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Soil Moisture

GROUND REGISTRATION OF DATA FROM
AN AIRBORNE SCATTEROMETER

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GROUND REGISTRATION OF DATA FROM
AN AIRBORNE SCATTEROMETER

Job Order 71-323

This report describes activities of the Soil Moisture project
of the AgRISTARS program.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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PREFACE

The Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing is an 8-year program of research, development, evaluation, and application of aerospace remote sensing for agricultural resources, which began in fiscal year 1980. This program is a cooperative effort of the National Aeronautics and Space Administration; the U.S. Agency for International Development; and the U.S. Departments of Agriculture, Commerce, and the Interior.

The work which is the subject of this document was performed within the Earth Resources Research Division, Space and Life Sciences Directorate, at the Lyndon B. Johnson Space Center, National Aeronautics and Space Administration. Under Contract NAS 9-15800, personnel of Lockheed Engineering and Management Services Company, Inc., performed the tasks which contributed to the completion of this research.
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1. INTRODUCTION

Radar scatterometer measurements were taken by the National Aeronautics and Space Administration (NASA) C-130 aircraft at 1500 feet above ground level as part of the Agricultural Soil Moisture Experiment (ASME) near Colby, Kansas, on July 18, 20, 21, and 22 and on August 8, 9, and 11, 1978. These data are a measure of the efficiency of surface backscattering as seen from the sensor. Four radar scatterometers were mounted on the aircraft: 0.4, 1.6, 4.75, and 13.3 GHz. Their location on the aircraft is illustrated in figure 1. Each sensor collected data by looking aft with incidence angles between 5° and 50°. All angles were sensed simultaneously.

Soil samples from several layers were collected from preselected fields of approximately 40 acres on each of the 7 flight days. These samples were weighed, oven dried, and weighed again so that the moisture content of the layers could be calculated. They will be used for comparison with the scatterometer data.

The purpose of this report is to document a method of converting the scatterometer computer-compatible tape (CCT) data into disk files, wherein each file contains the date, the scatterometer data, and the ground reference position of the data within the sampled field. This conversion is accomplished by executing three programs on the National Advanced Systems AS/3000 computer, located in the Earth Observations Division Laboratory (EODL) in Building 17 at the NASA Lyndon B. Johnson Space Center (JSC). A listing and discussion of each program are given in this document.

2. REQUIRED INPUT DATA

As the plane flew down the flight line, the scatterometer data were recorded on tape in analog form. The tapes were sent to the Sensor Analysis Laboratory (SAL) in JSC Building 15. At the SAL, the analog data were subjected to a Doppler frequency shift filtering which separated the data by incidence angle. Then, the data were digitized and manipulated so that all incidence angles representing approximately the same target area were grouped together.
Figure 1. Bottom view of the NASA C-130 aircraft.
In the case of the Colby ASME, the output CCT's from the SAL contain four files for each sensor on each run over a flight line. Only files 1 and 4 are required by the programs described in this document. The two files containing sensor calibration and bandwidth information (files 2 and 3, respectively) are not used.

File 1 contains the aircraft's flight parameters. Each record in the file contains the roll angle, pitch angle, drift angle, altitude, ground speed, and true heading angle of the aircraft referenced by the Auxiliary Data Annotation System (ADAS) time of measurement. New aircraft flight parameters were measured approximately every six-tenths of a second. A listing of a sample file is shown in figure 2.

File 4 on the CCT contains the scatterometer data. Figure 3 is a sample listing of this file. Each record in the file contains the backscatter coefficients, in decibels, for approximately the same area as viewed from 10 different incidence angles. They are referenced by the ADAS time when the aircraft passed over or closest to the target area. If the drift angle is nonzero, the areas viewed at various angles are unregistered and decorrelated.

A great deal of aerial photography was collected at the Colby test site. Photographs taken at an altitude of 8000 feet were used to construct controlled strip mosaics of each flight line. Additional aerial photography was acquired as the aircraft collected scatterometer data at altitudes of 1000 and 1500 feet. The acquisition time and the frame number of every photograph were recorded on the analog data system. This made it possible to determine the aircraft's position at the frame times. The camera positions and frame numbers were plotted on transparent overlays by the JSC Cartographic Technology Laboratory. Additional overlays were made showing the location of the sampled fields in each flight line. All overlays were made at the same scale as the strip mosaics.
Figure 2.- A sample listing of the file containing the aircraft's flight parameters.
Figure 3.- A sample listing of the file containing the scatterometer data.
3. PROGRAM EXPLANATION

3.1 SCAT

The first program used to process the scatterometer data is a Fortran program called SCAT. A listing of the program and its execute file are given in the appendix. This program reads files 1 and 4 after they have been transferred from the CCT to a disk. The program uses these data to compute the intersection of the aircraft's negative z-axis with the ground in a scene-based coordinate system.

