Meeting. Lincoln, NE. September 1994.
Steve Meyer. Husker Harvest Days. Grand Island, NE. September 1994.
Steve Meyer. Wonderful World of Water. Pierce, NE. September 1994.
David Stooksbury. Nebraska Power Association. Lincoln, NE. October,
Steve Meyer. Nebraska Assoc. of Teachers of Science. Fremont, NE. October 1994.

HPCC response to site evaluation.

A site evaluation was conducted February 9-10, 1993. The review team was chaired by Stanley A. Changnon and included members Michael H. Glantz, Paul Janota, and James Zandlo. Robert Bermowitz represented the Climate Prediction Center.

A detailed plan for responding to recommendations of the site review team was prepared and submitted by Dr. Hubbard. Specific areas of progress are mentioned below.

The review team found ClimProb and WEATHER systems were not adequate to satisfy the functions of an interactive system. As a result the HPCC has purchased a SUN workstation and initiated the development of a dial-up interactive system that, in so far as possible, is compatible with the interactive systems now operated by other RCCs. Ken Hubbard worked with Ken Kunkel to develop uniformity standards, which the other directors approved. Much of the work to develop the interactive system at HPCC has been accomplished. The data base design, menuing, and pull-down options are nearly complete. The next phase will be the conversion of existing software to support the various menu options. The target date for release of the new system is May 1995.

An advisory committee has been formed by the HPCC as recommended by the site-review. Members have a wide area of expertise including members whose primary emphasis is in information technology, broadcasting, transportation, agricultural weather, energy, engineering, and hydrology. The new committee is composed of:

Bryce Anderson, DTN, Omaha, NE
Eric Brown, KRVN, Lexington, NE
Joe Kelly, Surface Systems Inc., St. Louis, MO.
Don Day, AgriWeather, Inc., Cheyenne, WY.
Scott Loeske, Nebraska Public Power, Columbus, NE.
Rodney Nohr, Nohr Engineering Co., Yankton, SD.
Anne Bleed, Dept. Water Resources, Lincoln, NE.

HPCC has also attempted to increase interactions with SCs in the region. A meeting of SCs from the High Plains region was held in conjunction with the Annual Meeting of SCs in Madison, WI. This meeting was chaired by Allen Dutcher and was well attended. One action item is the future of real-time quality control in the region and how HPCC can use its data archive to produce QC summaries for the participating state climatologists. Another issue identified was the need to conduct a workshop on maintenance and calibration of sensors. In addition, HPCC arranged with the Colorado State Climatologist for Mr. Nolan Doesken to represent HPCC at the recent Snow Conference in Minneapolis.

Major marketing efforts are on hold until the interactive system is ready for public access. HPCC has listed information for an entry in the Information Industry Directory, Gale Research Inc.

With respect to the space problem identified by the review team, Dr. Hubbard participated in a proposal to remodel the basement of Chase Hall so that space for climate and computer research areas can be consolidated. Initial indications from NSF are favorable.

In response to the call for a wider breadth of research, HPCC has funded or acquired funds for several projects that are outside the traditional focus of agriculture. For instance, the projects on aquaculture, weather and cattle rations, wind energy, urban lawn water use, and climate change indicate the wider spectrum now established for the research program.

PROFESSIONAL MEETINGS

Ken Hubbard. Western Regional Drought Conference. Portland, OR. May 1994.

Nolen Doesken. Workshop on Snow Data. Richfield, MN. May 1994.

Allen Dutcher. Annual SC Meeting. Madison, WI. July 1994.

Steve Meyer. Annual SC Meeting. Madison, WI. July 1994.

Ken Hubbard. National Turf Grass Conference. Lincoln, NE. August 1994.

David Stooksbury. Seasonal Forecast Training Meeting. Camp Springs, MD. August 1994.

Steve Meyer. Seasonal Forecast Training Meeting. Camp Springs, MD. August 1994.

Ken Hubbard. Seasonal Forecast Training Meeting. Camp Springs, MD. August 1994.

Steve Meyer. Groundwater Association Workshop. Nebraska City, NE. August 1994.

Ken Hubbard. NC-94 Regional Climate Committee. Champaign, IL. October 1994.

STAFF OF THE HIGH PLAINS CLIMATE CENTER

The following is a brief summary of staff and their responsibilities.

Kenneth G. Hubbard, PhD. Director. 1987. Dr. Hubbard is responsible for administration of applied climate research; coordination of HPCC activities with other RCCs, and federal and state agencies; and general supervision of personnel engaged in research and service activities of the center. Ken has primary responsibility for education programs of HPCC and for coordinating HPCC member and advisory committees. His research interests are in monitoring and modeling the environment.

