TEXAS HIPLEX
INTERIM PROGRESS REPORT

Prepared by:

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Interim Progress Report for October 1, 1978–March 31, 1979

Prepared for:

OFFICE OF ATMOSPHERIC RESOURCES MANAGEMENT
BUREAU OF RECLAMATION
BUILDING 67, DENVER FEDERAL CENTER
DENVER, COLORADO 80225

LP-100
APRIL 1979

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For the Period October 1, 1978 - March 31, 1979

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TEXAS DEPARTMENT OF WATER RESOURCES
1700 N. Congress Avenue
Austin, Texas

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April 10, 1979

Dr. Archie M. Kahan
Chief, Office of Atmospheric
Resources Management
Bureau of Reclamation
Building 67, Denver Federal Center
Denver, Colorado 80225

Dear Dr. Kahan:

Re: Texas HIPLEX Interim Progress Report

In compliance with Amendatory Agreement No. 1 to Contract No. 14-06-D-7587 between the Bureau and the Department, we hereby submit twenty (20) copies of the interim progress report for the Texas High Plains Cooperative Program (HIPLEX). The report discloses and explains all Texas HIPLEX work performed and results achieved during the interim period October 1, 1978 through March 31, 1979.

This report consists of a compilation of individual reports prepared by the Department and each of the Texas HIPLEX participants--Texas A&M University, Texas Tech University, the Colorado River Municipal Water District, and Meteorology Research, Incorporated. The individual reports consist of three sections which: (1) describes all Activity for the Report Period; (2) outlines the Work Planned for the next report period; and, (3) provides an Appendix of pertinent information. A Table of Contents and Lists of Tables and Figures are provided at the beginning of the report for order and ease of reference. An Executive Summary and a map of the Texas HIPLEX Region is included for introduction and orientation purposes.

Please direct any questions concerning this report, or the need for further information, to the Department's Weather Modification & Technology Section.

Sincerely,

Herbert W. Grubb

Herbert W. Grubb
Director, Planning and
Development Division

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EXECUTIVE SUMMARY

In 1974 the Bureau of Reclamation (Bureau), Office of Atmospheric Resources Management, entered into a cooperative cost-sharing agreement with the Texas Water Development Board (one of three predecessor water agencies to the September 1, 1977 organization of the Texas Department of Water Resources) for the purpose of conducting a long-term comprehensive, atmospheric research and weather modification development program. This program, called the High Plains Cooperative Program or HIPLEX--is part of the Bureau's more comprehensive developmental precipitation management program, Project Skywater. The overall goal of the HIPLEX program is to establish a verified, working technology and operational management framework capable of producing additional rain from summertime cumulus clouds in the Great Plains States. To achieve this goal, three field research sites were selected by the Bureau in the High Plains region. One site is located in Montana, another in Kansas, and a third in the Big Spring-Snyder area of Texas. The Texas HIPLEX site is managed by the Texas Department of Water Resources (TDWR) under the technical guidance of the Bureau.

The objective of the Texas HIPLEX program is to better understand the cloud and precipitation processes and the inter-relationships between cloud-development processes and the environment associated with both natural and "seeded" clouds which develop in West Texas. Certain clouds which meet general threshold requirements are "seeded" with artificial nucleating particles to affect the interior cloud volume where phase changes of water occur. This objective is being accomplished through the cooperative efforts of the following organizations:

Bureau of Reclamation, U.S. Department of the Interior
Texas Department of Water Resources
Colorado River Municipal Water District
Texas A&M University
Texas Tech University
Meteorology Research, Incorporated

This report presents the Texas HIPLEX work performed by these groups during the six-month period October 1, 1978 through March 31, 1979.

The TDWR serves as manager and administrator of the Texas HIPLEX program. The TDWR negotiates, awards, and administers contracts for services in support of the Texas HIPLEX program. TDWR staff meteorologists serve as field program managers who closely coordinate all phases of the project with the Texas HIPLEX Chief Scientist and other HIPLEX participants.

The services and support provided by the Colorado River Municipal Water District include: the maintenance and operation of an extensive network of recording and non-recording raingages; a rawinsonde operator and a radar meteorologist; and, the use of two multi-engine aircraft to perform cloud-seeding and cloud-particle sampling flights.

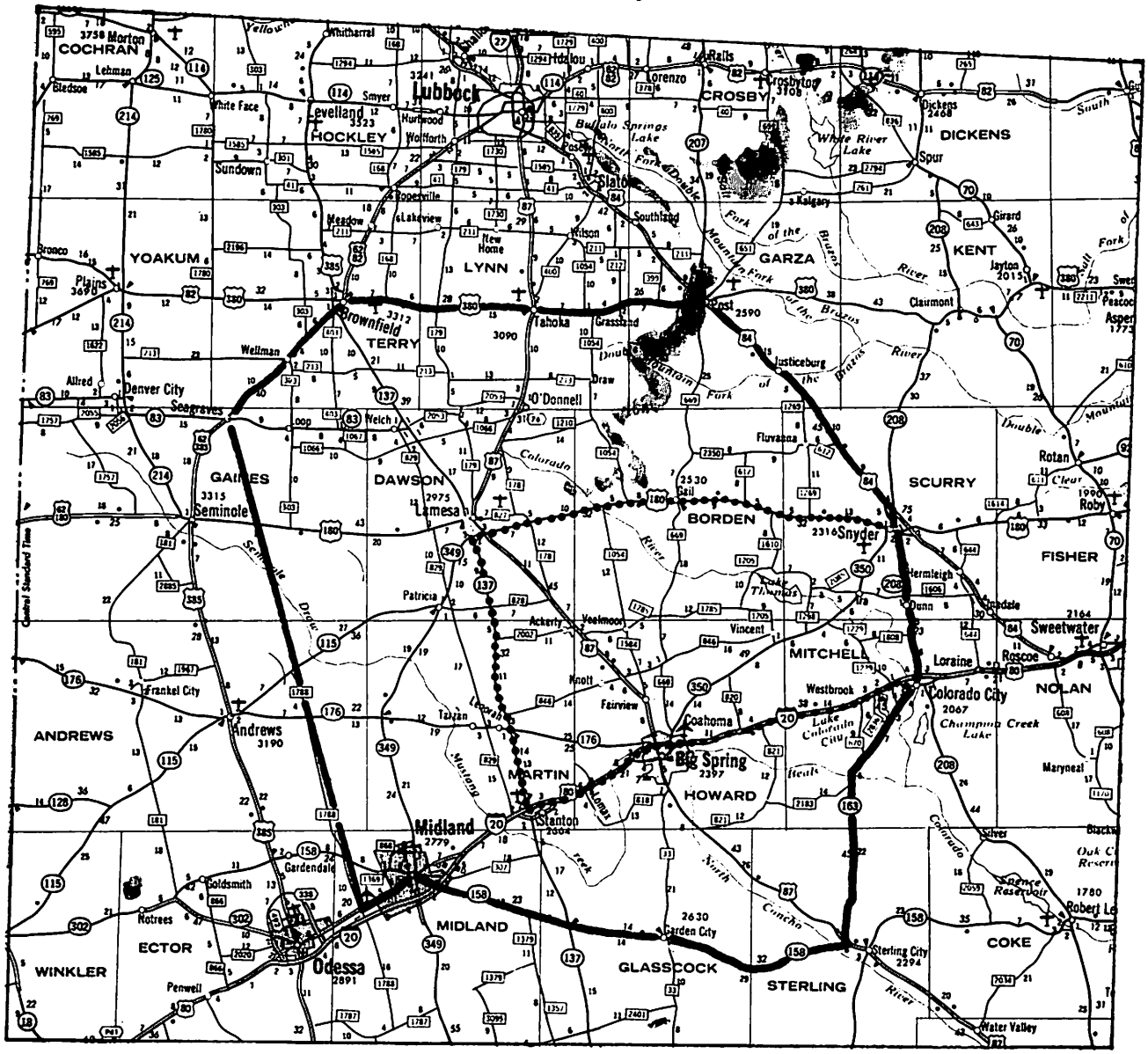
Texas A&M University provides: the services of a Chief Scientist for the program and the operation of a network of surface and upper-air meteorological measuring instruments during the field program; the analysis of the data collected with relation to cloud-system changes and microphysical changes within the cloud; and, the research and analysis for the development of a weather radar-echo climatology for the Texas HIPLEX region.

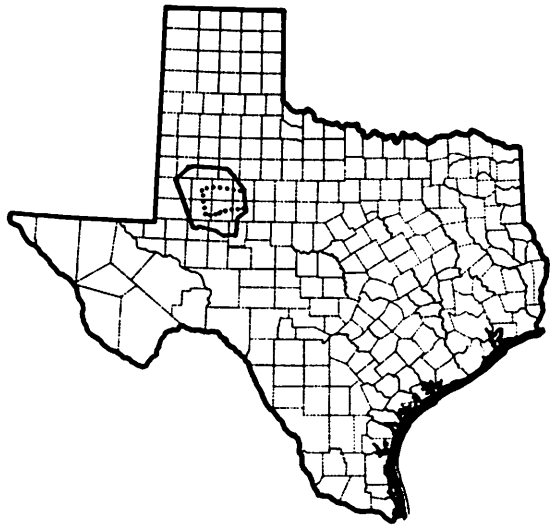
Texas Tech University provides: interpretative services using real-time satellite and weather radar data during the operation of the HIPLEX field program and the analysis of the data collected; and, the analysis of rainfall data collected by the Texas HIPLEX raingage network to relate storm rainfall to radar measurement of cloud-system development.

Meteorology Research, Incorporated provides a discussion on radar data which were collected and analyzed during the reporting period. The analyses of radar data are primarily oriented toward the study of small scale (mesoscale) rainshower patterns and their relationship with environmental conditions.

The objective of the HIPLEX long-term data collection and the progressive analyses of the behavior of West Texas summertime clouds, including the atmospheric environment, is to achieve a creditable level of confidence about the potential of a precipitation management program operated in the Southern High Plains region of the United States.

Map of the 1979 Texas HIPLEX Area
Delineated by Highways





The Texas HIPLEX Field Operations Center is housed at Big Spring Municipal Airport.

Legend

•••••••• Primary Area

——— Secondary Area

LIST OF TABLES

The "tables" and "figures" listed are numbered as they appear in the individual reports. For example, "TTU(II) means the second table in the Texas Tech University report. Other abbreviations used include: TDWR for Texas Department of Water Resources; MRI for Meteorology Research, Incorporated; and, TAMU for Texas A&M University.

LIST OF FIGURES

TEXAS HIPLEX INTERIM PROGRESS REPORTS

for the Period October 1, 1978 to March 31, 1979

Each of the interim progress reports contained herein, prepared by all five Texas HIPLEX participants, consist of three sections which (1) describe the work performed, (2) outline the work planned, and (3) provide an appendix of pertinent information.

TEXAS DEPARTMENT OF WATER RESOURCES

Management of the Texas HIPLEX Program

ACTIVITY FOR THE REPORT PERIOD

An important part of the Texas HIPLEX-related work performed by the Texas Department of Water Resources during this interim reporting period consisted of the drafting, conducting of negotiations and the awarding of contracts for work and services in support of the 1979 Texas HIPLEX program. Other work centered on: the compilation, publication and transmittal of various Texas HIPLEX reports prepared by the Texas HIPLEX participants; the arrangement and coordination of group planning sessions with the Texas HIPLEX Chief Scientist for the conduct of the 1979 Texas HIPLEX field program; and, the continuation of certain HIPLEX-related studies. These work topics are discussed below as: Reports and Proposals; Meetings and Planning Sessions; Contracts; and, In-House Studies.

Texas HIPLEX Reports and Proposals

The following Texas HIPLEX reports and proposals were transmitted to the Bureau's Office of Atmospheric Resources Management during this report period:

1. "Texas HIPLEX 1978 Field Operations Summary (LP-73)," by Robert F. Riggio and William O. Alexander, October 1978; five (5) copies transmitted on October 25, 1978.

2. "Mesoscale Characteristics of the Texas HIPLEX Area During Summer 1976," prepared by Dr. James R. Scoggins and others, Texas A&M University, under contract No. 14-70002; thirty (30) copies transmitted to the Bureau on October 26, 1978.