Three inputs from the terminal are requested by the program. The first input, AMISS, is the northward distance (in feet) of the plane from the southern field boundaries, if the flight line runs east-west, or westward from the eastern field boundaries for north-south flight lines, at the beginning of the flight line. The second input, YUP, is the crosstrack distance (in feet) that the airplane's position is from the reference field boundary at the end of the flight line. Figure 4 is a diagram of a flight line and shows the distances represented by AMISS and YUP. Both distances are measured (in millimeters) with the overlay on the strip mosaic. The final input requested is called CODE. It is a three-symbol numeric identifier for the day, sensor, and polarization of the data. The codes used for the Colby ASME are shown in table 1.

Program SCAT creates two output files. One file contains the downtrack and crosstrack locations of the airplane at each time that aircraft flight parameters were available. The second output file contains the scatterometer data and the location of the aircraft's negative z-axis intersection with the ground with respect to the beginning of the flight line. The file also contains the distance (in feet) of footprint decorrelation caused by aircraft drift. This distance represents the difference in crosstrack location of the 5° and 50° sensor footprints.
Figure 4. - A sample plot illustrating how and where to measure the variables AMISS and YUP.
TABLE 1.- CODES FOR THE COLBY SCATTEROMETER DATA

<table>
<thead>
<tr>
<th>Code</th>
<th>Day, 1978</th>
<th>Sensor, GHz</th>
<th>Polarization(^a)</th>
</tr>
</thead>
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<tr>
<td>1</td>
<td>199 - 7/18</td>
<td>13.3</td>
<td>VV</td>
</tr>
<tr>
<td>2</td>
<td>201 - 7/20</td>
<td>4.75</td>
<td>VH</td>
</tr>
<tr>
<td>3</td>
<td>202 - 7/21</td>
<td>1.6</td>
<td>HV</td>
</tr>
<tr>
<td>4</td>
<td>203 - 7/22</td>
<td>0.4</td>
<td>HH</td>
</tr>
<tr>
<td>5</td>
<td>220 - 8/08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>221 - 8/09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>223 - 8/11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)VV = vertical transmit and vertical receive, VH = vertical transmit and horizontal receive, HV = horizontal transmit and vertical receive, and HH = horizontal transmit and horizontal receive.

3.2 PLOT

The second program, PLOT, is a Statistical Analysis System (SAS) program. This program reads the two files output by program SCAT and produces a printer plot of the aircraft's ground track along with the corresponding 20° scatterometer data. The plot is at the same scale as the strip mosaics. The 20° incidence angle was chosen because it was judged to be most responsive to row direction effects. The advantage of this will be explained later in this paper. A portion of the plot is shown in figure 5, and a program listing is given in the appendix. At this point in the analysis, the scatterometer data are referenced by the distance (in feet) down track and the distance from the southern or eastern field boundaries, depending upon the direction of the flight line. It is necessary to know the ground reference position of the data within the sampled fields. This is accomplished by using the overlays in conjunction with the plot. Both overlays, one with photographic position and the other with field boundaries, are placed on the plot in the following manner. First, a time is found when the aircraft's flight parameters are available and when an aerial photograph was taken. The time represented by each asterisk in the flight path plot can be found by using the exclamation points plotted alongside. The exclamation points are time marks when the aircraft clock was at the
Figure 5.- A portion of the plot depicting the aircraft's ground track.
minute or a multiple of 10 seconds after the minute. Next, the overlays are placed on the plot so that the photographic position from the overlay is on top of the asterisk representing the same time. The solid line paralleling the plot of the flight path should be even with the southern field boundaries for an east-west flight or with the eastern field boundaries for a north-south flight. Figure 6 is an illustration of the plot with the overlays in place. The downtrack distance (in feet) of each field’s closest boundary to the beginning of the flight line is read from the plot. These distances, along with the dimensions of the corresponding fields, are written in a separate file. This file is used as an input to the next program.

