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Map, Time Series and other Plotting Routines for Use with the Stromberg-Carlson 4020 Plotter

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SUMMARY

This report describes six plotting packages for use with the SC4020 plotter. Three of the packages are for plotting maps, two for plotting time series and one for general cartesian co-ordinate graphs. A routine for drawing dotted lines is also described.

1. INTRODUCTION

In the past few years the UKAEA Seismology Group at Blacknest have been developing various plotting routines for use with the SC4020 plotter in conjunction with the IBM7030 (STRETCH) computer. These routines have been designed specifically for plotting seismic data but they can be used for plotting other data. This report describes the routines and their use as they may be of value to other computer users.

Six plotting packages are described; three are for plotting maps:-

APMAP - plots maps on an azimuthal great circle projection

MERCAT - plots maps on a mercators projection

MPLOT - plots maps on an orthographic projection;

two packages are for plotting time series data:-

TIMSER - plots data for a single time series

CHAN - plots up to 20 channels of data;

the remaining package is

CARGRF - plots data on a cartesian co-ordinate graph.

A series of subroutines for plotting dotted lines is also given.

In what follows it is assumed that the main program of the deck which calls one of these plotting routines has

CALL SCLIBR

as its first executable statement and that the appropriate SC4020 card has been included in the data deck.

2. MAPPING ROUTINES

The basic data of all the mapping routines is a library of shoreline co-ordinates defining the major land areas, islands and the larger inland bodies of water. These co-ordinates were compiled by

Dr. A.V. Hershey of the Naval Weapons Laboratory at Dahlgren, Virginia. The co-ordinates are expressed relative to three rectangular axes with origin at the centre of the earth; the earth is assumed to be a sphere of unit radius.

These rectangular co-ordinates have been converted to degrees and minutes latitude and longitude (positive north and east, negative south and west) and stored on punched cards; a listing of these cards is given in appendix C.

A second binary tape has been prepared containing these latitude and longitude points. The binary tape of latitude and longitude points is used as input to APMAP and MERCAT; the original tape is used as input to MPLOT.

Each land area or enclosed water body is defined as a loop of points, starting and finishing at the same co-ordinate. The end of each loop is defined by a series of nines.

2.1 APMAP

Comprises subroutines APMAP

APCOD

APPOL

This package plots maps on an azimuthal great circle projection. The centre point of the map, the origin, is specified and the co-ordinates of the coast lines and latitude and longitude lines are then converted to polar co-ordinates (θ',ϕ') relative to the centre point, where θ' is the angular distance subtended at the centre of the earth by the arc joining the origin and the point (θ',ϕ') and ϕ' is the azimuth of the point (θ',ϕ') relative to the origin (measured clockwise from north). The co-ordinates (θ',ϕ') are then converted to cartesian co-ordinates and scaled for plotting on the SC4020. The equations for computing θ' and ϕ' given the latitude and longitude of the centre point and the latitude and longitude of the point (θ',ϕ') have been derived by Mr. C.E. Wright (private communication) and are given with their derivation in appendix A.

The calling statement for APMAP is

CALL APMAP (IFRAME,DIST,CLAT,CLONG,NLAT,NLONG,ISEL,TITLE,KEY) where

DIST is the radius of the map to be plotted - in degrees (normally 180°).

CLAT and CLONG are the latitude and longitude of the centre point (positive north and east, negative south and west).

NLAT AND NLONG is the required spacing of the latitude and longitude grid (normally 10°).

ISEL is an indicator as follows:-

ISEL = 1 graticules, shorelines and data produced on separate frames

= 2 graticule only

= 3 shoreline only

= 4 composite picture (ie, full map).

There are also various specialised options (see listing appendix B).

KEY is the size of the title to be printed

IFRAME specifies the type of output:-

IFRAME = 0 output on hard copy

IFRAME = 1 output on microfilm

IFRAME = 2 output on hard copy

IFRAME = 3 output on microfilm and hard copy.

Once APMAP has been called the following subroutines can be used to plot points on the map:-

CALL APCŌD(X,Y,ALAT,ALŌNG) - converts the latitude and longitude, ALAT and ALŌNG, to X and Y SC4020 raster units which can then be used to plot a character by SC4020 subprograms.

CALL APPŌL(X,Y,DIST,ANGLE) - converts the polar co-ordinates DIST and ANGLE (north through east) to X and Y SC4020 raster units.

The graticule spacing is defined by NLAT and NLŌNG but the plotting interval for each line is decided by the program. The package picks a plotting interval and checks to see if the resulting SC4020 vector length is between 4 and 8 raster units; if it is, the vector is drawn, if it is not the vector is reduced or increased until the length does lie within the limits. This ensures that the graticule is evenly plotted at the centre as well as at the edge of the map. When the radius of the map is less than 180° the graticule is computed as for 180° and the vector lengths then scaled up and plotted. This means, for example, that the vector length varies between 8 and 16 units for a 90° radius map but because the grid lines are less curved there is no loss of definition.

APMAP can be used to produce standard maps through the calling sequence as described above. However by using the COMMON/SCOMON/ and the indicator ISEL, special purpose maps can be produced (see listing appendix B).

Typical maps drawn by APMAP are given in figures 1 and 2.

2.2 MERCAT

Comprises subroutines MERCAT

MERCŌD

This package plots a world map on a mercators projection. The map is plotted to 84° north and south; higher latitudes are plotted at 84°. The calling statement is

CALL MERCAT (IFRAME,NLAT,NLŌNG,ISEL)

where

IFRAME specifies the type of output

IFRAME = 1 output on microfilm

IFRAME = 2 output on hard copy

IFRAME = 3 output on hard copy and microfilm.

NLAT and NLŌNG is the spacing of the latitude and longitude grid required (normally 10° and 20°).

ISEL determines the following:-

ISEL = 0 advances frame

ISEL = 1 produces graticules, shorelines and data on separate frames

ISEL = 2 plots graticule only

ISEL = 3 plots shorelines only

ISEL = 4 produces composite picture.

From the CALL MERCŌD(X,Y,ALAT,ALŌNG) the latitude and longitude ALAT and ALŌNG (positive north and east, negative south and west) are converted to X and Y SC4020 raster units which can then be used to plot a character by the usual SC4020 subprograms.

The normal projection produced by MERCAT is centred on Greenwich and the Equator but a special version of the program produces maps centred on 180°W and the Equator (see listings appendix B).

The formula used by MERCAT is taken from Steers (1956). Latitude lines in SC4020 raster units are the lines

$Y = R \log_e (\sec(ALAT) + \tan(ALAT))$ where $R = \frac{1024}{2\pi}$.

Longitude lines are evenly spaced.

Figures 3 and 4 show examples of maps drawn with MERCAT.

2.3 MPLŌT

This program is based on an American program of the same name written by H.L. Baldwin Jnr, and described in "Orbit Display Using the

SC4020" (Baldwin (1963)). Basically designed for plotting satellite orbits the projection is orthographic, ie, it gives a picture of the earth as seen from space. A subprogram has been added to the original package to plot points given the latitude and longitude.

A listing of MPLŌT is given in appendix B. For detailed instruction on using the program the reader is referred to the original publication (Baldwin (1963)).

Examples of maps drawn by MPLŌT are given in figures 5 and 6.

3. TIME SERIES PLOTTING ROUTINES

3.1 TIMSER

Comprises subroutines TIMSER

RECŌRF

AMAX

AMIN

This plotting package plots N values of an array X, where X is a time series sampled at equal intervals. A typical output is shown in figure 7; the time series is divided into convenient lengths and plotted across the SC4020 frame, 3 lengths to a frame. The program continues on to successive frames until all N points have been plotted. If N is less than 100 an expanded time base is used.

The statement

```
CALL TIMSER(TITLE,X,N,DELA,IF)
```

causes N values of X to be plotted. DELA is the sampling interval and IF is an indicator which specifies the type of SC4020 output required.

If IF = 1 output is on microfilm

IF = 2 output is on hard copy

IF = 3 output is on both microfilm and hard copy.

TITLE is a 20 element array carrying data for annotating the output graphs. The TITLE array should be set up as follows:-

TITLE (1) - unused

TITLE (2) - unused

TITLE (3) - contains 8 Hollerith characters giving units of the time series, eg, SECONDS

TITLE (4) - unused

TITLE (5) - unused

TITLE (6) -)
  .)
  .) contains 80 Hollerith characters giving
  .) a title to the graph
TITLE (15)-)

TITLE (16) - contains 8 Hollerith characters giving the date of processing

TITLE (17) -)
  .)
  .) contains 24 Hollerith characters giving a
  .) subtitle to the graph
TITLE (19) -)

TITLE (20) - unused.

Note: the statement

CALL SDATE(TITLE (16)) will cause the date of processing to be stored in TITLE (16) as required.

Figure 7 shows a typical output from TIMSER.

3.2 CHAN

Comprises subroutines CHAN

PMULTI

SCHAN

TCHAN

PEN

AMAX

AMIN

This package plots up to 20 channels of a double suscripted array, X(I,J) where J defines the channel number and I the sample number in the Jth channel. The data are assumed to be sampled at equal intervals.

Five channels are plotted to a frame; the time axis is parallel to the y axis of the plotter. Successive frames are used until all the data in the first five channels are plotted. The program then switches to the next five channels and plots them. This process is repeated until all the data are plotted.

As described here the package uses the following COMMONS:-

COMMON X (3400, 20)

COMMON/GRAPH/TITLE(35), DELA

Most of the machine storage is therefore taken up by the X array. The user should modify the dimensions of the X array (subroutines CHAN and PMULTI) to suit his needs; the number of samples per channel is limited only by the machine size, the number of channels must be less than 20. If the number of samples per channel is increased beyond 3400 the dimensions of the TT array (subroutines SCHAN, TCHAN and PMULTI) must be correspondingly increased.

COMMON/GRAPH/ contains the array TITLE, which carries information for annotating the output, and DELA, the sampling interval of the time series.

The TITLE array is constructed as follows (note this TITLE array differs from that used previously in TIMSER):-

TITLE (1) - TITLE (J) - TITLE (20) -	Each element carries an 8 character title describing the data in the channel
TITLE (21) - TITLE (30) -	Carries 80 Hollerith characters giving a title to the output
TITLE (31) -	Carries 8 Hollerith characters giving units of time series
TITLE (32) -	Carries 8 Hollerith characters giving date of processing (cf, TIMSER:TITLE (16)).

The calling statement for this package is

CALL CHAN (N, NC, IF, IND)

This causes N points from the first NC channels of the X array to be plotted. IF is again an indicator to specify the type of output required:-

IF = 1 output is on microfilm

= 2 output is on hard copy

= 3 output is on both microfilm and hard copy.

IND is an indicator; if set to 1 the maximum amplitude in each channel is scaled to the full range available; if set to 2 the maximum range of the X array is scaled to the full range available.

Setting IND to 1 destroys the original data in the X array, plotting using CHAN should therefore be done only when all required computation has been carried out on X - this restriction does not apply if IND is 2.

Figures 8 and 9 show typical outputs from CHAN.

4. CARTESIAN CO-ORDINATE GRAPHS - CARGRF

Comprise subroutine CARGRF

SCALEN

PŌSMIN

CLŌG

AMAX

AMIN

This package plots N points, the cartesian co-ordinates of the J^{th} point being specified as X(J),Y(J). The calling statement is

CALL CARGRF(X,Y,N)

The package uses the COMMON:-

COMMON/GRFF/TITLE(20),XMAX,XMIN,YMAX,YMIN,INDX,INDY,IND,IDŌT,

ANSTR1, IF, XLIMIT,YLIMIT,SCALX,SCALY

This COMMON must be set up as follows before CALL CARGRF(X,Y,N).

The TITLE array carries information for annotating the output graph. Setting up the array is identical to setting up the TITLE array for TIMSER except:-

TITLE (1) -)
.)
.) Contains 24 Hollerith characters giving the
.) units of the abscissae
TITLE (3) -)

TITLE (4) -)
) Contains 16 Hollerith characters giving the units
TITLE (5) -) of the ordinate.

XMAX and XMIN are the maximum and minimum values of the horizontal (X) scale. If both XMAX and XMIN are set to zero the program finds its own maximum and minimum values. By setting XMAX and XMIN to values of the programmer's choosing the limits of the horizontal axis can be constrained to a chosen value. Note: the program will not usually choose a scale that extends exactly from XMIN to XMAX but will select a rather larger range to fit a more convenient scale.

YMAX and YMIN are the equivalent parameters for the Y scale.

INDX is in indicator for plotting the abscissae on a log scale:-

INDX = 1 abscissae on linear scale

INDX = 2 abscissae on log scale.

Should the X array contain a zero or negative value when a log scale is requested the program will simply ignore the negative and leave a blank on the graph. If all the values of the X array are negative or zero when logs are requested the program prints out an error message to this effect and calls EXIT. Similarly for INDY and the Y array.

Also, a CARGRF call with INDX set to 2 converts the X array to logs and this array is returned as logs to the calling program. Similarly for the Y array.

IND is an indicator for controlling frame calls and finish calls, thus,

IND = 0 CARGRF calls ADVFLM(IF) and FINISH

= 1 CARGRF calls ADVFLM(IF) but not FINISH

= 2 CARGRF calls neither FINISH nor ADVFLM(IF)

IDOT is the SC4020 code of the plotting symbol required, eg,

if IDOT = 44 points will be parked with an asterisk

IDOT = 16 points will be marked with a plus sign

IDOT = 48 points will be left blank.

A table of all codes available is given in appendix D.

ANSTR1 indicates whether the plotted points have to be joined up

ANSTR1 = 1. points not joined

= 2. points joined

IF specifies the type of output:-

IF = 1 output on microfilm

IF = 2 output on hard copy

IF = 3 output on both microfilm and hard copy.

The indicator IND allows several lots of data to be plotted on the same graph and to the same scale as is illustrated by the figures 10 and 11.

If only one lot of data has to be plotted IND is set to 0 and CARGRF completes the graph. If two sets of data are to be plotted CARGRF is called twice; before the first call IND is set to 1, before the second IND is set to 2. By changing the plotting code between the two calls the two sets of data can be distinguished by different symbols. If more than two data blocks have to be plotted on the same graph, CARGRF is called for each block; IND is set to 1 before the first call, to 2 before the last call and to 3 for all the intermediate calls. At any time after the first call of CARGRF (with IND = 1) and before the last (with IND = 2) any other points or annotations can be added to the graph directly from the calling program. For example the dotted lines in figure 10 and the labels SIGNAL NUMBER 1 and SIGNAL NUMBER 2 in figure 11 were added between CARGRF calls. To convert a point P,Q to SC4020 raster units XPLOT1, YPLOT1, outside CARGRF the following statements should be used:-

```
XPLOT1 = (P - XLIMIT)*SCALX + 123.

YPLOT1 = 923.  - (Q - YLIMIT)*SCALY
```

These statements must come after at least one call of CARGRF because XLIMIT, YLIMIT, SCALX and SCALY are not set up until CARGRF has been called.