3. A draft copy of the Department's proposal for the 1979 Texas HIPLEX program; transmitted on November 2, 1978.

4. "A Texas HIPLEX Forecast Decision Tree," prepared by William O. Alexander and Robert F. Riggio, Texas Department of Water Resources, November 1978; thirty (30) copies transmitted on December 13, 1978.

5. "A Proposal for Work and Services in Support of the 1979 Texas HIPLEX Program," prepared by the Department and the Texas HIPLEX participants, Texas A&M, Texas Tech, and the Colorado River Municipal Water District; three (3) copies transmitted on December 22, 1978.

6. A copy of the Request For Proposal published in the December 26, 1978 issue of the "Texas Register" for the analysis of weather radar data collected at the Texas HIPLEX site during the field programs of 1976, 1977 and 1978.

7. "Texas HIPLEX Biennial Report, October 1976 - October 1978" compiled by all the Texas HIPLEX participants; five (5) copies transmitted on January 18, 1979.

8. "Texas HIPLEX 1978 Satellite and Radar Data Summary (LP-84)," prepared by Dr. Jerry Jurica of Texas Tech University and the staff of Meteorology Research, Incorporated; five (5) copies transmitted on February 14, 1979.

9. "Determination of Cloud Properties from Bispectral Satellite Measurements (LP-92)," prepared by Dr. Jerry Jurica and Shwe-Yi Chi, March 1979; twenty (20) copies transmitted on March 19, 1979.

10. "Development and Interpretation of a M-33 Radar Climatology for the Texas HIPLEX Region (LP-93)," prepared by M. E. Humbert and others of Meteorology Research, Inc., March 1979; twenty (20) copies transmitted on March 19, 1979.

11. "Texas HIPLEX Mesoscale Experiment, Summer 1978 Data Tabulations (LP-80)," prepared by P. G. Reynolds and others of Texas A&M University, April 1979; fifteen (15) copies transmitted on March 28, 1979.

Texas HIPLEX Participants Meetings and Planning Sessions

A meeting of the Texas HIPLEX participants and the Bureau of Reclamation occurred on February 14, 1979 in Big Spring, Texas to decide the location of the Bureau's Skywater radar for use during the 1979 Texas HIPLEX field program. The site selected to operate the Skywater radar is Howard County Airport, immediately north of Big Spring.

The Department's resident HIPLEX forecaster in Big Spring, Texas temporarily worked at the Austin headquarters for a one-month period during January and February. The objective was to coordinate more closely with the Austin-based staff for the preparation of the 1979 forecasting season and to continue the refinement of the forecast-decision tree.

Department personnel conferred with the Texas HIPLEX Chief Scientist on February 8-9, 1979 at Texas A&M University to formulate and execute a plan for the analysis of HIPLEX rawinsonde data collected during the 1976-1978 field programs.

During the week of February 19-23, 1979, Department technical personnel traveled to Big Spring, Texas to conduct an introductory course on calibration and maintenance procedures for Belfort Recording Raingages for Colorado River Municipal Water District technicians. The addition of 25 raingages to the network warrants additional personnel who are knowledgeable of the calibration process.

A meeting of the Department's Weather Modification Advisory Committee was conducted on January 11, 1979. Texas HIPLEX-related business included a briefing on the status of the 1979 Texas HIPLEX program by the Texas HIPLEX Chief Scientist.

1979 Texas HIPLEX Contracts

The negotiation and award of contracts to Texas A&M University (TAMU), Texas Tech University (TTU), and the Colorado River Municipal Water District (CRMWD) by the Department in support of the 1979 Texas HIPLEX program was completed during January 1979. No contract was awarded during the report period to perform the analysis of the 1976, 1977 and 1978 M-33 weather radar data (see page11, Work Planned).

The 1979 Texas HIPLEX contracts between the Department and the supporting organizations are listed in Table 1. The Department cannot issue an inter-agency contract that transcends the State's biennium, which ends August 31, 1979. Consequently, the three inter-agency Texas HIPLEX contracts to TAMU and TTU were prepared in two parts, with the "continuing" portion to become effective on September 1, 1979 (through December 31, 1979) upon approval by the Texas Water Development Board.

In-House Studies

A status report of the Texas HIPLEX In-House studies conducted by the Department during this report period is provided below:

1. Agro-Eco study, phase III, Phase IV proposal--After a critical review of the original draft by Department personnel a number of substantive changes are being considered. These changes are to incorporate results of recent research conducted by the Colorado River Municipal Water District.
2. Refinement of forecast-decision tree--Computer software to implement the forecast-decision tree on the Bureau's computer was written and debugged. The program analyzes certain local sounding variables and pre-stratifies the day's convective activity according to the Texas HIPLEX Convective Index.

TABLE 1. 1979 Texas HIPLEX Contracts Awarded by the Texas Department of Water Resources During the October 1, 1978 - March 31, 1979 Report Period

Number	Organization	Term	Purpose
14-90026	Texas A&M University	1-11-79/8-31-79	a) analyze 1978 HIPLEX mesoscale data; b) conduct the 1979 HIPLEX mesoscale field program
14-90023	Texas Tech University	1-11-79/8-31-79	a) analyze 1977 & 1978 satellite and rainfall data; b) collect 1979 radar data; c) provide real-time satellite support during the 1979 field program
14-90025	Texas A&M University	1-11-79/8-31-79	to develop a synoptic radar-echo climatology for the Texas HIPLEX program
14-90027	Colorado River Municipal Water District	1-1-79/12-31-79	a) provide radar, raingage & rawinsonde support; b) provide two aircraft for cloud operations

3. Refinement of thunderstorm-prediction model--A number of prediction models have been developed using the discriminate analysis technique found in the Statistical Package for Social Sciences. These models are being evaluated for "accuracy" and agreement with the physical world. The most realistic model will be selected for use in Big Spring.

4. Analysis of 1976-1978 HIPLEX rawinsonde data--Values of various parameters (e.g., temperature, dew-point depression, equivalent potential temperature, wind direction/speed for various levels) were extracted from rawinsonde data for the three HIPLEX sites (Miles City, Goodland-Colby, Big Spring) for the HIPLEX operational periods of 1976, 1977, and 1978. These will be analyzed using plots of the data, and inferences will be drawn about the relationships of these parameters among the three sites.

WORK PLANNED

The work activities planned by the Department during the next interim reporting period (April 1, through September 30, 1979) related to the management of the Texas HIPLEX program include:

--completion, publication and distribution of the "1979 Texas HIPLEX Operations Plan" as prepared by the Chief Scientist and the Department staff and approved by the Bureau;

--coordination with all the Texas HIPLEX participants for the conduct of the 1979 summer field program as described in the Operations Plan;

--direction and management of the field program during May, June and July by Department meteorologists, serving as Project Director (alternate with Chief Scientist), Project Coordinator and Project Forecaster;

--negotiation and award of a contract to analyze the 1976, 1977 and 1978 M-33 weather radar data;

--continued administration of the 1974 Master Agreement between the Bureau and the Department and the various interagency, consultant, and cost-reimbursement performance contracts; and,

--the preparation and transmittal of various Texas HIPLEX-related progress reports to the Bureau.

APPENDIX

Supplies

The Texas Department of Water Resources purchased and received nine Texas Instruments TI-59 Programmable Computers, nine PC-1000C Printers, two Applied Statistics Libraries, two A/C Adapter/Chargers and the accompanying software for use during the 1979 Texas HIPLEX program. The computers and other equipment will be loaned to Texas A&M for use during the field program.

Personnel

Department personnel involved with management of the Texas HIPLEX Program include:

Dr. Herbert W. Grubb, Director, Planning and Development Division
John T. Carr, Jr., Meteorologist and Chief, Weather Modification and Technology Section
Bill Alexander, Meteorologist
George Bomar, Meteorologist
Betty Flentge, Secretary
Bill Hanshaw, Hydrologist Assistant, Raingage Technician
Tom Larkin, Meteorologist
Bob Riggio, Meteorologist

TEXAS A&M UNIVERSITY

Mesoscale Research

SECTION I. ACTIVITY FOR THE REPORT PERIOD

1. Analysis of 1977 and 1978 Mesoscale Data

A report entitled "Mesoscale Characteristics of the Texas HIPLEX Area During Summer 1977" is nearing completion. This report will be similar to Report LP-65 which contains an analysis of the 1976 mesoscale HIPLEX data. The format will be identical to LP-65 and will contain the same major topics. This report should be completed during April 1979.

The analysis of mesoscale data for the summer of 1978 was initiated during this report period. Upper-level kinematic parameters, energy budgets and transformations, and the water vapor budget have been computed for all days on which soundings were available. Most of the results have been plotted but no interpretation or documentation has begun. Preliminary work has been done for the analysis of surface data but the results are not yet available.

Abstracts for four papers were prepared. Three were submitted to the Program Chairman for the Seventh Conference on Inadvertent and Planned Weather Modification, and one to the Program Chairman for the 11th Conference on Severe Local Storms. Both conferences are scheduled for October 1979.

2. Water Budget Models

A considerable amount of work has been done on the development of water budget models. The water vapor budget has been computed for 16 days for 1977 data, and for 19 days for 1978 data. These budgets were computed for all available sounding data. Average water vapor profiles

for convective and nonconvective cases for 1976, 1977, and 1978 have been computed and plotted. In addition, water vapor profiles were computed for squall line, isolated cells, clusters of cells, and as a function of the intensity and distance of cumulus activity from the Texas HIPLEX area for the 1976 and 1977 data combined. Results will be presented in one of the reports discussed in Item 1 above or in a report on water budget models that is under preparation.

3. Model for Entrainment

Work continued on the development of a model for entrainment but the model is not yet complete. Most of the emphasis during this report period has been on the analysis of mesoscale data and on preparations for the 1979 field program. More emphasis will be placed on this topic in the near future.

4. Environmental Response to Convective Activity

Work on this topic was begun in February 1979. Cross-sections of several meteorological parameters have been completed and the influence of convective activity on the environment as a function of distance from the cross-sections is being evaluated. The analysis will be extended to include fluxes of quantities such as moisture and latent heat energy through the cross-sections, but this has not been accomplished. Increased emphasis will be placed on this topic in the months ahead.

5. Cloud Microphysics - Environmental Interactions

Work on this topic began on March 19, 1979 with the arrival of Dr. Alexis B. Long. Since his arrival emphasis has been on familiarization and planning of future research in this area. Empahsis will be

placed on this topic during the next report period.

6. Mesoscale Field Experiments

The data report for the 1978 mesoscale experiment was completed in October 1978 and submitted for publication. This report is entitled "Texas HIPLEX Mesoscale Experiment Summer 1978 Data Tabulations" and is identified as TDWR Report LP-80.

Plans were made for the mesoscale field experiment for 1979. These plans call for an expansion of both the surface and sounding networks as well as the precipitation network. The 1979 mesoscale field experiment will consist of 7 rawinsonde stations, 25 surface stations, approximately 100 recording rain gages and about the same number of fencepost gages, one Skywater radar, and three aircraft. The 25 automatic surface weather stations will be provided by the Bureau of Reclamation, and arrangements were made with NASA for the loan of four rawinsonde systems. Arrangements were made with residents in the Texas HIPLEX area for the location of all equipment for the 1979 mesoscale experiment.

Considerable effort has been spent on hiring and training of personnel for the 1979 mesoscale field program. Special training sessions have been held on how to make rawinsonde soundings and how to process sounding data; additional sessions will be held on real-time data analysis.

A significant component of the 1979 mesoscale field program will be the real-time processing and analysis of rawinsonde data from all seven stations. Programs for the TI-59 calculator have been prepared to compute rawinsonde soundings (thermodynamic variables and wind) from ordinate and angle data, and others are being prepared for the

analysis of the data. These programs will be completed before the start of the 1979 field program.

7. Chief Scientist Activities

The Chief Scientist performed a variety of activities during this report period. The principal items included instrumentation for the CRMWD p-Navajo, participation by the MITRE Corporation in the 1979 Texas HIPLEX field program, plans for the expanded mesoscale field program including data processing for 1979, development of Texas HIPLEX program plans and budgets for 1979 and 1980, and coordination among Texas HIPLEX participants.