When the procedure is carried out in the manner described above, a discrepancy may become apparent. If the overlay and plot were registered at an extreme end of the flight line, the overlay and plot positions will not necessarily correspond at the opposite end. This is due to a lack of sufficient accuracy in recording the airplane's flight parameters. Therefore, it is recommended that the overlay and plot be registered at several points along the flight line. The plot of the 20° scatterometer values is useful for a final, small adjustment in the alongtrack direction.

The row direction of the fields can be determined from the aerial photography. Since the 20° scatterometer angle is highly responsive to row direction effects, knowledge of how the row direction changes from field to field can aid in determining exactly which points fall in the sampled field.

3.3 GRID

The GRID program reads in the boundary data file, along with the file containing the scatterometer data that was created by program SCAT. A listing of this Fortran program and its execute file are given in the appendix. A separate output file is generated for each sampled field within the flight line. Each record in the file contains the distance (in feet) from the 30° footprint to the northern and the western field boundaries, along with the corresponding scatterometer data and decorrelation distance. The output files can then be combined in the manner which best suits the analysis techniques that will be used.
Figure 6.- Illustration of the plot of the aircraft's ground track with overlays indicating the photographic position and field boundaries.
APPENDIX

PROGRAM LISTINGS AND EXECUTE FILES
APPENDIX

PROGRAM LISTINGS AND EXECUTE FILES

A listing for program SCAT and its execute file are provided in figures A-1 and A-2, respectively. The listing for program PLOT is given in figure A-3. Figures A-4 and A-5 are respectively the listing and execute file for program GRID.
This is the first of three programs used to convert the scatterometer data tapes from the sensor analysis lab into a format that facilitates comparison to the soil moisture ground truth.

The input parameters from unit 10 are:

- F1 and F2 = contain the frequency of the sensor in A2 format
- ILINE = the number of the flight line
- IRUN = the number of the run
- IDAY = calendar day number
- POLAR = the polarization of the sensor data in A2 format
- ET = the elapsed time of the run
- IMIN = the number of minutes on the aircraft clock
- SEC = the number of seconds on the aircraft clock
- ROLL = the aircraft roll in degrees and tenths
- PITCH = the aircraft pitch in degrees and tenths
- DRIFT = a positive drift is when the nose is up
- ALT = the aircraft altitude in feet
- SPEED = the aircraft ground speed in knots
- HEAD = the aircraft heading in degrees and tenths
- ITEN = the elapsed time of the run
- MILE = the number of notes on the aircraft clock
- REC = the number of second on the aircraft clock
- SIGZ = an array that contains the scatterometer data for one footprint

The input parameters from unit 11 are:

- KMIN = the number of minutes on the aircraft clock
- SEC = the number of seconds on the aircraft clock
- SIGZ = an array that contains the scatterometer data for one footprint

The output parameters to unit 12 are:

- TOTX = the downtrack distance (in feet) of the aircraft
- TOTY = the footprint decorrelation distance
- SCATX = the downtrack distance (in feet) of the scatterometer data
- SCATY = the distance (in feet) to the southern/eastern field boundaries for the flight parameters
- ITEN = used to put time marks on the plot

The output parameters to unit 13 are:

- SMEAR = the footprint decorrelation distance
- SCATX = the downtrack distance (in feet) of the scatterometer data
- SCATY = the distance (in feet) to the southern/eastern field boundaries for the flight parameters
- K TEN = used to put time marks on the plot
- ISIGZ = an array that contains the scatterometer data for all angles in one field

These statements ask for and read information from the terminal:

```
WRITE(16,161)
161 FORMAT('INPUT AMISS AND YUP IN F3.0*F3.0')
READ(15,151)AMISS,YUP
151 FORMAT((F3.0,F3.0))
WRITE(16,162)
162 FORMAT('TYPE IN THE THREE NUMBER CODE FOR DAY/FREQ/POLAR')
READ(15,152)IC1,IC2,IC3
152 FORMAT(3I1)
YUP=(AMISS-YUP)/25.4*1000.0
AMISS=(AMISS/25.4)*1000.0
IC1=IC1*1.0
IC2=IC2*1.0
IC3=IC3*1.0
```