Once CARGRF has been called all succeeding graphs will be plotted on the same scale unless XMAX, XMIN, YMAX and YMIN are set to new values. If the program has to choose a new scale, XMAX etc should be set to zero.

5. DOTTED LINE ROUTINES - DŌTLIN

Comprises subroutines DŌTLIN

AXDL

The statement

```
CALL DŌTLIN(X1, Y1, X2, Y2)
```

causes a dotted line to be drawn between the points X1, Y1 and X2, Y2, where X1, Y1 and X2, Y2 are in SC4020 raster units. DŌTLIN must only be called between an ADVFLM call and a FINISH call.

6. ACKNOWLEDGMENTS

The authors would like to thank Dr. J.G.T. Jones for the copy of the MPLOT program and the binary tape of the shorelines.

REFERENCES

J.A. Steers: "An Introduction to the Study of Map Projection". Tenth ed. University of London Press Ltd (1956)

H.L. Bladwin: "Orbit Display Using the SC4020". General Dynamics/ Astronautics Report No. GD/A 63-0459 (5 July 1963)

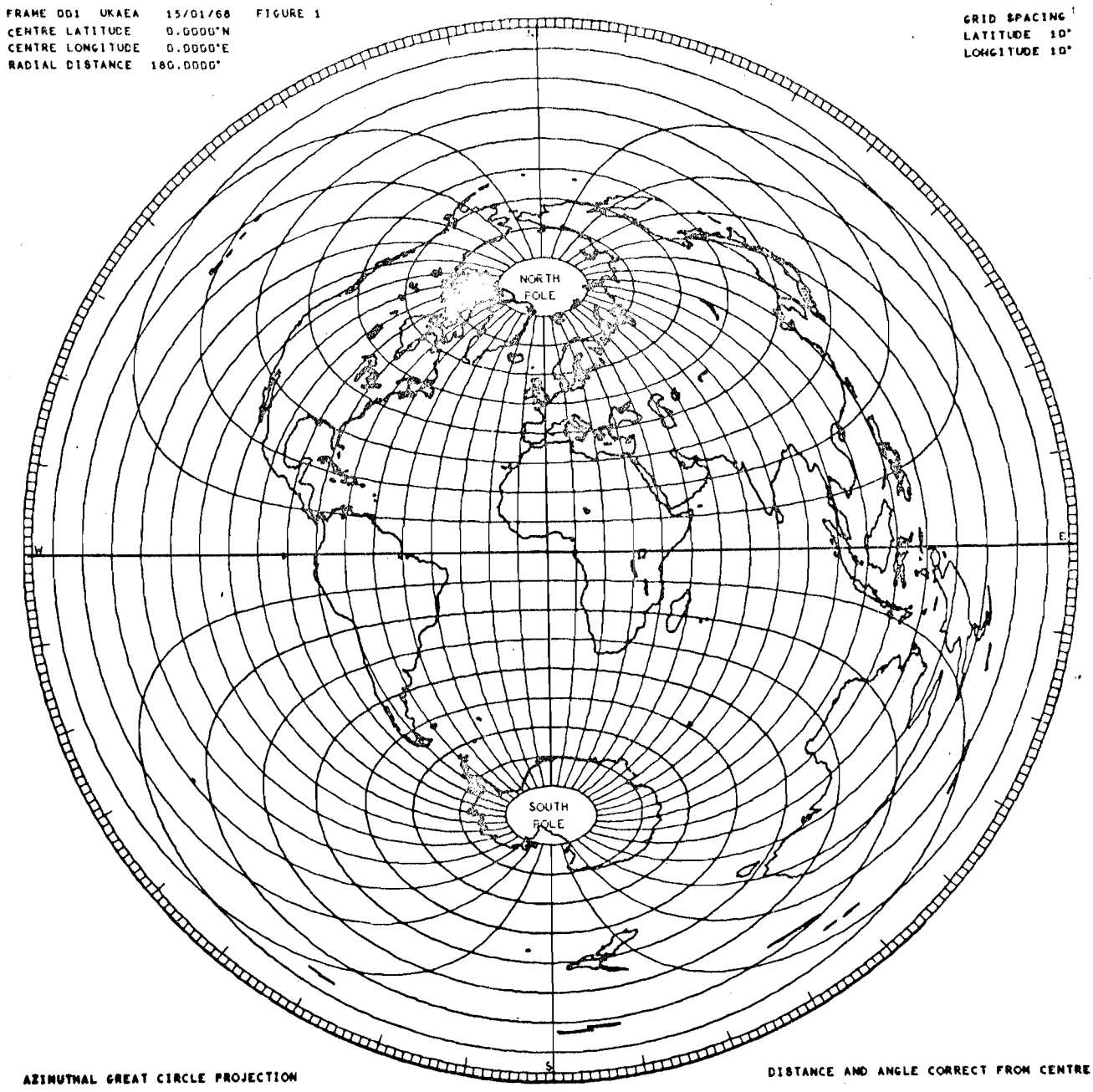


FIGURE 1. AZIMUTHAL GREAT CIRCLE PROJECTION OF THE WHOLE EARTH CENTRED ON 0.0N, 0.0E

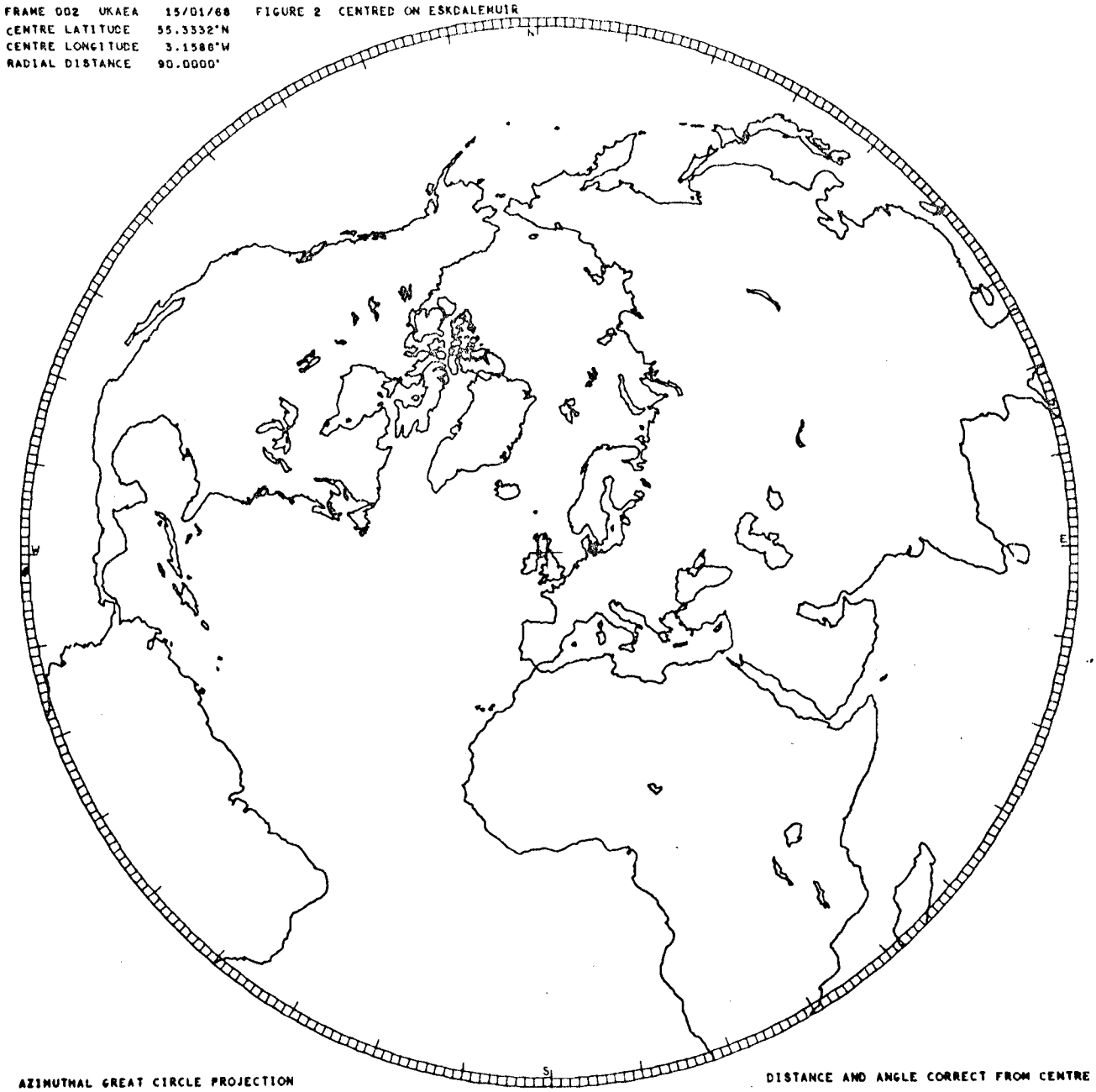
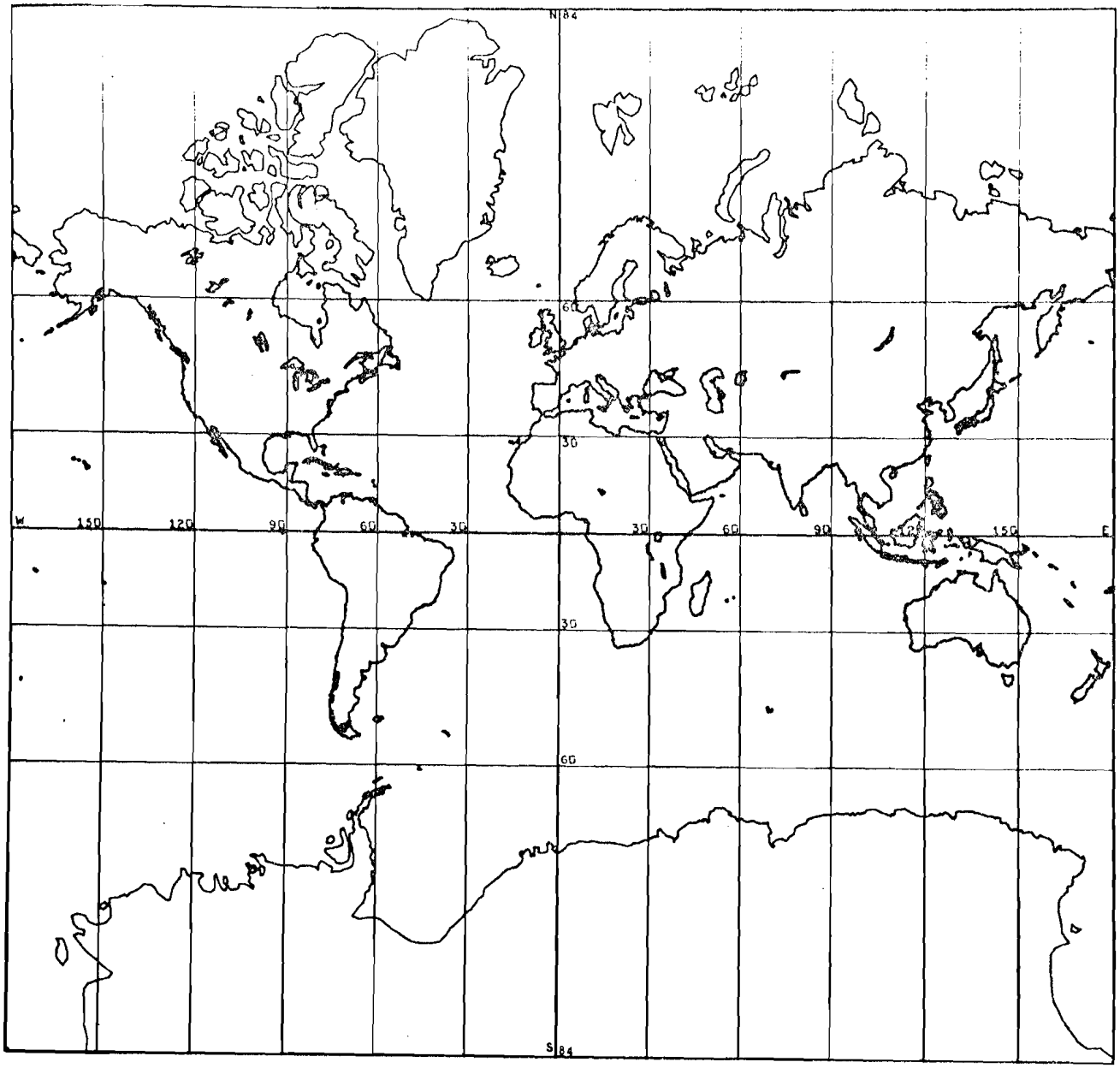


