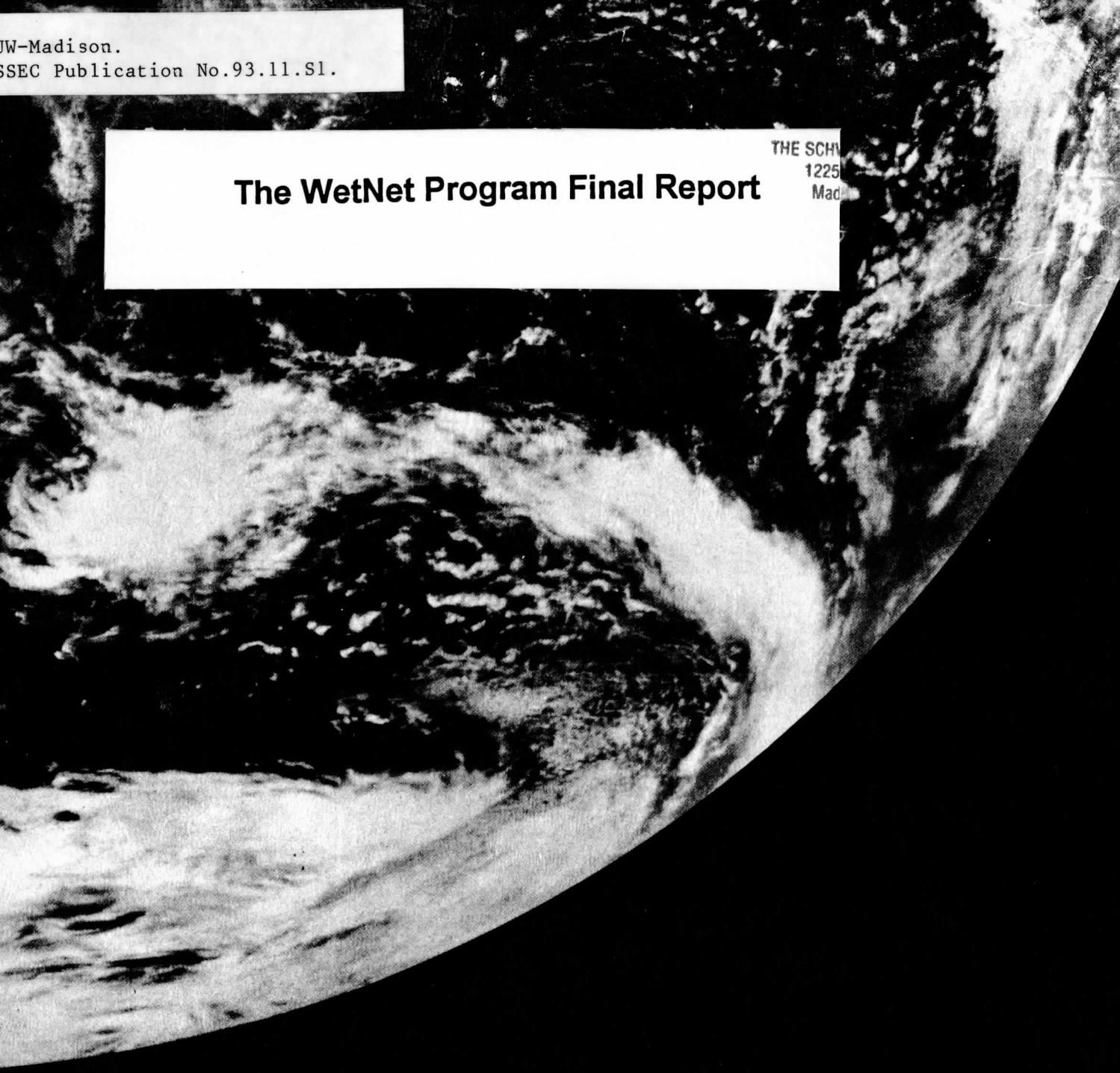
The WetNet Program Final Report



A REPORT

from the space science and engineering center
the university of wisconsin-madison
madison, wisconsin

The WetNet Program Final Report

for

National Aeronautics and Space Administration's (NASA)

contract

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from

The University of Wisconsin - Madison (UW)
Space Science and Engineering Center (SSEC)

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I. INTRODUCTION

The Space Science and Engineering Center (SSEC) of the University of Wisconsin - Madison (UW) undertook a contract with the National Aeronautics and Space Administration's (NASA) Marshall Space Flight Center (MSFC) to participate in the WetNet project. The contract for the "Implementation of the WETnet System" was awarded March 27, 1989. This is the final report on the activities related to this project.