These statements read in and manipulate the aircraft data:

```
```

Figure A-1 - Computer listing for program SCAT.
FILE: SCAT FORTRAN A CONVERSATIONAL MONITOR SYSTEM

106 READ(10,106)FL,FLINE,IRUN,IOAY,POLAR
FORMAT(T17,A4,A2,T65,I12,T72,I12,T90,I12,T110,A2)
IF(LINE.EQ.01)CHGSN=1
IF(LINE.EQ.05)CHGSN=0
DO 15 M=1,2
15 READ(10,105)NUMMY
DO 16 IFLAG=0,1
6
READ(10,101)END=201,ET,MIN,SEC,ROLL,PITCH,DRIFT(I)+ALT,SPEED(I)
6 T5S,F,T2,T66,F6,2,T76,F,F6,2,T110,A2)
MIN=FLOAT(MIN)
ACSEC(I)=(MIN*4.0)*SEC
DTIM=FLOAT(ROLL)+3.141593/180.0
OFF=ALT*TAN(DTOR)
NUMBAC=1
MIN=MIN+100
SEC=SEC+SEC+10.0
ITIME(I)=ITIME(I)-1
IF(CHK.GT.30)IFLAG=2
IF(FLAG.GT.2)ITIME(I)=ITIME(I)-1
IF(FLAG.EQ.2)ACSEC(I)=ACSEC(I)-360.0
TRACT(I)=DRIFT(I)+HEAD
CONTINUE
20 YUP=YUP/ET*SPEED(NUMBAC)
14 HTOT=HTOPT(K)
14 HAVG=HTOPT/MM
C THESE STATEMENTS COMPUTE THE AVERAGE FLIGHT DIRECTION
14 NN=FLOAT(NN)
DO 14 IK=1,NN
14 HTOT=HTOPT(K)
14 HAVG=HTOPT/MM
C THIS SECTION COMPUTES THE LOCATION OF THE AIRCRAFT
DO 11 I=1,NUMBAC
11 TOD=0.0
11 JD=I
DO 18 KJ=10
18 JD=JD+1
18 JD=JD*(JD+1)/2
AVGD=((TOTAL/H1.0)*S141593/180.0
ELTIME=FLOAT(ITIME(I)-ITIME(I))/10.0
ANGLE=((NAVNG-TRACK(I))3.141593/180.0
YDIP=DISP*SIN(ANGLE)*CHGSN
11 YDIP=DISP*SIN(ANGLE)*CHGSN
11 TOTX(I)=TOTAL(I)+XDISP
11 TOTY(I)=TOTAL(I)+YDISP
11 TOTX(I)=TOTAL(I)+XDISP
11 TOTY(I)=TOTAL(I)+YDISP
11 CONTINUE
C THIS SECTION DETERMINES WHICH AIRCRAFT DATA IS AT 10 SECONDS
DO 8 I=2,NUMBAC
8 L=1
8 TEMP=ITIME(I)/100
8 DIFF=ITIME(I)-ITIME(I-1)
8 DIFF=ITIME(I)-ITIME(I-1)
8 CONTINUE
C THIS SECTION READS IN THE SIGMA-ZEKOIS
Figure A-1.- Continued.
A-3
DO 16 N=1,3
   READ(11),107,DUMMY
107 FORMAT(A4)
DO 2 K=1,510
   READ(11),102,END=202,KMIN,SEC,(SIGZ(M),M=1,10)
102 FORMAT(10I2,T8,F4.1,T16,1D9.5)
DO 17 N=1,10
   SIGZ(K+M)=IFIX(SIGZ(N)*10.0)
17 NUMBSO=K
   KMIN=FLOAT(KMIN)
   SCATS(K)=(KMIN/10.0)*SEC
   KM=KTIME(I)-KTIME(I-1)
   IF(KCHK.GT.30)KFLAG=1
   IF(KCHK.LT.-50000)KFLAG=2
   (KFLAG.EQ.1)KTIME(K)=KTIME(K)-400
   IF(KFLAG.EQ.2)SCATS(K)=SCATS(K)+500
202 CONTINUE
   THESE STATEMENTS COMPUTE WHICH SCATTEROMETER DATA IS AT 10 SECONDS
DO 9 K=1,NUMBS0
   KTEMP=KTIME(K)/100
   KDIFF=KTIME(K)-KTEMP*100
   MM=SIGZ(K+1)
   IF(KDIFF.GT.96)KDIFF=96
   IF(KDIFF.GT.0.0)KDIFF=0.0
   IF(KDIFF.GT.96)KDIFF=96
   IF(KDIFF.GT.0.0)KDIFF=0.0
9 CONTINUE
   THESE STATEMENTS FIND DOWNTRACK LOCATION OF THE SIGMA ZERO'S
   SCATX(K)=0.0
   SCATY(K)=0.0
   IF(SCATS(K).LT.ACSEC(I))GO TO 3
   IF(SCATS(K).LT.ACSEC(I))GO TO 33
   IF(KLENMUMAC)GO TO 203
   GO TO 32
33 RANGE=ACSEC(I+1)-ACSEC(I)
   RANGE2=SCATS(K)-ACSEC(I)
   RATIO=RANGE2/RANGE
   IF(1,F9.1)GO TO 13
   ALOFF=TOTX(L)-TOTX(L-1)
   YYOFF=TOTY(L)-TOTY(L-1)
   OCFF=DECOR(L)-DECOR(L-1)
   SCATX(K)=ALOFF*RATIO+TOTX(L-1)
   SCATY(K)=YYOFF*RATIO+TOTY(L-1)
   SNAME(K)=OCFF*RATIO+DECOR(L-1)
   SCATX(K)=TOTX(L)*RATIO
13 CONTINUE
   THESE STATEMENTS WRITE OUT THE FILES TO DISK
203 CONTINUE
   DO 4 I=1,NUMBAC
   WRITE(12,103)TOTX(I),TOTY(I),ITEN(I)
103 FORMAT(10F7.3,F4.0)
   DO 5 K=1,NUMBSO
   WRITE(13,104)C1,C2,C3,ILINE,IRUN,SMEAR(K),SCATX(K),SCATY(K)
5 CONTINUE
   FORMAT(15I11,1X,F4.0,1X,F6.0,1X,F5.0)
104 FORMATA(15I11,1X,F4.0,1X,F6.0,1X,F5.0)
STOP
END