FIGURE 2. AZIMUTHAL GREAT CIRCLE PROJECTION, RADIUS 90°, CENTRED ON 55.3°N, 3.2°W

FRAME 551

FIGURE 3



MERCATOR PROJECTION

ALL BEARINGS CORRECT AND ORTHOMORPHIC

FIGURE 3. MERCATORS PROJECTION OF THE WHOLE EARTH CENTRED ON O.ON, O.OE

FRAME GG1

FIGURE 4

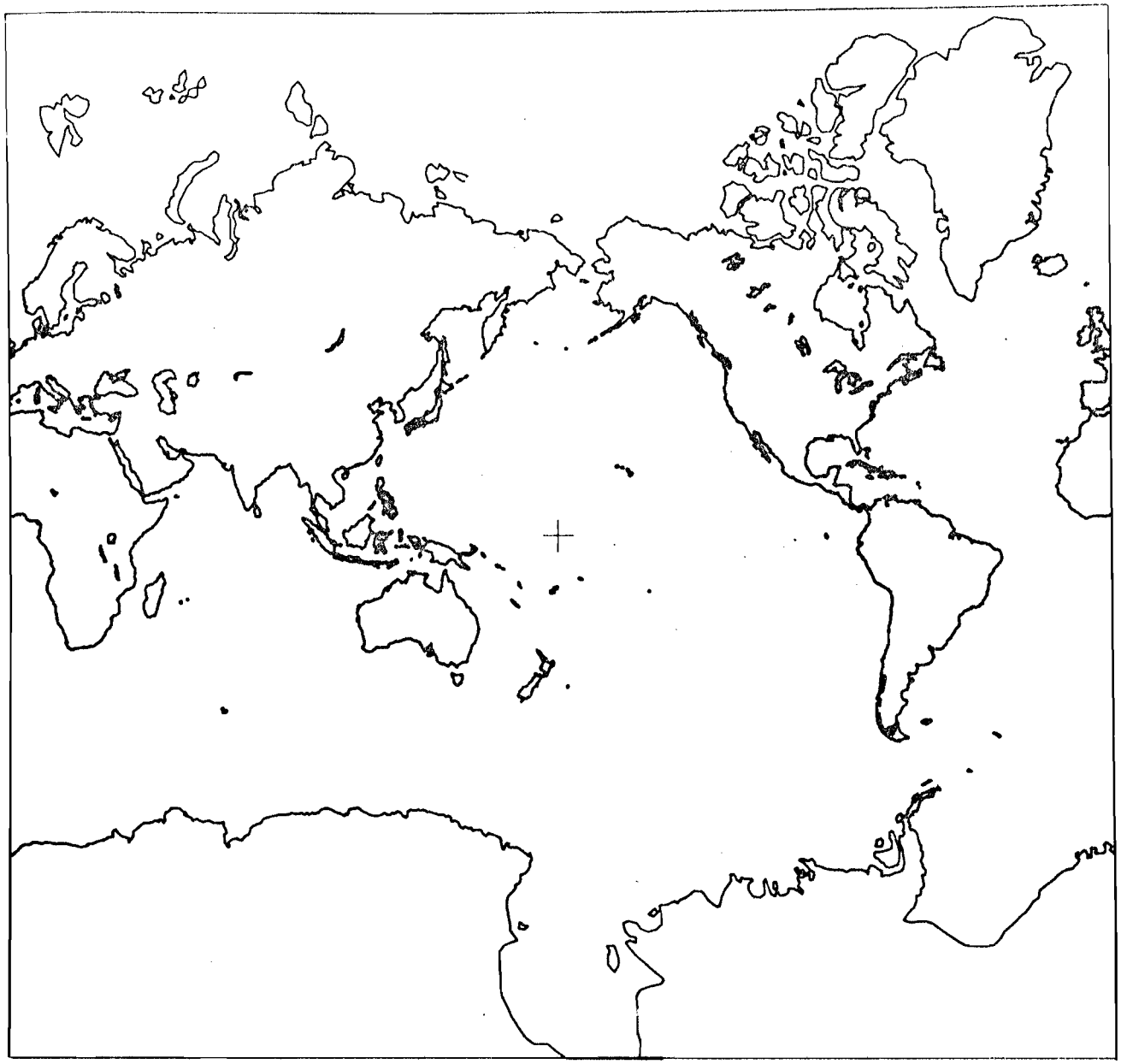


FIGURE 4. MERCATORS PROJECTION OF THE WHOLE EARTH CENTRED ON 0.0N, 180.0E

FRAME 001

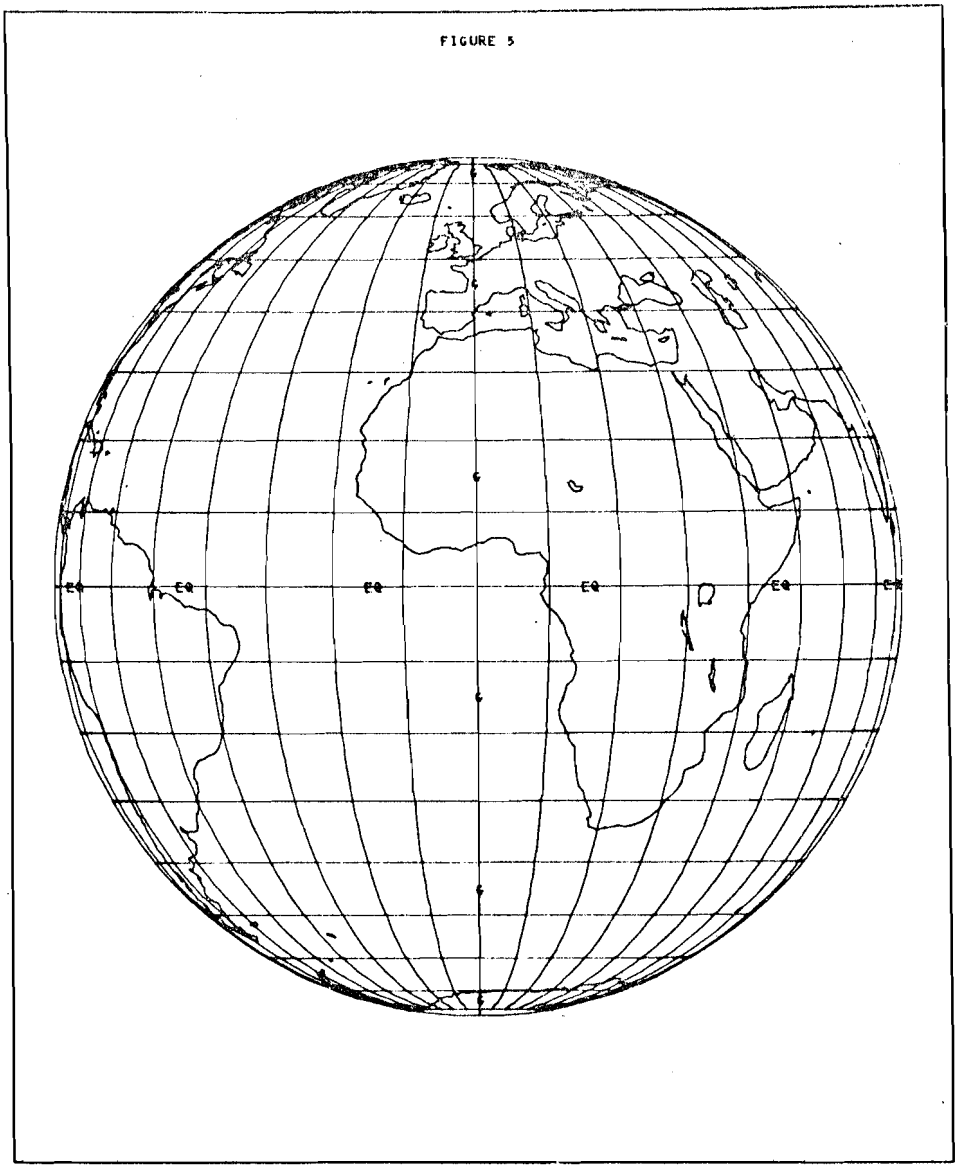


FIGURE 5. ORTHOGRAPHIC PROJECTION OF THE WHOLE EARTH CENTRED ON 0.0N, 0.0E

FRAME 002

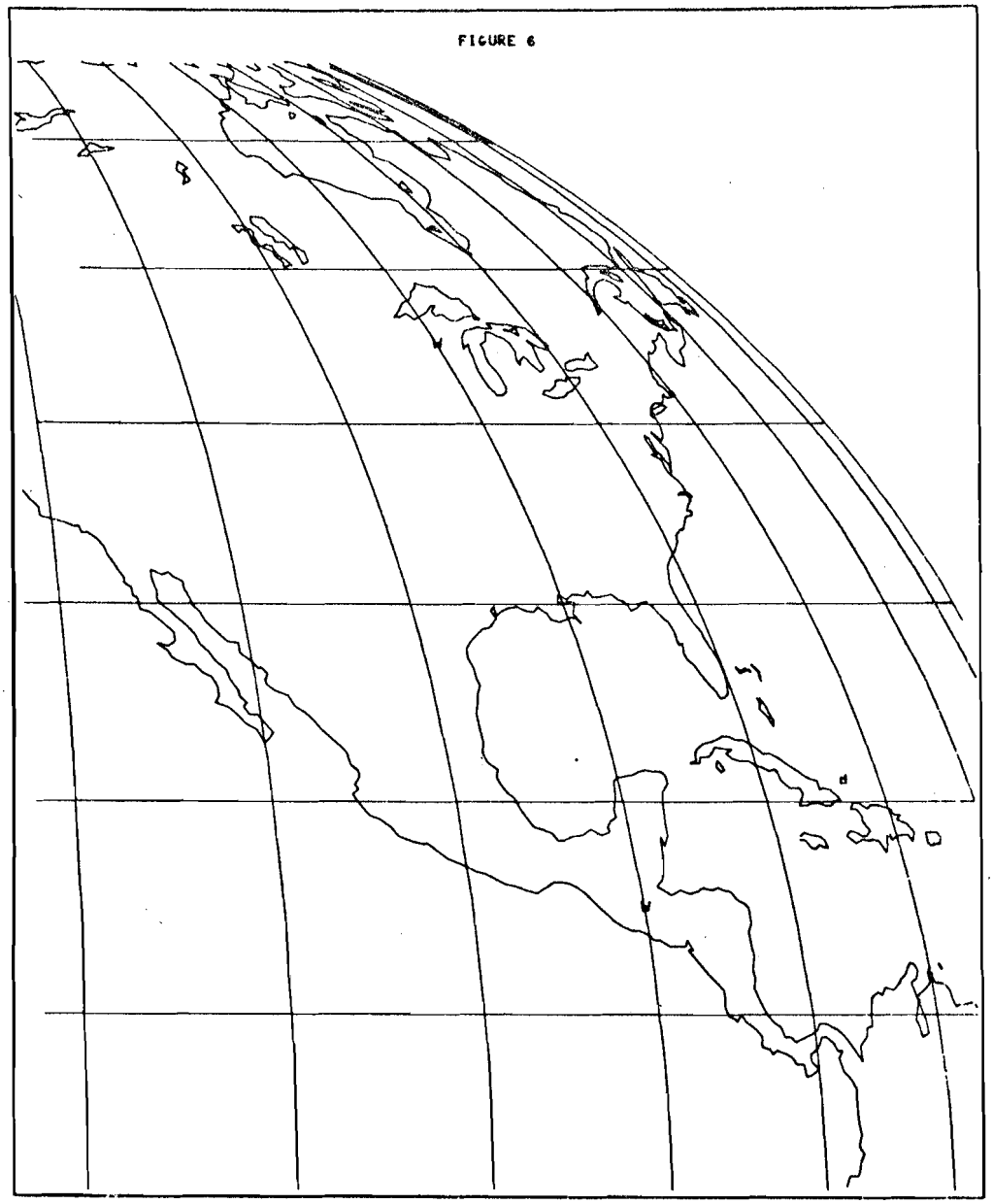


FIGURE 6. ORTHOGRAPHIC PROJECTION OF PART OF EARTH AS VIEWED FROM A POINT ABOVE THE PACIFIC OCEAN

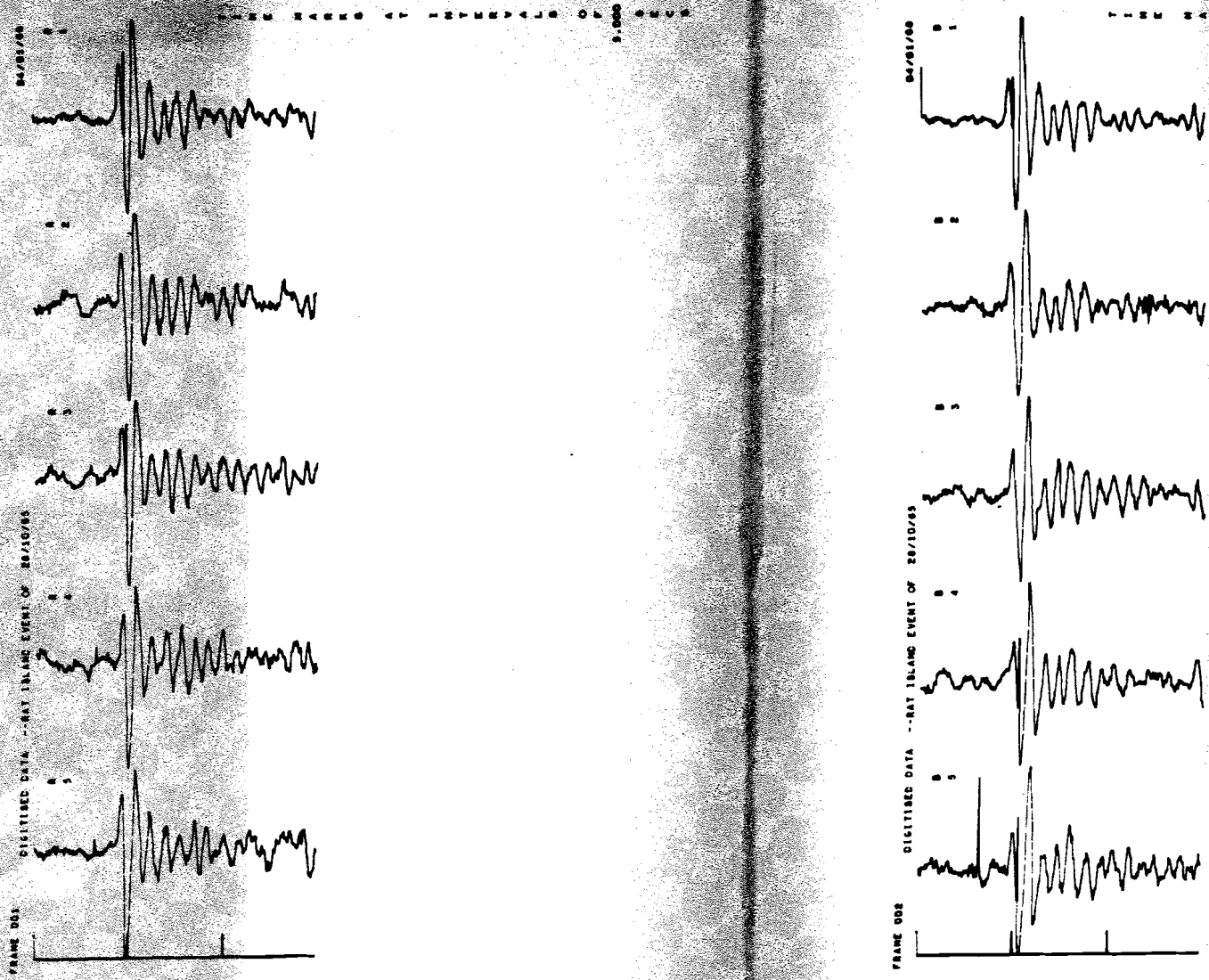


FIGURE 8. AN EXAMPLE OF THE OUTPUT OF CHAN SHOWING 10 CHANNELS OF DATA

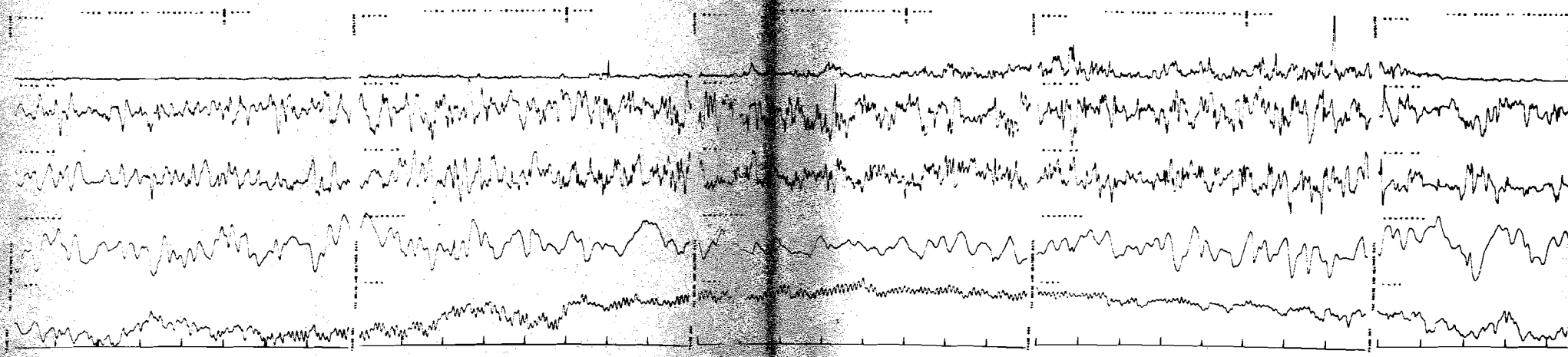


FIGURE 9. TYPICAL OUTPUT OF CHAN SHOWING 5 CHANNELS OF DATA

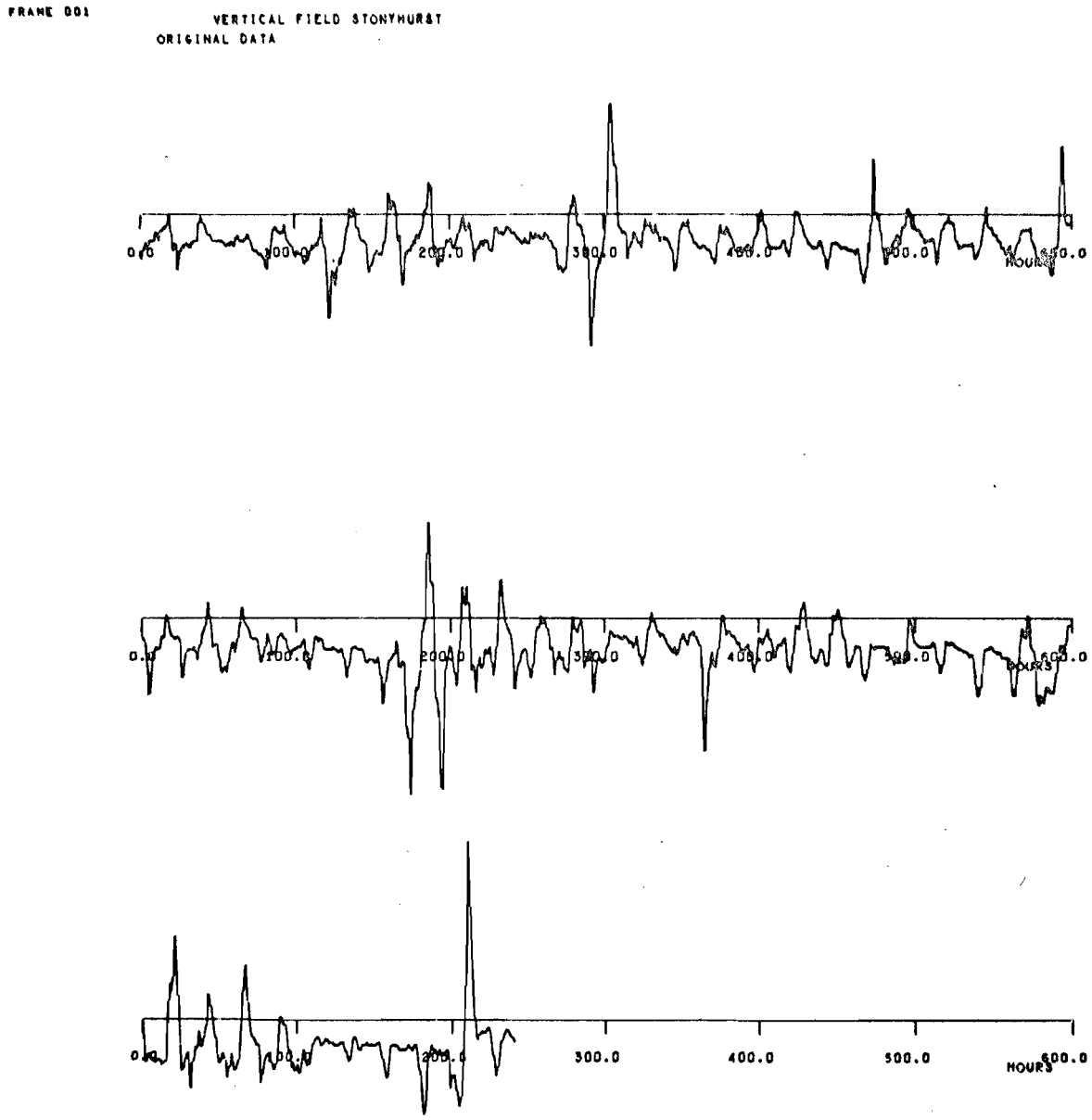


FIGURE 7. AN EXAMPLE OF THE OUTPUT FROM TIMSER

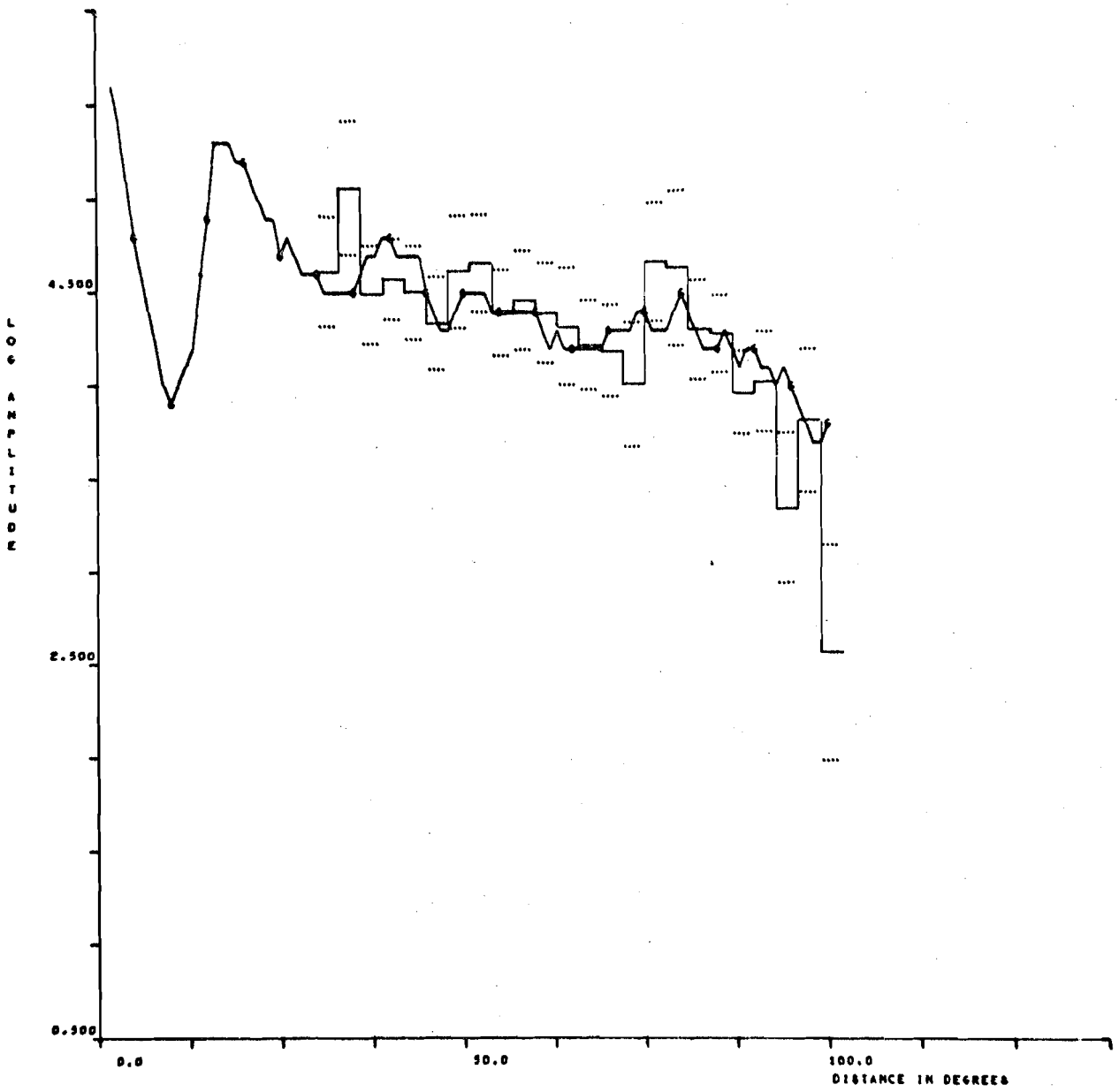


FIGURE 10. AN EXAMPLE OF A COMPOSITE GRAPH GENERATED BY CARGRF