SECTION II. WORK PLANNED

During the next report period we expect progress to be made in all areas discussed in Section I of this report. Emphasis will be placed on the preparation for and conduct of the 1979 field experiment early in the next report period with emphasis on other activities following the field program. We expect to complete the 1978 mesoscale analysis report and a report on water budget models during the next report period. We also expect to greatly increase our activities in the cloud microphysics - environment interaction area as well as in the development of entrainment models and environmental response to convective activity. The Chief Scientist plans to spend approximately 5-6 weeks in the Big Spring area during the 1979 field program. Also, he will prepare the 1979-80 Operations Plan for the Texas HIPLEX program early during the next report period. This operations plan will be in final form and distributed to the participants in advance of the start of the 1979 field program.

If the four papers are accepted for presentation at the AMS conferences in October, they will be prepared during the next report period in accordance with instructions for each conference.

SECTION III. APPENDIX

Personnel employed on TDWR Contract No. 14-90026 during this report period are as follows.

Name and Title	Principal Activity
James R. Scoggins, Professor	Principal Investigator and Chief Scientist
Alexis B. Long, Associate Research Scientist	Data Analysis
Steven F. Williams, Graduate Assistant	Data Analysis
Myron Gerhard, Graduate Assistant	Data Analysis
Karen Hood, Student	Technician
Tammy Chisum, Student	Technician

Personnel who have been hired and who will be located in College Station during the 1979 field program are as follows.

Name and Title	Principal Activity
Myron Gerhard, Research Assistant	Data Processing
Nine-Min Chou, Research Assistant	Data Processing
Karen Cobbs, Research Assistant	Data Processing
John Benson, Student	Technician
Karen Hood, Student	Technician
Meta Sienkiewicz, Graduate Assistant	Data Analysis

Personnel who have been hired and who will participate in the field program are as follows.

Name and Title	Principal Activity
Bruce Burdick, Research Assistant	Rawinsonde operator
John Rod, Research Assistant	Rawinsonde operator
Steve Bishkin, Research Assistant	Rawinsonde operator
Tim Deegan, Research Assistant	Rawinsonde operator
Robert Cohen, Research Assistant	Rawinsonde operator
Phil Zamora, Research Assistant	Rawinsonde operator
Dan Neville, Research Assistant	Rawinsonde operator
Dan Tschoepe, Research Assistant	Rawinsonde operator
Kip Etheridge, Research Assistant	Rawinsonde operator
Bill Babb, Research Assistant	Rawinsonde operator
Jerry Guynes, Research Assistant	Electronics Technician
Gordon Grant, Research Assistant	Surface Station Technician
Steve Williams, Research Assistant	Data Analyst
Nick Horvath, Research Assistant	Data Analyst
Alexis B. Long, Associate Research Scientist	Aircraft Observer
James R. Scoggins, Professor	Project Manager

Changes in assignments from those indicated above may be necessary and will be made as needed in order to take advantage of capabilities and expertise. The work schedules for all personnel will vary and depend on the work load. Those who will work during the summer will begin employment approximately May 15 and terminate near the end of August.

TEXAS TECH UNIVERSITY

Satellite, Rainfall, Radar Research

TEXAS TECH UNIVERSITY

Interim Report

1 January 1979 to 31 March 1979

for

Office of Atmospheric Resources Management
Bureau of Reclamation

TDWR Contract No. 14-90023

This document constitutes an interim report for activity conducted under Interagency Contract Number IAC(79-80)14-90023 for the period ending 31 March 1979. The report is divided into three sections: (1) activity for the report period for each task stated in the contract, (2) statement of work planned for the next report period, (3) personnel assigned to the project and travel during the report period.

1. Activity for the Report Period

Task 1 - Analysis of 1977 Satellite Radiance and Rainfall Data. Four dates from the 1977 Texas HIPLEX field period have been selected for detailed case study analysis; they are June 22, June 24, June 27 and July 8. On June 22 and July 8 significant precipitation occurred in the Texas HIPLEX area while on June 24 and June 27 no precipitation was recorded despite the presence of significant cloud development. A major thrust of the analysis of the 1977 radiance data will be the development of techniques for discrimination of precipitation from non-precipitation days based upon satellite radiance data, and the correlation of these with radar and raingage measurements.

Raw data tapes for the four case study days have been obtained from Colorado State University (CSU), which was responsible for acquisition of 1977 HIPLEX satellite data. The data consist of visible and infrared radiance data collected by GOES-WEST (Subsatellite point 0^{o}N, 135^{o}W). Processing of the data has begun and sectors of data have been extracted for an area 315 km x 315 km centered at Big Spring, Texas (see Figure 1). Analysis of the data will be performed at all times when measurements were made. These are listed in Table I.

Also given in Table I are values of the visible data determined to be the threshold brightness level for a convective cloud element. These results were obtained with the cooperation and support of the Department of Atmospheric Science at CSU, in particular, through the use of the ADVISAR (All Digital Video Imaging System for Atmospheric Research).

Task 2 - Analysis of 1977 and 1978 Satellite Data. Visible and infrared photographic images were gathered at the Lubbock office of the National Weather Service (NWS) during the 1978 Texas HIPLEX field program. All

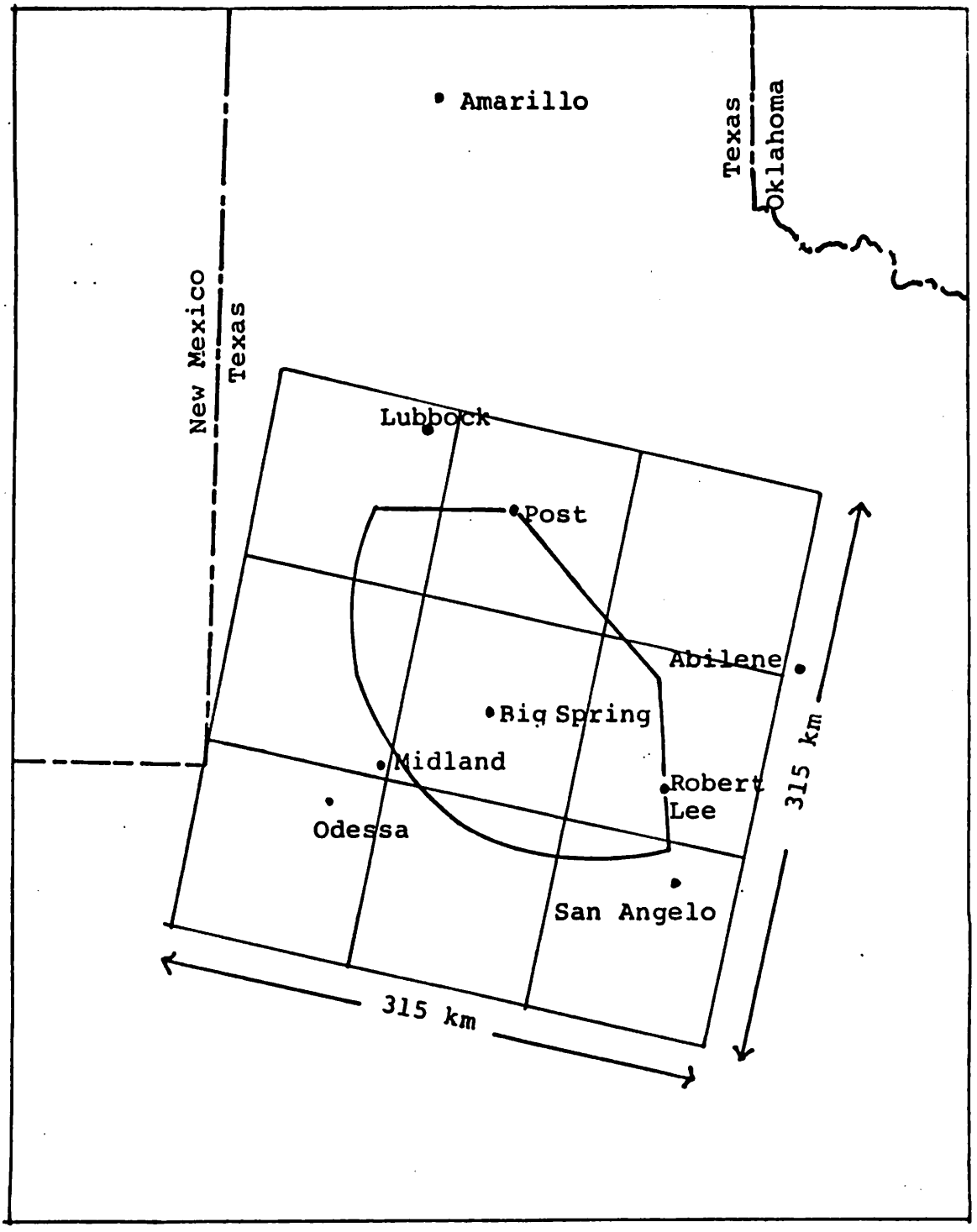


Figure 1. The area of study. The sector at the center is the Texas HIPLEX study region.

TABLE I

1977 Case Study Dates and Times
for Satellite Analysis

Also listed in parentheses for each time is the threshold level of the visible data for a pixel to be considered a convective cloud element

June 22		June 24		June 27		July 08	
		1745GMT	(128)	1745GMT	(128)	1745GMT	(128)
1815GMT	(128)	1815	(128)	1815	(128)		
1845	(128)	1845	(128)	1845	(128)	1845	(128)
1915	(128)	1915	(128)	1915	(128)	1915	(128)
1945	(128)	1945	(128)	1945	(128)	1945	(128)
2015	(128)	2015	(128)	2015	(128)	2015	(128)
2045	(128)	2045	(128)	2045	(128)		
2115	(128)	2115	(128)	2115	(128)	2115	(128)
2145	(124)	2145	(100)	2145	(124)	2145	( )**
2215	(120)	2215	(96)	2215	(124)	2215	( )**
2245	(112)	2245	(88)			2245	(124)
2315	(92)	2315	(88)				
2345	(80)	2345	(80)			2345	(100)
0015	(72)	0015	(68)			0015	(76)

*Next day

**Not available at present

available photos were obtained at 30-minute intervals 24 hours a day from June 1 through July 31. Each photo has been processed by hand to obtain cloud populations in several categories -- isolated convective, convective cluster, convective line, and widespread--, percent cloud cover and minimum cloud top temperature for each of the 9 sub-areas shown in Figure 1. The data have been punched on cards and are being verified at the present time. Upon completion of this task, a statistical summary of the satellite-derived cloud properties for the 1978 Texas HIPLEX field period will be prepared.

Task 3 - Rainfall Analysis. Isohyetal analyses with 15-minute resolution have been completed for all periods of significant rainfall within the HIPLEX raingage network during the 1977 and 1978 field seasons. Maps are presently available for the periods given in Table II. The processing of all data for 1977 and 1978 has been completed. A report containing a data summary will be published before the end of the next quarter. Rainfall intensity and duration have been completed for each period given in Table II. In addition, total storm precipitation (in acre feet) has been completed for each and every rainfall event observed in any portion of the gage network. Digital radar data have been acquired from MRI to supplement the raingage, satellite and rawinsonde data. Analyses incorporating all of the data is proceeding for the case study dates of June 22 and July 8, 1977. Using these data and documentation provided by MRI, a computer program has been prepared which reads the radar data from magnetic tape and prints it in the form of vertical cross sections of radar reflectivity.

Task 4 - Radar Data Collection for the 1979 Field Experiment. Location of the Skywater 5-cm radar has been established for the 1979 field experiment and arrangements for installation have been completed. A description

TABLE II

1977 and 1978 Isohyetal Analyses Dates and Times

YEAR	DATE	TIME (GMT)
1977	20 June	0415 - 0845
	22 June	2045 - 2245
	23 June	2000 - 2330
	8 July	1830 - 2045
	28 Aug	0000 - 0430
1978	2 June	1300 - 1700
	5 June	2200 - 0145 (6 June)
	6 June	1400 - 1800
	30 June	2000 - 0100 (1 July)
	3 July	2200 - 0445 (4 July)
	22 July	1915 - 2330
	23 July	2000 - 2345

of radar data collection guidelines has been proposed for inclusion in the Operations Plan for the 1979 field season.

