TEXAS HIPLEX
INTERIM PROGRESS REPORT

Prepared by:

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Interim Progress Report for October 1, 1980–March 31, 1981

Prepared for:

OFFICE OF ATMOSPHERIC RESOURCES RESEARCH
WATER AND POWER RESOURCES SERVICE
BUILDING 67, DENVER FEDERAL CENTER
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This interim progress report presents descriptions and evaluations of 1978-80 Texas HIPLEX data, including progress on the reduction analysis, and interpretation of mesoscale ambient air, radar, precipitation gage, and satellite radiance data.

The ability to model isolated cumulonimbus kinematics by use of storm and wind motions in conjunction storm updraft mass flux is introduced.

Analysis of rawinsonde, surface station, radar, satellite, and cloud microphysical data continued on schedule with few-if any-difficulties, as did the development of a mesoscale numerical model for the Texas HIPLEX area.

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October 1, 1980 - March 31, 1981

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Weather and Climate Section
Planning and Development Division

Texas Department of Water Resources
P. O. Box 13087; Capitol Station
Austin, Texas 78711

LP-161

April 1981

April 10, 1981

Dr. Bernard A. Silverman
Chief, Office of Atmospheric
Resources Research
Water and Power Resources Service
Building 67; Denver Federal Center
Box 25007
Denver, Colorado 80225

Dear Dr. Silverman:

Re: Texas HIPLEX Interim Progress Report, October 1930-March 1981

In compliance with Amendatory Agreement No. 1 Contract No. 14-06-D-7587 between the Water and Power Resources Service (the Service) 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, 1980 through March 31, 1981.

The report consists of a compilation of individual reports prepared by the Department and each of the Texas HIPLEX participant organizations: Texas A&M University, Texas Tech University, and the Colorado River Municipal Water District. The individual reports consist of three sections: work performed during the reporting period; work planned during the next interim period (April through September, 1981); and, a listing of personnel involved with the Texas HIPLEX Program during the reporting period. A Table of Contents and an Executive Summary are included for order, ease of reference and orientation.

Please direct any questions concerning this report, or the need for further information, to the Department's Weather and Climate Section of the Planning and Development Division.

Sincerely,

Herbert W. Grubb

Herbert W. Grubb
Director, Planning and
Development Division

P.O. Box 13087 Capitol Station • Austin, Texas 78711 • Area Code 512/475-3187

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EXECUTIVE SUMMARY

In 1974 the Office of Atmospheric Resources Management of the U. S. Bureau of Reclamation (now the Office of Atmospheric Resources Research of the Water and Power Resources Service--WPRS) entered into an Agreement with the Texas Water Development Board (one of three predecessor agencies to the Texas Department of Water Resources--TDWR) to conduct a long-term, comprehensive atmospheric research and weather modification development program known as the High Plains Cooperative Program--HIPLEX. The overall goal of HIPLEX was to establish a verified, working technology and operational management framework for producing additional rainfall from Summertime convective clouds in the High Plains. Pursuant to this goal three sites were selected on which to center the experimental activities: Miles City, Montana; Colby, Kansas; and Big Spring, Texas. The 1974 Agreement between the WPRS and the TDWR was designed to initiate and maintain the Texas HIPLEX Program through 1980.

The objective of the Texas HIPLEX Program has been and continues to be to understand more completely the cloud and precipitation processes occurring in the Texas High Plains. To this end, each of the following organizations participated in the Texas HIPLEX Program during this reporting period:

Water and Power Resources Service, U. S. Department of the Interior

Texas Department of Water Resources

Texas A&M University (Department of Meteorology)

Texas Tech University (Atmospheric Sciences Group)

Colorado River Municipal Water District.

This report presents a summary of the work which has been performed by the TDWR--also called the Department herein--and each of its subcontractors during the period October 1, 1980 through March 31, 1981. It also provides a brief description of work planned for the forthcoming six-month period of April 1 through September 30, 1981. A roster of personnel directly involved in the Texas HIPLEX Program during this reporting period is also included.

The report summarizes the Department's role as manager and administrator of the Program. The Department negotiated and/or administered a total of five Texas HIPLEX-related contracts during the reporting period. Department staff edited and published four major publications and numerous administrative and technical reports during the reporting period. In conjunction with personnel representing each of the organizations listed above, Department staff prepared both the Proposal for the Texas HIPLEX Program, 1981-1985, and its Addendum. Finally, considerable work was performed on the report, "HIPLEX In Texas: A Summary Report on Six Years of Experimentation." The report was in final draft form as the reporting period came to a close.

Texas A&M University (TAMU) performed several diversified tasks during the reporting period, among them the processing of mesoscale surface weather station, rawinsonde, and radar data. In addition, studies were continued in cloud microphysics, mesoscale cloud modelling, and the determiniation of environmental responses to convective activity. The latter area of study provided significant findings concerning the wind structure of isolated cumulonimbus clouds in the Texas High Plains.

Texas Tech University (TTU) continued work on the evaluation of precipitation gage, radar, and satellite radiance data in an effort to develop a methodology for consolidating the data from each source into a single technology. Specifically, intercomparisons were made between cloud data received from the GOES satellite and that recorded by the Skywater radar. The analysis showed a good relationship between data from the two sources, although the satellite detected convective cloud tops to be slightly higher than did the radar. This is due to the radar detecting larger cloud particles than the satellite, and larger particles generally lie lower in the cloud.

The Colorado River Municipal Water District (CRMWD) performed work in three areas: precipitation-gage surveillance and maintenance, precipitation data reduction and management, and equipping the CRMWD's Aztec and pressurized Navajo aircraft with sophisticated cloud physics data-collection probes.

Significant contributions to the development of a viable and proven weather modification technology have been realized as a result of Texas HIPLEX research. Therefore, in spite of the termination of Federal funding for the next phase of the Program, this Department intends to maintain as high a level of analysis of the 1979-1980 field data as is feasible using State funds. The importance of this research on West Texas Summertime convective clouds and their environment cannot be overstated in order to acquire an understanding of the processes inducing rain in this water-deficient area of the Great Plains.

SECTION I:

WORK PERFORMED,

October 1, 1980 - March 31, 1981

TEXAS DEPARTMENT OF WATER RESOURCES

1. Meetings and Management of the Texas HIPLEX Program
2. Contract Administration
3. Reports

Meetings and Management of the Texas HIPLEX Program

In mid-January, principle investigators and Department personnel convened in Austin to address questions directed to the Department by Dr. Bernard A. Silverman of the WPRS in a December letter referencing the Department's 1981-1985 Texas HIPLEX Proposal. At that meeting Dr. Silverman's response to the Proposal was reviewed, and significant steps were taken to consolidate views on possible seeding hypotheses, seeding methodologies, statistical units and response variables. The meeting was followed up later in the month by the Department receiving from the Texas HIPLEX participants at TAMU and TTU lists of their salient findings based on studies conducted during the initial five years of the Texas HIPLEX Program.

At the close of January, representatives from the Department, each of the Texas HIPLEX participant organizations, and the WPRS met in Austin to discuss the future of the Texas HIPLEX Program. A consolidated working proposal for cloud seeding experimentation in the Texas High Plains, which included tentative seeding hypotheses, experimental unit, sampling unit, statistical unit, and response variables, was presented by Bob Riggio of the Department staff. Representatives of the WPRS concluded that, while significant progress toward achieving a full-scale experimental rain-increase technology for the Texas HIPLEX area was evident, much more quantification and documentation is still needed before the next five-year contract may be implemented. Specific issues requiring additional investigation regard the amount of additional field data needed to stratify mesoscale convective regimes.

Throughout the reporting period work continued on the Department report to be entitled "HIPLEX In Texas: A Summary Report on Five Years of Experimentation." The report is to be a consolidation of the significant findings and conclusions attained as a result of the 1976-1980 Texas HIPLEX Program. By the end of the reporting period the first draft neared completion. Copies of the draft are to be distributed to each Texas HIPLEX participant, and to WPRS personnel, for review and comment prior to publication as a Department Limited Publication (LP).

Also among the managerial aspects of the Department's responsibility to administer the Texas HIPLEX Program was the preparation of the Texas HIPLEX Proposal for 1981-1985. The Proposal was submitted to the WPRS after review by Texas HIPLEX personnel in November 1980. It was Dr. Silverman's letter of response to that Proposal which mandated the Texas HIPLEX meetings (above) and necessitated clarification of the Proposal. That clarification was realized with the Department forwarding the "Addendum to the Texas HIPLEX Proposal 1981-1985" to the WPRS in February 1981. The Addendum specifically outlines each aspect of the proposed 1981-1985 Texas HIPLEX Program and addresses the questions raised by WPRS personnel regarding ambiguities in the Proposal. The Addendum included proposed budgets for each aspect of the proposed 1981 Texas HIPLEX Field Program.

All endeavors to negotiate a new five-year Master Agreement between the Department and the WPRS were terminated in early March when the U. S. Department of the Interior, WPRS, notified the Department that in light of the Reagan Administration's proposed budget cuts the overall HIPLEX program would be "mothballed." The Department is continuing in its managerial capacity to review and publish Texas HIPLEX technical and administrative reports and to administrate Texas HIPLEX-related contracts. These efforts are being carried out by using remaining previously appropriated funds. Attempts will be made to proceed with Texas HIPLEX data analysis using limited State funds.

Contract Administration

During the six-month reporting period, the Department: administered three contracts previously in force, negotiated a no-cost extension to one of these pre-existing contracts, and negotiated two new contracts in obligation to its Master Agreement with the Water and Power Resources (Table A).

Reports

During the reporting period, the Department published a total of four Limited Publications (LP's) pertaining to the Texas HIPLEX Program (Table 2). Additionally, Texas HIPLEX Monthly Progress Reports were prepared and distributed for work performed during October, November, and December of 1980 and January, February, and March of 1981. The 1980 Texas HIPLEX Annual Report was prepared and forwarded to the WPRS and each Texas HIPLEX participant in early January. Five copies of a report entitled "Analysis of Digitized M-33 Radar Data for Texas HIPLEX, 1976-1978" were forwarded to the WPRS during the month of October 1980. The report, prepared by Meteorology Research, Inc., presents results of an analysis of radar echoes. Finally, a technical report entitled "Evolution of Two Summertime Convective Clouds in West Texas," prepared by Dr. Alexis B. Long of Texas A&M University (TAMU), was received by the Department. It will be included in TAMU's Final Report to be submitted to the Department in May 1981.

Contract No.	Organization	Period Beg.		Period End	Purpose
PREEXISTENT CONTRACTS:					
14-00030	Texas A&M University	2-80	-	1-81 (extended to 5-81)	Analysis of 1979 mesoscale data, cloud microphysical studies, development of entrainment model, environmental response to convective activity, Skywater radar data analysis, mesoscale field program, services of sciential advisor
14-00026	Texas Tech University	1-80	-	12-80	Analysis of structure, water budget and precipitation efficiency of mesoscale convective systems, determination of a Z-R relationship, precipitation efficiency of isolated cumulonimbus clouds, rainfall data processing and analysis, Case studies based on satellite data, satellite imagery studies, real-time satellite imagery support for field program, radar data collection for field program
14-00027	Colorado River Municipal Water District	1-80	-	12-80	Maintenance of precipitation gage network and precipitation gage data collection, service of radar and radar meteorologist, service of aircraft and pilot, acquisition of aircraft cloud physics equipment
NEW CONTRACTS:					
14-10030	Texas Tech University	1-81	-	5-81	Same as 14-00026 (above), plus comprehensive radar, raingage and satellite imagery - based Case Study analyses
14-10033	Colorado River Municipal Water District	1-81	-	5-81	Same as 14-00027 (above)

Table A: Contracts Administered by the TDWR in support of the Texas HIPLEX Program during the reporting period.

Table B: Texas HIPLEX Reports Published by the Department During the Reporting Period

Title	Author	Report #	Pub. Date
"Analysis of Digitized M-33 Radar Data from Texas HIPLEX, 1976-1978"	NAWC	135	November 1980
"Texas HIPLEX Interim Progress Report, April - September 1980"	TDWR	136	October 1980
"Texas HIPLEX 1980 Field Operations Summary"	TDWR	138	November 1980
"A Study of Clouds Using Satellite Radiance Data in Comparison with Raingage Network and Radar Observations"	TTU	140	January 1980

TEXAS A&M UNIVERSITY

1. Mesoscale Data Processing
2. Cloud Microphysics
3. Environmental Response to Convective Activity
4. Meso- and Synoptic-Scale Analysis
5. Comparison of TAMU and NWS Soundings for Midland
6. Development of Mesoscale Numerical Model
7. Skywater Radar Data Analysis

Texas A&M University

1. Mesoscale Data Processing

Processing of the 1980 mesoscale sounding and surface data was completed during this reporting period. The sounding data were processed by using previously-applied TAMU and WPRS methods. A data report was prepared with data placed on magnetic tape for computer analysis. Surface data were extracted from the strip charts, keypunched, and included in the data report as well as on the magnetic tape. Radar data obtained from the National Weather Service (NWS) at Midland were coded as in previous years and charts were prepared showing the general area and intensity of echoes over the Texas HIPLEX region. These data also are included in the technical report but were not included on the magnetic tape.

2. Cloud Microphysics

Work on this task proceeded along two topics during the report period. An aircraft operations summary report was prepared jointly by Drs. A. B. Long of TAMU and Jerry Jurica of TTU. This report includes details for each day on which aircraft flights were made and summaries of the conditions during each day. A second effort consisted of a study of two convective clouds in West Texas and culminated in a report entitled "Evolution of Two Summertime Convective Clouds in West Texas." This study will be included as a section in the final project report which is due at the end of May 1981.

3. Environmental Response to Convective Activity

The kinematics of the environment around an isolated West Texas thunderstorm were represented by theoretical potential flow models. These models were then verified by comparing streamlines and velocities with values collected around isolated thunderstorms in four independent research studies. Results are very encouraging and showed that the storm-scale kinematics of an isolated and growing thunderstorm may be adequately modelled by combining four basic flow components: storm motion, environmental wind velocity, flow around a solid body, and mass flux into the updraft or away from the echo near the tropopause.

The mass flux term can be estimated using aircraft data collected in the near vicinity of the storm. However, for cases lacking detailed aircraft data, a method of evaluating the mass flux of isolated storms is needed. Thus, mass flux as determined from HIPLEX rawinsonde data has been related to thunderstorm radar-echo characteristics so that remote radar observations might be used to determine mass flux in a real-time sense. These relationships have proven to be interesting and, in some cases, unexpected. Results of the mass flux-echo characteristic relationships will be used in conjunction with information learned from the flow models to determine the extent and magnitude of thunderstorm-environment interactions.

A technical report presenting results from this part of the research is in draft form and will be submitted for publication in May 1981. This research will be Mr. Myron Gerhard's Master of Science thesis.

4. Meso- and Synoptic-Scale Analyses

Primary emphasis remained on the analysis and interpretation of four mesoscale days previously selected for study: 4-5 June, 3-4 July, 5-6 July and 17-18 July. Computer-analyzed fields of several meteorological variables were contoured and reduced in size for publication. Contoured synoptic-scale data include temperature, mixing ratio, wind velocity, divergence, moisture divergence, vorticity and vorticity advection. These variables were contoured for the 850-, 700-, 500- and 300-mb levels. The synoptic and mesoscale contoured fields were prepared in a form suitable for publication.

Skywater radar data were processed, and contoured maps were produced to indicate graphically the areas of convective activity at predetermined levels in the atmosphere. Liquid water content maps were produced using the same radar data to reveal the amount of liquid water present in the layers surface to 3.5 km, 3.5 to 6.5 km, and above 6.5 km. These charts are being interpreted in conjunction with the mesoscale and synoptic-scale charts.

Computer and hand-plotted soundings were prepared in an attempt to explain certain mesoscale features and characteristics. Also, synoptic-scale and mesoscale stability maps were prepared to show the difference in spatial resolution between the two scales and to depict more accurately areas suitable for convective development.

5. Comparison of TAMU and NWS Soundings for Midland

For the first time, during 1980, a HIPLEX rawinsonde station was co-located with the National Weather Service (NWS) station at Midland. On several occasions the same radiosonde was tracked by both the TAMU and NWS systems. The data were processed independently for each pressure contact, and discrepancies in temperature, dewpoint temperature, and wind velocity were analyzed. The analysis was performed for selected layers from surface to 100 mb.

The results show remarkably good agreement between the two sets of profiles, which attests to the high quality of data derived from both systems not only in 1980 but in previous years as well. Root-mean-square (RMS) discrepancies in temperature were generally less than 1C; those for dewpoint were somewhat higher (2-4C), while RMS values for wind speed generally less than 3 mps. Discrepancies of these magnitudes were expected on the basis of instrument error alone as quoted in published literature. The results of this analysis will be included in the final report due at the end of May 1981.

6. Development of Mesoscale Numerical Model

Considerable progress was made on the development of a mesoscale numerical model for use in the Texas HIPLEX area. A literature search was made, all existing models were examined carefully, and an approach was formulated for the development of a model for the Texas HIPLEX area. The model was formulated in a mathematical sense and programmed for the Amdahl computer at TAMU, and initial runs were made for the purpose of checking out the computer program. Significant aspects of this research were related to the initialization of the model and to the formulation of boundary conditions. The model as constituted is capable of forecasting mesoscale conditions of temperature, geopotential height and wind. Moisture has not been included in the model, although a proper moisture budget equation has been developed and will be included soon. The model is now ready for full-scale testing. It will be documented in the final report to be submitted in May 1981.

7. Skywater Radar Data Analysis

Various radar analyses were performed during this reporting period in support of the mesoscale and cloud microphysical studies. Constant altitude reflectivity maps (CAZM's) were prepared for 4, 8, and 12-km altitude. A computer program was developed to extract data along the flight track of the cloud physics airplane; and a program was prepared for computing the integrated liquid water content below 3.5 km, between 3.5 and 6.5 km, and above 6.5 km. The results of the radar analyses will appear in the mesoscale and cloud microphysical reports.

TEXAS TECH UNIVERSITY

1. Microphysical Aircraft Data Processing
2. Case Studies
3. Survey of 1979 Radar Data
4. Z-R Relationship
5. Rainfall Analyses

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Texas Tech University

All activity during this period focused upon analysis of data gathered during 1979 and 1980. Efforts were devoted to analyzing microphysical aircraft data, performing case studies by integrating radar, rawinsonde, rainfall and satellite measurement; and examining raingage data. Each of these tasks is discussed below.

1. Microphysical aircraft data processing

Following the 1980 field program, a summary of aircraft flights was prepared (Long and Jurica, 1981). A list of those flights judged to be of particular importance to HIPLEX is given in Tables 1 and 2. All of the data tapes from the CRMWD p-Navajo flights have been processed through the WPRS computer and are available upon request. A summary of the contents of these data tapes is given in Table 3.

As part of the preparation for detailed analyses of the data for selected case studies, graphical techniques were developed for displaying the aircraft data. A sample is given in Figure 1.

2. Case studies

a. 17 July 1979

The mesoscale convective system that developed over the Texas HIPLEX area on 17 July 1979 has been studied using digitized radar and satellite data and rawinsonde and surface observations. The system occurred in connection with a shallow cold front, observed to be slowly moving southward. Surface temperature analyses show that the largest horizontal thermal gradient (about 0.2^{o} C/km) occurred near the time of peak convective activity. Figure 2 shows a subjective analysis of surface temperature, based on data from five rawinsonde stations, superposed on the radar-echo pattern at this time (2100 GMT). The 850-mb wind vectors are also plotted. The echoes tend to be aligned at right

Table 1. Summary of important cloud physics missions of the CRMWD p-Navajo.