Steven J. Meyer, PhD. Regional Climatologist. 1993. Responsible for developing climate-related applications tools and for conducting climate studies that may lead to such application tools or products. Steve is responsible for the ClimProb software and writes the climate impacts newsletter. His research interests are in crop specific drought monitoring and assessment. Steve's appointment also includes 50% extension for the Department of Agricultural Meteorology and Climatology.

David E. Stooksbury, PhD. Regional Climatologist. 1993. Dr. Stooksbury is general editor of the TRIPOD newsletter. He also coordinates McIDIS activities for HPCC and is heading up the team working on marketing. David is responsible for developing climate-related applications tools and products and for conducting studies that lead to such application tools and products. His research interests are in relationships among climate variables and between climate variables and variables in various other sectors, including agriculture.

Lynn L. Mortensen, PhD. Educator (Consultant). 1994. Dr. Mortensen is responsible for the Project Earthlink activities in the High Plains region. She will organize workshops and educational training meetings in the region, focusing on the role of global change on climate-related activities.

Allen L. Dutcher, M.S. Climatologist. 1989. Mr. Dutcher is responsible for coordinating activities with the state climatologists in the region. Al is responsible for preparing reports and special summaries that are required by the center. His work also includes keeping all files on the dial-up system current as well as monitoring the demand on computer data products. Al supervises the staff performing climate services and provides public consultation.

James R. Hines, B.S. Computer Systems Analyst. 1987. Mr. Hines is responsible for designing data management and data handling software and the computer systems that are required to handle the data archives. He is the senior computer consultant for the center and provides computer support for all HPCC personnel in regard to hardware and software issues.

Jerome J. Schmidt, B.S. Research Technologist. 1987. Mr. Schmidt is responsible for the

daily operations of a network of automated weather stations in the High Plains, coordinating maintenance and quality control issues with member states, and developing and nurturing linkages between HPCC and users of automated environmental monitoring systems in the region.

Deborah Wood, M.A. Editorial Assistant. 1987. Ms. Wood participates, as needed in quality control (QC) of HPCC data, but her main responsibility is technical editing. She does general editing of articles and reports prepared by the center and is the editor of TRIPOD, a newsletter published twice annually for persons and organizations interested in the aspects of automated weather data collection. In addition to her responsibilities with HPCC, Deb has 75% appointment in the International Drought Information Center.

Mathew D. Werner, M.P.A. Climate Data Specialist. 1987. Mr. Werner consults with users of climate resource information. Mat is responsible for telephone and mail requests for climate data and services and for placing the orders for data with NCDC. He coordinates the invoices for services performed and the certification of climate data.

Lorene Reinert. Accountant. 1987. Mrs. Reinert is responsible for accounting on High Plains Climate Center projects. Lorene prepares purchase orders and makes payment as well as collecting receipts. She also is responsible for all paperwork necessary for personnel and payroll and prepares a monthly summary budget for all projects.

Karl E. Blauvelt, AAS. Electronics Technician. 1989. Mr. Blauvelt is responsible for electronic support on all HPCC projects, including remote sites, communications linkages, and local operations. He is responsible for maintenance and calibration of various components in the climate network and data collection system.

Shellie Henneman. 1994. Shellie's position is clerical assistant and she works under the general supervision of Allen Dutcher. Among her duties are QC monitoring of the incoming data, assistance in preparation of data requests, filing, and retrieval of climate information.

PUBLICATIONS

An updated publications list is enclosed with this report as an attachment in the appendices.

APPENDICES

1. High Plains Climate Center publications list
2. Interim research updates

A COMPILATION OF PUBLICATIONS

by staff of the

HIGH PLAINS CLIMATE CENTER

1987 THROUGH OCTOBER 1994

Journal Articles

Neild, R.E., D.A. Wilhite, and K.G. Hubbard. 1987. Preseason precipitation probabilities as an aid to corn planting decisions. Agric. Forest Meteorol. 41:259-266.

Aceves-Navarro, L.A., K.G. Hubbard, and J.J. Schmidt. 1988. Group calibration of silicon cell pyranometers for use in an automated network. J. Atmos. Oceanic Tech. 5:875-879.

Hubbard, K.G., A. Bauer, B.L. Blad, J.L. Hatfield, E.T. Kanemasu, D.J. Major, R.J. Reginato, and S.B. Verma. 1988. Monitoring weather at five winter wheat experimental field sites. Agric. Forest Meteorol. 44:117-130.

