AD-A034 581 M AND S COMPUTING INC HUNTSVILLE ALA F/G 4/1

PAR AURORAL STUDY. VOLUME III. A PRELIMINARY ANALYSIS OF THE DA--ETC(U)

AUG 76 M J MITCHELL, P L ALLEY, J L BROWN DASG60-74-C-0026

UNCLASSIFIED 76-0027 NL

1 OF 2

AD

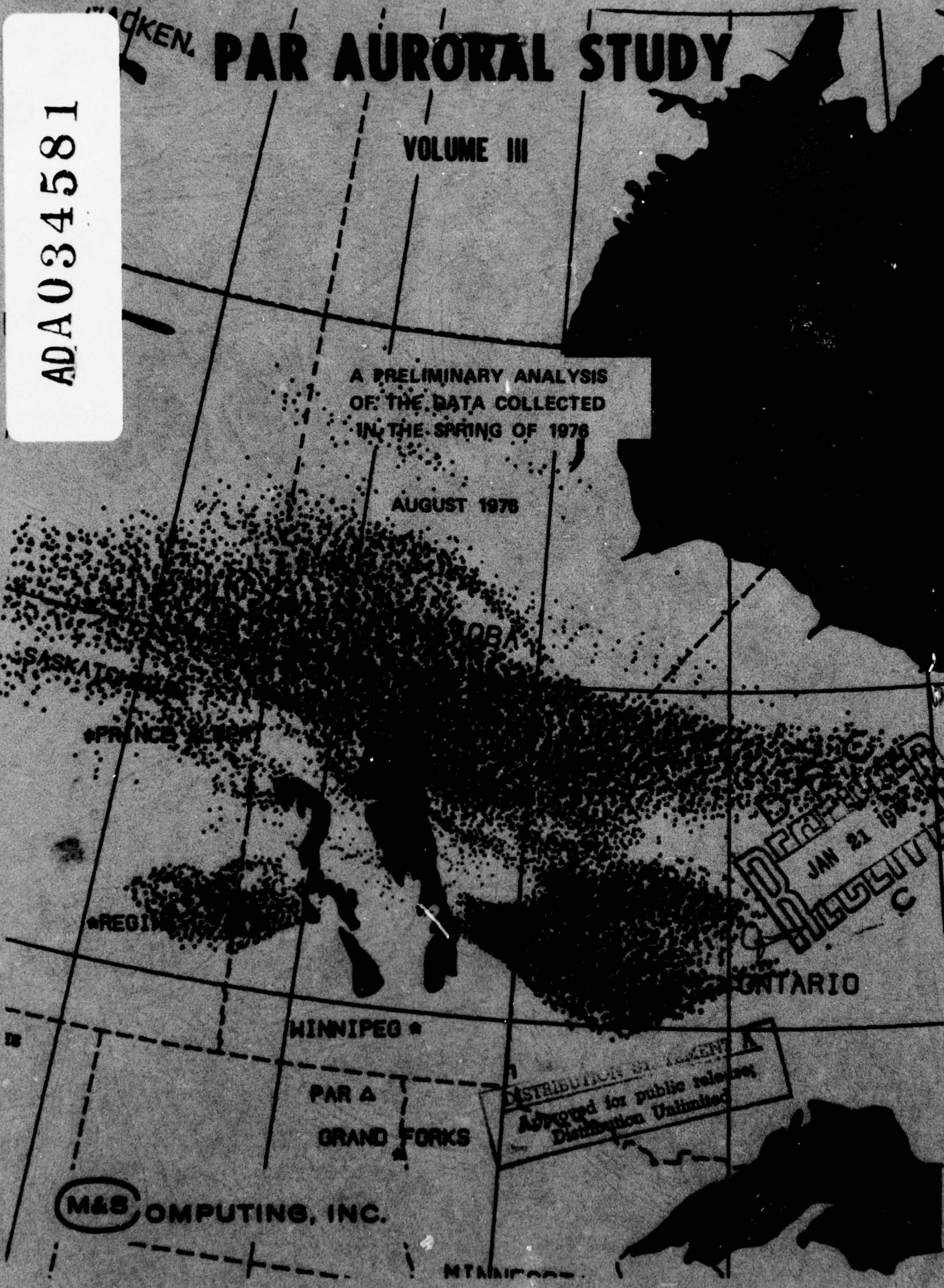
A034581

PAR AURORAL STUDY

VOLUME III

A PRELIMINARY ANALYSIS OF THE DATA COLLECTED IN THE SPRING OF 1976

AUGUST 1976



M&S COMPUTING, INC.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Volume III	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) PAR AURORAL STUDY. Volume III. A Preliminary Analysis of the Data Collected in the Spring of 1976.		5. TYPE OF REPORT & PERIOD COVERED Interim - one of six volumes
		6. PERFORMING ORG. REPORT NUMBER (14) 76-0027
7. AUTHOR(s) (10) M. J. Mitchell, ~~et al~~ J. L. Brown, P. L. Alley, M. Cochran		8. CONTRACT OR GRANT NUMBER(s) (15) Army DASG60-74-C-0026
9. PERFORMING ORGANIZATION NAME AND ADDRESS M&S Computing, Inc. P. O. Box 5183 Huntsville, AL 35805		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS not applicable
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Ballistic Missile Defense Systems Command BMDSC-WH, P. O. Box 1500 Huntsville, AL 35807		12. REPORT DATE (11) 6 Aug 76
		13. NUMBER OF PAGES 119
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) (9) Interim rept., Same as above.		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE not applicable

16. DISTRIBUTION STATEMENT (of this Report)

Unlimited Distribution (12) 123p.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Same

18. SUPPLEMENTARY NOTES

This is one of six volumes of reports that present the aurora borealis data collected by a multi-megawatt phased array radar. The radar has excellent sensitivity and range resolution affording very precise aurora detail.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Aurora borealis, radar/aurora effects, phased array radar, aurora maps, satellite track perturbation effects, aspect sensitivity.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The report describes the data collected in connection with research of aurora borealis effects on the performance of a phased array radar. The primary objective of the study was to advance the understanding of the auroral phenomenon and of its interactions with radar. A multi-megawatt phased array radar was used to collect large quantities of high resolution auroral backscatter data with simultaneous tracking of a number of selected satellites. The report provides a detailed description of the data collection process and data reduction techniques in connection with Mar 76 auroral storms. These auroral storms may have been

next page

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED 406226 LB

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

Block 20

cont → the most intense ever recorded by a radar. The sequence of forms was very dynamic and most unusual.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

PREFACE

This report describes the aurora borealis research effort being performed by M&S Computing, Inc., under Contract No. DASG60-74-C0026 for the U.S. Army Ballistic Missile Defense Command in Huntsville, Alabama. PAR Auroral Study, Volume III, dated August 6, 1976, constitutes M&S Computing's Report No. 76-0027.

The primary objective of the study is to advance the understanding of the auroral phenomenon, especially in its interactions with radar. The primary data-gathering instrument is the SAFEGUARD Perimeter Acquisition Radar in North Dakota. This radar has been used to collect large quantities of high resolution auroral backscatter data with the simultaneous tracking of a number of selected satellites.

The data presented represents the initial results of the reduction of data collected on March 10, 18, 26, and April 1, 1976.

Prepared by:

M. J. Mitchell
P. L. Alley
J. L. Brown
M. Cochran

Approved by:

W. E. Salter
W. E. Salter

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES
(Continued)

1. INTRODUCTION

This report describes spring, 1976, data collection events, presents some of the data, and discusses the analyses being performed on that data.

1.1 Some Background on Auroral Study

Plans for auroral studies using data from the PAR radar were initiated in the spring of 1975. The purpose of this study was to determine, for the military, the effects of aurora on the radar surveillance and tracking functions. The results of a number of these studies were also much sought by the scientific community. The PAR possesses numerous characteristics including very high transmit power, extreme sensitivity, and excellent resolution which can provide auroral backscatter data of a quality previously unobtainable. Furthermore, the PAR is situated at a location and orientation which are especially well-suited for auroral data collection.

In the fall of 1975, during two previous data collection periods, nearly 18 hours of auroral data was collected. Reduction of this data is now complete. A portion of the reduced backscatter data was published by M&S Computing in the spring of 1976, as a report titled The PAR Auroral Study, (Volume I). Volume I was the first of several planned reports, two of which have now been published. This volume discusses the objectives of the auroral studies and describes the data reduction tools which created the auroral maps shown in Volume III. It will be necessary to refer to Section 4 of Volume I for an explanation of the auroral maps.

It is not the intent of this volume to present the results of any data analysis, but merely to present a portion of the data from the four auroral data collection periods from the spring of 1976. Reports describing aspect sensitivity and satellite track analysis studies are being prepared and will be published in the fall of 1976.

Of the four spring, 1976, data collection periods, the first two were rather short-lived, for the auroral backscatter ceased after about two hours. However, the nights of March 26 and March 31 yielded a most impressive collection of backscatter data. On these two nights alone, about 90 reels of computer tape were filled with data. After processing this data, it was found that the radar may have observed the most intensely reflecting auroral forms ever recorded by a radar. In addition, the sequence of forms was very dynamic and most unusual.

1.2 New Techniques Applied in the Spring of 1976

Certain changes were made after the fall, 1975, data collection in order to improve the quality of the data. The first change was to the raster format used in the PAR's scanning sequence. The system of alternating full and restricted rasters used in 1975 has been replaced by the single main raster shown in

Figure 1-1. The radar scan is constrained within the crosshatched region. The scan begins at the lower left corner, works left to right and bottom to top, and requires about 28 seconds to perform an entire volume scan of this region.

The volume of space sampled by this raster, although limited, includes essentially all of the region where radar aurora could be observed by the PAR. Looking at greater elevation angles will not bring more aurora into view because of the radar's minimum usable range which, at higher elevations, extends its minimum altitude above the nominal altitude of the aurora.

Another change to the raster is the beam packing configuration. In its auroral scanning mode, the PAR is constrained to certain fixed angles to which it points the dual beams used for auroral data collecting. For the fall, 1975, auroral data collection, the beams were nested in the pattern shown in the top of Figure 1-2. For spring, 1976, this experiment pattern was changed to that shown at the bottom of the figure. The main advantage of this new pattern was the elimination of an undesirable checkerboard effect apparent when observing the thin altitude slices of auroral "Top-Down" maps.

The remaining change from fall, 1975, was the addition of a small selectable raster. This raster is a 6-beam wide by 9-beam high arrangement, the center of which may be pointed manually at any angle with the constraint that all beam positions in the raster are within the allowable steering limits of the PAR. These limits extend far outside the limits of the main auroral search raster. The advantage of this small raster is that such a volume scan requires only .7 second; thus, there is a higher degree of time correlation between volume scans. This is useful when it is desirable to perform point-by-point averaging of many scans. Using the small raster, this operation may be performed without the significant errors which result from large scale changes within the aurora. Examples of a Top-Down and a Profile map for the small raster are included as Figures 1-3 and 1-4.

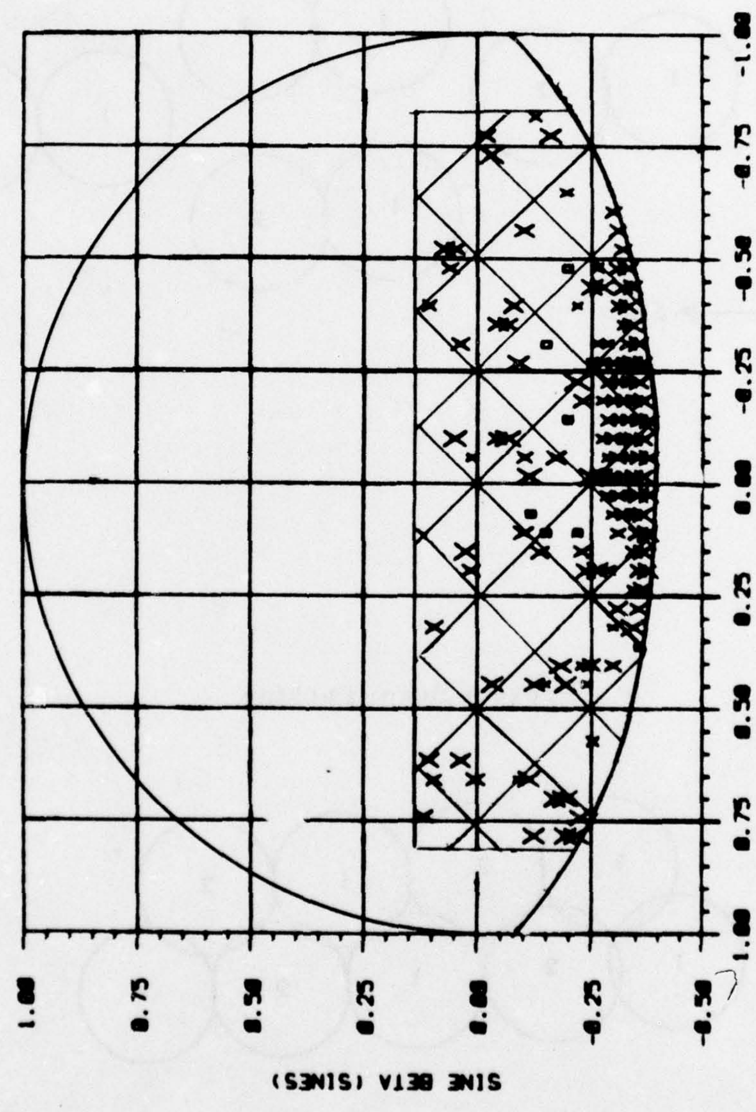
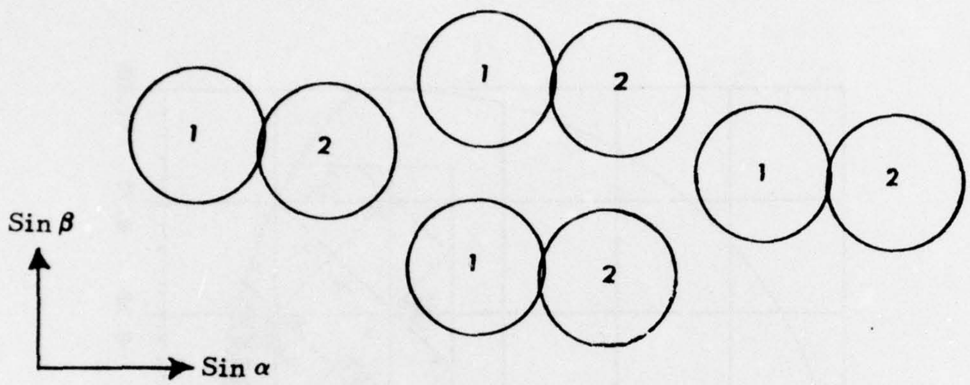

SINE ALPHA (SINES)
SINE BETA (SINES)
-1.00
-0.75
-0.50
-0.25
0.00
0.25
0.50
0.75
1.00

Figure 1-1

AURORAL MODE BEAM PACKING

Previous Beam Packing



Present Beam Packing

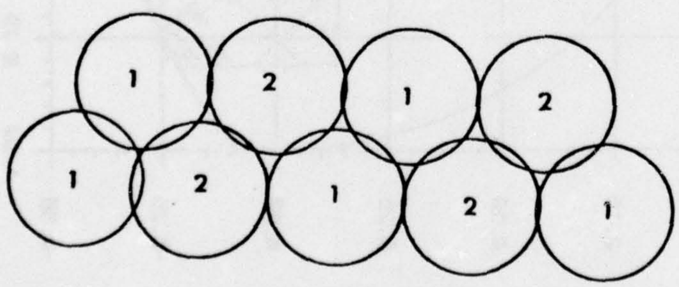
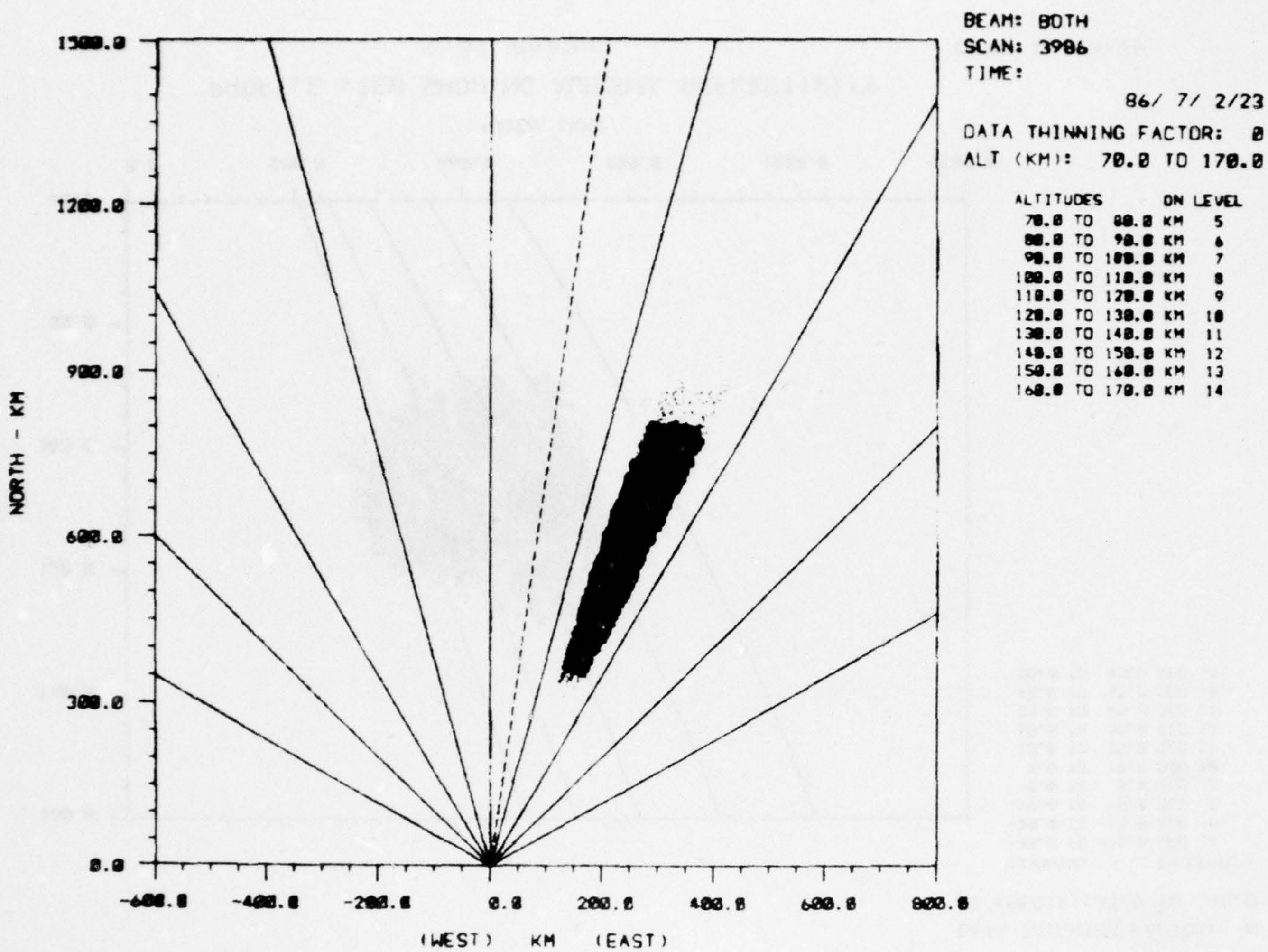


Figure 1-2

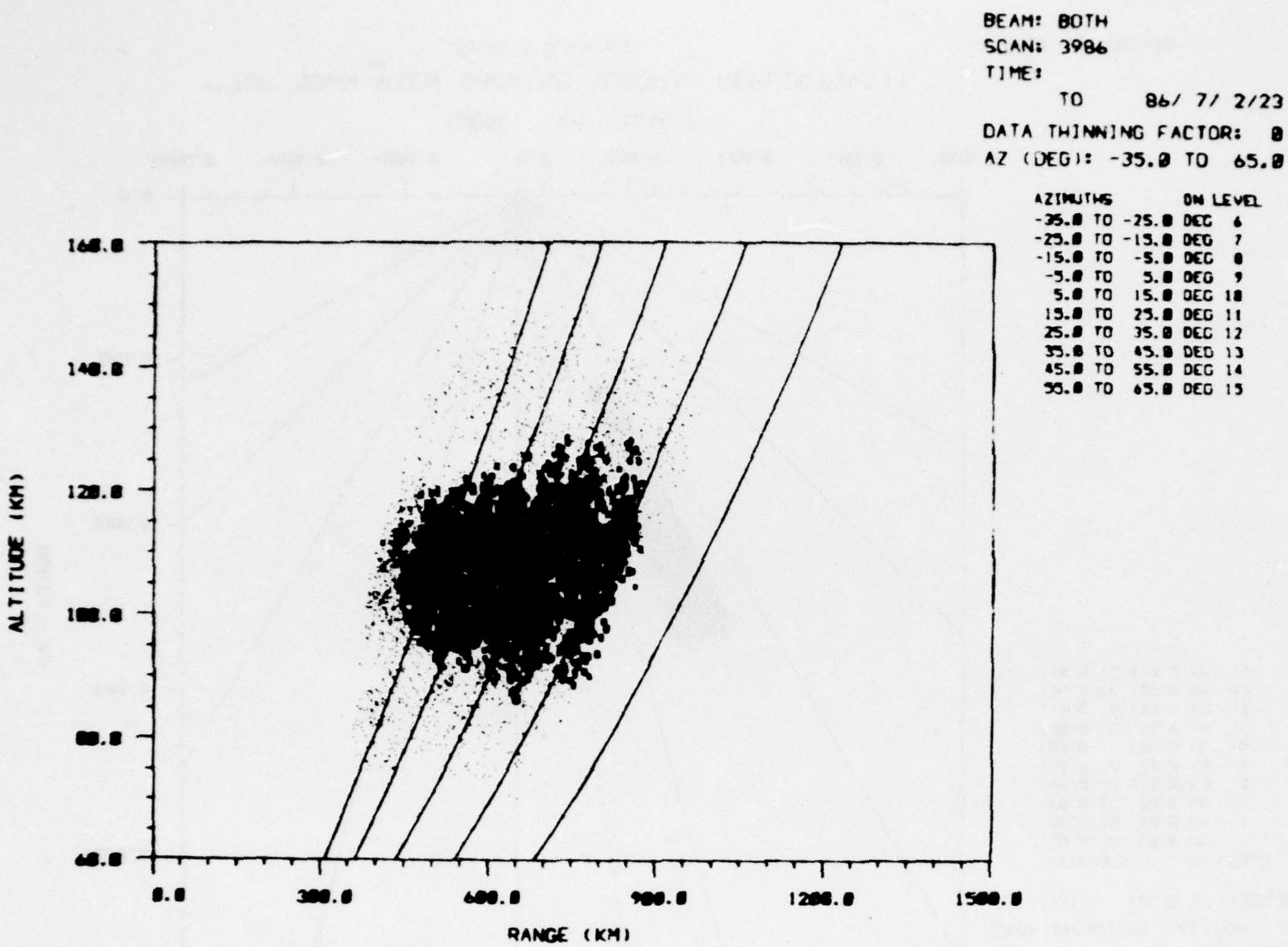


TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Small Raster

DATE: 11-MAY-76

Figure 1-3



PROFILE VIEW SHOWING AURORAL REFLECTIVITY

Small Raster

DATE: 11-MAY-76

Figure 1-4

2. GATHERING THE AURORAL DATA

Global Weather Central forecast moderate to active magnetic activity for the 2-week period centered about the Vernal Equinox. This period was later extended to include the first week of April, 1976. Data was gathered on four occasions during the period March 10, 1976, through April 1, 1976. The activities and events of each data collection period are described in this section.

2.1 March 10, 1976

Data received from Global Weather Central indicated the possibility of minor geomagnetic disturbances occurring for the period March 10, 1976, to March 12, 1976. The predicted Ap Index ranged from 33 on March 10, to 22 on March 12. Auroral data collection was not scheduled to begin until March 15, 1976. However, during the software verification period on the night of March 10, radar aurora of approximately 60 dB s/n was observed on the A-scope. Data collection commenced at 0105 UT with mild auroral reflections. Auroral activity remained at this level until 0135 UT when the number of auroral returns and the strength of the returns increased significantly. Peak echo strength recorded was of order 70 dB s/n. Auroral intensity remained at this level until 0208 UT. A gradual decrease in extent was observed until a stable arc was apparently formed at 0217 UT. Peak echo intensity decreased to 60 dB s/n. A secondary peak was observed to occur at 0225 UT exhibiting a very rapid buildup and sharp decay. During the remainder of the data collection period, the observed auroral returns indicated a rapidly fluctuating, unstable event which decreased in intensity until 0257 UT when data collection was terminated.

Several small scan special search activities were initiated during the test period with search windows directed toward the region anticipated to produce maximum auroral reflectivity.

Figures 2-1 through 2-16 provide a representative sampling of the radar aurora observed for the 2-hour period.

2.2 March 18, 1976

Preparations for collecting auroral data were completed on March 15, 1976. All software modifications had been successfully validated. Early forecasts from Global Weather Center had indicated a good probability of moderately active aurora. Global Weather Center predicted an Ap Index of only 19. However, the site team supporting the data collection was assembled and data collection commenced at 0100 UT. The A-scope presentation was already indicating a significant auroral display. The intensity and extent of the aurora was similar to that observed on March 10; however, the duration and activity of the auroral presentations were significantly less than previously observed. The apparent diffuse arc gradually faded until 0145 UT when a relatively discrete stable form was achieved. Data collection was terminated at 0156 UT.

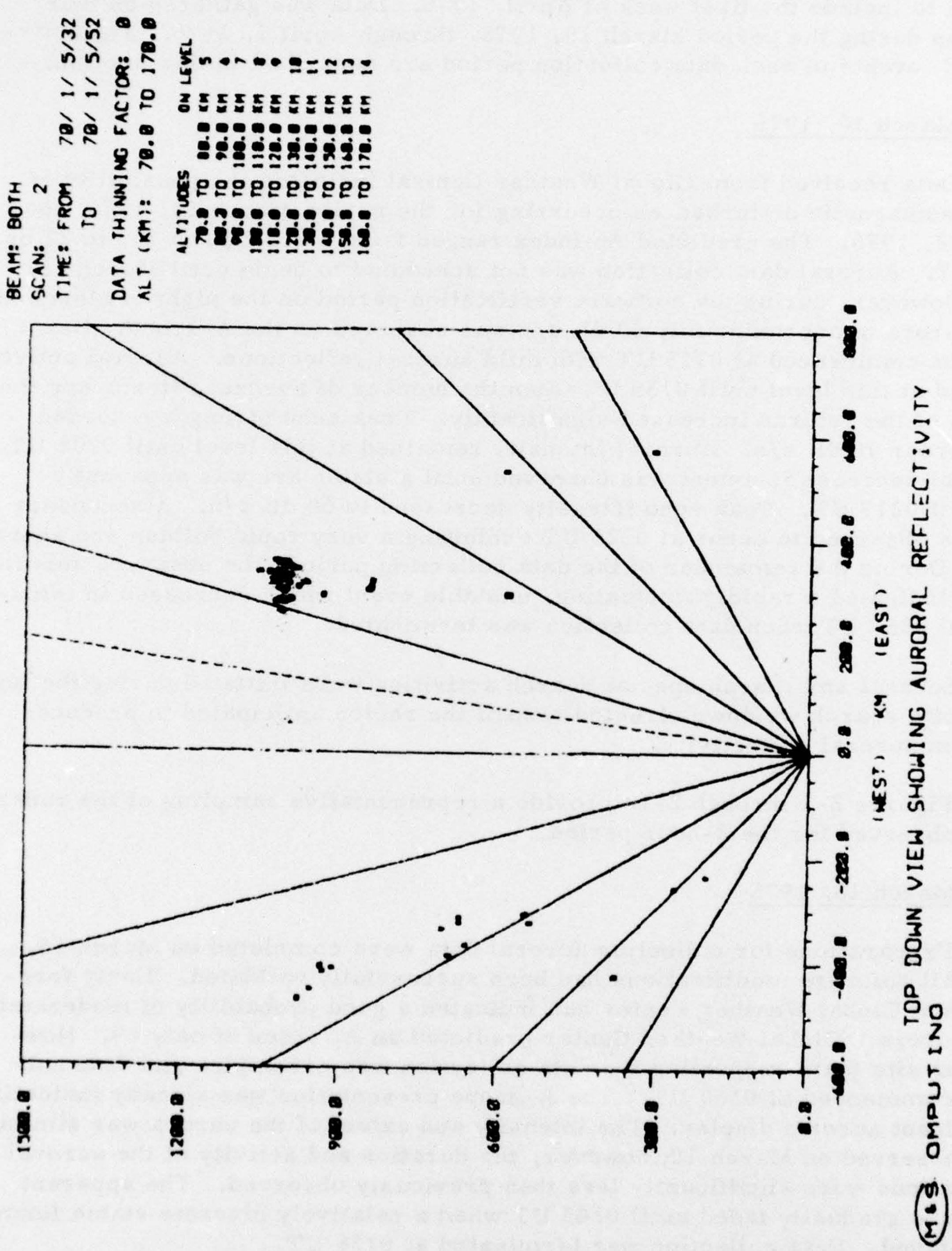

BEAM: BOTH
SCAN: 2
TIME: FROM 70/ 1/ 5/32
TO 70/ 1/ 5/52
DATA THINNING FACTOR: 0
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S COMPUTING

Figure 2-1

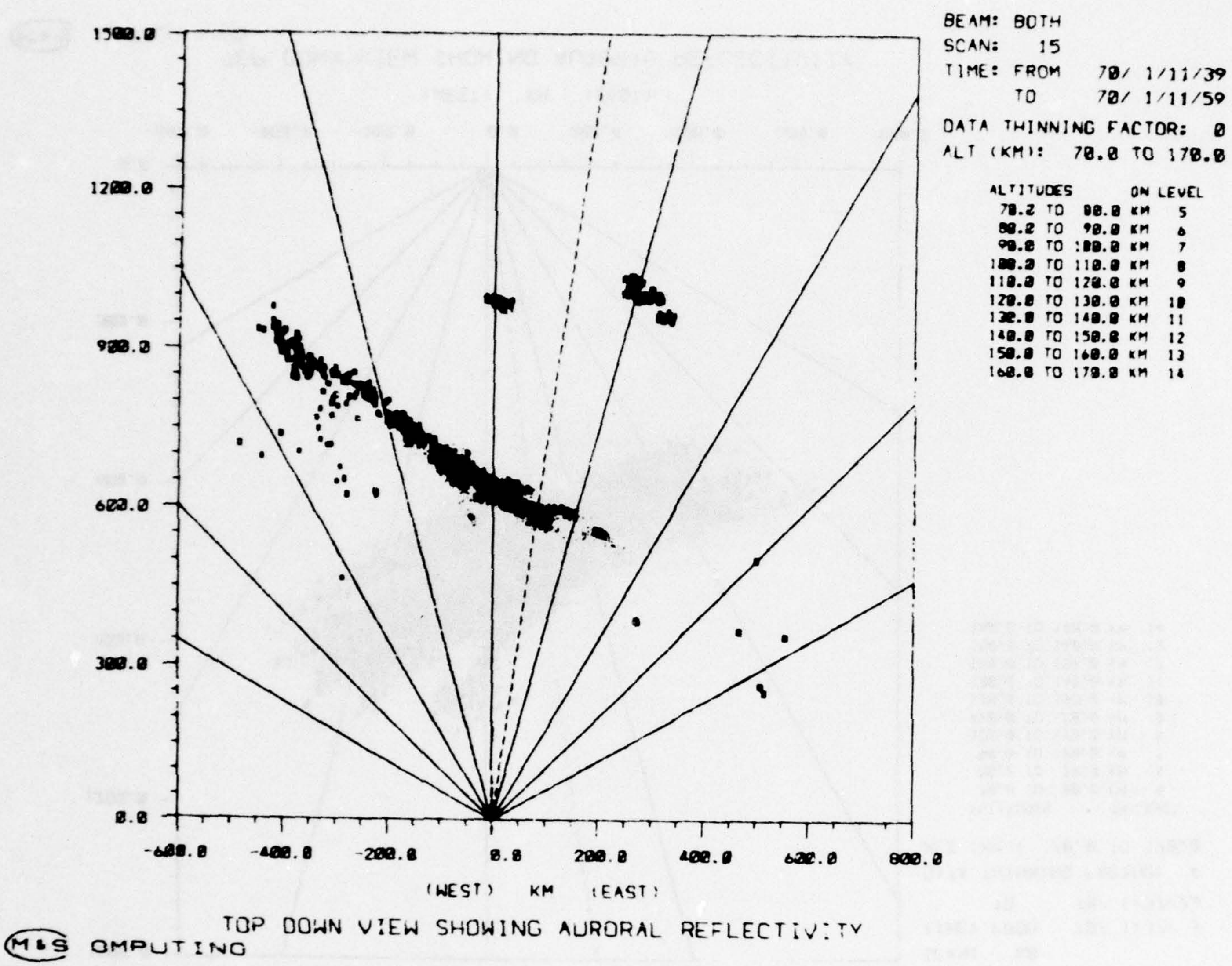

BEAM: BOTH
SCAN: 15
TIME: FROM 70/ 1/11/39
TO 70/ 1/11/59
DATA THINNING FACTOR: 0
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.2 TO 80.0 KM 5
80.2 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTING

Figure 2-2

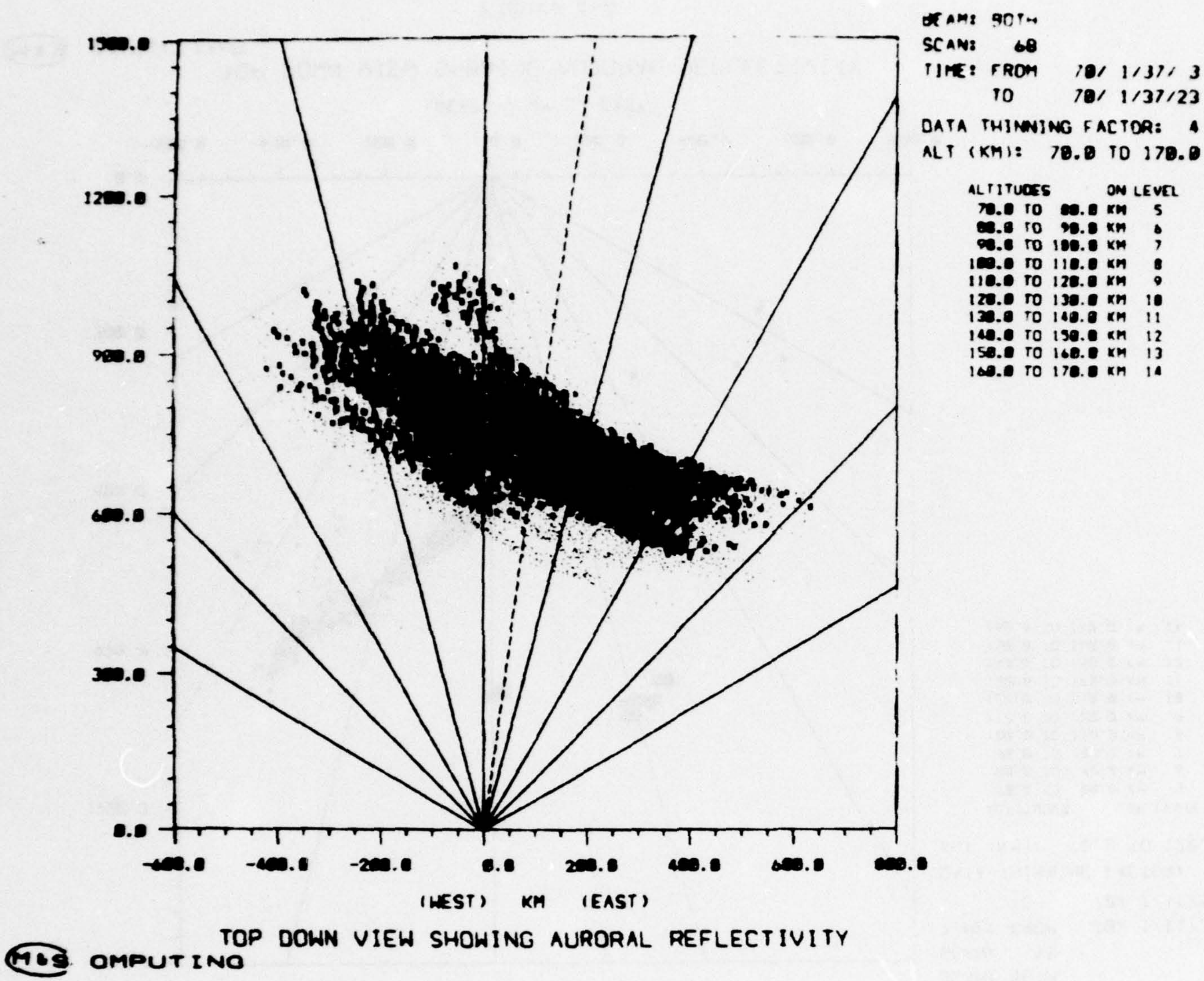
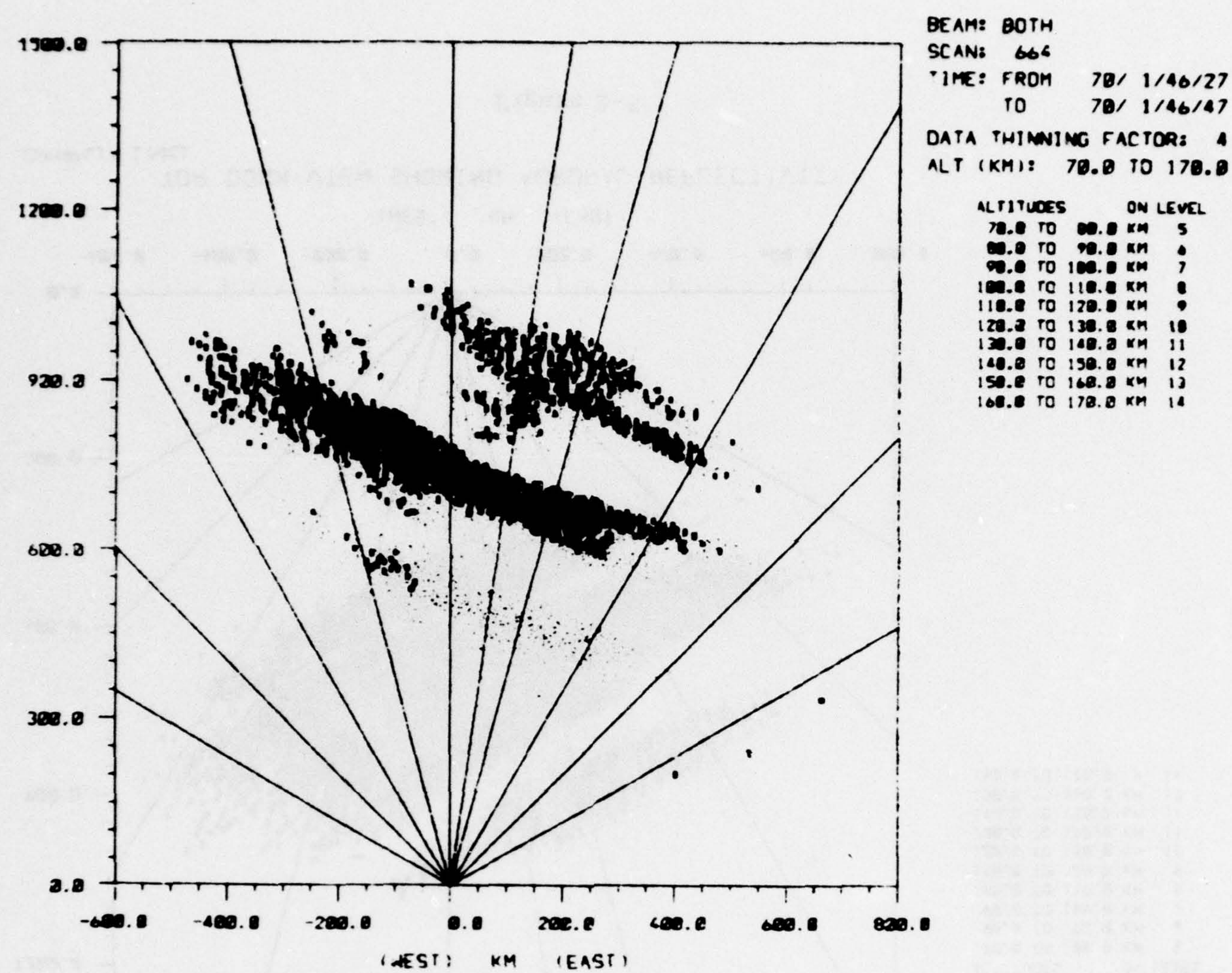

BEAM: BOTH
SCAN: 68
TIME: FROM 78/ 1/37/ 3
TO 78/ 1/37/23
DATA THINNING FACTOR: 4
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTING

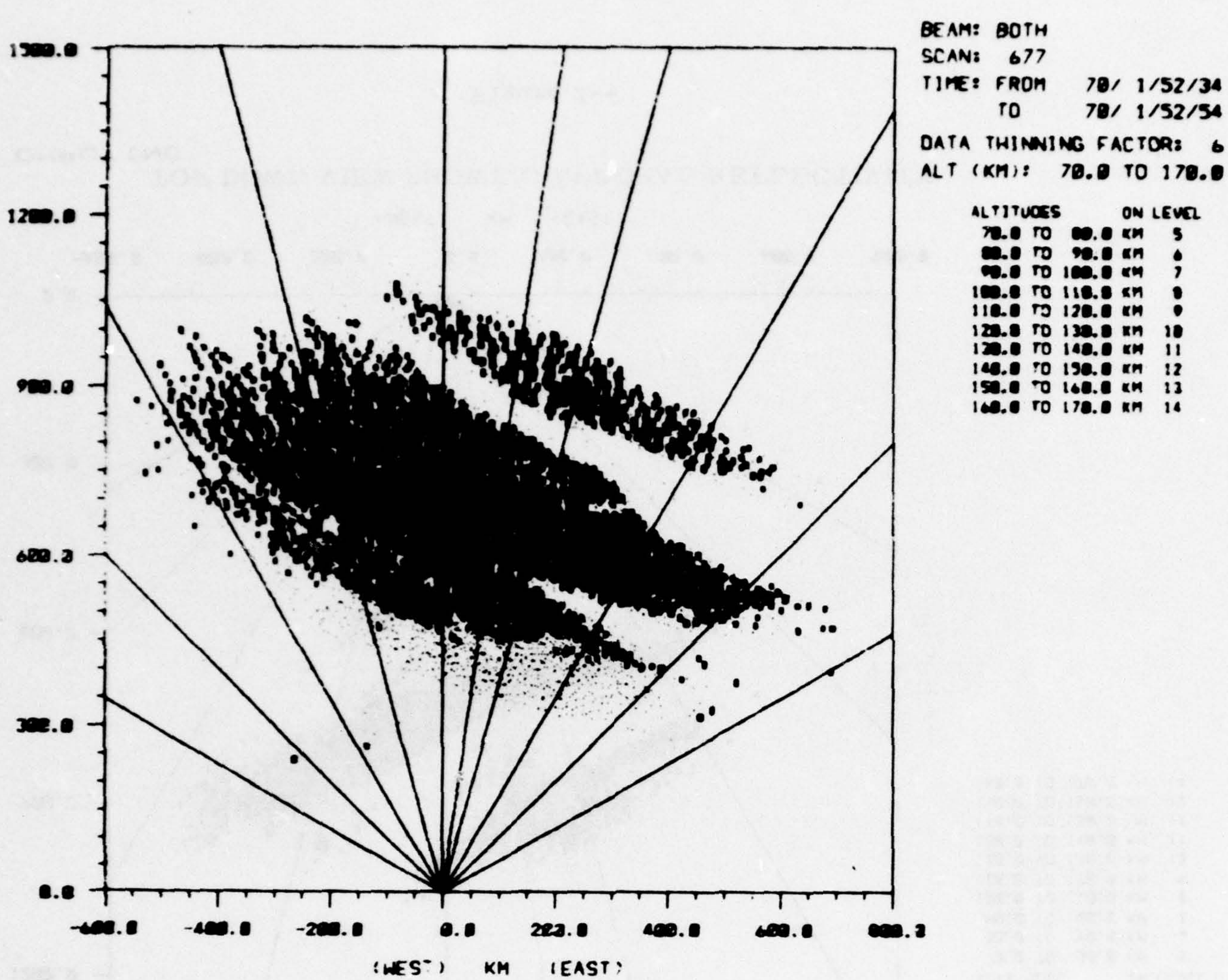
Figure 2-3



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

M&S COMPUTING

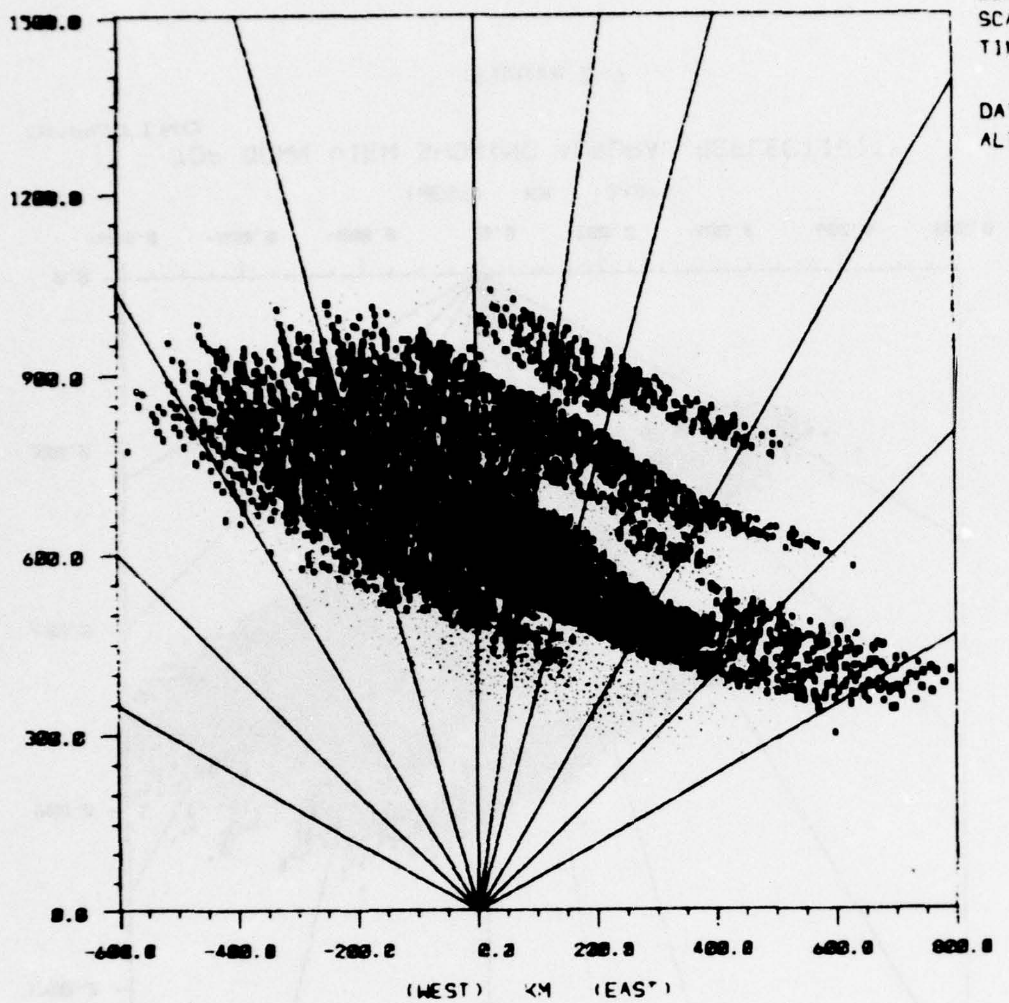
Figure 2-4



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

M&S COMPUTING

Figure 2-5



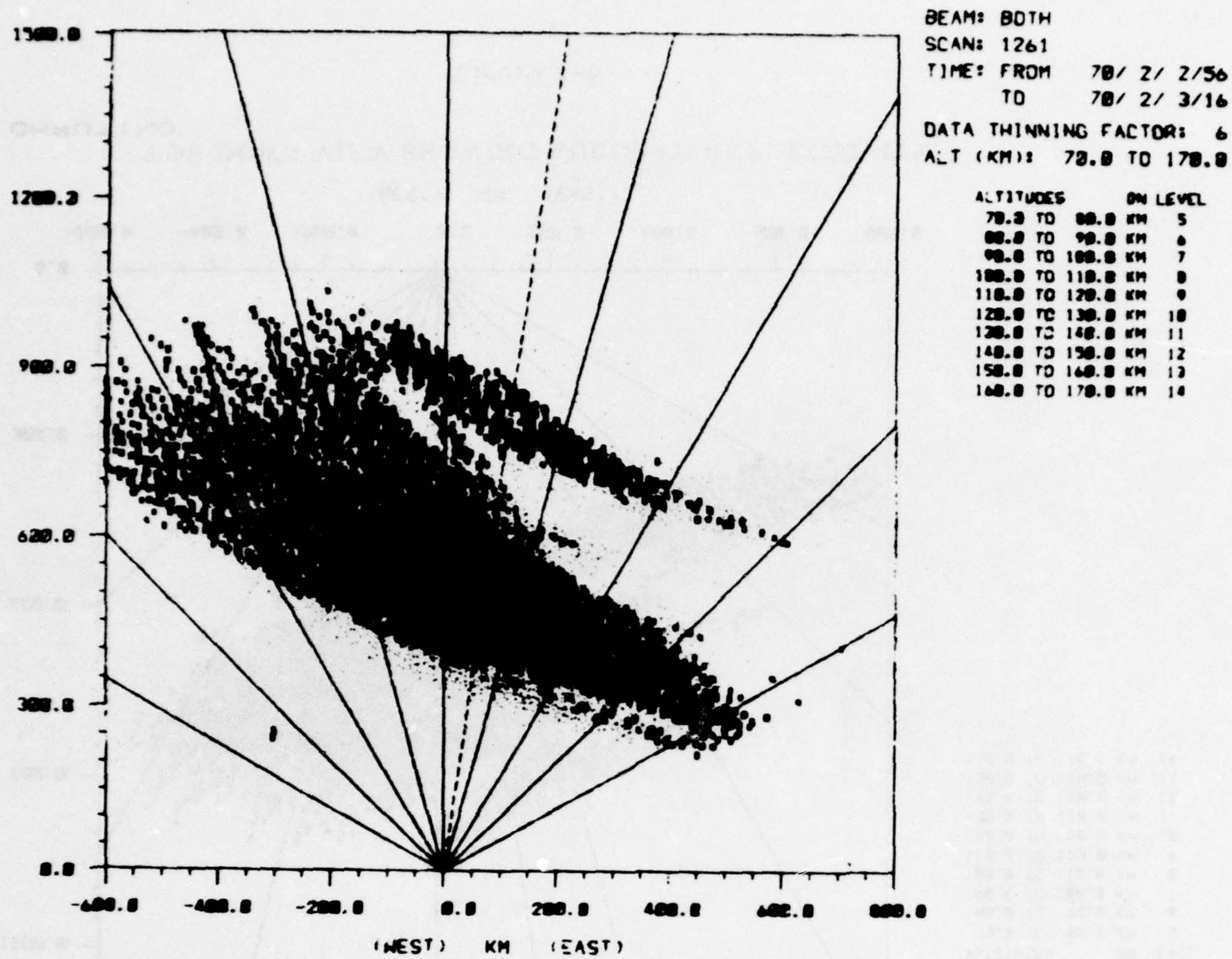
BEAM: BOTH
SCAN: 896
TIME: FROM 70/ 1/56/24
TO 70/ 1/56/44
DATA THINNING FACTOR: 6
ALT (KM): 70.0 TO 170.0

ALTITUDES	ON LEVEL
70.0 TO 80.0 KM	5
80.0 TO 90.0 KM	6
90.0 TO 100.0 KM	7
100.0 TO 110.0 KM	8
110.0 TO 120.0 KM	9
120.0 TO 130.0 KM	10
130.0 TO 140.0 KM	11
140.0 TO 150.0 KM	12
150.0 TO 160.0 KM	13
160.0 TO 170.0 KM	14

TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

M&S OMPUTING

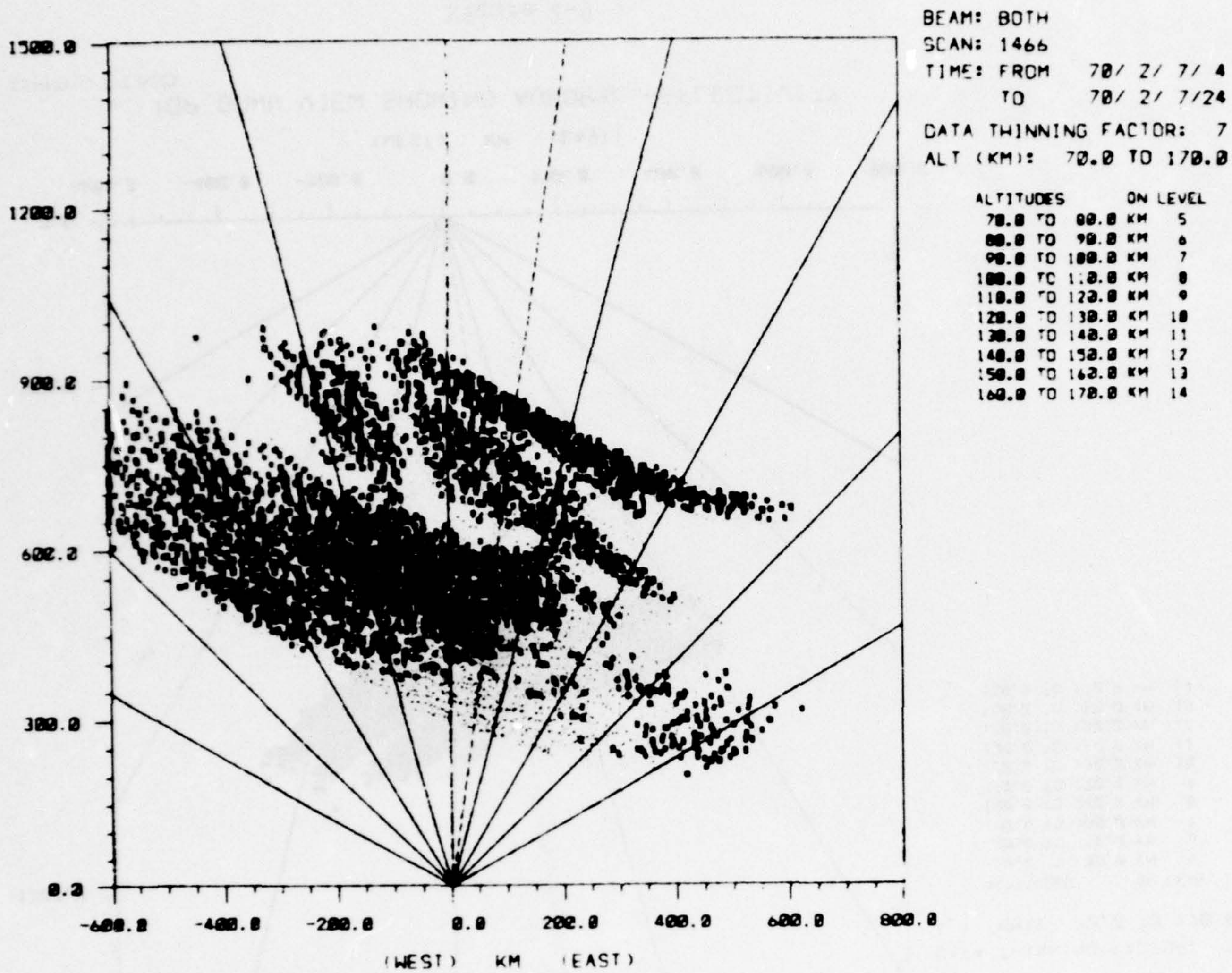
Figure 2-6



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

M&S COMPUTING

Figure 2-7



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

M&S OMPUTINO

Figure 2-8

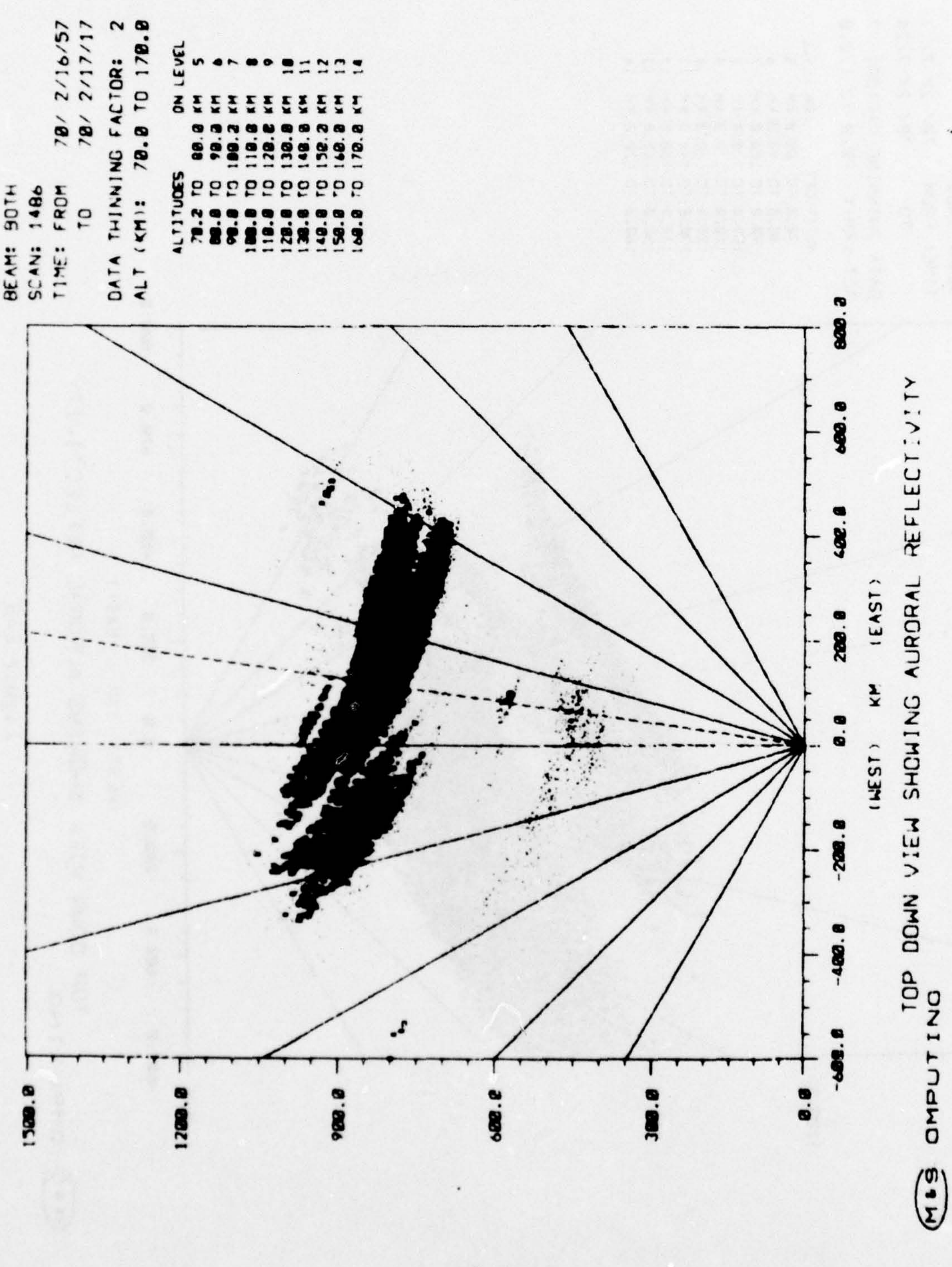

BEAM: BOTH
SCAN: 1486
TIME: FROM 70/ 2/16/57
TO 70/ 2/17/17
DATA THINNING FACTOR: 2
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.2 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-9

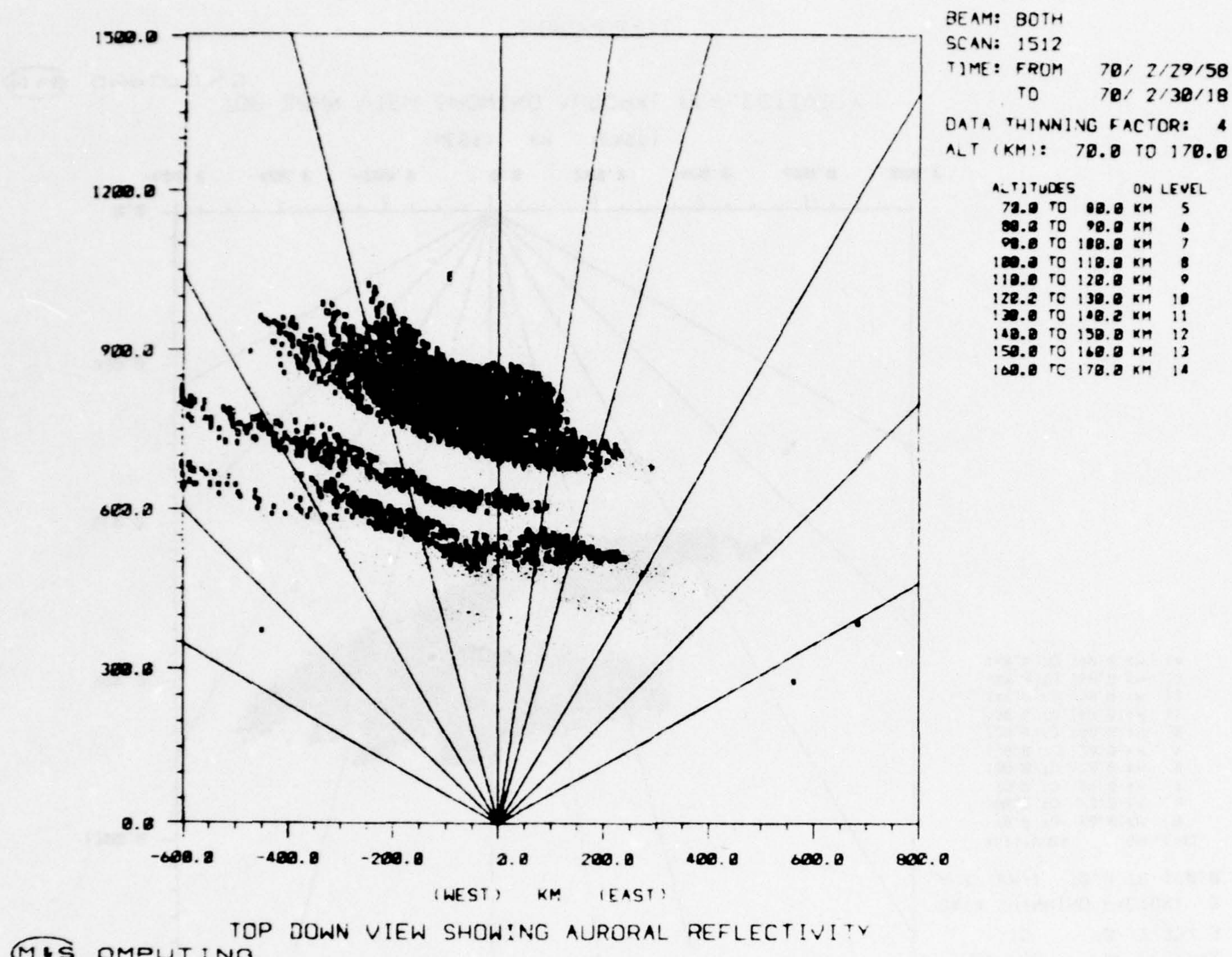
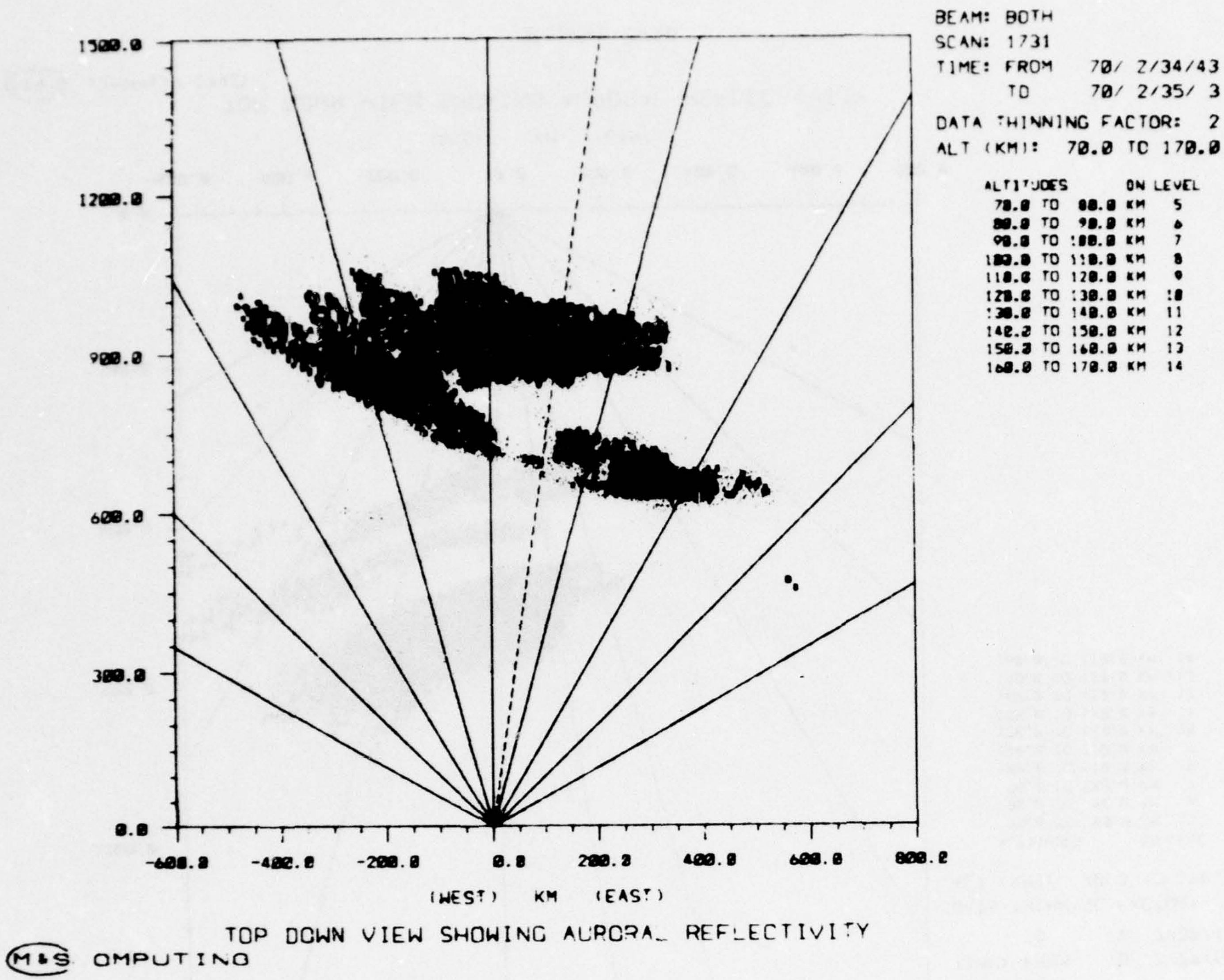

BEAM: BOTH
SCAN: 1512
TIME: FROM 70/ 2/29/58
TO 70/ 2/30/18
DATA THINNING FACTOR: 4
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.2 TC 130.0 KM 10
130.0 TO 140.2 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TC 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTING

Figure 2-10



BEAM: BOTH
SCAN: 1731
TIME: FROM 70/ 2/34/43
TO 70/ 2/35/ 3
DATA THINNING FACTOR: 2
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTING

Figure 2-11

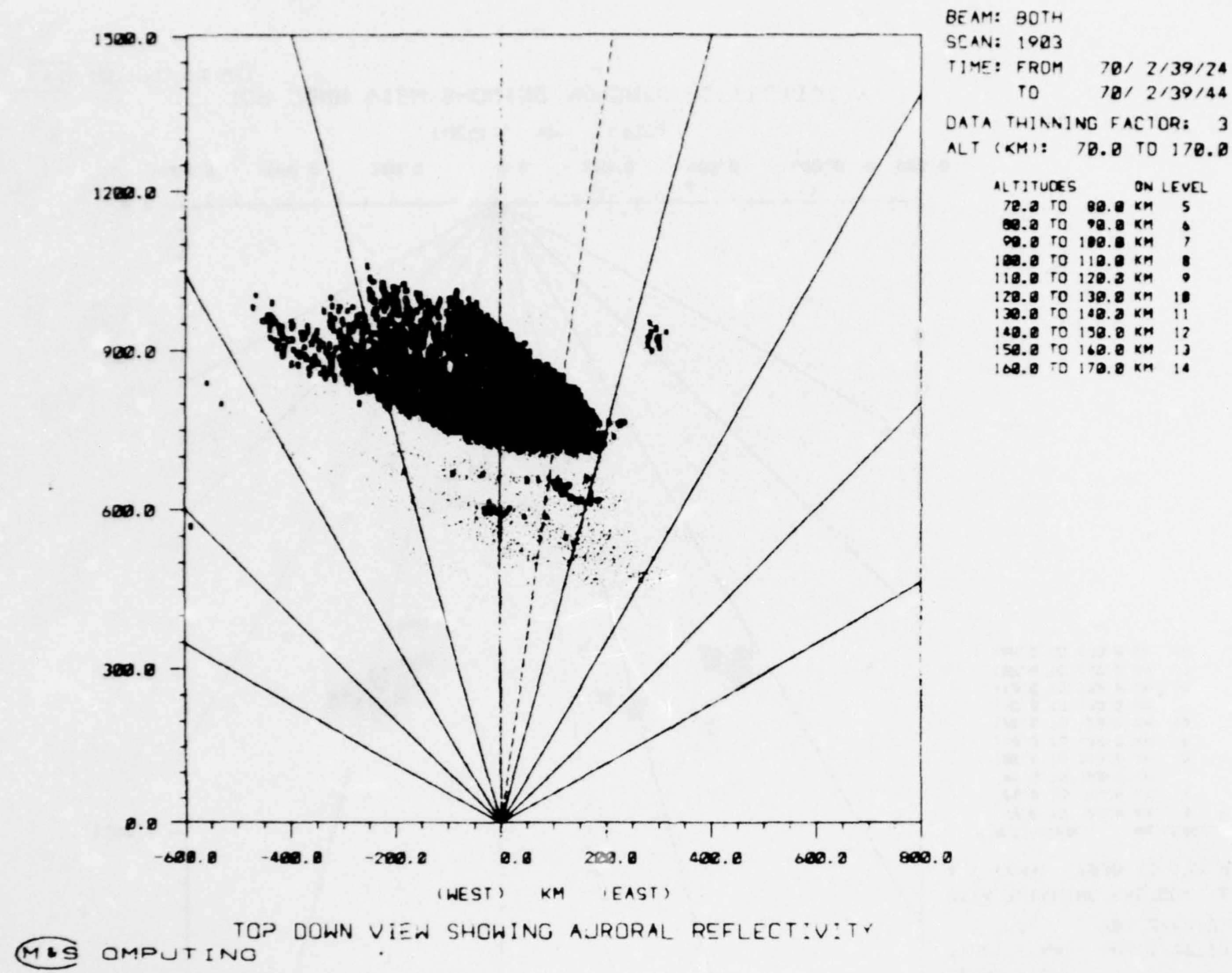

BEAM: BOTH
SCAN: 1903
TIME: FROM 70/ 2/39/24
TO 70/ 2/39/44
DATA THINNING FACTOR: 3
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTING

Figure 2-12

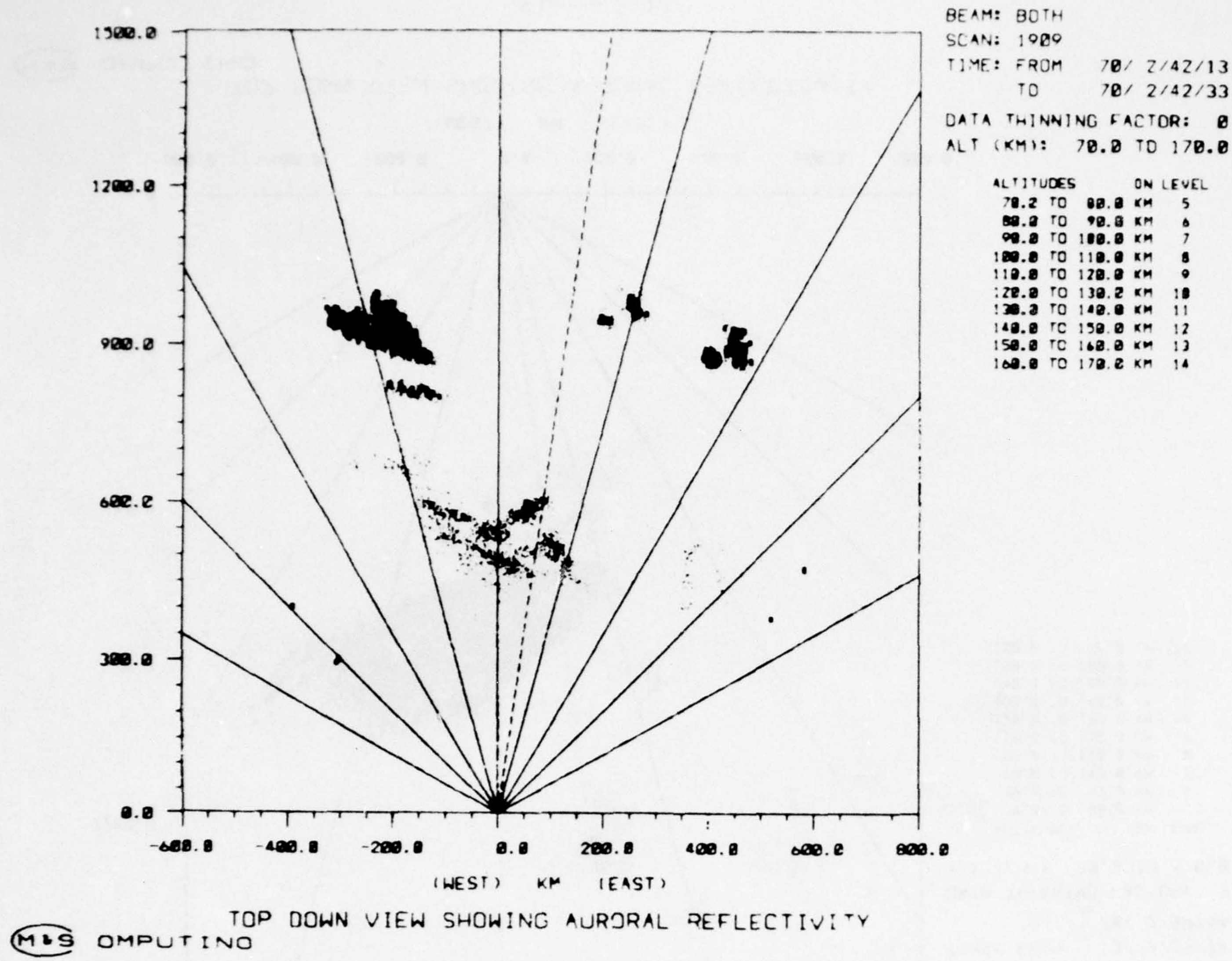

BEAM: BOTH
SCAN: 1909
TIME: FROM 70/ 2/42/13
TO 70/ 2/42/33
DATA THINNING FACTOR: 0
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.2 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.2 KM 10
130.3 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.2 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTINO

Figure 2-13

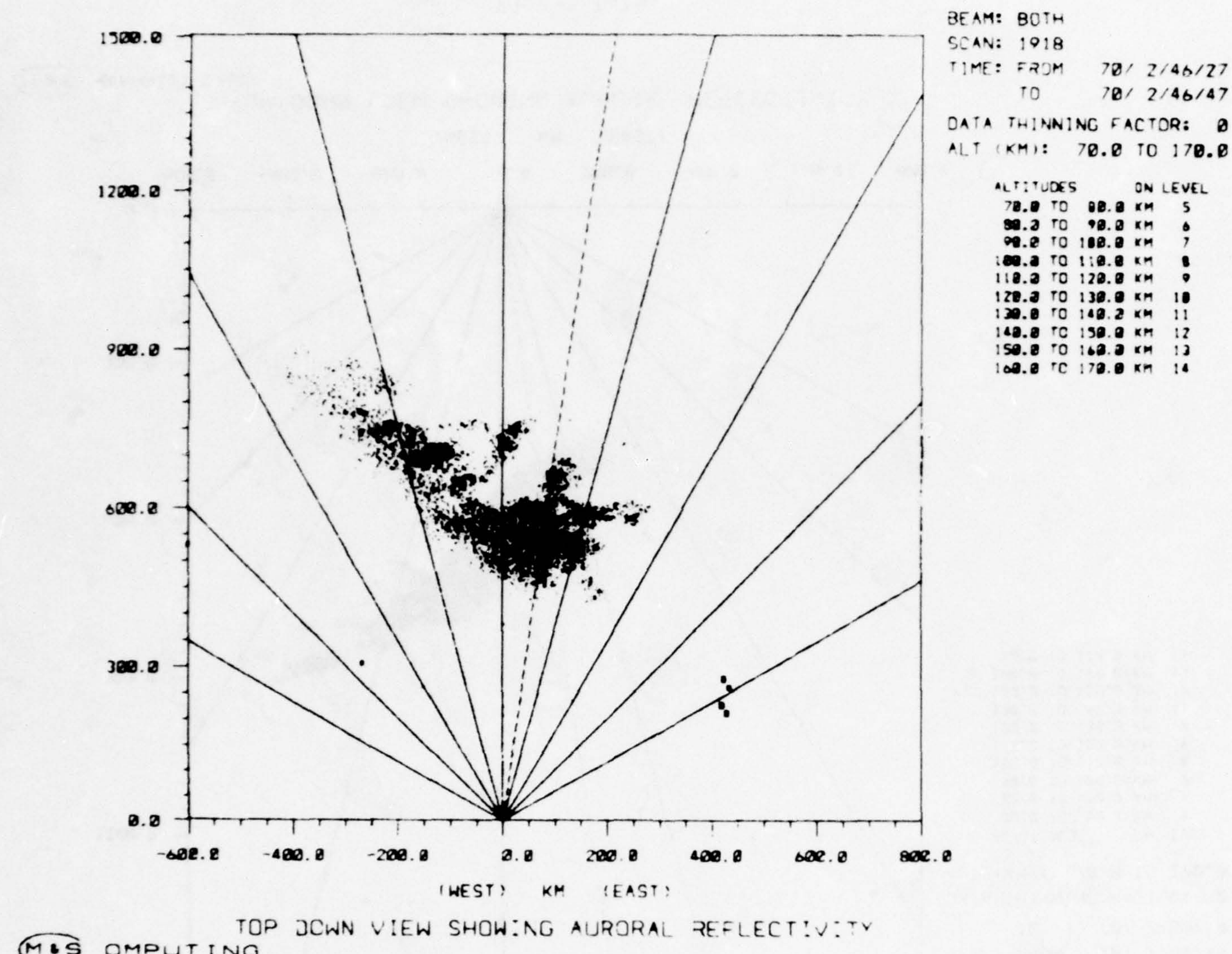

BEAM: BOTH
SCAN: 1918
TIME: FROM 70/ 2/46/27
TO 70/ 2/46/47
DATA THINNING FACTOR: 0
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.2 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTING

Figure 2-14

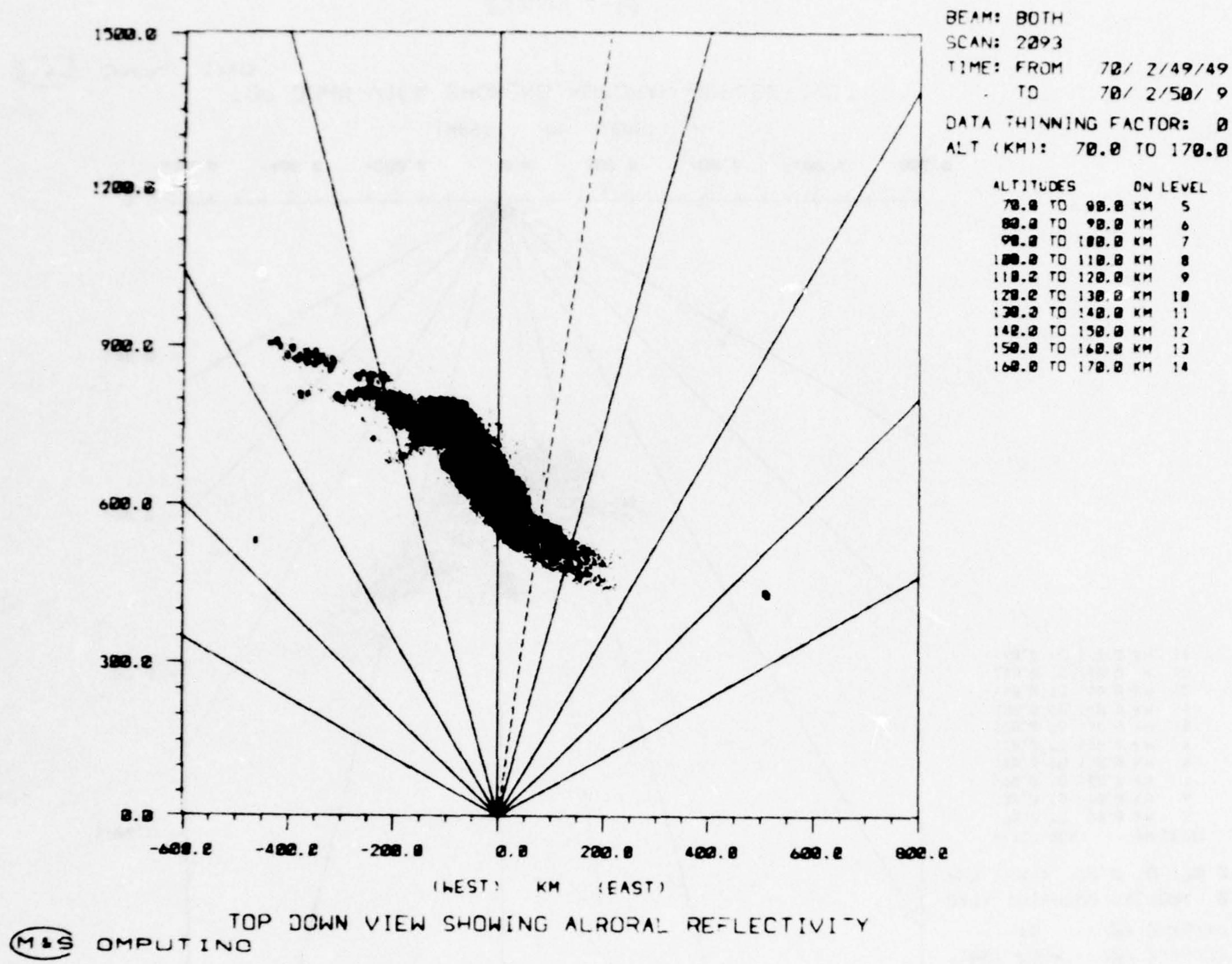

BEAM: BOTH
SCAN: 2093
TIME: FROM 70/ 2/49/49
TO 70/ 2/50/ 9
DATA THINNING FACTOR: 0
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.2 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTING

Figure 2-15

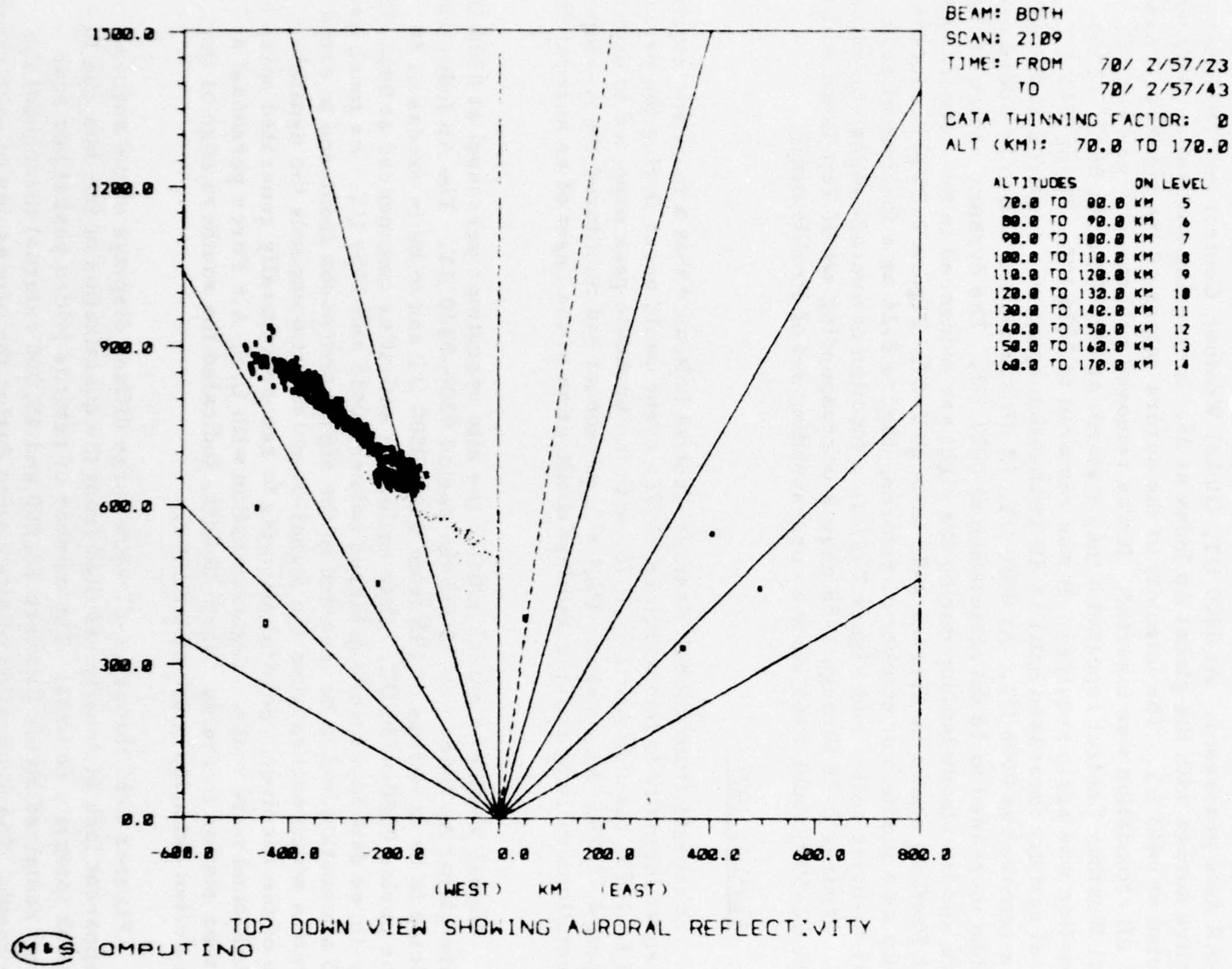

BEAM: BOTH
SCAN: 2109
TIME: FROM 70/ 2/57/23
TO 70/ 2/57/43
DATA THINNING FACTOR: 0
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTING

Figure 2-16

Figures 2-17 through 2-24 provide a sampling of the data gathered.

2.3 March 26, 1976

On March 26, 1976, at 0100 UT, the auroral software was loaded into the PAR data processor. At 0300 UT, Global Weather Central reported quiet-to-active aurora with the global Ap Index at 25. Increasing auroral activity was reported at 0443 UT. The intensity of the aurora saturated the signal processor so 12 dB attenuation was inserted. It was removed subsequently at 0449 UT. Global Weather Central reported a major storm at 0515 UT. At 0633, 12 dB attenuation was again required. It was removed at 0634 UT. From 0700 UT, auroral activity increased until 12 dB attenuation again was required at 0905 UT. It was removed at 0906 UT. At 0920 UT, 12 dB attenuation had to be added again and then increased to 18 dB attenuation at 0921 UT. The dynamic nature of the aurora and its steady buildup during the night are evidenced in the Activity and Event Profiles shown in Figures 2-25 through 2-27. Figure 2-25 presents the activity as a function of number of returns, Figure 2-26 as a function of peak signal-to-noise ratio, and Figure 2-27 as a function of average signal-to-noise ratio. Figures 2-28 through 2-58 show a corresponding set of Top-Down maps. Figures 2-59 through 2-65 show a corresponding set of Profile maps.

2.4 April 1, 1976

Forecasts from Global Weather Central indicated that a magnetic storm of near equal intensity to the March 26, 1976, event would occur during the period April 2, 1975, through April 6, 1976, with the probable peak expected to occur on April 4, 1976. As a result, PAR site personnel had monitored the A-scope presentations daily to provide an alert notification of the onset of an auroral display.

Global Weather Central notified the site operations personnel at 0300 UT that the global Ap Index was 78 for the period 0300-0430 UT. The Ap Index was predicted to be in excess of 125 from 0430-0500 UT and to be in excess of 50 for the period 0500-0730 UT. Data collection activities commenced at 0415 UT. Forty-three data tapes were gathered between 0415 and 1059 UT. As much as 30 dB attenuation had to be inserted in the signal processor front-end to avoid saturation which occurs when the signal-to-noise ratio exceeds the dynamic range of the receiver. Several attempts to record aurorally generated noise in the PAR band were made. Communication with U.S. Air Force personnel at the radar station in Finley, North Dakota, indicated the southern edge of the aurora often extended south of the PAR.

Figures 2-66 through 2-87 show large diffuse displays of the aurora. The apparent lack of density resulted from the quantization of the data due to high peak intensity returns. The number of returns (video peaks) per scan interval remained stable (between 30,000 and 45,000 returns) throughout the experiment. The application of attenuation during the processing of each return resulted in the loss of some of the smaller echoes, since after attenuation they would no longer satisfy the thresholding requirements. Figure 2-82 is of note

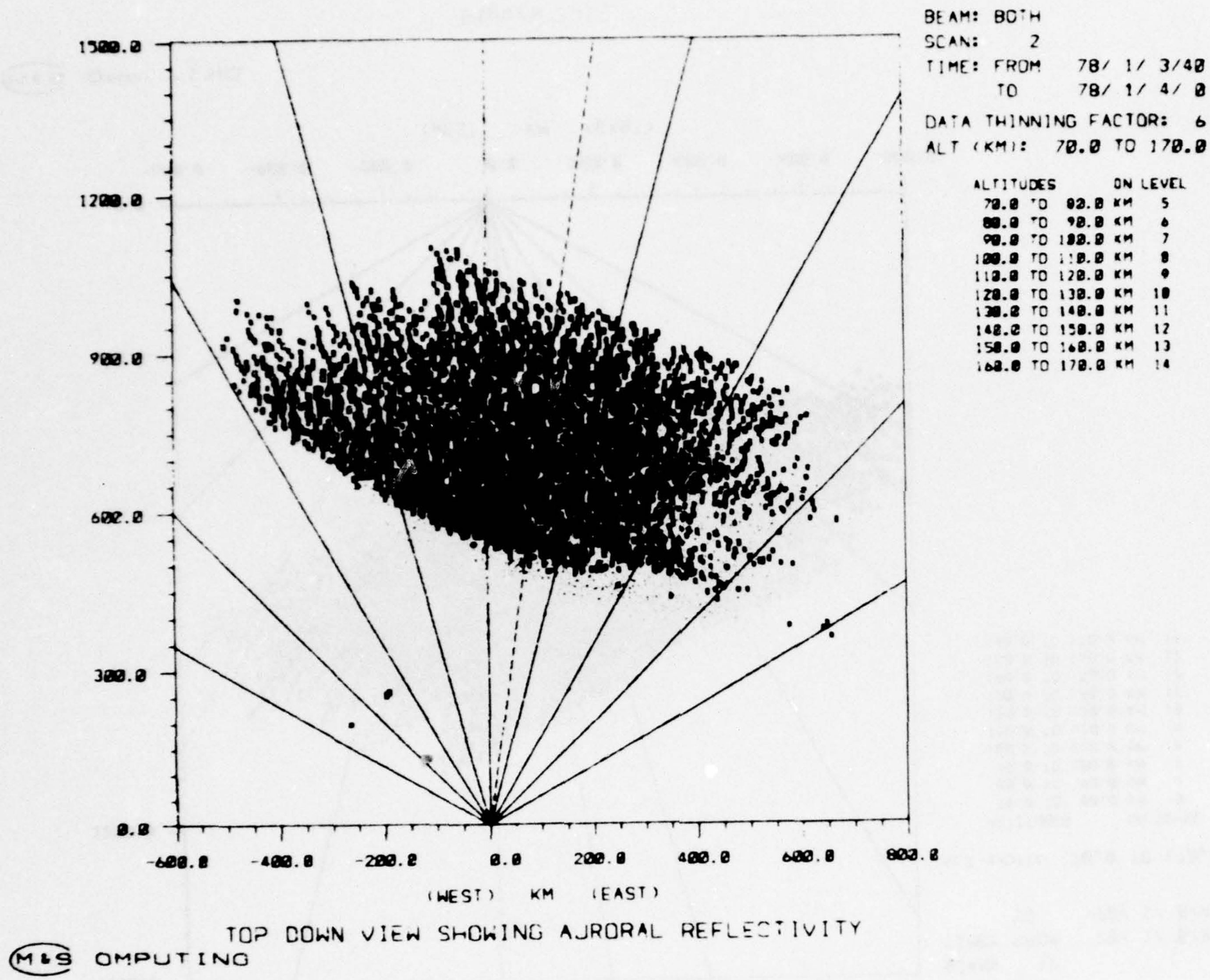
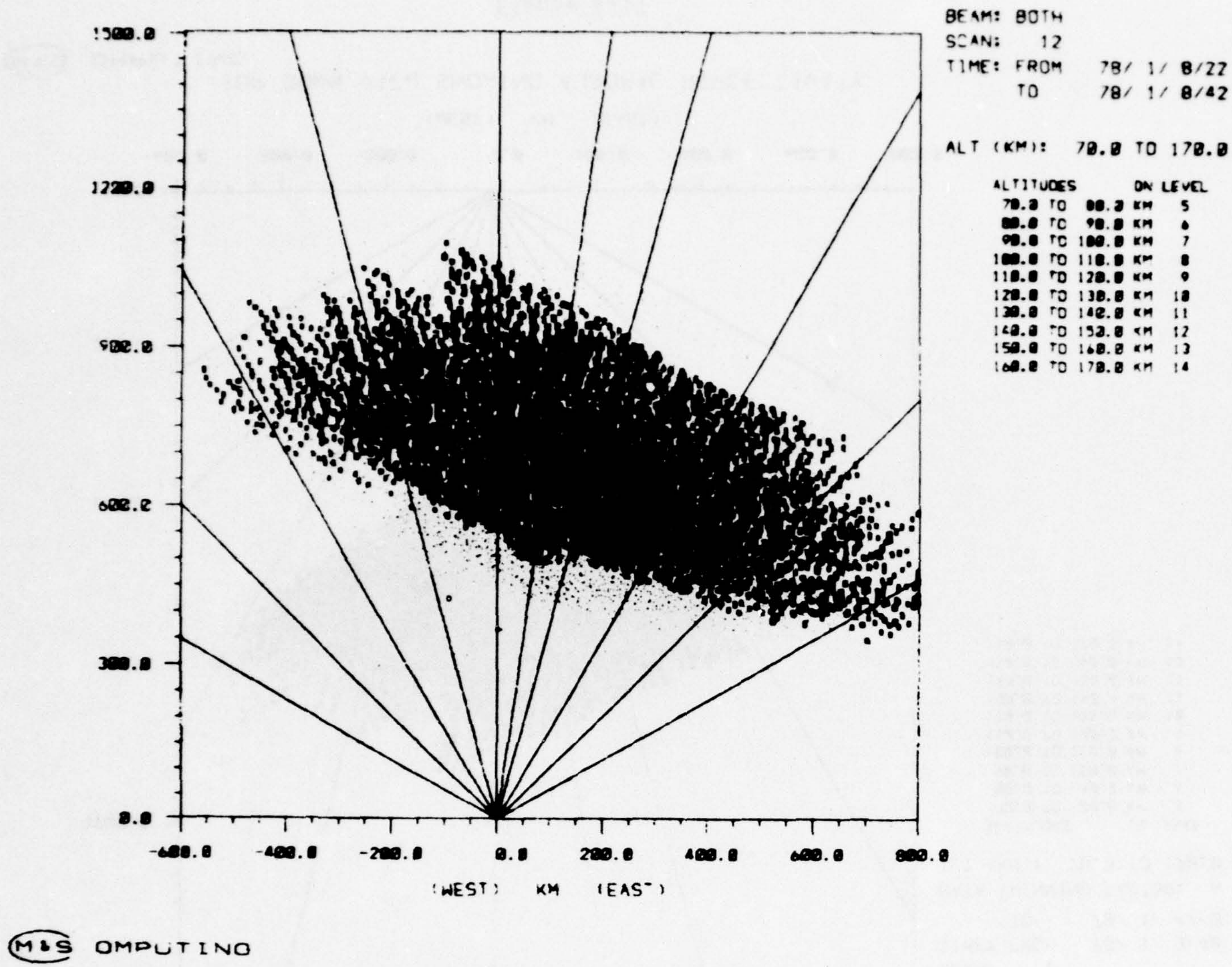

BEAM: BOTH
SCAN: 2
TIME: FROM 78/ 1/ 3/40
TO 78/ 1/ 4/ 0
DATA THINNING FACTOR: 6
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTING

Figure 2-17



1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
BEAM: BOTH
SCAN: 12
TIME: FROM 78/ 1/ 8/22
TO 78/ 1/ 8/42
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
M&S OMPUTINO

Figure 2-18

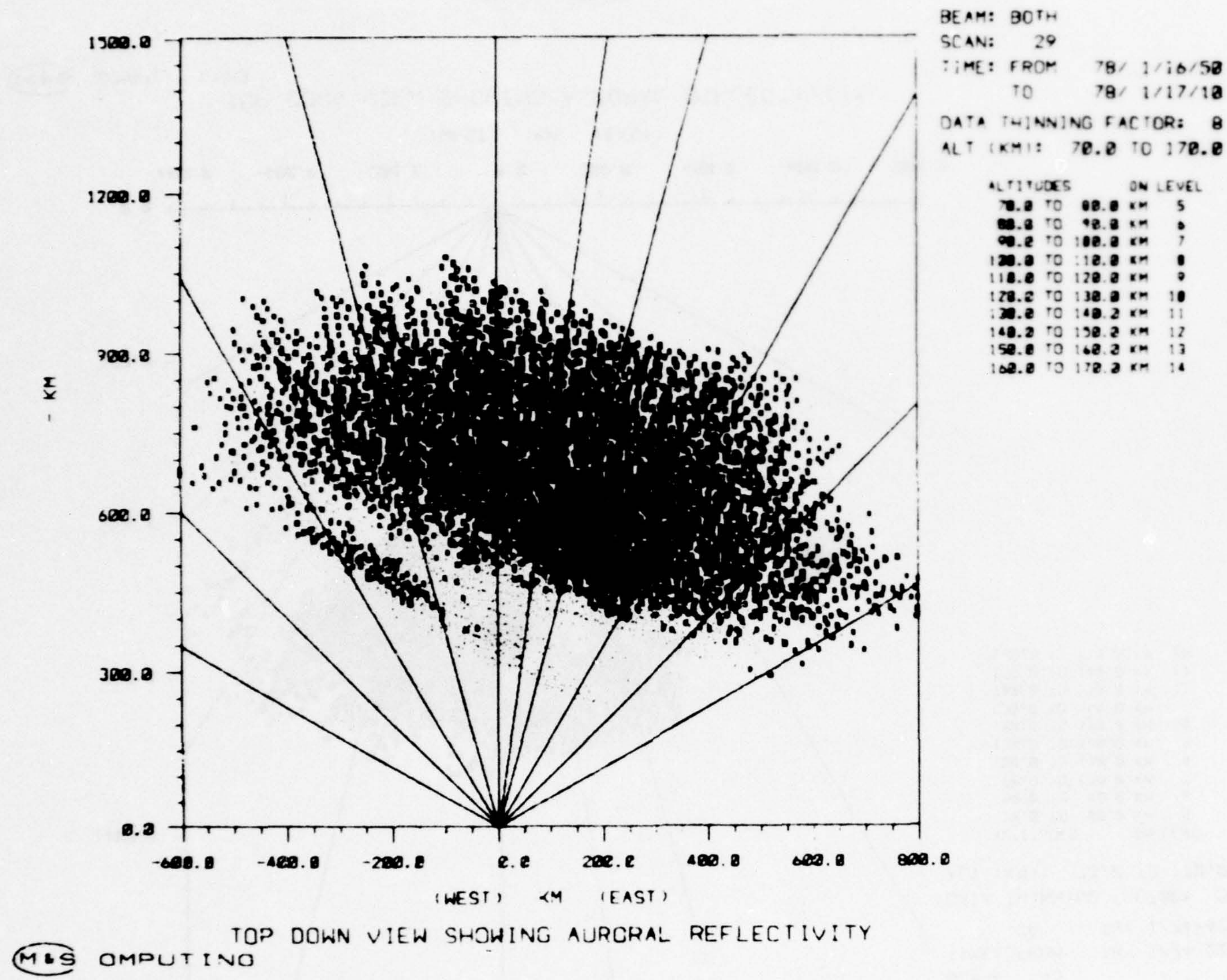

BEAM: BOTH
SCAN: 29
TIME: FROM 78/ 1/16/50
TO 78/ 1/17/10
DATA THINNING FACTOR: 8
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
- KM
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTING

Figure 2-19

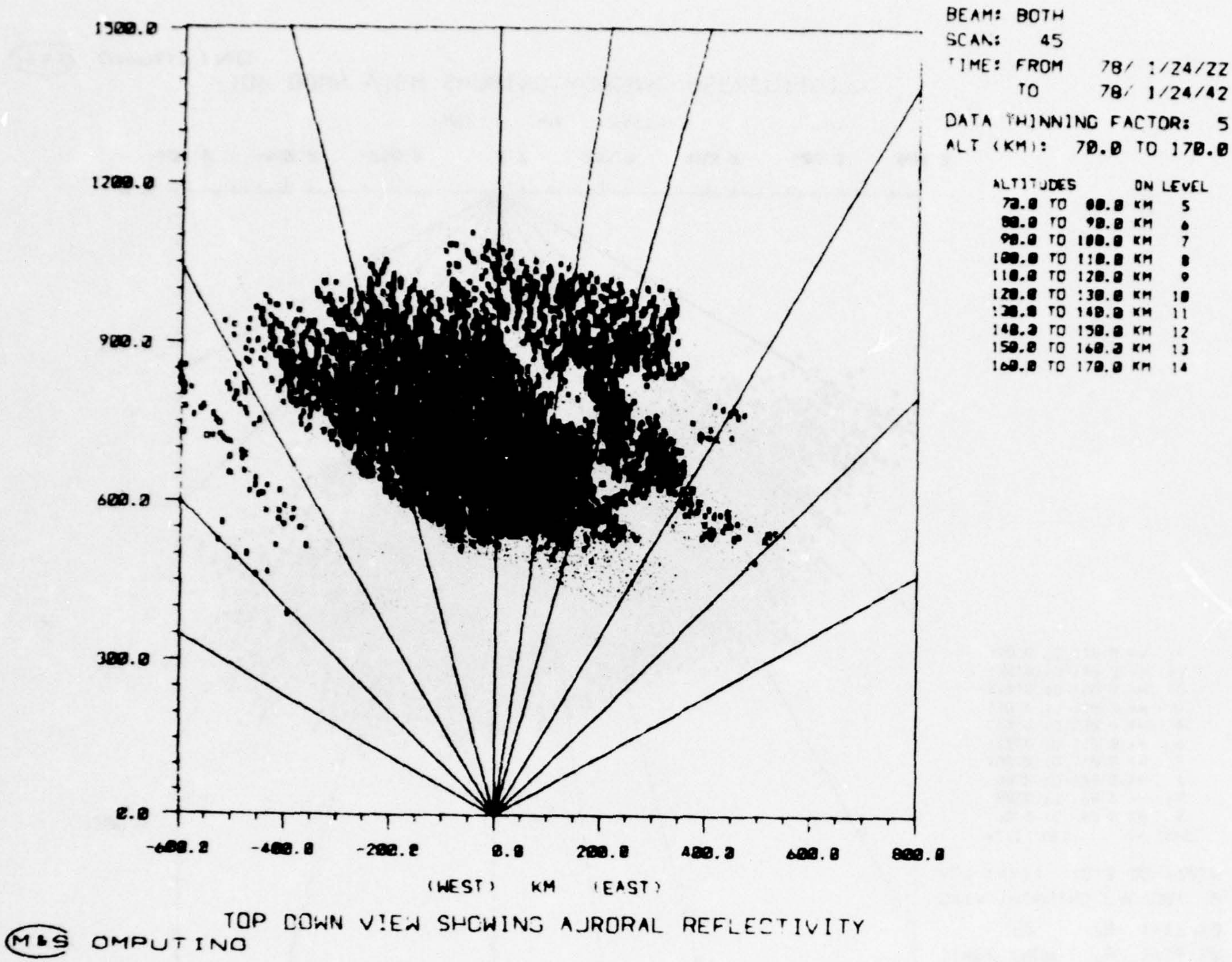

BEAM: BOTH
SCAN: 45
TIME: FROM 78/ 1/24/22
TO 78/ 1/24/42
DATA THINNING FACTOR: 5
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTING

Figure 2-20

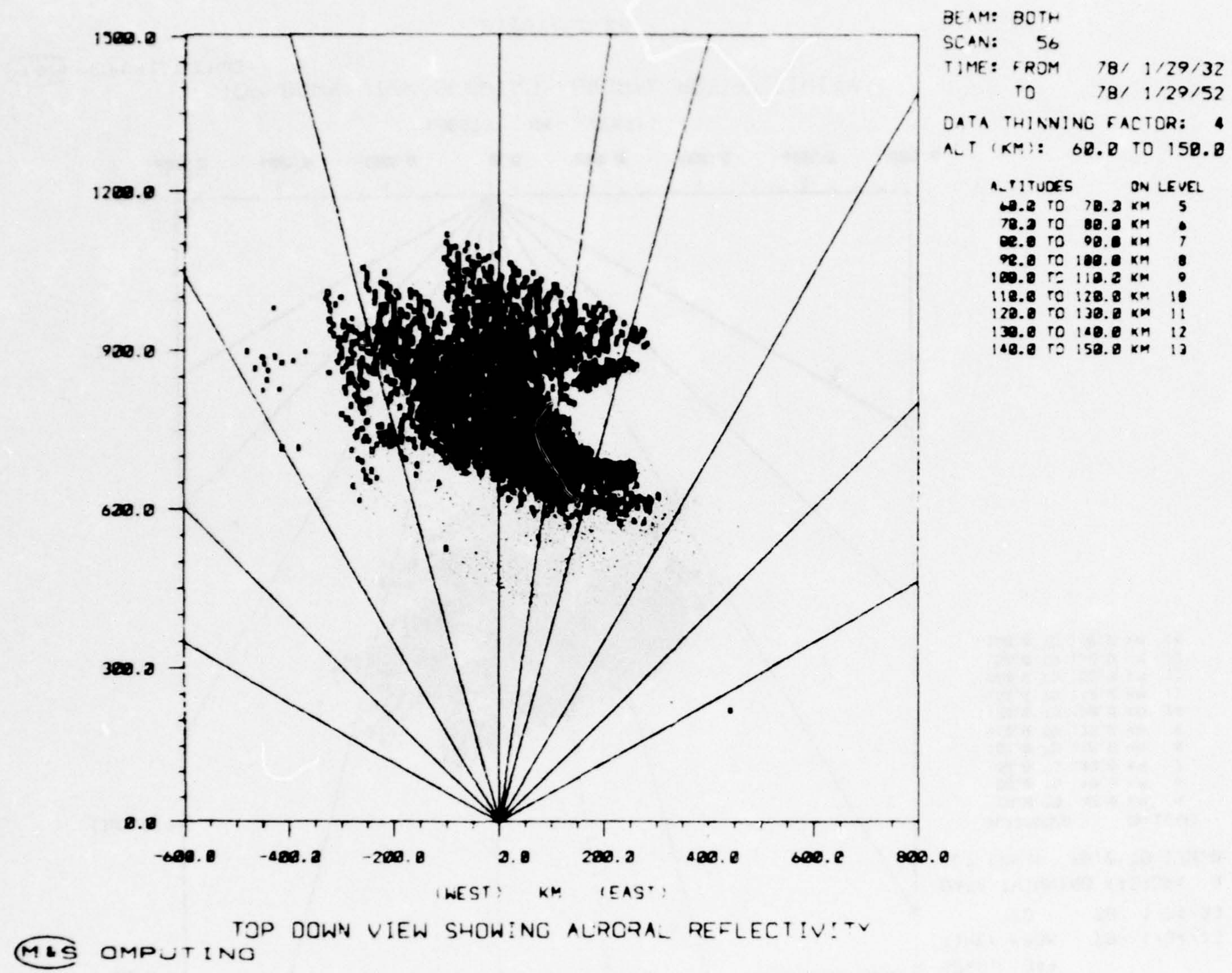

BEAM: BOTH
SCAN: 56
TIME: FROM 78/ 1/29/32
TO 78/ 1/29/52
DATA THINNING FACTOR: 4
ALT (KM): 60.0 TO 150.0
ALTITUDES ON LEVEL
60.0 TO 70.0 KM 5
70.0 TO 80.0 KM 6
80.0 TO 90.0 KM 7
90.0 TO 100.0 KM 8
100.0 TO 110.0 KM 9
110.0 TO 120.0 KM 10
120.0 TO 130.0 KM 11
130.0 TO 140.0 KM 12
140.0 TO 150.0 KM 13
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTING

Figure 2-21

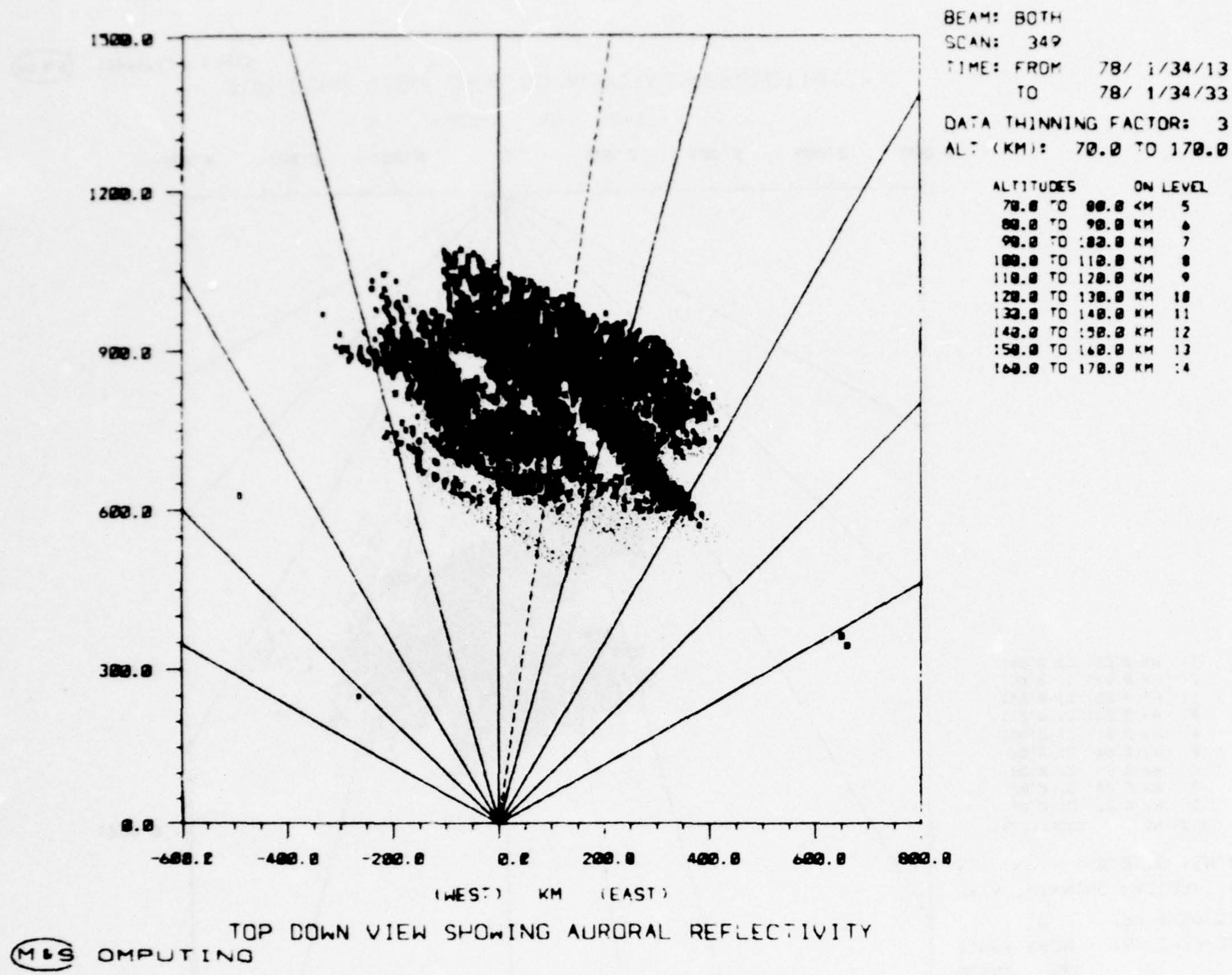

BEAM: BOTH
SCAN: 349
TIME: FROM 78/ 1/34/13
TO 78/ 1/34/33
DATA THINNING FACTOR: 3
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTING

Figure 2-22

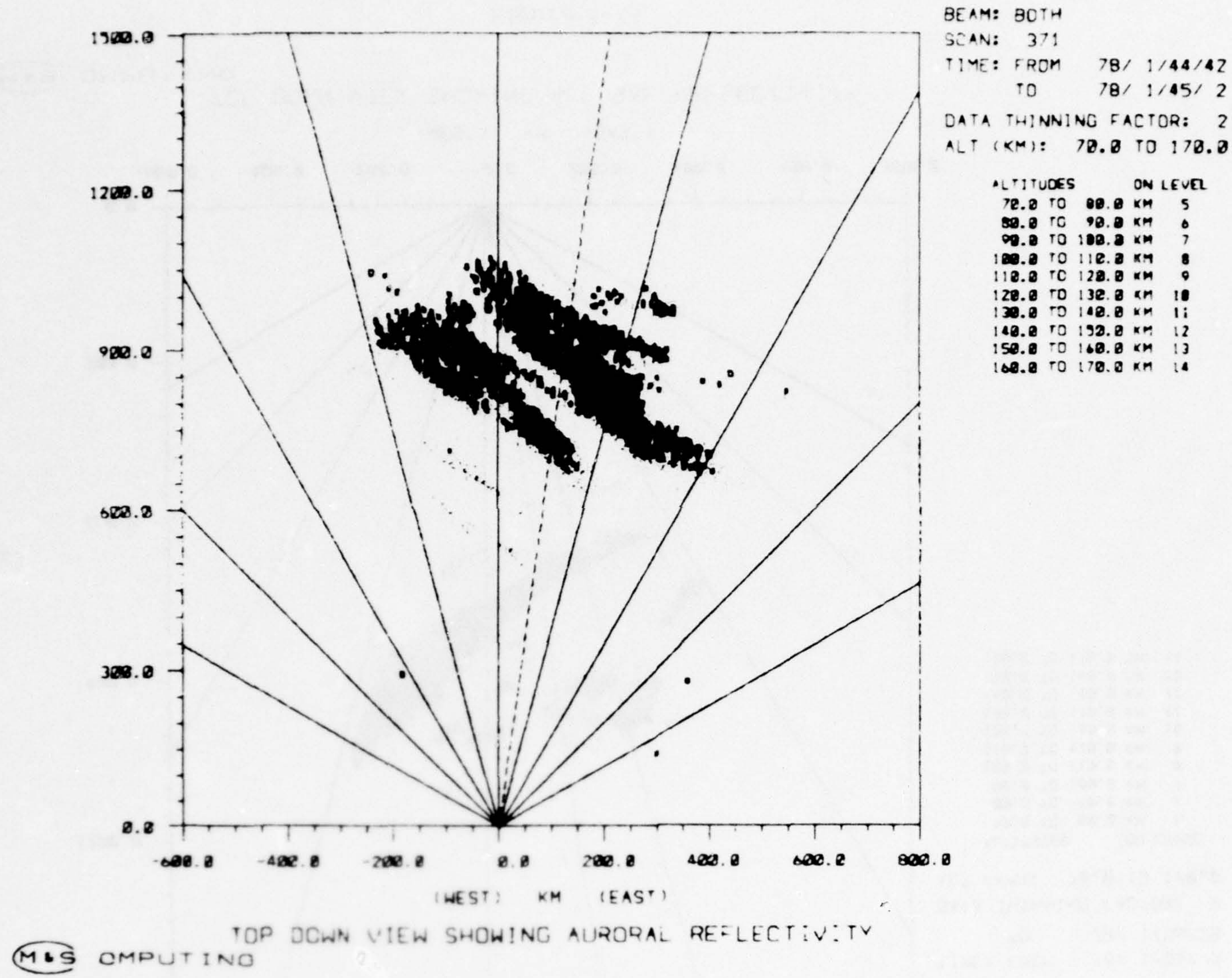

BEAM: BOTH
SCAN: 371
TIME: FROM 78/ 1/44/42
TO 78/ 1/45/ 2
DATA THINNING FACTOR: 2
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTINO

Figure 2-23

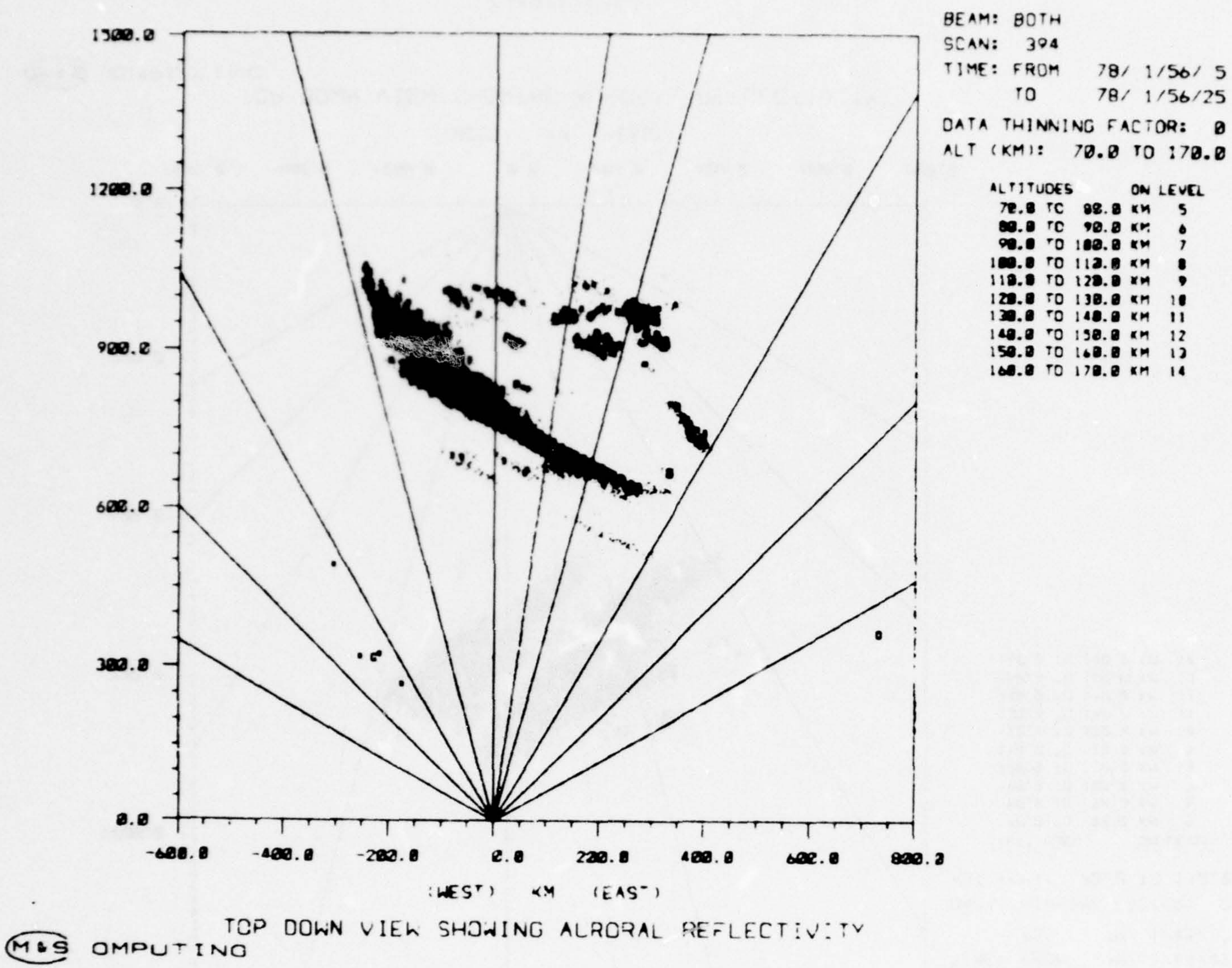

BEAM: BOTH
SCAN: 394
TIME: FROM 78/ 1/56/ 5
TO 78/ 1/56/25
DATA THINNING FACTOR: 0
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTING

Figure 2-24

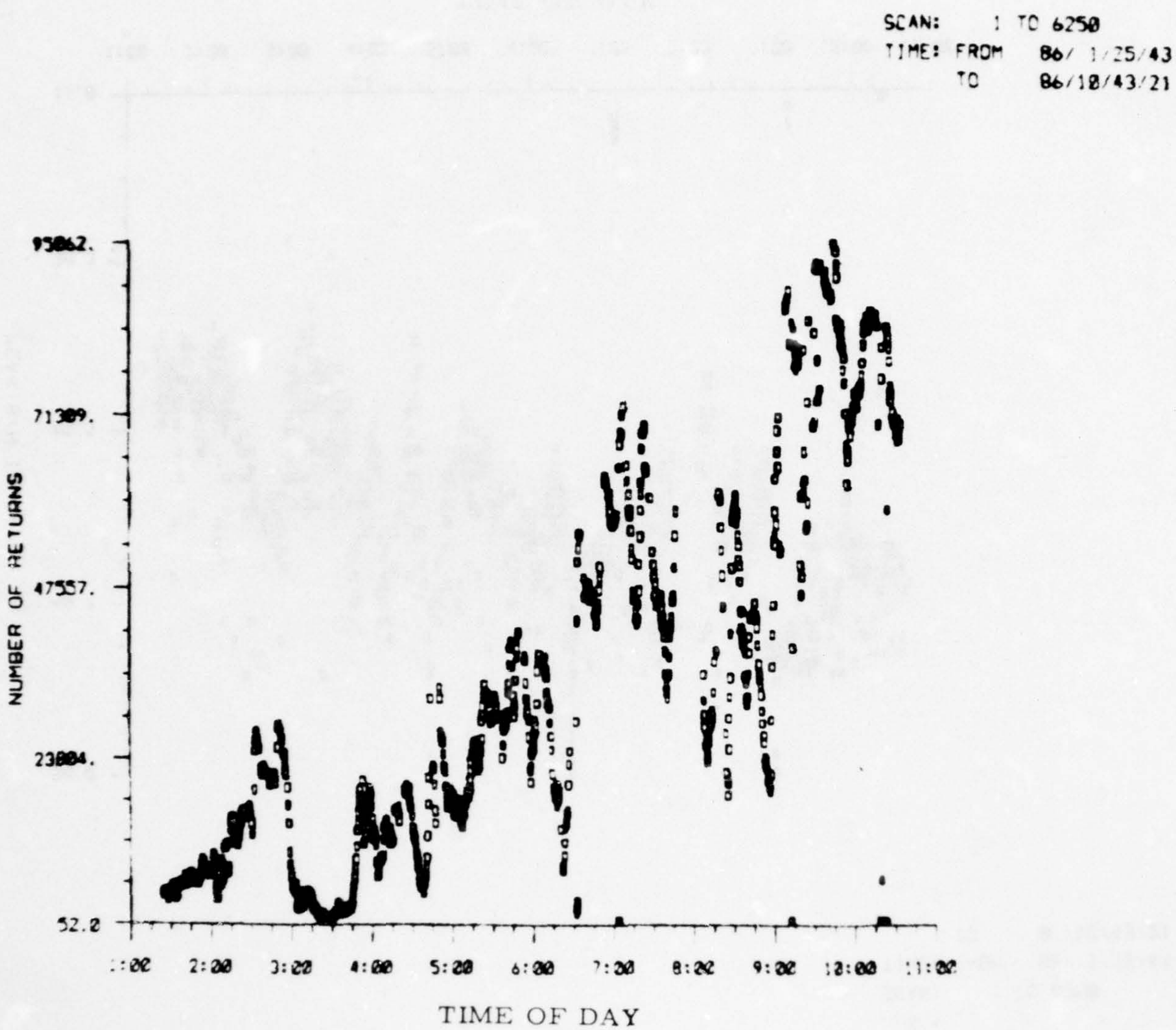

SCAN: 1 TO 6250
TIME: FROM 86/ 1/25/43
TO 86/10/43/21
95062.
71309.
47557.
23804.
52.0
NUMBER OF RETURNS
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
TIME OF DAY

Figure 2-25

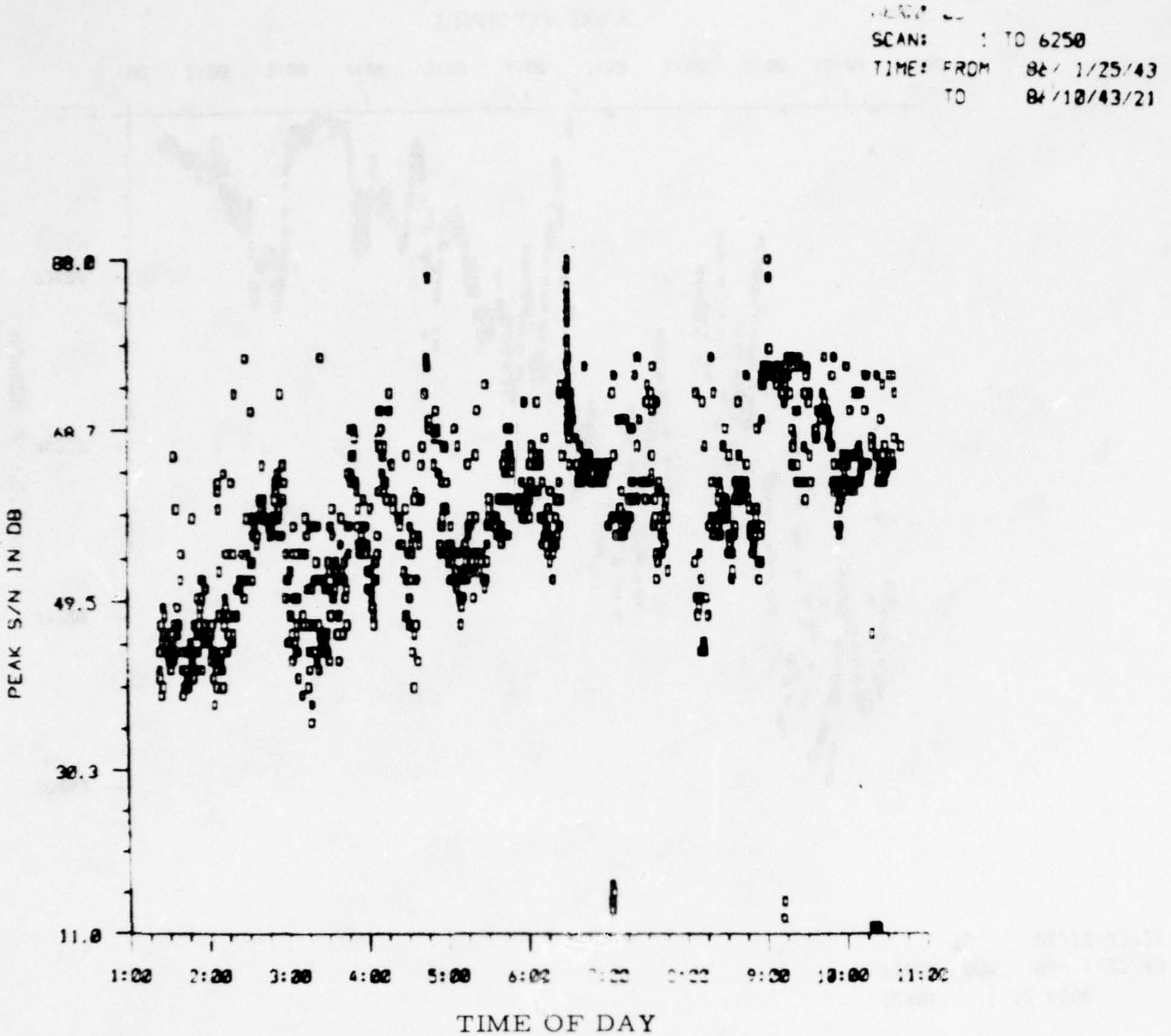

SCAN: 1 TO 6250
TIME: FROM 86/ 1/25/43
TO 84/10/43/21
PEAK S/N IN DB
88.0
68.7
49.5
30.3
11.0
1:00
2:00
3:00
4:00
5:00
6:00
9:00
10:00
11:00
TIME OF DAY

Figure 2-26

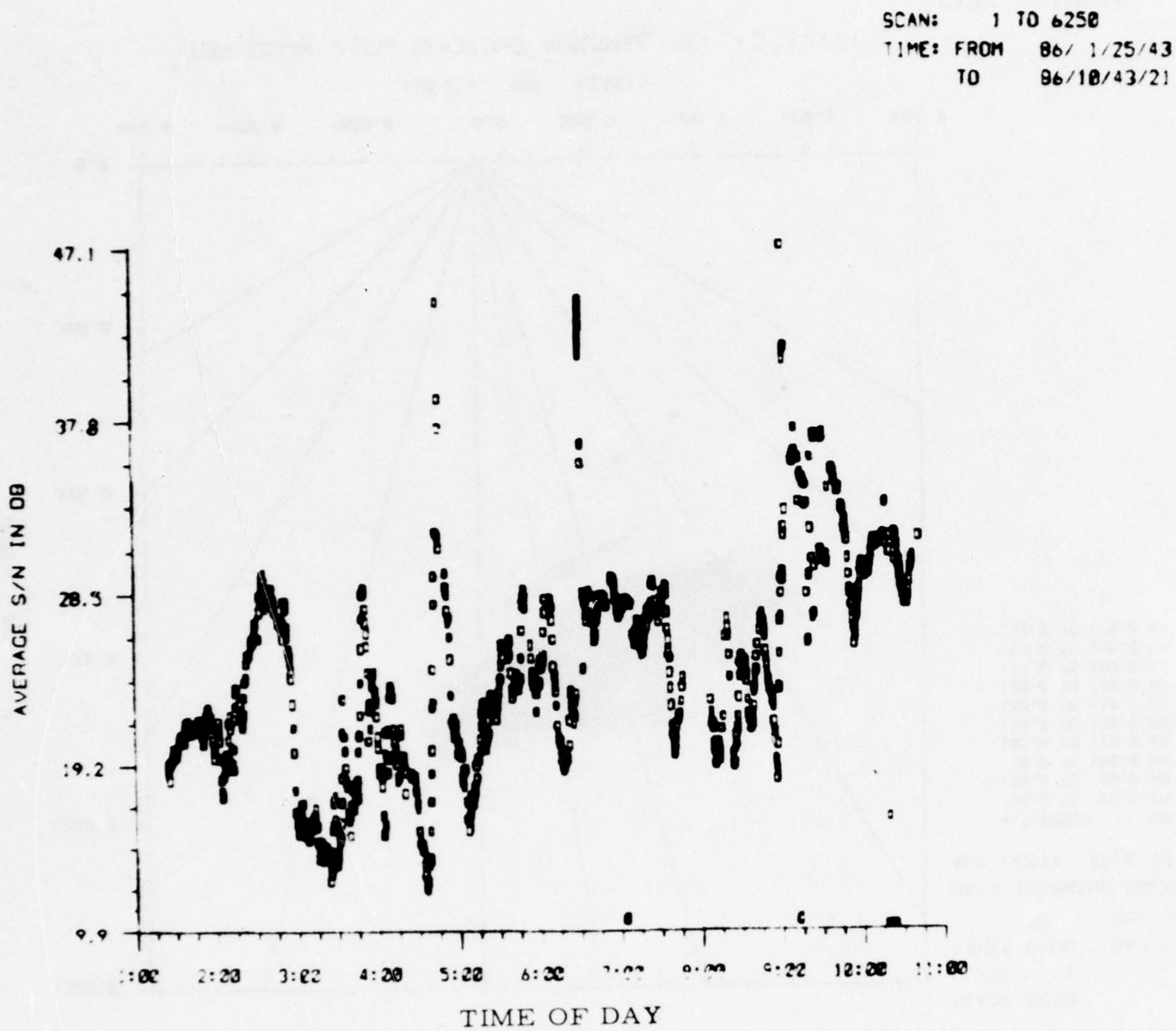
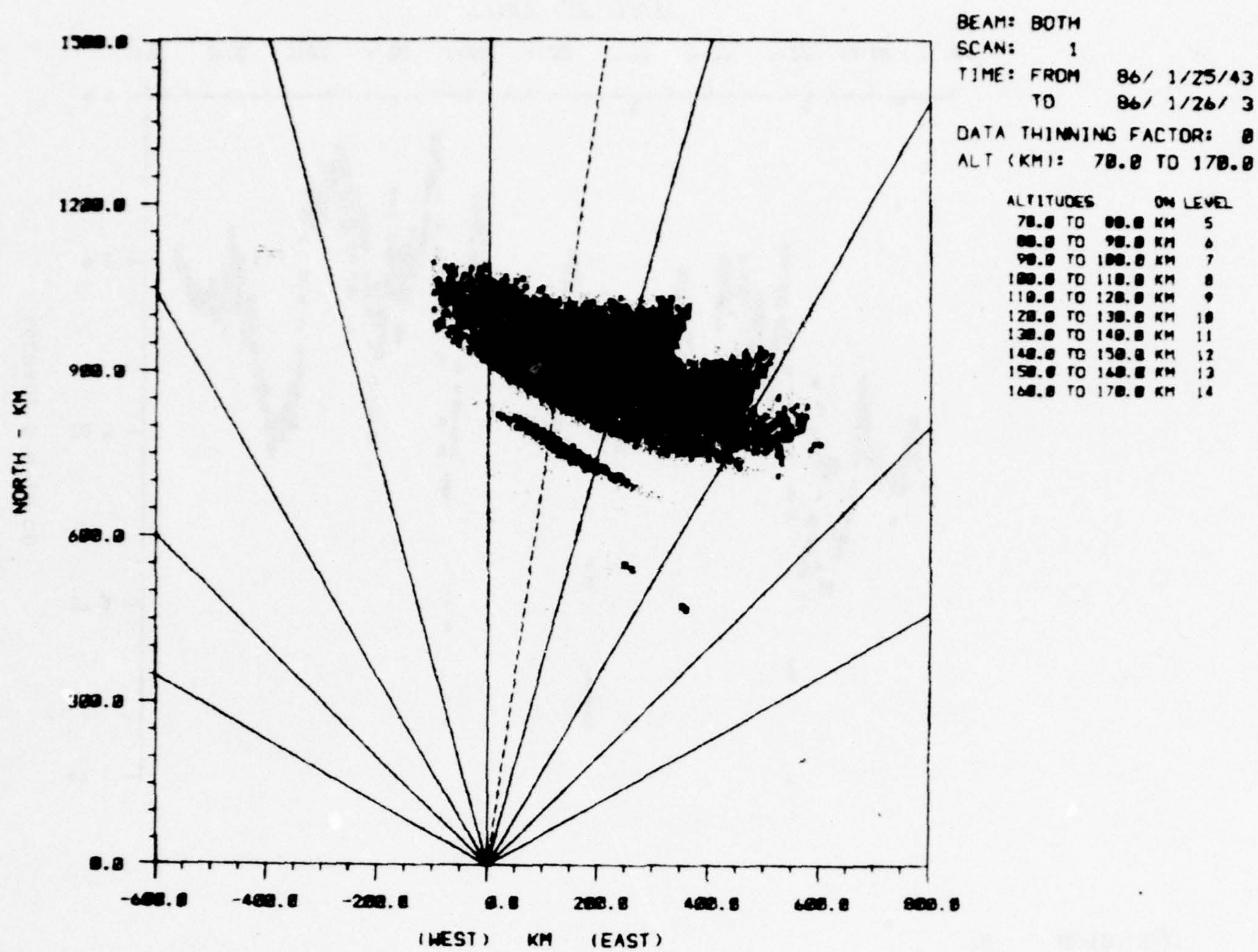

SCAN: 1 TO 6250
TIME: FROM 86/ 1/25/43
TO 86/10/43/21
47.1
37.8
28.5
19.2
9.9
AVERAGE S/N IN DB
2:20
3:22
4:20
5:20
6:30
9:22
10:00
11:00
TIME OF DAY

Figure 2-27



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

DATE: 13-APR-76

Figure 2-28

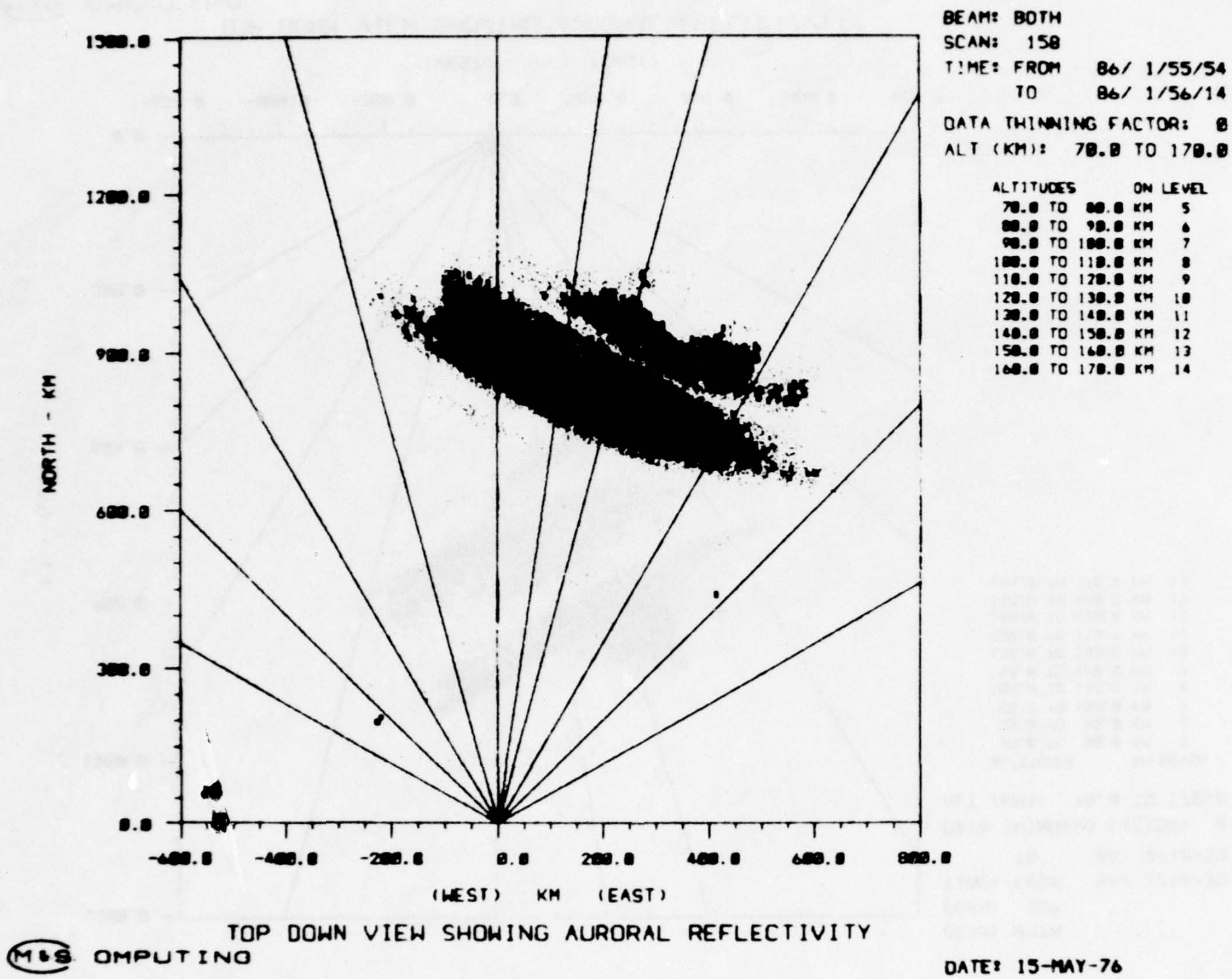

BEAM: BOTH
SCAN: 158
TIME: FROM 86/ 1/55/54
TO 86/ 1/56/14
DATA THINNING FACTOR: 0
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
NORTH - KM
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTING
DATE: 15-MAY-76

Figure 2-29

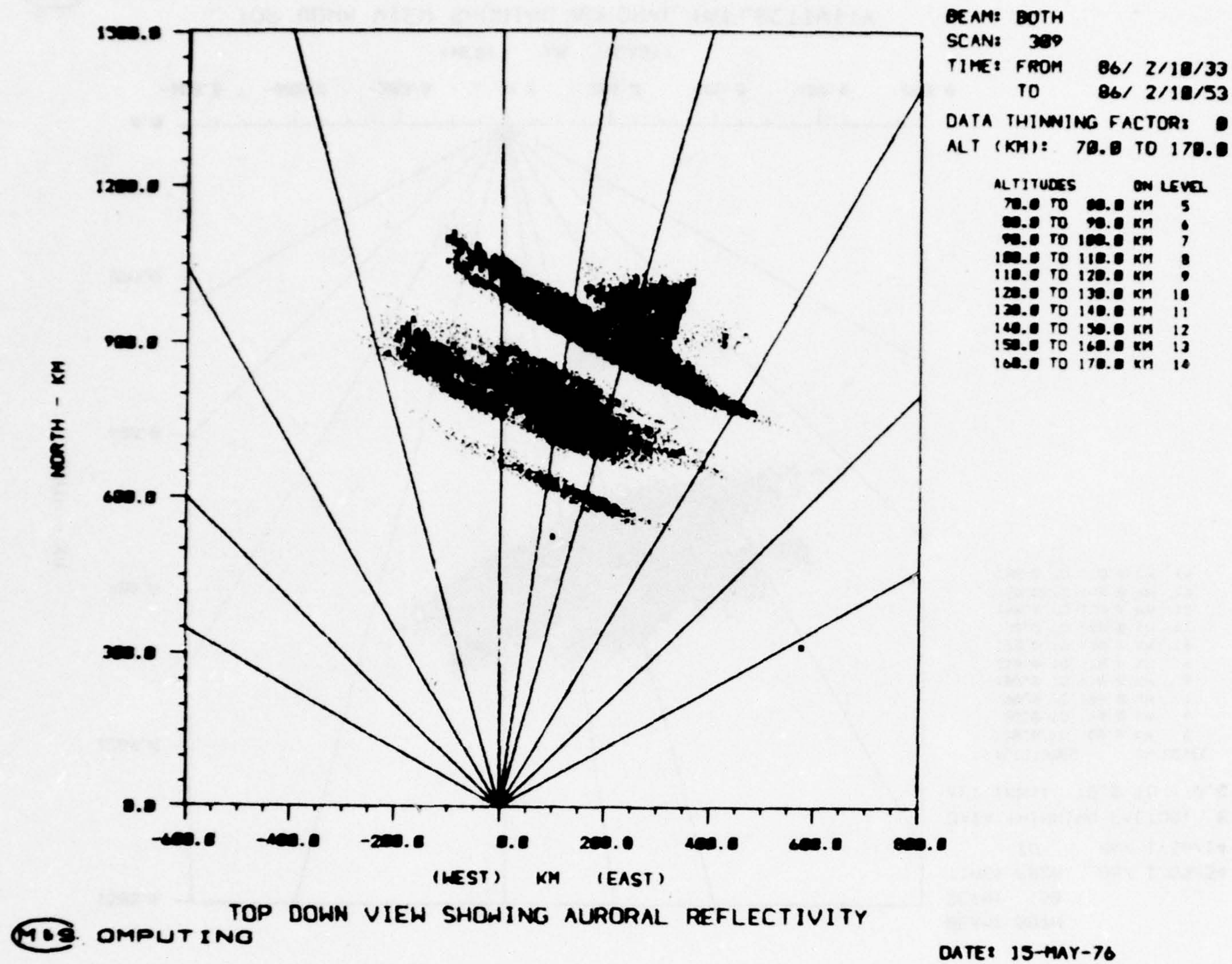

BEAM: BOTH
SCAN: 309
TIME: FROM 06/ 2/10/33
TO 06/ 2/10/53
DATA THINNING FACTOR: 0
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
NORTH - KM
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTING
DATE: 15-MAY-76

Figure 2-30

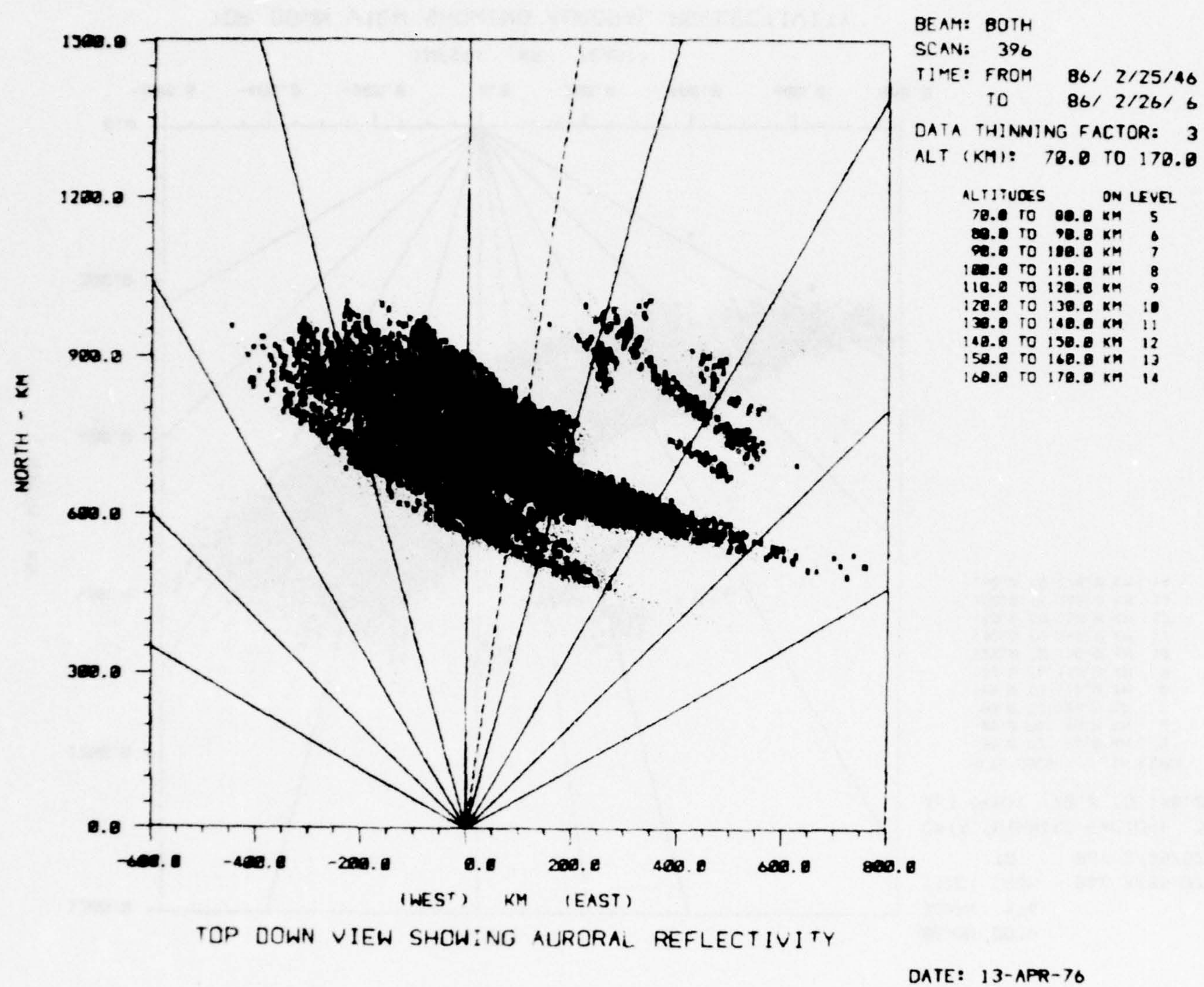
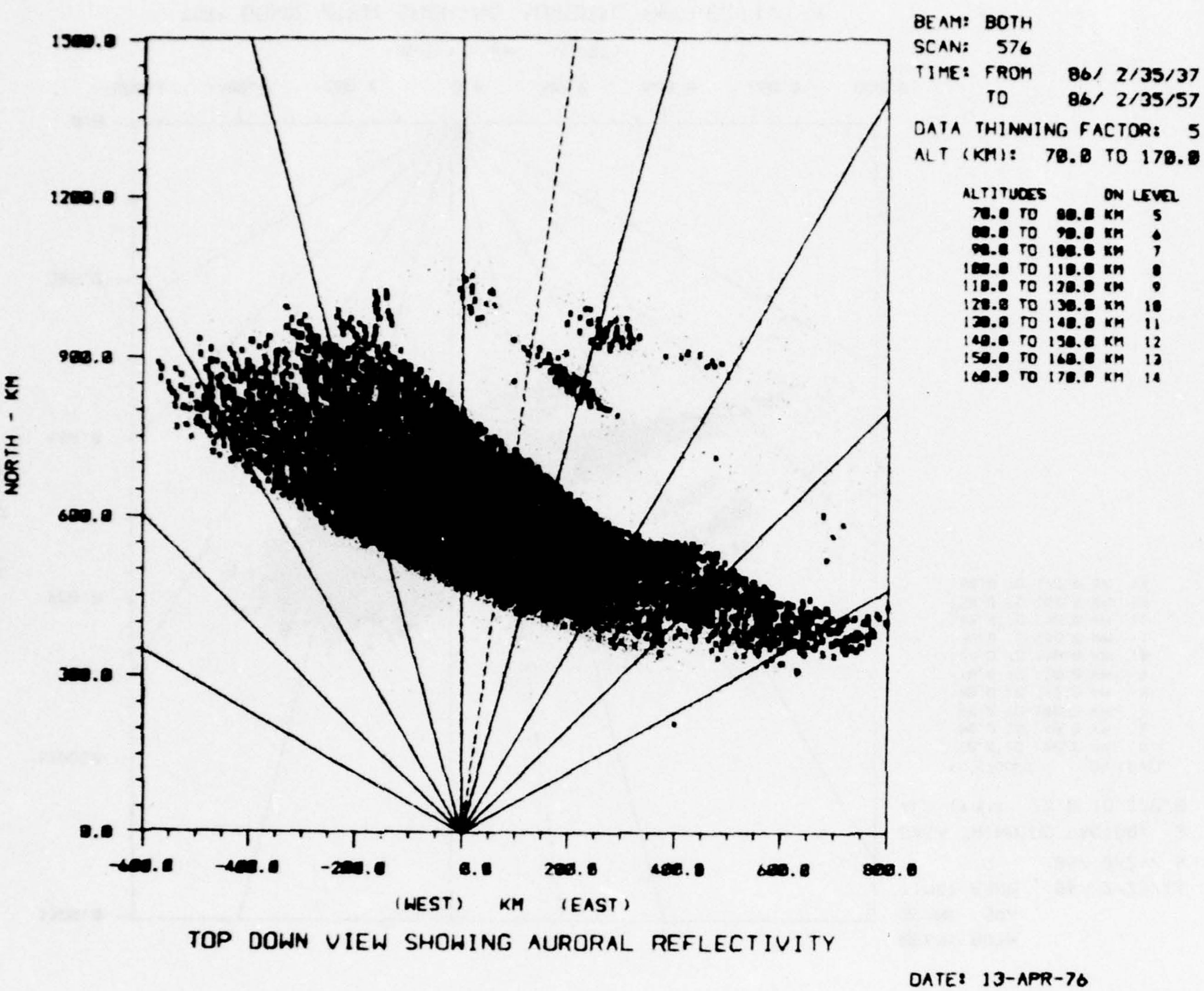

BEAM: BOTH
SCAN: 396
TIME: FROM 86/ 2/25/46
TO 86/ 2/26/ 6
DATA THINNING FACTOR: 3
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
NORTH - KM
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
DATE: 13-APR-76

Figure 2-31



BEAM: BOTH
SCAN: 576
TIME: FROM 86/ 2/35/37
TO 86/ 2/35/57
DATA THINNING FACTOR: 5
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
NORTH - KM
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
DATE: 13-APR-76

Figure 2-32

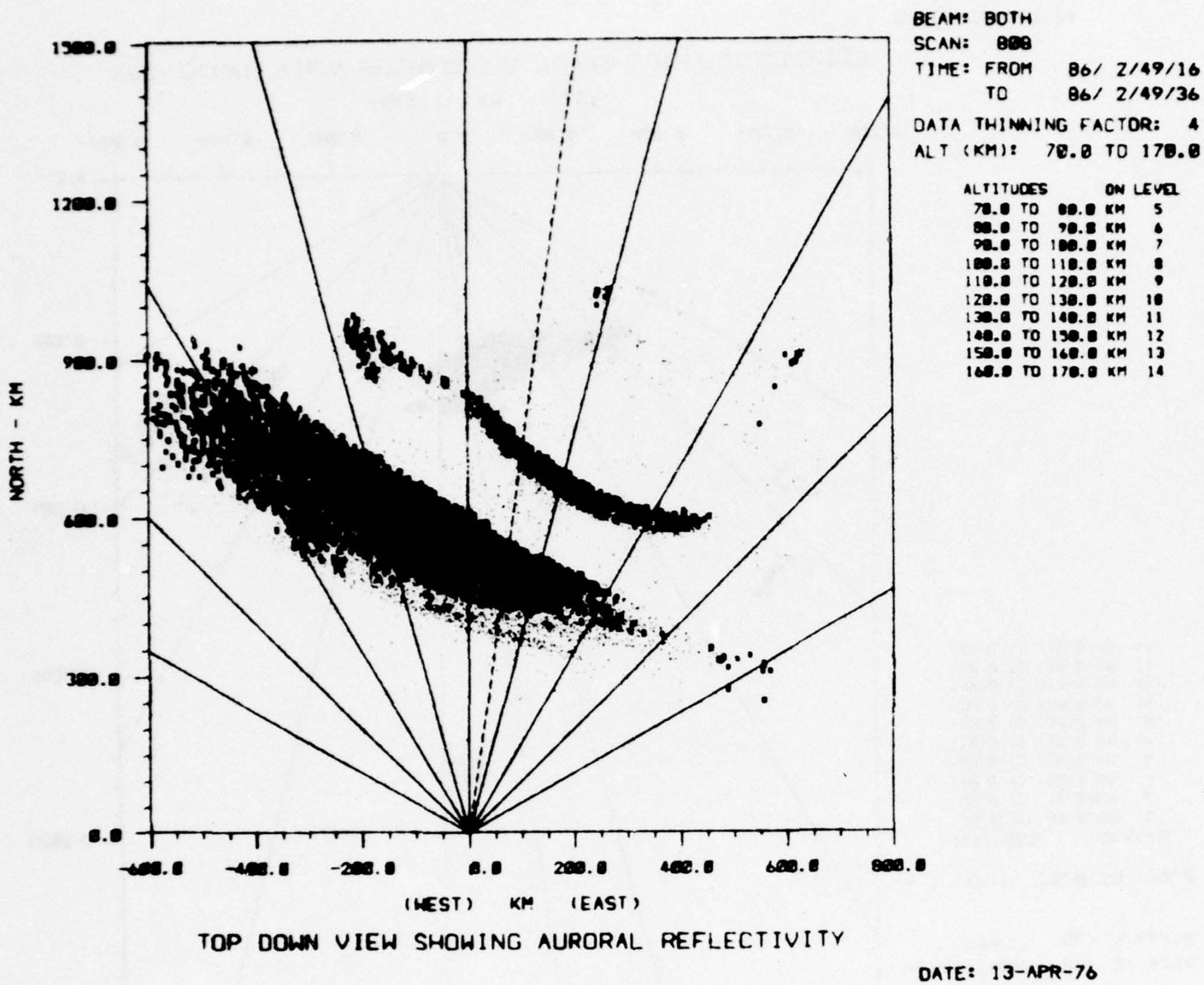
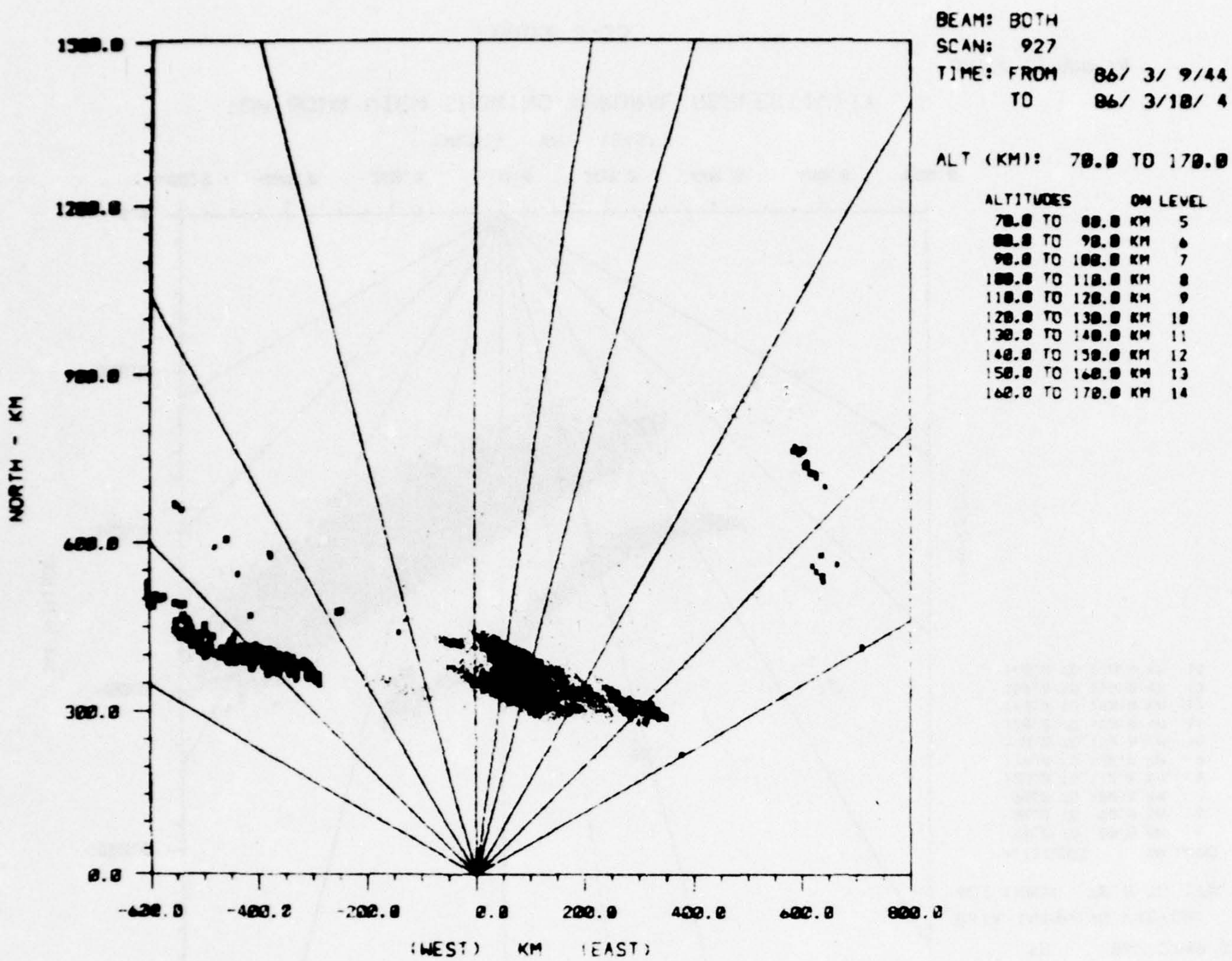

BEAM: BOTH
SCAN: 000
TIME: FROM 86/ 2/49/16
TO 86/ 2/49/36
DATA THINNING FACTOR: 4
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
NORTH - KM
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
DATE: 13-APR-76