Task 5 - Real-Time Support of the 1979 Texas HIPLEX Field Program. The Bureau has made available a Laserfax for the reception of satellite imagery at the Texas HIPLEX field operations center during the 1979 field program. As a result, the real-time support provided by telephone from the NWS Forecast Office in Lubbock in past years will be eliminated in 1979. In its place, real-time support will be provided for the duration of the field program directly at the field operations center. Assistance has been provided to Bureau and NWS personnel in arranging for a GOES-tap line to be installed between the Lubbock office and the HIPLEX operations center in Big Spring.

2. Work Planned

Task 1. Analysis of the 1977 radiance data will proceed and be completed during the next report period. Special emphasis will be placed upon the integration and correlation of satellite-derived results with both radar and raingage data analyses.

Two problems in the analysis of the 1977 data have been uncovered recently and will, of necessity, be dealt with immediately. The first involves a synchronization problem in the data receiving equipment used to collect the satellite radiance data at White Sands Missile Range, New Mexico, in 1977. Occasionally, but not predictably, the start time of a record of data would be in error by an amount which differed from one occurrence to another. The effect upon the appearance of reconstructed images of clouds is to add "ragged" edges to the clouds. This is shown in Figure 2. This problem will certainly have an influence upon some aspects of the data analysis. Its impact will be assessed during the next report period.

The second problem encountered arises from the presence of extremely large gradients of visible brightness values in the data, especially at the edges of deep convective clouds casting dark shadows on the ground. An example is given in Figure 3. Differences as large as 112 units from one pixel to the next have been observed at such boundaries. It will be necessary to modify some of the smoothing and interpolating techniques previously developed to accommodate this situation.

Task 2. Upon completion of the data preparation, a detailed analysis of the diurnal and spatial variations of cloud populations will be performed on the 1978 satellite imagery data. Finally, a comparison will be made of

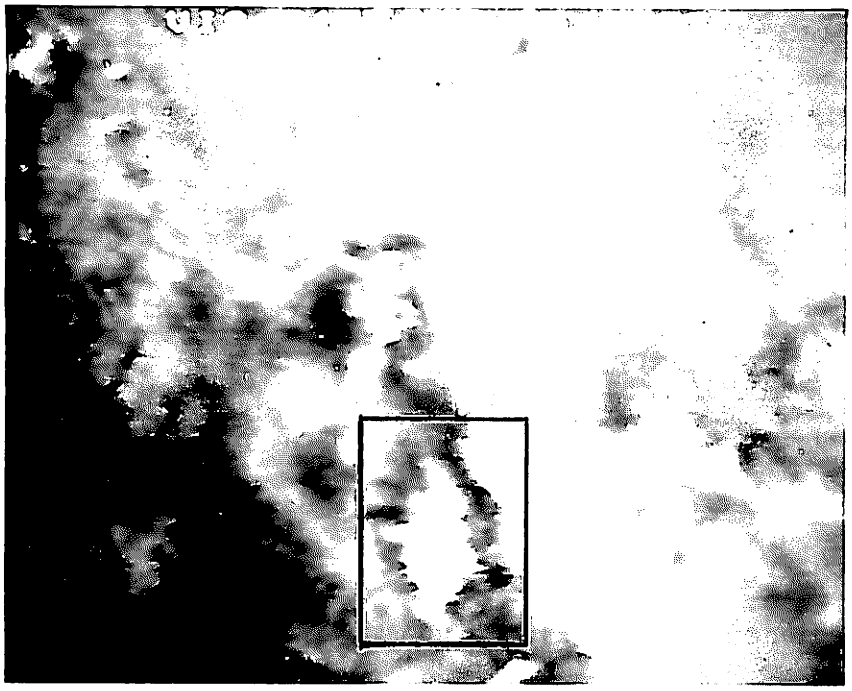


Figure 2. Visible radiance data in the study area at 2145 GMT on 27 June 1977 showing ragged cloud edges enclosed in box caused by synchronization errors in start time of data records.

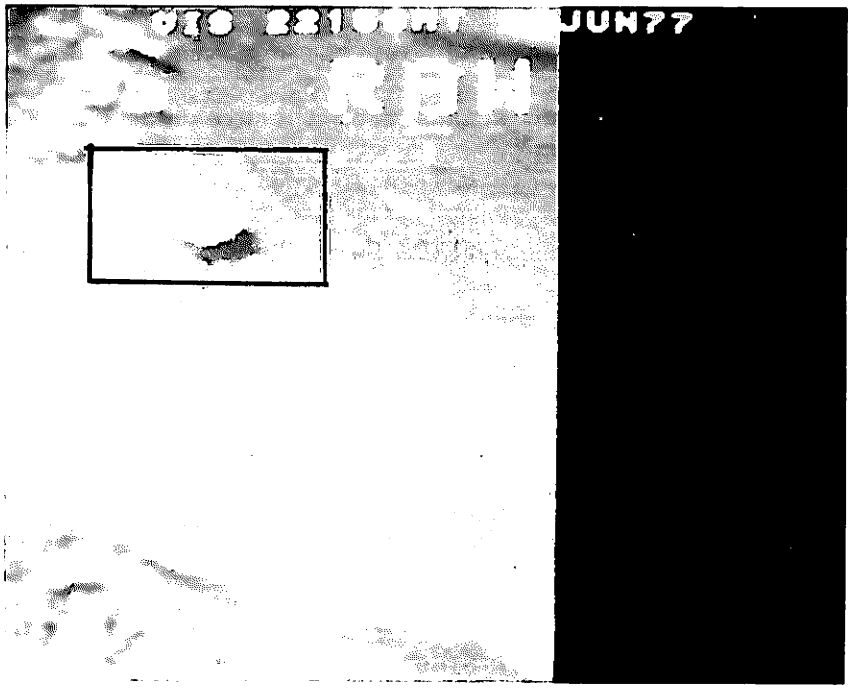


Figure 3. Visible radiance data in the study area at 2215 GMT on 27 June 1977 showing strong gradients in cloud shadow area enclosed in box.

results obtained independently for the 1976 and 1977 Texas HIPLEX field periods. The results of the intercomparison will be published as a technical report.

Task 3. Emphasis during the next period will focus upon integration of the rainfall dates with radar, satellite and mesoscale observations for the case study periods in 1977 and 1978. Inclusion of the digital radar data will allow detailed study of the three-dimensional precipitation patterns for these periods. Radar and precipitation patterns will be analyzed in an attempt to select an appropriate radar reflectivity - rainfall rate calibration (Z-R relationship). Analyses of rawinsonde and surface wind observations will be made for integration with the radar data. Design of the raingage network for the 1979 field season has been completed with the addition of 25 new gages. Installation and calibration of the gages by the staff of the Colorado River Minicipal Water District has also been accomplished and the measurement program has begun. All data will be processed at Texas Tech University and made available in the format specified by the Bureau of Reclamation.

Task 4. Plans for the collection of 5-cm radar data during the 1979 field experiment are complete. Four scanning sequences for the collection of digital data have been selected and are described in Table III. The radar is scheduled to arrive in Big Spring on 23 April 1979.

Task 5. The GOES-tap line will be installed and the Laserfax equipment will arrive in Big Spring in late April. Dr. Jurica will be present at the field operations center in Big Spring for the duration of the 1979 field program. Real-time support will be provided to the decisions of forecasting operational days, selecting target areas and evaluation of missions.

TABLE III

Scanning mode sequence for Skywater radar

	Forecasting Mode	Z-R Relationship Mode	Aircraft Mode	Deep Convection Mode
Range interval	1 km	0.5 km	0.5 km	0.5 km
Range delay	20 km	10 km	10 km	10 km
Pulse repetition frequency	414 s^{-1}	414 s^{-1}	414 s^{-1}	414 s^{-1}
A scan				
Elevation angle	0.5°	0.5°	1°	1°
Samples per degree azimuth	8	8	16	16
B scan				
Lowest elevation angle	1°	1°	2°	2°
Highest elevation angle	10°	3.5°	9°	18°
Elevation step	0.5°	0.5°	0.5°	1°
Samples per degree azimuth	8	32	8	8
Time required for volume scan	∿240 s	∿250 s	∿260 s	∿260 s
Interval between start of successive volume scans	10 min	5 min	5 min	5 min

3. Appendix

Personnel Assigned to the Project

NAME	TITLE	RESPONSIBILITY
Donald R. Haragan	Principal Investigator	Rainfall Data Processing and Analysis and Project Management
Jerry Jurica	Principal Investigator	Satellite Data Analysis and Field Support
Colleen A. Leary	Principal Investigator	Radar data collection and analysis
Shih-Cheng Chao	Research Assistant	Data Analysis
James Holman	Research Associate	Computer Programming
Debbie Kerr	Secretary II	Data Processing and Budget Analysis
Don Williams	Research Associate	Computer Programming

Travel

February 8	Dr. Jurica and Dr. Leary traveled to Snyder, Texas to investigate potential sites for placement of the Skywater radar during the 1979 field program.
February 14	Dr. Haragan, Dr. Jurica and Dr. Leary traveled to Big Spring to meet with other HIPLEX personnel and make final selection of the radar site.
March 26-28	Dr. Jurica, Mr. Chao and Mr. Williams traveled to Fort Collins, Colorado to utilize the ADVISAR at CSU for an initial analyses of 1977 GOES radiance data.

COLORADO RIVER MUNICIPAL WATER DISTRICT

Field Support

COLORADO RIVER MUNICIPAL WATER DISTRICT

Interim Progress Report

1 October 1978 - 31 March 1979

Prepared for:

United States Department of the Interior
Bureau of Reclamation
Division of Atmospheric Water Resources Management

Contract No. 14-90027, 1 January 1979
Contract No. 14-80040, 1 February 1978

April 1979

RAINGAGE NETWORK

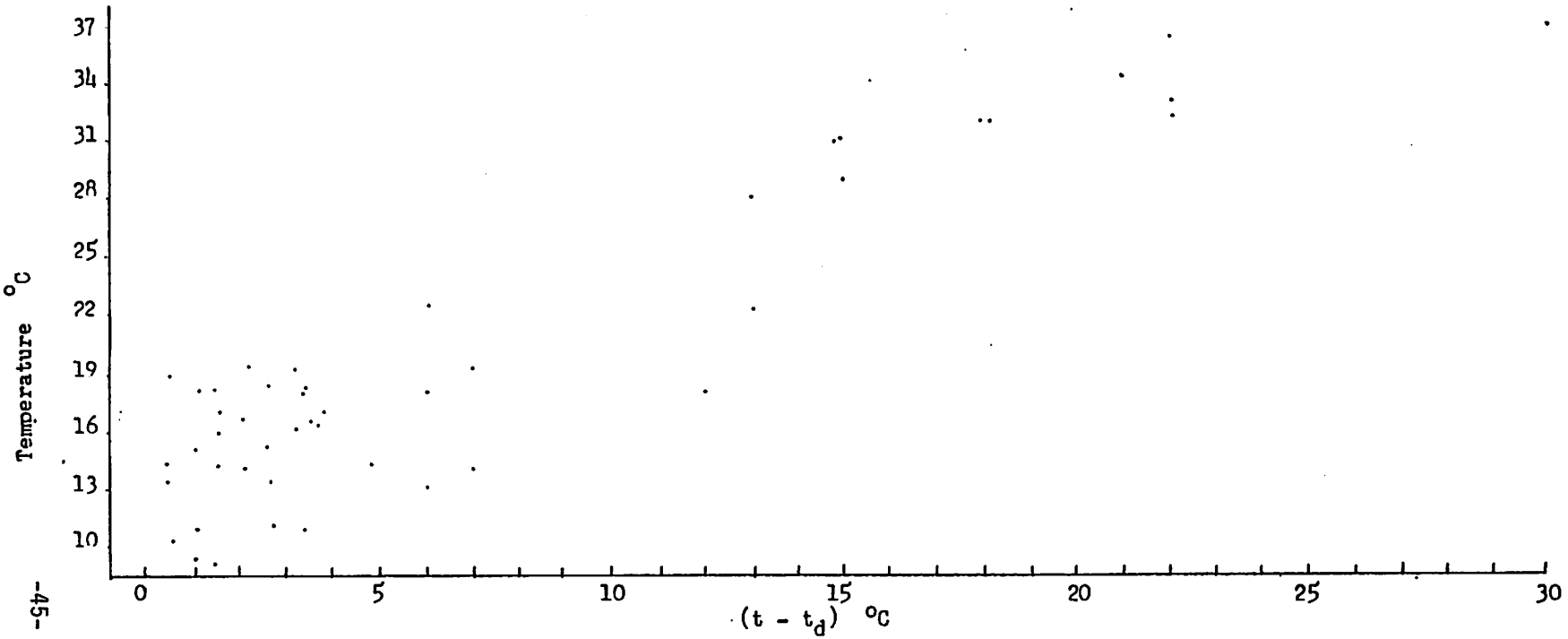
During this period District personnel removed the clocks, drums and buckets from the 81 recording gages in the field and wrapped each gage in a plastic material to protect them from the weather and inspected them on a regular basis to prevent vandalism. During January and February 1979, an additional 25 Belfort recording gages were received from the Bureau. Bases for these gages were built and the gages placed in the field at locations suggested by Texas Tech personnel and others.