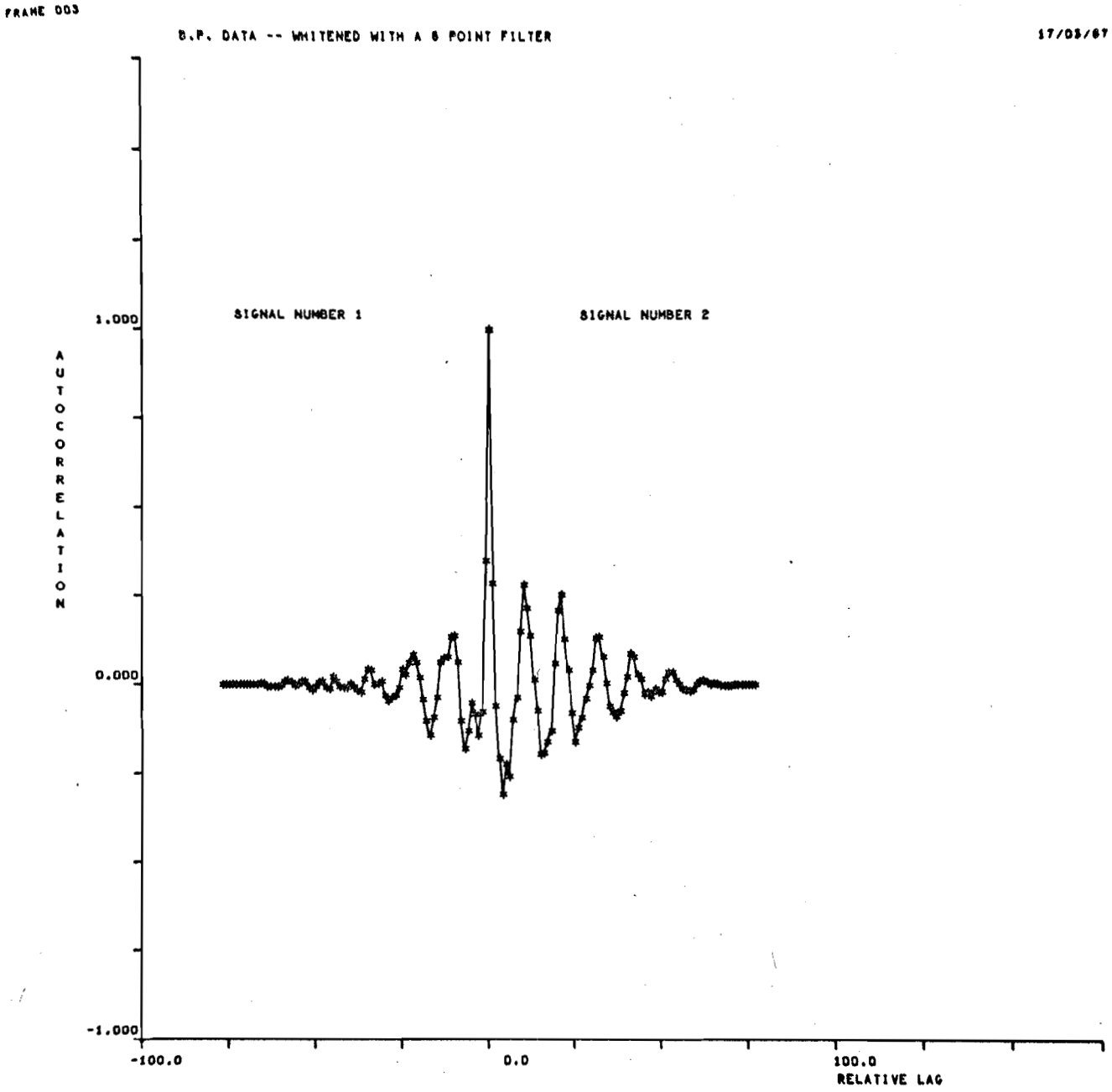


FIGURE 11. AN EXAMPLE OF A COMPOSITE GRAPH GENERATED BY CARGRF

APPENDIX A

AZIMUTHAL GREAT CIRCLE MAP PROJECTIONS - DERIVATION OF THE EQUATIONS

Symbols Used:-

θ = colatitude of any point

ϕ = corrected east longitude as defined below

α = colatitude of station

θ' = colatitude of any point with respect to the "new pole"

ϕ' = east longitude with respect to the "new pole", ie, with the Z-axis passing through the station.

Consider the earth to be a sphere of unit radius, and take the origin of a cartesian co-ordinate system as the centre of the earth. Let the Z-axis pass through the north pole, and let the 0° meridian lie in the ZOX plane. The first step is to rotate the co-ordinate system about the Z-axis until the X-axis passes through the line of longitude intersecting the station. Let the new east longitudes with respect to this rotated frame of reference be denoted ϕ. Thus initially all longitudes have to be corrected by an amount equal to the longitude of the station.