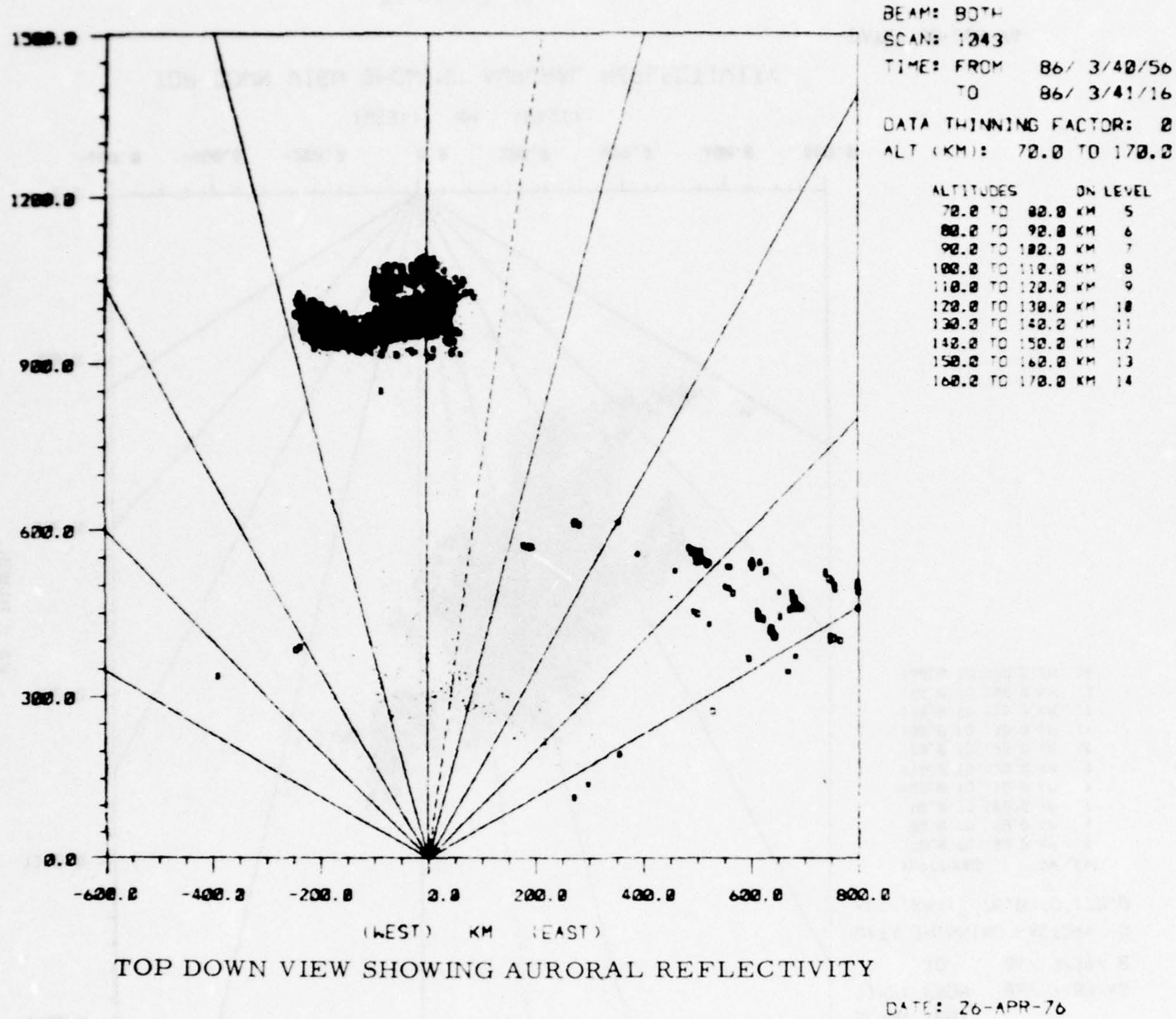
Figure 2-33



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

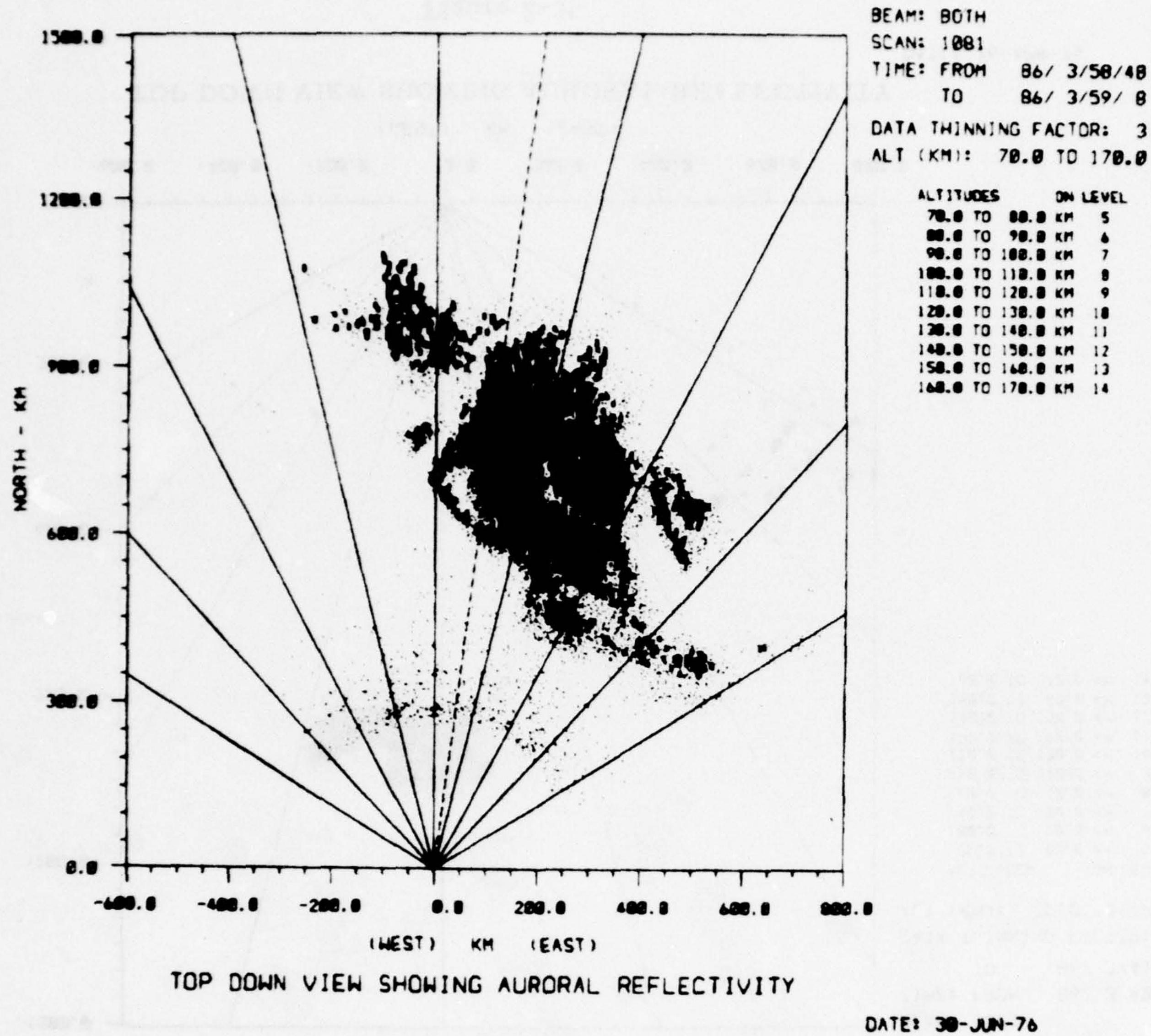
DATE: 20-APR-76

Figure 2-34



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-35



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-36

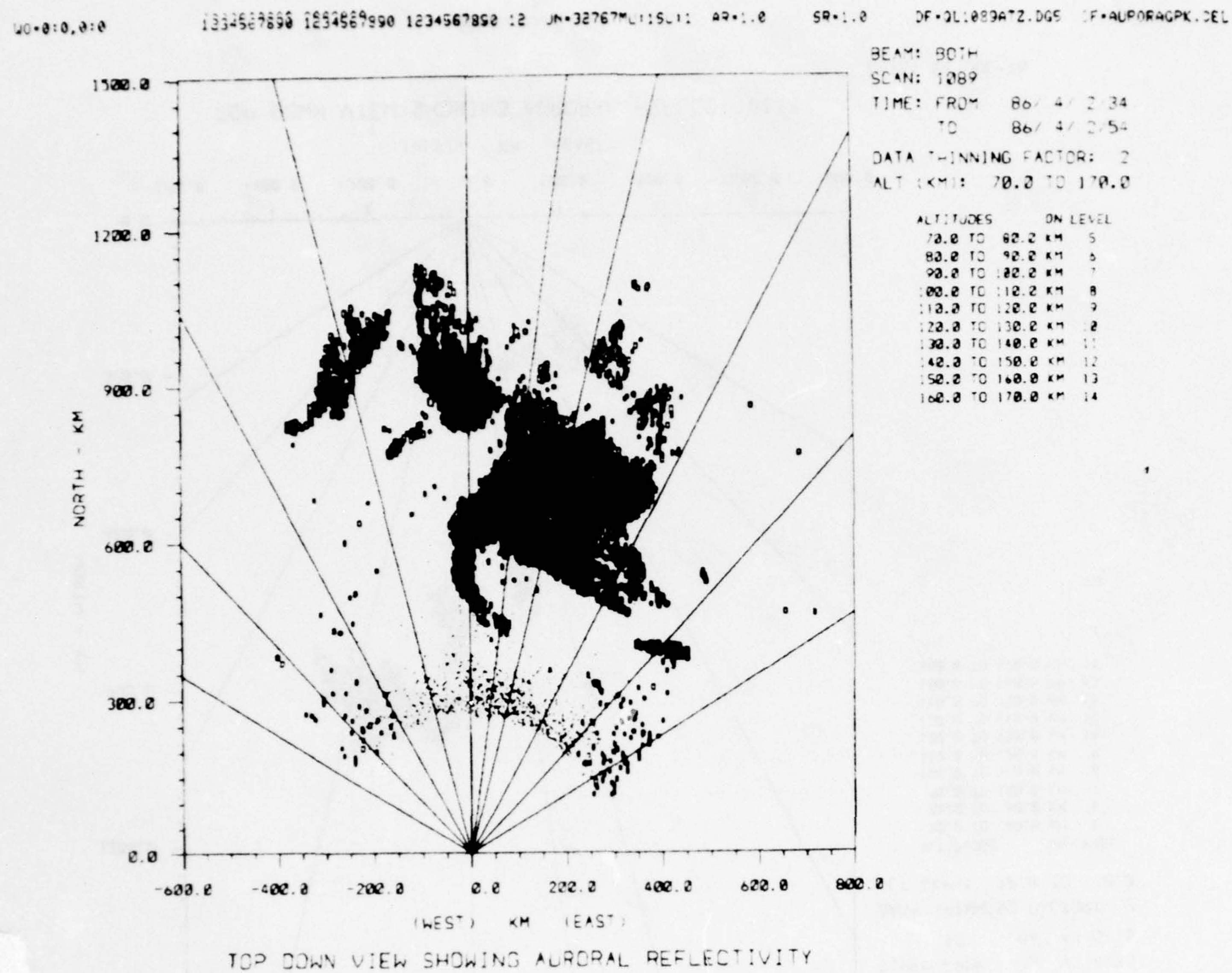

W0=0:0,0:0
1334567890 1234567890 1234567892 12 JN=32767ML1:SL1: AR=1.0 SR=1.0 DF=DL1089ATZ.DGS IF=AURORAGPK.DEL
BEAM: BOTH
SCAN: 1089
TIME: FROM 86/ 4/ 2/34
TO 86/ 4/ 2/54
DATA THINNING FACTOR: 2
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
NORTH - KM
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
DATE: 07-JUL-76

Figure 2-37

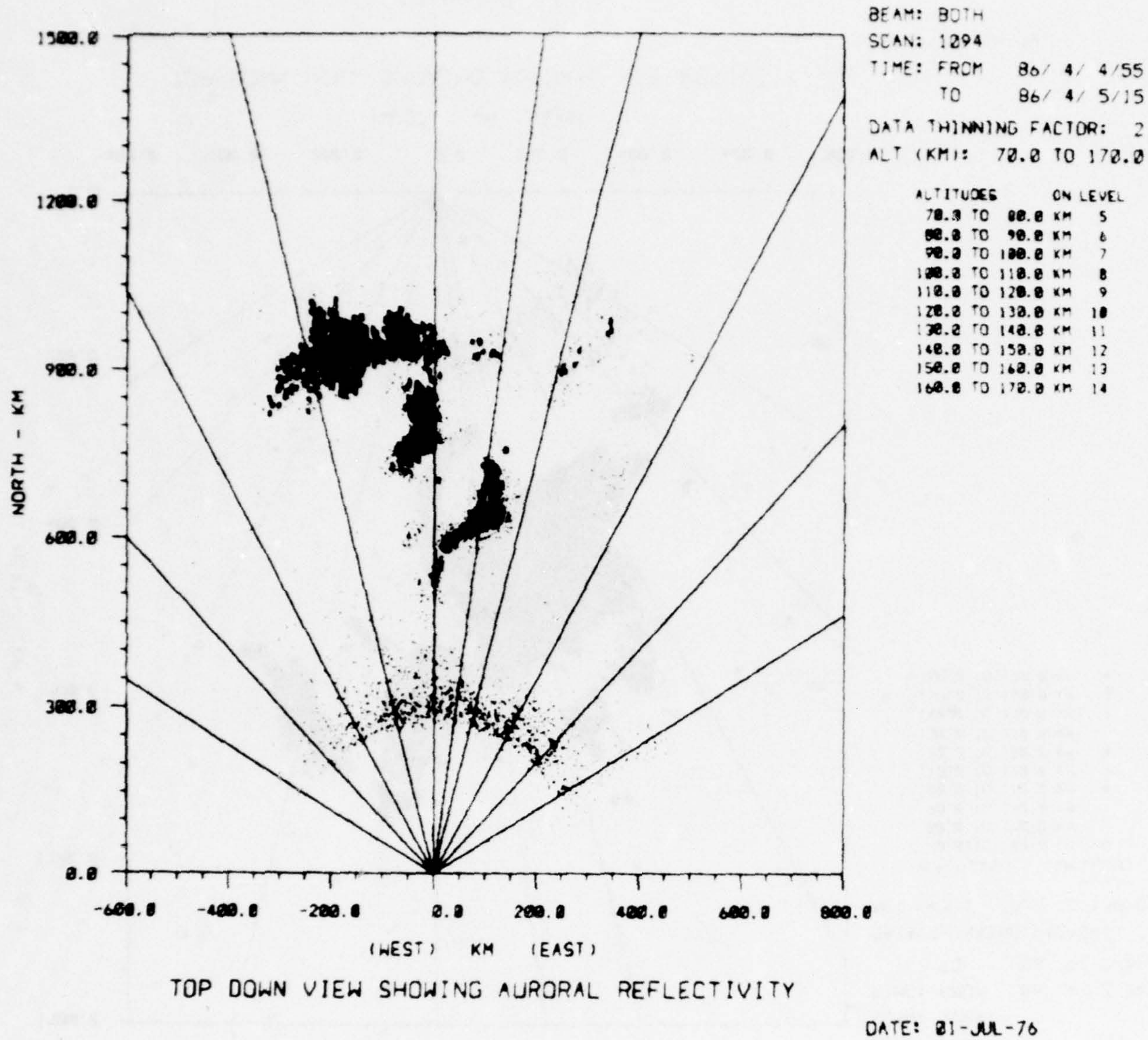
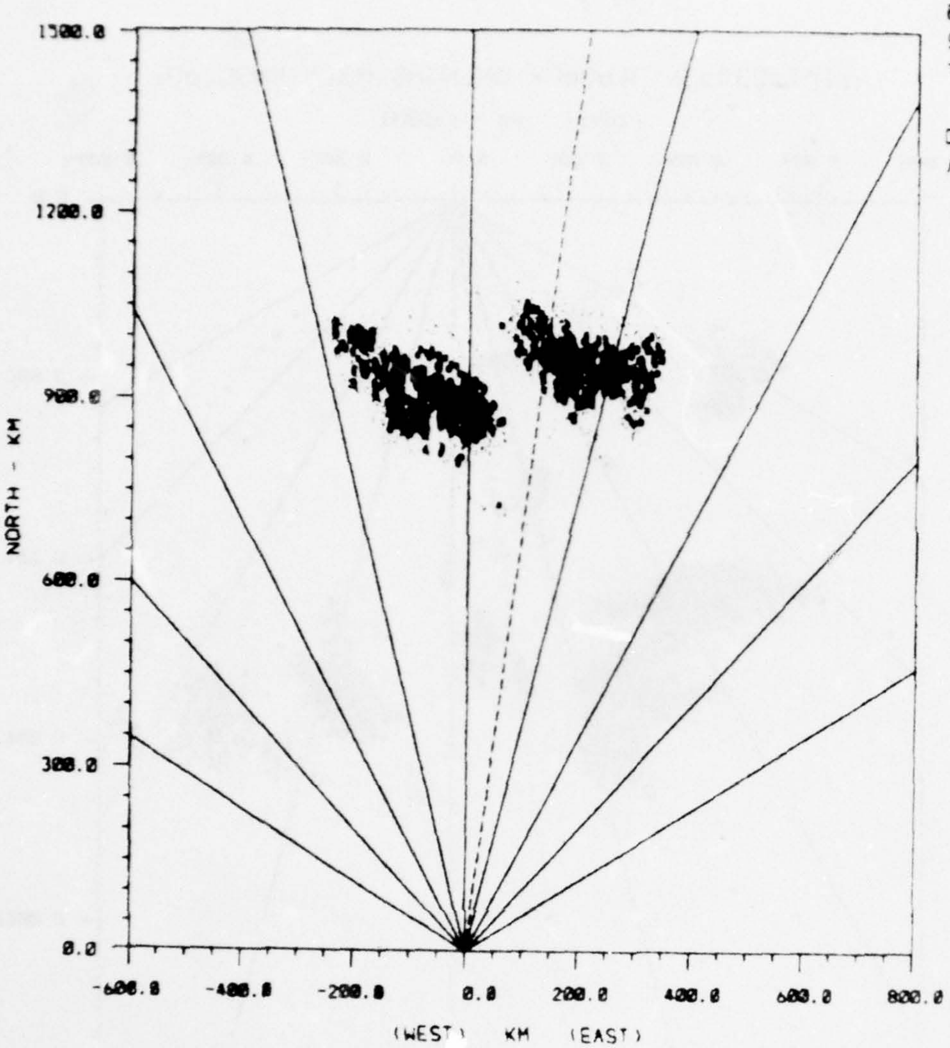

BEAM: BOTH
SCAN: 1294
TIME: FROM 86/ 4/ 4/55
TO 86/ 4/ 5/15
DATA THINNING FACTOR: 2
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
NORTH - KM
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
DATE: 01-JUL-76

Figure 2-38



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-39

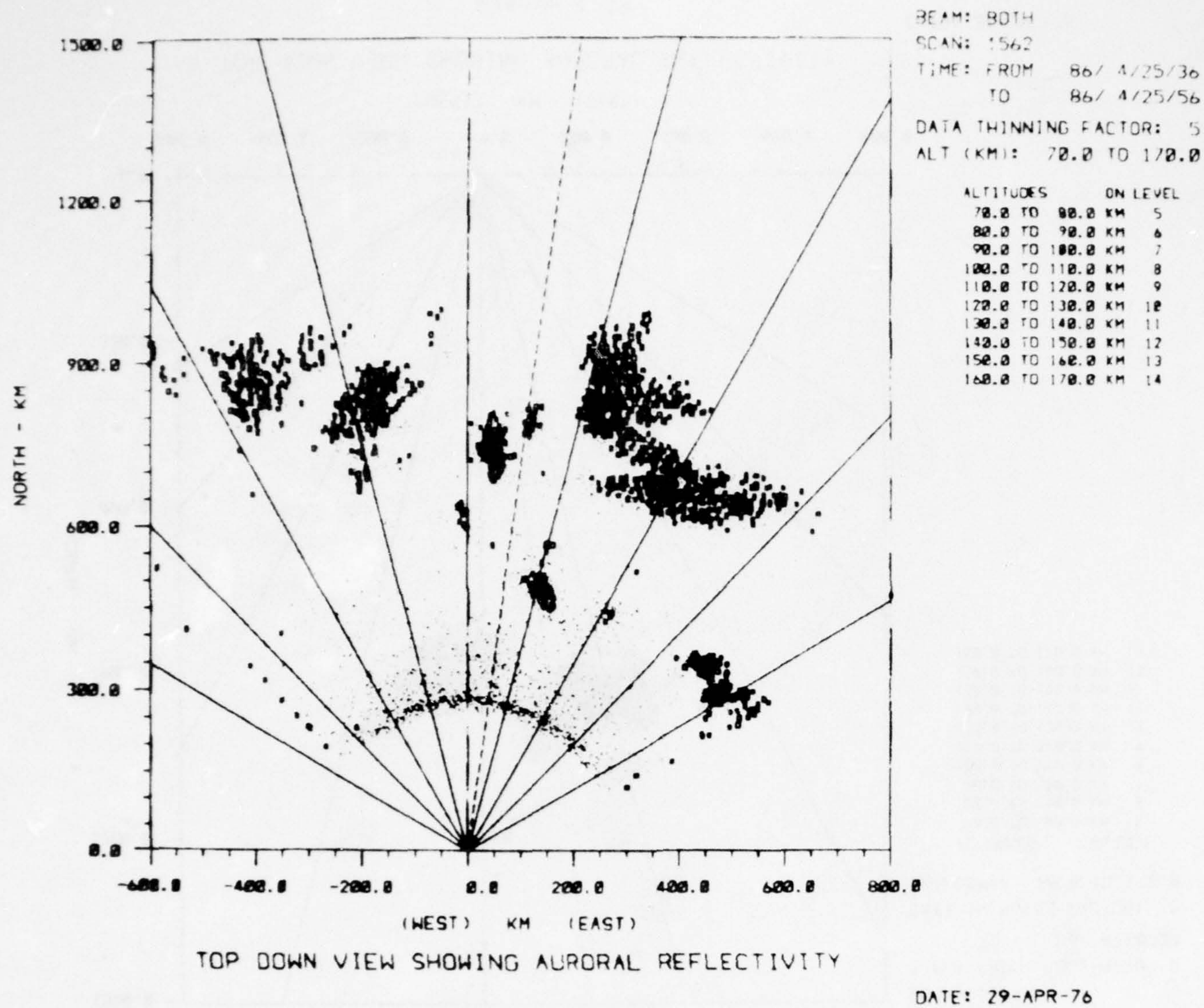
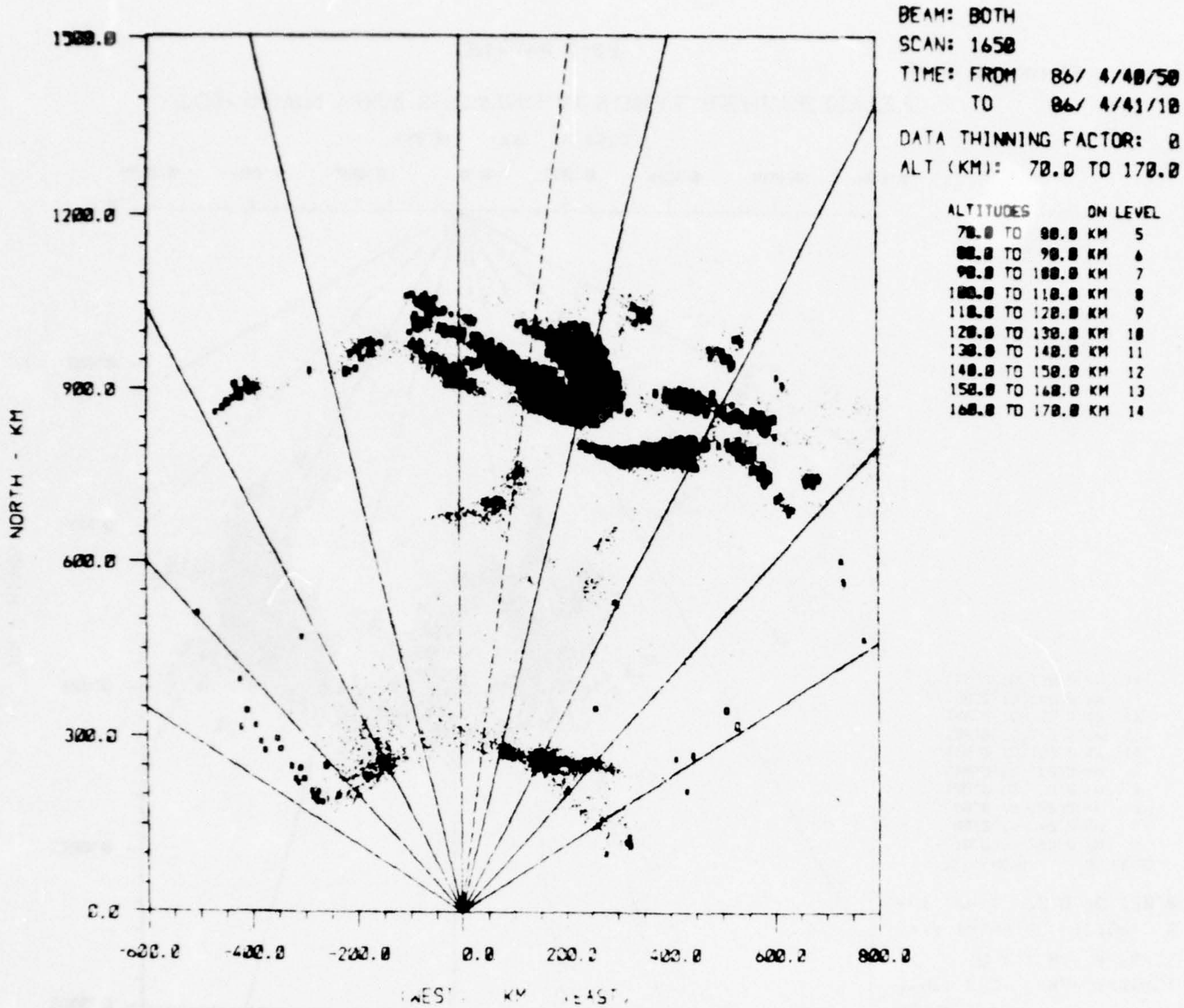

BEAM: BOTH
SCAN: 1562
TIME: FROM 86/ 4/25/36
TO 86/ 4/25/56
DATA THINNING FACTOR: 5
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
NORTH - KM
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
DATE: 29-APR-76

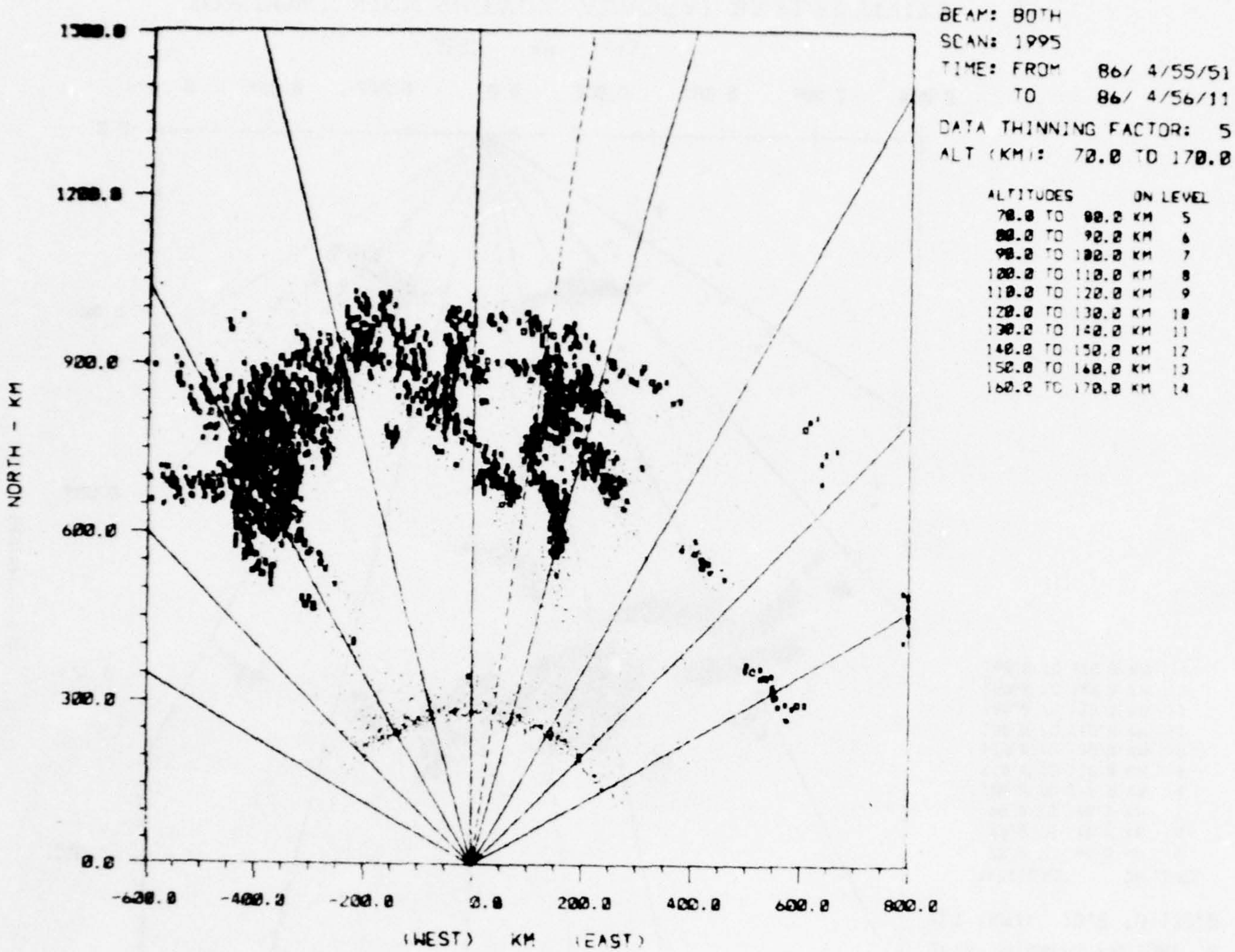
Figure 2-40



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

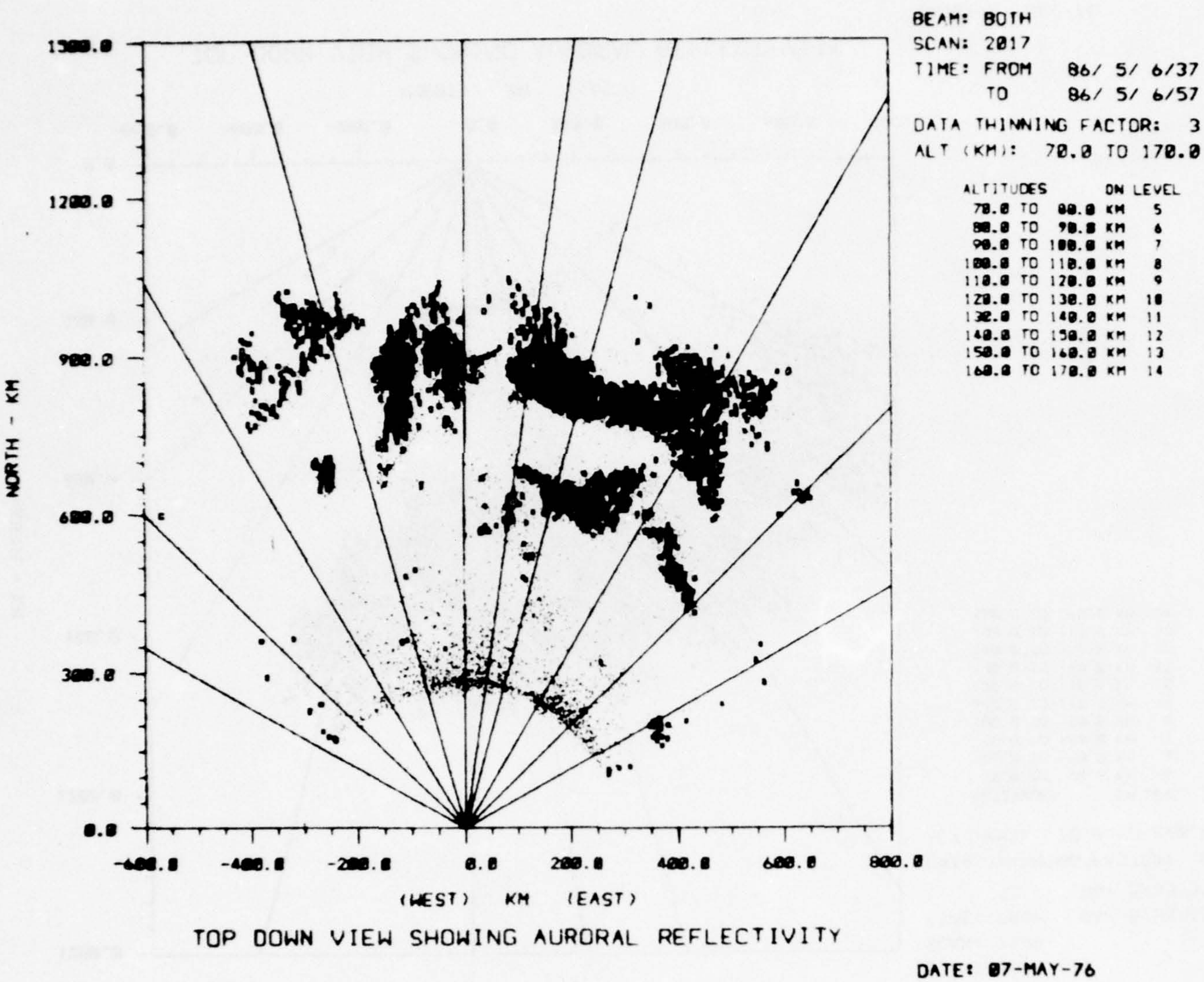
29 APR 76

Figure 2-41



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-42



BEAM: BOTH
SCAN: 2017
TIME: FROM 86/ 5/ 6/37
TO 86/ 5/ 6/57
DATA THINNING FACTOR: 3
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
NORTH - KM
1300.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
DATE: 07-MAY-76

Figure 2-43

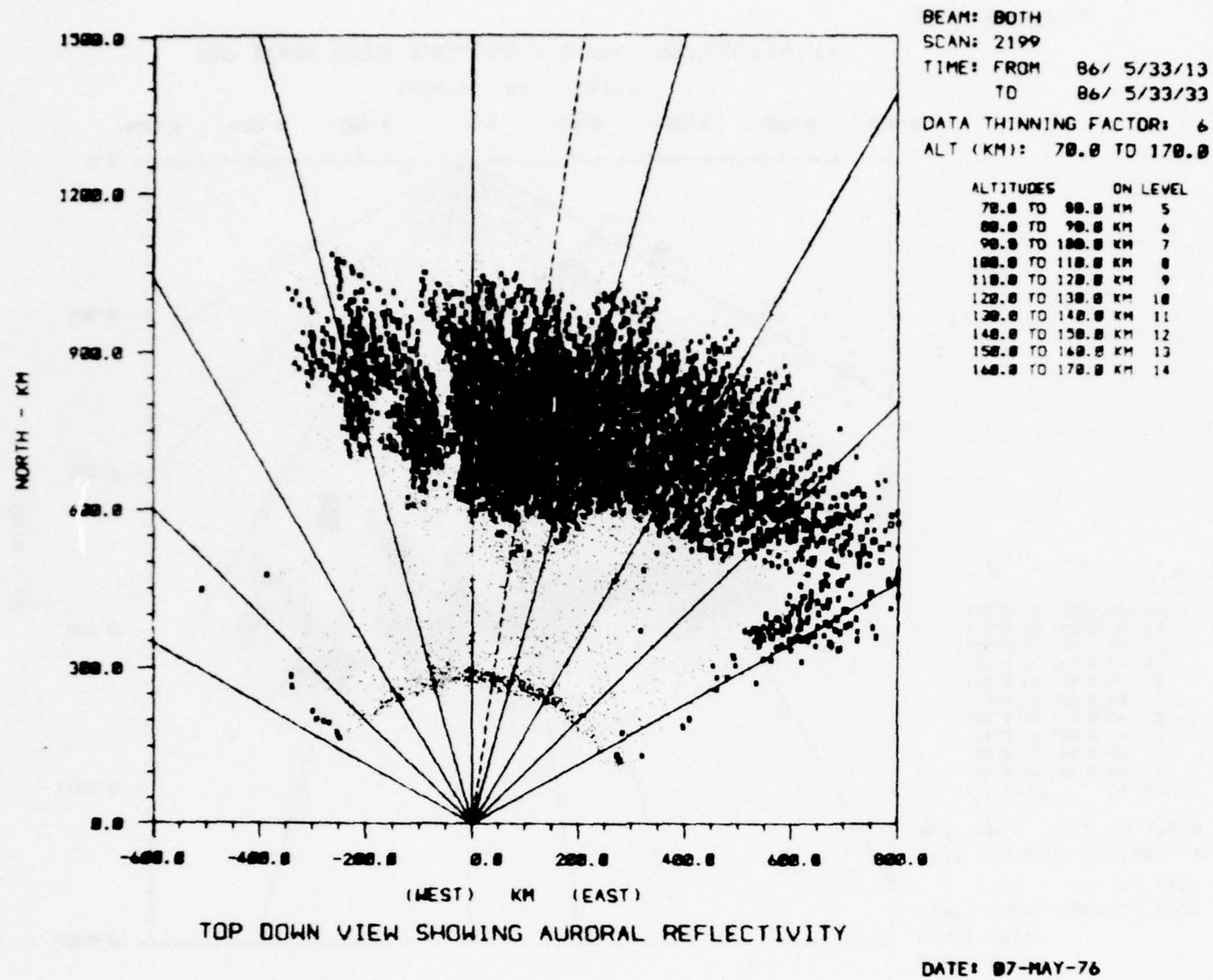

BEAM: BOTH
SCAN: 2199
TIME: FROM 86/ 5/33/13
TO 86/ 5/33/33
DATA THINNING FACTOR: 6
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
NORTH - KM
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
DATE: 07-MAY-76

Figure 2-44

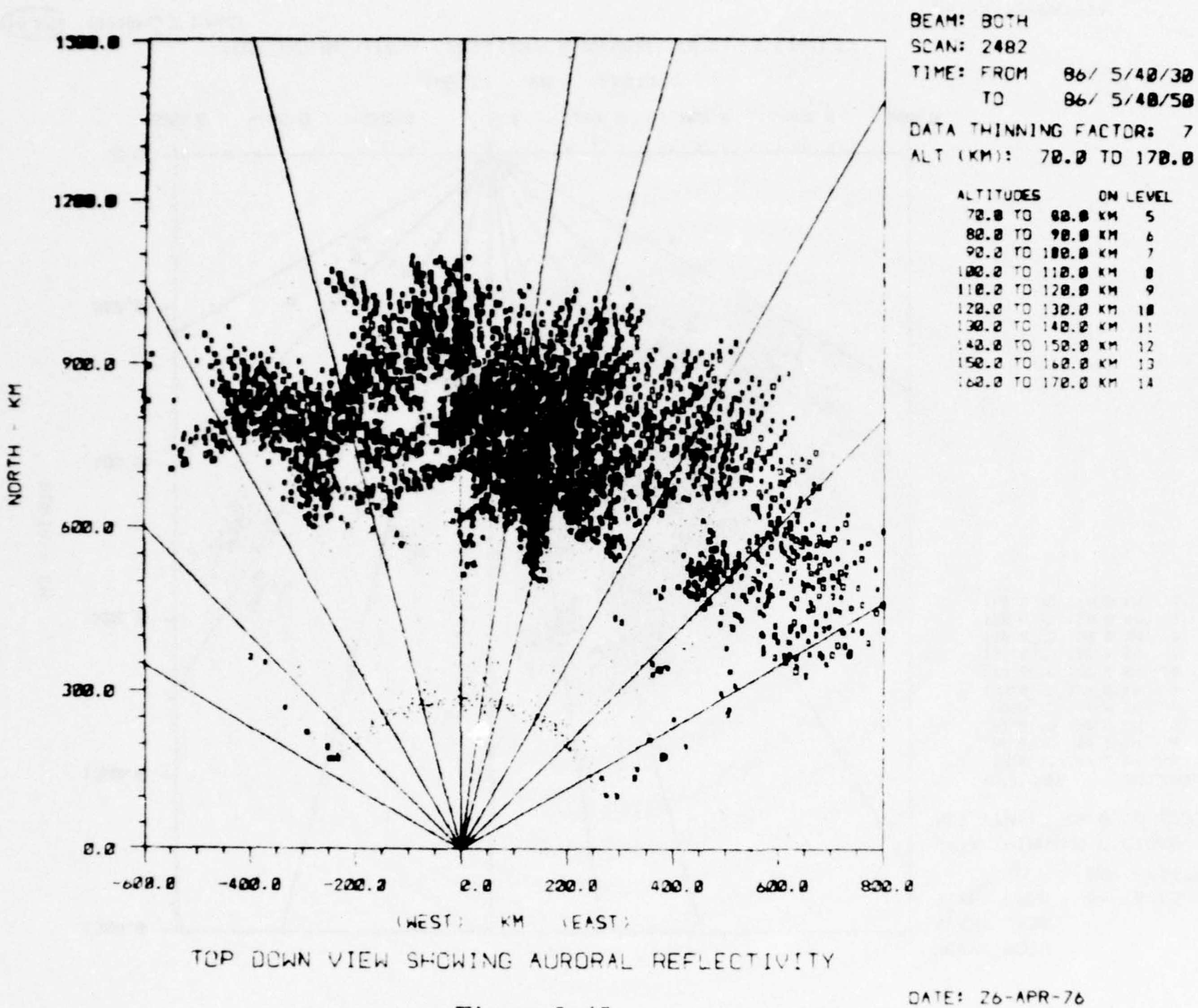

BEAM: BOTH
SCAN: 2482
TIME: FROM 86/ 5/40/30
TO 86/ 5/40/50
DATA THINNING FACTOR: 7
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
NORTH - KM
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
DATE: 26-APR-76

Figure 2-45

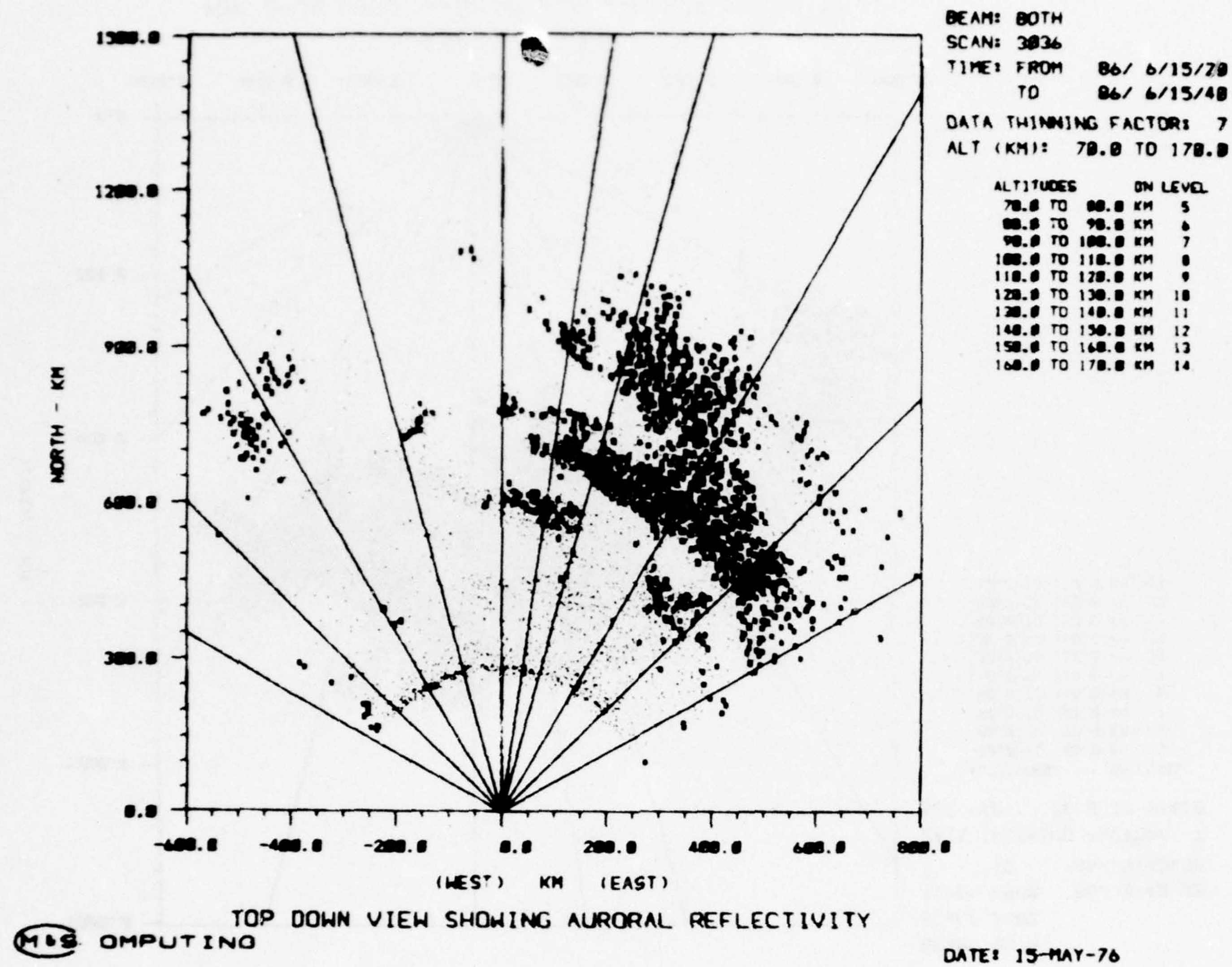

BEAM: BOTH
SCAN: 3036
TIME: FROM 06/ 6/15/20
TO 06/ 6/15/40
DATA THINNING FACTOR: 7
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
NORTH - KM
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTING
DATE: 15-MAY-76

Figure 2-46

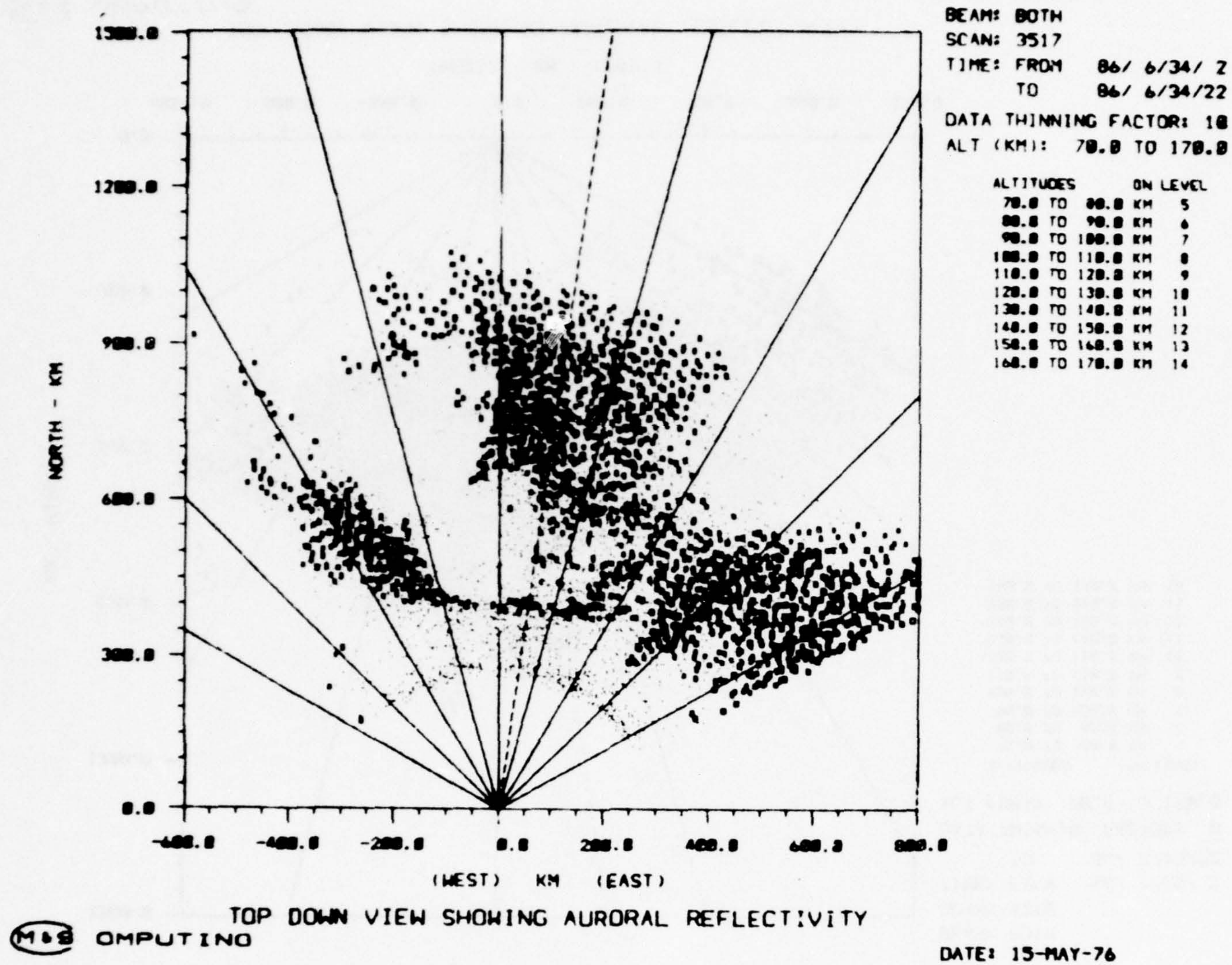

BEAM: BOTH
SCAN: 3517
TIME: FROM 86/ 6/34/ 2
TO 86/ 6/34/22
DATA THINNING FACTOR: 10
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
NORTH - KM
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTINO
DATE: 15-MAY-76

Figure 2-47

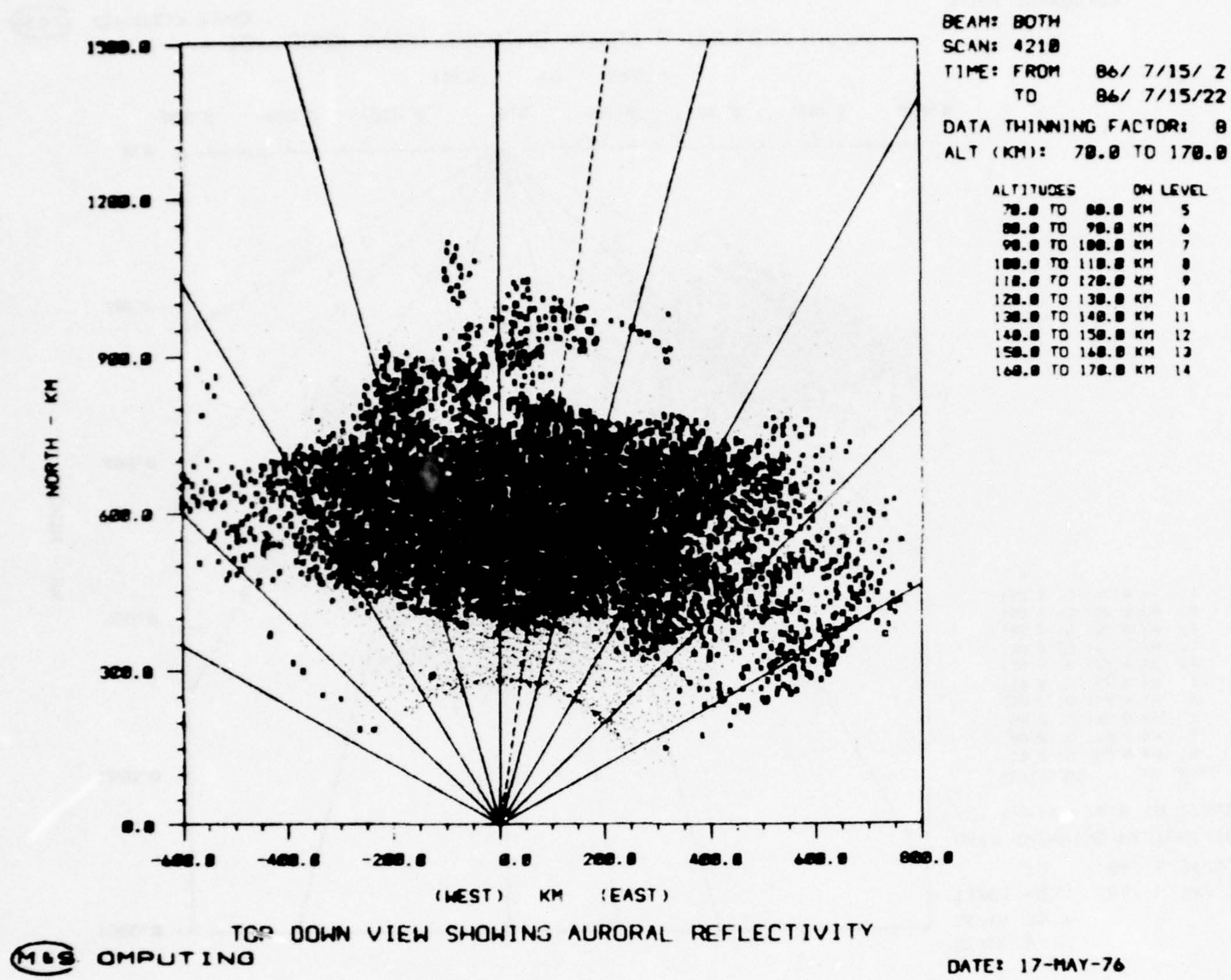

BEAM: BOTH
SCAN: 4210
TIME: FROM 86/ 7/15/ 2
TO 86/ 7/15/22
DATA THINNING FACTOR: 8
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
NORTH - KM
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTING
DATE: 17-MAY-76