The fundamental goal of WetNet has been to determine how scientists, with similar research goals, using a modern networked data system, would work together in a collegial fashion to improve scientific understanding of the global hydrologic cycle.

The objectives of the WetNet project were to: organize a group of scientists working in hydrological cycle research, develop and test a prototype Earth Science and Applications Data System tool that would optimize scientist's ability to conduct research and applications development, and provide an extensive global data base to support the research. This involved the acquisition, management, analysis and display of specific data relevant to studies of the global precipitation. The objective of this contract was to provide a system and appropriate functionality to support WetNet.

II. BACKGROUND

SSEC's Man computer Interactive Data Access System (McIDAS) technology was used in this project because it's attributes closely matched those needed to meet the WetNet system level objectives. The McIDAS is an end-to-end system for the acquisition, management, analysis, and display of a wide variety of meteorological data, including data from geostationary and polar orbiting satellites. The McIDAS also provides an environment that allows the scientist to develop new scientific techniques without developing special computer programs for data handling. The SSEC has built a McIDAS environment in the IBM PC/AT and PS/2 series computers, which uses the same basic functionality and data structures as the mainframe McIDAS. The result is a very low cost, powerful workstation. The McIDAS-OS2 operates as a

stand-alone workstation that can dial-up access a remote database, or it can be used with a full service dedicated connection to a mainframe McIDAS.

At the start of the project, the McIDAS provided extensive capabilities, but we found that enhancements were needed. It was necessary to add the capability to acquire, process and catalog the Special Sensor Microwave/Image (SSM/I) data generated by the Defense Meteorological Satellite Program (DMSP) after it was processed into Temperature Data Records (TDR) by the Navy's Fleet Numerical Oceanographic Center (FNOC).

III. IMPLEMENTATION

A. Initial WetNet System Concept

Throughout the life of this project it has been the intent of the organizers to keep the focus on the users' needs, and to fulfill those needs in an iterative implementation. Consequently, annual meetings were held for the WetNet PIs. During these meetings, demonstrations of possible future enhancements were presented and discussed. Many additional enhancements were recommended by the PIs based on their recent experience with the system. A WetNet executive committee used the recommendations to determine the next steps in the evolution of the WetNet system. Thus the system developed as a result of this direct feedback from the user community (PIs).

The basic system concept was to collect in near-real-time, data of interest to researchers studying the hydrological cycle, distribute these data and selected derived products to workstations in the hands of the PIs, and provide extensive data analysis capability in the workstation. The researchers, using the same environment were to develop new algorithms and share these in a collegial fashion. It was hoped that this approach would lead to a more interactive approach to scientific research and development.

An organizing meeting was held at MSFC in May 1988. At this meeting a conceptual plan for WetNet was developed. From this plan an implementation plan was developed. In the initial implementation plan, SSEC was to acquire the SSM/I data, transfer it to MSFC, and put it into the MSFC/McIDAS data base along with the ancillary data (navigation, calibration, etc.). The MSFC/McIDAS would prepare data sets and derived products for near real-time access by the WetNet community. Both PC-McIDAS and non-McIDAS users would be able to access these

data and products using a McIDAS subsystem called the Dial Access Facility (DAF). The DAF was to be a dial-in communication facility which (isolated from the McIDAS) was to provide an asynchronous ASCII interface from which prepared products could be downloaded using simple product identifier codes. While products were updated to the DAF, the catalog and browse subsystems would be updated as well. The McIDAS browse would provide a quick look capability for users of the PC-McIDAS from magneto-optical (MO) disk. The browse data and product sets would be automatically added to the browse storage as they become available. When two weeks of data and products were collected they were to be stored on a disk, and that the disk be replicated and shipped to the user community as quickly as possible.

PC-McIDAS users would have a set of menus that would, on request, establish a communication link to the MSFC DAF; list the catalog; list the data and product menus; allow them to select limited historical or real-time data and/or derived products to be downloaded; and display the satellite data schedule. The PC-McIDAS would also allow the user to schedule automatic downloads, if the MSFC communications access did not require human intervention. Once a data set or product has been downloaded, the user would be able to display images and graphics using the IBM PS/2's and PC/AT's VGA display. The user could do this while on-line with the MSFC DAF or as a stand-alone, disconnected from the DAF.

B. Work accomplished

The work during the contract period can be divided into two phases: a development phase and an operations phase. During the development phase, UW, together with MSFC staff, implemented the various components of the system. During the operations phase, data and products were delivered to the PIs, and the system was modestly enhanced to optimize its utility.