Meyer, S.J., K.G. Hubbard, and D.A. Wilhite. 1988. Improving projected potential evapotranspiration estimates using National Weather Service forecasts. J. Appl. Meteorol. 44:105-116.

Meyer, S.J., K.G. Hubbard, and D.A. Wilhite. 1989. Estimating potential evapotranspiration: The effect of random and systematic errors. Agric. Forest Meteorol. 46:285-296.

Changnon, S.A., P. Lamb, and K.G. Hubbard. 1990. Regional climate centers: New institutions for climate services and climate-impact research. Bull. Amer. Meteorol. Soc. 71:527-537.

Robinson, J.M. and K.G. Hubbard. 1990. Soil water assessment model for several crops in the High Plains. Agron. J. 82:1141-1148.

Meyer, S.J., K.G. Hubbard, and D.A. Wilhite. 1991. The relationship of climatic indices and variables to corn (maize) yields: A principal components analysis. Agric. and Forest Meteorol. 55:59-84.

Hubbard, K. G. 1992. Climatic factors that limit daily evapotranspiration in sorghum. Climate Research 2:73-80.

Meyer, S.J. and K.G. Hubbard. 1992. Nonfederal automated weather stations and networks in the United States and Canada: A preliminary survey. Bull. Amer. Meteorol. Soc. 73:449-457.

Meyer, S.J., K.G. Hubbard, and D.A. Wilhite. 1993. A crop-specific drought index for corn. I. Model development and validation. Agron. J. 85:(2)388-395.

Meyer, S.J., K.G. Hubbard, and D.A. Wilhite. 1993. A crop-specific drought index for corn. II. Applications in drought monitoring and assessment. Agron. J. 85:(2)396-399.

Hubbard, K.G. 1994. Spatial variability of daily weather variables in the High Plains of the USA. Agric. and Forest Meteorol. 68: 29-41.

Hubbard, K. G. and F. Flores-Mendoza. 1994. Relating U.S. crop land-use to natural resources and climate change. J. Climate. (in press)

Stooksbury, D.E. and P.J. Michaels. 1994. Climate change and large-area corn yield in the southeastern U.S. Agron. J. (in press).

Deshpande, R.Y., K.G. Hubbard, D.P. Coyne, J.R. Steadman and A.M. Parkhurst. 1994. Estimating leaf wetness in dry bean canopies as a prerequisite to evaluating white mold disease. Agron. J. (in review).

Camargo, M.P. and K.G. Hubbard. 1994. Components of a daily water balance for a sorghum crop under different irrigation treatments. Bragantia. (in press)

Camargo, M.P., K.G. Hubbard, F. Flores-Mendoza. 1994. Determination of drought sensitivity indices for a sorghum crop under different irrigation treatments. Agric. and Forest Meteorol. (submitted)

Koester, R.J. and D.E. Stooksbury. 1994. Behavioral profile of possible Alzheimer's disease patients in Virginia search and rescue incidents. J. Wilderness Med. (in press).

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Progress Report from the High Plains Climate Center

Data Documentation Project

Kenneth G. Hubbard and Steven J. Meyer

October 31, 1994

An effort was undertaken to document the data sets that are available at the High Plains Climate Center. The results of this documentation have been placed in the Directory Interchange Format and forwarded to Gerry Barton for use in NOAA's Environmental Services Data Directory.

We are currently evaluating the need to expand data documentation for the region (e.g., other state archives) for the work plan of the coming year.

Progress Report from the High Plains Climate Center

A User-Interactive Approach to Determining Probabilities of Climatic Events

Steven J. Meyer and Kenneth G. Hubbard

HPCC staff are working to develop an on-line, user interactive system that will operate on the new SUN workstation. In the meantime, users self-service needs are met by the WEATHER RBBS and climatological needs are met by full service requests of staff or by use of ClimProb. Version 3.1 of ClimProb was completed during the summer of 1994 and application has been made for copyright. The latest version includes 17 temperature options, 6 precipitation options, and 8 degree day options. There are now 596 data sets covering 41 states for use with ClimProb. Nearly all data sets contain at least 60 years of historical climate data, with some stations dating back to the 1890s. The software is used in research, extension, and education in addition to service applications.