Figure 2-48

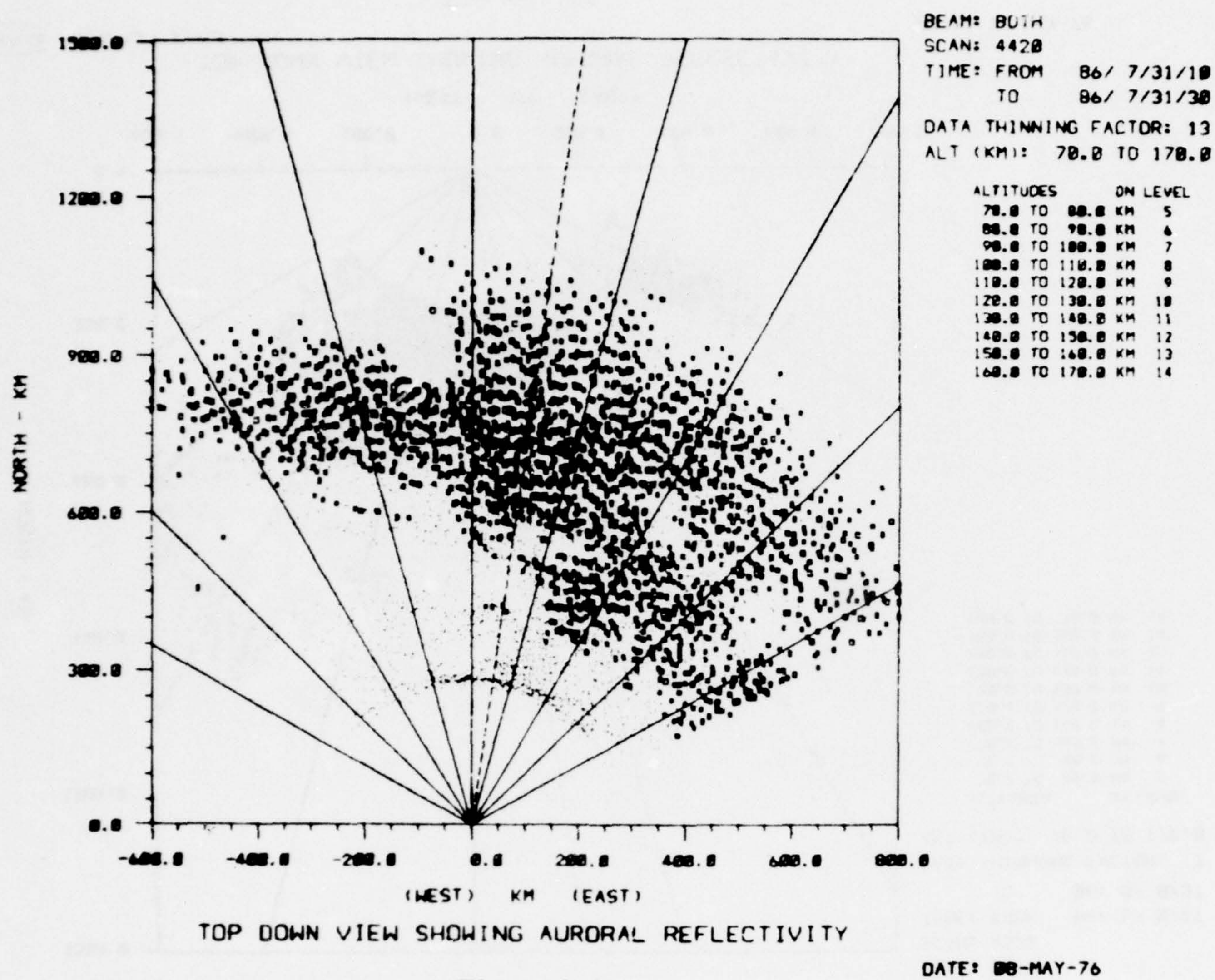

BEAM: BOTH
SCAN: 4420
TIME: FROM 86/ 7/31/10
TO 86/ 7/31/30
DATA THINNING FACTOR: 13
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
NORTH - KM
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
DATE: 08-MAY-76

Figure 2-49

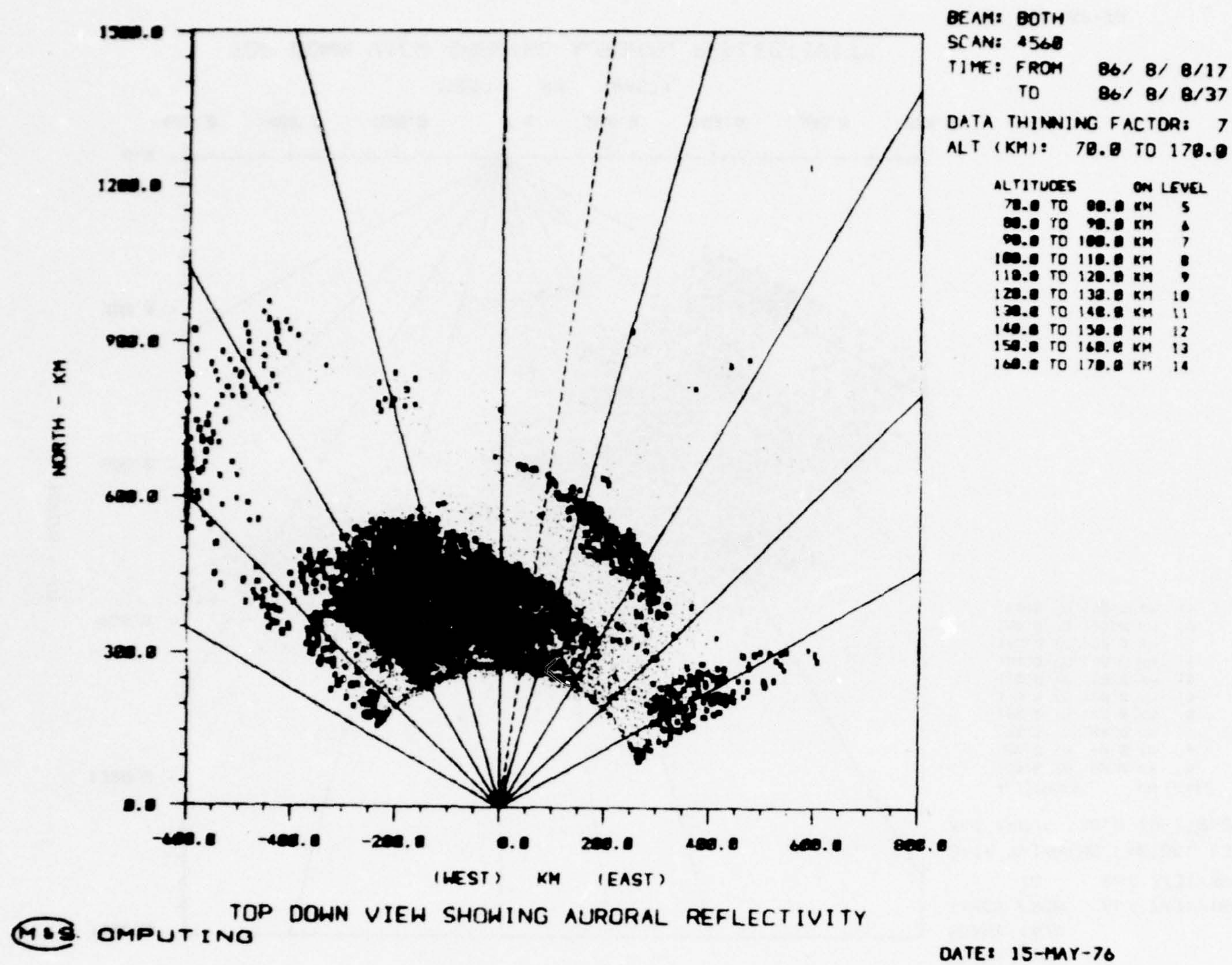

1500.0
1200.0
900.0
600.0
300.0
0.0
NORTH - KM
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
M&S OMPUTING
BEAM: BOTH
SCAN: 4560
TIME: FROM 86/ 8/ 8/17
TO 86/ 8/ 8/37
DATA THINNING FACTOR: 7
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
DATE: 15-MAY-76

Figure 2-50

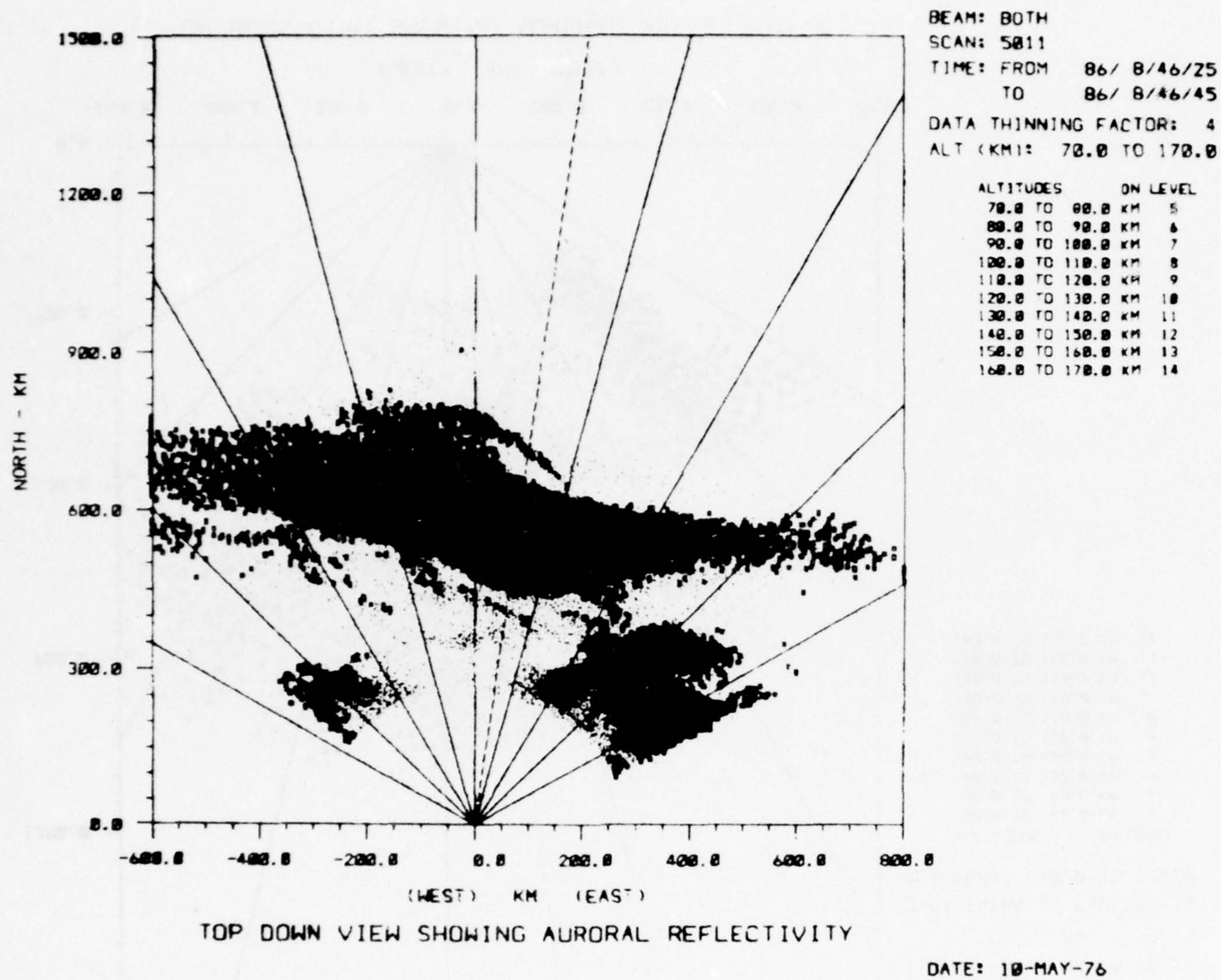
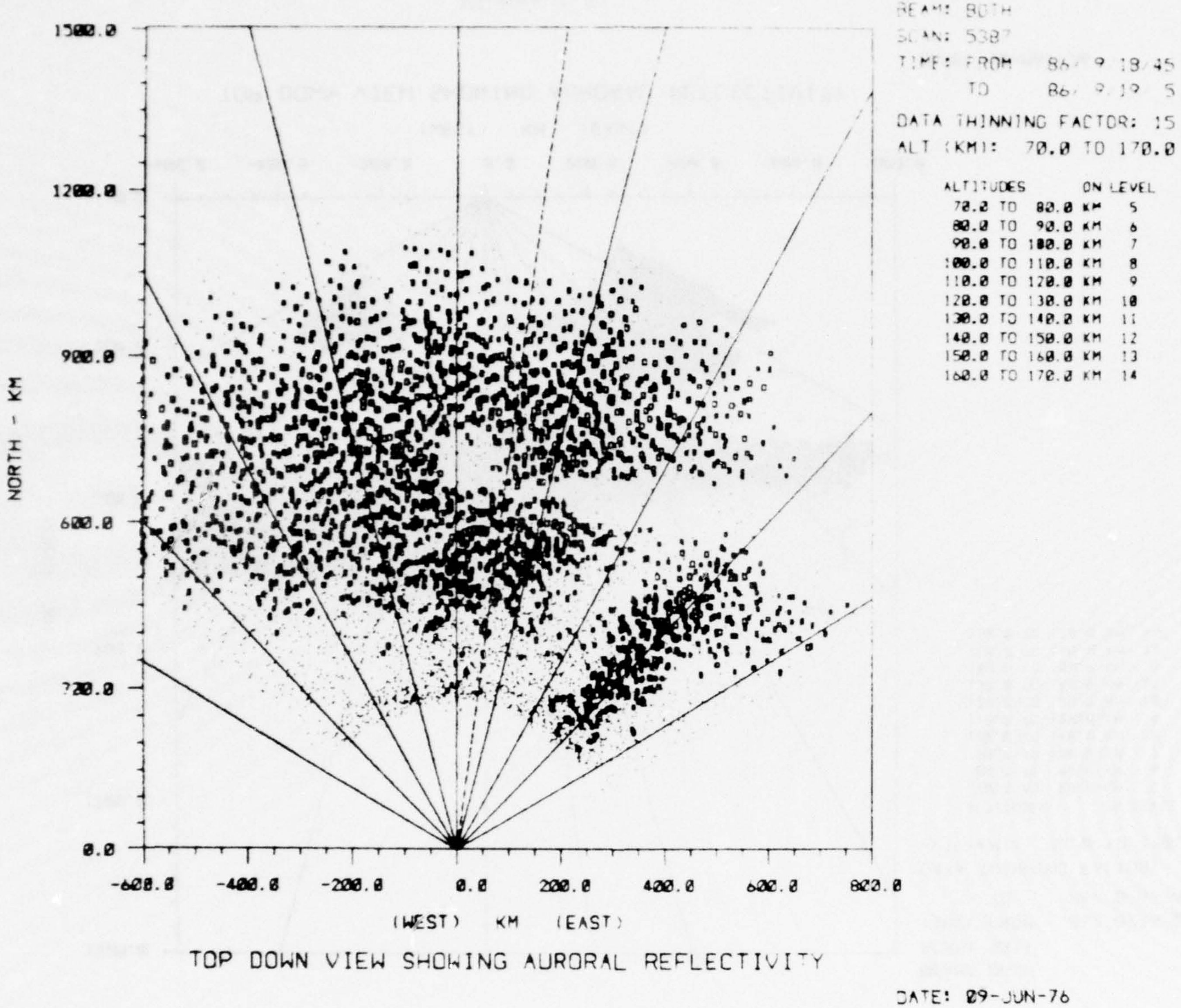
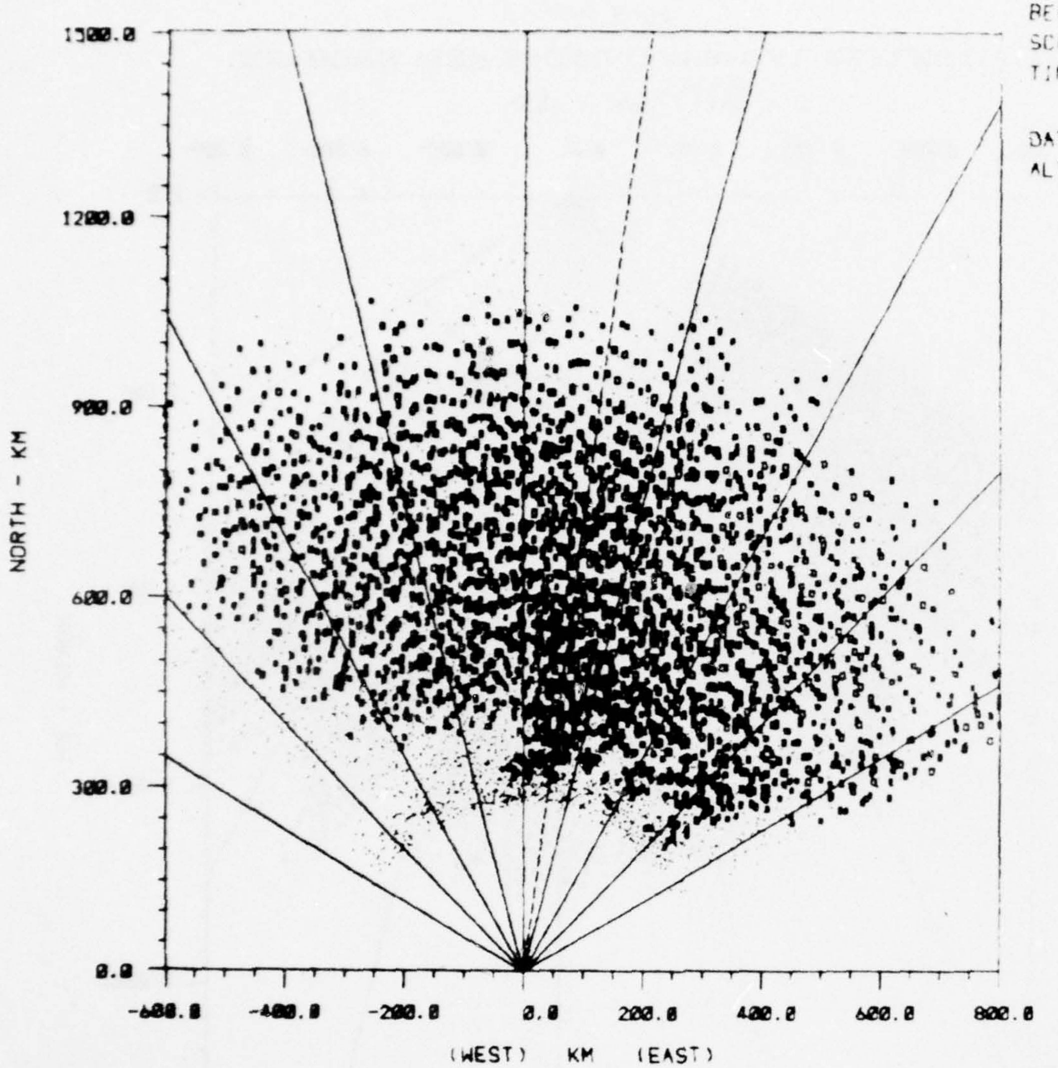

BEAM: BOTH
SCAN: 5011
TIME: FROM 86/ 8/46/25
TO 86/ 8/46/45
DATA THINNING FACTOR: 4
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TC 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
NORTH - KM
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
DATE: 10-MAY-76

Figure 2-51



BEAM: BOTH
SCAN: 5387
TIME: FROM 86/ 9.18/45
TO 86/ 9.19/ 5
DATA THINNING FACTOR: 15
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
NORTH - KM
1500.0
1200.0
900.0
600.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
DATE: 09-JUN-76

Figure 2-52



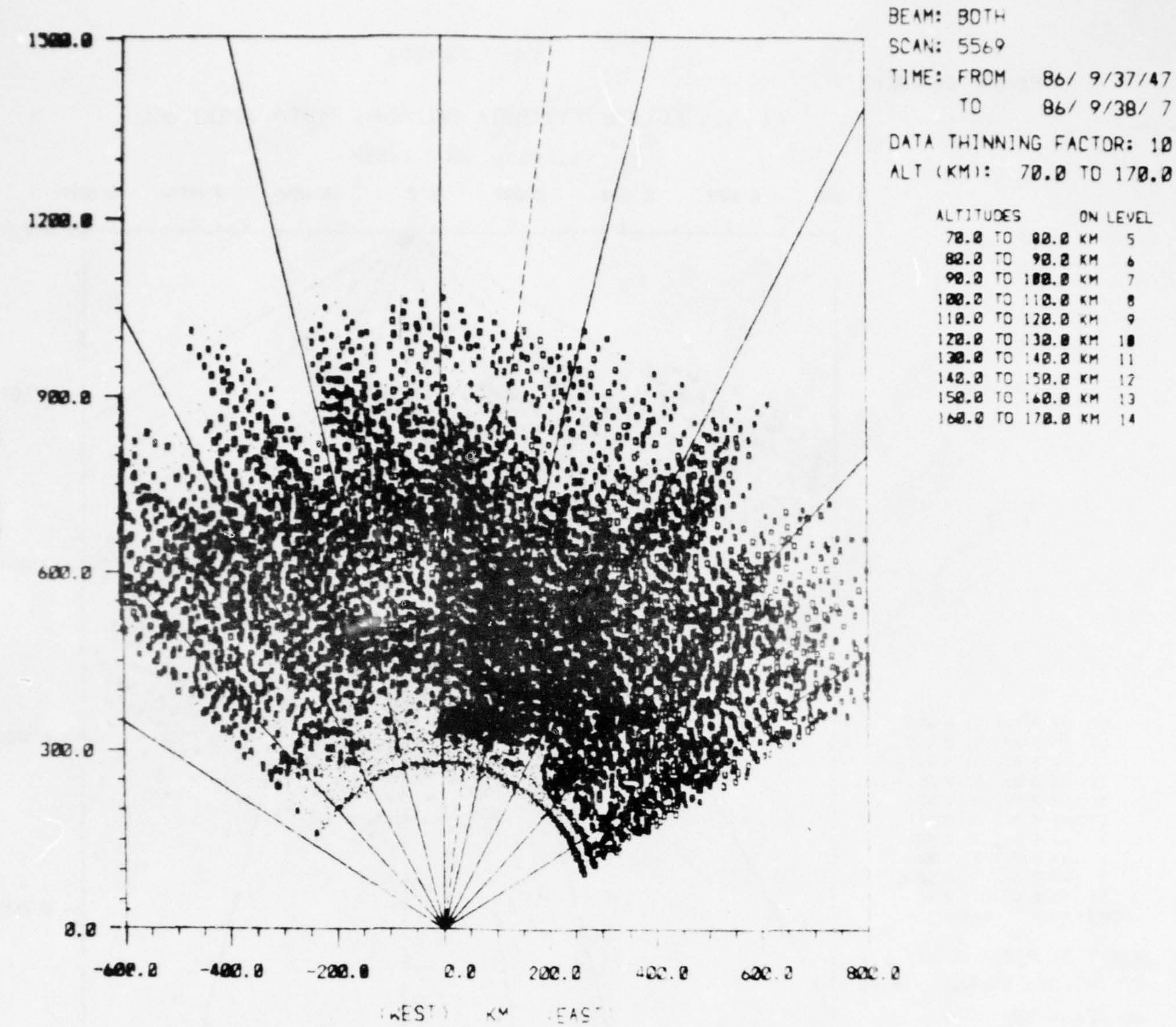
BEAM: BOTH
SCAN: 5558
TIME: FROM 86/ 9/32/37
TO 86/ 9/32/57
DATA THINNING FACTOR: 18
ALT (KM): 70.0 TO 170.0

ALTITUDES	ON LEVEL
70.0 TO 80.0 KM	5
80.0 TO 90.0 KM	6
90.0 TO 100.0 KM	7
100.0 TO 110.0 KM	8
110.0 TO 120.0 KM	9
120.0 TO 130.0 KM	10
130.0 TO 140.0 KM	11
140.0 TO 150.0 KM	12
150.0 TO 160.0 KM	13
160.0 TO 170.0 KM	14

TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

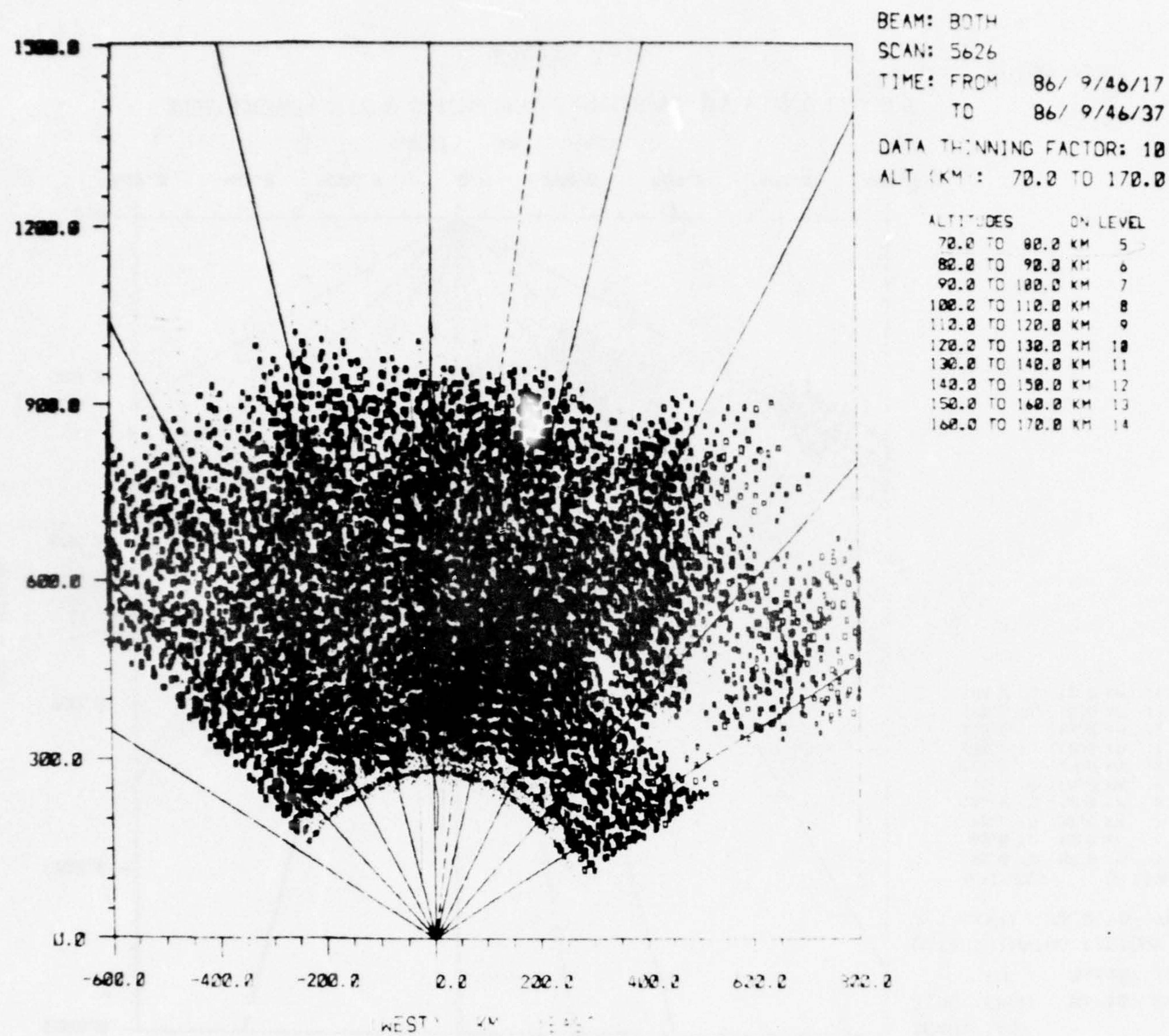
DATE: 09-JUN-76

Figure 2-53

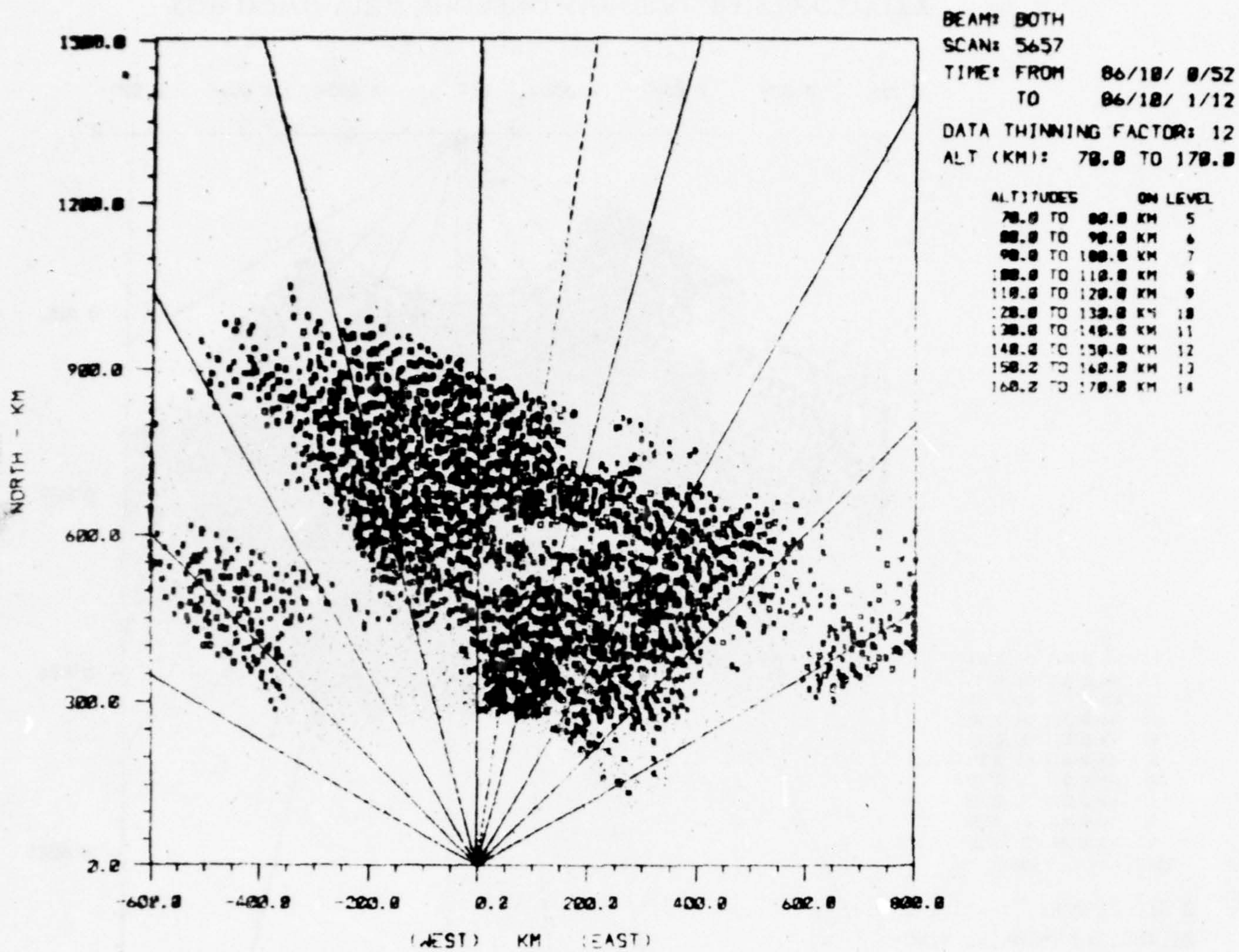


TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-54



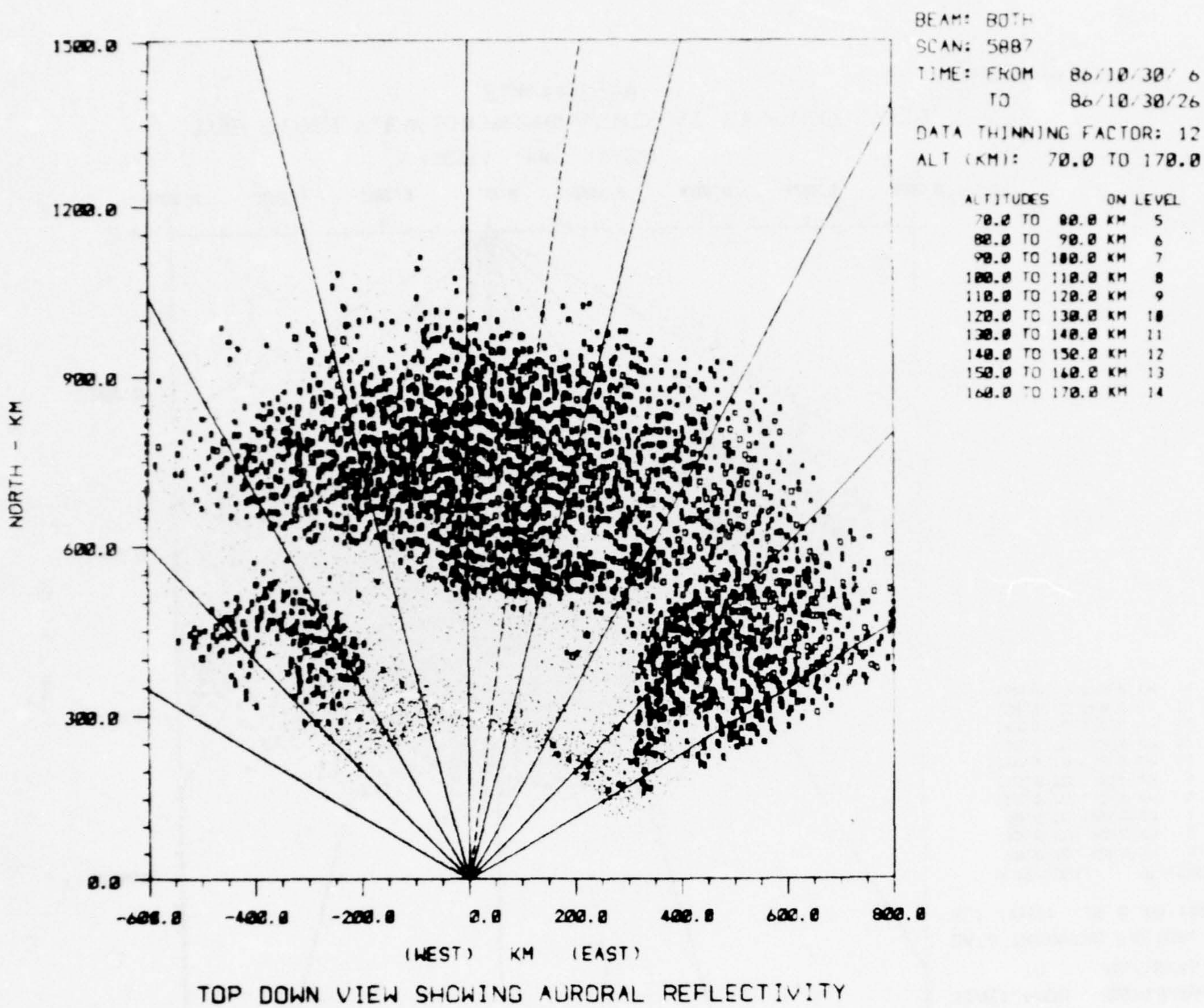
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
Figure 2-55



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

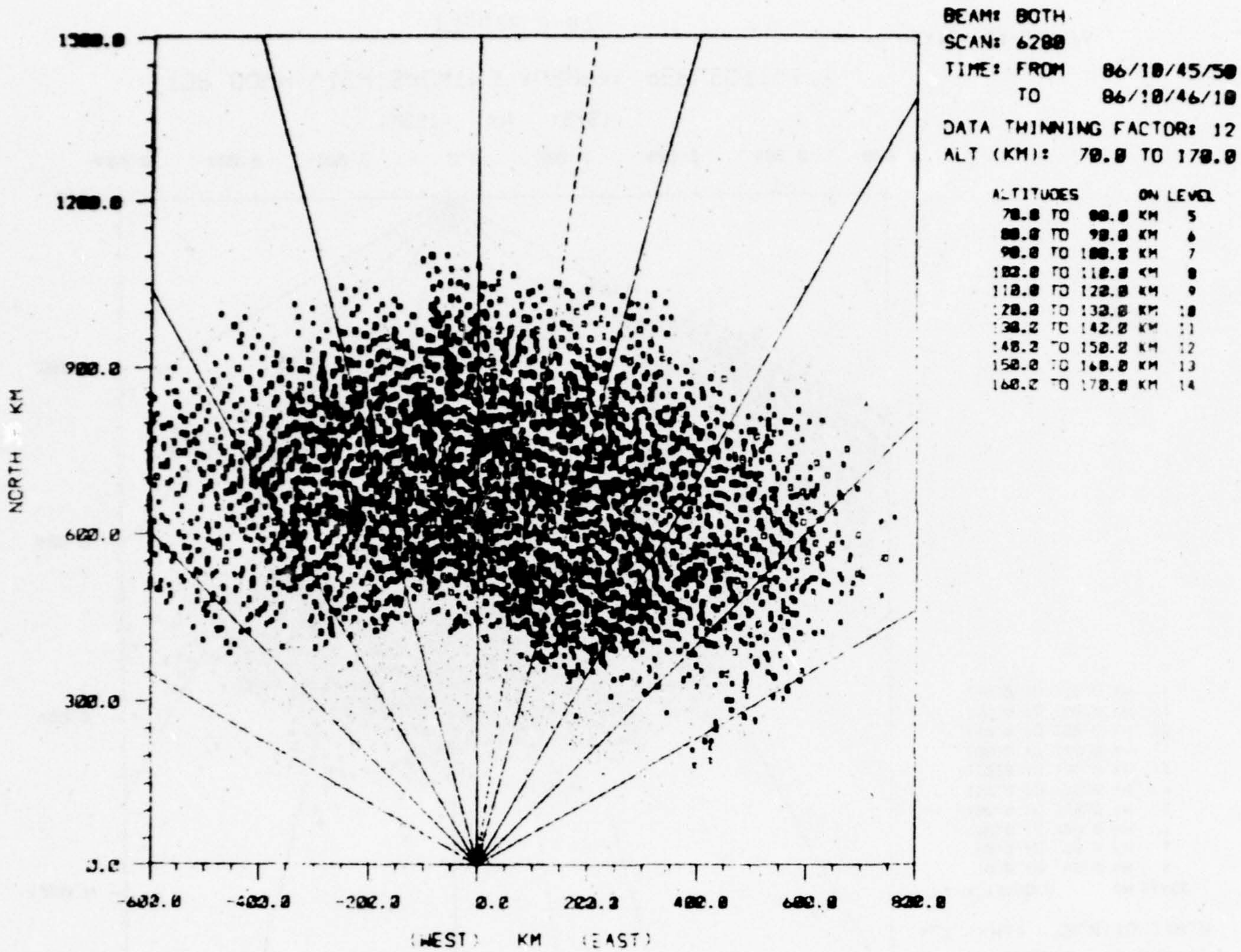
DATE: 24-MAY-76

Figure 2-56



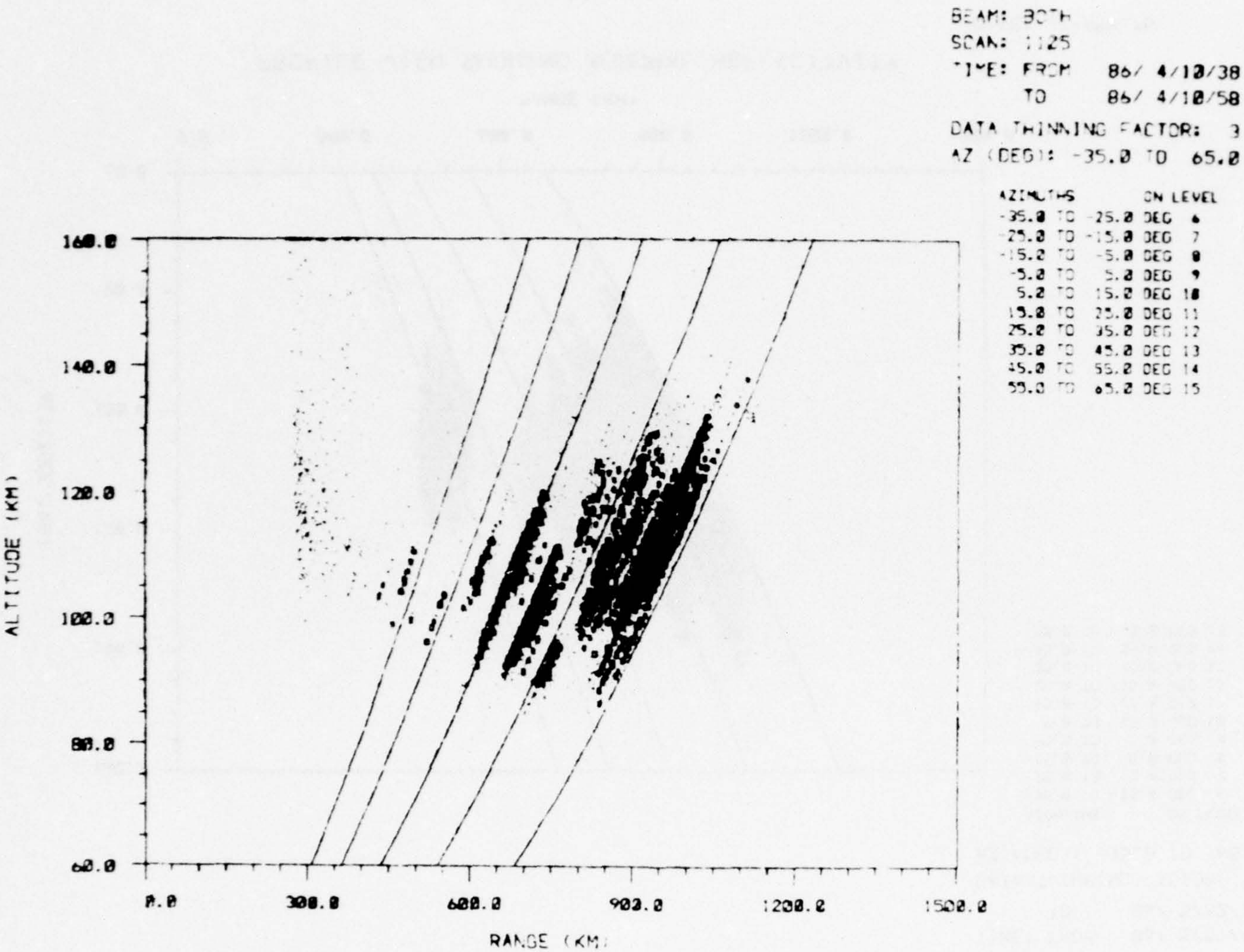
1500.0
1200.0
900.0
600.0
300.0
0.0
NORTH - KM
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
BEAM: BOTH
SCAN: 5887
TIME: FROM 86/10/30/ 6
TO 86/10/30/26
DATA THINNING FACTOR: 12
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
DATE: 09-JUN-76

Figure 2-57



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY
Figure 2-58

DATE: 24-MAY-76



PROFILE VIEW OF AURORA PHENOMENA AT PAR

DATE: 19-MAY-76

Figure 2-59

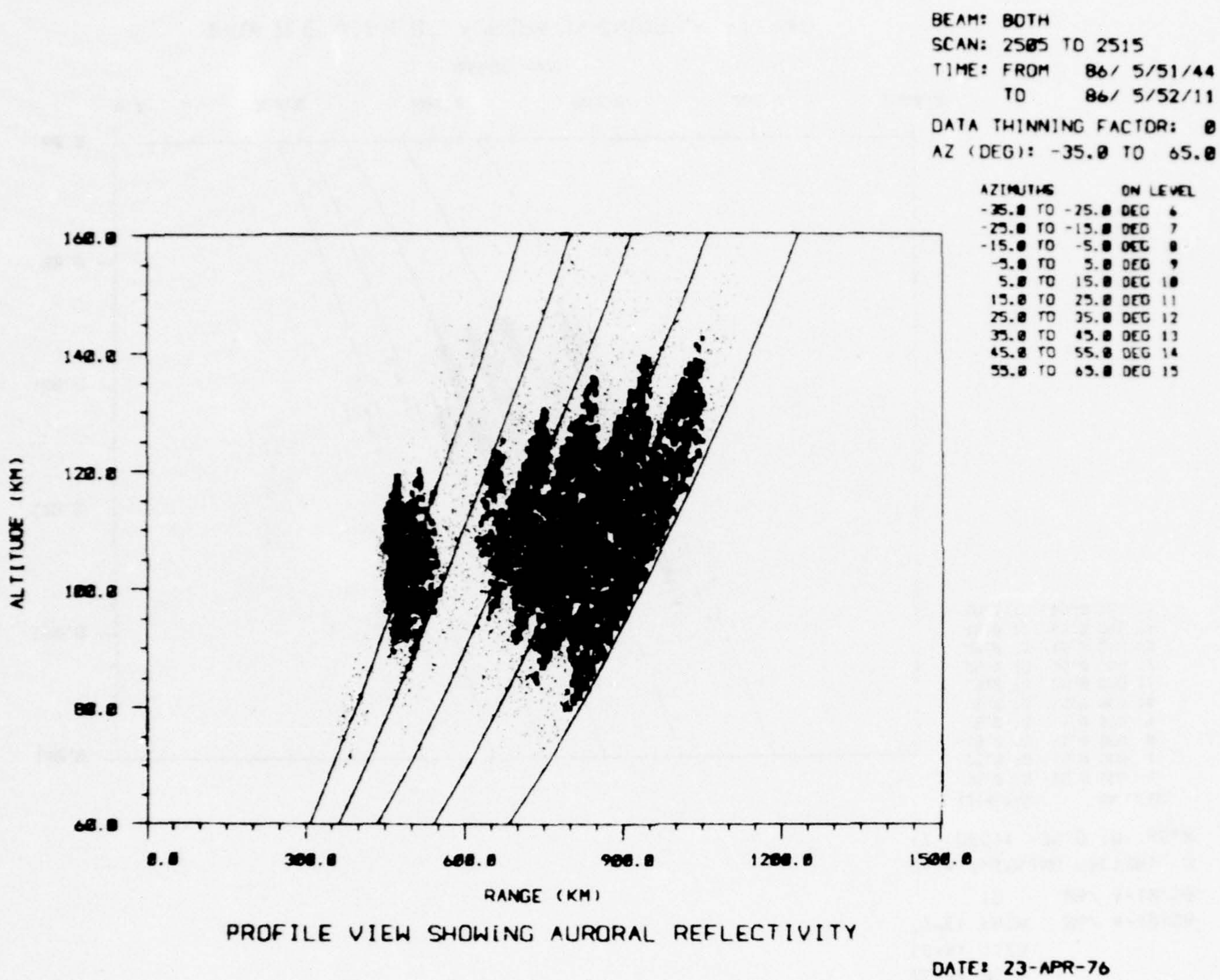
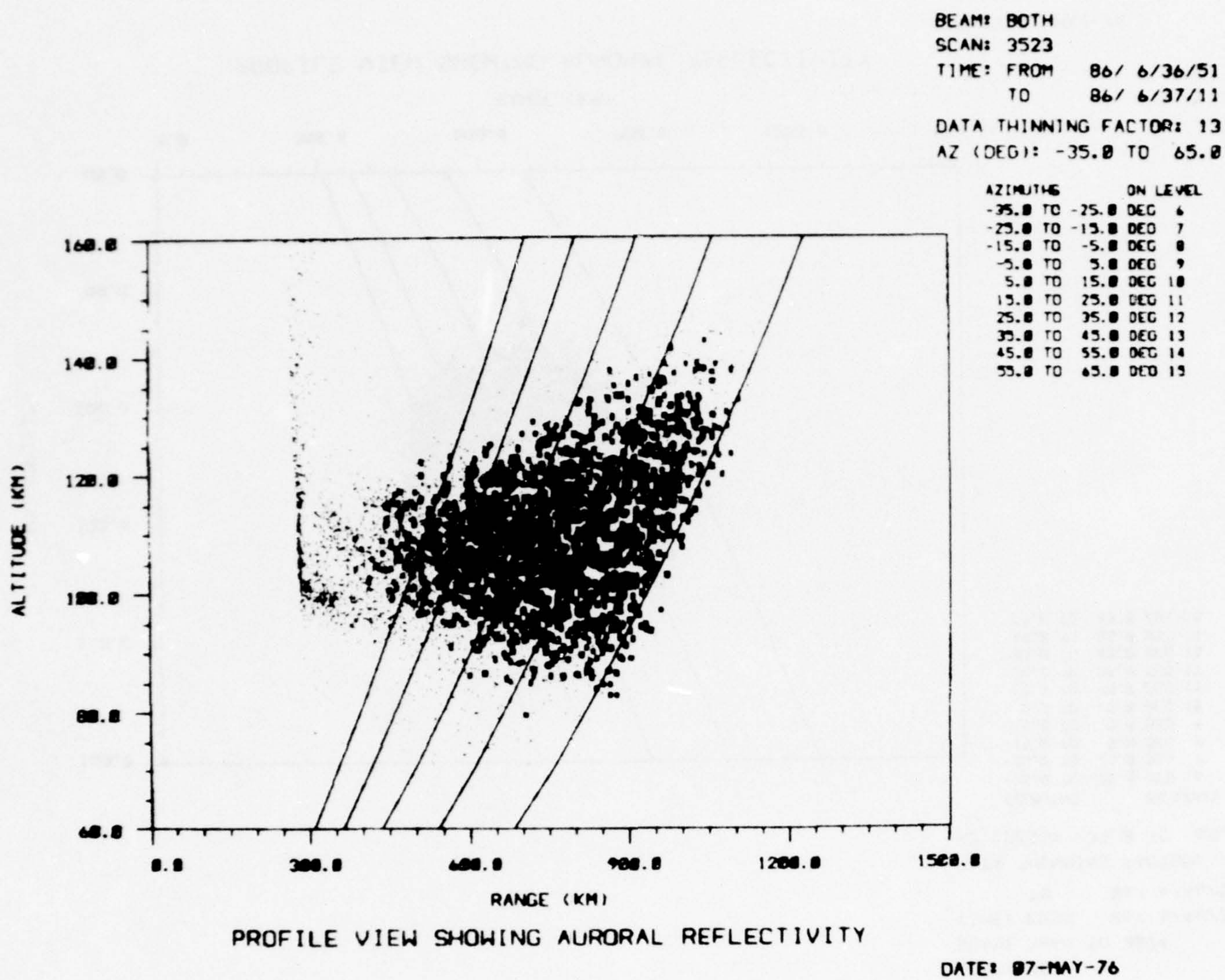

BEAM: BOTH
SCAN: 2505 TO 2515
TIME: FROM 86/ 5/51/44
TO 86/ 5/52/11
DATA THINNING FACTOR: 0
AZ (DEG): -35.0 TO 65.0
AZIMUTHS ON LEVEL
-35.0 TO -25.0 DEG 6
-25.0 TO -15.0 DEG 7
-15.0 TO -5.0 DEG 8
-5.0 TO 5.0 DEG 9
5.0 TO 15.0 DEG 10
15.0 TO 25.0 DEG 11
25.0 TO 35.0 DEG 12
35.0 TO 45.0 DEG 13
45.0 TO 55.0 DEG 14
55.0 TO 65.0 DEG 15
ALTITUDE (KM)
160.0
140.0
120.0
100.0
80.0
60.0
0.0
300.0
600.0
900.0
1200.0
1500.0
RANGE (KM)
PROFILE VIEW SHOWING AURORAL REFLECTIVITY
DATE: 23-APR-76

Figure 2-60



BEAM: BOTH
SCAN: 3523
TIME: FROM 86/ 6/36/51
TO 86/ 6/37/11
DATA THINNING FACTOR: 13
AZ (DEG): -35.0 TO 65.0
AZIMUTHS ON LEVEL
-35.0 TO -25.0 DEG 6
-25.0 TO -15.0 DEG 7
-15.0 TO -5.0 DEG 8
-5.0 TO 5.0 DEG 9
5.0 TO 15.0 DEG 10
15.0 TO 25.0 DEG 11
25.0 TO 35.0 DEG 12
35.0 TO 45.0 DEG 13
45.0 TO 55.0 DEG 14
55.0 TO 65.0 DEG 15
160.0
140.0
120.0
100.0
80.0
60.0
ALTITUDE (KM)
0.0
300.0
600.0
900.0
1200.0
1500.0
RANGE (KM)
PROFILE VIEW SHOWING AURORAL REFLECTIVITY
DATE: 07-MAY-76