Date	Time periods of Interest (GMT)	Comments
2 June	2249-2307	Four altocumulus castellanus cloud elements were sampled one or more times each.
21 June (1)	2133-2142 2153-2222	HIPLEX mission 1. Two cumulus congestus clouds were sampled three and twelve times each. Seven AgI flares were dropped into second cloud. Entire life of second cloud was apparently observed.
21 June (2)	2349-0001	One towering cumulus was sampled four times. Cloud progressed from non-precipitating stage to precipitating stage.
22 June (1)	2145-2158 2211-2216 2225-2237	HIPLEX mission 2. Three cumulus congestus clouds were sampled five, two, and four times each. Second cloud was the HIPLEX cloud. Third cloud may have been observed over most of its life cycle.
1 July	2242-2252	HIPLEX mission 3. Cumulus congestus was sampled four times. Most observations were of the precipitating stage.
8 July	2210-2221	Nine small cumulus clouds were sampled one time each.
21 July (1)	1803-1812 1818-1825	HIPLEX mission 4. Two convective clouds were sampled four and three times each. First cloud was the HIPLEX cloud. First cloud dissipated during sampling, and second cloud was in the precipitating stage.
21 July (2)	2136-2144 2145-2151	Two turrets associated with a thunderstorm were sampled four and three times each. Life cycle of first cloud was apparently observed. Second cloud was dry and dissipating.

Table 1. Continued.

Date	Time periods of Interest (GMT)	Comments
22 July (1)	1510-1518	Convective cloud near thunderstorm was sampled four times. Cloud intensified during sampling period.
22 July (2)	2102-2125	HIPLEX mission 5. One towering cumulus was sampled nine times. All stages in precipitation process were apparently observed.
22 July (3)	2255-2302 2306-2326 2348-2358 2327-2342	Three convective clouds were sampled three, six (possibly ten), and six times each. A large fraction of the cloud life cycle was observed for the last two clouds.
25 July	2203-2209 2226-2252	Two convective clouds were sampled three and ten times each. Second cloud was observed over much of its life cycle.
26 July (2)	2104-2124	One altocumulus turret was sampled four times. Ice and downdrafts were mainly observed.
27 July	1829-1856	Altocumulus line was sampled three times transversely. Clouds appeared to be in precipitating stage.

Table 2. Summary of important cloud physics missions of the NCAR Queen Air.

Date	Time periods of Interest (GMT)	Comments
26 May	2000-2006 2015-2035 2105-2112	Three cumulus congestus were sampled four, seven, and three times each. By the end of the cloud sampling the first two cumulus had grown up into altostratus aloft and the third cloud had dissipated.
28 May	2230-2304	Twenty cumulus were sampled one time each just above cloud base.
29 May	2002-2106	Thirty-two cumulus were sampled one time each just above cloud base.
2 June	2246-2313	Nine altocumulus castellanus cloud elements were sampled one or more times each.
3 June (1)	1732-1930	Stratus, then stratocumulus, and then cumulus were sampled along a path from Big Spring to Corpus Christi, Texas in a study of micro-physical differences in clouds along the coast and inland.
3 June (2)	2109-0007	Cumulus were sampled along the coast from Corpus Christi to Houston, cumulus cloud streets oriented north-south were sampled transversely from Houston to west of Austin, and stratocumulus streets were sampled from Austin to the San Angelo area. Decreased visibility was observed downwind of Houston.
13 June (2)	2115-2120 2124-2143	Two cumulus congestus clouds near Davis Mtns. in southwest Texas were sampled three and six times each. Considerable cloud water was found. Air entering the clouds probably originated in the interior of Mexico.

Table 3

CRMWD p-Navajo 1980 aircraft data tapes available from WPRS. Tapes with file names beginning with "C" contain coded data in engineering units and tapes with file names beginning with "R" contain raw data. Time in GMT.

VSN Tape/File	File Name	Date	Time
4510/1	CF22046	22 July 1980	2302-2313
2	C801731	21 June 1980	2002-2100
3	C801732	21 June 1980	2113-2201
4	C801733	21 June 1980	2204-2239
5	C801734	21 June 1980	2315-2400
6	C801741	22 June 1980	2100-2226
7	C802045	22 July 1980	2229-2312
8	C802045	22 July 1980	2229-2312
9	C802046	22 July 1980	2335-2400
10	C802071	25 July 1980	2100-2236
11	C802072	25 July 1980	2200-2314

VSN Tape/File	File Name	Date	Time
4959/1	C801831	1 July 1980	2101-2316
2	C801832	1 July 1980	2320-2356
3	C802031	21 July 1980	1720-1835
4	C802032	21 July 1980	1839-1913
5	C802033	21 July 1980	2038-2158
6	C802042	22 July 1980	1453-1545
7	C802042	22 July 1980	1453-1545
8	C802043	22 July 1980	1942-2054
9	C802044	22 July 1980	2058-2140
10	C802091	27 July 1980	1748-1837
11	C802092	27 July 1980	1842-1913

VSN Tape/File	File Name	Date	Time
6322/1	C801481	27 May 1980	0156-0300
2	C801533	1 June 1980	2301-0008
3	C801571	5 June 1980	1207-1309
4	C801541	2 June 1980	2151-2322
5	C801621	10 June 1980	1912-2012
6	C801651	13 June 1980	1219-1318
7	C801661	14 June 1980	2102-2226
8	C801662	14 June 1980	2230-2331
9	C801711	19 June 1980	1958-2114

Table 3 (cont.)

VSN Tape/File	File Name	Date	Time
6340/1	C801712	19 June 1980	2117-2145
2	C801713	19 June 1980	2257-0012
3	C801714	19 June 1980	0015-0031
4	C801721	20 June 1980	2049-2206
5	C801743	22 June 1980	2337-0049
6	C801901	8 July 1980	2153-2242
7	C801981	16 July 1980	2151-2256
8	C802011	19 July 1980	1159-1303
9	C802081	26 July 1980	1828-1921
10	C802082	26 July 1980	2015-2125
11	C802101	28 July 1980	1204-1255

VSN Tape/File	File Name	Date	Time
4506/1	R801731	21 June 1980	2002-2100
2	R801732	21 June 1980	2113-2201
3	R801733	21 June 1980	2204-2239
4	R801734	21 June 1980	2315-2400
5	R801741	22 June 1980	2100-2226

VSN Tape/File	File Name	Date	Time
4509/1	R802045	22 July 1980	2229-2312
2	R802045	22 July 1980	2229-2312
3	R802046	22 July 1980	2335-2400
4	R802071	25 July 1980	2100-2236
5	R802072	25 July 1980	2200-2314
6	RF22046	22 July 1980	2302-2313

VSN Tape/File	File Name	Date	Time
4884/1	R801831	1 July 1980	2101-2316
2	R801832	1 July 1980	2320-2356
3	R802031	21 July 1980	1720-1835
4	R802032	21 July 1980	1839-1913
5	R802033	21 July 1980	2038-2158
6	R802042	22 July 1980	1453-1545

Table 3 (cont.)

VSN Tape/File	File Name	Date	Time
4943/1	R802042	22 July 1980	1453-1545
2	R802043	22 July 1980	1942-2054
3	R802044	22 July 1980	2058-2140
4	R802091	27 July 1980	1748-1837
5	R802092	27 July 1980	1842-1913

VSN Tape/File	File Name	Date	Time
6323/1	R801481	27 May 1980	0156-0300
2	R801533	1 June 1980	2301-0008
3	R801571	5 June 1980	1207-1309

VSN Tape/File	File Name	Date	Time
6324/1	R801541	2 June 1980	2151-2322
2	R801621	10 June 1980	1912-2012
3	R801651	13 June 1980	1219-1318
4	R801661	14 June 1980	2102-2226
5	R801662	14 June 1980	2230-2331
6	R801711	19 June 1980	1958-2114

VSN Tape/File	File Name	Date	Time
6341/1	R801712	19 June 1980	2117-2145
2	R801713	19 June 1980	2257-0012
3	R801714	19 June 1980	0015-0031
4	R801721	20 June 1980	2049-2206
5	R801743	22 June 1980	2337-0049
6	R801901	8 July 1980	2153-2242

VSN Tape/File	File Name	Date	Time
6342/1	R801981	16 July 1980	2151-2256
2	R802011	19 July 1980	1159-1303
3	R802081	26 July 1980	1828-1921
4	R802082	26 July 1980	2015-2125
5	R802101	28 July 1980	1204-1255

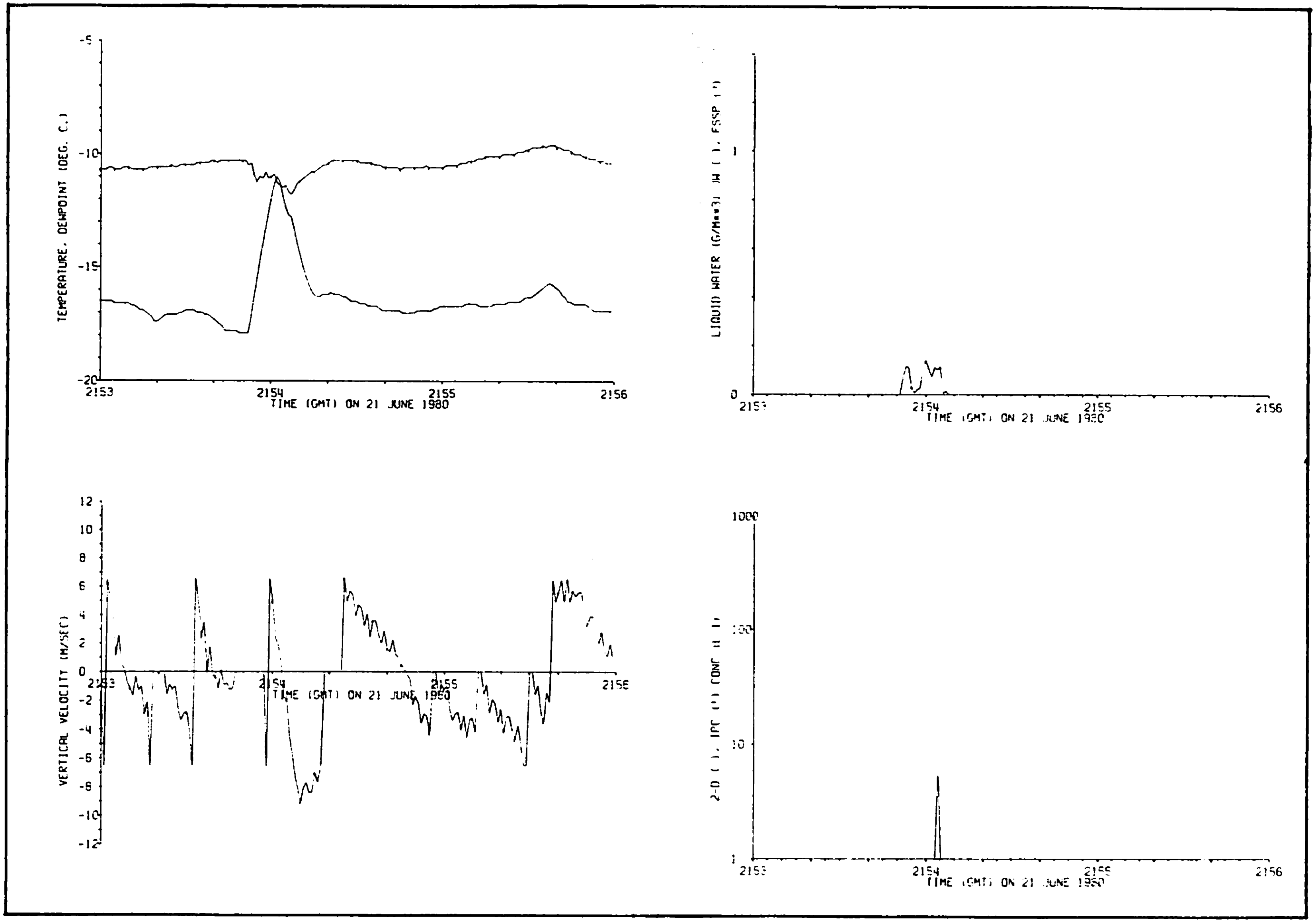

Figure 1. Sample plots of CRMWD p-Navajo 1980 aircraft measurements.

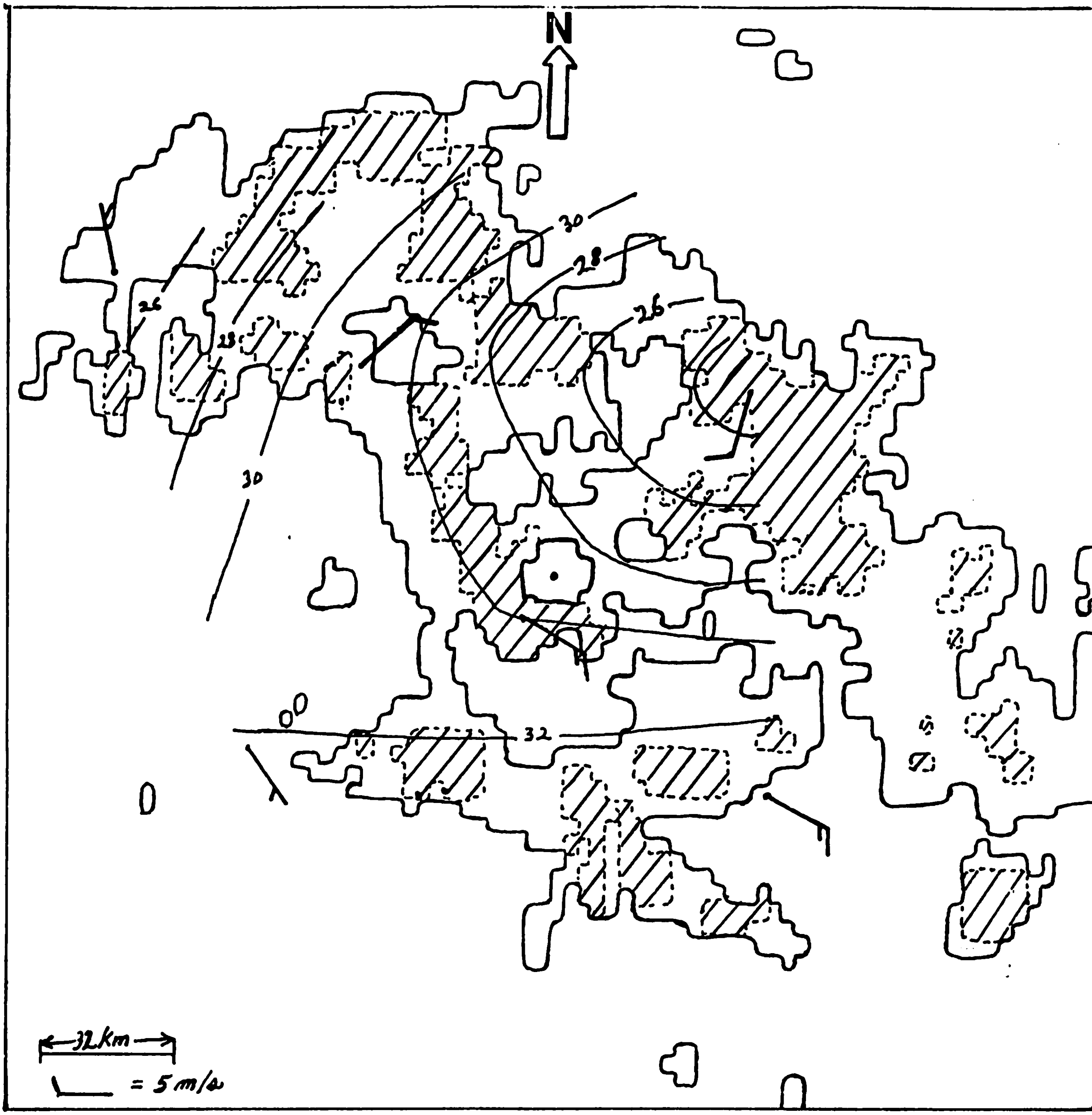

Figure 2. Surface temperature (°C) contours superposed on 850-mb winds and radar echo pattern at 2100 GMT on 17 July 1979. Outer contour is for minimum detectable signal and hatched areas have reflectivity ≥30 dBZ.

angles to the horizontal temperature gradient. A cold pool is situated near the center of the echo pattern, surrounded by intense echoes. This cold pool suggests the presence of a meso-high and an associated mesoscale downdraft. The 850-mb winds indicate difluence in the vicinity of the cold pool and confluence further to the west.

Figure 3 is height-time cross-section of the temperature field over Big Spring, Texas, located near the center of the Texas HIPLEX area, on 17 July. It clearly displays a baroclinic zone passing through the station between about 1900 GMT and 2200 GMT. This is consistent with the surface temperature contours plotted in Figure 2 for 2100 GMT. This type of baroclinic zone was observed at all stations during the day. While it reached as high as 600 mb at this station, it extended no higher than 700 mb at the others. When completed, this case study should contribute to the understanding of the structure and evolution of deep, precipitating convection in the presence of weak synoptic-scale forcing.

This case study, which will form Michael Lepage's Master of Science thesis, is the subject of a paper which will be presented at the Twentieth Conference on Radar Meteorology, sponsored by the American Meteorological Society, in the fall of 1981. The text of the paper will appear in the Conference Proceedings.

The paper authored by Lepage and Colleen A. Leary and entitled "Comparison of Radar with Rawinsonde and Satellite Data for a Mesoscale Convective System," was accepted on the basis of the following abstract:

> "A mesoscale convective system that developed over the Texas South Plains on 17 July 1979 was observed by radar, rawinsonde, satellite, and surface instrumentation. The mesoscale convective system occurred in connection with a shallow cold front, slowly moving southward. Surface temperature analyses show that the largest horizontal thermal gradient (about 0.2°C/km)

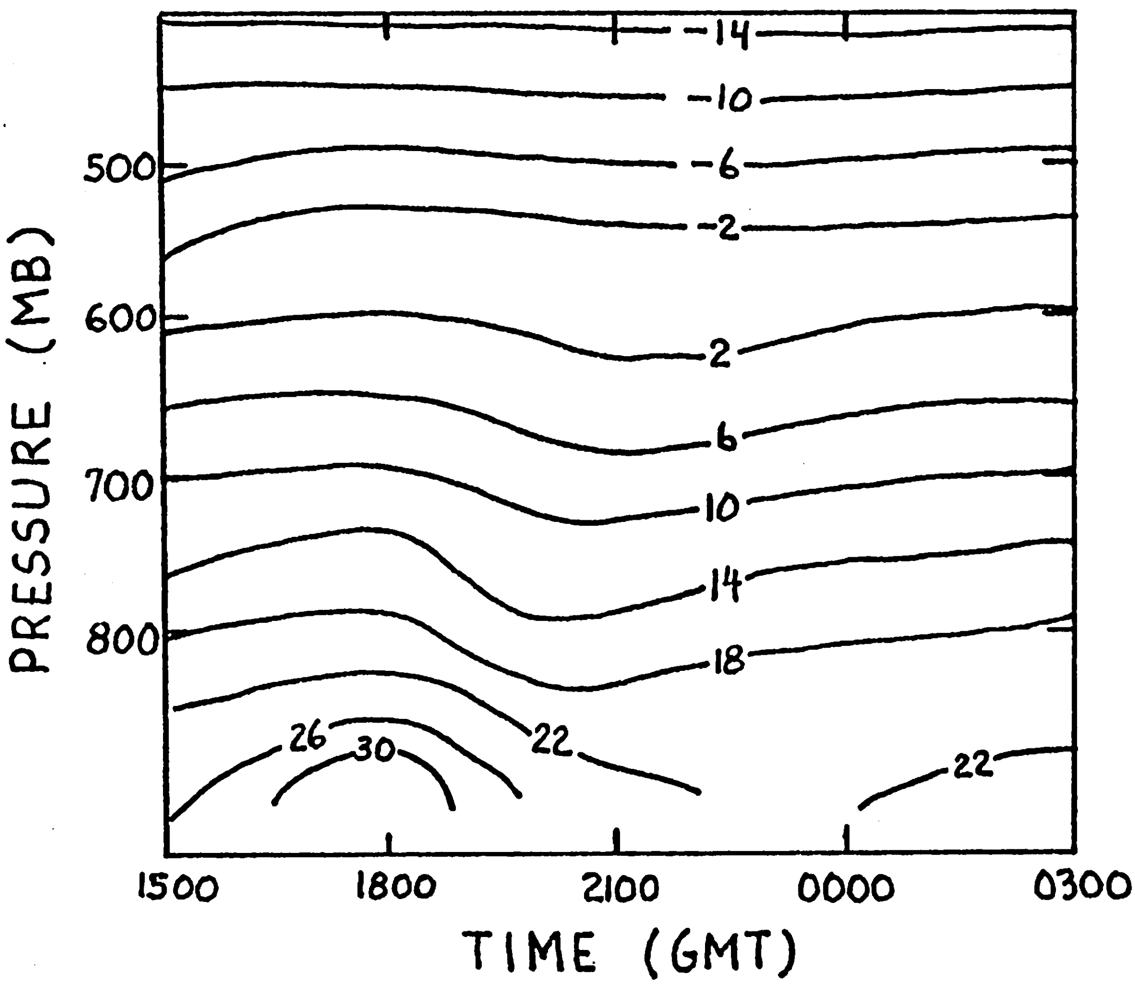

Figure 3. Temperature (°C) as a function of time and pressure at Big Spring, Texas on 17 July 1979.