Progress continues on the interface for the on-line, user-interactive system. TeamMate is the software that has been selected as the backbone of this system. Soheil Ameri, a programmer of the HPCC, was sent to TeamMate headquarters in Redondo Beach, CA for advanced training on the use of TeamMate. TeamMate's role in the interactive system is to provide the menus and communications required by users. Prototype menus are available for the complete system and most "pass through" NWS products that will be supported on the new system have been activated. Some features of TeamMate are:

- interface supports Internet and dial-up connection
- software license allows distribution of graphics package to users
- hot keys are available for activating station selection or system autopilot

HPCC has make considerable progress on the development of the data base on the SUN workstation. The data base structure will be random access with a pointer system taken from the DOS version of AWDN with expanded capability to store all NWS flags. All data for AWDN, SOD, and SA will be kept on-line on the SUN. Jim Hines and Ken Hubbard put together the data management package.

The next step is software conversion to support the interactive features of the system.

INTERIM REPORT

to the

High Plains Climate Center

on the project

Soil Moisture Monitoring Study

Period Covered: September 1993 to October 1994

prepared by

Gary A. Peterson

Principal Investigator
Colorado State University
Fort Collins, CO 80523

October 18, 1994

Introduction

Soil moisture is one of the most critical environmental variables affecting agricultural production in the Great Plains. Timing and amount of precipitation obviously affect it, but equally important is the developmental stage of the crop and the physical characteristics of the soil. This study is part of a continuing effort to monitor the soil moisture status of the region in near-real time.

The objective of this project is to assess the affects of topography on soil water storage and its ultimate effect on crop water use efficiency across a climate gradient.

The Dryland Agroecosystem Project maintains three major sites in eastern Colorado, which have the same annual precipitation, 16-17 inches/year, but increase in potential evapotranspiration from north to south. The open pan evaporation data from nearby long-term station records ranges from 42 inches/year near Sterling (Northeast)to 75 inches per year near Walsh (Southeast). This gradient allows interesting comparisons of rainfall effectiveness as related to plant development and biomass yield (grain + stover). Each site consists of a soil catena with a level upland summit position to a sideslope, and finally to a toeslope position that catches runoff water during large storm events. Crop rotations with combinations of wheat, corn, grain sorghum, proso millet, and fallow have been installed across the soil gradient at each site. Soil water measurements are made frequently on summit and toeslope positions, and twice annually on sideslope positions. During the summer growing season soil water data are collected in each crop bi-weekly and the data transmitted to the Climate Center in Lincoln via diskette.

Results

Soil water content in each of the target crops has been reported to the High Plains Climate Center as agreed upon in the contract. Conversion of the weather stations from satellite data transmission to cellular phone access is 2/3 completed and will be finished in spring 1995. Crop yields, soil water data and climate data for the 1993 season are reported in an Technical Bulletin TB-94-1, which is enclosed. Technical bulletins are available from previous years and they provide easy data access for the modelling community. In addition to these publications a bulletin describing the economic outcome of the cropping systems, TB-93-3, is enclosed.

The 1994 crop year has been challenging. Precipitation amounts at the Sterling site were lower than for any previous year of record. The long-term mean rainfall for March through September is 14.7", but in 1994 we received 4.03", which is a deficit of -10.67". Wheat yields at Sterling averaged 30 bu/A over all soils, which is a bit less than the long-term county mean of 32 bu/A. Farmer yields in the community were substantially lower than ours because their water conservation techniques were not as effective. Corn yields at Sterling were essentially zero on the summit soil, low on the sideslope(15 bu/A) and a bit better on the toeslope(21 bu/A). Obviously the lack of summer precipitation was devastating. At the Stratton site we received about 50% of the average precipitation. Wheat yields averaged 40 bu/A and corn yields averaged 50 bu/A where all nutrient deficiencies were corrected. Precipitation at the Walsh site has been normal to above. Wheat yields averaged 38 bu/A. The grain sorghum has not been harvested yet, but looks excellent.

Grower meetings in the winter season were well attended and adoption of the systems is progressing. Several farmers were included on the programs at these meetings and shared their experiences with their peers. Another indication of adoption of intensified cropping systems is the increase in dryland corn acreage in eastern Colorado. Acres planted to dryland corn have increased from 20,000 (1970-1990) to 80,000 in 1993. Data for 1994 planted acres are not available at this writing, but preliminary indications are that it was near 100,000 acres. Field Days were held at each site in 1994.The Cooperative Extension Service also accesses the real-time weather information and makes it available to farmers for planning and irrigation scheduling purposes.