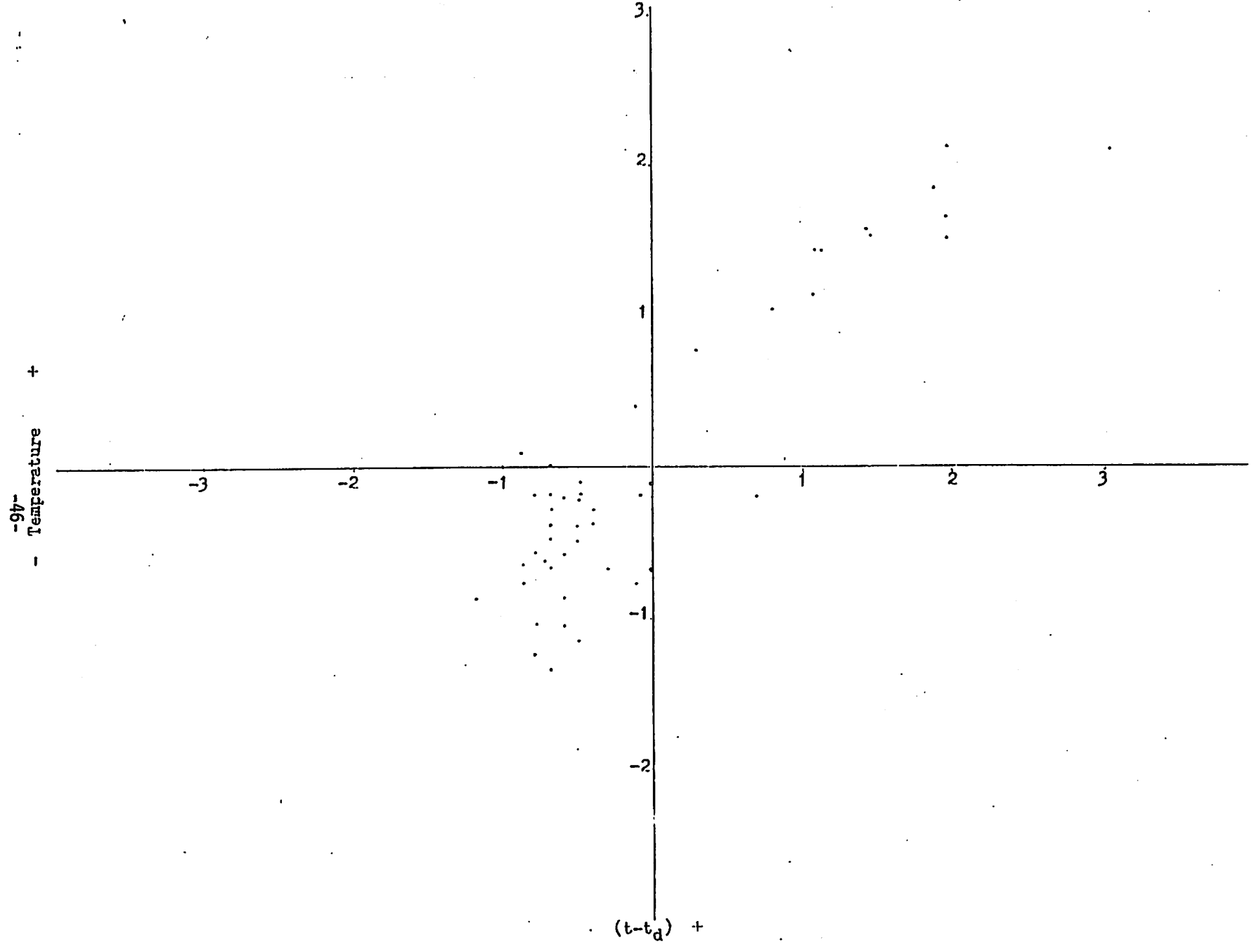
Beginning in early March, raingage technicians began reinstalling clocks, drums and buckets in the gages and each gage was calibrated for accuracy in measuring rainfall. All 106 gages were in operation on March 15th and clocks were checked for accuracy during the last two weeks in March 1979.

During the week of February 19 - 23, 1979, Mr. Bill Hanshaw of Texas Department of Water Resources, visited Big Spring and instructed Mr. Richard Halfmann and Wesley Cox in procedures for calibrating the Belfort recording gages. Mr. Halfmann in turn has instructed Mr. Tom Heffner in the procedure.

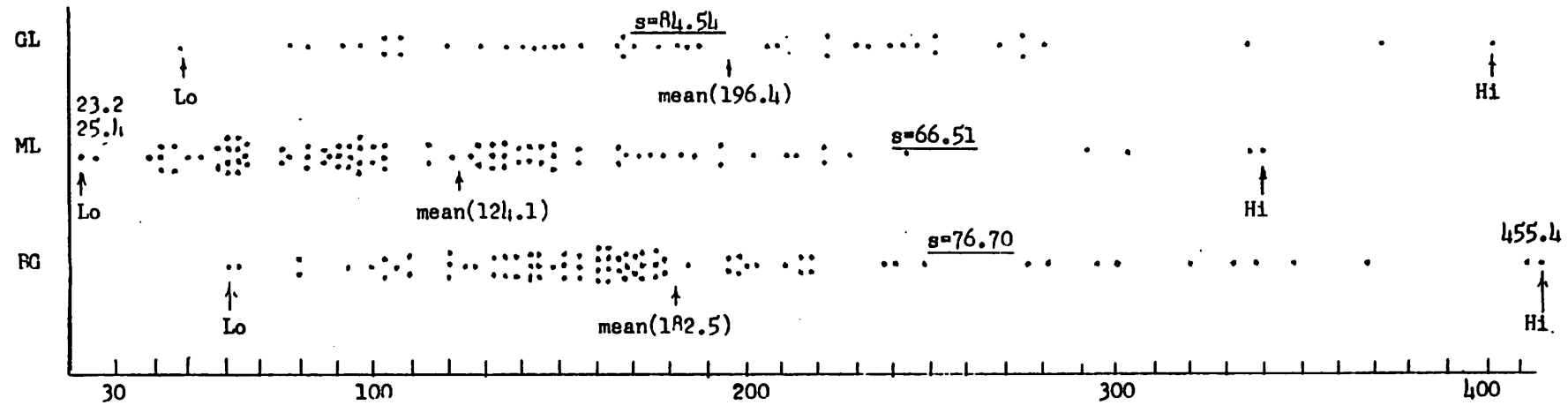
The fence post network of 81 gages were placed in position during March and were monitored and rainfall recorded for the month.

T vs $(t - t_d)$ GL 1978




Normalized Distributation (Surface T vs $(t-t_d)$)
GL 1978
3
2
1
-1
-2
-3
1
2
3
+
Temperature
-
$(t-t_d)$ +

SWEAT INDEX 1978



GOODLAND KS

48.7 1	142.0 1	186.0 1	252.2 1
78.4 1	144.9 1	188.3 1	269.0 1
82.1 1	146.7 1	208.0 1	275.8 1
91.8 1	150.5 1	210.0 1	276.8 1
97.1 1	152.2 1	222.3 1	280.9 1
102.7 1	157.4 1	223.3 1	337.0 1
104.2 1	166.8 1	231.1 1	364.4 1
107.4 1	169.1 1	233.5 1	367.2 1
109 0 1	169.6 1	239.9 1	372.7 1
120.5 1	172.1 1	243.1 1	408.0 1
130.0 1	179.4 1	246.5 1	
138.0 1	183.9 1	251.2 1	

MILES CITY MT

23.2 1	75.7 1	115.0 1	166.6 1
25.4 1	77.0 1	115.3 1	167.0 1
39.0 1	78.3 1	121.5 1	169.1 1
43.3 1	81.1 1	127.6 1	173.7 1
43.5 1	82.2 1	129.7 1	175.9 1
43.6 1	83.4 1	129.9 1	179.0 1
47.6 1	87.1 1	130.8 1	183.5 1
48.3 1	89.7 2	131.7 1	186.7 1
50.9 1	90.5 1	132.1 1	192.6 1
54.4 1	92.7 1	132.9 1	194.0 1
58.3 1	93.5 1	134.9 1	201.9 1
59.7 1	94.5 1	136.2 1	211.3 1
60.4 1	95.1 1	138.6 1	214.1 1
61.0 1	95.2 1	140.5 1	220.8 1
61.3 1	96.5 1	141.3 1	222.0 1
62.7 1	97.4 1	142.3 1	228.5 1
63.0 1	99.3 1	145.2 1	244.2 1
63.7 1	99.8 1	146.1 1	292.4 1
65.9 1	100.0 1	146.9 1	303.7 1
66.6 1	100.6 1	1[illegible].5 1	337.8 1
66.9 1	102.1 1	14[illegible].6 1	339.5 1
67.1 1	102.6 1	155.1 1	
68.4 1	103.6 1	156.3 1	

BIG SPRING TX

61.3 1	139.0 1	163.4 1	212.1 1
64.4 1	142.6 1	165.7 1	213.9 1
79.9 1	142.8 1	166.2 1	216.2 1
80.4 1	143.3 1	166.8 1	219.1 1
94.3 1	144.2 2	169.9 1	219.6 1
100.5 1	144.3 1	171.0 1	237.8 1
102.4 1	144.8 1	172.5 1	240.1 1
103.7 1	148.8 1	173.5 1	248.8 1
105.3 1	150.8 1	173.9 1	276.8 1
108.7 1	151.0 1	174.8 1	281.8 1
110.4 1	152.9 1	175.0 1	295.4 1
120.7 1	155.7 1	175.2 1	305.6 1
121.1 1	156.0 1	175.9 1	321.2 1
121.3 1	156.2 1	179.1 1	333.1 1
126.6 1	159.8 1	185.5 1	338.7 1
128.3 1	160.1 1	196.7 1	348.5 1
134.5 1	160.3 1	197.0 1	368.5 1
134.8 1	160.6 1	198.3 1	368.6 1
136.7 1	161.0 1	198.6 1	411.1 1
137.7 1	162.4 2	200.6 1	455.4 1
138.9 1	163.3 1	203.7 1	

In addition, there is a 'sorted' tabulation typed below the plot which shows each value and the number of times that value occurs.

The design for the plots called for in Task 3 differ from those for Tasks 1 and 2 in that the surface data information is for one HIPLEX site only. The 'winds' plots include tabulated values; and the 'Temperature vs Dew Point' plots include a separate normalized plot.

The plots for Task 4 show a three-way comparison of data from the three Texas radiosonde sites, ie., Post, Texas; Robert Lee, Texas and Midland, Texas.

It is the intent of the project scientist to further analyze these data and enter these data findings into a technical report.

AIRCRAFT, RADAR AND RAWINSONDE OPERATIONS

There were no aircraft, rawinsonde or radar activities conducted during this reporting period because all weather modification field operations terminated on 31 October 1978.