> occurred near the time of peak convective activity. At the same time a large pool of cold air was observed implying the presence of a mesohigh. Intense radar echoes tended to be situated along the boundary of this cold pool. The movement of intense echoes was predominantly southward and comparable to the movement of the front. The direction and speed of movement were consistent with the 500-mb winds prior to the time of peak convective activity, and with the 700-mb winds afterward."

Work on the 17 July 1979 case study will continue through the end of summer 1981.

b. Four Case Studies for 1977.

A set of four case studies were performed on 1977 satellite, radar and raingage data sets. The purpose was to compare satellite-derived results with radar and raingage data, thereby increasing our knowledge of the predominant precipitation processes. The work has been completed (Jurica and Chao, 1981) and has demonstrated the reliability of satellite data when compared with radar and raingage measurements. An example of the comparisons among the several data sets is given in Figure 4. The cloud top heights from the infrared radiances varied from 11 to 12.5 km over two intense storm cells, but decreased rapidly beyond the third storm cell located about 80 km from the radar. The agreement between the satellite cloud-top heights and radar reflectivity values was good along this cross section. A strong reflectivity maximum of more than 60 dBZ was located 35 km from radar site. It is probable that heavy rain occurred under this intense echo which was situated within the raingage network, but there was no raingage located exactly along this direction. This example illustrates the restrictions associated with interpreting rainfall measurements even from a raingage network with rather dense spacing. It also points to the desirability of higher-resolution data sources such as radar or satellite

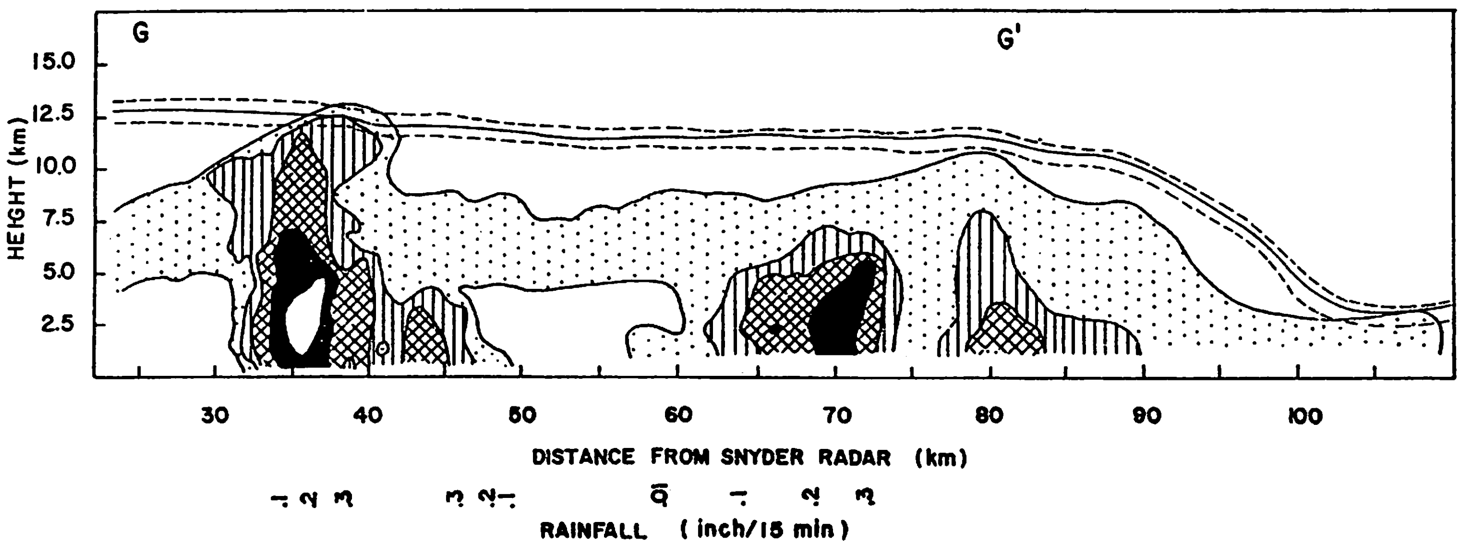

Figure 4. RHI display derived from M-33 radar for the azimuth angle 259° at 2018 GMT 8 July 1977. The threshold is 20 dBZ and is contoured in 10 dBZ increments. The upper solid line is the cloud top height derived from satellite infrared data and the dashed lines correspond to a temperature uncertainty of ±3 C. Also shown are rainfall analysis results with actual raingage measurements marked by ▲.

measurements.

3. Survey of 1979 radar data.

A survey of all 1979 radar data showed that maximum echo-top heights exceeded 9 km on every one of the 32 days for which digitized radar data were recorded. On 26 (81%) days, maximum echo-top heights reached 14 km or higher. Figure 5 shows a direct relationship between peak reflectivity value observed on each day and the maximum echo-top height observed on that day. It suggests that great care must be taken in attributing increases in echo top height to cloud seeding because deep convection occurs naturally on most days when radar echoes are observed.

The survey of 1979 data will continue until the end of summer 1981, with particular attention paid to days on which rawinsonde data were also collected.

4. Z-R relationship.

A computer program has been developed to print out digitized radar data in a form suitable for comparison with raingage data. Such comparisons will form part of the 17 July 1979 case study, as well as an important part of the rainfall analysis of data obtained throughout the summer of 1979.

Obtaining a Z-R relationship is a prerequisite to performing diagnostic model calculations of the vertical fluxes of mass and energy in mesoscale convective systems observed during HIPLEX, because the calculations are based on radar-derived rainfall amounts.

5. Rainfall analyses.

All 1980 quarter-hourly recording raingage data were received from CRMWD and transferred to magnetic tape. A copy of this tape was sent to WPRS in January, 1981. Upon examining these data, it was realized that one raingage, TA3, had been covered during the entire 1980 recording period. This gage should be considered inoperable but was not coded as such. All analyses of these data

MAXIMUM ECHO TOP HEIGHT (KM)	21-30	31-40	41-50	51-60	>60
> 18.0				6/8* 7/16* 7/18*	5/20* 7/5* 5/31 7/9 7/17*
17.5-17.9					
17.0-17.4				5/27* 7/15	6/25 7/3* 7/8
16.5-16.9			7/19?	5/28* 7/6*	6/4*
16.0-16.4				6/24* 7/7* 7/4*	
15.5-15.9			6/23	6/26	
15.0-15.4			6/21*	7/2*	
14.5-14.9			7/14*		
14.0-14.4				6/5*	
13.5-13.9					
13.0-13.4					
12.5-12.9		6/9*			
12.0-12.4	7/12		6/1*		
11.5-11.9			6/2		
11.0-11.4					
10.5-10.9					
10.0-10.4			6/7		
9.5-9.9		7/20			

MAXIMUM RADAR REFLECTIVITY (dBZ)

Figure 5. Maximum echo top height for each day during the 1979 field season when digitized radar data were collected. Asterisks indicate days on which rawinsonde data were collected.

should account for this.

To understand better the spatial characteristics and variability of rainfall in the Texas HIPLEX region, isohyetal analyses of 15-minute raingage data have been completed for the period May through July in 1979 and 1980. This was facilitated through the development of a computer program to print areal maps of the data on a high-speed line printer.

In addition, rainfall volumes were computed for 15-minute and daily totals for these same months. Daily volumes for 1979 and 1980 are listed in Tables 4 and 5, respectively. Volumes for 15-minute rain periods on these days are shown in Tables 6 and 7. Information similar to this for 1977 and 1978 was previously reported by Haragan et al. (1980). Volumes were calculated by an areal weighting scheme using a network of triangles based on gage locations. Note the wide range of values in Tables 4 and 5, varying from 419,405.4 acre-ft. to 87.8 acre-ft. (518 million m^3 to 0.1 million m^3). This indicates the high variability of precipitation events in the southern High Plains.

The multitude of potential meteorological situations coupled with a wide range of rainfall volumes establishes the need for a systematic stratification in further analyses. The distinction between intensities of these events is most clearly demonstrated by radar. After examining radar films, four categories were established according to stage of growth and scale of organization. These are: convective cells, small convective clusters, large convective clusters and nested convective clusters. Examples of these are shown in Figures 6a, 7a, 8a and 9a. The boundary between small and large convective clusters has been rather arbitrarily set at a size near 100 km (50 n. mi.). Nested convective clusters manifest an organization of large convective clusters on a scale too large for radar to detect in its entirety. Note that small convective clusters may be present in "nested" situations but are not required.

Table 4

Daily Network Rainfall Volumes, 1979

Date*		Rainfall Volume Acre-Feet	Rainfall Volume 10^6 m^3
May	10	17890.8	22.07
	20	68486.4	84.48
	21	107010.7	132.00
	27	55759.6	68.78
	28	1212.0	1.50
	29	1587.9	1.96
	31	25612.0	31.59
June	1	103764.4	128.00
	2	35041.7	43.22
	4	142075.5	175.25
	5	1283.6	1.58
	8	34506.4	42.56
	9	95277.1	117.53
	20	1367.1	1.69
	23	1939.8	2.39
	24	1261.5	1.56
	25	12634.6	15.59
	26	21614.2	26.66
	29	1312.6	1.62
July	3	1003.2	1.24
	4	284.9	0.35
	5	8307.1	10.25
	6	1834.0	2.26
	7	337.5	0.42
	8	749.9	0.92
	9	16939.4	20.90
	15	2477.3	3.06
	17	98362.2	121.33
	18	81942.3	101.08
	19	367582.9	453.42
	20	18413.2	22.71
	30	714.3	0.88
	31	32079.3	39.57

Total rain volume May 10 - July 31 = 1360666.0 acre-ft.
= 1678.36×10^6 m^3

*Note: Dates are referenced to CDT.

Table 5

Daily Network Rainfall Volume, 1980

Date*		Rainfall Volume Acre-Feet	Rainfall Volume 10^6 m^3
May	15	419405.4	517.35
	18	690.5	0.85
	20	55798.5	68.83
	21	7663.0	9.45
	23	87.8	0.11
	27	8645.5	10.66
	28	129.3	0.16
June	1	4621.1	5.70
	7	8469.3	10.45
	8	95911.7	118.31
	11	144097.1	177.75
	17	776.5	0.96
	18	1206.8	1.49
	19	25140.3	31.01
	20	7944.7	9.80
	21	105017.1	129.54
	22	415.3	0.51
July	1	184.5	0.23
	20	269.7	0.33
	21	3892.6	4.80
	22	8781.4	10.83
	26	2095.5	2.58
	27	517.4	0.64

Total rainfall volume May 15 - July 27 = 901761.0 acre-ft.
= 1112.31 x 10^6 m^3

*Note: Dates are referenced to CDT.

Table 6

1979 Precipitation

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	10^6 m^3
May 10	0000-0015	534.0	0.66
	0015-0030	397.1	0.50
	0030-0045	426.8	0.53
	0045-0100	548.9	0.68
	0100-0115	1420.7	1.75
	0115-0130	2139.7	2.64
	0130-0145	3357.8	4.14
	0145-0200	2658.9	3.28
	0200-0215	2992.2	3.69
	0215-0230	1528.7	1.89
	0230-0245	1099.2	1.36
	0245-0300	710.1	0.88
	0300-0315	69.4	0.09
	0345-0400	7.5	0.01
May 20	1630-1645	19.6	0.02
	1645-1700	116.2	0.14
	1700-1715	495.4	0.61
	1715-1730	969.9	1.20
	1730-1745	282.2	0.35
	1745-1800	129.2	0.16
	1800-1815	620.7	0.77
	1815-1830	1108.2	1.37
	1830-1845	2409.2	2.97
	1845-1900	3673.7	4.53
	1900-1915	7251.6	8.94
	1915-1930	7880.9	9.72
	1930-1945	7301.1	9.01
	1945-2000	7004.4	8.64
	2000-2015	4046.0	4.99
	2015-2030	2153.7	2.66
	2030-2045	1803.0	2.22
	2045-2100	979.8	1.21
	2100-2115	1388.4	1.71
	2115-2130	1449.6	1.79
	2130-2145	1256.3	1.55
	2145-2200	2770.2	3.42
	2200-2215	3246.0	4.00
	2215-2230	3573.9	4.41
	2230-2245	2760.6	3.41
	2245-2300	2174.9	2.68
	2300-2315	960.0	1.18
	2315-2330	431.1	0.53
	2330-2345	200.5	0.25
	2345-0000	30.4	0.04

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	Rainfall Volume 10^6 m^3
May 21	0000-0015	22.6	0.03
	0015-0030	15.5	0.02
	0130-0145	37.2	0.05
	0145-0200	283.7	0.35
	0200-0215	998.7	1.23
	0215-0230	2383.1	2.94
	0230-0245	4700.1	5.80
	0245-0300	5322.9	6.57
	0300-0315	6505.2	8.02
	0315-0330	4120.1	5.08
	0330-0345	4913.1	6.06
	0345-0400	3762.9	4.64
	0400-0415	4687.5	5.78
	0415-0430	4059.8	5.01
	0430-0445	2955.1	3.65
	0445-0500	2909.9	3.59
	0500-0515	3406.3	4.20
	0515-0530	3658.5	4.51
	0530-0545	1994.2	2.46
	0545-0600	709.5	0.86
	0600-0615	257.2	0.31
	0615-0630	122.4	0.15
	0630-0645	119.1	0.15
	0645-0700	51.1	0.06
	1145-1200	51.0	0.06
	1200-1215	348.5	0.43
	1215-1230	4029.1	4.97
	1230-1245	3682.1	4.54
	1245-1300	6473.0	7.98
	1300-1315	9028.6	11.14
	1315-1330	3119.9	3.85
	1330-1345	5009.8	6.18
	1345-1400	4551.5	5.61
	1400-1415	5049.9	6.23
	1415-1430	4583.9	5.65
	1430-1445	2013.1	2.48
	1445-1500	860.7	1.06
	1500-1515	163.5	0.20
	1515-1530	51.1	0.06
May 27	0100-0115	1346.1	1.66
	0115-0130	548.9	0.68
	0130-0145	1800.3	2.22
	0145-0200	1513.2	1.87
	0200-0215	1374.2	1.70
	0215-0230	1796.0	2.22
	0230-0245	1200.9	1.48

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	10^6 m^3
May 27	0245-0300	284.8	0.35
	0300-0315	105.4	0.13
	0330-0345	15.6	0.02
	0345-0400	7.1	0.01
	0400-0415	15.6	0.02
	0430-0445	6.4	0.01
	0500-0515	6.4	0.01
	0945-1000	70.6	0.09
	1000-1015	189.4	0.23
	1015-1030	72.6	0.09
	1030-1045	76.5	0.09
	1045-1100	36.1	0.04
	1100-1115	160.1	0.20
	1115-1130	85.2	0.11
	1645-1700	17.9	0.02
	1700-1715	1090.1	1.34
	1715-1730	1334.6	1.65
	1730-1745	2139.3	2.64
	1745-1800	2086.4	2.57
	1800-1815	2267.3	2.80
	1815-1830	2828.1	3.49
	1830-1845	2734.3	3.37
	1845-1900	2528.9	3.12
	1900-1915	2615.7	3.23
	1915-1930	2680.0	3.31
	1930-1945	2679.1	3.30
	1945-2000	5446.5	6.72
	2000-2015	3685.9	4.55
	2015-2030	2741.2	3.38
	2030-2045	2846.7	3.51
	2045-2100	2914.3	3.59
	2100-2115	1552.8	1.92
	2115-2130	721.7	0.89
	2145-2200	19.8	0.02
	2200-2215	29.3	0.04
	2215-2230	23.3	0.03
	2230-2245	26.0	0.03
	2245-2300	26.1	0.03
	2315-2330	13.5	0.02
May 28	0215-0230	26.3	0.03
	0230-0245	157.8	0.19
	1230-1245	77.5	0.10
	1245-1300	159.6	0.20
	1315-1330	192.8	0.24
	1330-1345	211.7	0.26

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	10^6 m^3
May 28	1345-1400	205.9	0.25
	1400-1415	18.3	0.02
	1415-1430	11.1	0.01
	1615-1630	50.8	0.06
	1630-1645	85.1	0.10
	2300-2315	15.1	0.02
May 29	0015-0030	29.4	0.04
	0100-0115	16.8	0.02
	0115-0130	190.1	0.23
	0130-0145	374.5	0.46
	0145-0200	147.5	0.18
	0200-0215	149.0	0.18
	0215-0230	64.8	0.08
	0230-0245	131.8	0.16
	0245-0300	111.6	0.14
	0300-0315	94.8	0.12
	0315-0330	93.7	0.12
	0330-0345	32.2	0.04
	0400-0415	9.8	0.01
	1615-1630	19.1	0.02
	1630-1645	12.7	0.02
	1645-1700	8.4	0.01
	1700-1715	40.8	0.05
	1715-1730	22.4	0.03
	1730-1745	19.2	0.02
	1745-1800	19.2	0.02
May 31	1300-1315	27.5	0.03
	1315-1330	55.0	0.07
	1330-1345	27.5	0.03
	1345-1400	110.0	0.14
	1415-1430	41.6	0.05
	1430-1445	319.2	0.39
	1445-1500	267.4	0.33
	1500-1515	247.5	0.31
	1515-1530	220.0	0.27
	1530-1545	101.3	0.12
	1545-1600	58.3	0.07
	1600-1615	27.5	0.03
	1615-1630	82.5	0.10
	1630-1645	69.1	0.09
	1645-1700	75.1	0.09
	1700-1715	9.8	0.01
	1845-1900	18.2	0.02
	1900-1915	36.6	0.05