In the frame $\Sigma OXYZ$ any point on a unit sphere has co-ordinates $(\sin\theta\cos\phi, \sin\theta\sin\phi, \cos\theta)$ - see figure A1. Now rotate the co-ordinate system about the y-axis through an angle α as shown in figure A2. so that the new Z-axis passes through the station. The new frame of reference is denoted $\Sigma OX'Y'Z'$. Then

$$\left.\begin{aligned} Z' &= Z\cos\alpha + X\sin\alpha \\ X' &= X\cos\alpha - Z\sin\alpha \\ Y' &= Y \end{aligned}\right\} \quad \ldots(A1)$$

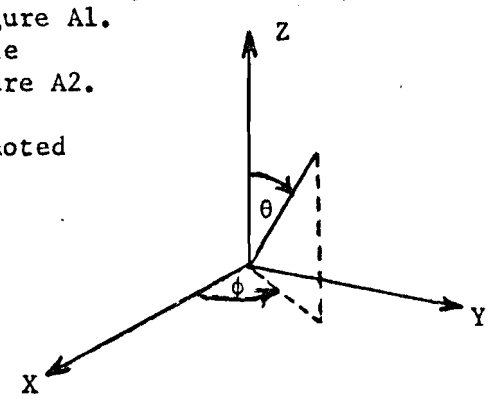


FIGURE A1

But if the polar angles of the new frame are θ' and ϕ',

$$\left.\begin{aligned} X' &= \sin\theta'\cos\phi' \\ Y' &= \sin\theta'\sin\phi' \\ Z' &= \cos\theta', \end{aligned}\right\} \quad \ldots(A2)$$

$$\therefore \quad \sin\theta'\cos\phi' = \sin\theta\cos\phi\cos\alpha - \cos\theta\sin\alpha \quad \ldots(A3)$$

$$\sin\theta'\sin\phi' = \sin\theta\sin\phi \quad \ldots(A4)$$

$$\cos\theta' = \cos\theta\cos\alpha + \sin\theta\cos\phi\sin\alpha \quad \ldots(A5)$$

$$\theta' = \cos^{-1}(\cos\theta\cos\alpha + \sin\theta\cos\phi\sin\alpha). \quad \ldots(A5A)$$

From equations (A3) and (A4)

$$\tan \phi' = \frac{\sin \theta \sin \phi}{\sin \theta \cos \phi \cos \alpha - \cos \theta \sin \alpha}. \qquad \text{.....(A6)}$$

The required projection on to a plane is given by polar co-ordinates (θ', ϕ') as sketched in figure A3.
In cartesian co-ordinates

$$X = \theta' \cos \phi' \qquad \text{.....(A7)}$$

$$Y = \theta' \sin \phi'. \qquad \text{.....(A8)}$$

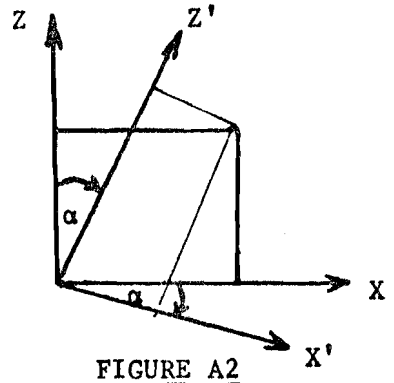


FIGURE A2

From (A6)

$$\cos \phi' = \frac{\sin \theta \cos \phi \cos \alpha - \cos \theta \sin \alpha}{\sqrt{((\sin \theta \cos \phi \cos \alpha - \cos \theta \sin \alpha)^2 + \sin^2\theta \sin^2\phi)}} \qquad \text{.....(A9)}$$

$$\sin \phi' = \frac{\sin \theta \sin \phi}{\sqrt{((\sin \theta \cos \phi \cos \alpha - \cos \theta \sin \alpha)^2 + \sin^2\theta \sin^2\phi)}}. \qquad \text{.....(A10)}$$

From (A5), if

$$K = \cos \theta \cos \alpha + \sin \theta \cos \phi \sin \alpha = \cos \theta'$$

$$\theta' = \tan^{-1} \frac{(\sqrt{(1 - K^2)})}{K}. \qquad \text{.....(A11)}$$

The expressions used in the programme are

(A7), (A8), (A9), (A10) and (A11).