Figure A-1.- Concluded.
EXEC A

FILE: SCAT

CONVERSATIONAL MONITOR SYSTEM

GLOBAL TITLE CMSLIB FORTHOD2
FILEDEF 5 READER (PERM
FILEDEF 6 DISK SCAT LISTING D (PERM RECFM F
FILEDEF 7 PUNCH (PERM
FILEDEF 10 DISK & PRATA D (PERM RECFM F LRECL 132 BLKSIZE 132
FILEDEF 11 DISK & PRATA D (PERM RECFM F LRECL 132 BLKSIZE 132
FILEDEF 12 DISK & YDATA D (PERM RECFM F LRECL 80
FILEDEF 13 DISK & YDATA D (PERM RECFM F LRECL 80
FILEDEF 14 TERMINAL (PERM
FILEDEF 15 TERMINAL (PERM
LOAD SCAT
START

Figure A-2.- Execute file for program SCAT.

A-5
FILE: PLOT

CONVERSATIONAL MONITOR SYSTEM

FILEOFF FILE1 DISK FILE4 YDATA1 B1
DATA PART1 PART21;
INFILE FILE1;
INPUT X Y TIC;
IF TIC = 0.0 THEN TIC = 1;
YMIC = (Y1 + 10.0) / 3.0 + 1000.0;
IF YMIC = 0.0 THEN YMIC = 1;
Y2 = YMIC + 1000.0;
YMIC2 = (YMIC / 3.0) * 1000.0 + 4000.0;
DROP YMIC AA1;
IF X LE 20000 THEN OUTPUT PART31;
IF X GE 20000 THEN OUTPUT PART41;
DATA PART3 PART41;
INFILE FILE4;
INPUT X Y TIC;
IF TIC = 0.0 THEN TIC = 1;
YMIC = (Y1 + 10.0) / 3.0 + 1000.0;
IF YMIC = 0.0 THEN YMIC = 1;
Y2 = YMIC + 1000.0;
YMIC2 = (YMIC / 3.0) * 1000.0 + 4000.0;
DROP YMIC AA1;
IF X LE 20000 THEN OUTPUT PART31;
IF X GE 20000 THEN OUTPUT PART41;
DATA PLOT1;
MERGE PART1 PART31
BY XI;
DATA PLOT2;
MERGE PART2 PART41
BY XI;
PROC PLOT DATA=PLOT1;
PLOT X*Y=*** X*YMIC=** X*YMIC2=** /OVERLAY
MAXIS=3000 TO 9000 BY 1000
VAXIS=0 TO 40000 BY 1000
HSPACE=10 VSPACE=8
VPFF=0 TO 40000 BY 5000
VP0S=350;
PROC PLOT DATA=PLOT2;
PLOT X*Y=*** X*YMIC=** X*YMIC2=** /OVERLAY
MAXIS=2000 TO 62000 BY 1000
VAXIS=0 TO 62000 BY 1000
HSPACE=10 VSPACE=8
VPFF=0 3000 3150 7333
VP0S=350;