Figure 2-61

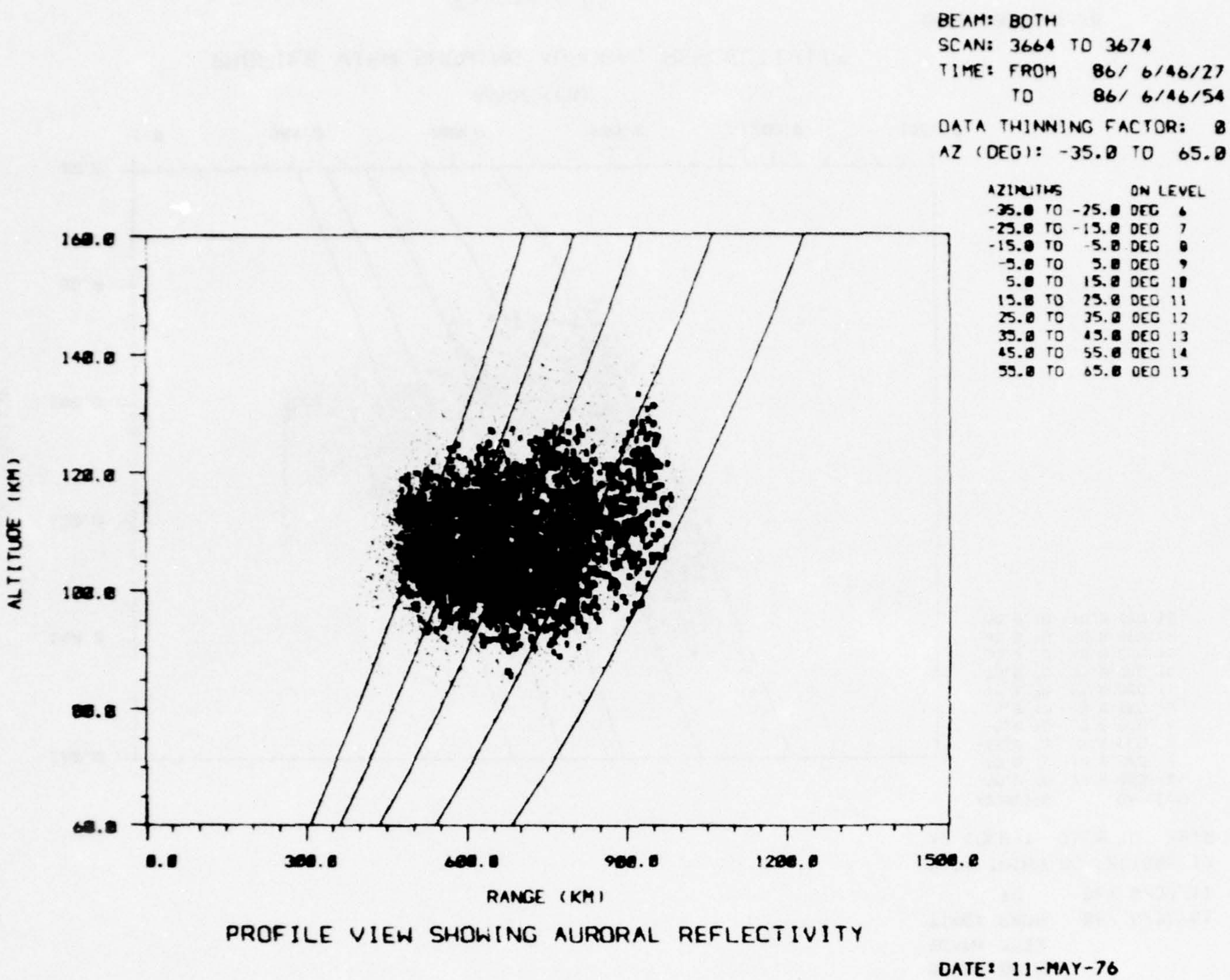
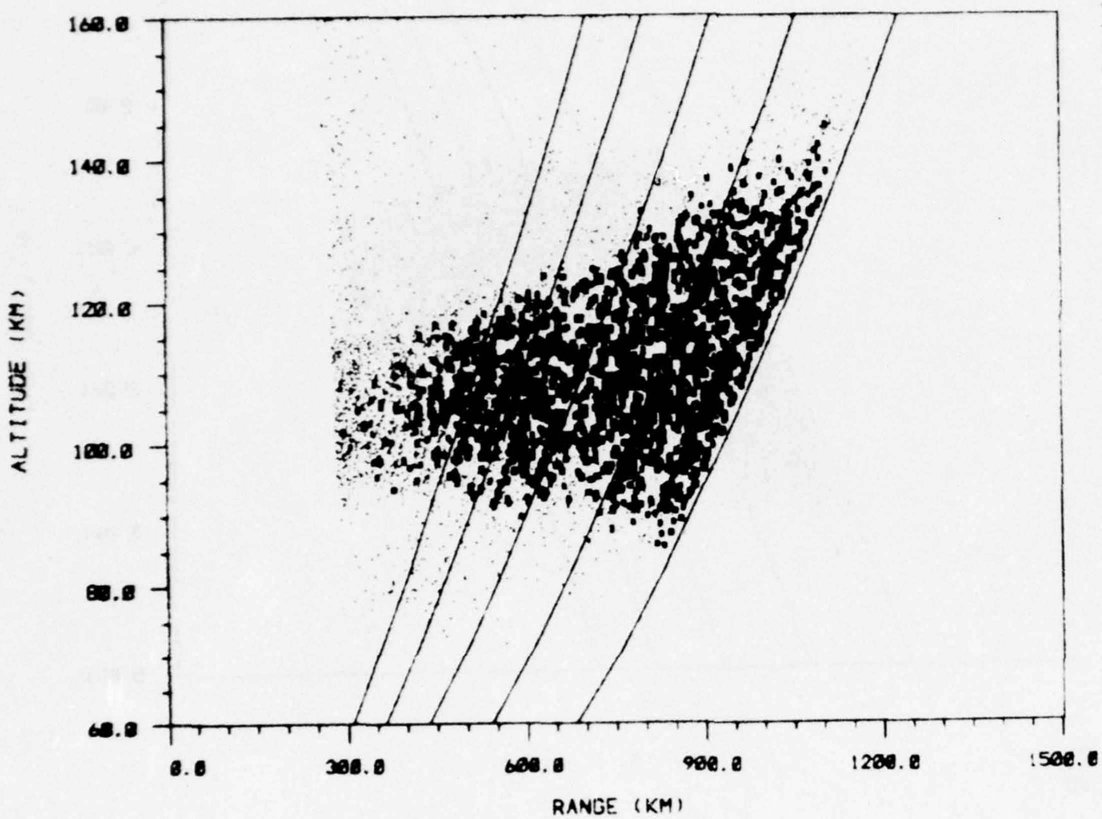

BEAM: BOTH
SCAN: 3664 TO 3674
TIME: FROM 86/ 6/46/27
TO 86/ 6/46/54
DATA THINNING FACTOR: 0
AZ (DEG): -35.0 TO 65.0
AZIMUTHS ON LEVEL
-35.0 TO -25.0 DEG 6
-25.0 TO -15.0 DEG 7
-15.0 TO -5.0 DEG 8
-5.0 TO 5.0 DEG 9
5.0 TO 15.0 DEG 10
15.0 TO 25.0 DEG 11
25.0 TO 35.0 DEG 12
35.0 TO 45.0 DEG 13
45.0 TO 55.0 DEG 14
55.0 TO 65.0 DEG 15
160.0
140.0
120.0
100.0
80.0
60.0
ALTITUDE (KM)
0.0
300.0
600.0
900.0
1200.0
1500.0
RANGE (KM)
PROFILE VIEW SHOWING AURORAL REFLECTIVITY
DATE: 11-MAY-76

Figure 2-62

BEAM: BOTH
SCAN: 5387
TIME: FROM 86/ 9/18/45
TO 86/ 9/19/ 5
DATA THINNING FACTOR: 15
AZ (DEG): -60.0 TO 40.0

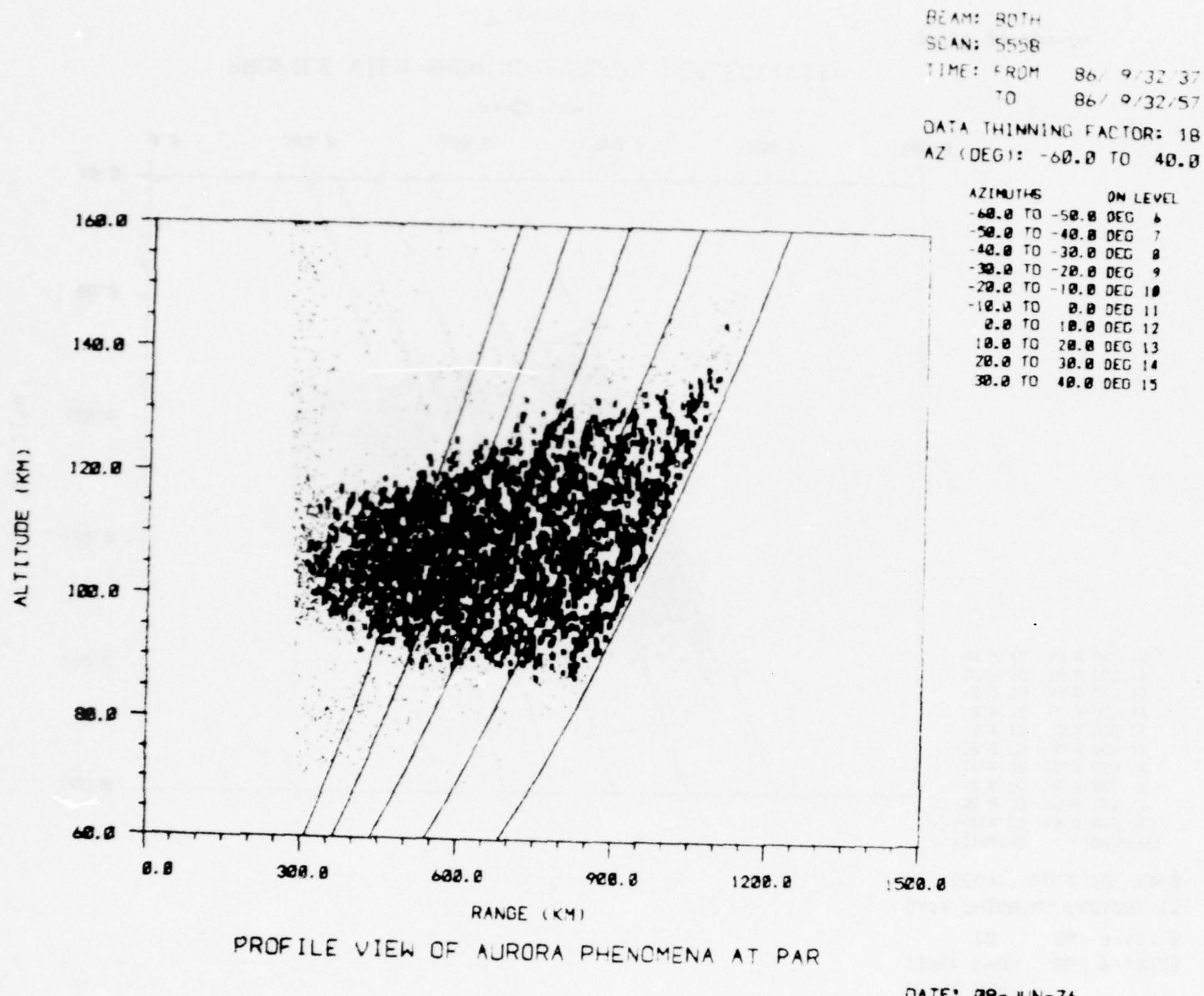
AZIMUTHS		ON LEVEL
-60.0 TO -50.0	DEG	6
-50.0 TO -40.0	DEG	7
-40.0 TO -30.0	DEG	8
-30.0 TO -20.0	DEG	9
-20.0 TO -10.0	DEG	10
-10.0 TO 0.0	DEG	11
0.0 TO 10.0	DEG	12
10.0 TO 20.0	DEG	13
20.0 TO 30.0	DEG	14
30.0 TO 40.0	DEG	15



PROFILE VIEW SHOWING AURORAL REFLECTIVITY

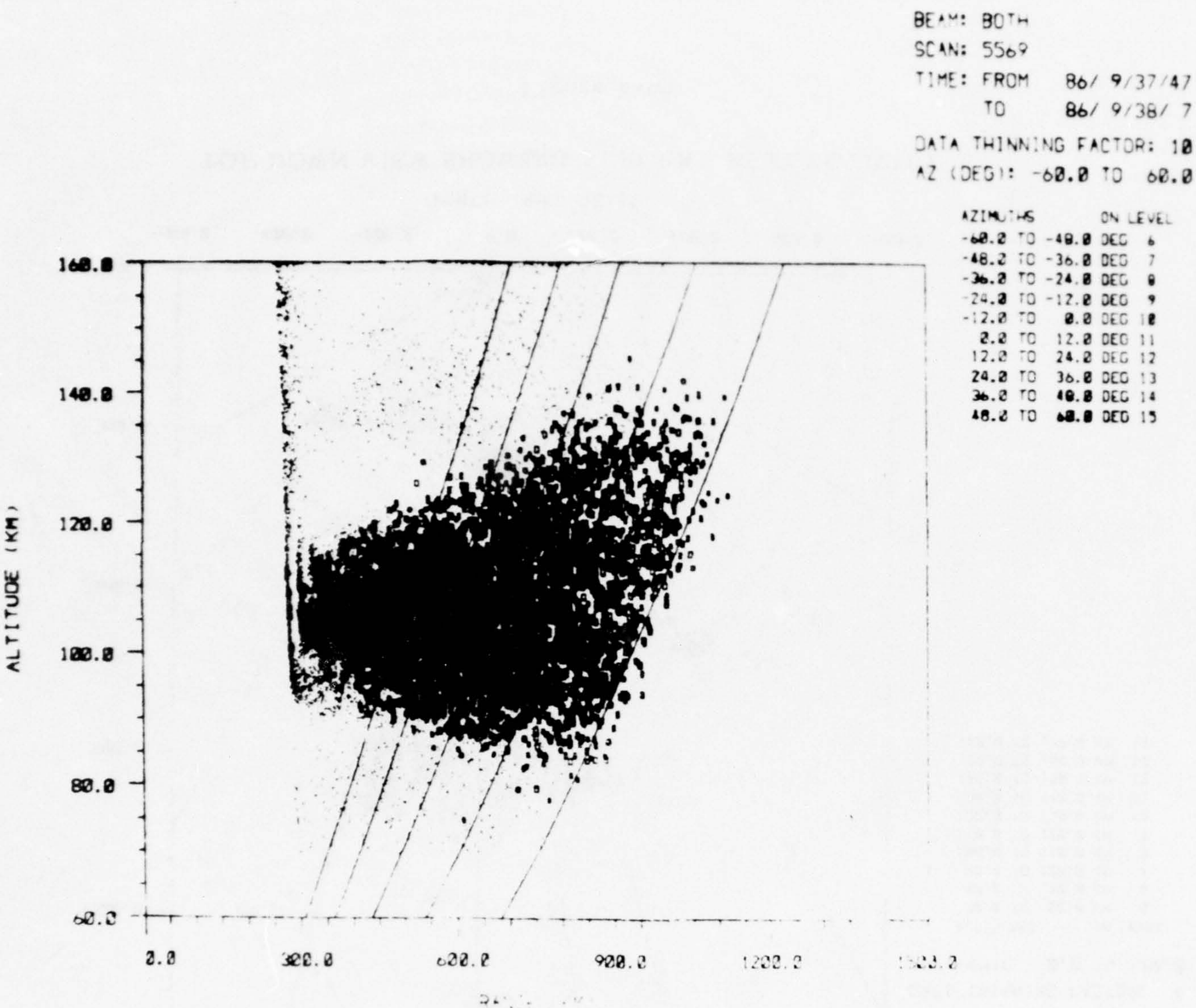
DATE: 08-JUN-76

Figure 2-63



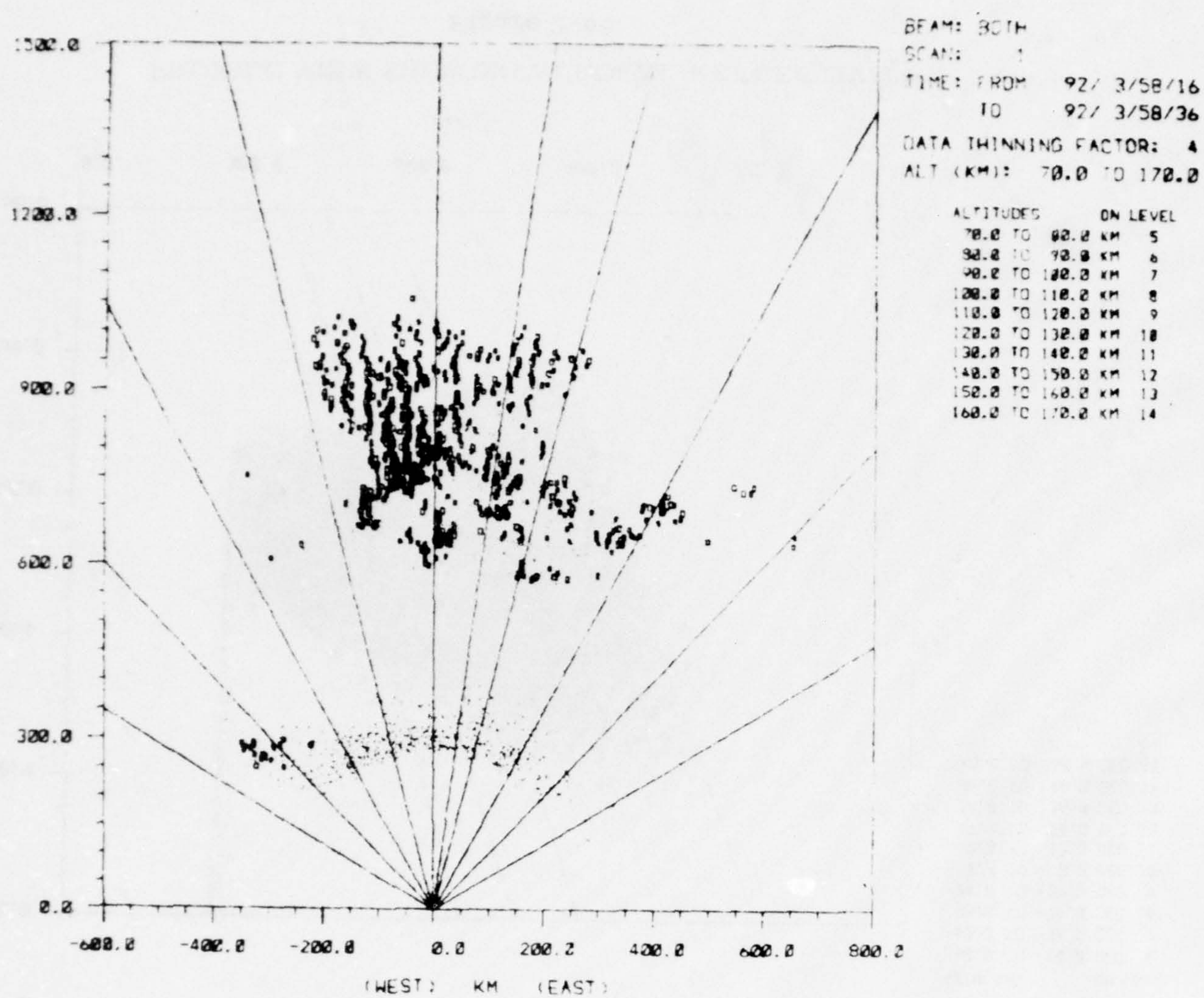
BEAM: BOTH
SCAN: 555B
TIME: FROM 86/ 9/32/37
TO 86/ 9/32/57
DATA THINNING FACTOR: 18
AZ (DEG): -60.0 TO 40.0
AZIMUTHS ON LEVEL
-60.0 TO -50.0 DEG 6
-50.0 TO -40.0 DEG 7
-40.0 TO -30.0 DEG 8
-30.0 TO -20.0 DEG 9
-20.0 TO -10.0 DEG 10
-10.0 TO 0.0 DEG 11
0.0 TO 10.0 DEG 12
10.0 TO 20.0 DEG 13
20.0 TO 30.0 DEG 14
30.0 TO 40.0 DEG 15
ALTITUDE (KM)
160.0
140.0
120.0
100.0
80.0
60.0
0.0
300.0
600.0
900.0
1200.0
1500.0
RANGE (KM)
PROFILE VIEW OF AURORA PHENOMENA AT PAR
DATE: 08-JUN-76

Figure 2-64



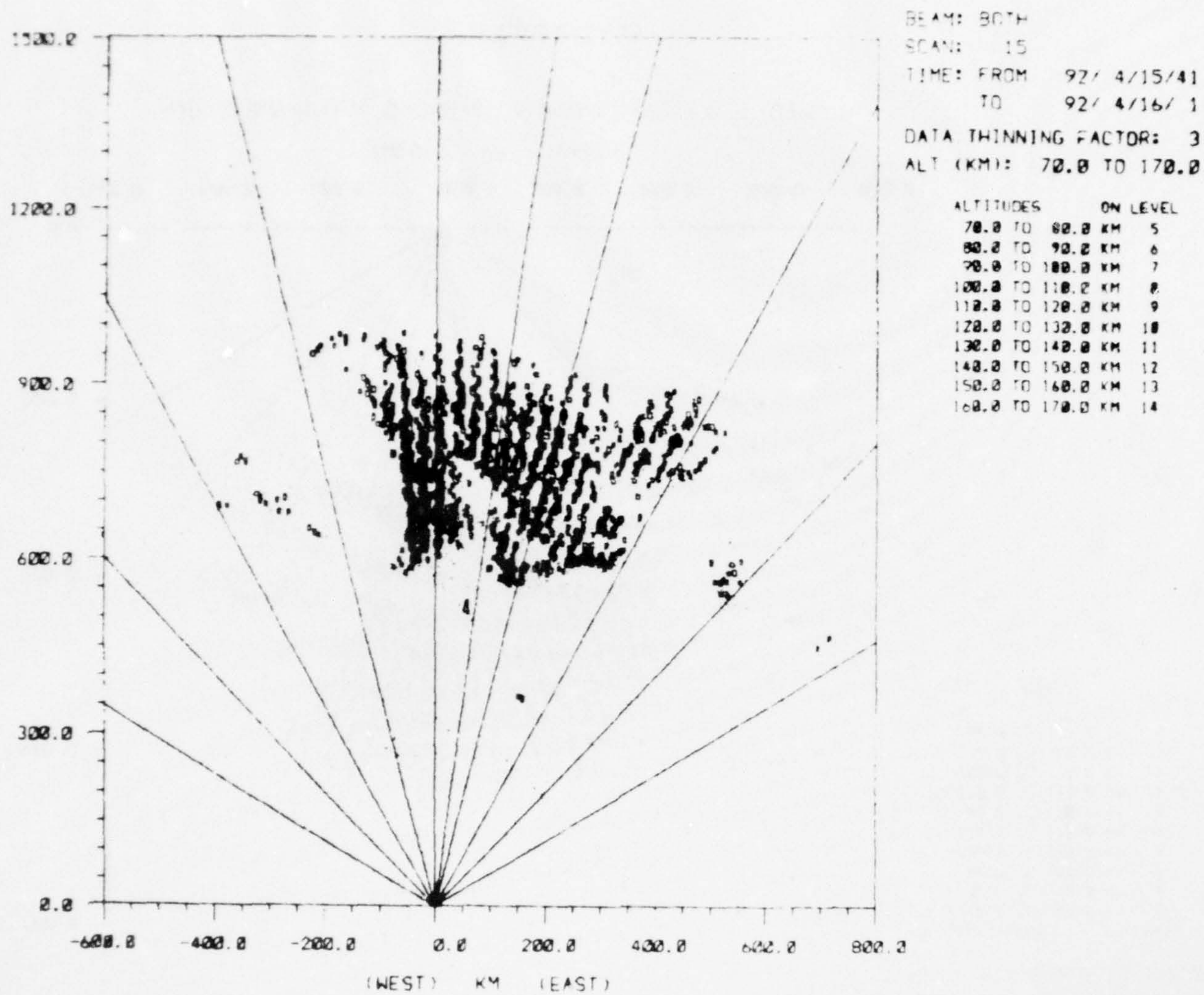
PROFILE VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-65



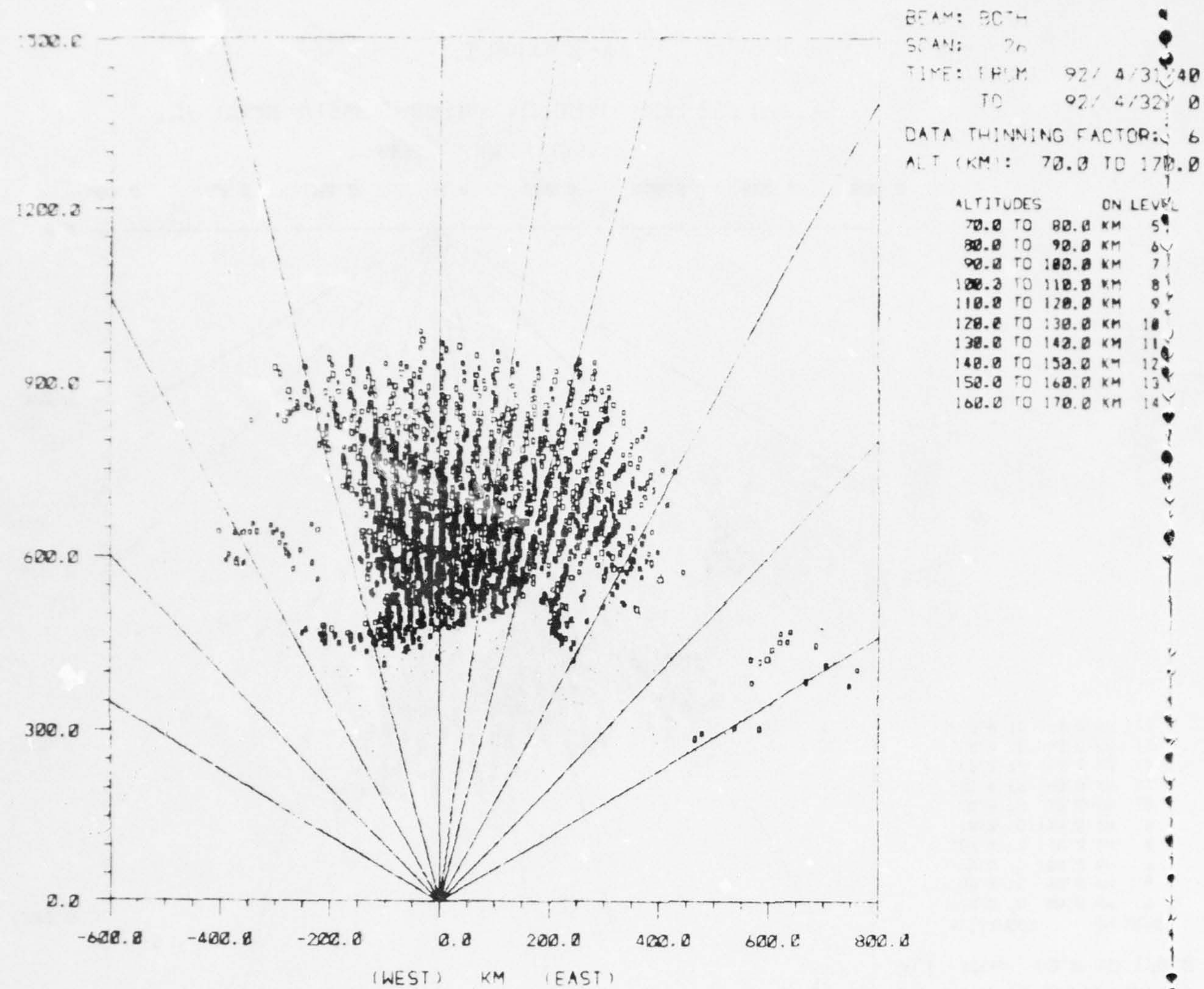
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-66



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-67



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-68

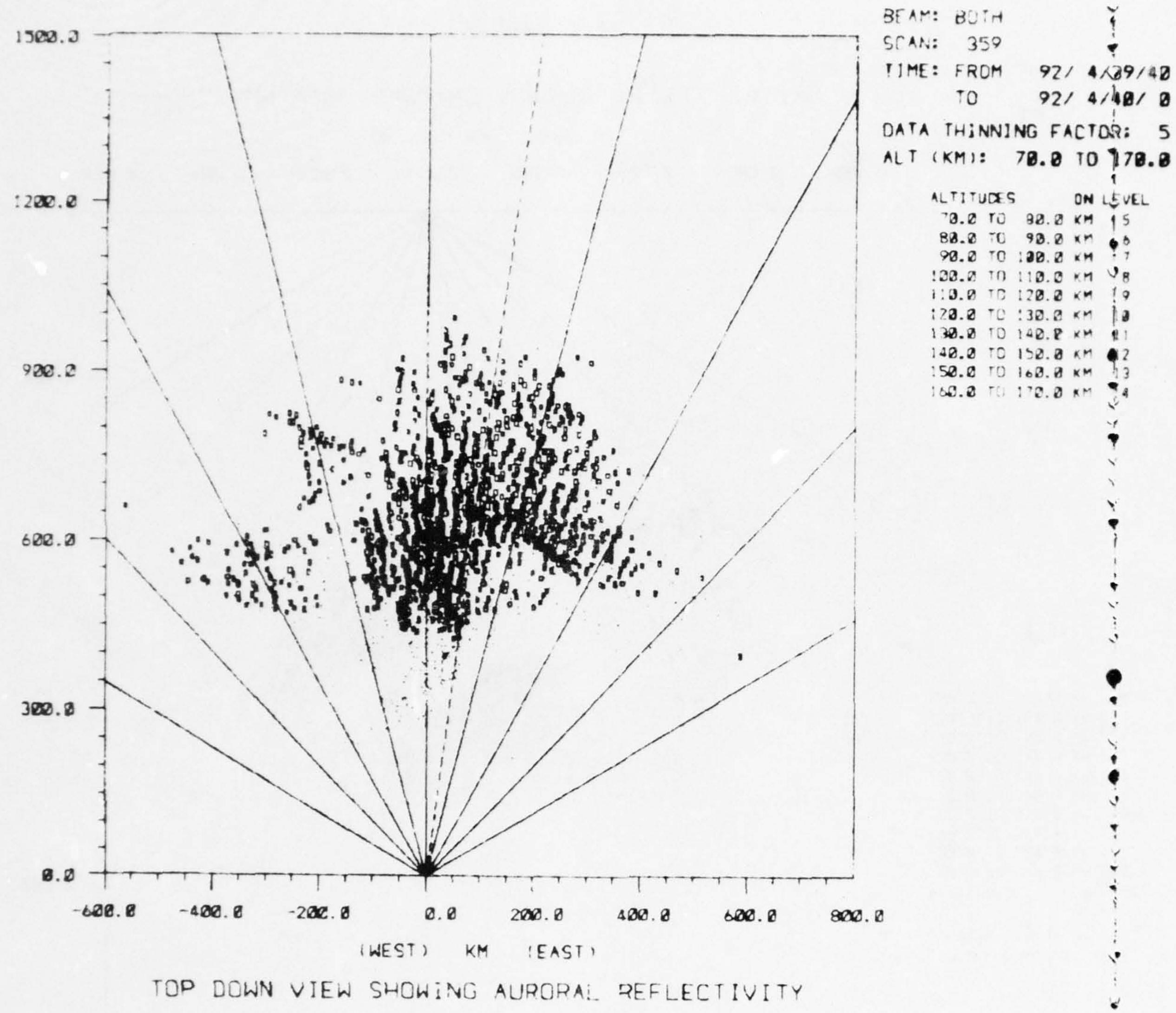
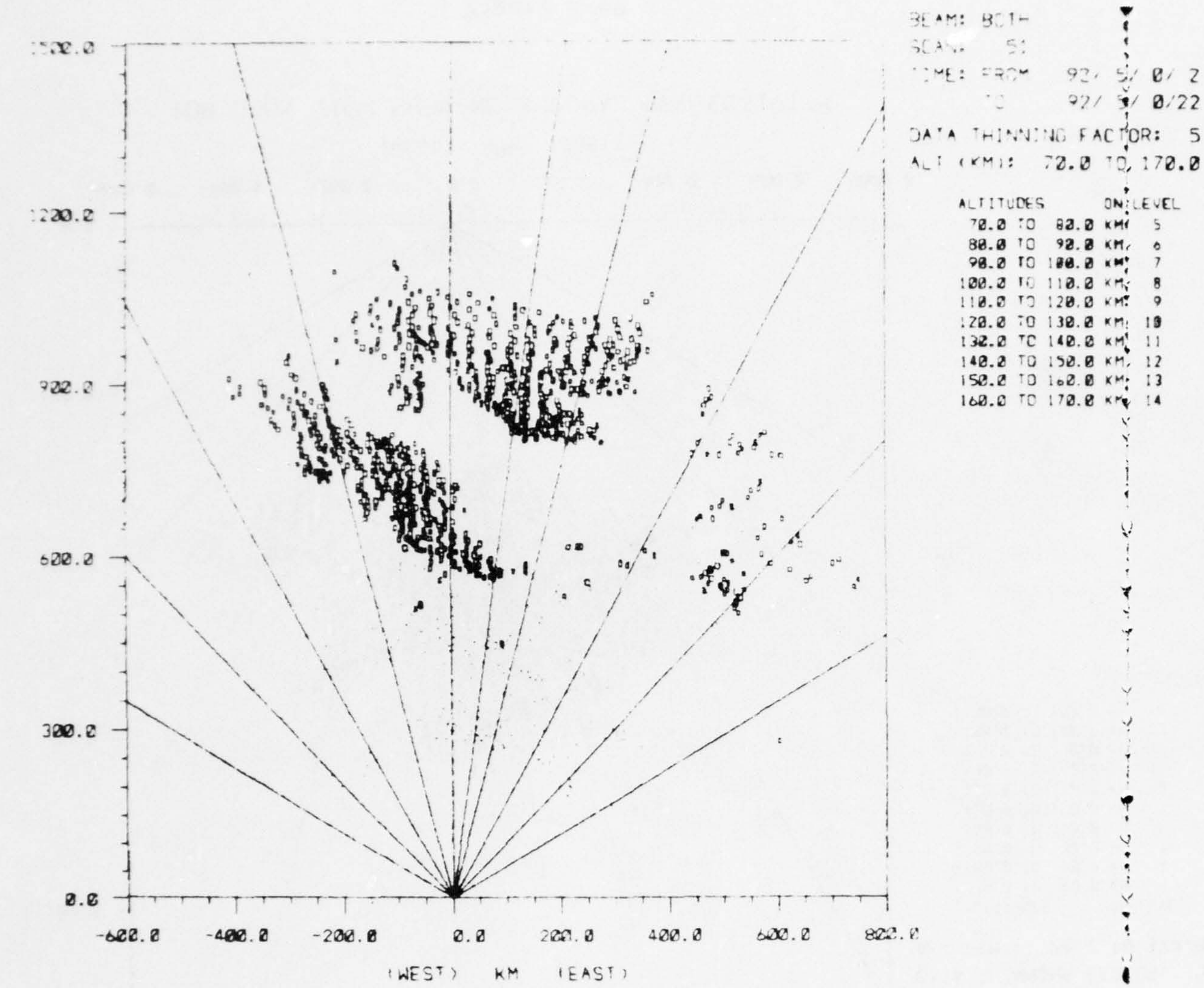
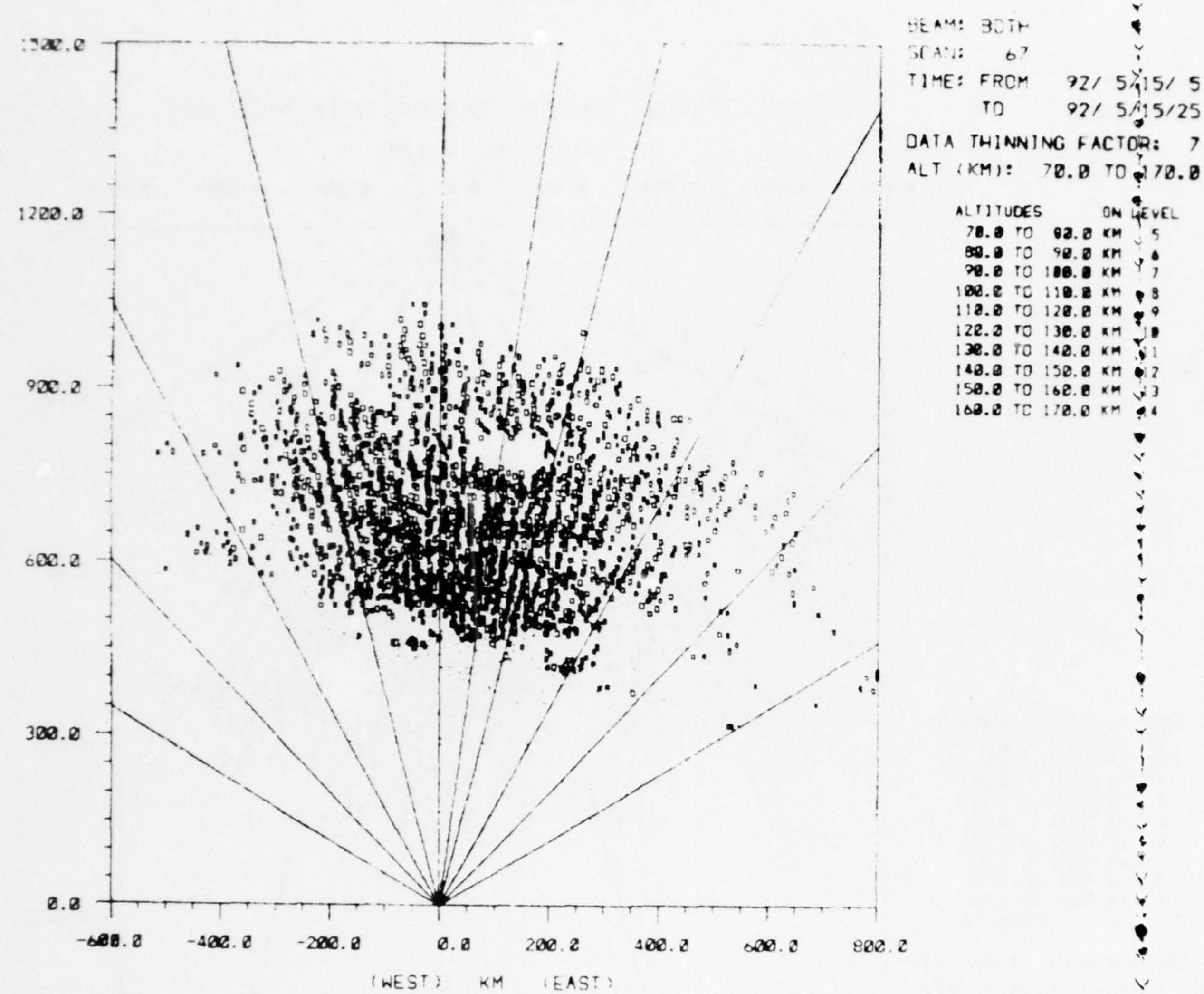

BEAM: BOTH
SCAN: 359
TIME: FROM 92/ 4/39/40
TO 92/ 4/40/ 0
DATA THINNING FACTOR: 5
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM
80.0 TO 90.0 KM
90.0 TO 100.0 KM
100.0 TO 110.0 KM
110.0 TO 120.0 KM
120.0 TO 130.0 KM
130.0 TO 140.0 KM
140.0 TO 150.0 KM
150.0 TO 160.0 KM
160.0 TO 170.0 KM
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-69



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-70



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-71

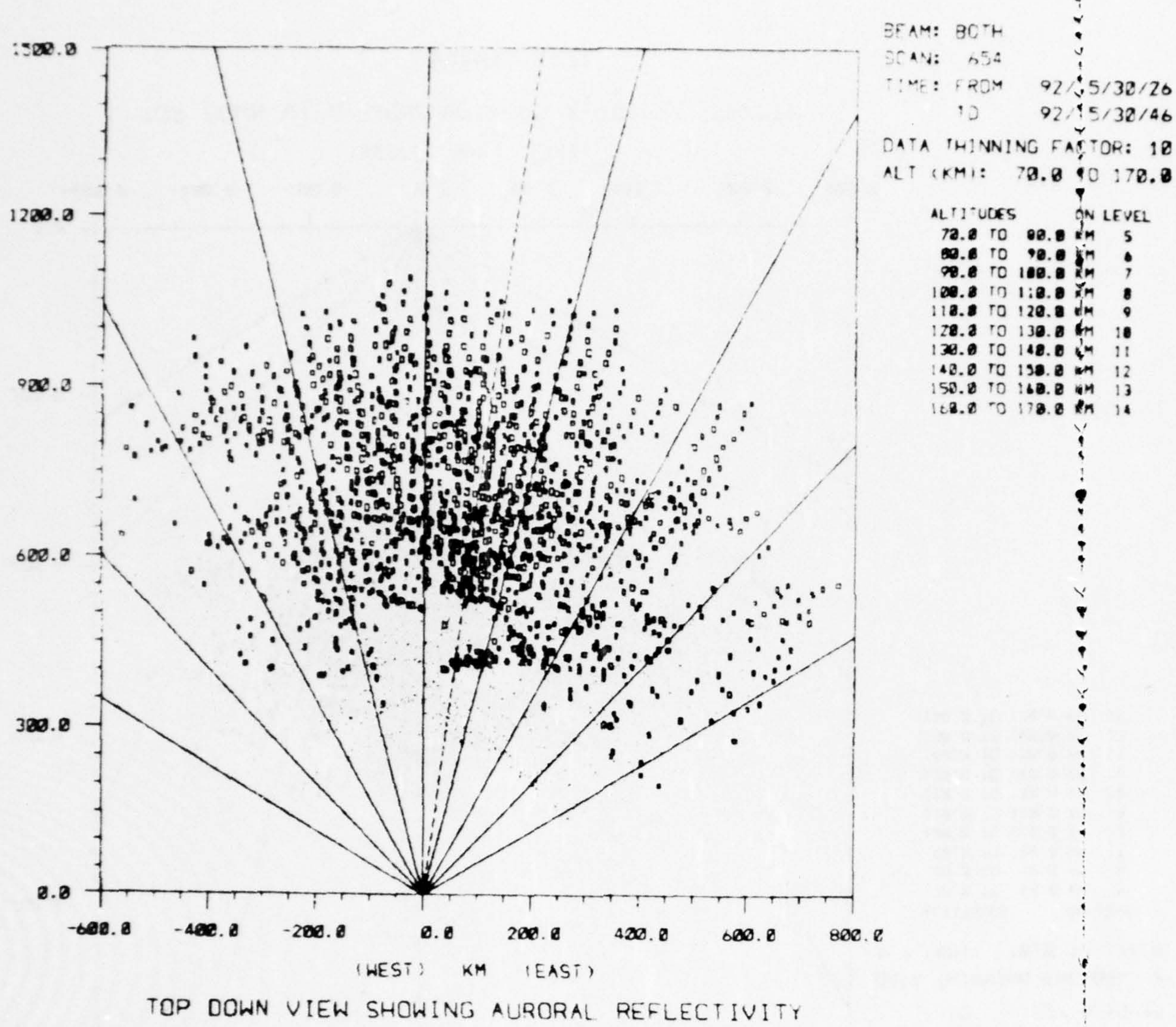
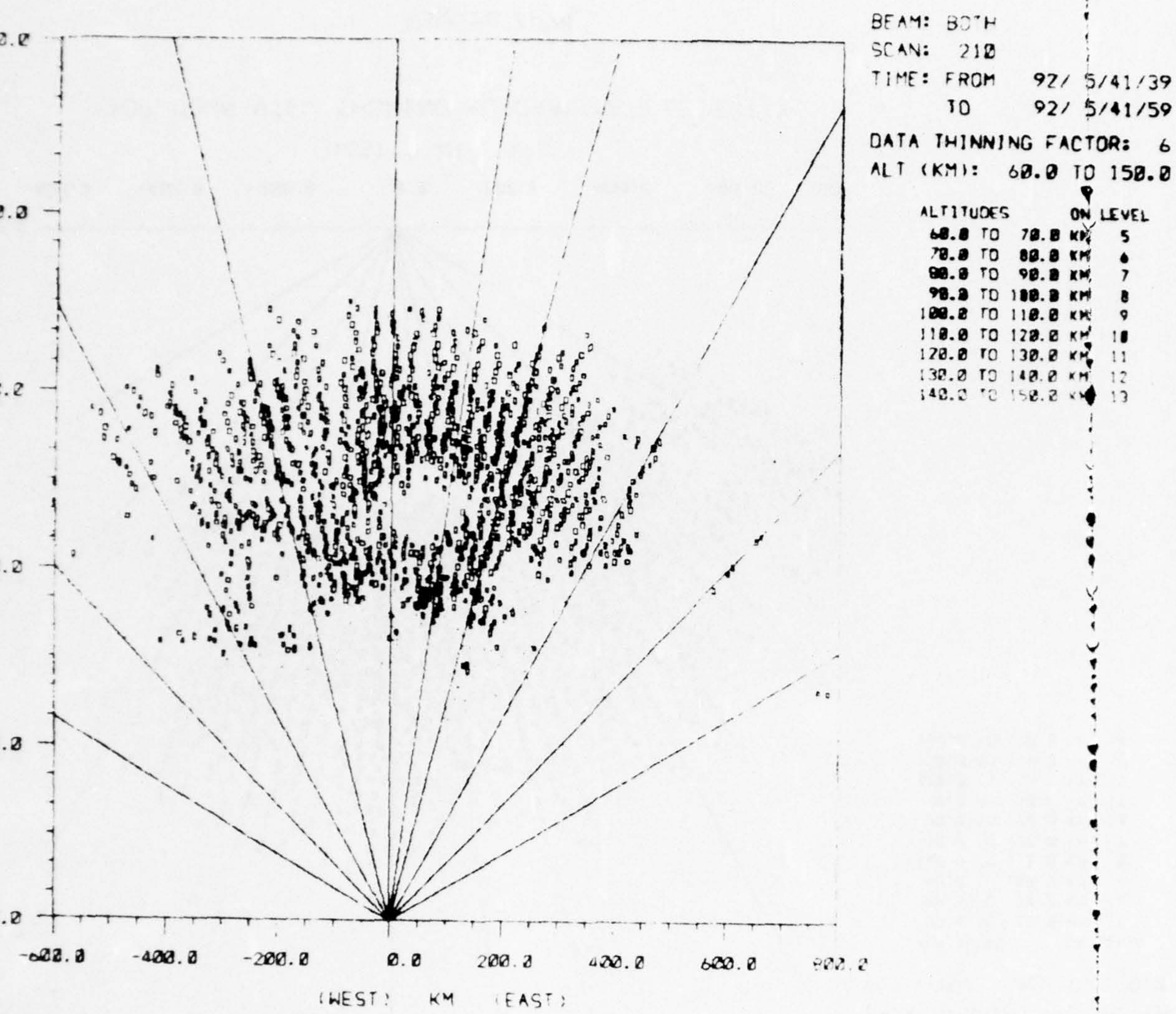
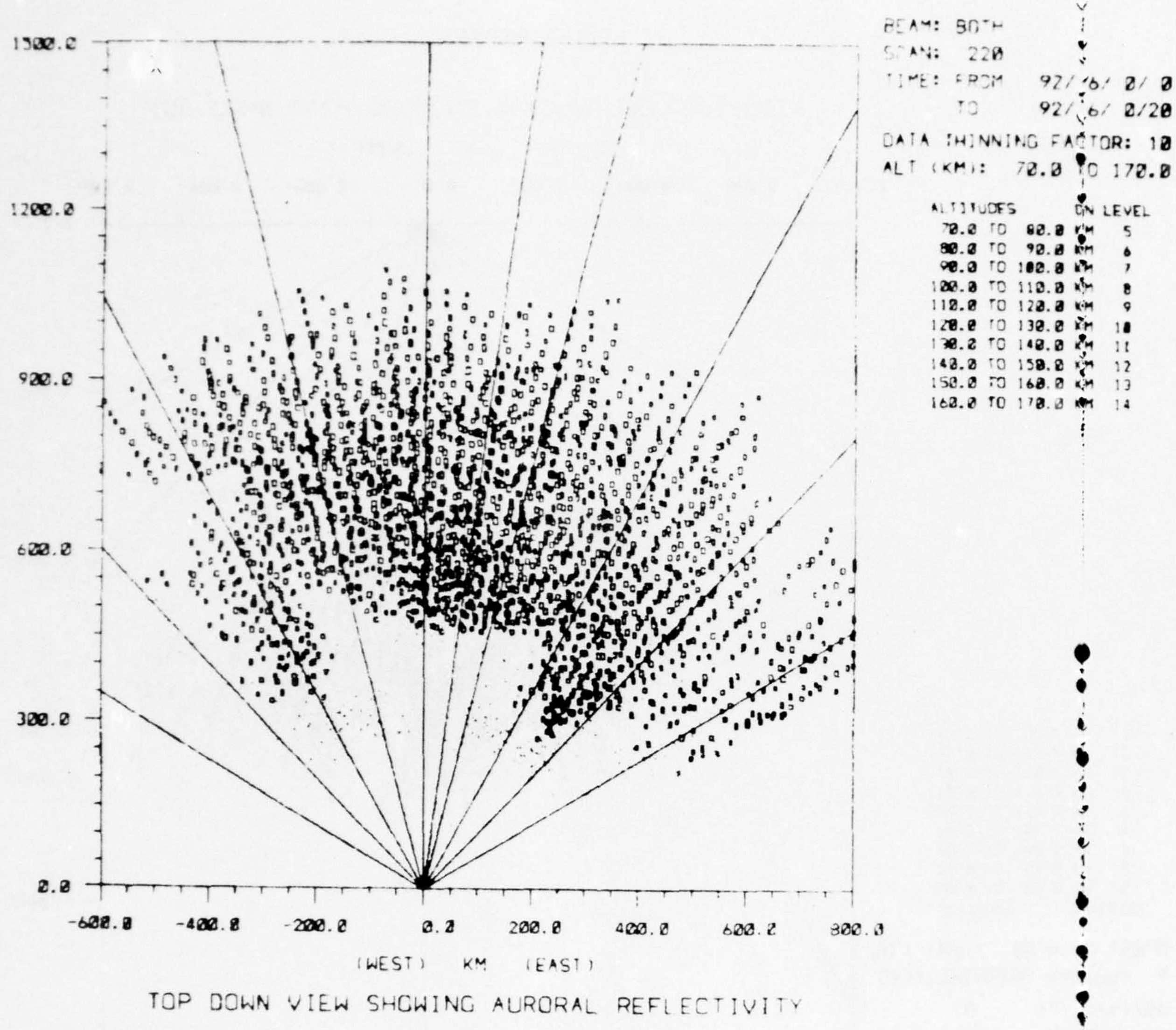

BEAM: BOTH
SCAN: 654
TIME: FROM 92/ 5/30/26
TO 92/ 5/30/46
DATA THINNING FACTOR: 10
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-72



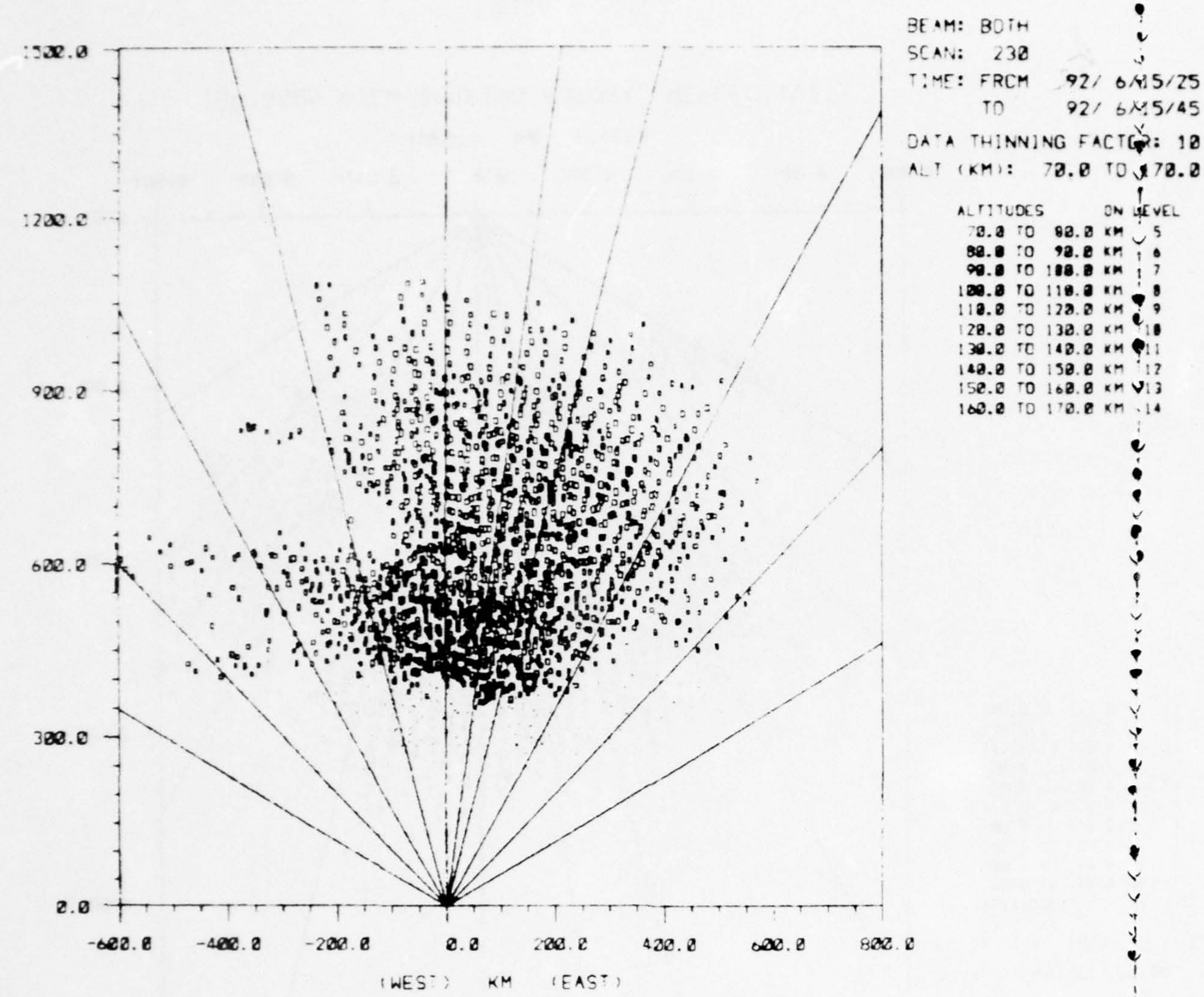
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-73