NOAA High Plains Climate Center Progress Report
Submitted by T. Kayes
Department of Forestry, Fisheries and Wildlife
University of Nebraska-Lincoln
November 1994

TITLE

Use of Climate Data to Evaluate Key Fish Species for Aquaculture Development in the High Plains Region

REPORTING PERIOD

May 1, 1994 - October 31, 1994

COST

$11,975 (Year 1 Direct Costs, FY1994-1995)

DURATION

2 Years

PRINCIPAL INVESTIGATORS AND AFFILIATIONS

Terrence B. Kayes, Associate Professor, Department of Forestry, Fisheries and Wildlife, University of Nebraska-Lincoln

Kenneth G. Hubbard, Professor, Department of Agricultural Meteorology, University of Nebraska-Lincoln

OTHER PARTICIPANTS AND AFFILIATIONS

Jess Hansen, Research Technician, Department of Forestry, Fisheries and Wildlife, University of Nebraska-Lincoln (Funded Participant)

Dennis Smydra, Undergraduate Student Staff Specialist, Department of Forestry, Fisheries and Wildlife, University of Nebraska-Lincoln (Funded Participant)

Ivan Bielik, Master's Student and Graduate Research Assistant, Department of Forestry, Fisheries and Wildlife, University of Nebraska-Lincoln (Non-Funded Participant)

Barry Johnson, Fishery Biologist, Upper Mississippi Science Center, U.S. Department of Interior Biological Survey, LaCrosse, Wisconsin (Non-Funded Participant)

OBJECTIVES

1. To develop and test an empirical model for predicting daily and seasonal variations in water temperature in aquaculture production ponds, based on air temperature and related climatic data in the High Plains Region.

2. To use pond water-temperature data and the temperature model in concert with existing and derived bioenergetics growth models to estimate lengths of growing season, potential total annual growth, and the amount of time required to raise key selected fish species to market size in the High Plains Region.

ANTICIPATED BENEFITS

Climatic temperature models combined with existing bioenergetics growth models that have been properly validated could greatly speed regional aquaculture development by identifying and focusing attention on the fish species best suited to the region's temperature conditions. Temperature data in aquaculture can be used to estimate growth rates, feed consumption, feed efficiency, reproductive performance, certain water-quality parameters, and susceptibility to certain diseases. All of these factors directly affect economic feasibility. We expect our research to generate specific information on the relationship between climate and water temperature in fish production ponds, as well as predictions of growth and performance of key selected fish species under water-temperature conditions that can be expected in the High Plains Region. Our findings should be extremely useful in identifying the fish species most suitable for aquaculture development in the region and in guiding future research.

PROGRESS TO DATE

In the autumn of 1992, automated weather stations were installed at both the North Platte State Fish Hatchery, near North Platte, Nebraska, and the Calamus State Fish Hatchery, near Burwell, Nebraska. These two hatcheries are operated by the Nebraska Game and Parks Commission, and are the sites of a number of University of Nebraska-Lincoln (UNL) projects on aquaculture, supported in part by the Commission, the UNL Agricultural Experiment Station, and the USDA North Central Regional Aquaculture Center. The fish production ponds at both hatcheries are rectangular (79-82 m long $\times$ 51-59 m wide), have a mean depth of about 1.2 m, hold 4,070-4,930 m^3 of water, and have similar morphometries. Since the summer of 1992, water temperatures have been recorded at 10- or 30-min intervals at 1.0 m depth at the same location in four replicate ponds with similar dimensions at both hatcheries, using Ryan Instruments "TempMentor" thermographs, which are calibrated to $\pm 0.5°C$ (total system accuracy) and their data "down-loaded" by computer at regular intervals.

Climatic and water-temperature data at the two hatcheries are being collected for the High Plains Climate Center project until the end of 1994. Compilation and analyses of water-temperature data were initiated in the summer of 1994, with particular emphasis being placed on determining daily temperature highs, lows, and means for each pond and for the four monitored ponds at each hatchery. As part of these analyses, weekly water-temperature highs, lows, and means are also being determined. The results of these analyses are being stored in computer files for future use in driving fish bioenergetics growth models and evaluating models for predicting seasonal variations in the temperature of aquaculture production ponds based on climatic data. One particularly time-consuming aspect of these analyses has been identifying those time intervals when the monitored ponds have been emptied or the thermographs have been removed from the ponds by Game and Parks Commission personnel, without notification or recording the times and dates of their actions. Fortunately, these intervals can be detected in the data collected, but complicate analysis significantly.