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	10^6 m^3
May 31	1915-1930	34.2	0.04
	1945-2000	104.5	0.13
	2000-2015	352.6	0.43
	2015-2030	489.7	0.60
	2030-2045	839.3	1.04
	2045-2100	1139.9	1.41
	2100-2115	1975.1	2.43
	2115-2130	2343.8	2.89
	2130-2145	1981.2	2.44
	2145-2200	2110.2	2.60
	2200-2215	1997.9	2.46
	2215-2230	966.5	1.19
	2230-2245	1046.3	1.29
	2245-2300	1643.6	2.03
	2300-2315	2080.4	2.56
	2315-2330	2240.3	2.76
	2330-2345	1422.8	1.75
	2345-0000	1048.9	1.29
June 1	0000-0015	692.0	0.85
	0015-0030	1249.9	1.54
	0030-0045	2826.1	3.49
	0045-0100	2247.7	2.77
	0100-0115	3024.6	3.73
	0115-0130	5516.4	6.80
	0130-0145	2809.0	3.46
	0145-0200	1928.4	2.38
	0200-0215	669.5	0.83
	0215-0230	523.2	0.65
	0230-0245	246.5	0.30
	0245-0300	393.1	0.48
	0300-0315	282.3	0.35
	0315-0330	318.9	0.39
	0330-0345	99.1	0.12
	0345-0400	114.9	0.14
	0400-0415	58.9	0.07
	0415-0430	4.2	0.01
	0430-0445	11.5	0.01
	0445-0500	31.5	0.04
	0500-0515	3.7	0.01
	0515-0530	24.2	0.03
	0530-0545	11.5	0.01
	0600-0615	45.6	0.06
	0615-0630	68.4	0.08
	0630-0645	33.0	0.04
	0715-0730	5.9	0.01
	0730-0745	11.9	0.01

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	10^6 m^3
June 1	0745-0800	713.9	0.88
	0800-0015	2103.4	2.59
	0815-0830	1440.9	1.78
	0830-0845	1360.4	1.68
	0845-0900	1440.1	1.78
	0900-0915	1208.2	1.49
	0915-0930	854.8	1.05
	0930-0945	1190.6	1.47
	0945-1000	879.3	1.09
	1000-1015	1225.7	1.51
	1015-1030	1815.4	2.24
	1030-1045	1545.1	1.91
	1045-1100	2009.0	2.48
	1100-1115	2838.8	3.50
	1115-1130	3415.5	4.21
	1130-1145	4066.2	5.02
	1145-1200	3467.2	4.28
	1200-1215	2756.1	3.40
	1215-1230	3272.8	4.04
	1230-1245	3254.9	4.01
	1245-1300	3207.4	3.96
	1300-1315	3536.5	4.36
	1315-1330	3102.7	3.83
	1330-1345	2868.7	3.54
	1345-1400	2864.9	3.53
	1400-1415	3058.5	3.77
	1415-1430	2670.5	3.29
	1430-1445	2232.8	2.75
	1445-1500	2024.5	2.50
	1500-1515	2877.4	3.55
	1515-1530	2057.0	2.54
	1530-1545	1759.3	2.17
	1545-1600	1267.5	1.56
	1600-1615	1459.6	1.80
	1615-1630	1482.1	1.83
	1630-1645	1178.5	1.45
	1645-1700	734.8	0.91
	1700-1715	396.3	0.49
	1715-1730	245.8	0.30
	1730-1745	307.3	0.38
	1745-1800	135.8	0.17
	1800-1815	60.6	0.07
	1815-1830	47.2	0.06
	1830-1845	35.7	0.04
	2030-2045	39.2	0.05
	2145-2200	4.7	0.01

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	10^6 m^3
June 2	0000-0015	13.7	0.02
	0015-0030	19.5	0.02
	0030-0045	76.2	0.09
	0045-0100	87.9	0.11
	0100-0115	180.3	0.22
	0115-0130	99.0	0.12
	0130-0145	159.3	0.20
	0145-0200	304.4	0.38
	0200-0215	435.2	0.54
	0215-0230	184.7	0.23
	0230-0245	144.8	0.18
	0245-0300	204.2	0.25
	0300-0315	257.5	0.32
	0315-0330	347.7	0.43
	0330-0345	348.9	0.43
	0345-0400	389.3	0.48
	0400-0415	232.9	0.29
	0415-0430	76.0	0.09
	0430-0445	61.7	0.08
	0445-0500	96.0	0.12
	0500-0515	71.7	0.09
	0515-0530	160.9	0.20
	0530-0545	133.1	0.16
	0545-0600	105.9	0.13
	0800-0815	35.0	0.04
	0815-0830	24.7	0.03
	0830-0845	155.1	0.19
	0845-0900	296.4	0.37
	0900-0915	271.8	0.34
	0915-0930	465.1	0.57
	0930-0945	529.9	0.65
	0945-1000	418.0	0.52
	1000-1015	531.8	0.66
	1015-1030	959.7	1.18
	1030-1045	716.6	0.88
	1045-1100	1045.9	1.29
	1100-1115	1547.8	1.91
	1115-1130	1883.5	2.32
	1130-1145	1758.7	2.17
	1145-1200	1882.1	2.32
	1200-1215	1910.8	2.36
	1215-1230	1886.5	2.33
	1230-1245	2501.5	3.09
	1245-1300	2031.3	2.51
	1300-1315	1981.8	2.44
	1315-1330	1804.3	2.23
	1330-1345	1432.7	1.77

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	Rainfall Volume 10^6 m^3
June 2	1345-1400	1315.0	1.62
	1400-1415	923.6	1.14
	1415-1430	941.3	1.16
	1430-1445	505.8	0.62
	1445-1500	383.4	0.47
	1500-1515	314.9	0.39
	1515-1530	162.9	0.20
	1530-1545	93.6	0.12
	1545-1600	44.0	0.05
	1600-1615	24.7	0.03
	1715-1730	70.9	0.09
June 4	1115-1130	92.9	0.11
	1130-1145	31.0	0.04
	1145-1200	31.0	0.04
	1230-1245	1100.2	1.36
	1315-1330	92.9	0.11
	1330-1345	88.3	0.11
	1345-1400	202.2	0.25
	1400-1415	272.9	0.58
	1415-1430	1373.4	1.69
	1430-1445	496.6	0.61
	1445-1500	191.7	0.24
	1500-1515	233.5	0.29
	1515-1530	181.4	0.22
	1530-1545	334.1	0.41
	1545-1600	707.9	0.87
	1600-1615	827.3	1.02
	1615-1630	955.3	1.18
	1630-1645	1466.5	1.81
	1645-1700	2786.4	3.44
	1700-1715	2407.9	2.97
	1715-1730	5384.8	6.64
	1730-1745	5352.1	6.60
	1745-1800	7188.8	8.87
	1800-1815	9141.9	11.28
	1815-1830	7755.6	9.57
	1830-1845	6521.8	8.04
	1845-1900	3585.7	4.42
	1900-1915	2825.7	3.49
	1915-1930	5309.9	6.55
	1930-1945	6640.5	8.19
	1945-2000	5479.8	6.76
	2000-2015	6510.3	8.03
	2015-2030	4508.6	5.56
	2030-2045	7599.8	9.37
	2045-2100	8592.6	10.60

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	10^6 m^3
June 4	2100-2115	3952.7	4.86
	2115-2130	3725.9	4.60
	2130-2145	5823.0	7.18
	2145-2200	4632.5	5.71
	2200-2215	3628.2	4.48
	2215-2230	2965.1	3.66
	2230-2245	2879.3	3.55
	2245-2300	2967.2	3.66
	2300-2315	1988.3	2.45
	2315-2330	1624.5	2.00
	2330-2345	930.0	1.15
	2345-0000	488.5	0.60
June 5	0000-0015	180.5	0.22
	0015-0030	226.5	0.28
	0030-0045	234.4	0.29
	0045-0100	196.3	0.24
	0100-0115	97.9	0.12
	0115-0130	60.3	0.07
	0130-0145	51.5	0.06
	0215-0230	19.4	0.02
	0530-0545	27.5	0.03
	0545-0600	60.2	0.07
	0800-0815	19.4	0.02
	0830-0845	29.1	0.04
	1545-1600	80.5	0.10
June 8	1030-1045	24483.6	30.20
	1530-1545	64.4	0.08
	1600-1615	183.1	0.23
	1615-1630	579.4	0.71
	1630-1645	170.4	0.21
	1645-1700	301.4	0.37
	1700-1715	202.1	0.25
	1730-1745	162.1	0.20
	1745-1800	102.2	0.13
	1800-1815	273.3	0.34
	1815-1830	586.2	0.72
	1830-1845	2091.7	2.58
	1845-1900	2071.5	2.56
	1900-1915	2293.3	2.83
	1915-1930	273.7	0.34
	1930-1945	43.0	0.05
	1945-2000	66.7	0.08
	2000-2015	7.1	0.01
	2015-2030	132.7	0.16
	2030-2045	10.5	0.01
	2045-2100	15.4	0.02

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	Rainfall Volume 10^6 m^3
June 8	2100-2115	15.4	0.02
	2200-2215	27.3	0.03
	2215-2230	29.4	0.04
	2245-2300	142.3	0.18
	2300-2315	145.6	0.18
	2315-2330	7.7	0.01
	2330-2345	8.4	0.01
	2345-0000	16.7	0.02
June 9	0145-0200	22.6	0.03
	0200-0215	73.1	0.09
	0215-0230	20.4	0.03
	0230-0245	120.6	0.15
	0245-0300	144.9	0.18
	0300-0315	197.7	0.24
	0315-0330	113.0	0.14
	0330-0345	22.6	0.03
	0345-0400	367.1	0.45
	0400-0415	659.2	0.81
	0415-0430	336.1	0.41
	0430-0445	1500.4	1.85
	0445-0500	2832.2	3.49
	0500-0515	4601.3	5.68
	0515-0530	6629.6	8.18
	0530-0545	7707.9	9.51
	0545-0600	8543.9	10.54
	0600-0615	11398.8	14.06
	0615-0630	9894.8	12.21
	0630-0645	8847.1	10.91
	0645-0700	8907.7	10.99
	0700-0715	7190.1	8.87
	0715-0730	4375.9	5.40
	0730-0745	3605.9	4.45
	0745-0800	2244.2	2.77
	0800-0815	2037.3	2.51
	0815-0830	1063.8	1.31
	0830-0845	695.9	0.86
	0845-0900	379.9	0.47
	0900-0915	277.0	0.34
	0915-0930	59.3	0.07
	0930-0945	19.1	0.02
	1030-1045	142.6	0.18
	1200-1215	26.3	0.03
	1215-1230	26.3	0.03
	1230-1245	26.3	0.03
	1445-1500	27.9	0.03
	1515-1530	27.9	0.03
	1530-1545	27.9	0.03

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	10^6 m^3
June 9	1615-1630	27.9	0.03
	1645-1700	27.9	0.03
	1745-1800	27.9	0.03
June 20	1830-1845	16.0	0.02
	1845-1900	258.9	0.32
	1900-1915	258.9	0.32
	1915-1930	378.8	0.47
	1930-1945	156.8	0.19
	1945-2000	178.7	0.22
	2000-2015	33.8	0.04
	2030-2045	21.9	0.03
	2045-2100	22.0	0.03
	2100-2115	16.5	0.02
	2115-2130	5.8	0.01
	2145-2200	19.6	0.02
June 23	1915-1930	15.1	0.02
	1945-2000	7.5	0.01
	2000-2015	15.1	0.02
	2115-2130	22.6	0.03
	2200-2215	15.1	0.02
	2215-2230	37.7	0.05
	2230-2245	80.9	0.10
	2245-2300	170.4	0.21
	2300-2315	267.6	0.33
	2315-2330	332.2	0.41
	2330-2345	320.0	0.40
	2345-0000	655.8	0.81
June 24	0000-0015	638.7	0.79
	0015-0030	358.1	0.44
	0030-0045	39.8	0.05
	0045-0100	19.8	0.02
	0300-0315	34.5	0.04
	0400-0415	34.5	0.04
	0500-0515	34.5	0.04
	2045-2100	50.8	0.06
	2100-2115	50.8	0.06
June 25	0600-0615	12.0	0.01
	0615-0630	136.5	0.17
	0630-0645	176.8	0.22
	0645-0700	279.4	0.34
	1330-1345	180.7	0.22
	1345-1400	340.8	0.42
	1400-1415	1045.9	1.29
	1415-1430	218.1	0.27

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	Rainfall Volume 10^6 m^3
June 25	1430-1445	223.6	0.28
	1445-1500	494.0	0.61
	1500-1515	496.6	0.61
	1515-1530	651.8	0.80
	1530-1545	1103.0	1.36
	1545-1600	717.0	0.88
	1600-1615	648.8	0.80
	1615-1630	237.1	0.29
	1630-1645	559.4	0.69
	1645-1700	418.9	0.52
	1700-1715	760.0	0.94
	1715-1730	592.5	0.73
	1730-1745	1058.8	1.31
	1745-1800	466.2	0.58
	1800-1815	16.6	0.02
	1815-1830	558.2	0.69
	1830-1845	616.7	0.76
	1845-1900	268.2	0.33
	1900-1915	237.0	0.29
	1915-1930	58.6	0.07
	2030-2045	12.7	0.02
	2230-2245	7.1	0.01
	2245-2300	7.1	0.01
	2300-2315	7.1	0.01
	2315-2330	7.1	0.01
	2330-2345	7.1	0.01
	2345-0000	13.5	0.02
	0000-0015	20.6	0.03
	0015-0030	13.5	0.02
June 26	0315-0330	10.9	0.01
	0330-0345	10.9	0.01
	0345-0400	10.9	0.01
	0400-0415	22.9	0.03
	0415-0430	43.9	0.05
	0500-0515	33.8	0.04
	0530-0545	29.6	0.04
	0545-0600	71.5	0.09
	0600-0615	264.6	0.33
	0615-0630	276.0	0.34
	0630-0645	274.8	0.34
	0645-0700	111.3	0.14
	0700-0715	164.3	0.20
	0715-0730	92.9	0.11
	0730-0745	95.6	0.12
	0745-0800	110.7	0.14
	0800-0815	156.4	0.19
	0815-0830	174.6	0.22

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	10^6 m^3
June 26	0830-0845	511.5	0.63
	0845-0900	1355.7	1.67
	0900-0915	709.8	0.88
	0915-0930	2165.6	2.67
	0930-0945	5299.6	6.54
	0945-1000	3410.7	2.97
	1000-1015	1652.7	2.04
	1015-1030	2738.6	3.38
	1030-1045	1063.6	1.31
	1045-1100	801.4	0.99
	1130-1145	17.8	0.02
	1145-1200	8.9	0.01
	1215-1230	319.9	0.40
	1230-1245	159.5	0.20
	1245-1300	68.1	0.08
	1300-1315	12.7	0.02
	1315-1330	63.5	0.08
	1330-1345	12.7	0.02
	1545-1600	3.3	0.01
	1645-1700	3.3	0.01
	1800-1815	5.4	0.01
	1815-1830	76.9	0.09
	1830-1845	144.2	0.18
	1845-1900	19.2	0.02
June 29	1745-1800	56.9	0.07
	1800-1815	42.7	0.05
	1815-1830	7.1	0.01
	1845-1900	28.8	0.04
	1900-1915	190.1	0.23
	1915-1930	433.5	0.53
	1930-1945	464.8	0.57
	1945-2000	69.3	0.09
	2000-2015	19.3	0.02
July 3	2045-2100	111.6	0.14
	2100-2115	827.0	1.02
	2115-2130	7.5	0.01
	2130-2145	57.1	6.07
July 4	1945-2000	15.4	0.02
	2000-2015	114.1	0.14
	2015-2030	120.1	0.15
	2115-2130	6.1	0.01
	2130-2145	29.4	0.04

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	10^6 m^3
July 5	1030-1045	12.1	0.01
	1045-1100	5.3	0.01
	1100-1115	5.3	0.01
	1245-1300	45.2	0.06
	1300-1315	30.1	0.04
	1345-1400	32.8	0.04
	1400-1415	87.9	0.11
	1415-1430	44.0	0.05
	1430-1445	704.1	0.87
	1445-1500	1576.6	1.94
	1500-1515	2357.0	2.91
	1515-1530	1564.8	1.93
	1530-1545	560.4	0.69
	1545-1600	386.1	0.48
	1600-1615	24.7	0.03
	1700-1715	14.5	0.02
	1900-1915	14.2	0.02
	1915-1930	168.4	0.21
	1930-1945	124.5	0.15
	1945-2000	106.8	0.13
	2000-2015	56.0	0.07
	2015-2030	95.7	0.12
	2030-2045	255.4	0.32
	2045-2100	35.1	0.04
July 6	1245-1300	9.3	0.01
	1300-1315	113.5	0.14
	1330-1345	174.9	0.22
	1345-1400	42.9	0.05
	1400-1415	58.8	0.07
	1430-1445	753.0	0.93
	1445-1500	484.8	0.60
	1500-1515	146.6	0.18
	1515-1530	23.3	0.03
	1530-1545	11.6	0.01
	1545-1600	11.6	0.01
	1600-1615	3.7	0.01
July 7	0645-0700	14.7	0.02
	1645-1700	23.7	0.03
	1715-1730	23.3	0.03
	1730-1745	102.3	0.13
	1745-1800	144.2	0.18
	1800-1815	29.4	0.04

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	Rainfall Volume 10^6 m^3
July 8	1515-1530	27.8	0.03
	1530-1545	27.8	0.03
	1545-1600	74.1	0.09
	1600-1615	15.4	0.02
	1645-1700	46.3	0.06
	1730-1745	153.8	0.19
	1745-1800	48.1	0.06
	1800-1815	88.1	0.11
	2045-2100	3.3	0.01
	2100-2115	200.9	0.25
	2115-2130	39.7	0.05
	2130-2145	14.9	0.02
	2200-2215	3.3	0.01
	2215-2230	3.3	0.01
	2245-2300	3.3	0.01
July 9	1615-1630	7.5	0.01
	1630-1645	15.1	0.02
	1645-1700	30.1	0.04
	1715-1730	22.6	0.03
	1730-1745	70.0	0.09
	1900-1915	99.6	0.12
	1915-1930	1153.5	1.42
	1930-1945	1838.0	2.27
	1945-2000	1612.1	1.99
	2000-2015	1612.0	1.99
	2015-2030	3416.3	4.21
	2030-2045	3529.0	4.35
	2045-2100	1145.1	1.41
	2100-2115	348.0	0.43
	2115-2130	28.5	0.04
	2130-2145	227.1	0.28
	2145-2200	496.2	0.61
	2200-2215	414.2	0.51
	2215-2230	234.1	0.29
	2230-2245	262.1	0.32
	2245-2300	231.6	0.29
	2300-2315	125.1	0.15
	2315-2330	17.8	0.02
	2330-2345	4.2	0.01
July 15	1815-1830	239.3	0.30
	1830-1845	76.1	0.09
	1845-1900	1505.9	1.86
	1900-1915	451.8	0.56
	1915-1930	150.6	0.19
	1945-2000	53.6	0.07