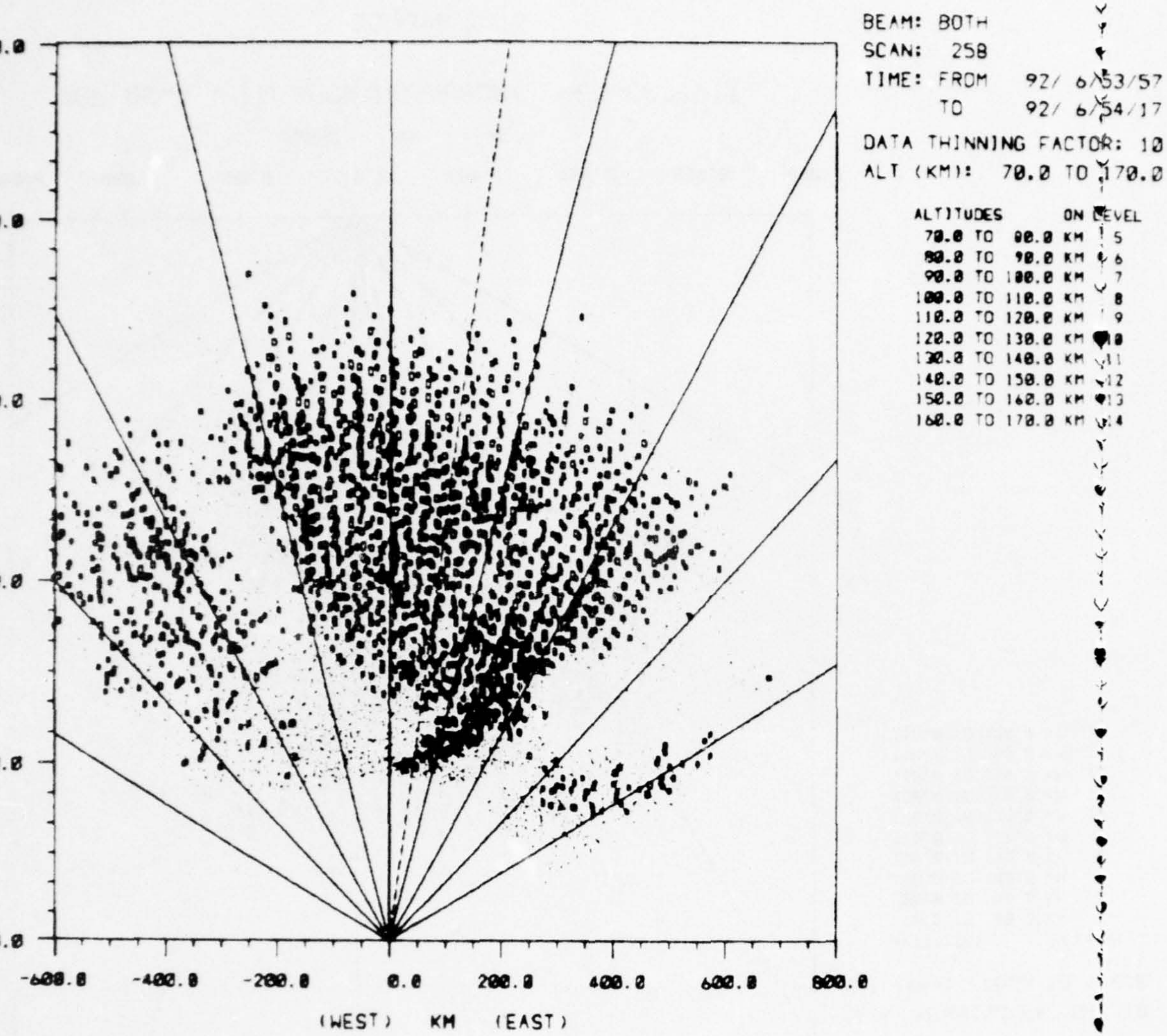
BEAM: BOTH
SCAN: 220
TIME: FROM 92/ 6/ 0/ 0
TO 92/ 6/ 0/20
DATA THINNING FACTOR: 10
ALT (KM): 70.0 TO 170.0
ALTITUDES DN LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-74



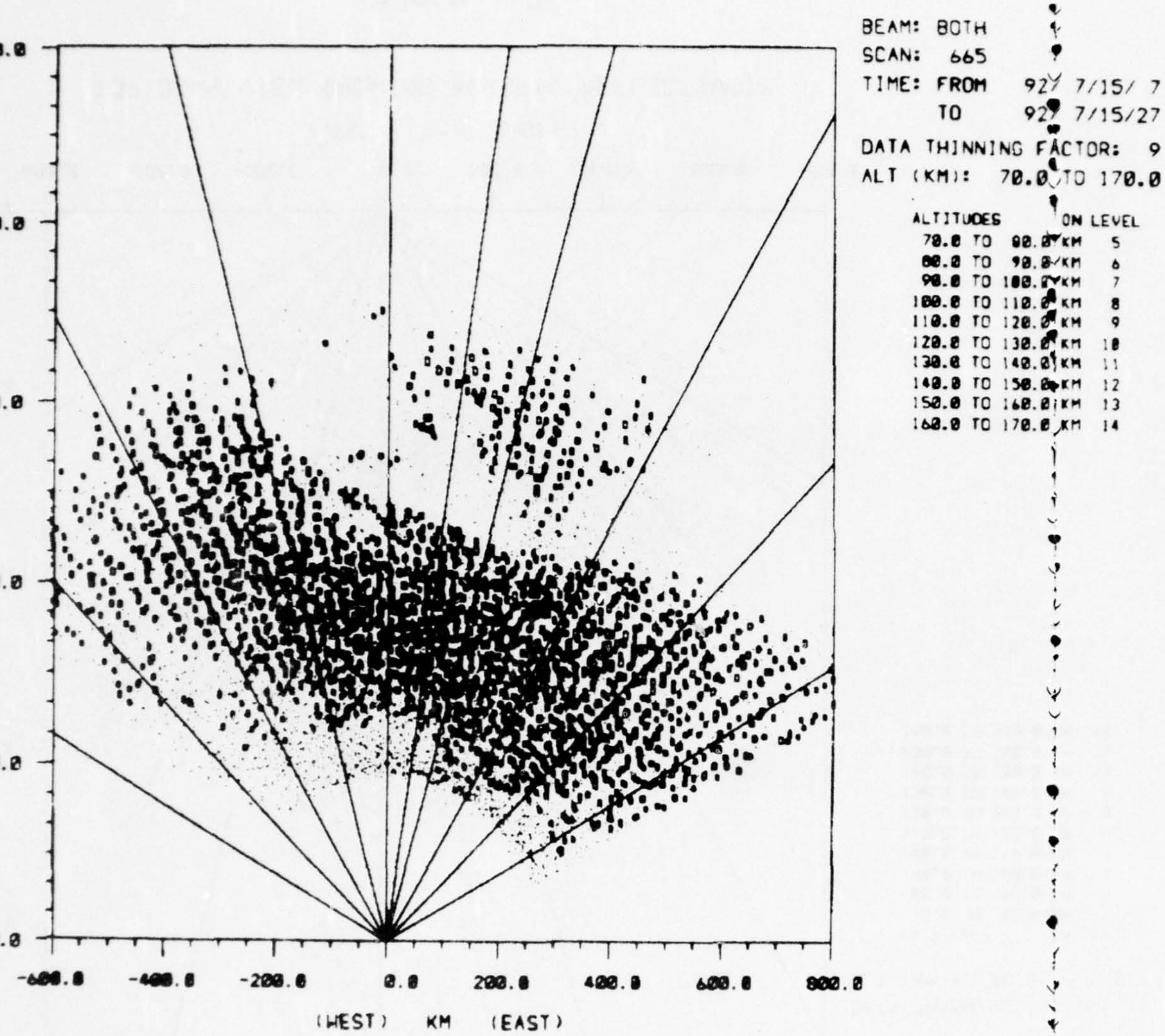
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-75



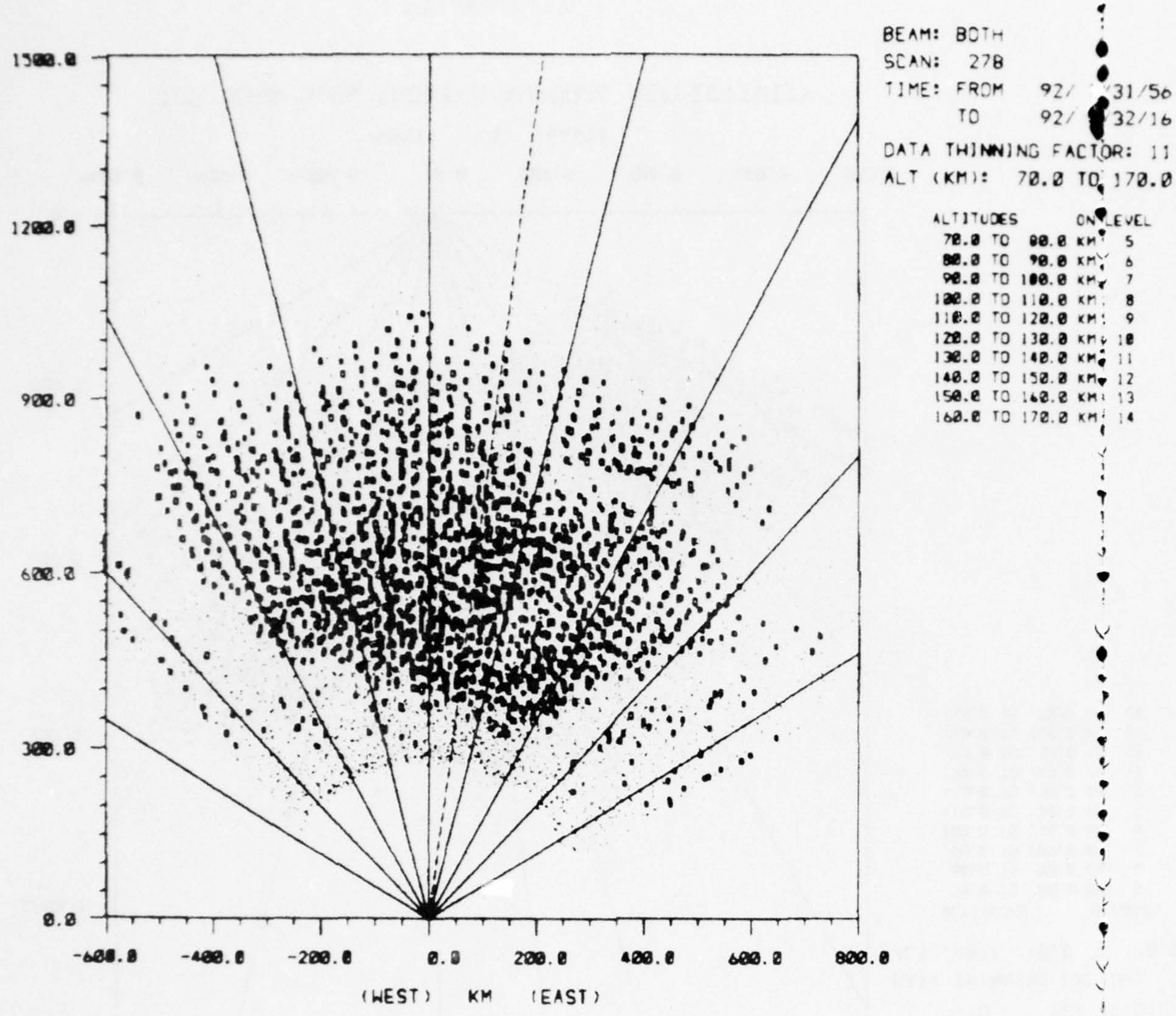
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-76



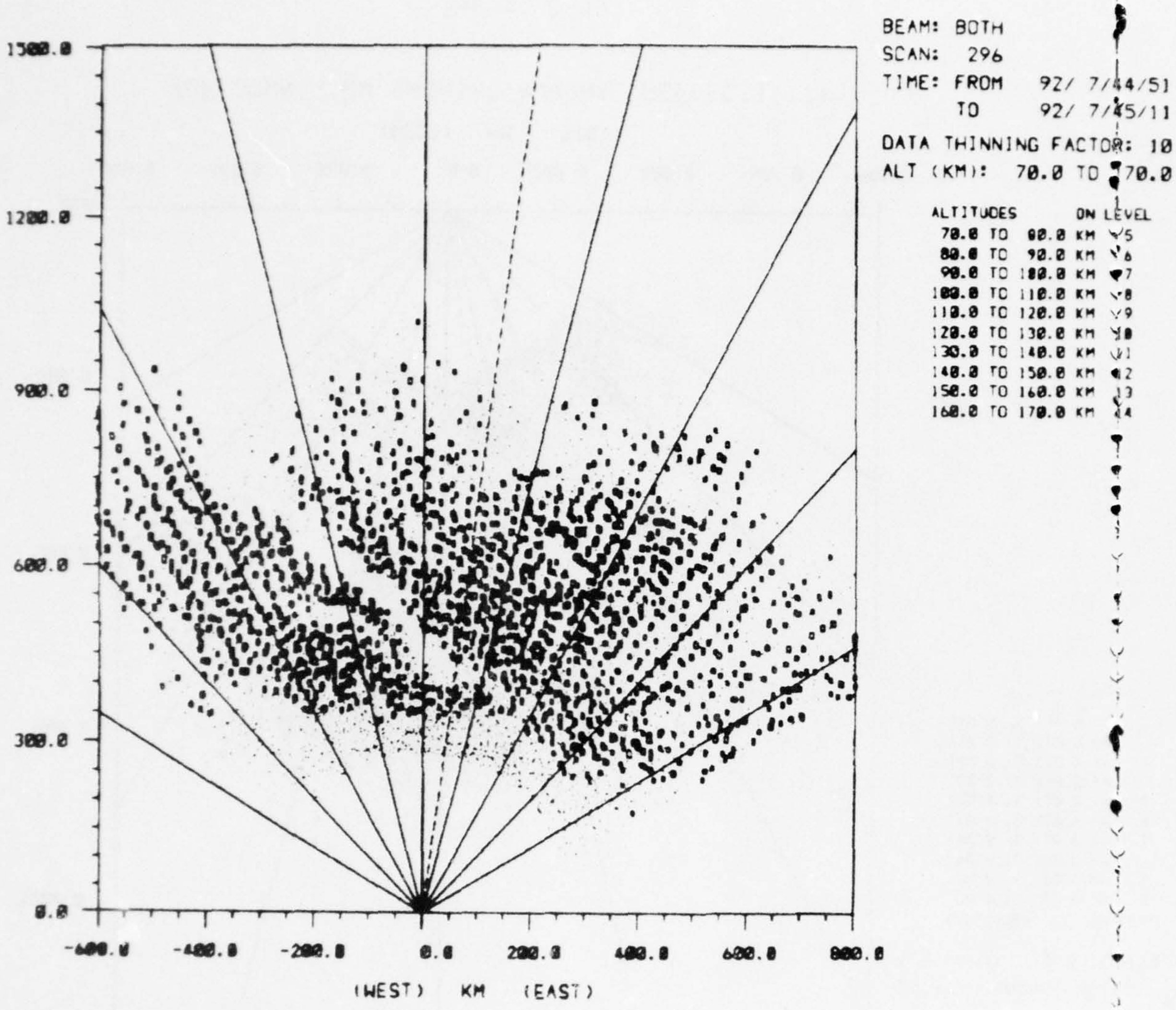
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-77



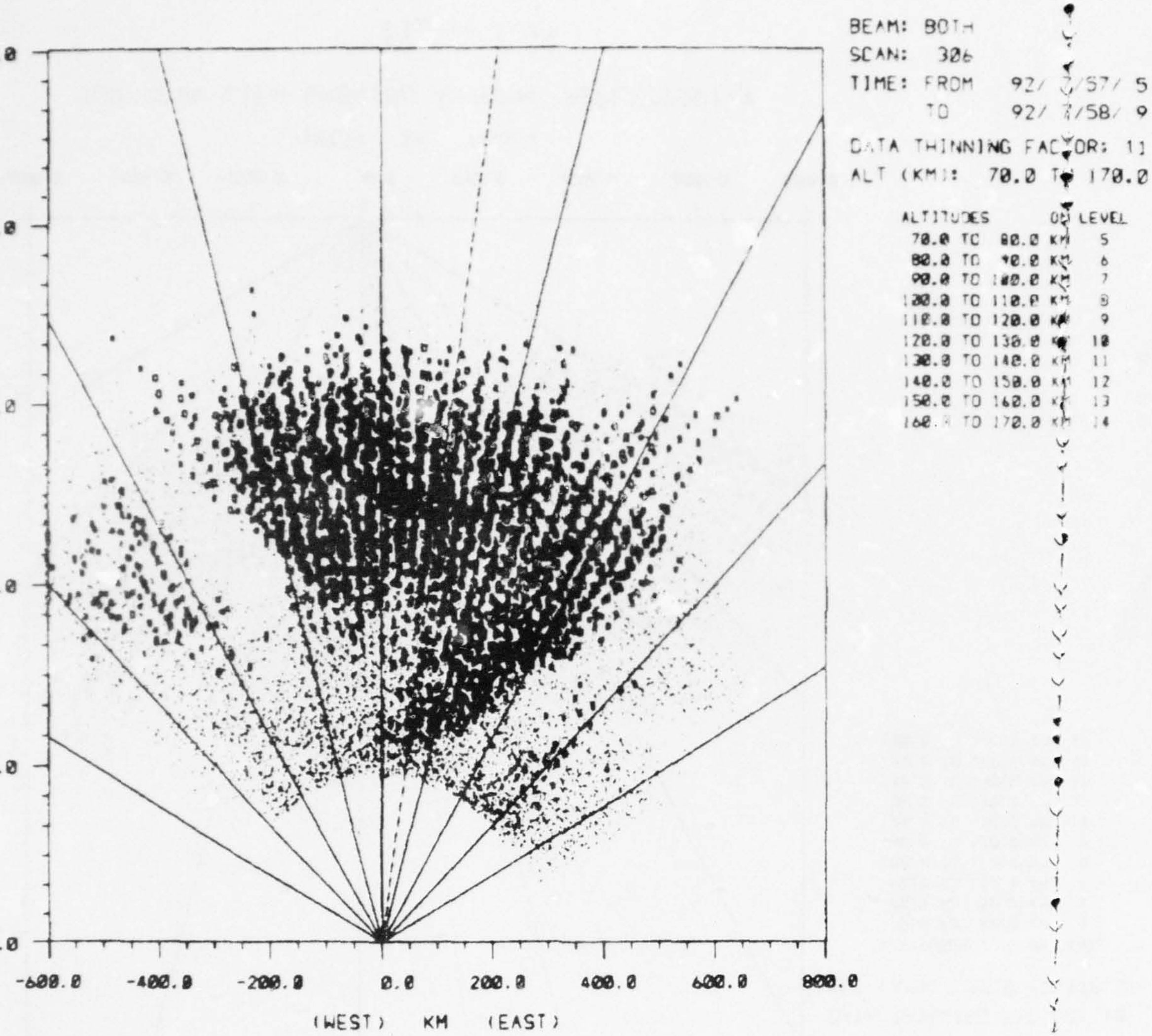
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-78



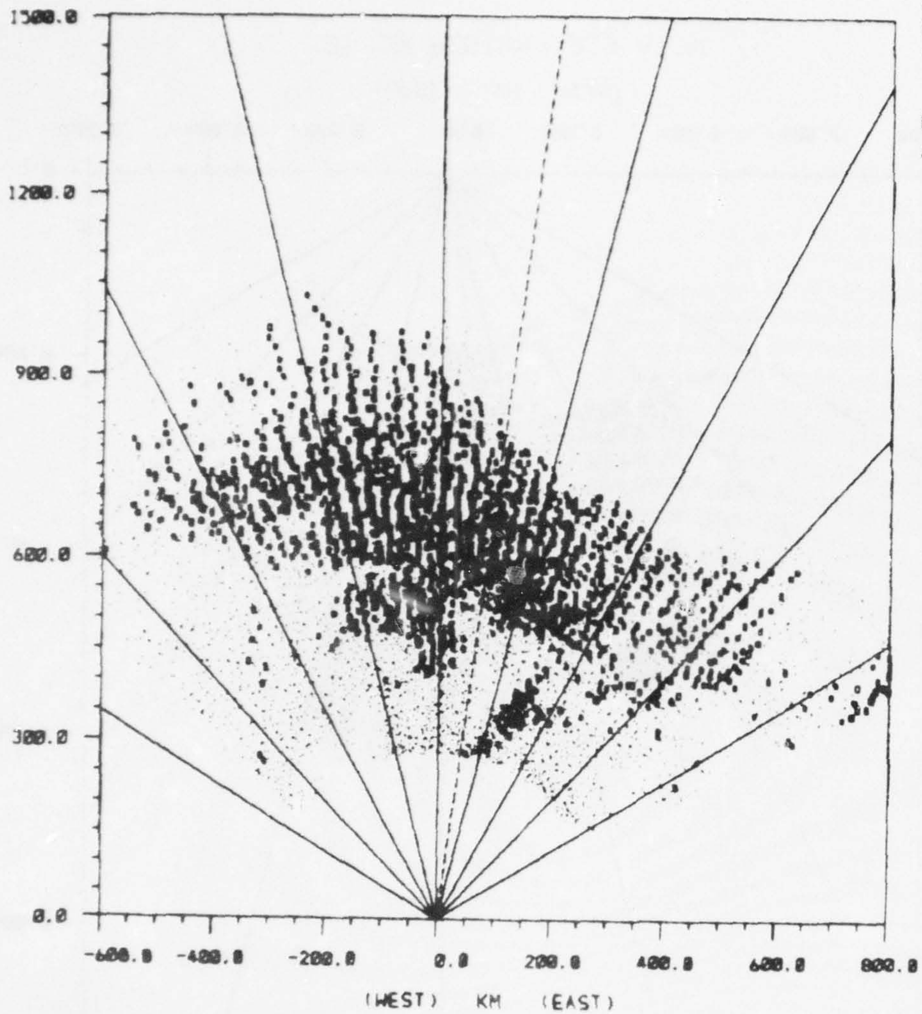
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-79



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-80



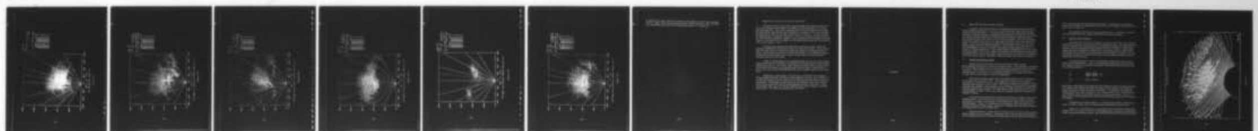
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-81

AD-A034 581 M AND S COMPUTING INC HUNTSVILLE ALA F/G 4/1
PAR AURORAL STUDY. VOLUME III. A PRELIMINARY ANALYSIS OF THE DA--ETC(U)
AUG 76 M J MITCHELL, P L ALLEY, J L BROWN DASG60-74-C-0026

UNCLASSIFIED 76-0027 NL

2 OF 2
AD
A034581



END
DATE
FILMED
2-77

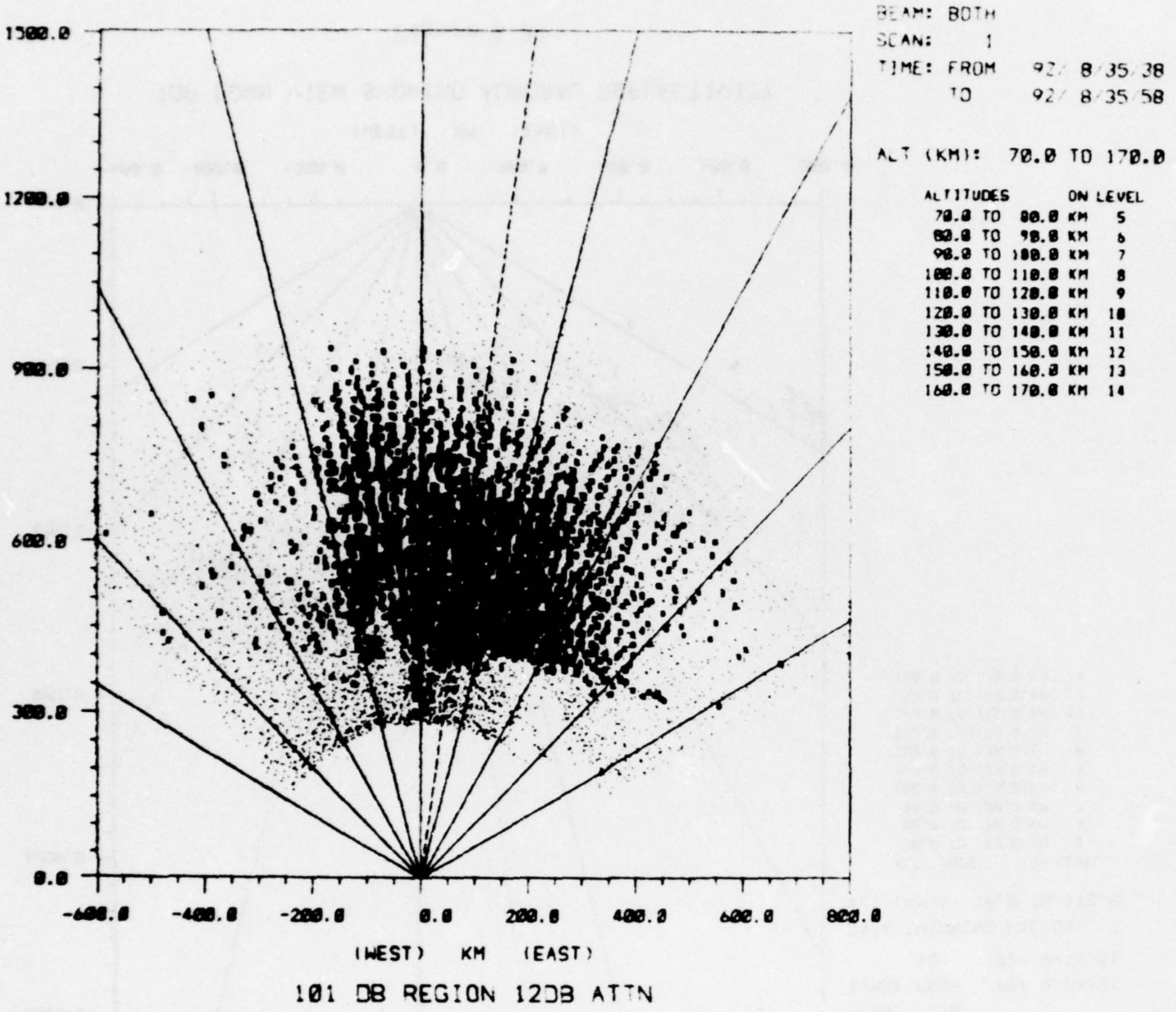
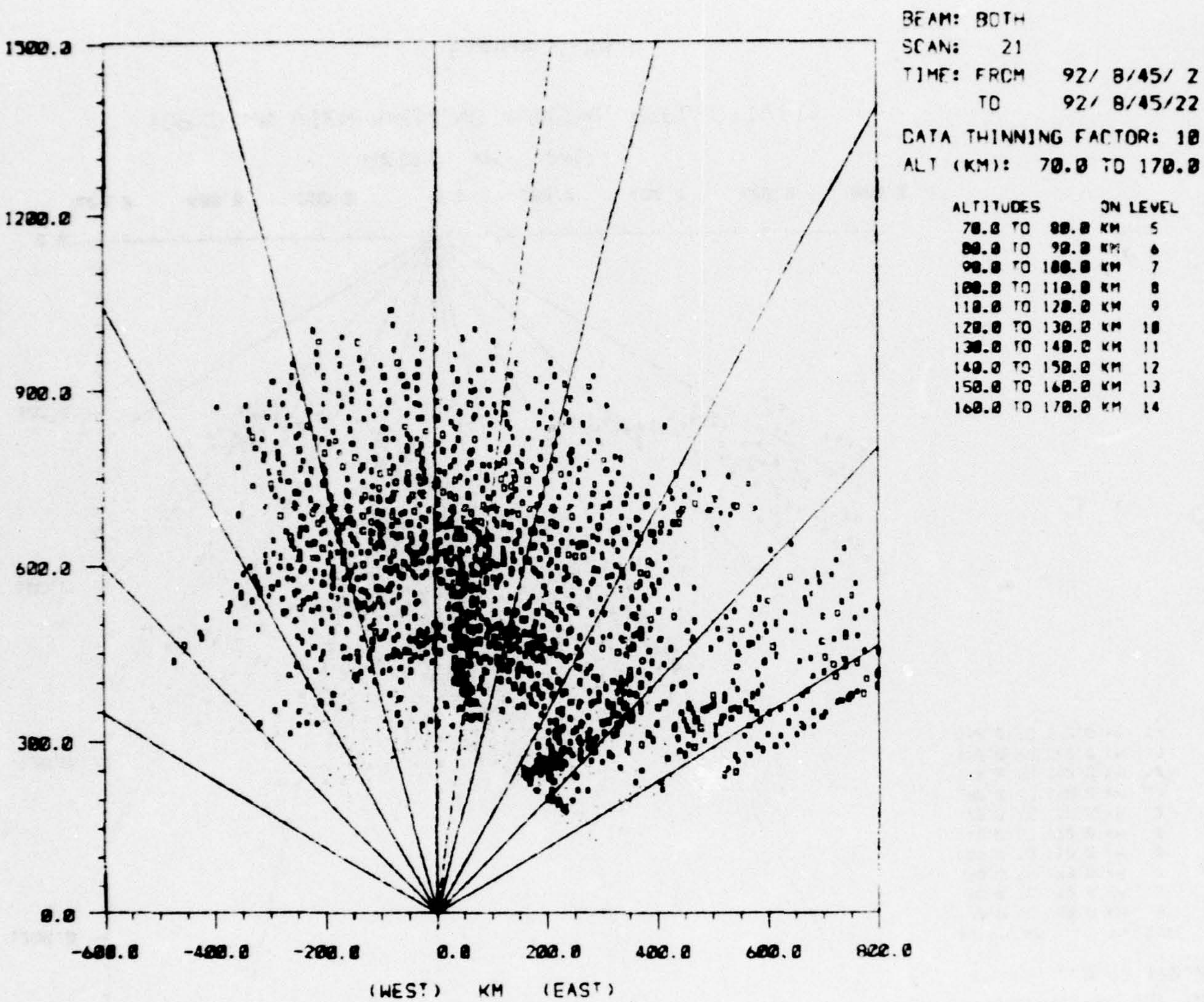

BEAM: BOTH
SCAN: 1
TIME: FROM 92/ 8/35/38
TO 92/ 8/35/58
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
-200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
101 DB REGION 12DB ATTN

Figure 2-82



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-83

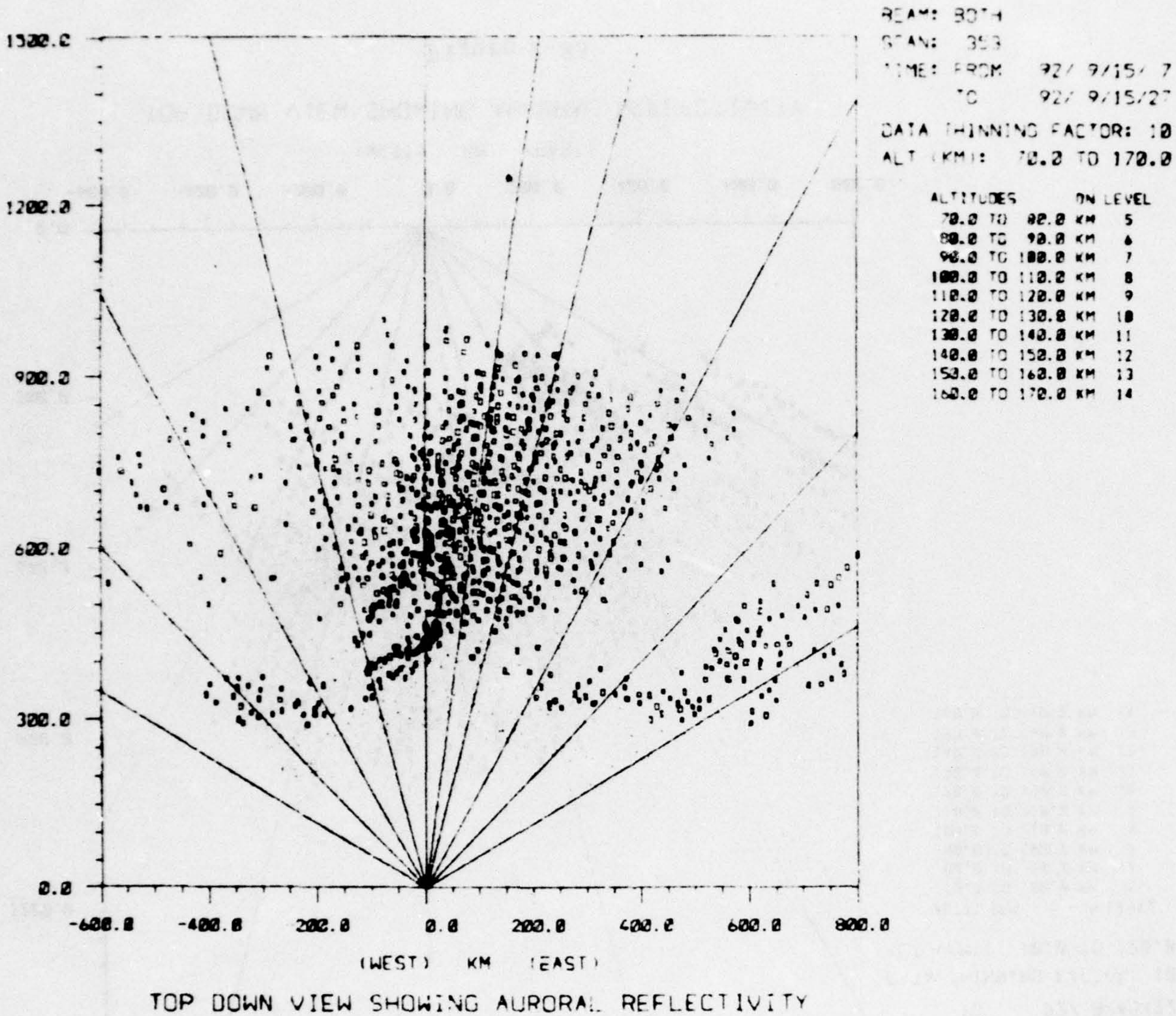
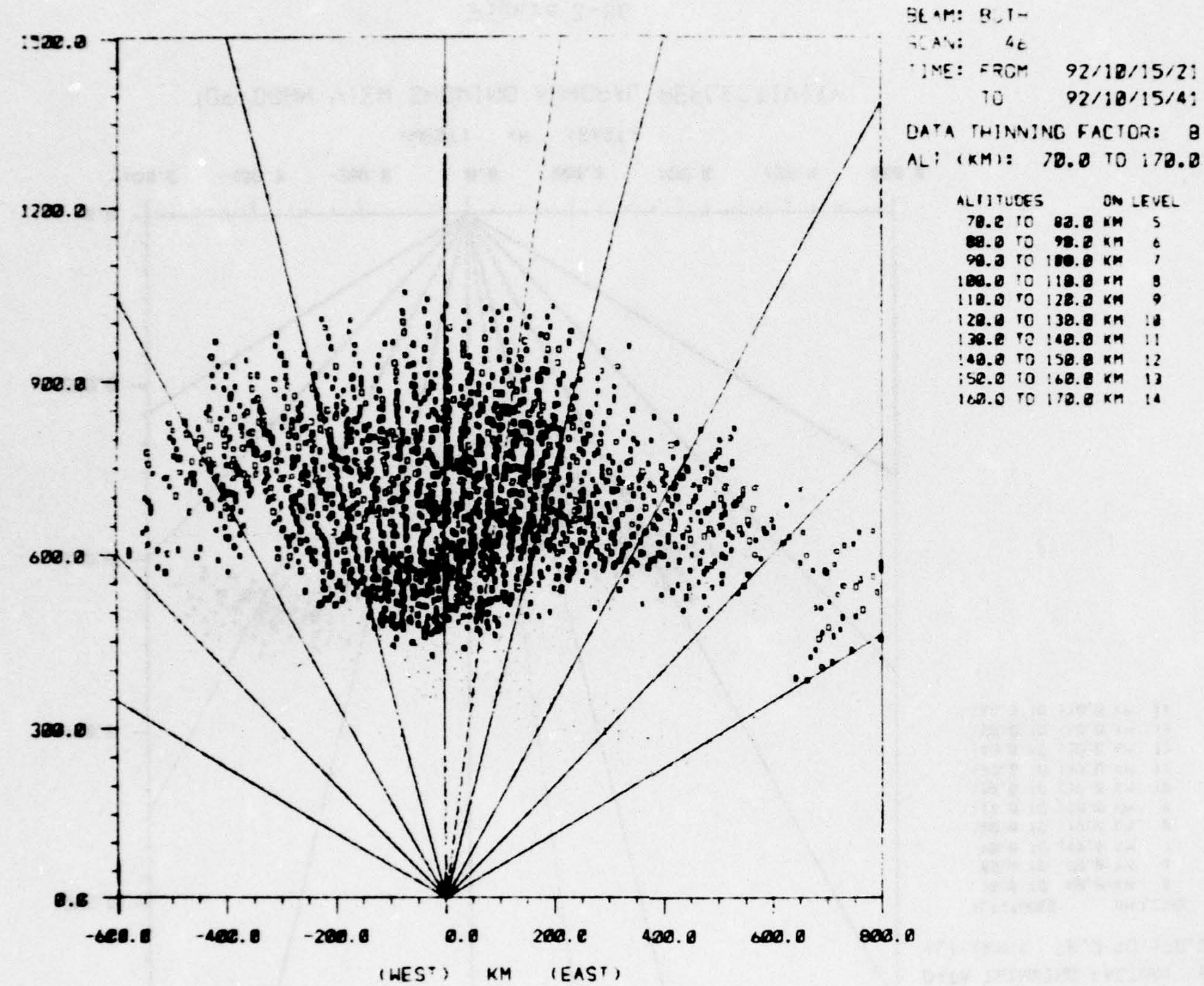
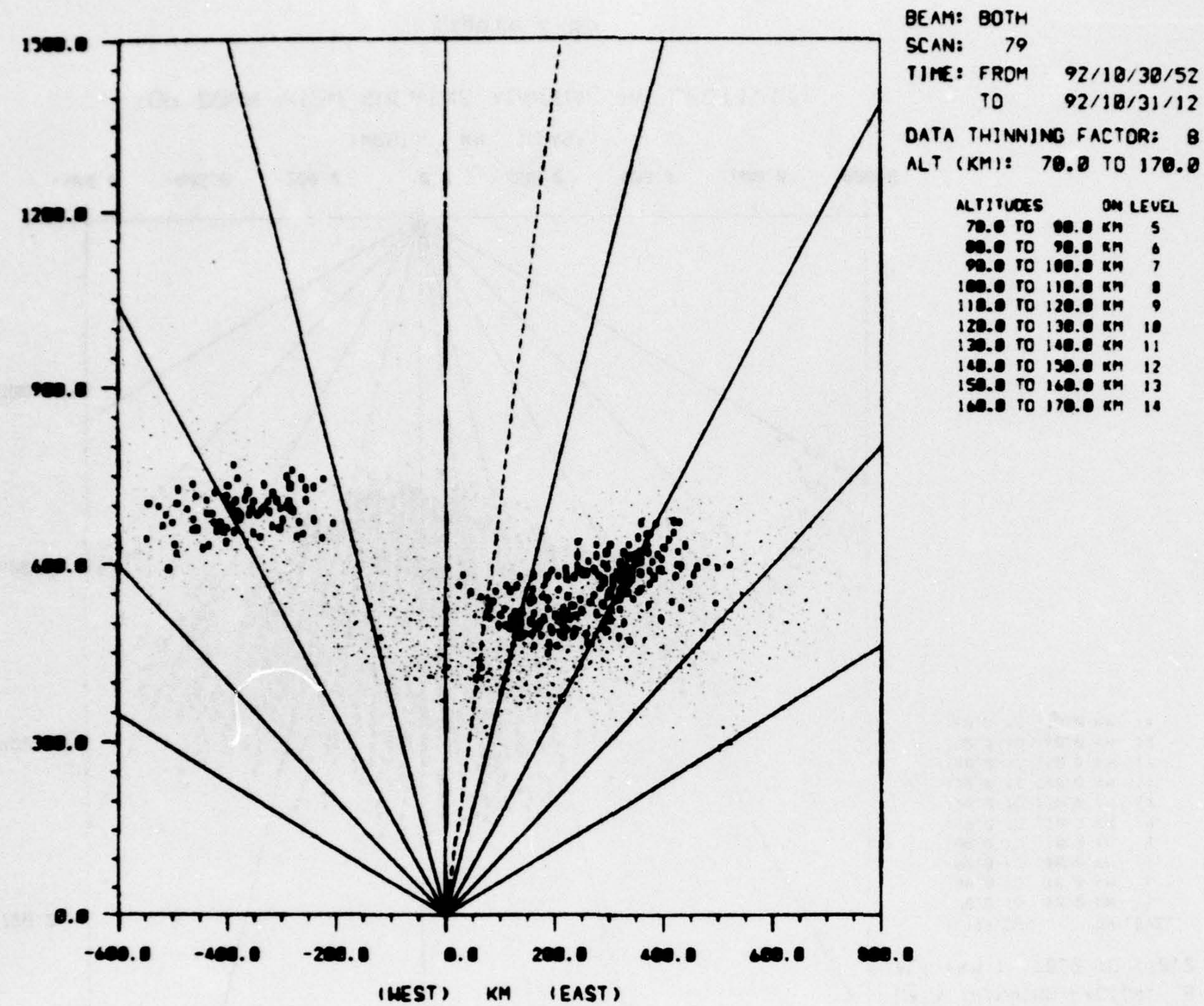

BEAM: BOTH
SCAN: 353
TIME: FROM 92/ 9/15/ 7
TO 92/ 9/15/27
DATA THINNING FACTOR: 10
ALT (KM): 70.0 TO 170.0
ALTITUDES ON LEVEL
70.0 TO 80.0 KM 5
80.0 TO 90.0 KM 6
90.0 TO 100.0 KM 7
100.0 TO 110.0 KM 8
110.0 TO 120.0 KM 9
120.0 TO 130.0 KM 10
130.0 TO 140.0 KM 11
140.0 TO 150.0 KM 12
150.0 TO 160.0 KM 13
160.0 TO 170.0 KM 14
1500.0
1200.0
900.0
600.0
300.0
0.0
-600.0
-400.0
200.0
0.0
200.0
400.0
600.0
800.0
(WEST) KM (EAST)
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-84



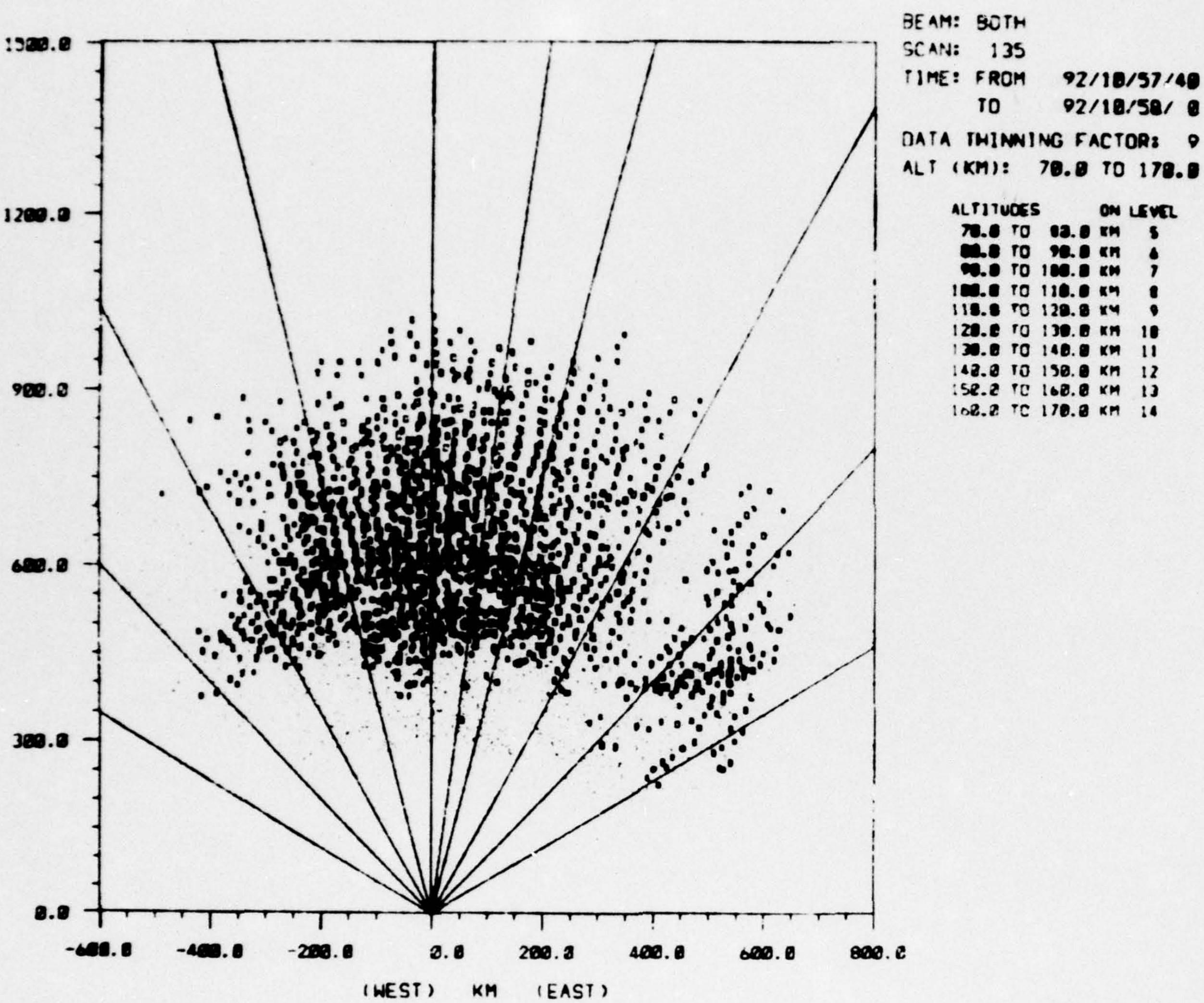
TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-85



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-86



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

Figure 2-87

in that this is a map of aurora in which the raw signal-to-noise ratio exceeded 101 dB. These may be the strongest auroral echoes which have been recorded. The reflectivity of the auroral irregularities exceeds $-75\ dB\ m^2/m^3$.

3. ADDITIONAL DATA AVAILABLE FOR STUDY

The data collected on the PAR magnetic digital data tapes includes only auroral backscatter and satellite track data and comprises nearly 95% of the total data gathered. Other data regarding the levels of ionospheric absorption and geomagnetic disturbances were gathered to provide a means of correlating the intensity of radar aurora with ionospheric perturbations. As was the case for experiments conducted in September, 1975, the auroral observation station at Fort Churchill, Manitoba, Canada, a site operated for the Canadian Research Council, monitored these conditions for the experiments conducted on March 26, 1976, and on April 1, 1976.

Riometer and magnetometer data were recorded on strip charts and supplied to BMDSCOM to aid in the analysis of the auroral data. These recordings are being used in an attempt to define the effects of geomagnetic disturbances on the aspect sensitivity of auroral backscatter. A detailed discussion of this effort is beyond the scope of this volume, but will be presented in a separate report at a later date.

Verbal communications were maintained with the U.S. Air Force radar station at Finley, North Dakota, to establish further the presence and southern extent of the aurora. The Finley radar station is located some 75 miles south of the PAR and operates at a frequency near the PAR band. Observation of aurora from this radar established that the aurora indeed extended south of the PAR.

Additionally, photographs of the aurora, as observed by the Defense Meteorological Satellite operated by Global Weather Central, were obtained to provide yet another possible means of correlating visual and radar auroral observations. Photographs received thus far were taken at times and locations which do not correspond with the data gathering periods at the PAR. It was learned that higher priority mission objectives precluded continuous satellite observation. No useful photographs were available.

(BLANK)

4. ANALYSIS OF THE AURORAL DATA

A number of analytical studies are being performed by M&S Computing. These include an attempt to measure any PAR band noise which might be generated by the active aurora. A second study involves an evaluation of the effectiveness of sidelobe blanking techniques in the presence of strong auroral echoes. The object of another study is to analyze the perturbations which associated auroral phenomena might induce in the tracking operation. The research which promises to yield some of the most interesting results is the aspect sensitivity study. The PAR has yielded backscatter data with better than 10 dB s/n from angles greater than 20^{o} off-perpendicular. The results of this study will be a characterization of the auroral aspect sensitivity relationship from near 0^{o} to almost 20^{o} off-perpendicular. This range exceeds considerably the results from previous studies. Due to much higher resolution of the PAR and new processing techniques, the results of this study should provide a much clearer characterization of the auroral aspect sensitivity relationship than was previously possible.

4.1 Aspect Sensitivity Analysis

Volume II of the PAR Auroral Study series described in detail the techniques being used to perform the aspect study. The PAR data is excellent for use in aspect studies because of the wide range of aspect angles and the high resolution. One of the tools for supporting this analysis is the scatter plot. Through visual correlation or curve fitting techniques, the scatter plot can be a useful tool for generating the aspect relationship.

The M&S Computing studies have demonstrated that auroral reflectivity is a function of many parameters. The researcher must be very careful in attempting to characterize aspect relationships by plotting the reflectivity versus magnetic aspect angle of a set of data. The location of the backscattering points, especially the altitude, often appears to have a stronger influence on reflectivity than the magnetic aspect angle. For this reason, data is selected from narrow altitude bands, usually 1 km or less, and from regions which are otherwise restricted in extent.

Tools have been developed to aid in the selection of specific sets of radar pointing angles. One of these tools incorporates an overlay of three critical parameters, location of backscatter, off-perpendicular angle, and actual beam-steering angles. This is accomplished by overlaying a Top-Down map slice, contours of constant aspect angle, and a grid of constant sin α and sin β contours, all restricted to a narrow altitude band.

The intersections of these sin α and sin β contours show the beam pointing angles used for auroral mapping. With these tools, one can select an optimum set of pointing angles and be assured that data points will be distributed uniformly over a selected band of off-perpendicular angles. Furthermore, the sample region can be restricted sufficiently so that it does not contain any obvious anomalies, holes, edges, etc.

An example of this overlay is given in Figure 4-1. Figures 4-2 and 4-3 are examples of the many scatter plots which have been generated.

4.2 Satellite Track Analysis

As a part of the PAR Aurora Study, a number of satellites was tracked concurrently with the collection of auroral backscatter data. This data was taken because previous work had indicated the possibility of significant scintillation effects at the PAR frequency during periods of auroral activity. These effects appear as rapid fluctuations in signal power and apparent target position and are thought to be caused by irregularities in the ionospheric F region, the characteristics of which are known to be related to the magnetic disturbances associated with auroral activity.

The method chosen to study the scintillation effects was to analyze the point-by-point fluctuations. From a sliding window consisting of five consecutive replies, indices of amplitude and angular scintillation are generated using the following equations:

$$SIp = \frac{Smax - Smin}{Smax + Smin}, \text{ and}$$

$$P_\theta = \theta max - \theta min,$$

where Smax and Smin are the maximum and minimum replies in watts from the five points in the window and θmax and θmin are the maximum and minimum angle in degrees of either azimuth or elevation. To emphasize the different mathematical form of the equations, the amplitude index will be referred to as a scintillation index and the angle indices as perturbation indices. Plots of these indices versus elapsed time are then generated and examined for scintillation effects.

In addition to the above indices, a composite plot showing curves of azimuth, elevation, range, and raw reply power is generated for each track.

Figure 4-4 is an example of a composite plot for spherical satellite 902. Figures 4-5, 4-6, and 4-7 are the corresponding plots of amplitude scintillation index, azimuth perturbation index, and elevation perturbation index respectively.