1. User Input

As previously mentioned, the WetNet PIs met on an annual basis to report on their research, provide feedback to the WetNet team on the utility of the system, and recommend additional enhancements to facilitate their research.

The first of these meetings was held in Madison, WI, 13-15 June 1989. At this meeting the system development status and a prototype workstation were presented. The prototype was

developed by UW prior to the meeting to give the PI's a feel for the types of functionality and data bases that could be available to the WetNet workstations. The PIs indicated a need to have both the McIDAS software and the appropriate hardware provided by NASA. A list of data bases to be supplied to the PIs from MSFC was considered by the group and recommendations were formulated. These recommendations were used to determine the UW work requirements for the following year.

In 1990, each Investigator with an assistant received training on the WetNet (McIDAS) software at MSFC. The first session was in February and the second was in May. Further feedback was forthcoming during these sessions. This feedback helped to refine the functionality of some of the commands.

In 1991, University of California - Santa Barbara was the site for the PI's meeting. The meeting was held in February. The focus of the meeting was on the research work accomplished to date, and the planning for the next year's efforts. At this meeting five clusters of interest were identified and groups formed. These groups met and developed cooperative research plans. A new suite of applications had been developed at UW prior to the meeting. These were presented along with the menus associated with each. The functionality of the software and the data bases were reviewed and plans for data delivery were presented.

In 1992, Florida State University was the host for the WetNet PI's meeting. The meeting focused on both the PI research efforts to date and the problems associated with setting up the data delivery system. At that point in time, near real time data acquisition and product generation had started, but at a very slow pace. Plans were laid for a major effort at MSFC to implement a pseudo operational data processing and product delivery system.

2. Development Phase

a) Data acquisition

The principal data base for research by the WetNet PIs was the DMSP SSM/I suite of sensors launched on DMSP-F8. At the May 1989 meeting, the PIs had stated a requirement for near real-time (within 24 hours) browse and product generation. During the search for a source of near real time DMSP SSM/I data, retrospective data from tapes processed by Frank Wentz were

used as an interim. UW developed a program to read these tapes, process the data into appropriate files, and store calibration and navigation information. This program was delivered to MSFC in July of 1989.

In April 1990, NESDIS agreed to provide the near real time SSM/I data from their processing data steam for WetNet support. The access method was through TCP/IP Internet. The implementation of this link was delayed until the Spring of 1992. The delay was caused by delays in the acquisition and configuration of appropriate hardware in the MSFC EADS facility.

Throughout the project, UW provided all the real time geostationary satellite data bases to MSFC for distribution to the PIs. The PIs request for the Japanese GMS data required that we establish Internet communications with the Australian Bureau of Meteorology (ABoM). This link was established in February of 1991. Personnel from the UW were sent to ABoM to install the software and setup the initial data transfer process. The link was quite slow initially providing only 1 kbps average transfer rates. The NASA Science Internet Project office eventually upgraded the link to provide satisfactory service. MSFC transfers the GMS data to their processing system after it was received at UW.

b) Processing

The processing of the SSM/I data from Wentz tapes and, to a limited extent, the generation of products was prototyped by UW on the McIDAS. These applications were then transferred to MSFC.

It was determined early in the project that the most likely way to encourage the PIs to work collegially was to provide them with the same hardware and software system. This increased the likelihood of sharing data, algorithms, and developmental products. 17 PC workstations were purchased for WetNet users. The systems were integrated at UW. The software was loaded and tested prior to shipment to the appropriate PIs. Two systems remain at UW for development and support of WetNet.

c) Cataloging

Cataloging software was developed to build a catalog of the data stored on all previous MOs. The program read the directory for the MO and updated a file with the appropriate information.

The catalog file is used by several data access routines (in menu form) to find and display data of interest to the Investigator. This software was delivered to MSFC in the Spring of 1990.

d) Browse

A browse capability was developed to provide a visual search for features of interest through a degraded sample of the SSM/I data on an MO. Once identified the software allowed the user to display and process the raw data corresponding to the browse. This software was also delivered to MSFC in the Spring of 1990.

e) User Interface

(1) PC-McIDAS

The user interface for WetNet was developed using the F-key menu subsystem of McIDAS. The menu provided data display, data manipulation, browse display and communications linkup with MSFC. The prototype menus were presented at the first WetNet PI meeting. Comments from the PIs helped refine the menu functionality. WetNet staff at MSFC further refined the menus after they were delivered. The menus were augmented as new analysis packages were developed. The menu for each new application was delivered along with the software.