WORK PLANNED

All data collection will be completed at the end of December 1994. The analysis of climatic data will be initiated in January 1995. Present plans are to have all the analyses of climatic and water-temperature data completed by May 1, 1995. Recently, work was begun to gain greater operational knowledge of the capabilities and limitations of the "Wisconsin" fish bioenergetics growth model, which was developed and has been improved, expanded, and verified over the past 20 years at the University of Wisconsin-Madison, largely through NOAA Sea Grant College Program funding. Dr. Barry Johnson of the U.S. Biological Survey, a leading expert on the Wisconsin model, recently visited the UNL, and held a workshop on the model for UNL investigators involved in the High Plains Climate Center project. Over the next several months, our working relationship with Dr. Johnson will be expanded by collaborating with him on growth simulation studies for key selected fish species, using the model and water-temperature data generated by the project. In Year 2 of the project, emphasis will be placed on developing and testing a predictive pond water-temperature model based on climatic inputs, and integrating it with the Wisconsin fish bioenergetics growth model, as outlined under Objectives 1 and 2.

Progress Report to the
High Plains Climate Center

Evaluation and Development of Intake Prediction Model for Feedlot Cattle

T.L. Mader, A. Parkhurst,
G.L. Hahn, K.G. Hubbard, and D.E. Stooksbury

October 31, 1994

We are making good progress on this project. Our analysis of the weather data is well underway. We have developed two new weather-stress indices based on principal component analysis of the weather data. These new indices will make it easier to partition the sensible and latent heat stress on cattle. The first index is a new thermal heat index (NTHI) that has more variance throughout the day than the traditional thermal heat index (THI). The second index, is a new wind-chill index (NWCI). A model is being developed to justify these new indices as a partitioning of latent and sensible heat stress on cattle.

Our next step is to test whether these new indices are reproducible across locations. We are testing data from automated weather stations in Minot North Dakota, Hesston Kansas and Sidney Nebraska. Being able to reproduce the indices will add more confidence to their underlying validity. With the completion of the indices development work, we will be ready to start the building of the intake prediction model.

Progress Report to the High Plains Climate Center
Research Grants Program

Reactive Management of Surge Irrigation Using Evapotranspiration Data

by

Dean E. Eisenhauer, Joel F. Cahoon, and C. Dean Yonts

October 28, 1994

Meteorogically-based estimates of evapotranspiration have been used for irrigation scheduling for many years. The method has been easiest to apply with sprinkler irrigation systems. With surface irrigation systems there is more difficulty in estimating the effective water applied for each irrigation. This leads to errors in water balance calculations.

In this project we are developing and evaluating a technique for use with surge flow furrow irrigation that improves the estimate of the effective water applied for each irrigation. The estimated effective application is based on advance time, application time, and the gross water applied. Additional management variables that are being evaluated as key parameters for surge flow are the on-times for each surge cycle and the relationship between the inflow rate and the steady-state infiltration rate.

The methodology is being evaluated at four field sites throughout Nebraska: the Agricultural Research and Development Center (ARDC) at Mead, the South Central Research and Extension Center (SCREC) at Clay Center, the Management Systems Evaluation Area (MSEA) at Shelton, and the Panhandle and Research and Extension Center (PHREC) at Scottsbluff. The soil textures range from silty clay loam (ARDC), silt loam (SCREC and MSEA), and fine sandy loam (PHREC). To evaluate the method, estimated soil moisture, based on water balance calculations, is compared to frequently measured soil moisture.

To develop a relationship between management options and the resulting application efficiency of the low quarter (AELQ), over 200 simulations were performed using a kinematic wave surface irrigation model (K-MODEL). Management parameters that were varied included the cutoff ratio, flow ratio, reuse system efficiency, and post advance management. Simulations were performed for three soil textural classes: silt loam, silty clay loam, and very fine sandy loam.

The AELQ was chosen as the efficiency parameter because it incorporates both water application amount and water distribution into a single efficiency index. Effective irrigation depth is then based on gross water applied and the AELQ.

An example of the results of the simulations is shown in Figure 1. AELQ is related to cutoff ratio and there is an interaction between flow ratio (FR) and cutoff ratio. The next step is to identify and test operational rules to recommend to irrigators based on their soil texture, field slope, and runoff system efficiency.

Field tests were conducted at all four sites during the summer of 1994. Meteorologically-based ET data was used in conjunction with the estimated effective irrigation depths to schedule the irrigations. Soil moisture was monitored to evaluate the performance of the practice. An example of the field results is shown in Figure 2. This figure shows relatively good agreement between predicted and measured available soil moisture and shows that measured and predicted soil moisture were both maintained between the recommended soil moisture limits (TAW and MB). Analysis of all field data is continuing at this time.

Since 1994 was a relatively wet year at Shelton, Clay Center, and Mead, another year of field data collection will most likely be necessary to more fully evaluate this new methodology.