TOP-DOWN OVERLAY OF 100Km OFF-1 CONTOURS SHOWING AURORA AND NORMAL POINTING ANGLES

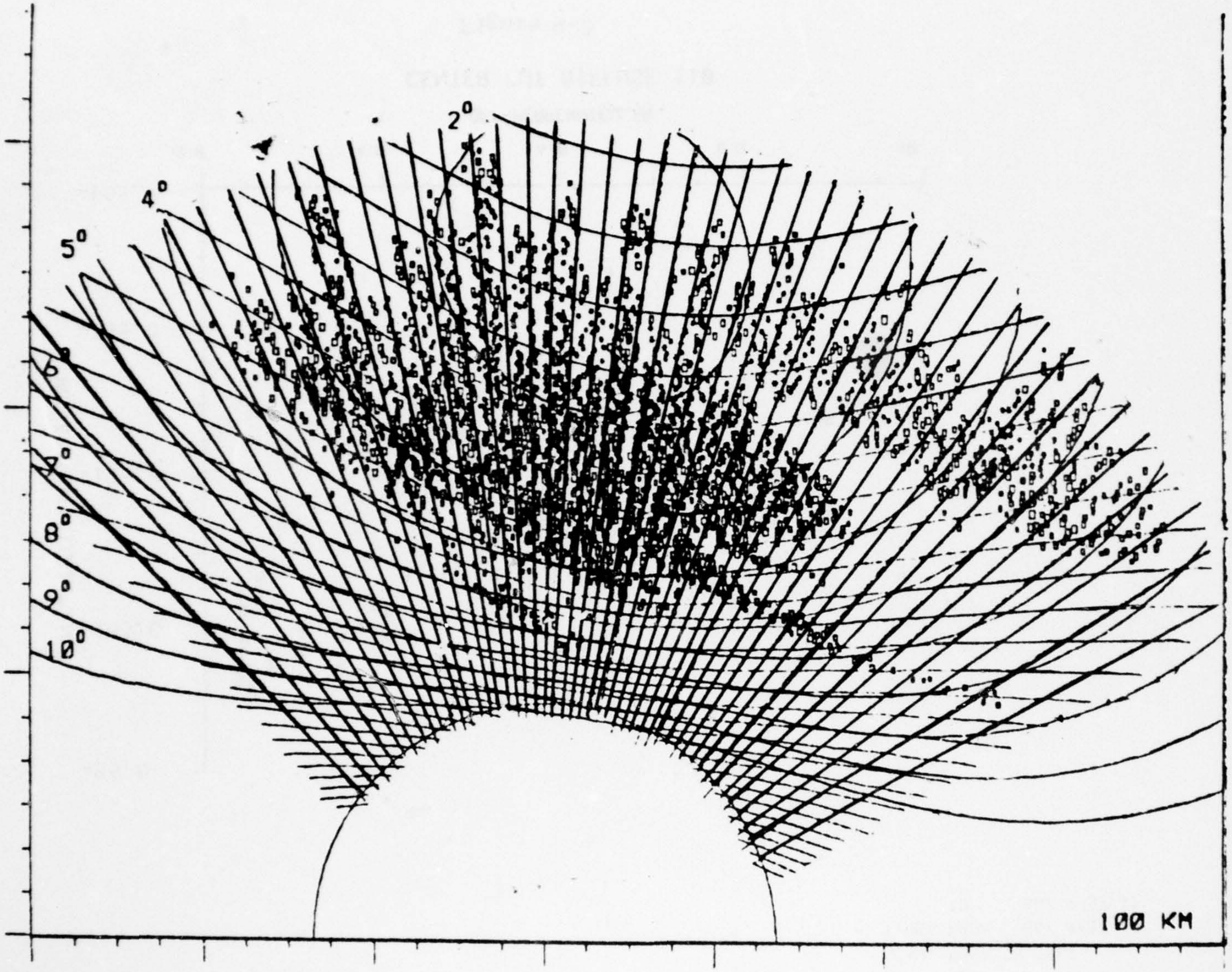


Figure 4-1

SCATTER PLOT OF DIFFUSE AURORA AT 110 TO 111 KM ALTITUDE

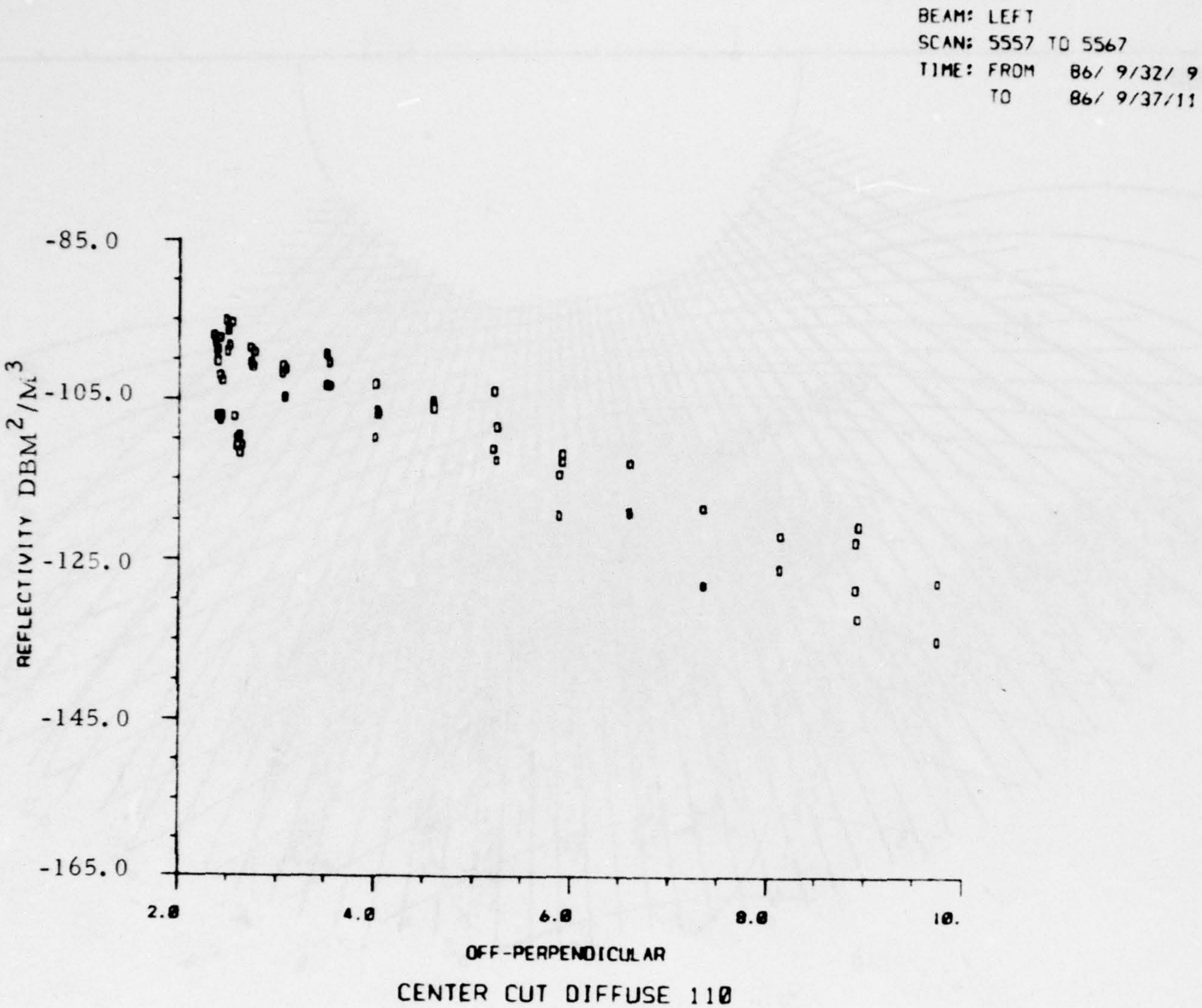
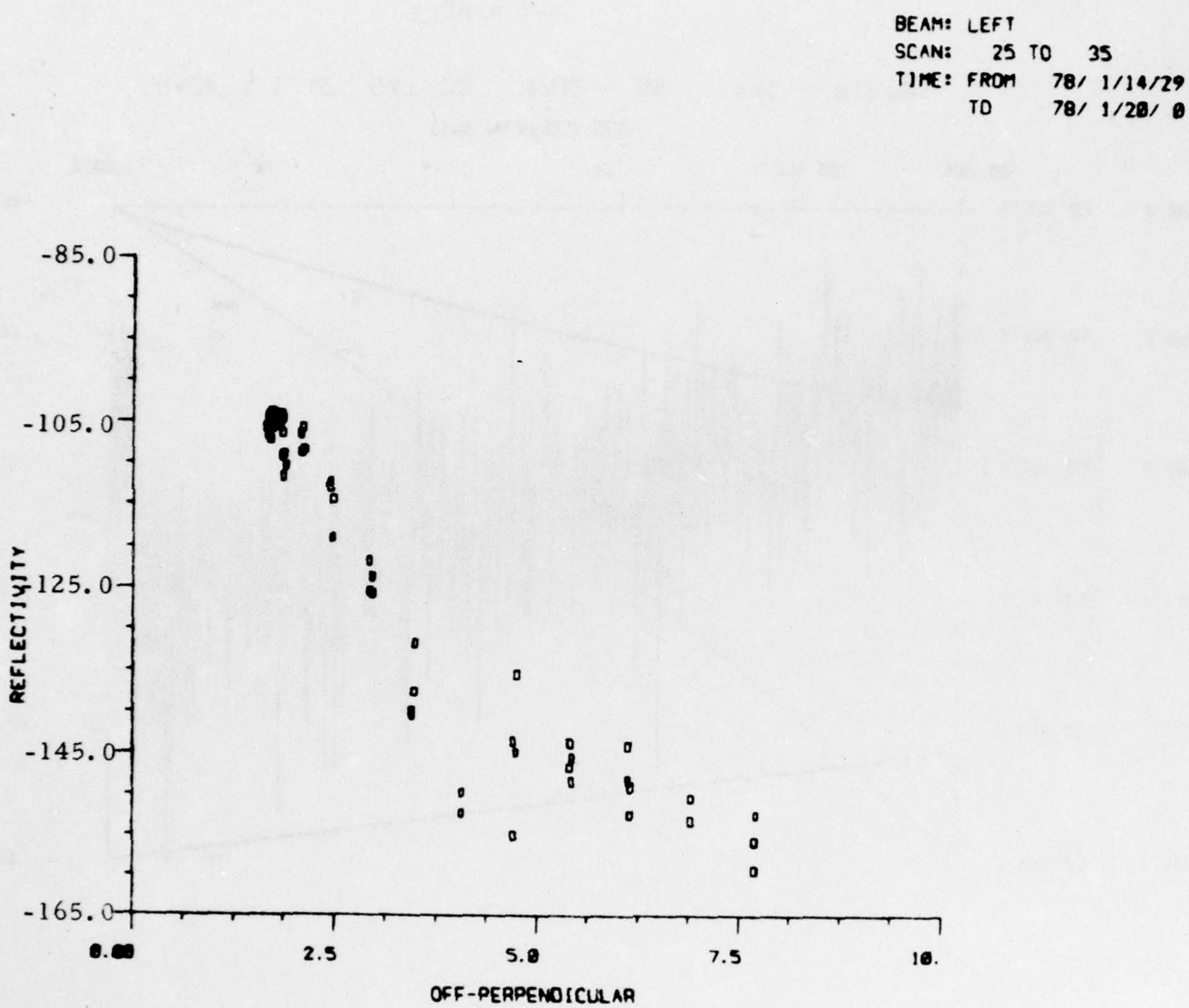


Figure 4-2

SCATTER PLOT OF AURORAL ARC AT 100 to 101 KM ALTITUDE



CENTER CUT ARC 100

Figure 4-3

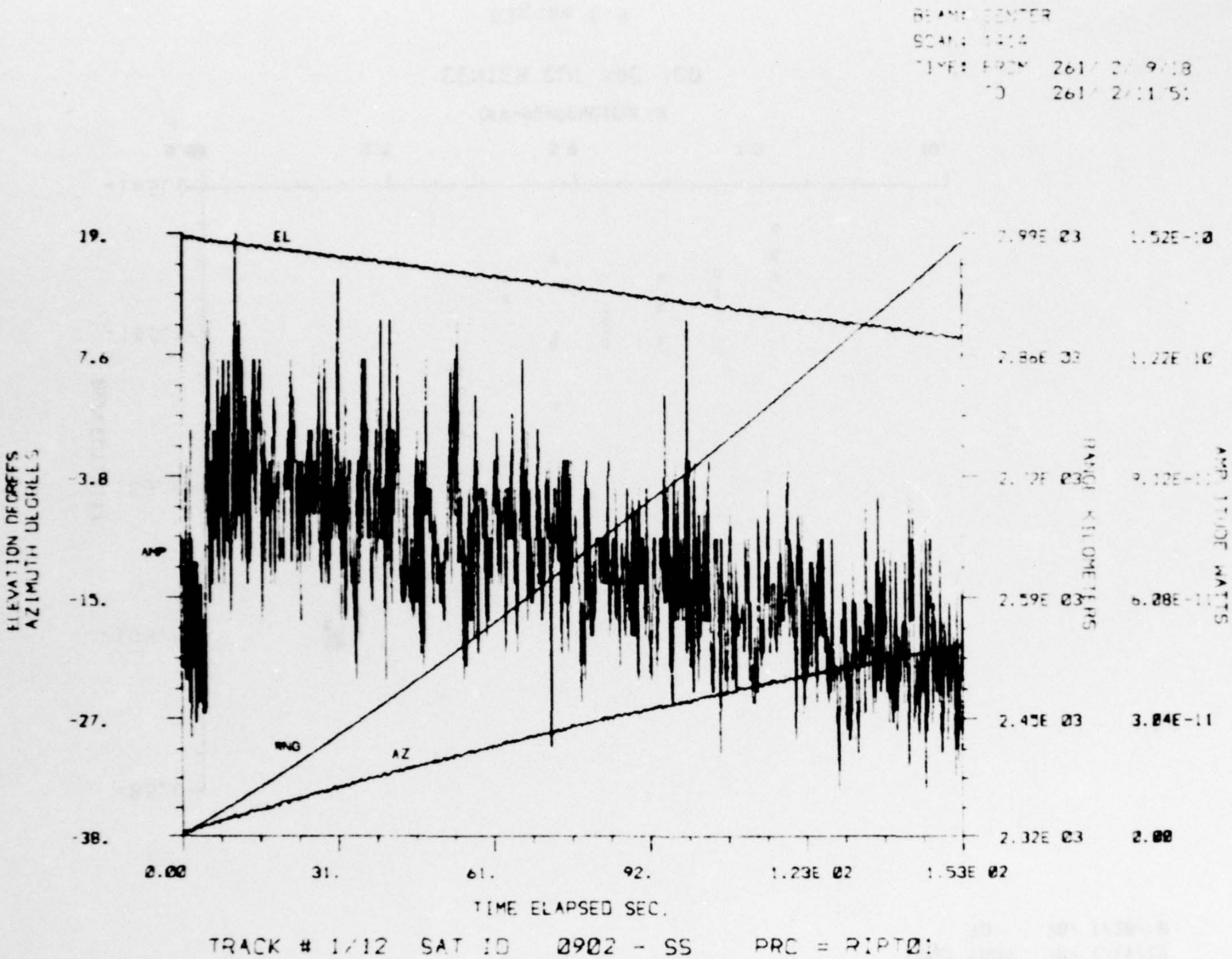
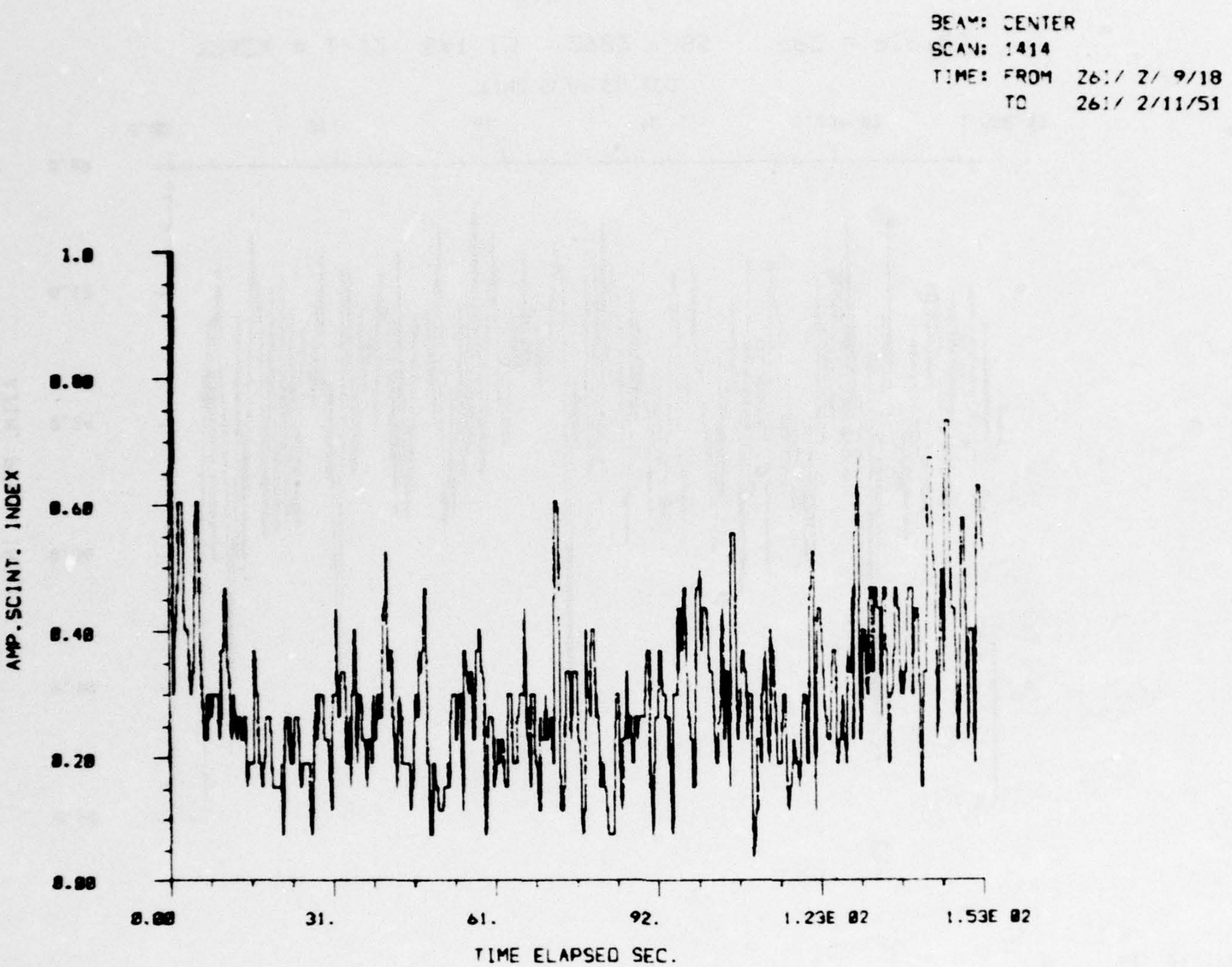

BEAM: CENTER
SCAN: 1414
TIME: FROM 261/ 2/ 9/18
TO 261/ 2/11/51
EL
AMP
RNG
AZ
ELEVATION DEGREES
AZIMUTH DEGREES
RANGE KILOMETERS
AMPLITUDE WATTS
19.
7.6
-3.8
-15.
-27.
-38.
2.99E 03
2.86E 03
2.72E 03
2.59E 03
2.45E 03
2.32E 03
1.52E-10
1.22E-10
9.12E-11
6.08E-11
3.04E-11
2.00
0.00
31.
61.
92.
1.23E 02
1.53E 02
TIME ELAPSED SEC.
TRACK # 1/12 SAT ID 0902 - SS PRC = RIPT01

Figure 4-4



TRACK # 1/12 SAT ID 0902 - SS PRC = RIPT05

Figure 4-5

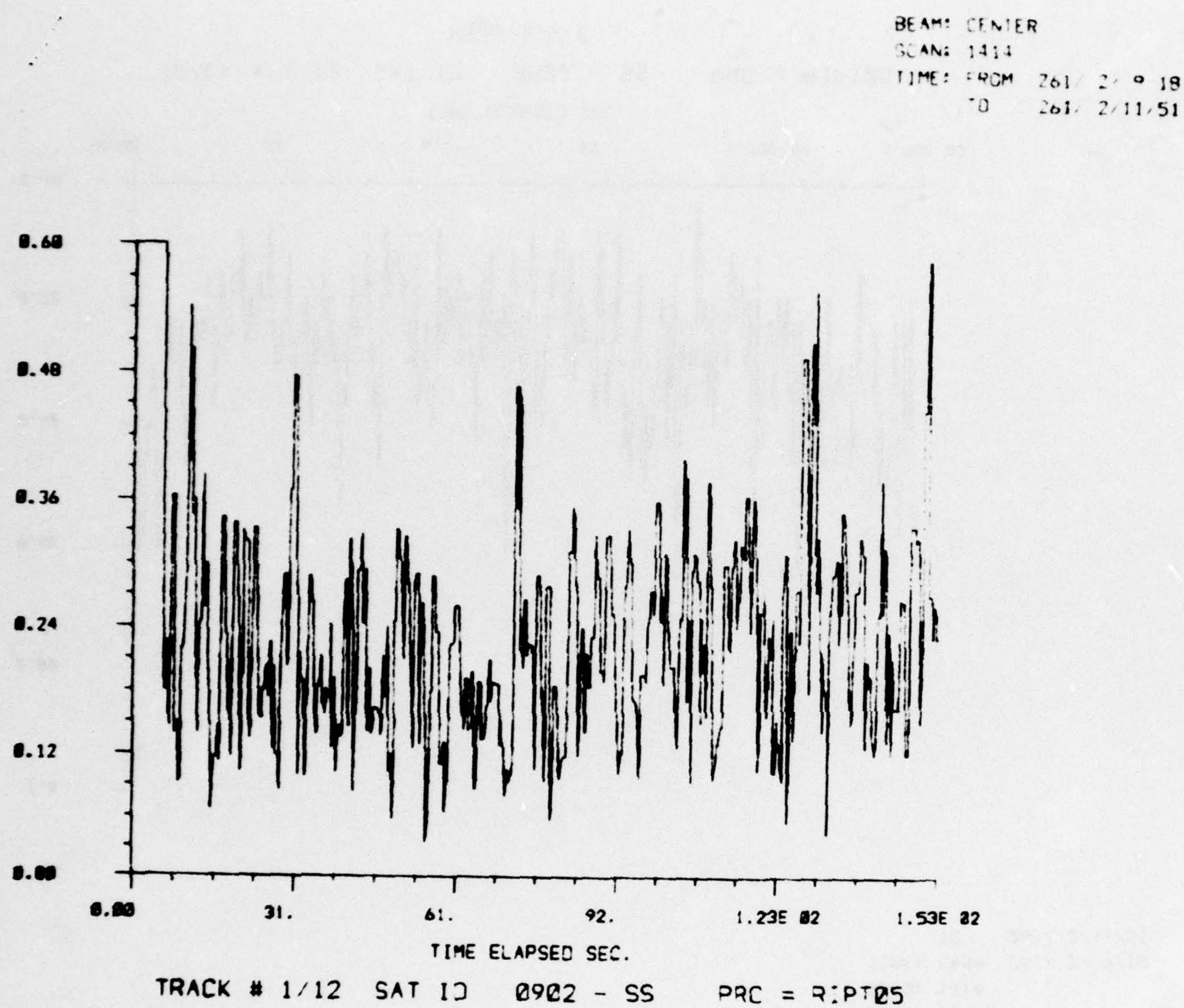
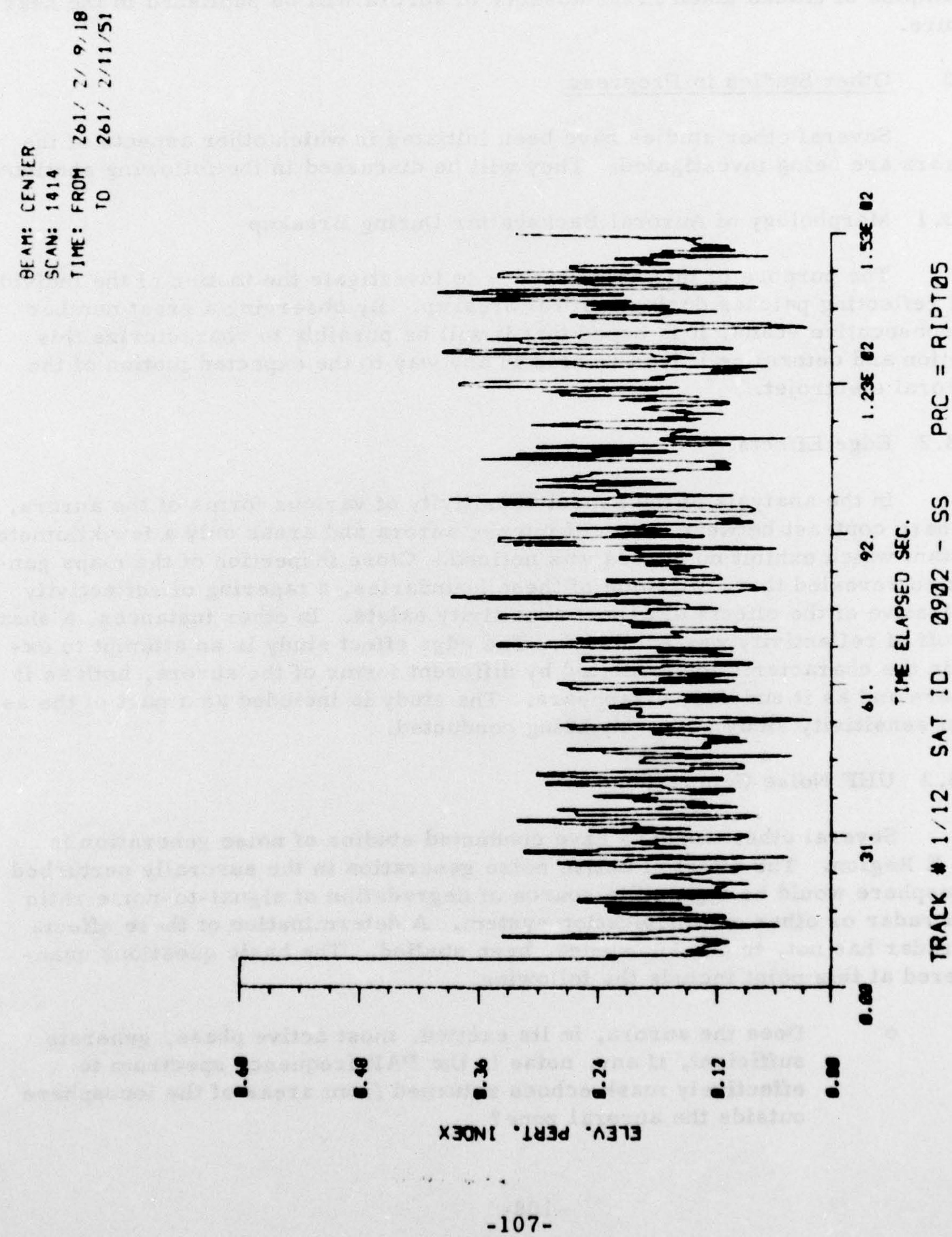

BEAM: CENTER
SCAN: 1414
TIME: FROM 261/ 2/ 9 18
TO 261/ 2/11/51
AZIM. PERT. INDEX
0.60
0.48
0.36
0.24
0.12
0.00
0.00
31.
61.
92.
1.23E 02
1.53E 02
TIME ELAPSED SEC.
TRACK # 1/12 SAT ID 0902 - SS PRC = RIPT05

Figure 4-6


BEAM: CENTER
SCAN: 1414
TIME: FROM 261/ 2/ 9/18
TO 261/ 2/11/51
ELEV. PERT. INDEX
0.00
0.12
0.24
0.36
0.48
0.60
0.00
31.
61.
92.
1.23E 02
1.53E 02
TIME ELAPSED SEC
TRACK # 1/12 SAT ID 0902 - SS PRC = RIPT05
Figure 4-7

Figures 4-8, 4-9, 4-10, and 4-11 show a set of plots for transit satellite 6909.

A full track analysis report containing plots for all satellites and several examples of tracks taken in the absence of aurora will be published in the near future.

4.3 Other Studies in Progress

Several other studies have been initiated in which other aspects of the aurora are being investigated. They will be discussed in the following sections.

4.3.1 Morphology of Auroral Backscatter During Breakup

The purpose of this study task is to investigate the motion of the individual reflecting patches during auroral breakup. By observing a great number of consecutive scans, it is hoped that it will be possible to characterize this motion and determine if it is related in any way to the expected motion of the auroral electrojet.

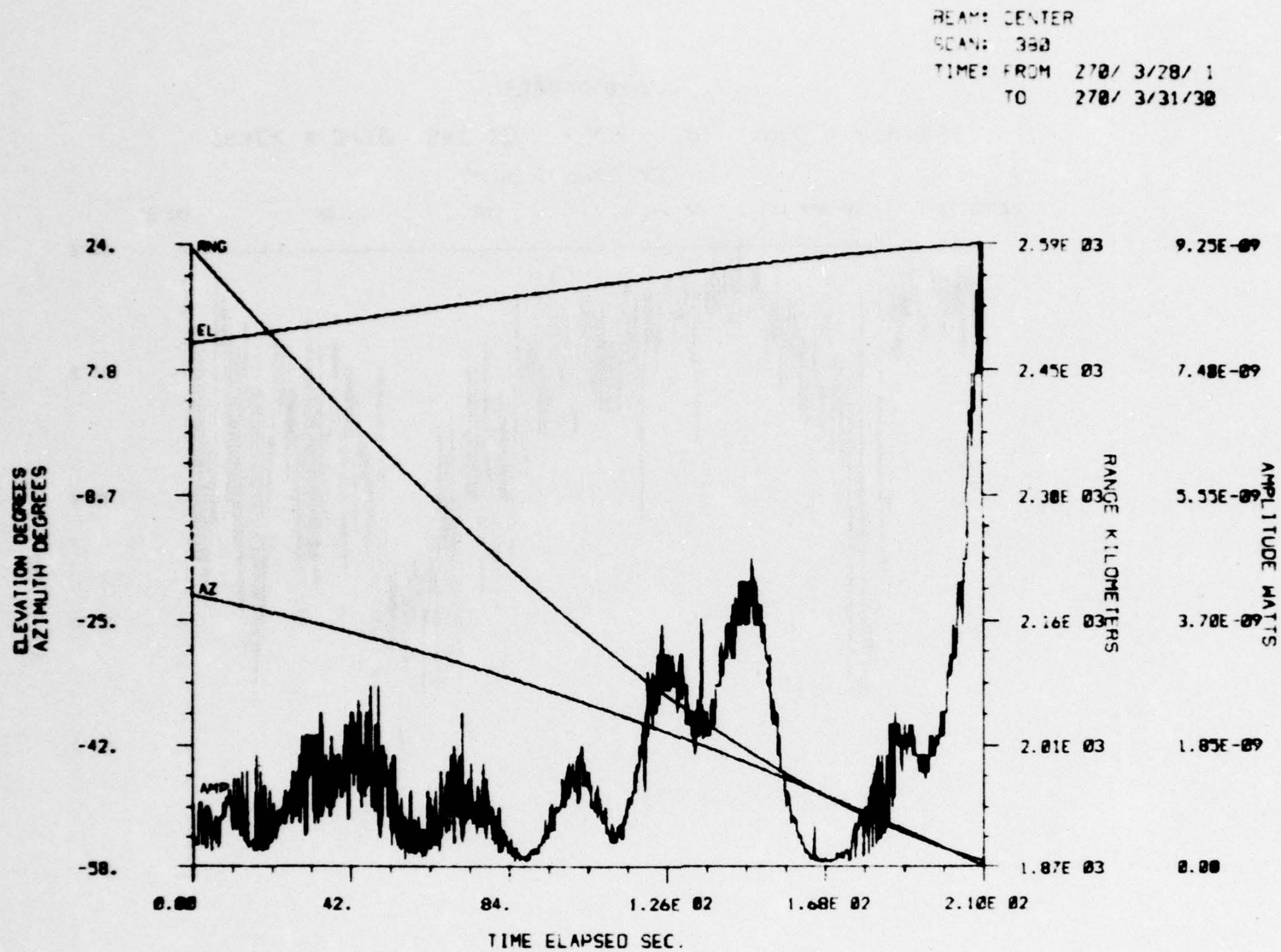
4.3.2 Edge Effects

In the analysis of the aspect sensitivity of various forms of the aurora, a sharp contrast between areas of intense aurora and areas only a few kilometers distant which exhibit no aurora was noticed. Close inspection of the maps generated revealed that, for some of these boundaries, a tapering of reflectivity indicative of the effects of aspect sensitivity exists. In other instances, a sharp cutoff of reflectivity was exhibited. The edge effect study is an attempt to explain the characteristics exhibited by different forms of the aurora, both as it tapers and as it suddenly disappears. The study is included as a part of the aspect sensitivity study currently being conducted.

4.3.3 UHF Noise Generation

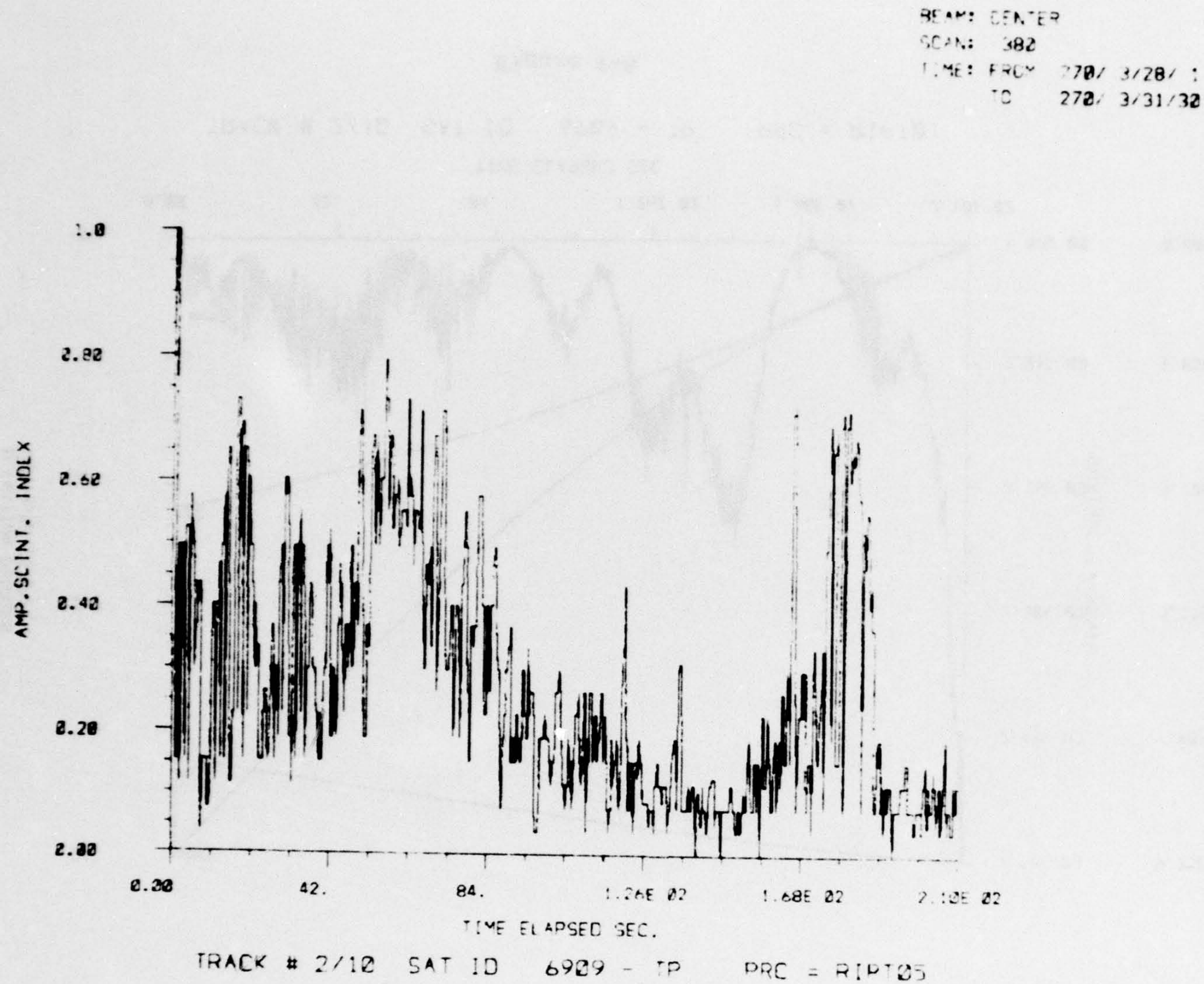
Several other workers have conducted studies of noise generation in the E Region. The effect of active noise generation in the aurorally perturbed ionosphere would be a possible source of degradation of signal-to-noise ratio of a radar or other communication system. A determination of these effects on radar has not, to our knowledge, been studied. The basic questions unanswered at this point include the following.

- Does the aurora, in its excited, most active phase, generate sufficient, if any, noise in the PAR frequency spectrum to effectively mask echoes returned from areas of the ionosphere outside the auroral zone?



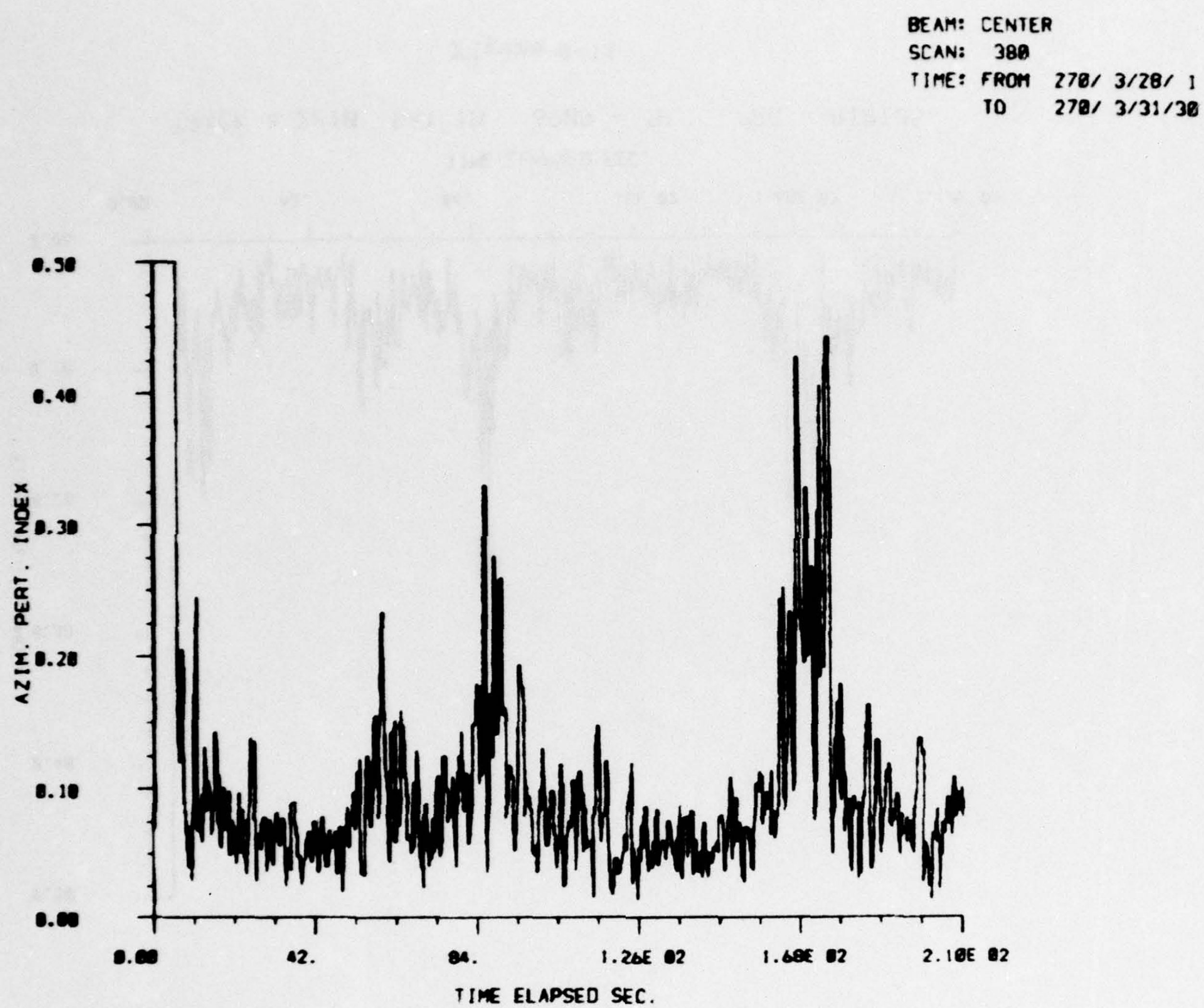
TRACK # 2/10 SAT ID 6909 - TP PRC = RIPT01

Figure 4-8



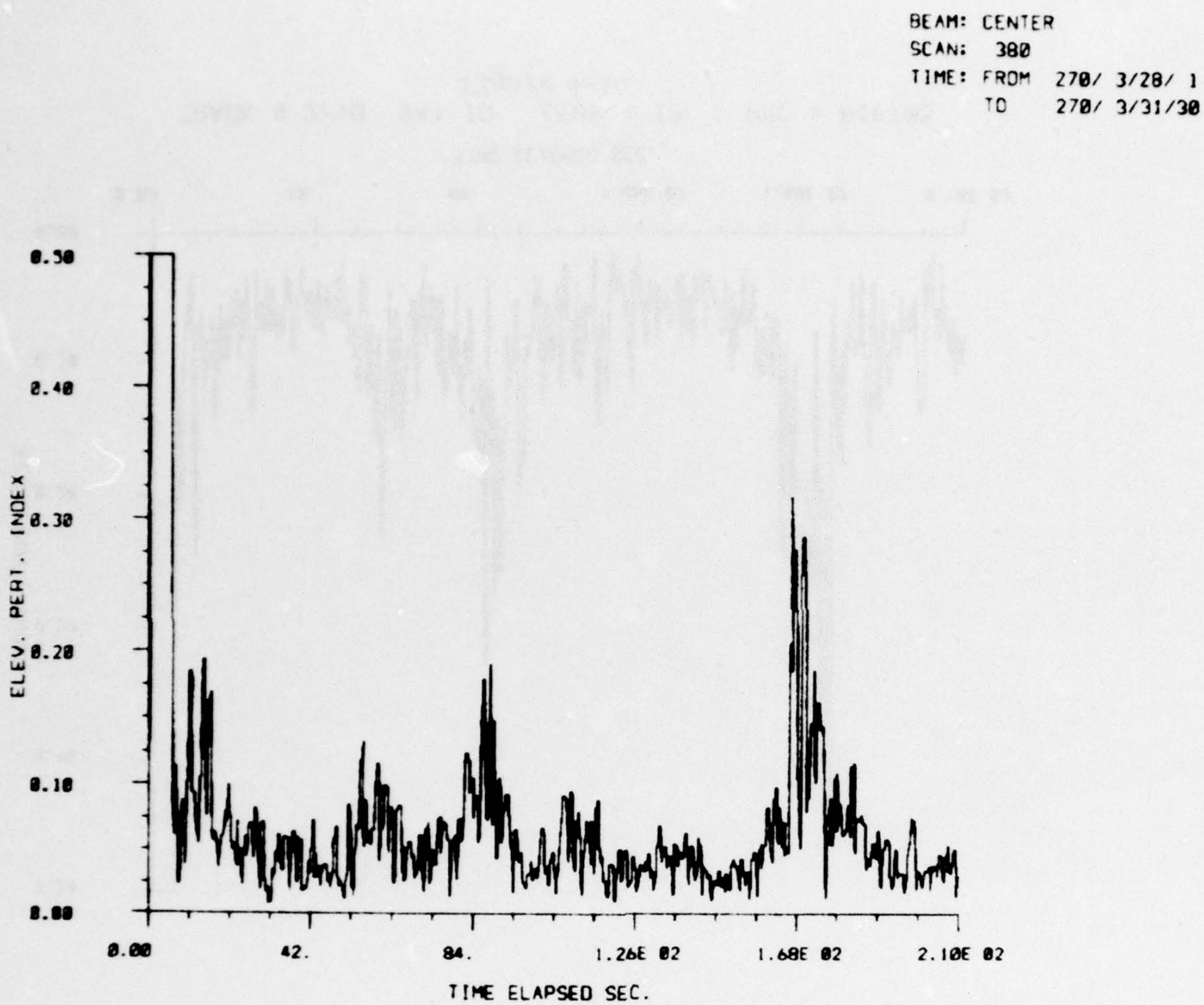
BEAM: CENTER
SCAN: 302
TIME: FROM 270/ 3/28/ 1
TO 270/ 3/31/30
1.0
0.80
0.60
0.40
0.20
0.00
AMP.SCINT. INDEX
0.00
42.
84.
1.26E 02
1.68E 02
2.10E 02
TIME ELAPSED SEC.
TRACK # 2/10 SAT ID 6909 - TP PRC = RIPT05

Figure 4-9



TRACK # 2/10 SAT ID 6909 - TP PRC = RIPT05

Figure 4-10



TRACK # 2/10 SAT ID 6909 - TP PRC = RIPTØ5

Figure 4-11

- Is the orientation of the PAR with respect to geomagnetic north related to the level of "sky noise" during the aurora, and does a significant portion of the noise emanate from the auroral zone?

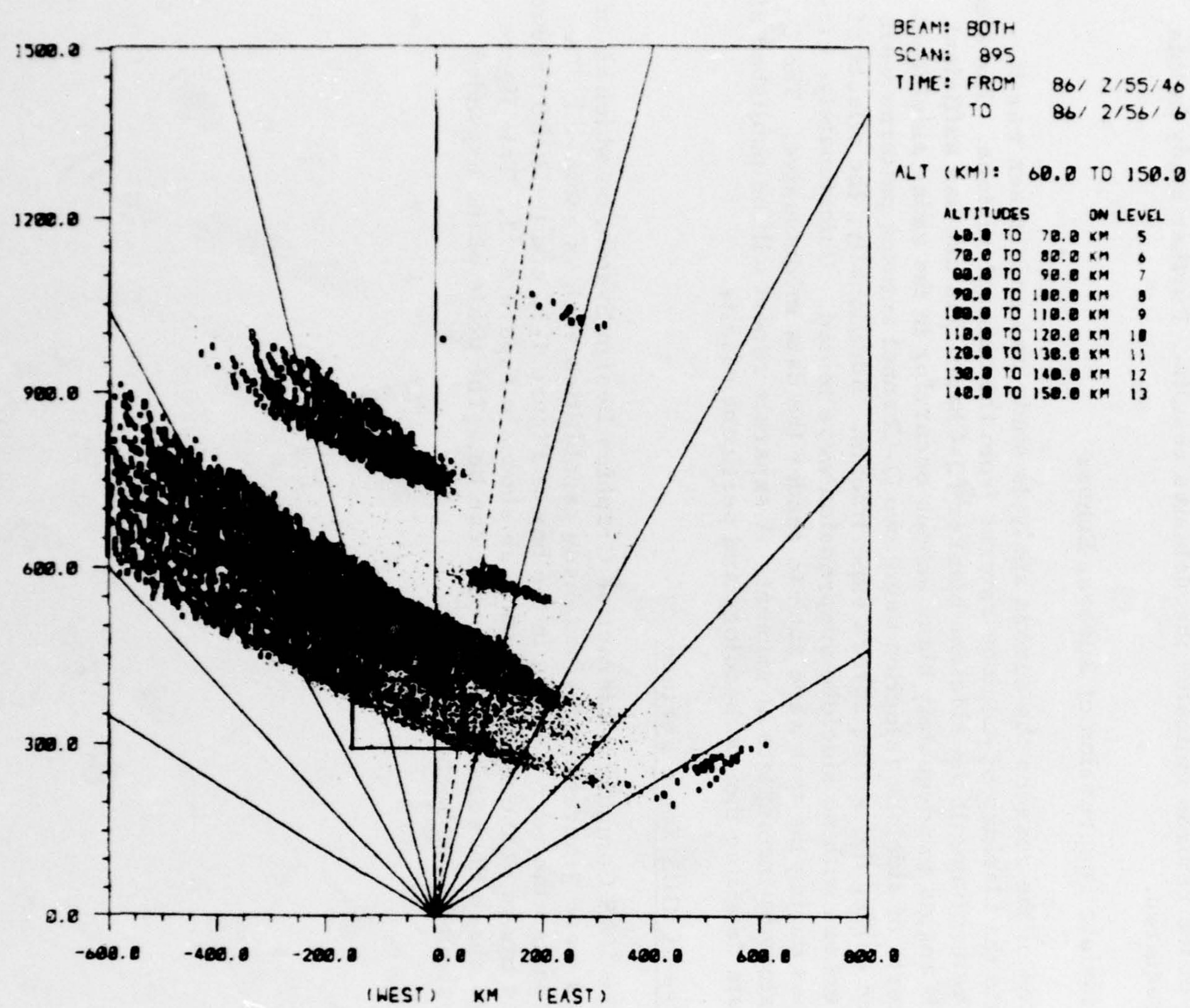
The study is incomplete at this time; however, preliminary analysis of intensity of the returns indicates inconclusive results. Further study in this area is required.

4.3.4 Sidelobe Suppression of Auroral Echoes

One of the reasons the aurora analysis study was undertaken was to investigate the blanking of sidelobe returns from the auroral regions. The study involved determining if the sidelobe blanker (Q-Channel) in use has sufficient gain at all angles to adequately blank echoes occurring in the radar sidelobes. Several tests of sidelobe rejection using two Q-Channel antenna patterns were performed during the spring aurora experiments. Additionally, the effects of sidelobe echoes with no sidelobe suppression were tested. Unfortunately, circumstances during the test were such to render the data inconclusive. The Q-Channel study is incomplete at present. A separate report will be published at a later date detailing the methodology and pertinent results.

4.4 Use of IGDS Zoom Feature

The M&S Computing Interactive Graphics Design System on which all of these plots were generated provides many capabilities such as zoom-in. The user designates the region shown in the box of Figure 4-12 and the IGDS produces a centered image at the expanded scale as shown in Figure 4-13. This figure shows how sharp the edges of the aurora can be. The scale of the expanded figure is about 25 km/inch.



TOP DOWN VIEW SHOWING AURORAL REFLECTIVITY

M&S OMPUTING

Figure 4-12

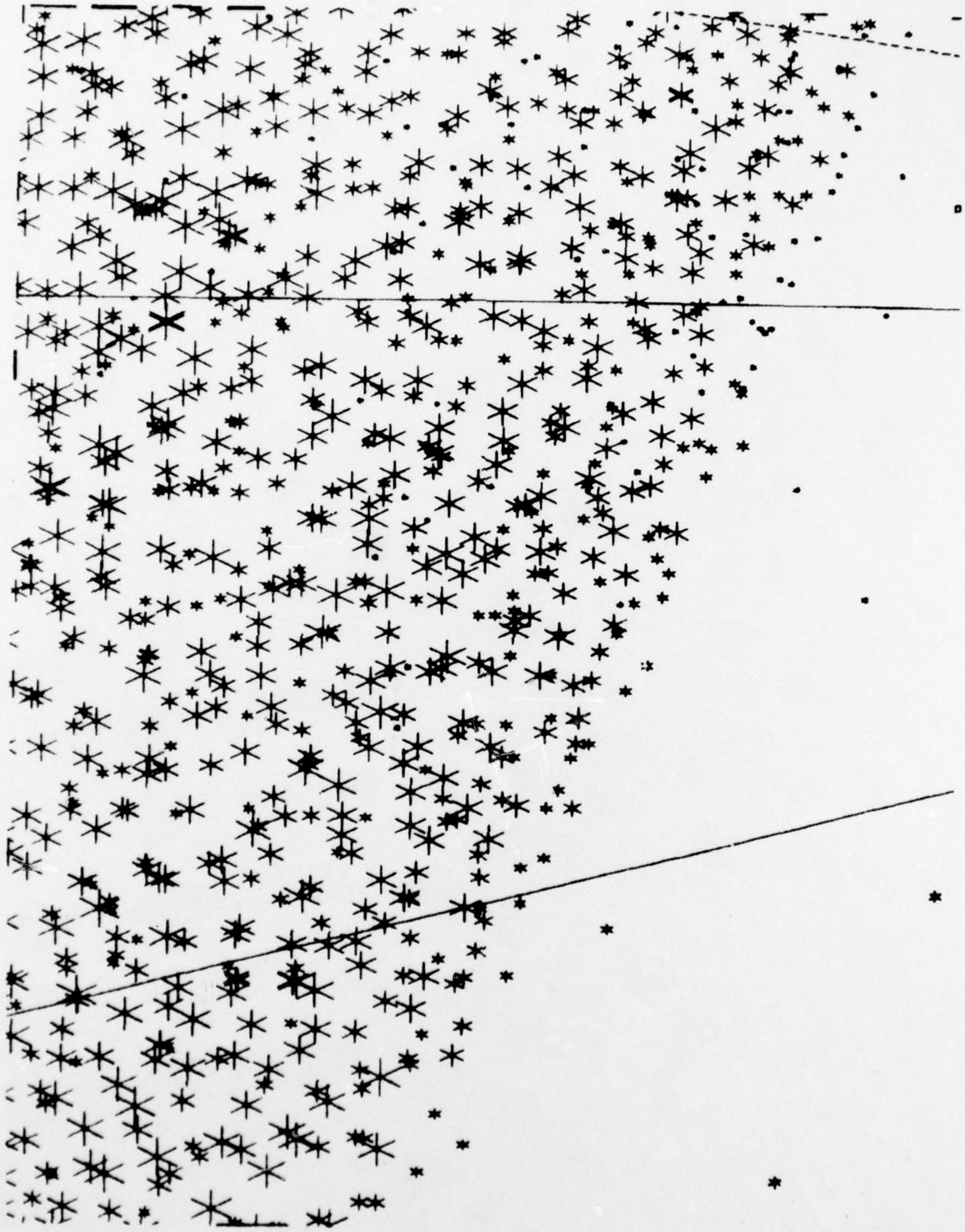


Figure 4-13

5. CONCLUSION

The data in this report has been presented with a minimum of explanation. It is intended to complement Volume I and depends heavily on that volume for background material and procedural explanations. Copies of Volumes I and II, as well as desired additional data including individual altitude slices of Top-Down's, azimuth slices of profiles, and expanded scale maps (blowups), also may be obtained.

LIST OF REFERENCES

1. C. G. Little, G. C. Reid, E. Stilner, and K. P. Merritt, "An Experimental Investigation of the Scintillations of Radio Stars Observed at Frequencies of 223 Mc/s and 456 Mc/s From Close to the Auroral Zone," Journal of Geophysical Research, Volume 67, 1763-1784, May, 1962.

2. Millstone Hill Radar Propagation Study, John V. Evans, ed., ESD-TR-73-259, 260, 261, Lincoln Laboratory, M.I.T., November, 1973.

   (Report prepared by Lincoln Laboratory for Office of the Chief of Research and Development, Department of the Army under Contract F19628-73-C-0002, and by Bell for U.S. Army SAFEGUARD under Contract DAHC60-71-C-0005).

3. PAR Auroral Study, Volumes I and II.

   (For the U.S. Army Ballistic Defense Command by M&S Computing, Inc.).