Figure A-3.- Computer listing for program PLOT.
THIS PROGRAM IS THE THIRD OF THREE Programs USED TO PROCESS THE COILY ASHE SCATTEROMETER DATA. THIS PROGRAM SEPARATES THE DATA INTO FILES FOR EACH SAMPLED FIELD ALONG THE FLIGHT LINE.

FILE: GRID FORTRAN A OF POOR QUALITY CONVERSATIONAL MONITOR SYSTEM

THE INPUT VARIABLES FROM UNIT 9 ARE:
- CODE = SEE TABLE IN TEXT FOR EXPLANATION
- IFLD = THE FLIGHT LINE NUMBER
- IRUN = THE NUMBER OF THE RUN
- DECORR = THE DECORRELATION DISTANCE (SEE TEXT)
- SCATX = THE DOWNTREK DISTANCE (IN FEET) OF THE DATA BOUNDARIES
- SCATY = THE DISTANCE TO THE SOUTHERN/EASTERN FIELD BOUNDARIES
- ISIGZ = THE ARRAY CONTAINING THE SCATTEROMETER DATA

THE INPUTS FROM UNIT 10 ARE:
- IFLD = AN ARRAY CONTAINING THE NUMBERS OF THE SAMPLED FIELDS IN THE FLIGHT LINE
- START = THE DOWNTRACK DISTANCES OF THE FIELDS IN THE LINE
- XWIDE = THE LENGTH OF THE FIELDS (ALONGTRACK)
- YWIDE = THE WIDTH OF THE FIELDS (CROSSTRAZ KC)

THE OUTPUT VARIABLES ARE:
- CODE = IF LD, IFLD, IRUN = SEE ABOVE
- SMEAR = THE DECORRELATION DISTANCE
- X = NUMBER OF FEET FROM NORTHERN FIELD BOUNDARY
- Y = NUMBER OF FEET FROM THE WESTERN FIELD BOUNDARY
- SCAT = THE ARRAY OF THE SCATTEROMETER DATA

INTENDED TO IF LD, ISIGZ(S1010), SCATX(S10), SCATY(S10)
REAL DECORR(S10), SCATX(S10)
REAL

READ THE INPUT FILES

READ(9,100)IC1,IC2,IC3,ILINE,IRUN,DECORR(K),SCATX(1),SCATY(1)
6 ISIGZ(L,N),N=1,10
100 FORMAT(1X,9I1,1X,5F4.0,6X,10I4)
DO 1 M=2,10
READ(10,101)CORELL(M),SCATX(M),SCATY(M),(ISIGZ(M,N),N=1,10)
101 FORMAT(6X,10X,F4.0,6X,10I4)
SCATY(M)=SCATY(M)+630.0
1 CONTINUE
11 DO 2 M=1,15
READ(10,102)END=M,START(M),XWIDE(N),YWIDE(N)
102 FORMAT(1X,9I1,1X,5F4.0,6X,10I4)
2 IFLD=10
M IS THE COUNTER FOR INPUT FILE 10
12 M=1

THIS SECTION LOOKS FOR THE BOUNDARIES IN THE DATA

DO 3 K=1,NUMB
IF(SCATX(M).LT.START(M))GO TO 3
LIM
END=START(M)+XWIDE(M)
3 CONTINUE
DO 4 N=1,10
IF(SCATX(L).GT.END)GO TO 44
4 L=L+1
44 L=L-1
ARANGE=SCATX(L)-SCATX(K)