WORK PLANNED

A letter of agreement for the construction and implementation of an airborne cloud physics package has been reached between the CRMWD and the Colorado International Corporation. This equipment will be installed on the CRMWD P-Navajo for use during the Texas HIPLEX field program. In addition, the FAA-Air Traffic Control Center, Fort Worth,

MEANS and STANDARD DEVIATIONS 1978

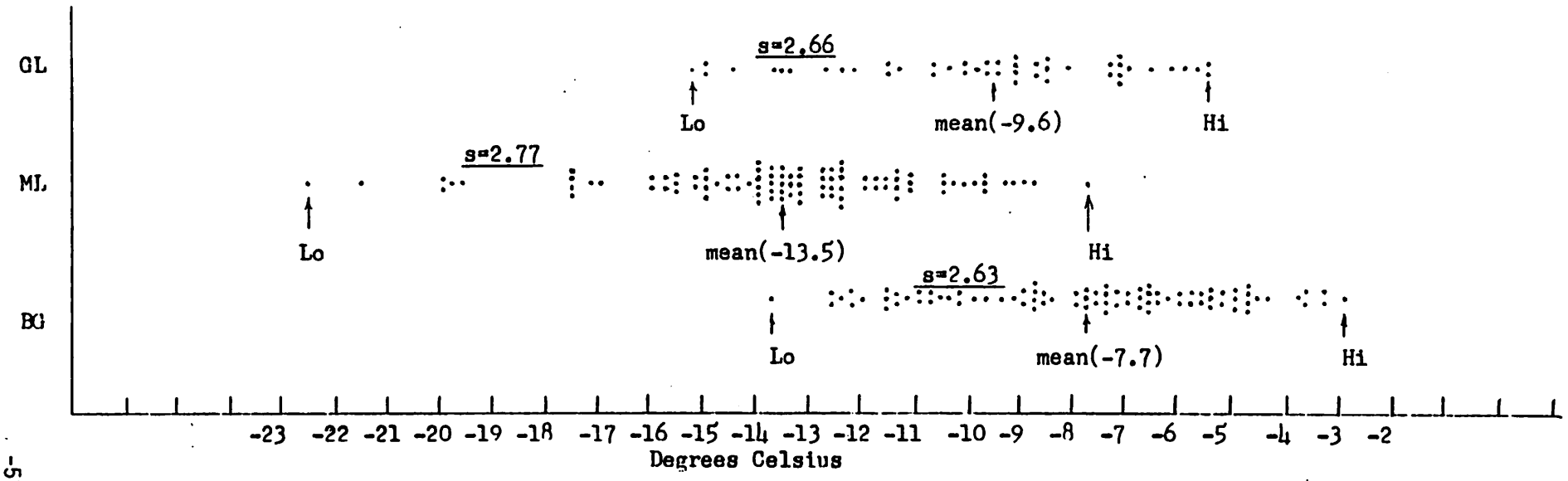
		GL		ML		BG	
	MBS	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
Temperature Distribution	850	20.2	6.18	15.7	5.43	21.8	3.49
	700	10.4	4.95	4.4	4.30	9.9	2.47
	500	-9.6	2.66	-13.5	2.77	-7.7	2.63
Geopotential Heights	850	1492	31.82	1496	37.77	1538	23.47
	700	3142	33.18	3110	38.79	3188	33.27
	500	5840	57.24	5759	60.69	5893	48.19
Dew Point Depression	850	11.2	7.70	12.3	7.06	11.7	5.04
	700	14.2	9.07	13.1	9.21	10.8	8.93
	500	17.0	9.89	18.8	11.03	16.3	11.14
THETA	850	307.3	6.47	302.6	5.69	309.0	3.66
	700	314.0	5.48	307.3	4.76	313.4	2.74
	500	321.3	3.25	316.6	3.37	323.7	3.21
THETE	850	333.0	9.65	320.1	8.08	336.2	5.87
	700	328.0	6.21	317.7	6.79	331.1	7.24
	500	325.5	4.66	319.9	3.94	329.7	6.28
Wind Speed	850	11.9	6.63	6.3	3.80	6.3	2.52
	700	8.9	4.72	9.4	3.95	5.1	2.73
	500	12.1	5.36	16.3	6.46	6.8	5.44
THETE	700 - 850	-4.7	7.07	-2.6	5.01	-5.1	8.06
	500 - 700	-2.7	4.00	1.8	5.07	-1.6	6.67
Wind Speed	700 - 850	-3.0	6.27	3.2	3.84	-1.2	3.01
	500 - 700	3.1	7.17	6.9	5.96	1.8	5.21
Precipitable Water	Sfc - 850	0.37	0.08	0.50	0.12	0.82	0.17
	Sfc - 700	1.35	0.30	1.22	0.32	2.02	0.32
	Sfc - 500	1.90	0.46	1.63	0.47	2.78	0.55
	Total	2.00	0.50	1.70	0.50	2.92	0.65

MEANS and STANDARD DEVIATIONS 1978

	GL		ML		BG	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
Isotherm Heights 0°	4453	581	3682	615	4641	342
-5°	5185	467	4459	570	5478	421
-10°	5903	437	5223	468	6274	495
-15°	6649	455	5972	451	7105	457
Mean Mixing Ratio Lowest 100 MB	8.36	1.90	6.52	1.69	10.16	1.83
Lifted Index 100 MB Layer Adiabatic	-0.8	2.83	1.8	3.11	-0.8	2.89
Lifted Index 50 MB Layer Mean Values	2.2	3.67	2.5	3.32	-0.9	2.99
Total Totals	48.1	4.84	46.1	5.09	47.2	4.88
K Index	24.4	8.92	19.5	11.02	28.7	8.75
SWEAT Index	196.4	84.54	124.1	66.51	182.5	76.70

TEMPERATURE DISTRIBUTION 1978

500 MB



GOODLAND KS

Deg. #	Deg. #	Deg. #	Deg. #
-15.1 1	-12.1 1	-9.5 2	-6.5 1
-14.9 2	-11.5 2	-9.1 4	-6.1 1
-14.3 1	-11.3 1	-8.7 2	-5.9 1
-13.7 1	-10.7 2	-8.5 3	-5.7 1
-13.5 1	-10.3 1	-8.1 1	-5.5 2
-13.3 1	-10.1 2	-7.3 2	
-12.7 1	- 9.9 1	-7.1 4	
-12.3 1	- 9.7 2	-6.9 1	

MILES CITY MT

Deg. #	Deg. #	Deg. #	Deg. #
-22.5 1	-15.5 3	-13.3 3	-10.5 3
-21.5 1	-15.1 2	-13.1 5	-10.3 1
-19.9 2	-14.9 4	-12.7 4	-10.1 1
-19.7 1	-14.7 1	-12.5 4	- 9.9 1
-19.5 1	-14.5 2	-12.3 6	- 9.7 3
-17.5 4	-14.3 2	-11.9 2	- 9.3 1
-17.1 1	-14.1 1	-11.7 2	- 9.1 1
-16.9 1	-13.9 6	-11.5 2	- 8.9 1
-15.9 2	-13.7 5	-11.3 4	- 8.7 1
-15.7 2	-13.5 5	-11.1 3	- 7.7 1

BIG SPRING TX

Deg. #	Deg. #	Deg. #	Deg. #
-13.7 1	-10.3 1	-7.7 3	-5.5 2
-12.5 2	-10.1 2	-7.5 2	-5.3 3
-12.3 1	- 9.9 1	-7.3 4	-5.1 2
-12.1 2	- 9.7 1	-7.1 2	-4.9 3
-11.9 1	- 9.3 1	-6.9 3	-4.7 4
-11.5 3	- 9.1 1	-6.7 3	-4.5 1
-11.3 2	- 8.9 2	-6.5 4	-4.3 1
-11.1 1	- 8.7 4	-6.3 2	-3.9 1
-10.9 2	- 8.5 2	-6.1 1	-3.7 2
-10.7 2	- 8.3 1	-5.9 2	-3.3 2
-10.5 1	- 7.9 2	-5.7 2	-2.9 1

Texas, has been notified by letter and advised of the HIPLEX aircraft activities that will take place this summer at Big Spring, Texas.

Briefly outlined below are the equipment and associated activities for which the CRMWD will be responsible in supporting the 1979 Texas HIPLEX Field Program.

I. Seeding and Sampling Aircraft

   A. P-Navajo & Aztec

   B. 2 Pilots & 1 Observer

   C. Physical Data Collection (Aztec)

   D. Airborne Cloud Physics Package

II. Rawinsonde Operation

   A. 1 Operator & 1 Key Punch Typist

   B. Signal Transformation & Data Input to Cyber 7400

   C. Support to the Meso-scale Program & Input into Daily Forecasts

III. Raingage Network

   A. Recording & Non-recording Raingages (101 & 81 Gages)

   B. 3 Raingage Technicians

   C. Weekly Data Collection & Chart Interpretation

   D. Forwarding of Data

   E. Periodic Maintenance & Gage Calibration

   F. Winterization of all Gages

IV. Radar Operation (FPS-77)

A. 1 Radar Meteorologist

B. Provide A/c Advisories

C. Monitor Radar Video Displays to Assist in Locating Clouds of Interest

Preparations at this time are being made for erecting the BREC SWR-75 radar system at Howard County Airport. In addition, the RD-65 manually operated rawinsonde unit at Big Spring is being replaced with an automated tracking system to correct antenna wind loading problems. Also, the LAZER-FAC to be operated by Texas Tech personnel has been set up with other HIPLEX weather displaying equipment at Big Spring.

Recently the District's P-Navajo completed a 100-hour airframe and mechanical inspection to minimize the possibility of aircraft down-time during the 1979 HIPLEX program. The Aztec will undergo a similar inspection prior to the start of HIPLEX.

At this time, it appears all necessary equipment and personnel being sponsored by the CRMWD will be properly functioning and on hand for the 1979 Texas HIPLEX field program.

TEXAS A&M UNIVERSITY

Radar-Echo Climatology

ACTIVITY FOR THE REPORT PERIOD

1: Synoptic Climatology of Southern HIPLEX

A. Objective Climatology of Weather Types

Surface and upper-air data for Midland, Texas, for the periods April 1 through September 30 of 1973-1976 were obtained on magnetic tape from the National Climatic Center. The data were edited for subsequent computer analysis. A series of computer programs from the Statistical Analysis System program library were used to perform various computational tasks.

The first task performed was a principal components analysis. This was based on a correlation matrix obtained from the original data, and determines which combinations of meteorological variables explain a major portion of the variation in the original data sample. Thus, the data volume is reduced from a large number of original variables to a much smaller number of linearly combined variables, or principal components.

The results of the principal components analysis served as input to a regression procedure which formulated a meteorological model for each day. That is, the regression analysis determines the weightings of the components for each day, and these weightings are in the form of regression coefficients.

The regression coefficients were then correlated against each other to differentiate, meteorologically, among the days. Then, using a threshhold value for these coefficients, the individual days become one of 10 to 20 distinct weather types. These types are presumed to be indicative of the HIPLEX area.

B. Subjective Classification of Weather Types

Surface synoptic patterns at 1200Z, from the Daily Weather Map series, were organized into a preliminary classification scheme. The classification criteria included orientation as well as type of frontal systems, and whether these systems were associated with an upper-level disturbance. Also, a note was made as to the location of these systems in relation in Southern HIPLEX. This resulted in an excessive number of weather types. Additional groupings will be performed to reduce the number of types to a more practical size.

The subjective classification will not only serve as a comparison with the objective analysis, but also as a check on the temporal continuity of weather types in Southern HIPLEX.

2. Resolution of the Radar Bias Problem

Previous research, with the Midland PPI films, indicated that the frequency of occurrence of echoes maximizes in the middle distance, or at about 70 nautical miles from the radar. This appears to be due, at least in part, to a combination of under- and overshooting of convective rain cells. The true geographic variation of echo occurrence was approximated by employing an empirical correction factor for this radar bias. The same factor also was applied in determining the efficacy of seeding.

To better formulate the relationship between distance and the ability of the WSR-57 (10 cm) radar to discern echoes, ten

years of PPI film from Amarillo, for the convective season (May through August), were obtained. A grid pattern in the form of a cross centered near the Amarillo radar is overlaid on the PPI photographs, and the occurrence of echoes in each of 48 squares is being tabulated (Appendix). By April 1, three of these ten years had been completed.

Additionally, a count of echoes is being made in the overlap area of the Midland and Amarillo radars (Appendix). Frames (times) of coincident coverage are being examined. An analysis of the variation with distance of echo occurrence for each radar, and the proportion of times echoes occurred in each square, for each radar, should allow us better to specify the desired correction factor.

3. Fine-scale Analysis of Seeding Effects

In previous research an attempt was made to determine echo frequency in seeded vs. nonseeded areas on seed days, and on seeded vs. nonseeded days in seeded areas. The results were less than definitive because it had to be assumed, implicitely, that the entire target area was seeded on a seed day.