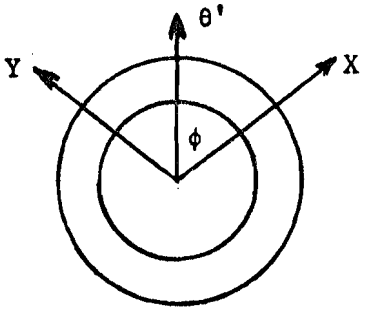


FIGURE A3

APPENDIX B

PROGRAM LISTINGS

```
B          JOB,
B          TYPE,COMPILGO,F4
T          SUBTYPE,FIOD
B       14BIOD,TAPE, , , , , ,SAVE
B          REEL,PLBB0800
           END
T          SUBTYPE,FORTRAN,LMAP,LSTRAP
      DIMENSION HEAD(4)
      DATA (HEAD(I),I=1,4)(32HFIGURE 2  CENTRED ON ESKDALEMUIR),
     1    FIG1(8HFIGURE 1)
C
      CALL SCLIBR
      CALL APMAP(0,0.,0.,0.,0,0,4,FIG1,1)
      CALL APMAP(2,90.,+55.3332,-3.1588,0,0,3,HEAD,4)
      CALL FINISH
      RETURN
      END
T          SUBTYPE,FORTRAN,LMAP,LSTRAP
C     AZIMUTHAL GREAT CIRCLE MAP PROJECTION  (APMAP)
C     ------------------------------------
C
C
C        THIS SUBROUTINE PLOTS THE GRATICULE, SHORELINES, ETC.
C        AS REQUIRED FOR AN AZIMUTHAL GREAT CIRCLE MAP PROJECTION
C
C
C     FROM THE  CALL APMAP(IFRAME,DIST,STNLAT,STNLNG,NLAT,NLONG,ISEL,TITLE,KEY)
C
C        DIST   RADIUS (IN DEGREES) OF MAP TO BE PLOTTED
C               IF ZERO 180 DEGREES IS USED
C        STNLAT LATITUDE OF CENTRE POINT (PLUS DEGREES NORTH)
C        STNLNG LONGITUDE OF CENTRE POINT (PLUS DEGREES EAST)
C
C        NLAT   SPACING OF LATITUDE IN DEGREES
C               IF ZERO SPACED AT 10 DEGREES
C        NLONG  SPACING OF LONGITUDE IN DEGREES
C               IF ZERO SPACED AT 10 DEGREES
C
C        ISEL DETERMINES THE FOLLOWING -
C               ISEL = 0   ADVANCE FRAME READY FOR DATA
C               ISEL = 1   SEPARATE PICTURES OF GRATICULE, SHORELINES, AND DATA
C               ISEL =-1   DATA PART ONLY
C               ISEL = 2   PICTURE OF GRATICULE ONLY
C               ISEL =-2   AS ABOVE WITHOUT ADVANCE FRAME AND PRINTING
C               ISEL = 3   PICTURE OF SHORELINES ONLY
C               ISEL =-3   AS ABOVE WITHOUT ADVANCE FRAME AND PRINTING
C               ISEL = 4   COMPOSITE PICTURE
C               ISEL =-4   AS ABOVE WITHOUT ADVANCE FRAME AND PRINTING
C
C        IFRAME DETERMINES THE FOLLOWING -
C               IFRAME = 0  HARDCOPY
C               IFRAME = 1  MICROFILM ONLY
C               IFRAME = 2  HARDCOPY ONLY
C               IFRAME = 3  HARDCOPY AND MICROFILM
C
C        KEY DETERMINES THE FOLLOWING HEADINGS INDEPENDENT OF ISEL -
C               POSITIVE  SIZE OF TITLE TO BE PRINTED PLUS THE DATE
C               ZERO      NO CHANGE IN HEADING
C               NEGATIVE  RESET TO BLANK
C
C
C     FROM THE  CALL APMAP(0.,0.,0.,0.,5,0,5,0,0)
C        A SCALE AT NLAT (DEGREES) INTERVAL IS DRAWN BUT NOT MARKED
C     FROM THE  CALL APMAP(0.,0.,0.,0.,0,5,5,0,0)
C        A SCALE AT NLONG (DEGREES) INTERVAL IS DRAWN BUT NOT MARKED
C     FROM THE  CALL APMAP(ANGLE,0.,0.,0.,0,0,5,0,0)
C        A LINE AT THE AZIMUTH ANGLE (DEGREES) IS DRAWN FROM THE CENTRE POINT
C     FROM THE  CALL APMAP(0.,DIST,0.,0.,0,0,5,0,0)
C        A CIRCLE AT DIST (DEGREES) FROM THE CENTRE IS DRAWN
C     FROM THE  CALL APMAP(IFRAME,0.,0.,0.,0,0,-5,TITLE,KEY)
C        THIS IS EQUIVALENT TO  CALL ADVFLM(IFRAME)
C
C
C     USE  -  FIRST - SET UP THE MAP WITH APMAP
C             SECOND - USE APCOD TO COMPUTE POINTS READY FOR PLOTTING
C
C
C
      SUBROUTINE APMAP(FRAME,DIST,STNLAT,STNLNG,NLAT,NLONG,ISEL,
     1                 TITLE,KEY)
      COMMON  /SHORES/  NCOAST, CLAT(8338), CLONG(8338), NCIND
      COMMON  /SCOMON/  IFRAME,NCOPY,CPX,CPY,RAD,RDIST,FACT,SLAT,SLONG,
     1                  R,COSR,SINR, P,COSP,SINP, Q,COSQ,SINQ
      DIMENSION TITLE(KEY),HEAD(12)
C
      REAL NURTH
      DATA B(4.),U(8.),E(0.0004),ARM(16.),LTAPE(14),
     1   NORTH(8HNORTH   ),SOUTH(8HSOUTH   ),POLE(8HPOLE    ),
     2   UKAEA(8HUKAEA   ),BLANK(8H        )
C
```

```
C
      SPACE(X1,Y1,X2,Y2)=SQRT((X2-X1)**2+(Y2-Y1)**2)
C
C
 1    IF(CPX-1023.)2,3,3
 2    IF(CPX)3,3,4
 3    CPX=511.
 4    IF(CPY-1023.)5,6,6
 5    IF(CPY)6,6,8
 6    CPY=515.
 8    WID=AMIN1(SPACE(CPX,CPY,CPX,0.),SPACE(CPX,CPY,CPX,1023.),
     1          SPACE(CPX,CPY,0.,CPY),SPACE(CPX,CPY,1023.,CPY))
C
C
1000  CALL EXPHVY(CPX,48,CPY)
1010  IF(KEY)1020,1014,1012
1012  IF(KEY-12)1030,1030,1050
1014  IF(CODE-BLANK)1016,1050,1016
1016  IF(CODE-UKAEA)1020,1050,1020
1020  DO 1022 I=1,12
      HEAD(I)=BLANK
1022  CONTINUE
      CODE=BLANK
      DATE=BLANK
      GO TO 1050
1030  DO 1032 I=1,KEY
      HEAD(I)=TITLE(I)
1032  CONTINUE
      NC=KEY+1
1040  DO 1042 I=NC,12
      HEAD(I)=BLANK
1042  CONTINUE
      CODE=UKAEA
      CALL SDATE(DATE)
1050  IND=IABS(ISEL)+1
      IF(IND-6)1060,800,700
1060  IF(ISEL+1)10,680,1070
1070  IFRAME=FRAME
      IF(IFRAME)1090,1090,1080
1080  IF(IFRAME-3)1100,1100,1090
1090  IFRAME=2
1100  CALL REPEAT(IFRAME,0)
      CALL TSP(80,48,0)
      CALL HORAM(CODE,8)
      CALL HORAM(DATE,8)
      CALL TSP(232,48,0)
      DO 1102 I=1,12
      CALL HORAM(HEAD(I),8)
1102  CONTINUE
      CALL STPTYP
      CALL VECTOR(CPX,CPY-ARM,CPX,CPY+ARM)
      CALL VECTOR(CPX-ARM,CPY,CPX+ARM,CPY)
      CALL VECTOR(1023.-ARM,0.,1023.,0.)
      CALL VECTOR(1023.,0.,1023.,ARM)
      RAD=WID
C
 10   CALL EXPLGT(CPX,48,CPY)
      RDIST=180.
      IF(DIST)18,18,16
 16   RDIST=DIST
 18   FACT=RAD/RDIST
      RFACT=180./RDIST
      SLONG=STNLNG
      SLAT=90.-STNLAT
      R = SLAT*0.017453293
      COSR = COS(R)
      SINR = SIN(R)
C
      DLAT=2.
      ILAT=NLAT
      IF(ILAT*(90/NLAT)-90)20,30,20
 20   ILAT=10
 30   IF(ILAT-1)20,20,40
 40   LAT=-90
      MLAT=90-ILAT
      HLAT=MLAT
      PLAT=0.
      DLONG=2.
      ILONG=NLONG
      IF(ILONG*(180/NLONG)-180)50,60,50
 50   ILONG=10
 60   IF(ILONG-1)50,50,70
 70   LONG=-180
 80   GO TO (400,90,90,320,90,710),IND
 90   FACT=FACT/RFACT
      XREF=CPX*(RFACT-1.)
      YREF=CPY*(RFACT-1.)
      GO TO 110
C
C
```

```
C                                          LATITUDES
 100  PLAT=LAT
 110  PLONG=-180.
      CALL APCOD(XS,YS,PLAT,PLONG)
      N1X=XS*RFACT-XRF
      N1Y=YS*RFACT-YRF
      LIND=1
 120  PLONG=PLONG+DLONG
      CALL APCOD(XF,YF,PLAT,PLONG)
      D=SPACE(XS,YS,XF,YF)
      IF(D-E)190,190,130
 130  IF(D-B)140,150,150
 140  PLONG=PLONG-DLONG
      DLONG=DLONG*2.
      GO TO 120
 150  IF(D-U)170,170,160
 160  PLONG=PLONG-DLONG
      DLONG=DLONG*0.2
      GO TO 120
 170  N2X=XF*RFACT-XRF
      N2Y=YF*RFACT-YRF
      IF(SPACE(FLOAT(N2X),FLOAT(N2Y),CPX,CPY)-RAD)174,172,172
 172  LIND=2
      GO TO 178
 174  GO TO (175,176),LIND
 175  CALL VECTOR(N1X,N1Y,N2X,N2Y)
 176  LIND=1
      N1X=N2X
      N1Y=N2Y
 178  XS=XF
      YS=YF
      IF((PLONG+DLONG)-180.)120,180,180
 180  PLONG=180.
      CALL APCOD(XF,YF,PLAT,PLONG)
      PLONG=0.
      N2X=XF*RFACT-XRF
      N2Y=YF*RFACT-YRF
      IF(SPACE(FLOAT(N2X),FLOAT(N2Y),CPX,CPY)-RAD)184,190,190
 184  GO TO (185,190),LIND
 185  CALL VECTOR(N1X,N1Y,N2X,N2Y)
 190  LAT=LAT+ILAT
      IF(LAT-MLAT)100,100,210
C
C                                          LONGITUDES
 200  PLONG=LONG
 210  PLAT=-MLAT
      CALL APCOD(XS,YS,PLAT,PLONG)
      N1X=XS*RFACT-XRF
      N1Y=YS*RFACT-YRF
      LIND=1
 220  PLAT=PLAT+DLAT
      CALL APCOD(XF,YF,PLAT,PLONG)
      D=SPACE(XS,YS,XF,YF)
      IF(D-E)290,290,230
 230  IF(D-B)240,250,250
 240  PLAT=PLAT-DLAT
      DLAT=DLAT*2.
      GO TO 220
 250  IF(D-U)270,270,260
 260  PLAT=PLAT-DLAT
      DLAT=DLAT*0.2
      GO TO 220
 270  N2X=XF*RFACT-XRF
      N2Y=YF*RFACT-YRF
      IF(SPACE(FLOAT(N2X),FLOAT(N2Y),CPX,CPY)-RAD)274,272,272
 272  LIND=2
      GO TO 278
 274  GO TO (275,276),LIND
 275  CALL VECTOR(N1X,N1Y,N2X,N2Y)
 276  LIND=1
      N1X=N2X
      N1Y=N2Y
 278  XS=XF
      YS=YF
      IF((PLAT+DLAT)-HLAT)220,280,280
 280  PLAT=HLAT
      CALL APCOD(XF,YF,PLAT,PLONG)
      PLONG=0.
      N2X=XF*RFACT-XRF
      N2Y=YF*RFACT-YRF
      IF(SPACE(FLOAT(N2X),FLOAT(N2Y),CPX,CPY)-RAD)284,290,290
 284  GO TO (285,290),LIND
 285  CALL VECTOR(N1X,N1Y,N2X,N2Y)
 290  LONG=LONG+ILONG
      IF(LONG-180)200,200,300
C
C                                          COASTLINES AND POLES
 300  FACT=FACT*RFACT
      IF(ISEL)308,308,301
 301  IF(ABS(STNLAT)-84.)302,302,307
```

```
  302  PLAT=90.
  303  CALL APCOD(XF,YF,PLAT,PLONG)
       CALL APCOD(XS,YS,-PLAT,PLONG)
       IF(SPACE(XF,YF,CPX,CPY)-RAD)304,305,305
C      48= BLANK
  304  CALL TSP(XF-28.,48,YF-8.)
       CALL HORAM(NORTH,5)
       CALL TSP(XF-24.,48,YF+8.)
       CALL HORAM(POLE,4)
  305  IF(SPACE(XS,YS,CPX,CPY)-RAD)306,307,307
  306  CALL TSP(XS-28.,48,YS-8.)
       CALL HORAM(SOUTH,5)
       CALL TSP(XS-24.,48,YS+8.)
       CALL HORAM(POLE,4)
  307  CALL EXPHVY(CPX,48,CPY)
       CALL TSP(915,48,16)
       CALL C4020H
       PRINT 31
  31   FORMAT(13HGRID SPACING )
       CALL TSP(915,48,32)
       CALL C4020H
       PRINT 32
  32   FORMAT(9HLATITUDE )
       CALL C4020I(ILAT,3)
C      58= DEGREES SIGN
       CALL TSP(1019,58,32)
       CALL TSP(915,48,48)
       CALL C4020H
       PRINT 33
  33   FORMAT(9HLONGITUDE)
       CALL C4020I(ILONG,3)
C      58= DEGREES SIGN
       CALL TSP(1019,58,48)
  308  CALL STPTYP
       CALL EXPHVY(CPX,48,CPY)
       GO TO (710,310,400,320,320,710),IND
  310  CALL ADVFLM(IFRAME)
       CALL TSP(80,48,0)
       CALL HORAM(CODE,8)
       CALL HORAM(DATE,8)
       CALL TSP(232,48,0)
       DO 312 I=1,12
       CALL HORAM(HEAD(I),8)
  312  CONTINUE
       CALL STPTYP
       CALL VECTOR(CPX,CPY-ARM,CPX,CPY+ARM)
       CALL VECTOR(CPX-ARM,CPY,CPX+ARM,CPY)
       CALL VECTOR(1023.-ARM,0.,1023.,0.)
       CALL VECTOR(1023.,0.,1023.,ARM)
  320  LIND=1
       NC=0
       IF(NCIND)330,333,330
  330  READ  (LTAPE)  NCOAST,(CLAT(I),CLONG(I),I=1,NCOAST)
       NCIND = 0
  333  NC=NC+1
       CALL APCOD(XS,YS,CLAT(NC),CLONG(NC))
       N1X=XS
       N1Y=YS
       GO TO 350
  340  CALL APCOD(XF,YF,CLAT(NC),CLONG(NC))
       N2X=XF
       N2Y=YF
       IF(SPACE(XF,YF,CPX,CPY)-RAD)344,342,342
  342  LIND=2
       GO TO 348
  344  GO TO (345,346),LIND
  345  CALL VECTOR(N1X,N1Y,N2X,N2Y)
  346  LIND=1
  348  N1X=N2X
       N1Y=N2Y
  350  NC=NC+1
       IF(NC-NCOAST)360,400,400
  360  IF(CLAT(NC))340,370,340
  370  IF(CLONG(NC))340,333,340
C
C                                          EDGING
  400  PLAT=RDIST
       DLAT=PLAT/60.
       JLONG=1
  410  CALL EXPLGT(CPX,48,CPY)
       LONG=JLONG
  420  PLONG=LONG
       CALL APPOL(XS,YS,PLAT,PLONG)
       CALL APPOL(XF,YF,PLAT-DLAT,PLONG)
       N1X=XS
       N1Y=YS
       N2X=XF
       N2Y=YF
       CALL VECTOR(N1X,N1Y,N2X,N2Y)
  430  LONG=LONG+JLONG
```

```
      IF(LONG-360)420,420,440
  440 IF(JLONG-1)460,450,460
  450 JLONG=ILONG
      PLAT=PLAT-DLAT
      GO TO 410
  460 CONTINUE
C     37=N
  470 CALL APPOL(XS,YS,PLAT,0.)
      CALL TSP(XS-8.,37,YS+6.)
C     21=E
      CALL APPOL(XS,YS,PLAT,90.)
      CALL TSP(XS-6.,21,YS-6.)
C     50=S
      CALL APPOL(XS,YS,PLAT,180.)
      CALL TSP(XS-8.,50,YS-6.)
C     54=W
      CALL APPOL(XS,YS,PLAT,270.)
      CALL TSP(XS+4.,54,YS-6.)
      CALL STPTYP
      GO TO 510
C
C                                        CIRCLES
  500 DLAT=0.
      IF(DIST-RDIST)510,510,590
  510 CALL EXPHVY(CPX,48,CPY)
      PLONG=-180.
      CALL APPOL(XS,YS,PLAT,PLONG)
      N1X=XS
      N1Y=YS
  520 PLONG=PLONG+DLONG
      CALL APPOL(XF,YF,PLAT,PLONG)
      D=SPACE(XS,YS,XF,YF)
      IF(D-E)590,590,530
  530 IF(D-B)540,550,550
  540 PLONG=PLONG-DLONG
      DLONG=DLONG*2.
      GO TO 520
  550 IF(D-U)570,570,560
  560 PLONG=PLONG-DLONG
      DLONG=DLONG*0.2
      GO TO 520
  570 N2X=XF
      N2Y=YF
      CALL VECTOR(N1X,N1Y,N2X,N2Y)
      XS=XF
      YS=YF
      N1X=N2X
      N1Y=N2Y
      IF((PLONG+DLONG)-180.)520,580,580
  580 PLONG=180.
      CALL APPOL(XF,YF,PLAT,PLONG)
      N2X=XF
      N2Y=YF
      CALL VECTOR(N1X,N1Y,N2X,N2Y)
  590 PLAT=PLAT+DLAT
      IF(DLAT)500,600,500
C
C                                        HEADINGS
  600 GO TO (610,620,620,620,620,700),IND
  610 CALL EXPHVY(CPX,48,CPY)
  620 IF(ISEL)690,630,630
C     17=A
  630 CALL TSP(0,17,1015)
      CALL C4020H
      PRINT 61
   61                                                              FORMAT(
     1127HZIMUTHAL GREAT CIRCLE PROJECTION
     1                              DISTANCE AND ANGLE CORRECT FROM CENTRE)
C     19=C
      CALL TSP(0,19,16)
      CALL C4020H
      PRINT 62
   62 FORMAT(15HENTRE LATITUDE )
      CALL C4020F(ABS(STNLAT),9,4)
C     58= DEGREES SIGN
      CALL TSP(200,58,16)
C     37=N      50=S
      NC=37
      IF(STNLAT)640,650,650
  640 NC=50
  650 CALL TSP(206,NC,16)
C     19=C
      CALL TSP(0,19,32)
      CALL C4020H
      PRINT 63
   63 FORMAT(15HENTRE LONGITUDE)
      CALL C4020F(ABS(STNLNG),9,4)
C     58= DEGREES SIGN
      CALL TSP(200,58,32)
C     21=E      54=W
```

```
      NC=21
      IF(STNLNG)660,670,670
 660  NC=54
 670  CALL TSP(206,NC,32)
C     41=R
      CALL TSP(0,41,48)
      CALL C4020H
      PRINT 64
 64   FORMAT(15HADIAL DISTANCE )
      CALL C4020F(RDIST,9,4)
C     58= DEGREES SIGN
      CALL TSP(200,58,48)
      GO TO (690,680,690,690,690,710),IND
 680  CALL ADVFLM(IFRAME)
      CALL TSP(80,48,0)
      CALL HORAM(CODE,8)
      CALL HORAM(DATE,8)
      CALL TSP(232,48,0)
      DO 682 I=1,12
      CALL HORAM(HEAD(I),8)
 682  CONTINUE
      CALL STPTYP
      CALL VECTOR(CPX,CPY-ARM,CPX,CPY+ARM)
      CALL VECTOR(CPX-ARM,CPY,CPX+ARM,CPY)
      CALL VECTOR(1023.-ARM,0.,1023.,0.)
      CALL VECTOR(1023.,0.,1023.,ARM)
 690  CALL STPTYP
      CALL ENDFME
 700  RETURN
 710  STOP
C
C                                          SPECIAL CALLS
 800  IF(ISEL)810,710,840
 810  I=FRAME
      IF(I)814,814,812
 812  IF(I-3)820,820,814
 814  I=2
 820  CALL ADVFLM(I)
      CALL TSP(80,48,0)
      CALL HORAM(CODE,8)
      CALL HORAM(DATE,8)
      CALL TSP(232,48,0)
      DO 822 I=1,12
      CALL HORAM(HEAD(I),8)
 822  CONTINUE
      RAD=WID
      GO TO 690
 840  NC=ILONG
      IF(NLONG-5)850,880,850
 850  NC=ILAT
      IF(NLAT-5)860,880,860
 860  PLAT=DIST
      IF(DIST)870,870,500
 870  CALL APPUL(XF,YF,RDIST,FRAME)
      CALL VECTOR(CPX,CPY,XF,YF)
      CALL VECTOR(CPX,CPY,XF,YF)
      GO TO 690
 880  CALL VECTOR(1023.-ARM,0.,1023.-RAD,0.)
      XF=RAD/RDIST
      N2X=NC
      NDIST=RDIST
      DO 930 I=1,NDIST
      N1X=1023.-XF*FLOAT(I)
      IF(N2X-1)920,910,920
 910  CALL VECTOR(N1X,0,N1X,8)
      N2X=N2X+NC
      GO TO 930
 920  CALL VECTOR(N1X,0,N1X,4)
 930  CONTINUE
      GO TO 690
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
C     AZIMUTHAL GREAT CIRCLE MAP PROJECTION  (APCOD)
C     ----------------------------------------
C
C
C     FROM THE  CALL APCOD(X,Y,PLAT,PLONG)
C     THIS SUBROUTINE CONVERTS COORDINATES  PLAT  AND  PLONG
C     TO UNITS  X  AND  Y  SUITABLE FOR PLOTTING THE AZIMUTHAL GREAT CIRCLE
C     MAP PROJECTION ON THE S-C4020 AFTER FIRST CALLING APMAP
C         PLAT   POSITIVE FOR DEGREES NORTH, NEGATIVE FOR DEGREES SOUTH
C         PLONG  POSITIVE FOR DEGREES EAST, NEGATIVE FOR DEGREES WEST
C
C     THE FORMULAE FOR THIS AZIMUTHAL GREAT CIRCLE MAP PROJECTION
C     ARE BASED ON BLACKNEST NOTE PA4/AG70 BY MR. C. WRIGHT
C     THIS PROGRAM SUPERCEDES THE PROGRAM WRITTEN AND DESCRIBED BY MR. WRIGHT
C     THOUGH IN PRINCIPLE THEY ARE THE SAME
C
C     THE FORMULAE USED ARE -
C     COSF - (9)   SINF - (10)   COST - (5)   SINT - (6)   X - (7)   Y - (8)
```

```
C                              AS NUMBERED IN THE NOTE
C
C     N.B.  THE COORDINATE SYSTEM HAS BEEN MODIFIED FOR THIS PROGRAM
C
C
      SUBROUTINE APCOD(X,Y,PLAT,PLONG)
      COMMON  /SCOMON/  IFRAME,NCOPY,CPX,CPY,RAD,RDIST,FACT,SLAT,SLONG,
     1                  R,COSR,SINR, P,COSP,SINP, Q,COSQ,SINQ,
     2                  F,COSF,SINF, T,COST,SINT
      DATA  DTOR(0.017453293), RTOD(57.295779513)
C
      P = (90.-PLAT)*DTOR
      COSP = COS(P)
      SINP = SIN(P)
      Q = (PLONG-SLONG)*DTOR
      COSQ = COS(Q)
      SINQ = SIN(Q)
C
      COSF=SINP*COSQ*COSR-COSP*SINR
      SINF=SINP*SINQ
      COST=COSP*COSR+SINP*COSQ*SINR
      SINT=SQRT(COSF*COSF+SINF*SINF)
      COSF=COSF/SINT
      SINF=SINF/SINT
      T=ATAN2(SINT,COST)*RTOD
      X = T*SINF
      Y = T*COSF
C
      X=CPX+X*FACT
      Y=CPY+Y*FACT
      RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
C     AZIMUTHAL GREAT CIRCLE MAP PROJECTION  (APPOL)
C     -------------------------------------
C
C
C     FROM THE  CALL APPOL(X,Y,DIST,ANGLE)
C     THIS SUBROUTINE CONVERTS THE POLAR COORDINATES  DIST  AND  ANGLE
C     TO UNITS  X  AND  Y  SUITABLE FOR PLOTTING THE AZIMUTHAL GREAT CIRCLE
C     MAP PROJECTION ON THE S-C4020 AFTER FIRST CALLING APMAP
C         DIST   DISTANCE IN DEGREES FROM THE CENTRE
C         ANGLE  ANGLE IN DEGREES FROM NORTH THROUGH EAST
C
C
      SUBROUTINE APPOL(X,Y,DIST,ANGLE)
      COMMON  /SCOMON/  IFRAME,NCOPY,CPX,CPY,RAD,RDIST,FACT,SLAT,SLONG
C
      R=DIST*FACT
      T=ANGLE*0.017453293
      X=CPX+R*SIN(T)
      Y=CPY-R*COS(T)
      RETURN
      END
T        SUBTYPE,DATA
```