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	10^6 m^3
July 17	1145-1200	29.1	0.04
	1200-1215	100.3	0.12
	1215-1230	47.4	0.06
	1230-1245	355.4	0.44
	1245-1300	184.8	0.23
	1300-1315	292.0	0.36
	1315-1330	527.3	0.65
	1330-1345	55.2	0.07
	1345-1400	42.7	0.05
	1400-1425	1729.1	2.13
	1415-1430	1397.6	1.72
	1430-1445	819.6	1.01
	1445-1500	758.2	0.94
	1500-1515	2069.1	2.55
	1515-1530	3670.4	4.53
	1530-1545	3215.0	3.97
	1545-1600	4800.1	5.92
	1600-1615	4774.1	5.89
	1615-1630	7242.9	8.93
	1630-1645	7594.6	9.37
	1645-1700	7057.2	8.71
	1700-1715	7536.7	9.30
	1715-1730	7783.8	9.60
	1730-1745	5393.7	6.65
	1745-1800	4177.4	5.15
	1800-1815	3764.6	4.64
	1815-1830	4202.3	5.18
	1830-1845	3437.7	4.24
	1845-1900	3274.0	4.04
	1900-1915	2969.2	3.66
	1915-1930	3098.0	3.82
	1930-1945	2151.3	2.65
	1945-2000	1478.8	1.82
	2000-2015	1009.9	1.25
	2015-2030	583.2	0.72
	2030-2045	327.0	0.40
	2045-2100	209.9	0.26
	2100-2115	31.4	0.04
	2115-2130	10.9	0.01
	2130-2145	40.7	0.06
	2200-2215	35.9	0.04
	2345-0000	76.6	0.09
July 18	0115-0130	21.3	0.03
	0145-0200	249.8	0.31
	0200-0215	957.7	1.18
	0215-0230	1561.4	1.93

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	10^6 m^3
July 18	0230-0245	1207.5	1.49
	0245-0300	166.6	0.21
	0300-0315	104.1	0.13
	0315-0330	83.3	0.10
	0330-0345	83.3	0.10
	0345-0400	106.6	0.13
	0400-0415	159.1	0.20
	0415-0430	261.1	0.32
	0430-0445	297.6	0.37
	0445-0500	437.3	0.54
	0500-0515	383.9	0.47
	0515-0530	610.3	0.75
	0530-0545	993.4	1.23
	0545-0600	1220.2	1.51
	0600-0615	821.3	1.01
	0615-0630	1545.1	1.91
	0630-0645	1559.7	1.92
	0645-0700	2525.5	3.12
	0700-0715	1016.1	1.25
	0715-0730	1572.6	1.94
	0730-0744	1732.2	2.14
	0745-0800	1598.9	1.97
	0800-0815	1302.1	1.61
	0815-0830	1764.7	2.18
	0830-0845	1199.4	1.48
	0845-0900	1056.6	1.30
	0900-0915	1075.8	1.33
	0915-0930	1026.7	1.27
	0930-0945	589.7	0.73
	0945-1000	372.6	0.46
	1000-1015	222.7	0.27
	1015-1030	130.7	0.16
	1030-1045	157.1	0.19
	1045-1100	449.4	0.55
	1100-1115	393.6	0.49
	1115-1130	497.5	0.61
	1130-1145	883.7	1.09
	1145-1200	2078.6	2.56
	1200-1215	1982.3	2.45
	1215-1230	1745.6	2.15
	1230-1245	3510.4	4.33
	1245-1300	1273.8	1.57
	1300-1315	2326.6	2.87
	1315-1330	1542.1	1.90
	1330-1345	778.9	0.96
	1345-1400	509.3	0.63

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	10^6 m^3
July 18	1400-1415	275.4	0.34
	1415-1430	808.5	1.00
	1430-1445	538.8	0.66
	1445-1500	213.9	0.26
	1500-1515	2656.4	3.28
	1515-1530	1712.3	2.11
	1530-1545	1912.6	2.36
	1545-1600	768.7	0.95
	1600-1615	2844.0	3.51
	1615-1630	2359.0	2.91
	1630-1645	2642.2	3.26
	1645-1700	1059.7	1.31
	1700-1715	1803.7	2.22
	1715-1730	661.4	0.82
	1730-1745	2031.4	2.51
	1745-1800	2313.9	2.85
	1800-1815	1056.0	1.30
	1815-1830	1044.2	1.29
	1830-1845	976.4	1.20
	1845-1900	697.1	0.86
	1900-1915	501.8	0.62
	1915-1930	1403.9	1.73
	1930-1945	423.0	0.52
	1945-2000	524.0	0.65
	2000-2015	1080.8	1.33
	2015-2030	797.0	0.98
	2030-2045	101.7	0.13
	2045-2100	42.7	0.05
	2100-2115	42.5	0.05
	2115-2130	64.1	0.08
	2130-2145	157.6	0.19
	2145-2200	42.8	0.05
	2215-2230	4.5	0.01
	2245-2300	15.5	0.02
	2345-0000	220.7	0.27
July 19	0000-0015	78.9	0.10
	0015-0030	440.7	0.54
	0030-0045	1527.3	1.88
	0045-0100	2106.4	2.60
	0100-0115	3021.8	3.73
	0115-0130	4253.4	5.25
	0130-0145	3969.3	4.90
	0145-0200	2382.3	2.94
	0200-0215	4832.2	5.96
	0215-0230	4854.1	5.99
	0230-0245	5921.4	7.30

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	10^6 m^3
July 19	0245-0300	5867.9	7.24
	0300-0315	4141.6	5.11
	0315-0330	4015.6	4.95
	0330-0345	5849.7	7.22
	0345-0400	6558.7	8.09
	0400-0415	8409.8	10.37
	0415-0430	8338.3	10.29
	0430-0445	9292.1	11.46
	0445-0500	6915.6	8.53
	0500-0515	7349.1	9.07
	0515-0530	8741.1	10.78
	0530-0545	7535.2	9.29
	0545-0600	6639.3	8.19
	0600-0615	7152.8	8.83
	0615-0630	6720.4	8.29
	0630-0645	7087.1	8.74
	0645-0700	7216.2	8.90
	0700-0715	7894.4	9.74
	0715-0730	7077.0	8.73
	0730-0745	6322.7	7.80
	0745-0800	5883.4	7.26
	0800-0815	7421.8	9.16
	0815-0830	6497.9	8.02
	0830-0845	7082.4	8.74
	0845-0900	6553.5	8.08
	0900-0915	5986.3	7.38
	0915-0930	6419.2	7.92
	0930-0945	6991.9	8.62
	0945-1000	6816.7	8.41
	1000-1015	6658.3	8.21
	1015-1030	5944.7	7.33
	1030-1045	6750.8	8.33
	1045-1100	8077.2	9.96
	1100-1115	7529.0	9.29
	1115-1130	7603.3	9.38
	1130-1145	7539.0	9.30
	1145-1200	9265.0	11.43
	1200-1215	8753.5	10.80
	1215-1230	9192.5	11.34
	1230-1245	8796.7	10.85
	1245-1300	8268.6	10.20
	1300-1315	7247.6	8.94
	1315-1330	5840.0	7.20
	1330-1345	5475.3	6.75
	1345-1400	4183.2	5.16
	1400-1415	3988.0	4.92
	1415-1430	3156.9	3.89

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	Rainfall Volume 10^6 m^3
July 19	1430-1445	3262.3	4.02
	1445-1500	2020.8	2.49
	1500-1515	1275.4	1.57
	1515-1530	1280.1	1.58
	1530-1545	1044.3	1.29
	1545-1600	763.2	0.94
	1600-1615	410.2	0.51
	1615-1630	315.5	0.39
	1630-1645	211.6	0.26
	1645-1700	227.7	0.28
	1700-1715	115.2	0.14
	1715-1730	68.0	0.08
	1745-1800	96.4	0.12
	1800-1815	7.1	0.01
	1845-1900	14.5	0.02
	1900-1915	11.7	0.01
	2215-2230	8.7	0.01
	2345-0000	16.8	0.02
July 20	0330-0345	12.1	0.01
	0345-0400	21.0	0.03
	0400-0415	67.3	0.08
	0415-0430	23.1	0.03
	0430-0445	173.3	0.21
	0445-0500	83.5	0.10
	0500-0515	177.0	0.22
	0515-0530	212.0	0.26
	0530-0545	424.6	0.52
	0545-0600	599.9	0.74
	0600-0615	826.2	1.02
	0615-0630	1020.0	1.26
	0630-0645	729.5	0.90
	0645-0700	766.2	0.95
	0700-0715	690.4	0.85
	0715-0730	757.4	0.93
	0730-0745	802.5	0.99
	0745-0800	441.6	0.54
	0800-0815	362.4	0.45
	0815-0830	345.8	0.43
	0830-0845	358.9	0.44
	0845-0900	302.9	0.37
	0900-0915	156.3	0.19
	0915-0930	361.7	0.45
	0930-0945	161.9	0.20
	0945-1000	113.6	0.14
	1000-1015	130.8	0.16
	1015-1030	144.0	0.18
	1030-1045	37.3	0.05

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	Rainfall Volume 10^6 m^3
July 20	1045-1100	25.1	0.03
	1100-1115	120.8	0.15
	1115-1130	867.8	1.07
	1130-1145	948.9	1.17
	1145-1200	613.9	0.76
	1200-1215	311.1	0.38
	1215-1230	358.4	0.44
	1230-1245	261.3	0.32
	1245-1300	141.2	0.17
	1300-1315	123.7	0.15
	1315-1330	34.0	0.04
	1330-1345	6.5	0.01
	1400-1415	56.8	0.07
	1415-1430	18.1	0.02
	1430-1445	46.4	0.06
	1445-1500	45.4	0.06
	1500-1515	95.4	0.12
	1515-1530	11.5	0.01
	1530-1545	11.5	0.01
	1615-1630	195.4	0.24
	1630-1645	179.8	0.22
	1645-1700	306.6	0.38
	1700-1715	98.8	0.12
	1715-1730	1148.4	1.41
	1730-1745	1048.9	1.29
	1745-1800	68.4	0.08
	1830-1845	3.7	0.01
	1845-1900	7.5	0.01
	1900-1915	457.8	0.56
	1915-1930	372.9	0.46
	1930-1945	62.1	0.08
	1945-2000	20.7	0.03
	2045-2100	20.7	0.03
	2245-2300	20.7	0.03
July 30	0145-0200	15.4	0.02
	0200-0215	7.7	0.01
	0215-0230	7.7	0.01
	0230-0245	7.7	0.01
	1100-1115	8.3	0.01
	1700-1715	7.5	0.01
	1800-1815	137.5	0.17
	1815-1830	412.6	0.51
	1830-1845	110.0	0.14

Table 6 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	Rainfall Volume 10^6 m^3
July 31	0015-0030	106.7	0.13
	0030-0045	68.1	0.08
	0045-0100	540.6	0.67
	0100-0115	1092.1	1.35
	0115-0130	1117.5	1.38
	0130-0145	891.9	1.10
	0145-0200	734.7	0.91
	0200-0215	803.3	0.99
	0215-0230	588.0	0.73
	0230-0245	235.3	0.29
	0245-0300	105.4	0.13
	0300-0315	10.2	0.01
	0345-0400	53.1	0.07
	0400-0415	159.6	0.20
	0415-0430	53.4	0.07
	0430-0445	177.0	0.22
	0445-0500	85.5	0.11
	0500-0515	85.4	0.11
	0515-0530	168.9	0.21
	0530-0545	449.8	0.55
	0545-0600	532.2	0.66
	0600-0615	267.6	0.33
	0615-0630	415.2	0.51
	0630-0645	217.3	0.27
	0645-0700	338.6	0.42
	0700-0715	446.4	0.55
	0715-0730	112.0	0.14
	0730-0745	185.5	0.23
	0745-0800	553.9	0.68
	0800-0815	677.0	0.84
	0815-0830	550.1	0.68
	0830-0845	516.9	0.64
	0845-0900	708.2	0.87
	0900-0915	292.8	0.36
	0915-0930	413.7	0.51
	0930-0945	618.4	0.76
	0945-1000	845.1	1.04
	1000-1015	869.2	1.07
	1015-1030	1926.5	2.38
	1030-1045	3241.6	4.00
	1045-1100	4195.5	5.18
	1100-1115	2431.6	3.00
	1115-1130	1362.2	1.68
	1130-1145	993.4	1.23
	1145-1200	839.9	1.04
	1200-1215	546.4	0.67
	1215-1230	274.0	0.33
	1230-1245	131.4	0.16
	1245-1300	50.3	0.06

Table 7

1980 Precipitation

Date	Time Period (CDT)	Rainfall Volume Acre-feet	10^6 m^3
May 15	0000-0015	9.8	0.01
	0015-0030	7.5	0.01
	0145-0200	20.8	0.03
	0200-0215	25.1	0.03
	0215-0230	648.7	0.80
	0230-0245	2145.6	2.65
	0245-0300	2849.5	3.51
	0300-0315	5814.1	7.17
	0315-0330	6580.0	8.12
	0330-0345	6025.4	7.43
	0345-0400	8783.7	10.83
	0400-0415	13433.8	16.57
	0415-0430	14622.5	18.04
	0430-0445	20018.1	24.69
	0445-0500	24760.0	30.54
	0500-0515	23665.9	29.19
	0515-0530	20528.1	25.32
	0530-0545	16939.5	20.90
	0545-0600	15450.0	19.06
	0600-0615	11683.1	14.41
	0615-0630	13318.4	16.43
	0630-0645	12172.3	15.01
	0645-0700	11338.0	13.99
	0700-0715	11729.7	14.47
	0715-0730	10246.1	12.64
	0730-0745	10978.6	13.54
	0745-0800	15191.4	18.74
	0800-0815	13046.1	16.09
	0815-0830	14600.0	18.01
	0830-0845	15177.9	18.72
	0845-0900	15451.6	19.06
	0900-0915	10315.9	12.72
	0915-0930	10399.9	12.83
	0930-0945	10345.4	12.76
	0945-1000	9065.5	11.18
	1000-1015	7628.5	9.41
	1015-1030	7448.1	9.19
	1030-1045	7046.8	8.69
	1045-1100	7676.2	9.47
	1100-1115	5599.5	6.91
	1115-1130	3068.9	3.79
	1130-1145	1319.9	1.63
	1145-1200	425.3	0.52
	1200-1215	84.3	0.10
	1215-1230	28.6	0.04
	1230-1245	14.5	0.02

Table 7 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	Rainfall Volume 10^6 m^3
May 15	1245-1300	14.5	0.02
	1345-1400	17.7	0.02
	1415-1430	28.5	0.04
	1430-1445	46.2	0.06
	1715-1730	3.7	0.01
	1730-1745	15.3	0.02
	1745-1800	148.8	0.18
	1800-1815	143.9	0.18
	1815-1830	388.5	0.48
	1830-1845	473.6	0.58
	1845-1900	215.7	0.27
	1900-1915	182.3	0.22
May 18	1630-1645	178.8	0.22
	1645-1700	224.2	0.28
	1700-1715	57.4	0.07
	1800-1815	18.5	0.02
	1815-1830	31.1	0.04
	1830-1845	84.9	0.10
	1845-1900	73.6	0.09
	2015-2030	21.9	0.03
May 20	1615-1630	1076.7	1.33
	1645-1700	349.8	0.43
	1700-1715	43.7	0.05
	1715-1730	240.1	0.30
	1730-1745	2817.2	3.48
	1745-1800	1366.1	1.69
	1800-1815	4942.9	6.10
	1815-1830	3891.6	4.80
	1830-1845	2290.3	2.83
	1845-1900	5645.8	6.96
	1900-1915	4147.6	5.11
	1915-1930	5413.4	6.68
	1930-1945	6854.4	8.46
	1945-2000	5594.7	6.90
	2000-2015	1500.6	1.85
	2015-2030	1455.3	1.80
	2030-2045	2681.9	3.31
	2045-2100	1675.0	2.07
	2100-2115	1141.9	1.41
	2115-2130	980.6	1.21
	2130-2145	734.4	0.91
	2145-2200	703.8	0.87
	2200-2215	194.5	0.24
	2215-2230	20.8	0.03
	2230-2245	7.5	0.01
	2300-2315	13.1	0.02

Table 7 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	10^6 m^3
May 20	2315-2330	15.2	0.02
May 21	0100-0115	7.5	0.01
	0515-0530	39.2	0.05
	0930-0945	7616.3	9.39
May 23	0215-0230	38.5	0.05
	0230-0245	49.3	0.06
May 27	1800-1815	39.2	0.05
	1815-1830	490.8	0.61
	1830-1845	1524.8	0.19
	1845-1900	778.4	0.10
	1900-1915	911.7	1.12
	1915-1930	1348.6	1.66
	1930-1945	897.6	1.11
	1945-2000	1029.1	1.27
	2000-2015	875.2	1.08
	2015-2030	506.9	0.63
	2030-2045	162.3	0.20
	2045-2100	63.1	0.08
	2100-2115	17.8	0.02
May 28	0500-0515	5.3	0.01
	0515-0530	5.3	0.01
	0530-0545	23.2	0.03
	0545-0600	6.3	0.01
	0600-0615	48.1	0.06
	0615-0630	34.7	0.04
	0630-0645	6.3	0.01
June 1	0600-0615	17.1	0.02
	0615-0630	115.2	0.14
	0645-0700	25.4	0.03
	1815-1830	466.4	0.58
	1830-1845	706.4	0.87
	1845-1900	874.7	1.08
	1900-1915	79.4	0.10
	2030-2045	32.6	0.04
	2045-2100	52.2	0.06
	2100-2115	495.0	0.61
	2115-2130	1161.8	1.43
	2130-2145	534.4	0.66
	2145-2200	60.7	0.07
June 7	2000-2015	60.4	0.07
	2015-2030	544.0	0.67
	2100-2115	12.1	0.01

Table 7 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	10^6 m^3
June 7	2115-2130	12.1	0.01
	2130-2145	24.2	0.03
	2145-2200	12.1	0.01
	2200-2215	12.1	0.01
	2300-2315	80.5	0.10
	2315-2330	756.7	0.93
	2330-2345	1438.8	1.77
	2345-0000	5516.5	6.80
June 8	0000-0015	6811.5	8.40
	0015-0030	9214.8	11.37
	0030-0045	7900.6	9.75
	0045-0100	8680.7	10.71
	0100-0115	7034.9	8.68
	0115-0130	6946.2	8.57
	0130-0145	2556.2	3.15
	0145-0200	695.5	0.86
	0200-2015	272.8	0.34
	0215-0230	159.8	0.20
	0230-0245	255.3	0.31
	0245-0300	558.0	0.69
	0300-0315	289.6	0.36
	0315-0330	62.8	0.08
	0330-0345	86.1	0.10
	0345-0400	165.7	0.20
	0400-0415	122.4	0.15
	0415-0430	126.2	0.16
	0430-0445	134.5	0.17
	0445-0500	142.8	0.18
	0500-0515	122.4	0.15
	0515-0530	102.0	0.13
	0530-0545	20.4	0.03
	0715-0730	46.1	0.06
	0730-0745	29.1	0.04
	0745-0800	197.8	0.24
	0800-0815	116.7	0.14
	0815-0830	59.4	0.07
	0830-0845	19.0	0.02
	0845-0900	57.0	0.07
	0900-0915	40.6	0.05
	1030-1045	24.2	0.03
	1045-1100	12.1	0.01
	1100-1115	24.2	0.03
	1115-1130	24.2	0.03
	1215-1230	12.1	0.01
	1230-1245	12.1	0.01
	1315-1330	12.1	0.01
	1330-1345	47.2	0.06