THIS SECTION SETS UP THE FIELD DIMENSIONS

NPTS=L-K+1
BTNN=0.0
X=WIDE(N)
Y=WIDE(N)
2 *FILNE=EQ.1)X=0.0
2 *FILNE=EQ.4)X=0.0
2 *FILNE=GE.6)Y=0.0

Figure A-4.- Computer listing for program GRID.
IF(ILINE.GT.416)GO TO 45

45 EDGE=(YWIDE(M)-ARANGE)/2.0

DO 7 M=1,NPTS
   NUM=L-N+1
   X(N)=IFIX(ABS(XW-EDGE+BTN))
   Y(N)=IFIX(YWIDE(M)-SCATY(NUM))
   SMEAR(N)=IFIX(DECRP(NUM))
   DO 6 N=1,10
      SCAT(N,NN)=ISIGZ(NUM,NN)
      KTR=L-N
      BTN=SCATX(L)-SCATX(KTR)
   6 CONTINUE
   GO TO 55

55 CONTINUE

THIS SECTION IS FOR LONGITUDINAL FLIGHT LINES

45 EDGE=(YWIDE(M)-ARANGE)/2.0

DO 7 M=1,NPTS
   NUM=L-N+1
   X(N)=IFIX(ABS(XW-SCATY(NUM)))
   Y(N)=IFIX(ABS(YW-EDGE+BTN)))
   SMEAR(N)=IFIX(DECRP(NUM))
   DO 6 N=1,10
      SCAT(N,NN)=ISIGZ(NUM,NN)
      KTR=L-N
      BTN=SCATX(L)-SCATX(KTR)
   6 CONTINUE

55 CONTINUE

PREPARE TO WRITE THE OUTPUT FILES

55 IUNIT=10*M

WRITE OUT THE FIELDS COMPUTED IN THIS PROGRAM

DO 22 KK=1,NPTS
   X(KK)=IFIX(ABS(XW-SCATY(NUM)))
   Y(KK)=IFIX(ABS(YW-EDGE+BTN)))
   SMEAR(KK)=IFIX(DECRP(NUM))
   WRITE(IUNIT,111)X(KK),Y(KK),SCAT(KK,1)...
111 FORMAT(3I11,2X,11I11,11I2,I14,1I4,I14,10I4)

3 CONTINUE

STOP

END

Figure A-4.- Concluded.
FILE: GRID EXEC A

A CONTROL OFF
A ERROR GOTO -ERR
A REMOTE E TO HOUSTON
A SPool E HOLD
A GLOBAL TXTLIB CMSLIB FORTRAN
A FORTRAN GRID
A FILEDEF 5 READER (PERM
A FILEDEF 7 PUNCH (PERM
A FILEDEF 8 TERMINAL (PERM
A FILEDEF 10 DISK & YDATA A (PERM RECFM F LRECL 80
A FILEDEF 11 DISK & ZDATA A (PERM RECFM F LRECL 80
A F 12 ED 1 GOTO -DONE
A FILEDEF 12 DISK & ZDATA A (PERM RECFM F LRECL 80
A FILEDEF 13 DISK & ZDATA A (PERM RECFM F LRECL 80
A FILEDEF 14 DISK & ZDATA A (PERM RECFM F LRECL 80
A FILEDEF 15 DISK & ZDATA A (PERM RECFM F LRECL 80
A FILEDEF 16 DISK & ZDATA A (PERM RECFM F LRECL 80
A FILEDEF 17 DISK & ZDATA A (PERM RECFM F LRECL 80
A FILEDEF 18 DISK & ZDATA A (PERM RECFM F LRECL 80
A FILEDEF 19 DISK & ZDATA A (PERM RECFM F LRECL 80
A FILEDEF 20 DISK & ZDATA A (PERM RECFM F LRECL 80
A FILEDEF 21 DISK & ZDATA A (PERM RECFM F LRECL 80
A FILEDEF 22 DISK & ZDATA A (PERM RECFM F LRECL 80
A FILEDEF 23 DISK & ZDATA A (PERM RECFM F LRECL 80
A TYPE NOT ENOUGH FILEDEF'S IN EXEC
A EXIT
A ERR & TYPE ERROR ENCOUNTERED IN DEFINING FILES
A EXIT -DONE & TYPE &2 OUTPUT FILES HAVE BEEN DEFINED
A LOAD GRID
A START

Figure A-5.- Execute file for program GRID.