This research will result in a management technique where meteorologically-based ET data will be used for management of a rapidly expanding irrigation technology surge irrigation. Since irrigated agriculture is unquestionably the largest consumer of water within the High Plains states, the resulting reduction in water withdrawals will be very significant. We believe that with proper irrigation scheduling used in combination with the improved surface irrigation method, water applications in surface irrigation will be reduced as much as 30% per year. On the 3.8 million surface irrigation ha in the High Plains, the reduction in withdrawals of ground and surface water would exceed 50 million ha-cm per year. Additional benefits include energy savings and a reduction in water quality degradation due to excessive irrigation.

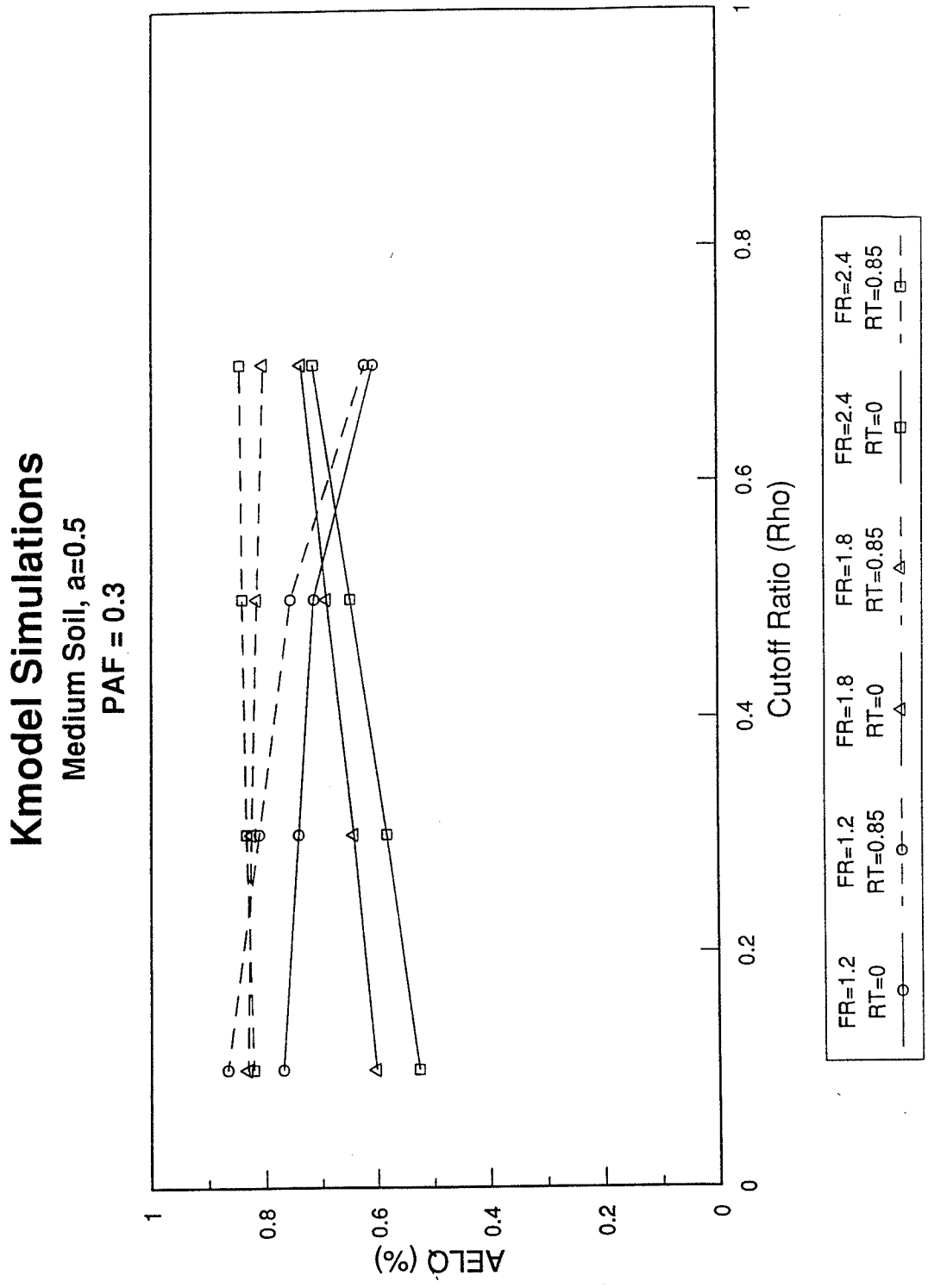

Figure 1. AELQ vs. cutoff ratio for various management options. PAF = post advance factor, FR = flow ratio, and RT = reuse system efficiency.