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B         JOB,                                    MERCATOR ATLANTIC
B         TYPE,COMPILGO,F4
T         SUBTYPE,FIOD
B      14BIOD,TAPE, , , , , ,SAVE
B         REEL,PLBB0800
          END
T         SUBTYPE,FORTRAN,LMAP,LSTRAP
       CALL SCLIBR
       DATA FIG3(8HFIGURE 3)
       CALL MERCAT(2,30,30,4)
       CALL TSP(472,48,8)
       CALL HORAM(FIG3,8)
       CALL FINISH
       RETURN
       END
T         SUBTYPE,FORTRAN,LMAP,LSTRAP                                    MERCT1
C      MERCATOR PLOTTING PROGRAM  MERCAT     (VERSION 1)
C      **********************************
C
C      THIS SUBROUTINE PLOTS A WORLD MAP ON MERCATORS PROJECTION
C      BASED ON THE EQUATOR AND THE GREENWICH MERIDIAN
C
C      FROM THE CALL MERCAT(IFRAME,NLAT,NLONG,ISEL)
C         NLAT    SPACING OF LATITUDE IN DEGREES
C                 IF ZERO SPACED AT 10 DEGREES
C         NLONG   SPACING OF LONGITUDE IN DEGREES
C                 IF ZERO SPACED AT 20 DEGREES
C
C         ISEL DETERMINES THE FOLLOWING -
C                 ISEL = 0    ADVANCE FRAME
C                 ISEL = 1    SEPARATE PICTURES OF GRATICULE, SHORELINES, AND DATA
C                 ISEL = 2    PICTURE OF GRATICULE ONLY
C                 ISEL = 3    PICTURE OF SHORELINES ONLY
C                 ISEL = 4    COMPOSITE PICTURE
C         IFRAME DETERMINES THE FOLLOWING -
C                 IFRAME = 1  MICROFILM ONLY
C                 IFRAME = 2  HARDCOPY ONLY
C                 IFRAME = 3  HARDCOPY AND MICROFILM
C
C
       SUBROUTINE MERCAT(IFRAME,NLAT,NLONG,ISEL)
       COMMON  /SHORES/  NCOAST, CLAT(8338), CLONG(8338), NCIND
       DATA LTAPE(14)
       CALL EXPLGT(511,48,511)
C
       IND=ISEL+1
       GO TO (410,10,10,10,10),IND
  10   CALL REPEAT(IFRAME,0)
       CALL VECTOR(1007,0,1023,0)
       CALL VECTOR(1023,0,1023,16)
C
       ILAT=NLAT
       IF(ILAT*(90/NLAT)-90)30,40,30
  30   ILAT=10
  40   LAT=180-ILAT
       ILONG=NLONG
       IF(ILONG*(180/NLONG)-180)50,60,50
  50   ILONG=20
  60   GO TO (410,100,100,300,100),IND
C
C                                LATITUDES
 100   ALONG=0.
       NP=-6
       DO 180 I=1,181,ILAT
       ALAT=I-91
       LAT=ABS(ALAT)
       CALL MERCOD(N1X,N1Y,ALAT,ALONG)
       CALL XAXSTP(0,N1Y,1023)
       IF(LAT) 120,110,120
 110   NP=6
       CALL XAXSTP(0,N1Y,1023)
       GO TO 180
 120   IF(LAT-84)140,140,130
 130   LAT=84
 140   N1Y=N1Y+NP
 150   CALL TSP(500,48,N1Y)
       CALL C4020I(LAT,3)
       CALL STPTYP
 180   CONTINUE
C
C                               LONGITUDES
 200   ALAT=84.
       CALL MERCOD(N1X,N1Y,-ALAT,ALONG)
       CALL MERCOD(N2X,N2Y,ALAT,ALONG)
       CALL TSP(504,37,N2Y+6)
       CALL TSP(504,50,N1Y-6)
       CALL TSP(1016,21,505)
       CALL TSP(6,54,505)
       CALL STPTYP
       NP=-30
```

```
      DO 280 I=1,361,ILONG
      ALONG=I-181
      LONG=ABS(ALONG)
      CALL MERCOD(N1X,N1Y,-ALAT,ALONG)
      CALL YAXSTP(N1X,N1Y,N2Y)
      IF(LONG) 220,210,220
  210 NP=-30
      CALL YAXSTP(N1X,N1Y,N2Y)
      GO TO 280
  220 IF(LONG-170)240,280,280
  240 N1X=N1X+NP
  250 CALL TSP(N1X,48,505)
      CALL C4020I(LONG,3)
      CALL STPTYP
  280 CONTINUE
      CALL EXPHVY(511,48,511)
      GO TO (300,290,400,300,300),IND
  290 CALL ADVFLM(IFRAME)
      CALL VECTOR(1007,0,1023,0)
      CALL VECTOR(1023,0,1023,16)
C
C                              SHORELINES
  300 ALAT=84.
      CALL MERCOD(N1X,N1Y,-ALAT,ALONG)
      CALL MERCOD(N2X,N2Y,ALAT,ALONG)
      CALL VECTOR(511,495,511,527)
      CALL VECTOR(495,511,527,511)
      CALL XAXSTP(0,N1Y,1023)
      CALL XAXSTP(0,N2Y,1023)
      CALL YAXSTP(0,N1Y,N2Y)
      CALL YAXSTP(1023,N1Y,N2Y)
      IF(NCIND)301,302,301
  301 READ  (LTAPE)  NCOAST,(CLAT(I),CLONG(I),I=1,NCOAST)
      NCIND = 0
  302 I=0
      NC=0
  310 NC=NC+1
      CALL MERCOD(N1X,N1Y,CLAT(NC),CLONG(NC))
      GO TO 380
  320 CALL MERCOD(N2X,N2Y,CLAT(NC),CLONG(NC))
      IF(CLONG(NC)+180.)360,330,360
  330 I=I+1
      GO TO (340,350),I
  340 N2X=1023
      CALL VECTOR(N1X,N1Y,N2X,N2Y)
      N1X=0
      GO TO 370
  350 N2X=0
      CALL VECTOR(N1X,N1Y,N2X,N2Y)
      N1X=1023
      I=0
      GO TO 370
  360 CALL VECTOR(N1X,N1Y,N2X,N2Y)
      N1X=N2X
  370 N1Y=N2Y
  380 NC=NC+1
      IF(NC-NCOAST)390,400,400
  390 IF(CLAT(NC))320,395,320
  395 IF(CLONG(NC))320,310,320
C
C
  400 CALL TSP(4,36,1015)
      CALL C4020H
      PRINT 3
    3                                                          FORMAT(
     1127HERCATOR PROJECTION
     2                                ALL BEARINGS CORRECT AND ORTHOMORPHIC)
      GO TO (420,410,420,420,420),IND
  410 CALL ADVFLM(IFRAME)
      CALL VECTOR(1007,0,1023,0)
      CALL VECTOR(1023,0,1023,16)
      CALL VECTOR(511,495,511,527)
      CALL VECTOR(495,511,527,511)
  420 CALL STPTYP
      CALL EXPHVY(511,48,511)
  430 RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP                                  MERC01
C     MERCATOR PLOTTING PROGRAM  MERCOD     (VERSION 1)
C     **********************************
C
C     FROM THE CALL MERCOD(NX,NY,ALAT,ALONG)
C     THIS SUBROUTINE CONVERTS COORDINATES  ALAT  AND  ALONG
C     TO S-C4020 RASTER UNITS  NX  AND  NY  FOR PLOTTING MERCATORS PROJECTION
C     BASED ON THE EQUATOR AND THE GREENWICH MERIDIAN
C         ALAT   POSITIVE FOR DEGREES NORTH, NEGATIVE FOR DEGREES SOUTH
C         ALONG  POSITIVE FOR DEGREES EAST, NEGATIVE FOR DEGREES WEST
C
C     THE MERIDIANS ARE EQUALLY SPACED WHERE  FACT = 1024/360
C     THE DISTANCE OF ANY PARALLEL FROM THE EQUATOR IS GIVEN BY
```

```
C          Y = R*LN(SEC(ALAT)+TAN(ALAT))  WHERE  2*PI*R = 1024
C     ANY LATITUDE OVER 84 DEGREES IS COMPUTED AT 84
C
C     REFERENCE - AN INTRODUCTION TO THE STUDY OF MAP PROJECTIONS
C                 BY J.A.STEERS  P.162
C
      SUBROUTINE MERCOD(NX,NY,ALAT,ALONG)
      DATA  FACT(2.844444444), DTOR(0.017453293), R(162.9746617 26)
C
      NX=511.+ALONG*FACT
      RLAT=ALAT*DTOR
      IF(ABS(ALAT)-84.)50,40,40
 40   RLAT=SIGN(84.,ALAT)*DTOR
 50   NY=511.-R*ALOG(SEC(RLAT)+TAN(RLAT))
 60   RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      FUNCTION SEC(X)
      SEC=1./COS(X)
      RETURN
      END
T        SUBTYPE,DATA
```

```
B         JOB,                                   MERCATOR PACIFIC
B         TYPE,COMPILGO,F4
T         SUBTYPE,FIOD
B      14BIOD,TAPE, , , , , ,SAVE
B         REEL,PLBB0800
          END
T         SUBTYPE,FORTRAN,LMAP,LSTRAP
      CALL SCLIBR
      DATA FIG4(8HFIGURE 4)
      CALL MERCAT(2,0,0,3)
      CALL TSP(472,48,8)
      CALL HORAM(FIG4,8)
      CALL FINISH
      RETURN
      END
T         SUBTYPE,FORTRAN,LMAP,LSTRAP                                    MERCT2
C     MERCATOR PLOTTING PROGRAM  MERCAT     (VERSION 2)
C     ***********************************
C
C     THIS SUBROUTINE PLOTS A WORLD MAP ON MERCATORS PROJECTION
C     BASED ON THE EQUATOR AND THE INTERNATIONAL DATE LINE
C
C     FROM THE CALL MERCAT(IFRAME,NLAT,NLONG,ISEL)
C        NLAT   SPACING OF LATITUDE IN DEGREES
C               IF ZERO SPACED AT 10 DEGREES
C        NLONG  SPACING OF LONGITUDE IN DEGREES
C               IF ZERO SPACED AT 20 DEGREES
C
C        ISEL DETERMINES THE FOLLOWING -
C               ISEL = 0   ADVANCE FRAME
C               ISEL = 1   SEPARATE PICTURES OF GRATICULE, SHORELINES, AND DATA
C               ISEL = 2   PICTURE OF GRATICULE ONLY
C               ISEL = 3   PICTURE OF SHORELINES ONLY
C               ISEL = 4   COMPOSITE PICTURE
C        IFRAME DETERMINES THE FOLLOWING -
C               IFRAME = 1  MICROFILM ONLY
C               IFRAME = 2  HARDCOPY ONLY
C               IFRAME = 3  HARDCOPY AND MICROFILM
C
C
      SUBROUTINE MERCAT(IFRAME,NLAT,NLONG,ISEL)
      COMMON  /SHORES/  NCOAST, CLAT(8338), CLONG(8338), NCIND
      DATA LTAPE(14)
      CALL EXPLGT(511,48,511)
C
      IND=ISEL+1
      GO TO (410,10,10,10,10),IND
  10  CALL REPEAT(IFRAME,0)
      CALL VECTOR(1007,0,1023,0)
      CALL VECTOR(1023,0,1023,16)
C
      ILAT=NLAT
      IF(ILAT*(90/NLAT)-90)30,40,30
  30  ILAT=10
  40  LAT=180-ILAT
      ILONG=NLONG
      IF(ILONG*(180/NLONG)-180)50,60,50
  50  ILONG=20
  60  GO TO (410,100,100,300,100),IND
C
C                              LATITUDES
 100  ALONG=0.
      NP=-6
      DO 180 I=1,181,ILAT
      ALAT=I-91
      LAT=ABS(ALAT)
      CALL MERCOD(N1X,N1Y,ALAT,ALONG)
      CALL XAXSTP(0,N1Y,1023)
      IF(LAT) 120,110,120
 110  NP=6
      CALL XAXSTP(0,N1Y,1023)
      GO TO 180
 120  IF(LAT-84)140,140,130
 130  LAT=84
 140  N1Y=N1Y+NP
 150  CALL TSP(500,48,N1Y)
      CALL C4020I(LAT,3)
      CALL STPTYP
 180  CONTINUE
C
C                              LONGITUDES
 200  ALAT=84.
      CALL MERCOD(N1X,N1Y,-ALAT,ALONG)
      CALL MERCOD(N2X,N2Y,ALAT,ALONG)
      CALL TSP(504,37,N2Y+6)
      CALL TSP(504,50,N1Y-6)
      CALL TSP(1016,54,505)
      CALL TSP(6,21,505)
      CALL STPTYP
      NP=-30
```

```
      DO 280 I=1,361,ILONG
      ALONG=I-181
      LONG=ABS(ALONG)
      CALL MERCOD(N1X,N1Y,-ALAT,ALONG)
      CALL YAXSTP(N1X,N1Y,N2Y)
      IF(LONG) 220,210,220
  210 NP=-30
      CALL YAXSTP(1023,N1Y,N2Y)
      GO TO 280
  220 IF(LONG-170)240,280,280
  240 N1X=N1X+NP
  250 CALL TSP(N1X,48,505)
      CALL C4020I(LONG,3)
      CALL STPTYP
  280 CONTINUE
      CALL EXPHVY(511,48,511)
      GO TO (300,290,400,300,300),IND
  290 CALL ADVFLM(IFRAME)
      CALL VECTOR(1007,0,1023,0)
      CALL VECTOR(1023,0,1023,16)
C
C                              SHORELINES
  300 ALAT=84.
      CALL MERCOD(N1X,N1Y,-ALAT,ALONG)
      CALL MERCOD(N2X,N2Y,ALAT,ALONG)
      CALL VECTOR(511,495,511,527)
      CALL VECTOR(495,511,527,511)
      CALL XAXSTP(0,N1Y,1023)
      CALL XAXSTP(0,N2Y,1023)
      CALL YAXSTP(0,N1Y,N2Y)
      CALL YAXSTP(1023,N1Y,N2Y)
      IF(NCIND)301,302,301
  301 READ  (LTAPE)  NCOAST,(CLAT(I),CLONG(I),I=1,NCOAST)
      NCIND = 0
  302 NC=0
  310 NC=NC+1
      CALL MERCOD(N1X,N1Y,CLAT(NC),CLONG(NC))
      GO TO 380
  320 CALL MERCOD(N2X,N2Y,CLAT(NC),CLONG(NC))
  322 IF(CLONG(NC))326,324,326
  324 IF(SIGN(1.,CLONG(NC+1))-SIGN(1.,CLONG(NC-1)))330,360,330
  326 IF(SIGN(1.,CLONG(NC))-SIGN(1.,CLONG(NC-1)))328,360,328
  328 IF(ABS(CLONG(NC))-170.)330,360,360
  330 IF(CLONG(NC-1))340,380,350
  340 N2X=1023
      CALL VECTOR(N1X,N1Y,N2X,N2Y)
      N1X=0
      GO TO 370
  350 N2X=0
      CALL VECTOR(N1X,N1Y,N2X,N2Y)
      N1X=1023
      GO TO 370
  360 CALL VECTOR(N1X,N1Y,N2X,N2Y)
      N1X=N2X
  370 N1Y=N2Y
  380 NC=NC+1
      IF(NC-NCOAST)390,400,400
  390 IF(CLAT(NC))320,395,320
  395 IF(CLONG(NC))320,310,320
C
C
  400 CALL TSP(4,36,1015)
      CALL C4020H
      PRINT 3
    3                                                          FORMAT(
     1127HERCATOR PROJECTION
     2                                ALL BEARINGS CORRECT AND ORTHOMORPHIC)
      GO TO (420,410,420,420,420),IND
  410 CALL ADVFLM(IFRAME)
      CALL VECTOR(1007,0,1023,0)
      CALL VECTOR(1023,0,1023,16)
      CALL VECTOR(511,495,511,527)
      CALL VECTOR(495,511,527,511)
  420 CALL STPTYP
      CALL EXPHVY(511,48,511)
  430 RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP                                MERCD2
C     MERCATOR PLOTTING PROGRAM  MERCOD     (VERSION 2)
C     **********************************
C
C     FROM THE CALL MERCOD(NX,NY,ALAT,ALONG)
C     THIS SUBROUTINE CONVERTS COORDINATES  ALAT  AND  ALONG
C     TO S-C4020 RASTER UNITS  NX  AND  NY  FOR PLOTTING MERCATORS PROJECTION
C     BASED ON THE EQUATOR AND THE INTERNATIONAL DATE LINE
C         ALAT   POSITIVE FOR DEGREES NORTH, NEGATIVE FOR DEGREES SOUTH
C         ALONG  POSITIVE FOR DEGREES EAST, NEGATIVE FOR DEGREES WEST
C
C     THE MERIDIANS ARE EQUALLY SPACED WHERE  FACT = 1024/360
C     THE DISTANCE OF ANY PARALLEL FROM THE EQUATOR IS GIVEN BY
```