To overcome this problem maps were made of the location of seeding missions (Appendix). These were then overlaid on PPI photographs of coincident times. The objective is to determine the characteristics (e.g., size, duration) of seeded echoes (cells) and compare them with those of proximate, unseeded echoes.

In our first few attempts a mistake was made: we failed to

account for 1976 being a leap year. With the correct association of Julian Day with calendar day better results are being obtained. However, it appears that it may not be possible to find control (proximate) echoes sufficiently like the seeded echoes to permit comparisons.

WORK PLANNED FOR THE NEXT REPORT PERIOD

1. Synoptic Climatology of Southern HIPLEX

   We expect to have all days of the convective seasons (April-September) of 1973-1976 typed within two weeks of this date. These types will then be compared with those determined subjectively, and associations will be made between weather types and radar echo characteristics determined in the previous study.

2. Resolution of the Radar Bias Problem

   The extraction of data from the Amarillo films should be completed by May 5. The desired correction factor will then be determined. The overlap analysis will be continued until a sufficiently large data base has been accumulated, after which appropriate analyses will be conducted to arrive at this correction factor.

3. Fine-scale Analysis of Seeding Effects

   We will continue to examine the association between seeded areas and radar echo characteristics, particularly with regard to formulating a methodology that will enable us to determine what effects, if any, seeding has on echo characteristics.

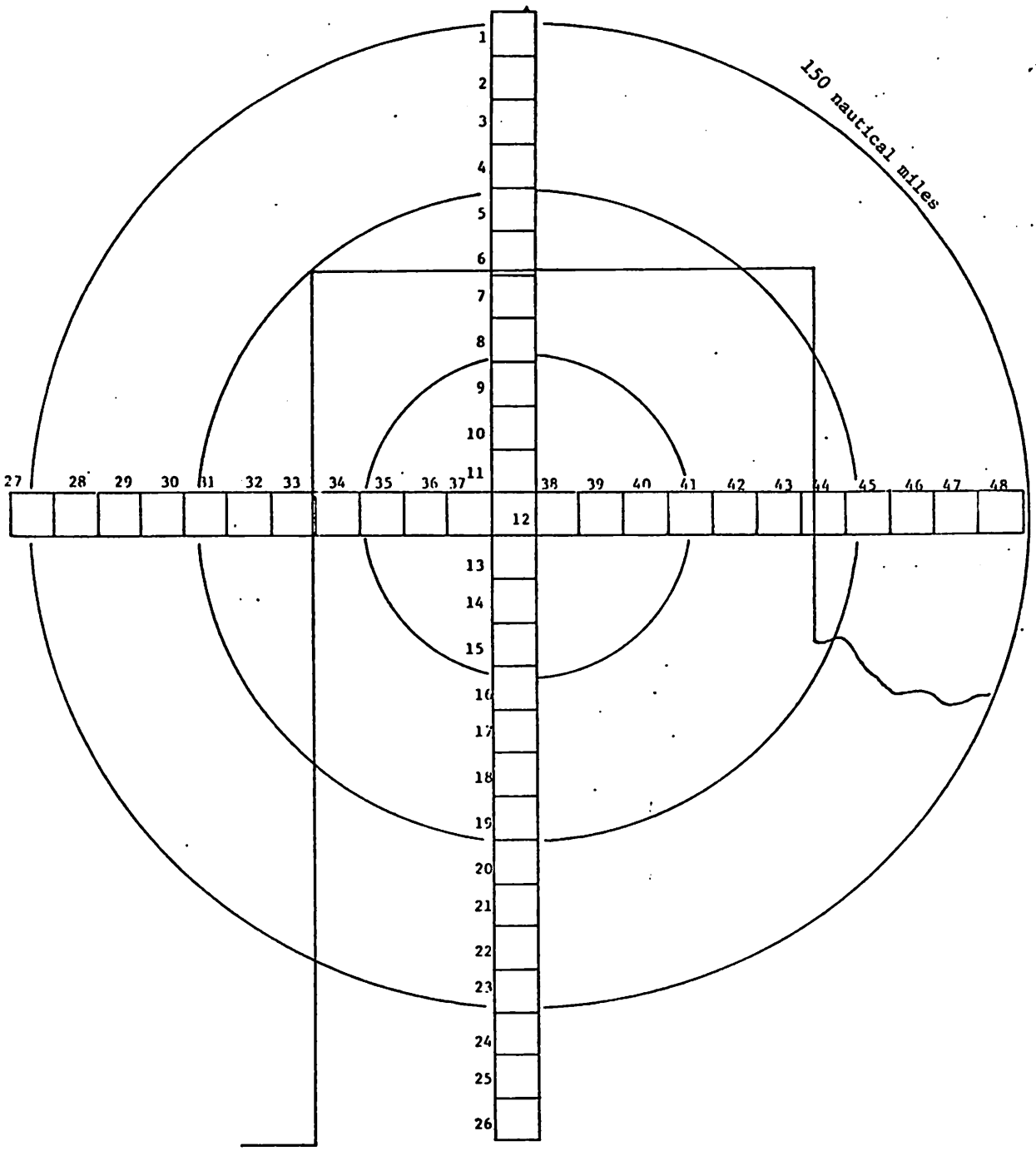
APPENDIX

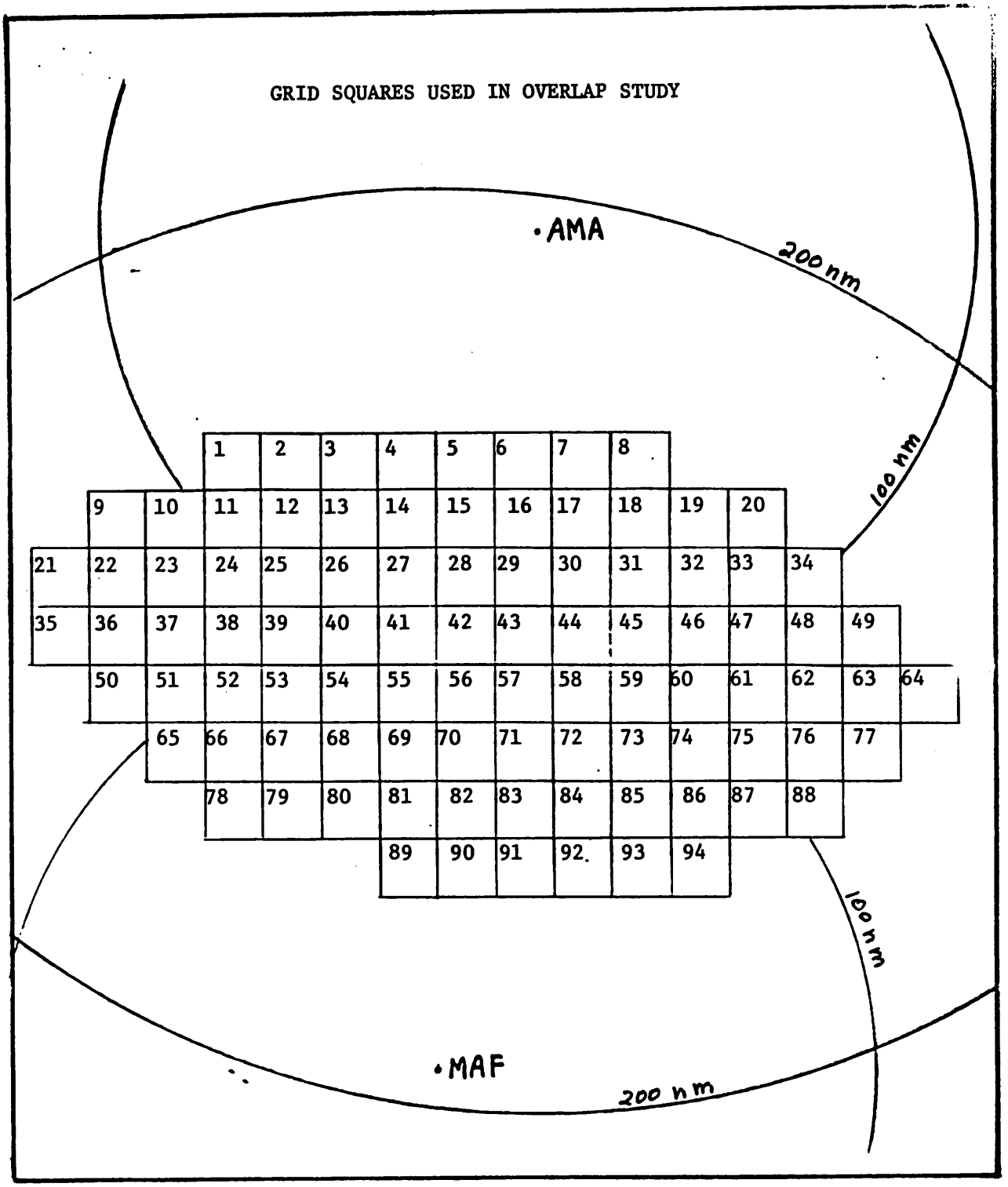
Grid pattern (squares) used in analysis of Amarillo radar data

Grid squares used in overlap study

Seeding tracks

GRID PATTERN (SQUARES) USED IN ANALYSIS OF AMARILLO RADAR DATA



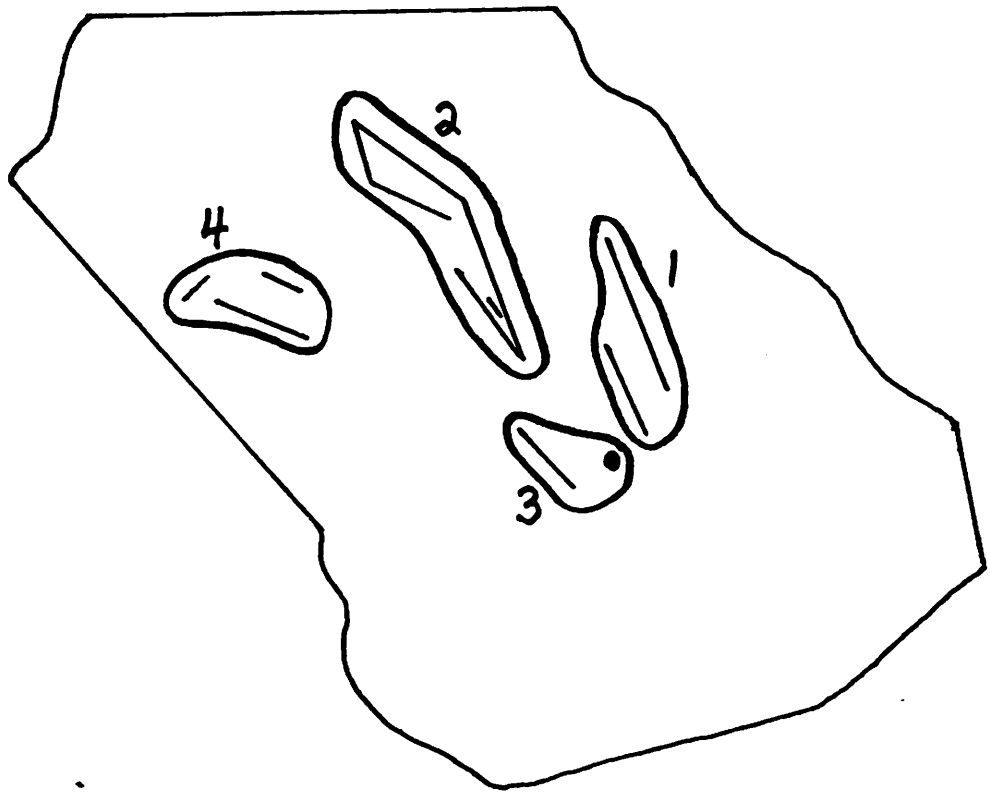

GRID SQUARES USED IN OVERLAP STUDY
AMA
200 nm
100 nm
1 2 3 4 5 6 7 8
9 10 11 12 13 14 15 16 17 18 19 20
21 22 23 24 25 26 27 28 29 30 31 32 33 34
35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
50 51 52 53 54 55 56 57 58 59 60 61 62 63 64
65 66 67 68 69 70 71 72 73 74 75 76 77
78 79 80 81 82 83 84 85 86 87 88
89 90 91 92 93 94
100 nm
MAF
200 nm

SEEDING TRACKS

9/6/76, 1900-2051Z, 14 flares

Line segments indicate beginning and ending positions of flare burns. Dot indicates aircraft position was the same at the beginning and ending of flare burn.