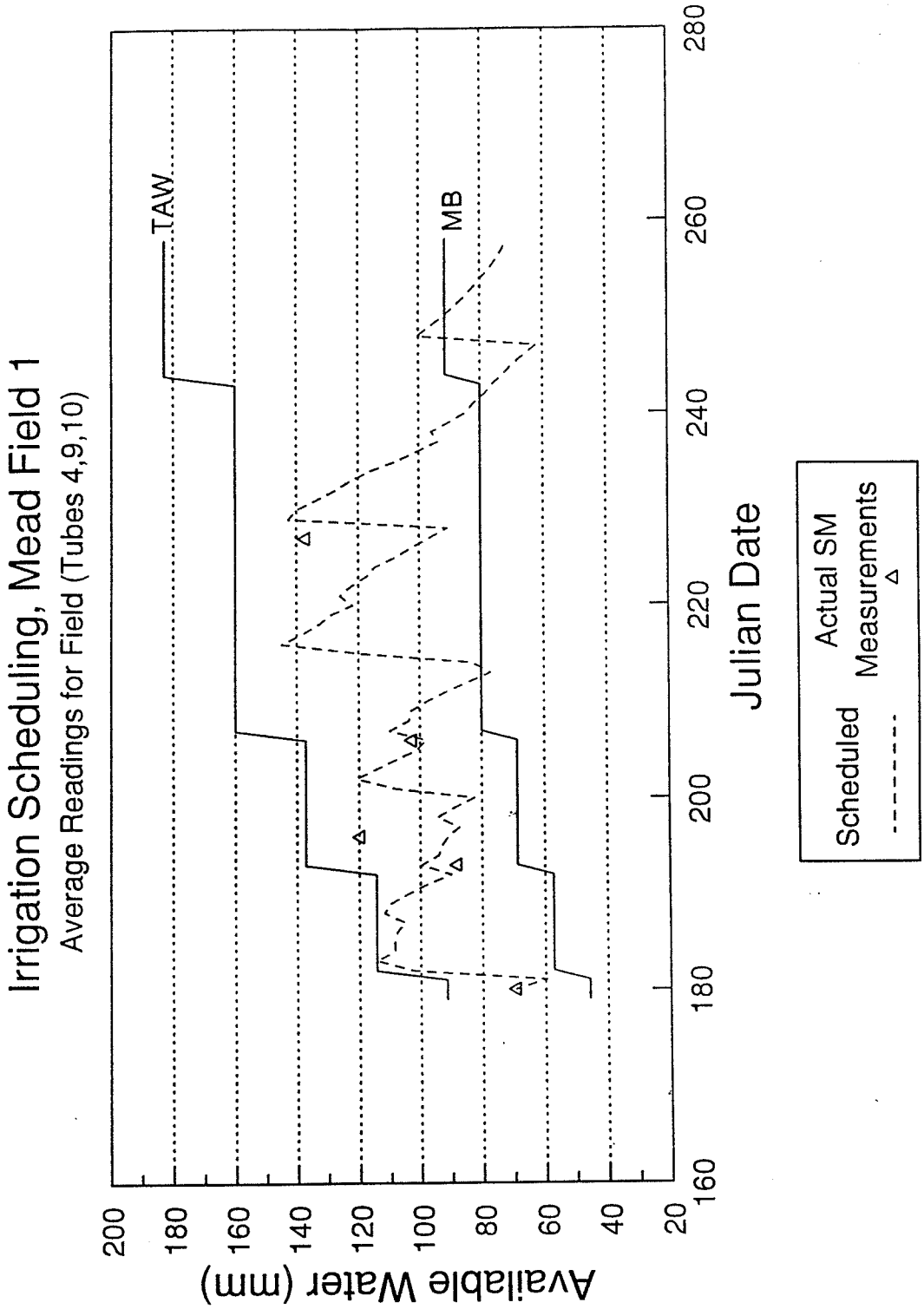

Figure 2. Measured and predicted available soil moisture at Mead site, 1994. TAW = total available water, MB = minimum balance.

Progress Report from the High Plains Climate Center

Research Initiation and Improvement Funds for the High Plains Climate Center

Kenneth G. Hubbard

A graduate student, Craig Idso, has been funded from this project. His topic is climate change and he is searching for empirical evidence of limits on climate change within the HCN data set. His initial work is directed at deriving legitimate averages for all months in the HCN data set. A special study to evaluate the affect of missing data on accuracy of the monthly average is underway as part of this study.

Funds have also been used from this project to purchase the TD3210 (daily) and TD3280 (hourly) Surface Airways data on 8 mm tape and to provide additional storage (4 Gbytes) on the SUN system.