Table 7 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	10^6 m^3
June 8	1345-1400	59.3	0.07
	1400-1415	941.0	1.16
	1415-1430	1739.2	2.15
	1430-1445	2443.1	3.01
	1445-1500	4297.2	5.30
	1500-1515	4685.0	5.78
	1515-1530	5087.7	6.28
	1530-1545	3756.7	4.63
	1545-1600	3712.0	4.58
	1600-1615	3242.9	4.00
	1615-1630	2578.7	3.18
	1630-1645	2755.9	3.40
	1645-1700	2116.4	2.61
	1700-1715	1725.8	2.13
	1715-1730	1342.6	1.66
	1730-1745	1011.9	1.25
	1745-1800	732.9	0.90
	1800-1815	272.9	0.34
	1815-1830	157.1	0.19
	1830-1845	28.2	0.03
	1845-1900	17.8	0.02
	1900-1915	17.8	0.02
June 11	0030-0045	7.5	0.01
	0045-0100	7.5	0.01
	0100-0115	15.1	0.02
	0115-0130	414.2	0.51
	0130-0145	2473.3	3.05
	0145-0200	5345.2	6.59
	0200-0215	7588.2	9.36
	0215-0230	10744.0	13.25
	0230-0245	11094.2	13.69
	0245-0300	16387.7	20.21
	0300-0315	15582.7	19.22
	0315-0330	15648.2	19.30
	0330-0345	12168.8	15.01
	0345-0400	6942.6	8.56
	0400-0415	8774.0	10.82
	0415-0430	6142.8	7.58
	0430-0445	6281.9	7.75
	0445-0500	5565.8	6.87
	0500-0515	4891.0	6.03
	0515-0530	3506.6	4.33
	0530-0545	2137.8	2.63
	0545-0600	1211.9	1.49
	0600-0615	682.8	0.84
	0615-0630	288.7	0.36
	0630-0645	118.6	0.15

Table 7 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	10^6 m^3
June 11	0645-0700	70.5	0.09
	0700-0715	10.9	0.01
June 17	2030-2045	5.3	0.01
	2045-2100	152.8	0.19
	2100-2115	31.7	0.04
	2115-2130	10.5	0.01
	2215-2230	104.1	0.13
	2230-2245	213.7	0.26
	2245-2300	229.5	0.28
	2300-2315	9.8	0.01
	2330-2345	19.0	0.02
June 18	1730-1745	75.0	0.09
	1800-1815	37.7	0.05
	1815-1830	7.5	0.01
	2215-2230	72.8	0.09
	2230-2245	470.9	0.58
	2245-2300	319.60	0.39
	2300-2315	207.2	0.26
	2315-2330	15.9	0.02
June 19	1800-1815	825.11	1.02
	1815-1830	1016.6	1.25
	1830-1845	538.0	0.66
	1845-1900	1761.9	2.17
	1900-1915	2912.3	3.59
	1915-1930	2476.8	3.06
	1930-1945	2430.8	3.00
	1945-2000	2020.3	2.49
	2000-2015	2436.9	3.01
	2015-2030	3036.8	3.75
	2030-2045	3307.6	4.08
	2045-2100	1045.8	1.29
	2100-2115	183.6	0.22
	2115-2130	79.5	0.10
	2130-2145	31.0	0.04
	2145-2200	25.5	0.03
	2200-2215	464.2	0.57
	2215-2230	491.3	0.61
	2230-2245	41.9	0.05
	2245-2300	14.5	0.02
June 20	1900-1915	390.3	0.48
	1915-1930	552.5	0.68
	1930-1945	845.4	1.04
	1945-2000	2094.8	2.58
	2000-2015	1371.2	1.69

Table 7 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	10^6 m^3
June 20	2015-2030	247.2	0.30
	2045-2100	104.0	0.13
	2200-2215	101.2	0.12
	2215-2230	281.8	0.34
	2230-2245	831.5	1.03
	2245-2300	415.5	0.51
	2300-2315	608.7	0.75
	2315-2330	52.0	0.06
	2330-2345	29.5	0.04
	2345-0000	15.4	0.02
June 21	0015-0030	33.7	0.04
	0030-0045	3.7	0.01
	0045-0100	3.7	0.01
	0115-0130	18.7	0.02
	1745-1800	22.9	0.02
	1815-1830	51.0	0.06
	1830-1845	1981.0	2.44
	1845-1900	1197.2	1.48
	1900-1915	3996.1	4.93
	1915-1930	6243.2	7.70
	1930-1945	6082.0	7.50
	1945-2000	6712.7	8.28
	2000-2015	6141.9	7.58
	2015-2030	5487.9	6.77
	2030-2045	10019.4	12.36
	2045-2100	7623.6	9.40
	2100-2115	8011.5	9.88
	2115-2130	9379.6	11.57
	2130-2145	9444.5	11.65
	2145-2200	6676.2	8.24
	2200-2215	6085.8	7.51
	2215-2230	3761.9	4.64
	2230-2245	2886.9	3.56
	2245-2300	1610.0	1.99
	2300-2315	866.4	1.07
	2315-2330	355.5	0.44
	2330-2345	186.4	0.22
	2345-0000	131.2	0.16
June 22	0000-0015	109.3	0.13
	0015-0030	109.3	0.13
	0030-0045	109.3	0.13
	0045-0100	65.6	0.08
	0100-0115	21.9	0.03

Table 7 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	Rainfall Volume 10^6 m^3
July 1	1800-1815	8.8	0.01
	1815-1830	158.2	0.20
	1830-1845	17.6	0.02
July 20	1930-1945	9.8	0.01
	1945-2000	150.3	0.19
	2045-2100	21.2	0.03
	2130-2145	88.3	0.11
July 21	1000-1015	545.8	0.67
	1015-1030	35.4	0.04
	1115-1130	47.1	0.06
	1130-1145	702.8	0.25
	1145-1200	602.0	0.74
	1200-1215	180.0	0.22
	1215-1230	507.8	0.63
	1500-1515	275.3	0.34
	1515-1530	8.9	0.01
	1545-1600	588.0	0.73
	1600-1615	220.7	0.27
	1615-1630	283.7	0.35
	1630-1645	39.8	0.05
	1645-1700	78.5	0.10
	1700-1715	63.2	0.08
	1715-1730	142.7	0.18
	1730-1745	35.7	0.04
	1830-1845	35.2	0.04
July 22	0415-0430	7.5	0.01
	0430-0445	15.0	0.02
	0445-0500	75.6	0.09
	0500-0515	170.9	0.21
	0515-0530	219.9	0.27
	0530-0545	646.5	0.80
	0545-0600	550.2	0.68
	0600-0615	774.5	0.96
	0615-0630	932.2	1.15
	0630-0645	893.3	1.10
	0645-0700	834.5	1.03
	0700-0715	762.1	0.94
	0715-0730	571.4	0.70
	0730-0745	474.8	0.59
	0745-0800	333.1	0.41
	0800-0815	364.6	0.45
	0815-0830	435.9	0.54
	0830-0845	387.5	0.48
	0845-0900	69.3	0.09
	0900-0915	41.0	0.05

Table 7 (cont.)

Date	Time Period (CDT)	Rainfall Volume Acre-Feet	Rainfall Volume 10^6 m^3
July 22	1045-1100	19.9	0.02
	1745-1800	78.5	0.10
	1815-1830	30.8	0.04
	1830-1845	46.2	0.06
	1845-1900	15.4	0.02
	1900-1915	30.8	0.04
July 26	2100-2115	106.5	0.13
	2115-2130	57.1	0.07
	2130-2145	239.1	0.29
	2145-2200	339.0	0.42
	2200-2215	820.1	1.01
	2215-2230	533.9	0.66
July 27	0445-0500	33.6	0.04
	0500-0515	151.9	0.19
	0515-0530	119.5	0.15
	0530-0545	115.7	0.14
	0545-0600	15.2	0.02
	0600-0615	15.1	0.02
	0615-0630	30.1	0.04
	0630-0645	22.6	0.03
	1645-1700	13.7	0.02

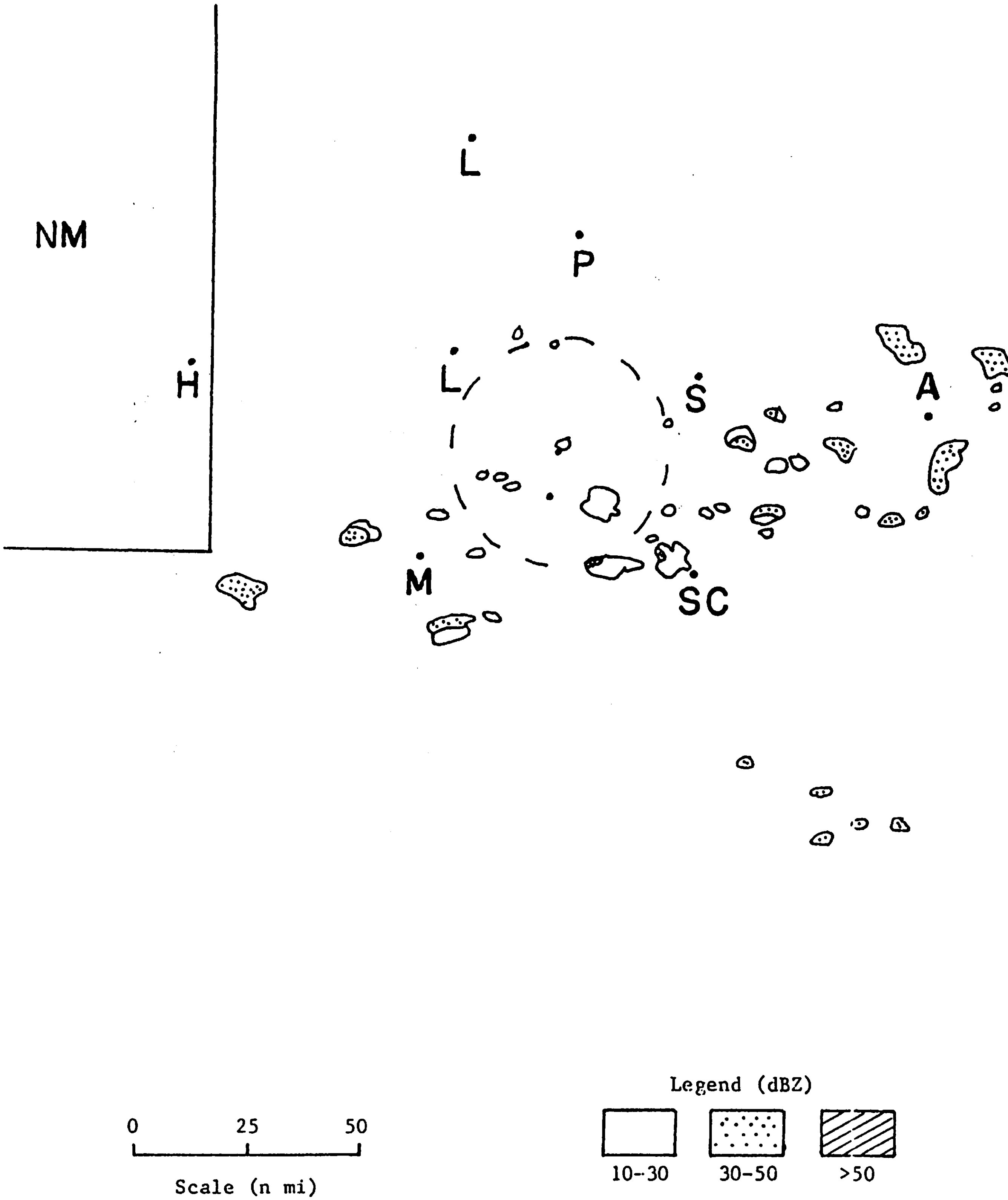

Figure 6a. An example of convective cells taken on 6 July 1979 at 19:40:04 GMT (tilt angle 1.0°)

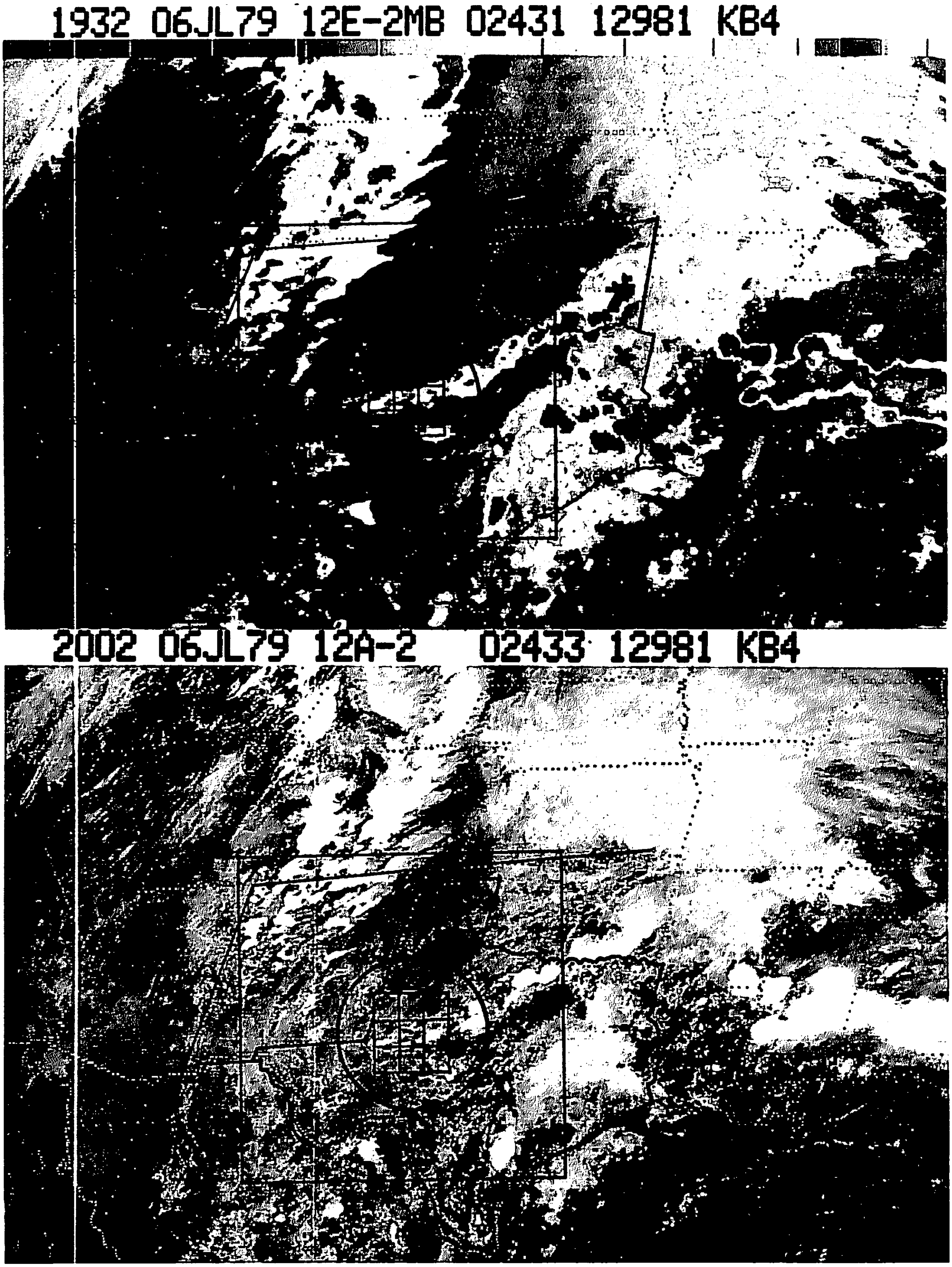

Figure 6b. Satellite imagery on 6 July 1979 showing the convective cells depicted by radar in Figure 6a; the solid circle corresponds to the total radar coverage in Figure 6a.

NO

RAINFALL

RECORDED

Figure 6c. Rainfall observed during 1915-1930 GMT on 6 July 1979 produced by the convective cells depicted by radar in Figure 6a.

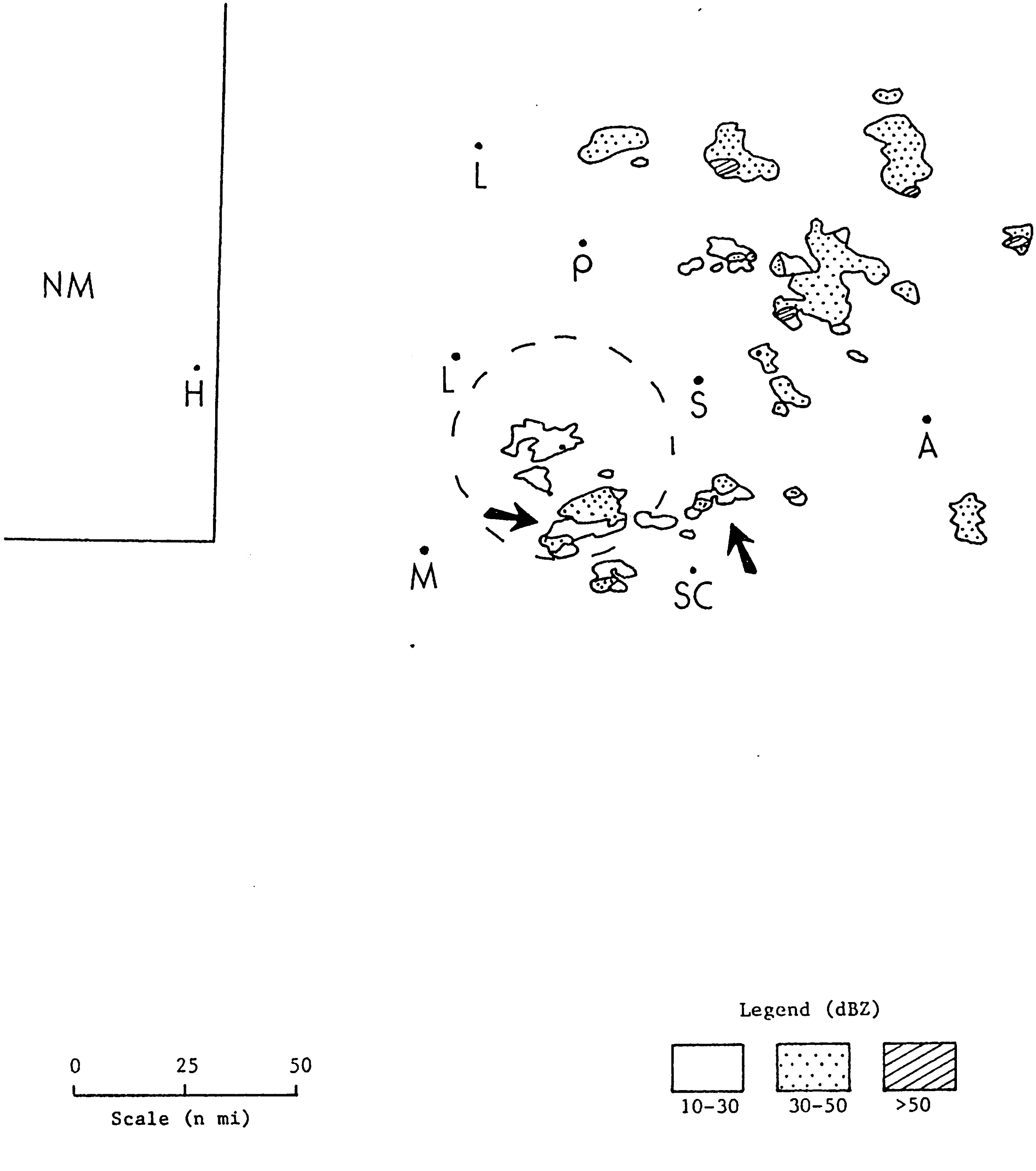

Figure 7a. An example of small convective clusters taken on 25 June 1979 at 19:15:40 GMT (tilt angle 1.0°)

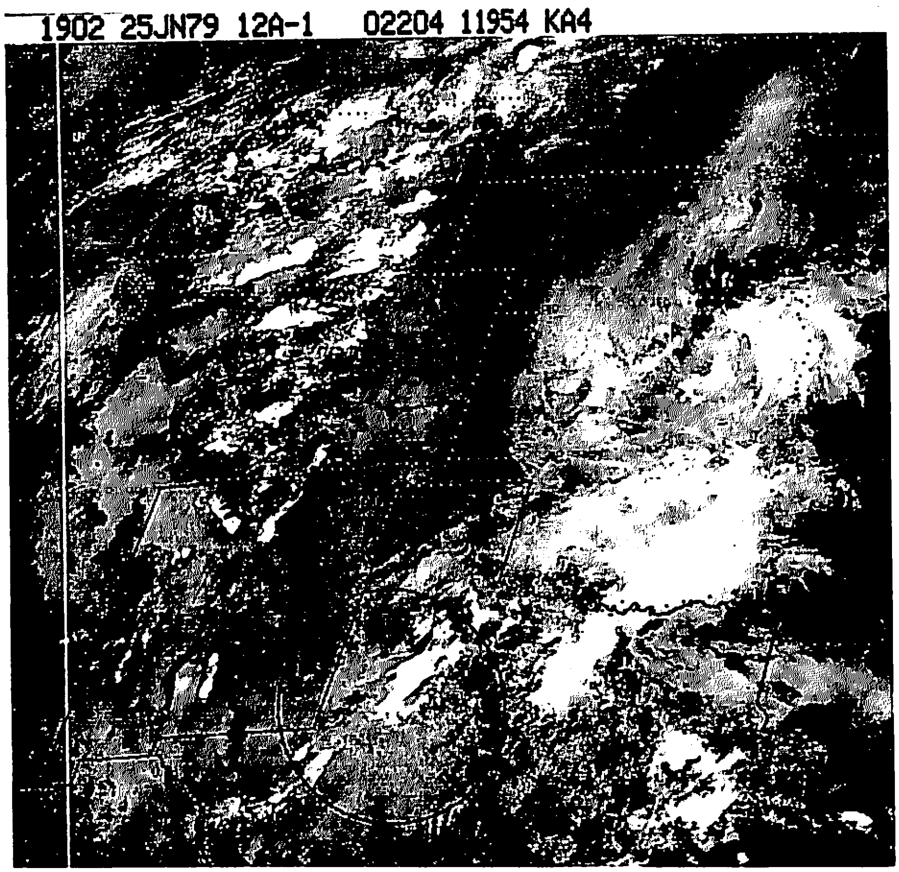

Figure 7b. Satellite imagery on 25 June 1979 showing the small convective clusters depicted by radar in Figure 7a; the solid circle corresponds to the total radar coverage in Figure 7a.