(2) Dial Out Facility/Dial Access Facility (DOF/DAF)

The initial plans for communications required access to the WetNet facility at MSFC using a dial access facility. The DAF had 2 components, the workstation component and the central data base component at MSFC. Through the WetNet menu, the PIs could select a menu item that would dial MSFC and establish a connection for data transfer. This facility was not used as it created security problems with the MSFC computer facility.

Browse products were to be delivered daily to the PIs. Initially this was to be handled by the DOF. The DOF was developed and tested at UW. A special program was written to select which products to store on each workstation. This was necessary since some PIs wanted less than all the products to be sent from MSFC. This software was delivered to MSFC but was not used because the NASA Science Internet (NSI) superceded it as a more efficient distribution method.

(3) Optical Disk Drive

The magneto-optical drive was a key element of the WetNet workstation. It was needed to provide random access to the large data volumes needed by the PIs. We did a search for MO drives with an appropriate device driver for OS/2. None were available. Several sources of MO drives recommended a company in St. Louis with the expertise to develop a device driver for OS/2. We secured a contract with SoftwareTechnology Inc. (STI) to develop a device driver. Speed of access to read the image files was a major consideration in the development of the driver. It was necessary to make an unfortunate tradeoff in the development. To get adequate speed from the technology of that time, it was necessary to implement a unique disk format. This later created an incompatibility with other systems which has detremental to the wide spread use of these cartridges.

In the last few years of the contract, STI provided maintenance support for the device driver. This part of the WetNet workstation configuration was the most problematic. The driver required considerable modifications with each new release of the OS/2 operating system.

f) Communications

(1) MSFC - SSEC Communications

The initial concept of operations required large quantities of data to be transferred from the UW McIDAS to the MSFC EADS. The 9.6 kbps link in existence was upgraded to 56 kbps SNA by the government. In addition, an upgrade to the UW communications controller was needed to support the 56 kbps link. This link was put into operation in the Fall of 1989. GOES data sets were needed for browse covering the time period of the retrospective SSM/I data from F-8. These data were initially transferred over this link.

In the March of 1990, SSEC implemented a TCP/IP communications protocol for McIDAS to McIDAS connections. This protocol provides for the efficient transfer of commands, data and display packets.

(2) **Workstation Communications**

Asynchronous

In the initial workstation configuration, a high speed modem was included to support the DOF/DAF capabilities. This capability was tested, but didn't become operational.

TCP/IP communications

When the TCP/IP link and software development were finished, the capability was used to exchange data with the ABoM. This proved successful, we proceeded to replace the modems on the workstations with ethernet cards and the TCP/IP software. NSIPO was contacted to arrange for connectivity to all the WetNet PI sites.

Two facilities were developed under this contract for handling the data distribution. IDEX was implemented to move data from the MSFC system to the PI's workstations. This capability was used to distribute the browse data base in an automated fashion. IDABB was also developed as an FTP server that would be automatically updated by the MSFC product generating processor. This facility was not implemented at MSFC, though it was demonstrated at SSEC.

3. Operational Phase

In June of 1992, MSFC began the operational phase of the project. The UNIX version of McIDAS (McIDAS-X) was used at MSFC to process the DATA and products. SSEC provided software to facilitate the operational (automated) processing of the SSM/I data, the production of the MO data base and the generation of the browse products. SSEC has also provided consulting to the MSFC WetNet team on operational processing issues.

IV. CONCLUSIONS

During the project, several papers were written and presented at conferences. The specific references are sited in the Appendix A.

The WetNet program has been generally very successful. This is, in a large part, due to the "scientist driven" approach to the system design and implementation. Frequent feedback, and the implementors responsiveness to a changing set of requirements have been the key elements in this success.

V. APPENDIX A.

Goodman, H. M., R. Chase, J. Dodge, R. Spencer, J. Star, G. Wilson, and J.T. Young. 1989. WETNET: A NASA Earth Science and Applications Data System Prototype for Global Moisture Cycle Studies. Preprint of Fifth International Conf. on Interactive Info. and Processing Systems for Meteor., Ocean. and Hydro., Jan. 1989, Amer. Met. Soc.

Smith, M.R., C.V. LaFontaine, F.J. LaFontaine, D.D. Moss, B.M. Goodman, R.C. Dengel, J.T. Young and H.M. Goodman. 1992. WetNet: A Status Report. Preprint of the Eighth International Conference on Interactive Information Processing Systems for Meteorology, Oceanography, and Hydrology, Jan. 1992, Amer. Met. Soc.

Young, J.T., R. Dengel, and D. Santek. 1990. WetNet System. Preprint of the Sixth International Conference on Interactive Information Processing Systems for Meteorology, Oceanography, and Hydrology, Feb. 1990, Amer. Met. Soc.