1: 1900-1914
2: 1917-1945
3: 2007-2020
4: 2030-2051



METEOROLOGY RESEARCH, INC.

Radar Data Analysis

Interim Report No. 8

BIG SPRING - HIPLEX

Meteorology Research, Inc.
464 West Woodbury Road
Altadena, California 91001

MRI 79 IR-1671

Interim Report for 1 October 1978 to 31 March 1979

Subcontract 14-80038 with
Texas Department of Water Resources
Post Office Box 13087
Capitol Station
Austin, Texas 78711

Bureau of Reclamation Contract
14-06-D-7587 as amended 1 June 1975

Date 3 April 1979

SECTION 1 - ACTIVITY FOR THE REPORT PERIOD

Task 1 - Radar Data Processing and Mesoscale Analysis

A. Radar Data Processing

The proposed work to be accomplished under this sub-task during FY 78 consisted essentially of the following functions:

1. Develop and implement programs REDIT and PPI
2. Develop program RANGE
3. Run programs on 1976 and 1977 data

Program REDIT was intended to translate the field data tapes into an "A-File" format while detecting, rejecting and/or correcting all format errors. Program PPI plots contours of radar reflectivity in horizontal plan position. Program RANGE eliminates a few, sporadic data groups which appear on the tapes at an incorrect range.

The processing of the 1978 data through REDIT and RANGE was included in the proposed work plan under Task 4 - Field Program.

Work on REDIT and RANGE was completed during the late spring of 1978. At that time, a test tape run at the University of North Dakota revealed a number of format differences which precluded the use of the University of North Dakota computer programs on the 1976-77 data at that time. At the end of the 1978 field season the 1978 tapes were run through REDIT and RANGE so that all M-33 tapes were available in the "A-File" format. All of the 1976 and 1977 data were also processed

through program PPI so that contoured representatives of radar reflectivity were available for all days. Since last fall, all of the effort in radar data processing has been devoted to developing programs which would convert the "A-File" data into a format compatible with the University of North Dakota programs.

Two separate conversion programs (A-7 and A-8) are required to process the radar data from the A-File format to the UND format. The flow of the data through the various processing steps is shown in Figure 1. This system component and flow diagram is very similar to Figures 3.1 and 3.2 in MRI's original proposal (P710 807 6882-R3) except for the addition of the RADPROC compatibility program, A-8 which was not included in the FY 1978 program plans. The other difference not visible in this figure is in the content and purpose of the program previously called, AEDIT which is now called A-7.

The problems which made A-7 and A-8 necessary have arisen from the fact that while REDIT structured the radar data into the "A" file format, the information contained within this format style was not directly compatible with the RADPROC program, which was still under development at the University of North Dakota at the time of the MRI proposal for the FY 78 radar processing. A consequence of this was the proposal to process all of the data into "A-File" format.

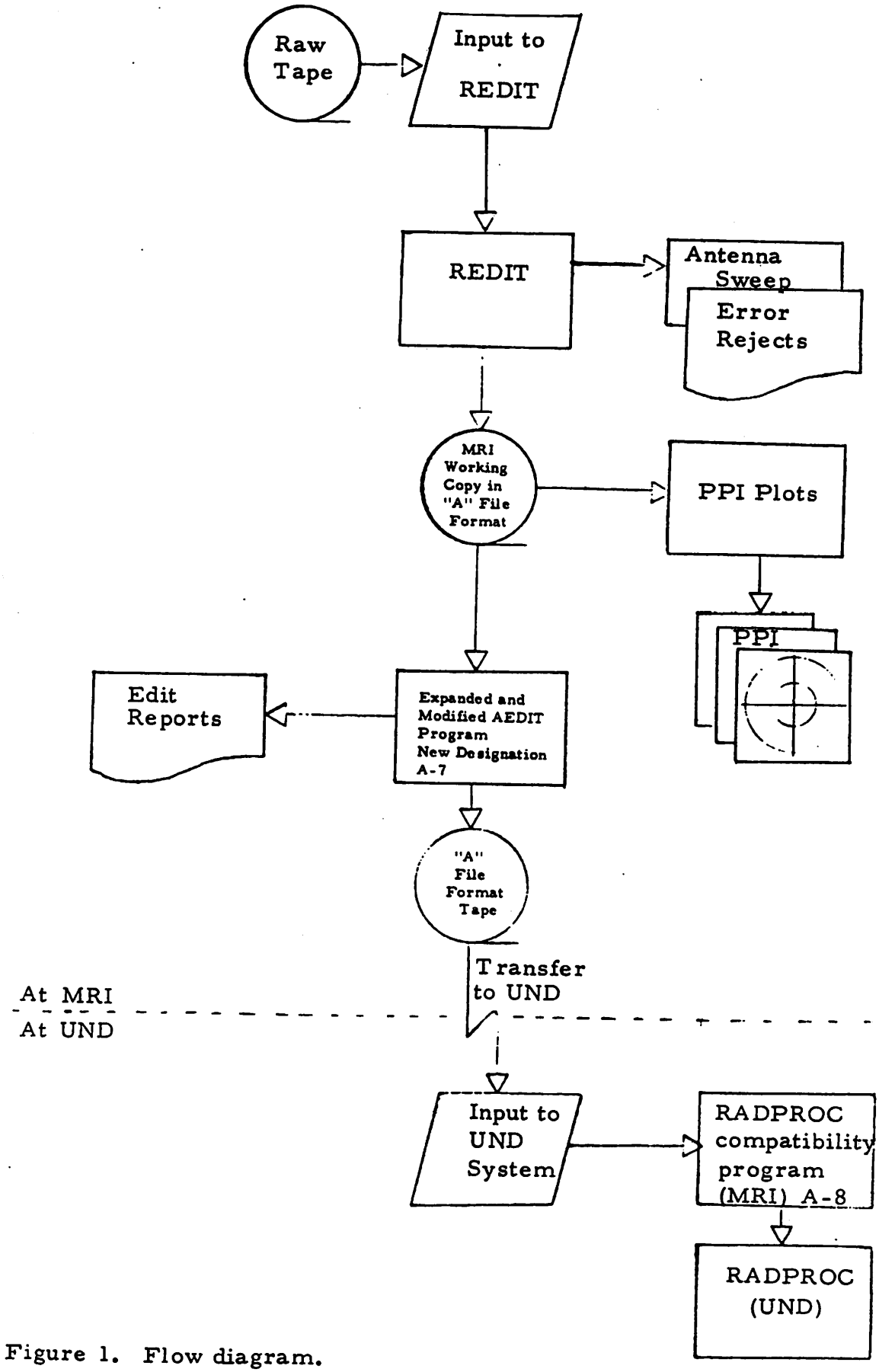


Figure 1. Flow diagram.

A coordination visit to the University of North Dakota in January 1979 resulted in the identification of a number of problem areas which had not been anticipated. A detailed breakdown of the status of the problems and the correction programs is provided in Table 2. The problem numbers correspond to those outlined in Table 1.

Programming for problem types 1 through 8, 11, and 23 has been completed. The programs have been written, coded, debugged and are operational. The programs to correct problem types 15 and 22 have been written, coded and debugged. Those to correct for problem types 13, 14, 16, 17, 18, and 19 have been written and are in various stages of coding and debugging. The program design for problem types 9, 10, 12, 20, 21, 24 and 25 has been completed and they are awaiting coding and debugging efforts.

B. Mesoscale Analyses

Two technical reports covering the mesoscale analysis work performed in FY 78 were completed and submitted for publication. These are:

1. Humbert, M., S. Howard, P. Chen and T. Smith 1978: Development and Interpretation of an M-33 Radar Climatology for the Texas HIPLEX Region, 37 pp. (see #10, page 6).

Table 1. M-33 radar reduction progress.

	Problem Type	Not Anticipated
1.	Reset lost radar and range flags	
2.	Eliminate data groups at wrong range	
3.	Average bin size to be compatible with UND program	
4.	Correct field tapes for occasional missing bits	
5.	Correct dates as needed	
6.	Correct clock times as needed	
7.	Correct ID's as needed	
8.	Relocation of calibration pulses	
9.	Set EOF's for data gaps	X
10.	Reset new volume flags	
11.	Remove ground clutter	
12.	Remove volume scans when elevation angle varies due to antenna bounce	X
13.	Reset tilt angle for scans with minor variability	X
14.	Set new flags when elevation increment changes	X
15.	Reset spurious elevation data points	X
16.	Define new elevation start azimuth	X

Table 1. M-33 radar reduction progress (Continued)

	Problem Type	Not Anticipated
17.	Eliminate transition radials between elevation scans	X
18.	Eliminate azimuth wrap-around	
19.	Eliminate multiple scans of the same elevation	
20.	Eliminate multiple radials on a given azimuth	X
21.	Reassign radials to fixed interval azimuths when wind loading is not excessive	X
22.	Eliminate radials recorded during antenna drop to base angle tilt	
23.	Set calibration pulses to 1's (DVIP)	
24.	Remove null radials	
25.	Maintain first radial of volume	X
26.	Eliminate "caught" calibration pulse	X

Table 2. Program structure for radar data tape processing.

Program Title	Problem Correction
REDIT	1 2 3 4 (anticipated problems)*
A-7	5 6 7 8 11 23 (anticipated problems)
A-8	
A-81	Initialization
A-82	15 (unanticipated) 22 (anticipated)
A-83	Adjustments to azimuth
A-84	12 13 14 16 17 (unanticipated) 18 19 (anticipated)
A-85	9 14 20 21 24 25 (unanticipated) 10 (anticipated)
University of North Dakota programs	26

* Anticipated or unanticipated refer to the status before the January visit to the University of North Dakota.

2. Chen, P., M. Humbert and T. Smith, 1978: Radar Echo Organization and Development in the Mesoscale Environment - A Case Study Approach, 89 pp. (to be published during May 197 as TDWR report LP-97).

Both of these reports were based on studies and interpretation of the data from the M-33 radar at Snyder.

Technical papers based on Chen's report have been submitted for consideration to the Weather Modification Conference and the Severe Storms Conference. Both conferences will be held in October 1979.

Task 2 - Summarization of Radar Data

This task requires the radar data to be processed through RADPROC into summaries of cell heights, movements, sizes, etc. No work was undertaken in this area since the RADPROC summaries were not available.

Task 3 - Radar-Raingage Relations

No work on this task was undertaken during this period. Available funds were allocated to the radar data processing work.

Task 4 - Field Program

A tape containing hourly wind data from 15 Mechanical Weather Station locations and from the Big Spring airport was completed and furnished to Texas A & M.

Radar data from the 1978 field season were processed into the PPI program. PPI contour plots were produced for all days in 1978 and appear in the Texas Department of Water Resources Report LP-84 entitled "Texas HIPLEX 1978 Satellite and Radar Data Summary" dated December 1978.

SECTION 2 - WORK PLANNED

The radar data processing will continue in the following sequence:

1. Complete program A-8
2. Submit two test tapes (A-7 output) to the University of North Dakota for trial runs
3. Submit one test tape (A-8 output) to the University of North Dakota for trial run
4. Complete processing of balance of tapes through A-7 program (if the University of North Dakota results are satisfactory).

SECTION 3 - APPENDIX

Staff working on HIPLEX M-33 radar data October 1978 to April 1979.

Name	Title	Performance Dates	Responsibilities
Dr. Ted Smith	President of MRI	Oct 1978-April 1979	Project management and data analysis
Dr. Philip Chen	Technical Staff Specialist	Oct 1978	Data analysis
Mr. Mark Humbert	Research Meteorologist	Oct 1978	Data analysis
Dr. Al Vanderpol	Technical Staff Specialist	Oct 1978-April 1979	Design of radar processing programs
Mr. George Bosworth	Senior Programmer	Oct 1978	Design, coding and debugging of radar processing programs
Mr. Mark Young	Programmer	Oct 1978-April 1979	Design, coding and debugging of radar processing programs
Ms. Janet Smith	Computer Supervisor	Oct 1978-Jan 1979	Preparation of tapes for processing and coordination of programming efforts
Ms. Ruby Murphy	Computer Supervisor	Jan 1979-April 1979	Preparation of tapes for processing coordination of programming efforts