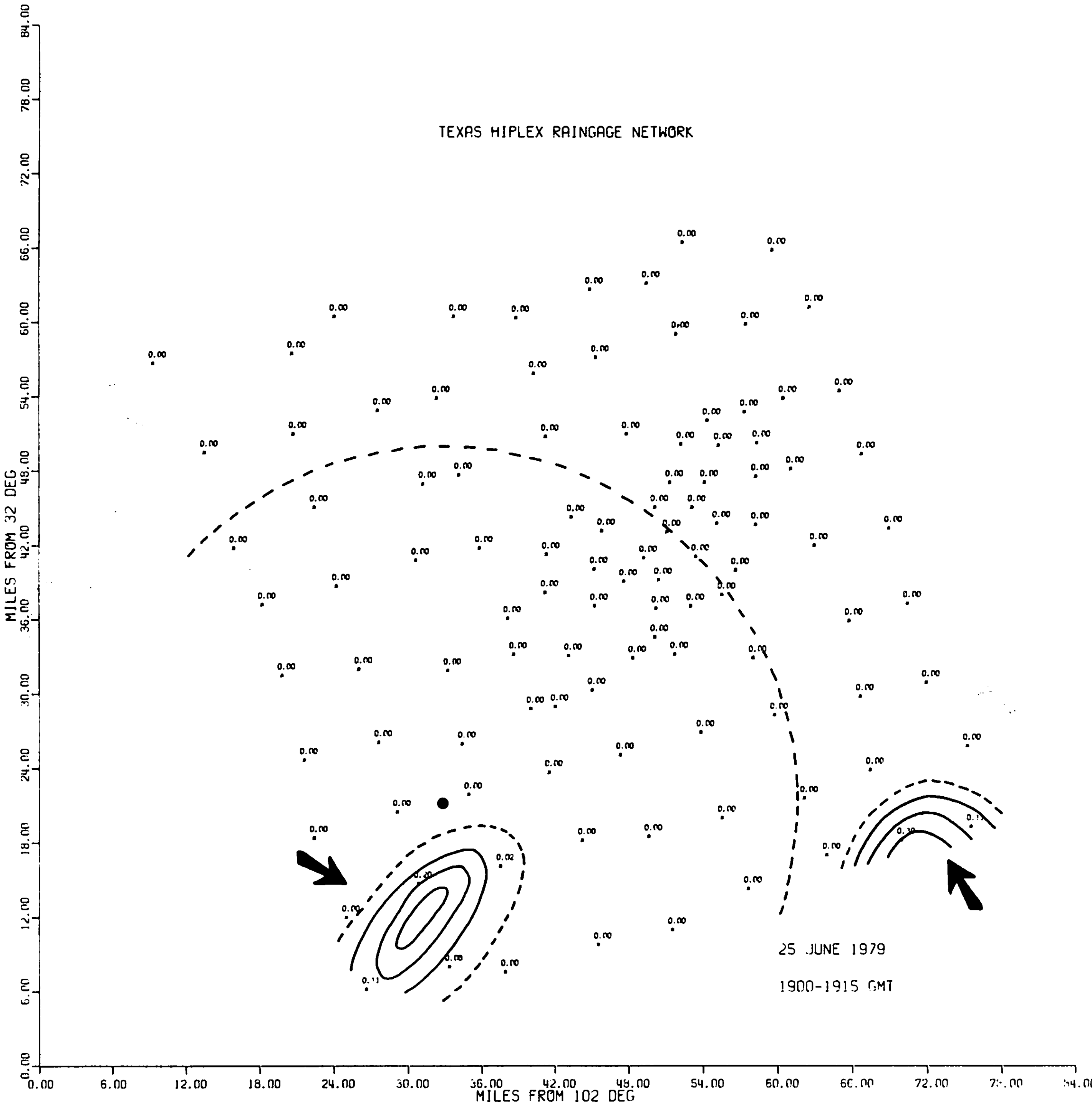

Figure 7c. Rainfall observed during 1900-1915 GMT on 25 June 1979 produced by the small convective clusters depicted by radar in Figure 7a; the dashed circle is at a 25 n. mi. distance from the radar and corresponds to the dashed circle in Figure 7a.

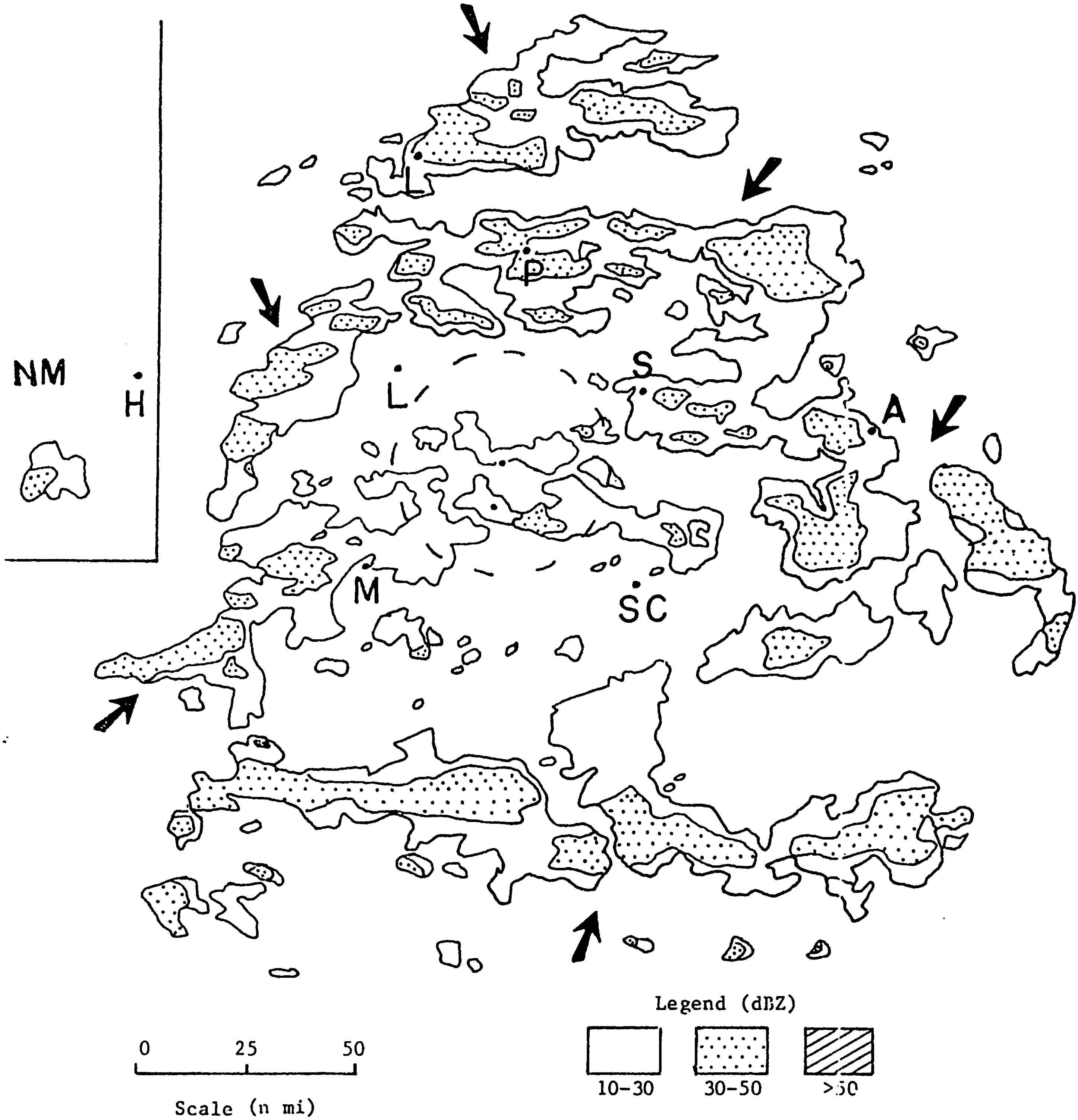

Figure 8a. An example of large convective clusters taken on 18 July 1979 at 23:23:54 GMT (tilt angle 1.0°)

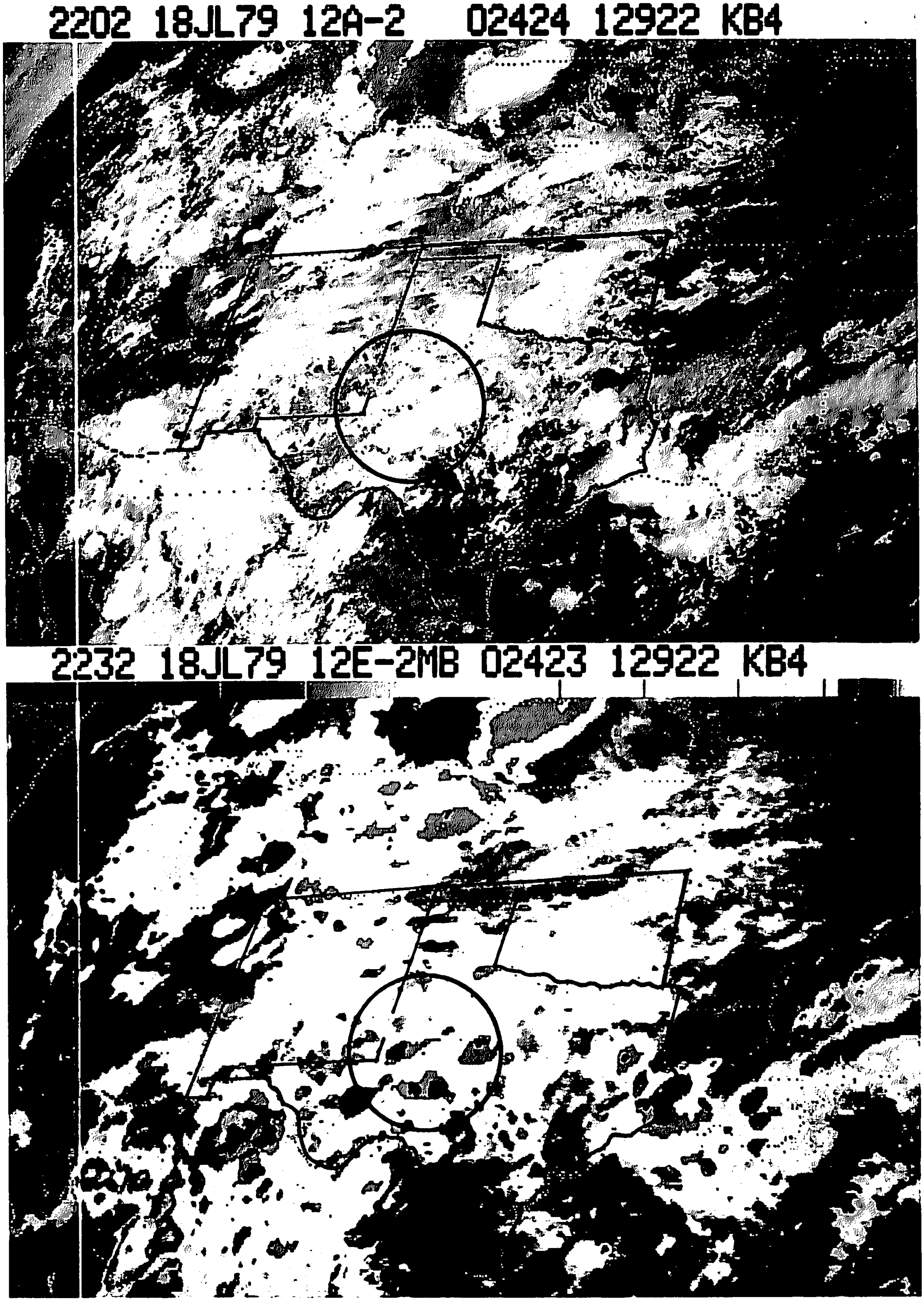

Figure 8b. Satellite imagery on 18 July 1979 showing the large convective clusters depicted by radar in Figure 8a; the solid circle corresponds to the total radar coverage in Figure 8a.

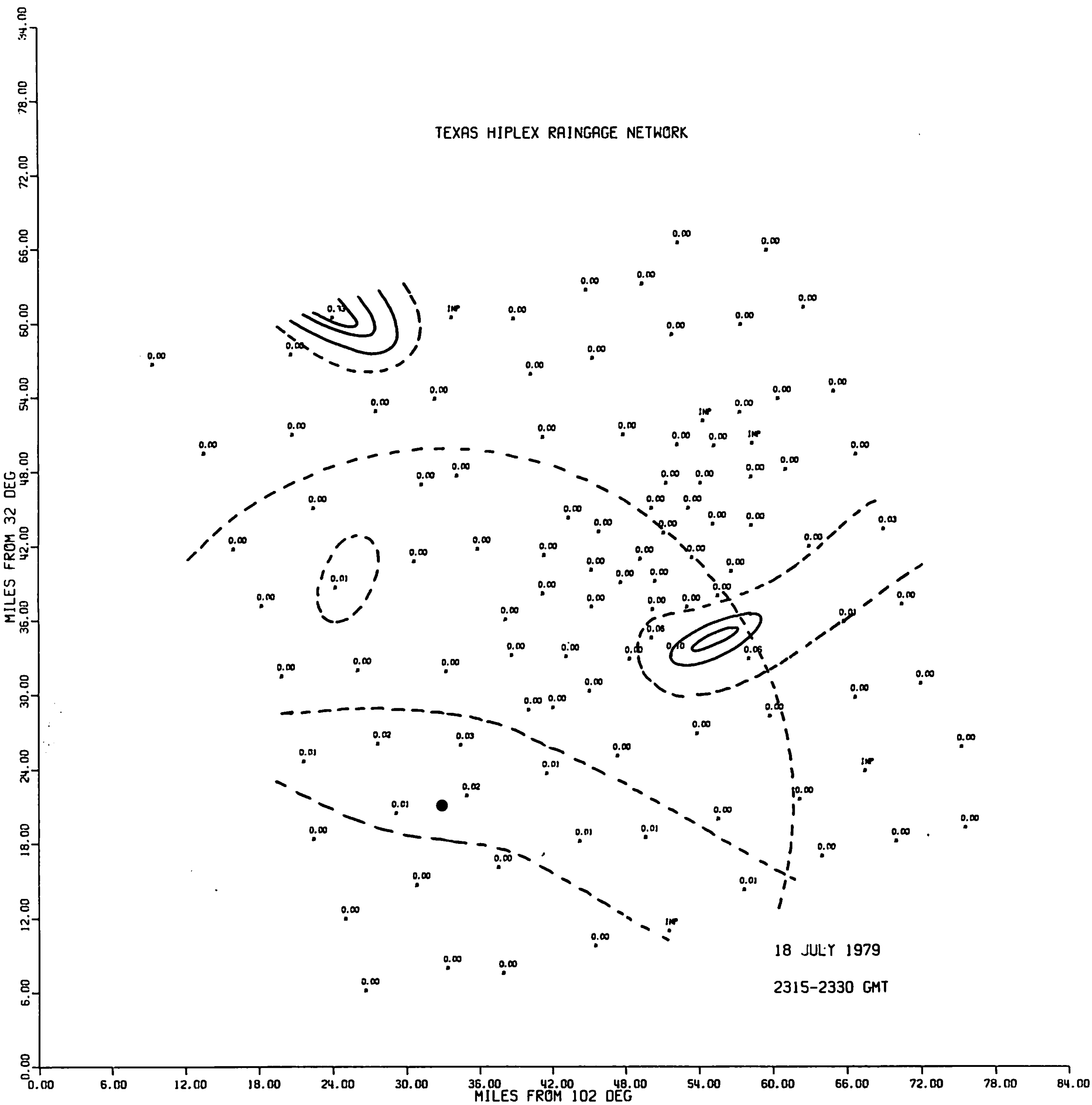

Figure 8c. Rainfall observed during 2315-2330 GMT on 18 July 1979 produced by the large convective clusters depicted by radar in Figure 8a; the dashed circle is at a 25 n. mi. distance from the radar and corresponds to the dashed circle in Figure 8a.

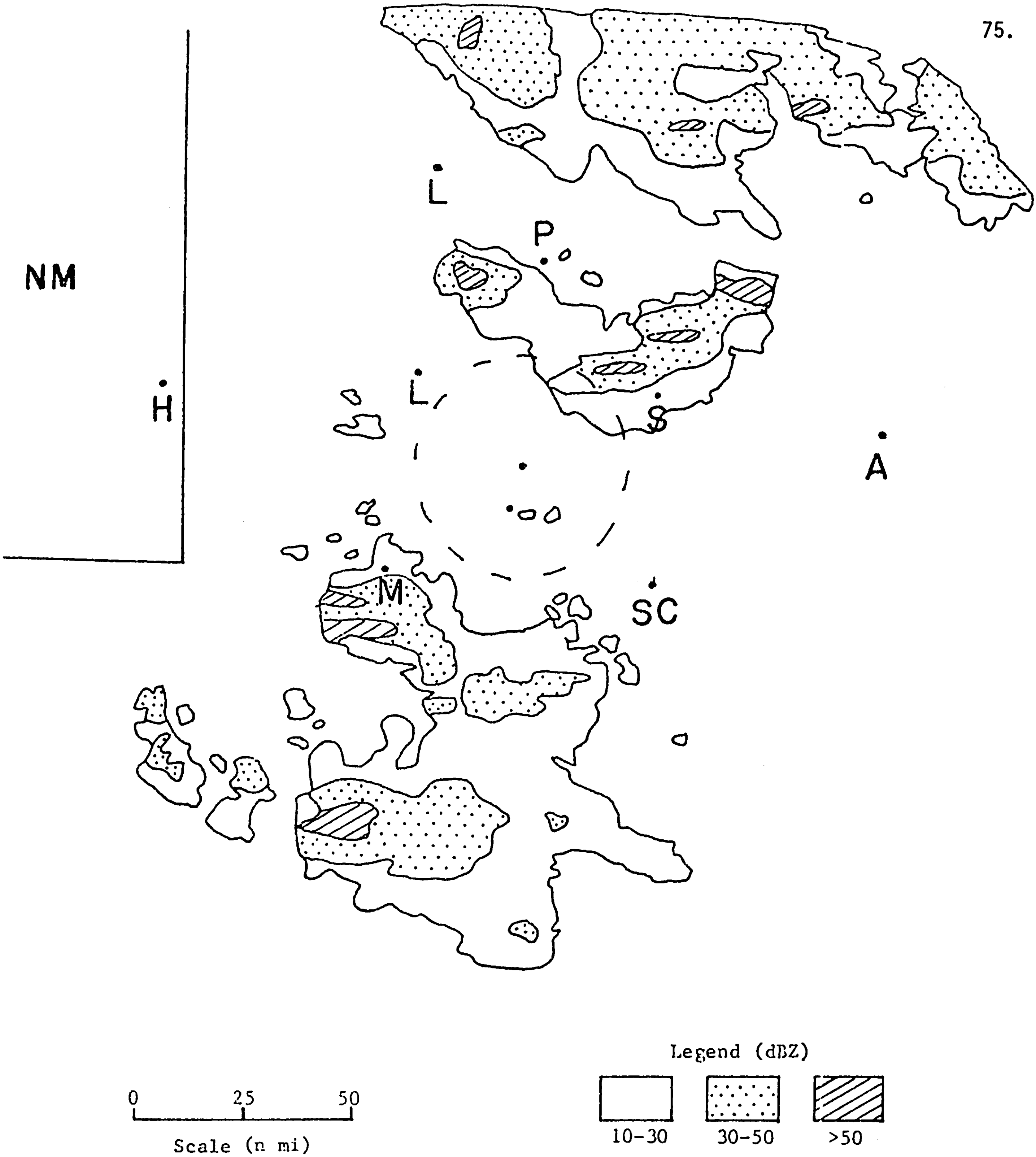

Figure 9a. An example of nested convective clusters taken on 10 July 1979 at 01:04:31 GMT (tilt angle 1.0°)

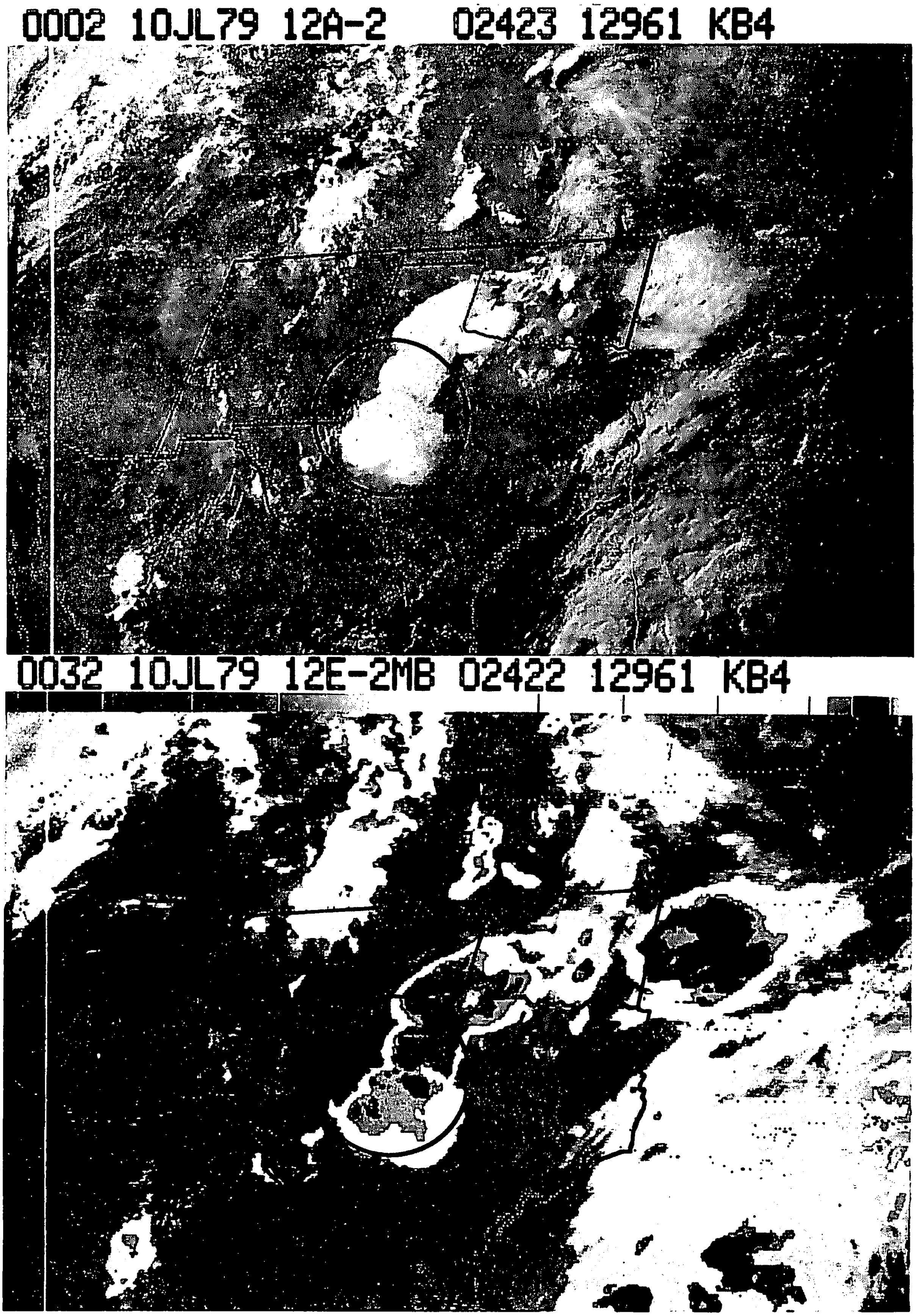

Figure 9b. Satellite imagery on 10 July 1979 showing the nested convective clusters depicted by radar in Figure 9a; the solid circle corresponds to the total radar coverage in Figure 9a.

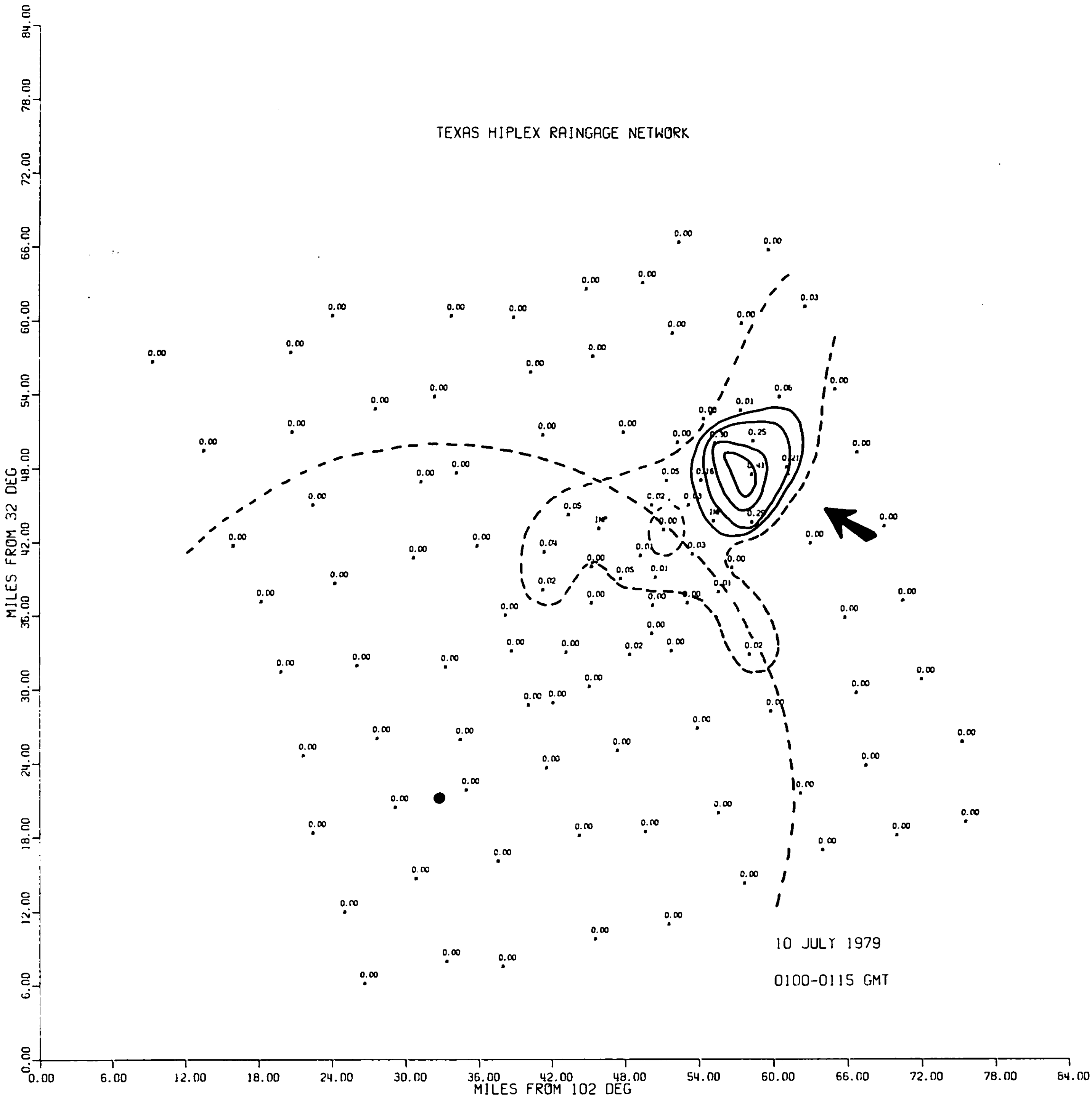

Figure 9c. Rainfall observed during 0100-0115 GMT on 10 July 1979, produced by the nested convective clusters depicted by radar in Figure 9a, the dashed circle is at a 25 n. mi. distance from the radar and corresponds to the dashed circle in Figure 5a.

The patterns displayed by each category with respect to the other data-collection devices are also significant. Although the primary goal of this categorization is stratification of raingage data, the satellite perspective is interesting, especially in the case of nested convective clusters. In addition, correlation among the independent data sets within each category is necessary. This requirement appears to be fulfilled by examination of concurrent radar echo patterns (Figures 6a, 7a, 8a, 9a), satellite imagery (Figures 6b, 7b, 8b, 9b), and raingage maps (Figures 6c, 7c, 8c, 9c). How these patterns represent significant variations of meteorological parameters between categories is the subject of further research.

COLORADO RIVER MUNICIPAL WATER DISTRICT

1. Raingage Surveillance and Maintenance
2. Precipitation Data Management
3. Preparation for 1981 Field Program

Colorado River Municipal Water District

Raingage Surveillance and Maintenance

During the period October - March, a routine surveillance of the Belfort recording raingages was performed biweekly to prevent vandalism and to insure that the protective winter covering on each gage was intact. As part of the 1980 winterization program each gage clock, silicone oil, and the collection bucket were removed.

One recording raingage was reported stolen during January; all gage components were missing, including the support base. A Certificate of Loss form was completed and forwarded for appropriate action. The gage was subsequently replaced with another gage that was positioned in a new, more secure locality. During March, one gage was discovered to have been shot several times with a small caliber weapon. The outer casing was destroyed beyond repair. The remaining undamaged parts were salvaged and placed in the spare parts inventory to be utilized in keeping the entire recording raingage network operational.

Precipitation Data Management

By the end of December 1980, all remaining 1980 field season rainfall data had been transcribed from the recording charts to the Fortran coding sheets and forwarded to Texas Tech University for keypunching. The heavy stratiform precipitation experienced during the month of September made chart interpretation and documentation a tedious and lengthy process.

Preparation for 1981 Field Program

Effective January 1, 1981, the CRMWD entered into a five-year lease agreement with the City of Big Spring for Hangar T-9 at the Industrial Park. The lease agreement obligates the CRMWD to rental payments for the first two years, and thereafter provides a renewal option for three successive years. The purpose of a lease agreement for a large aircraft hangar was to provide uncrowded aircraft parking space for CRMWD and HIPLEX weather modification aircraft.

On March 2, 1981, two CRMWD technicians began dewinterizing the gages in preparation for the 1981 Texas HIPLEX Program. All component parts removed earlier during winterization were reinstalled, and a weighing and timing calibration test was performed for each gage. Tests on all 106 recording gages were completed by March 15, 1981. In addition to the 106 recording gages, the CRMWD also implemented its network of 81 non-recording fencepost gages.

On March 3, 1981, a team of Air Force personnel arrived at the Big Spring Industrial Park to dismantle the FPS-77 Radar. The team was comprised of technicians stationed at San Antonio, Texas. All radar components were removed and crated for return shipment to the Air Force inventory.

Prior to the removal of the FPS-77 Radar, the CRMWD installed, calibrated, and placed into operation a 3-centimeter X-Band Radar as a replacement for the FPS-77. The 3-cm Radar has subsequently been used during two operational seeding missions during the month of March.

Letters of Contract Agreement were issued by the CRMWD to the Colorado International Corporation (CIC) for instrumentation services and aircraft modifications to the P-Navajo and Aztec aircraft in support of Texas HIPLEX 1981. These contracts were initiated in accordance with the Texas Department of Water Resources Interim Contract for the period of January 1, 1981 through May 31, 1981, which authorizes third-party contracts in preparation for the Texas HIPLEX Program. The cloud physics package was crated and shipped via Merchants Fast Motor Lines to CIC early in February to allow sufficient lead time for component upgrading and calibration prior to installation in the P-Navajo. The aforementioned CIC Contracts were subsequently cancelled by the CRMWD, and all aircraft instrumentation services were terminated early in March as a result of the cancellation of the Texas HIPLEX Program.

SECTION II:

Work Planned,

April 1, 1981 - September 30, 1981

Texas Department of Water Resources

The Department shall continue in its capacity as the administrator of the 1974 Master Agreement between the Department and the WPRS. Among the duties charged the Department by the Agreement are: administration of the Texas HIPLEX Program and management and monitoring of all Texas HIPLEX-related contracts.

The Department will continue to serve as principal reviewer and editor of all Texas HIPLEX-related technical and data reports as they are submitted to the Department by Texas HIPLEX participant organizations. In addition to publishing these reports, the Department shall submit to the WPRS monthly and interim Texas HIPLEX progress reports which consist of progress reports submitted to the Department by the various Texas HIPLEX subcontractors.

The Department shall also submit to the WPRS the Texas HIPLEX completion report, entitled "HIPLEX In Texas: A Summary Report on Six Years of Experimentation." The report is to consolidate the salient findings from each aspect of the Texas HIPLEX research effort, beginning with its inception and following through the 1980 field program.

Texas A&M University

The primary emphasis during April and May will be to document all analytical results and submit the reports to TDWR for publication. Two reports will be prepared--one on environmental response to convective activity, and the other a composite containing meso- and synoptic-scale analyses, cloud microphysics studies, comparison of TAMU and NWS soundings for Midland, and the mesoscale numerical model.

Beginning in June, research will continue on mesoscale analysis, variability in radar echoes, and on the development of the mesoscale numerical model.

Texas Tech University

The work planned for the next several months will emphasize the analysis of data already collected and can be summarized into three tasks:

Task 1.

Conduct analyses of microphysical data to establish natural precipitation mechanisms and develop tentative seeding hypotheses. The focus of Texas HIPLEX has been placed upon the potential rainfall increases resulting from seeding clusters of convective cells. Both previously analyzed data and measurements which have yet to be studied in detail need to be investigated with this point in mind. Of particular interest are those aspects of the precipitation process which can be associated with possible dynamic seeding effects.

Task 2.

Conduct case study analyses of the structure and evolution of precipitation events. The integration of radar, satellite, upper air, surface, and raingage data permits a qualitative description of the development of precipitation. Emphasis to date has been placed upon 17 July 1979, and this study is nearing completion. In addition, diagnostic tehcniques will be developed to yield quantitative estimates of mass and energy transports by cumulus and mesoscale vertical motions.

Task 3.

Establish in terms of rainfall characteristics the natural conditions associated with the occurrence of precipitation. Several categories of precipitation events have been established from radar echo patterns. These categories are small, large, and nested clusters. Raingage data will be utilized to generate the statistical properties of rainfall for all rainfall events. Further, it will be determined if statistically significant differences in these properties exist among the several cluster categories. Raingage and radar data will be used to establish a Z-R relationship for all precipitation events, and digitized radar data will be used to determine if improvements can be made in spatial rainfall patterns derived from raingage data alone.

Colorado River Municipal Water District

The CRMWD will continue to operate and maintain the Texas HIPLEX precipitation gage network throughout the Summer of 1981 in order to continue a record of precipitation patterns in the southern High Plains of Texas. The CRMWD intends to conduct their own precipitation augmentation program independent of the overall Texas HIPLEX effort for the purpose of stimulating rainfall over the watersheds of their two reservoirs.

SECTION III:

Personnel

PERSONNEL

Texas Department of Water Resources

Herbert W. Grubb*	Director, Planning & Development Division
John T. Carr, Jr.*	Chief, Weather and Climate Section
Robert F. Riggio	Acting Chief, Weather & Climate Section
George W. Bomar	Meteorologist
William O. Alexander	Meteorologist
Thomas J. Larkin	Meteorologist
William Hanshaw	Meteorologist Technician
Betty Flentge	Secretary

*Resigned 12-31-80

Note: Effective January 15, 1981 the Department's Weather Modification and Technology Section was renamed the Weather and Climate Section to conform more closely with its duties and responsibilities.

Texas A&M University

Name and Title	Principal Activity
James R. Scoggins, Professor and Head	Principal Investigator
George L. Huebner, Professor	Data Analysis
Alexis B. Long, Associate Research Scientist	Data Analysis
Myron Gerhard, Research Assistant	Data Analysis
Susan Callander, Student Worker	Data Processing
Mark Schwirtz, Student Worker	Data Processing
David Montplaisir, Student Worker	Data Processing
Timothy Deegan, Student Worker	Data Processing
Darrel Brissette, Student Worker	Data Processing
Meta Sienkiewicz, Research Assistant	Data Analysis and Processing
Michael July, Graduate Assistant Research	Data Analysis
John Trares, Graduate Assistant Research	Data Analysis
Phil Reba, Student Worker	Data Processing
Melinda Culver, Student Worker	Typing and Data Processing

Texas Tech University

Donald R. Haragan	Principal Investigator, Precipitation
Jerry Jurica	Principal Investigator, Satellite
Colleen A. Leary	Principal Investigator, Radar
Michael Lepage	Research Assistant
Eric Pani	Research Assistant
Erik Rasmussen	Research Assistant
Tamar Neta	Programmer
James Taylor	Programmer
Denise Bentley	Secretary
Russell John	Student Assistant

Colorado River Municipal Water District

Owen H. Ivie	General Manager
John R. Girdzus*	Administrative Assistant and Meteorologist
Donald Couvillion	Administrative Assitant & Pilot
Jeff Benson	Weather Modification Pilot
Ray Pat Jones	Meteorologist
Wesley Cox	Raingage Technician
Bert Padilla	Radar Technician

*Resigned effective December 22, 1980