```
C           Y = R*LN(SEC(ALAT)+TAN(ALAT))  WHERE  2*PI*R = 1024
C      ANY LATITUDE OVER 84 DEGREES IS COMPUTED AT 84
C
C      REFERENCE - AN INTRODUCTION TO THE STUDY OF MAP PROJECTIONS
C                  BY J.A.STEERS  P.162
C
       SUBROUTINE MERCOD(NX,NY,ALAT,ALONG)
       DATA  FACT(2.844444444), DTOR(0.017453293), R(162.974661726)
C
       IF(ALONG)20,10,10
  10   NX=ALONG*FACT
       GO TO 30
  20   NX=1023.+ALONG*FACT
  30   RLAT=ALAT*DTOR
       IF(ABS(ALAT)-84.)50,40,40
  40   RLAT=SIGN(84.,ALAT)*DTOR
  50   NY=511.-R*ALOG(SEC(RLAT)+TAN(RLAT))
  60   RETURN
       END
T         SUBTYPE,FORTRAN,LMAP,LSTRAP
       FUNCTION SEC(X)
       SEC=1./COS(X)
       RETURN
       END
T         SUBTYPE,DATA
```

```
$         JOB,                                    MPLOT
$         TYPE,COMPILGO,F4
T         SUBTYPE,FIOD
$      14BIOD,TAPE, , , , , ,SAVE
$         REEL,PLBB0800
          END
T         SUBTYPE,FORTRAN,LMAP,LSTRAP
      DATA FIG5(8HFIGURE 5),FIG6(8HFIGURE 6)
      CALL SCLIBR
      CALL MPLOT(0.,0.,0.,0,0,0.,0.,0.,14,4,116,32,FIG5,1)
      CALL MPLOT(-0.5,-0.5,0.,0,0,-0.5,0.0,-130.,14,4,116,32,FIG6,1)
      CALL FINISH
      RETURN
      END
T         SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE MPLOT (X,Y,Z,IX,NPT,RADIUS,GLAT,GLON,LCOAST,ISEL,IXMAR,
     1IYMAR,T,KEY)
C
C *** X, Y, AND Z ARE THE LOCATIONS OF THE FIRST POINT TO BE CONSIDERED FOR
C          PLOTTING.  (THE POINT WILL NOT BE PLOTTED IF IT IS HIDDEN BY THE
C          EARTH.)  THE COORDINATE SYSTEM IS AN EARTH-CENTERED,RIGHT-HAND
C          RECTANGULAR SYSTEM WITH THE +X-AXIS GOING THROUGH  HE GREENWICH
C          MERIDIAN AND THE EQUATOR( AND THE +Z AXIS PASSING THROUGH THE
C          NORTH POLE.
C *** IX IS THE NUMBER OF CELLS TO COUNT TO GET FROM THE FIRST X (OR Y OR
C          Z) COORDINATE TO THE SECOND X (OR Y OR Z) COORDINATE.
C *** NPT IS THE NUMBER OF COORDINATE TRIPLETS IN CORES
C *** RADIUS IS THE RADIUS OF THE EARTH IN THE SAME UNITS AS X, Y, AND Z.
C *** GLAT IS THE LATITUDE OF THE POINT BENEATH THE VIEWPOINT, MEASURED
C          DEGREES PLUS NORTH FROM THE EQUATOR.
C *** GLON IS THE LONGITUDE OF THE POINT BENEATH THE VIEWPOINT, MEASURED
C          DEGREES PLUS EAST FROM THE GREENWICH MERIDIAN.
C *** LCOAST IS THE LOGICAL NUMBER OF THE TAPE UNIT ON WHICH WILL BE LOADED
C          THE TAPE CONTAINING THE COASTLINE POINTS.
C *** ISEL DETERMINES THE BACKGROUND.  IF
C          ISEL = 1, SEPARATE PICTURES SHOWING GRID LINES (SPACED 10 DEGREES
C               APART) AND COASTLINES WILL BE FORMED.
C          ISEL = 2, ONLY PICTURES SHOWING GRID LINES WILL BE FORMED.
C          ISEL = 3, ONLY PICTURES SHOWING COASTLINES WILL BE FORMED.
C          ISEL = 4, PICTURES SHOWING BOTH GRID LINES AND COASTLINES WILL
C               BE FORMED.
C          ISEL = 5, EXTRA FACILITY ADDED TO HELP WITH PLOTTING POINTS
C               (SEE MPCOD)
C *** IXMAR IS THE NUMBER OF CHARACTRON UNITS TO BE RESERVED FOR A MARGIN
C         ON THE LEFT AND RIGHT SIDES OF THE FRAME.
C *** IYMAR IS THE NUMBER OF CHARACTRON UNITS TO BE RESERVED FOR A MARGIN
C          ON THE TOP AND BOTTOM OF THE FRAME.
C *** T IS THE LOCATION OF THE FIRST WORD CONTAINING THE BCD CHARACTERS
C          THE TITLE.
C *** KEY  IS THE NUMBER OF CHARACTERS IN THE TITLE.
C
C
      DIMENSION MT(2),RAN(5),AMAT(9),XX(200,2),YY(200,2),T(KEY)
      COMMON  /SCOMON/  IFRAME,NCOPY,CPX,CPY,RAD,SCFX,SCFY
C
      IF(IFRAME)2,2,1
 1    IF(IFRAME-3)3,3,2
 2    IFRAME=2
 3    IAXX=IABS(ISEL)                                                  MPLOT045
      IF(IAXX-5)30,8008,31                                             MPLOT046
   31 PRINT 32, IAXX                                                   MPLOT047
   32 FORMAT(////31H THE VALUE OF THE ARGUMENT ISEL,I6,39H IS TOO LARGE.MPLOT048
     1  ISEL MUST BE 5 OR LESS.///)                                    MPLOT049
      GO TO 8                                                          MPLOT050
   30 IF(CPX-1023.)3002,3003,3003                                      MPLOT051
 3002 IF(CPX)3003,3003,3004                                            MPLOT051
 3003 CPX=511.                                                         MPLOT051
 3004 IF(CPY-1023.)3005,3006,3006                                      MPLOT051
 3005 IF(CPY)3006,3006,3008                                            MPLOT051
 3006 CPY=511.                                                         MPLOT051
 3008 RAD=AMIN1(SPACE(CPX,CPY,CPX,0.),SPACE(CPX,CPY,CPX,1023.),        MPLOT051
     1           SPACE(CPX,CPY,0.,CPY),SPACE(CPX,CPY,1023.,CPY))      MPLOT051
      NXMAR=IABS(IXMAR)                                                MPLOT052
      NYMAR=IABS(IYMAR)                                                MPLOT053
      XMAR=CPX-FLOAT(NXMAR)                                            MPLOT054
      YMAR=CPY-FLOAT(NYMAR)                                            MPLOT055
      GO TO (8001,8002,8003,8002),IAXX                                 MPLOT056
 8001 IOPT=2                                                           MPLOT057
      ICOA=1                                                           MPLOT058
      GO TO 8000                                                       MPLOT059
 8002 IOPT=1                                                           MPLOT060
      ICOA=1                                                           MPLOT061
      GO TO 8000                                                       MPLOT062
 8003 IOPT=2                                                           MPLOT063
      ICOA=2                                                           MPLOT064
 8000 CONTINUE                                                         MPLOT065
      IF(RADIUS)8204,8004,8005                                         MPLOT066
 8204 CONTINUE                                                         MPLOT067
      RAN(1)=-RADIUS                                                   MPLOT068
      AVX=-X                                                           MPLOT069
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      AVY=-Y                                                            MPLOT070
      IGOP=1                                                            MPLOT071
      GO TO 8006                                                        MPLOT072
 8004 IGOP=1                                                            MPLOT073
      AVX=0.                                                            MPLOT074
      AVY=0.                                                            MPLOT075
      RAN(1)=1.101*RAD/AMIN1(XMAR,YMAR)                                 MPLOT076
      GO TO 8006                                                        MPLOT077
 8005 IGOP=0                                                            MPLOT078
 8006 CONTINUE                                                          MPLOT079
      CALL MPAMAT (AMAT,GLAT,GLON)                                      MPLOT080
      IF(IGOP)2001,2000,2001                                            MPLOT081
 2000 CONTINUE                                                          MPLOT082
      CALL MPTRAJ (X,Y,Z,IX,NPT,RADIUS,MT,XX,YY,AMAT)                   MPLOT083
      IF(MT(1)+MT(2)-2)888,888,122                                      MPLOT084
  888 PRINT 889, GLAT,GLON                                              MPLOT085
  889 FORMAT(////37H NO POINTS VISIBLE FROM VIEW LATITUDE,F7.2,30H DEGREMPLOT086
     1ES NORTH, VIEW LONGITUDE,F8.2,14H DEGREES EAST.///)               MPLOT087
      GO TO 8                                                           MPLOT088
  122 CONTINUE                                                          MPLOT089
      CALL MPSCAL (XX,YY,MT,RAN,AVX,AVY,XMAR,YMAR)                      MPLOT090
 2001 CONTINUE                                                          MPLOT091
      DO 501 KZB=ICOA,IOPT                                              MPLOT092
      IZZ=1+IGOP                                                        MPLOT093
      DO 98 KIJ=1,4                                                     MPLOT094
      RAG=RAN(KIJ)                                                      MPLOT095
      HL=RAG/64.                                                        MPLOT096
      VL=HL*1.5                                                         MPLOT097
      ZXX=XMAR/CPX*RAG                                                  MPLOT098
      ZYB=YMAR/CPY*RAG                                                  MPLOT099
      IF(KEY)10,11,10                                                   MPLOT100
   10 ZYT=ZYB-.9/11.*RAG                                                MPLOT101
      GO TO 12                                                          MPLOT102
   11 ZYT=ZYB                                                           MPLOT103
   12 CALL ADVFLM(IFRAME)                                               MPLOT104
      CALL EXPLGT(CPX,48,CPY)                                           MPLOT105
      CALL XSCALV(RAG)                                                  MPLOT106
      CALL YSCALV(RAG)                                                  MPLOT107
      IF(IGOP)2004,2005,2004                                            MPLOT108
 2005 CONTINUE                                                          MPLOT109
      CALL MPDRAW (XX,YY,MT,ISEL)                                       MPLOT110
 2004 CONTINUE                                                          MPLOT111
      CALL MPHORZ (CONST,IZZ,AVX,AVY,ZYT,ZYB,ZXX)                       MPLOT112
  201 RAN(KIJ+1)=CONST*RAG                                              MPLOT113
  203 CONTINUE                                                          MPLOT114
      GO TO (599,598),KZB                                               MPLOT115
  599 CONTINUE                                                          MPLOT116
      CALL MPGRID (GLAT,GLON,AVX,AVY,AMAT,ZYT,ZYB,ZXX)                  MPLOT117
      CALL EXPHVY(CPX,48,CPY)                                           MPLOT117
      CALL MPLETR (AMAT,AVX,AVY,ZYT,ZYB,ZXX)                            MPLOT118
      IF(IAXX-4)597,3457,597                                            MPLOT119
 3457 CONTINUE                                                          MPLOT120
  598 CONTINUE                                                          MPLOT121
      IF(RAN(KIJ)-2.)1301,1301,1401                                     MPLOT122
 1301 CONTINUE                                                          MPLOT123
      CALL MPPOLE (AMAT,AVX,AVY,HL,VL,ZYT,ZYB,ZXX)                      MPLOT124
 1401 CONTINUE                                                          MPLOT125
      CALL MPSHOR (LCOAST,AMAT,AVX,AVY,ZYT,ZYB,ZXX,RAG)                 MPLOT126
  597 CONTINUE                                                          MPLOT127
      IF(IXMAR)20,21,21                                                 MPLOT128
   21 IF(IYMAR)20,22,22                                                 MPLOT129
   22 CONTINUE                                                          MPLOT130
      CALL MPBORD (NXMAR,NYMAR)                                         MPLOT131
   20 CONTINUE                                                          MPLOT132
      IF(KEY)1050,8010,1050                                             MPLOT133
 1050 CONTINUE                                                          MPLOT134
      CALL MPTITL (KEY,T,NYMAR)                                         MPLOT135
 8010 CONTINUE                                                          MPLOT136
      GO TO (301,302),IZZ                                               MPLOT137
  301 CONTINUE                                                          MPLOT138
   98 CONTINUE                                                          MPLOT139
  302 CONTINUE                                                          MPLOT140
  501 CONTINUE                                                          MPLOT141
    8 RETURN                                                            MPLOT142
C
 8008 T(1)=COS(GLAT)*COS(GLON)
      T(2)=COS(GLAT)*SIN(GLON)
      T(3)=SIN(GLAT)
      X=AMAT(1)*T(1)+AMAT(4)*T(2)+AMAT(7)*T(3)-AVX
      Y=AMAT(2)*T(1)+AMAT(5)*T(2)+AMAT(8)*T(3)-AVY
      Z=AMAT(3)*T(1)+AMAT(6)*T(2)+AMAT(9)*T(3)
      IF(Z)8665,8665,8020
 8020 IF(ABS(X)-ZXX)8021,8665,8665
 8021 IF(Y-ZYT)8022,8665,8665
 8022 IF(Y+ZYB)8665,8670,8670
 8665 Z=0.
      GO TO 8
 8670 IXMAR=NXV(X)
      IYMAR=NYV(Y)
      GO TO 8
```

```
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE MPAMAT (AMAT,GLAT,GLON)                                MPLOT146
      DIMENSION AMAT(1)                                                 MPLOT147
      PLAT=GLAT/57.29578                                                MPLOT148
      PLON=GLON/57.29578                                                MPLOT149
      CL=COS(PLON)                                                      MPLOT150
      SL=SIN(PLON)                                                      MPLOT151
      CP=COS(PLAT)                                                      MPLOT152
      SP=SIN(PLAT)                                                      MPLOT153
      AMAT(1)=-SL                                                       MPLOT154
      AMAT(2)=-CL*SP                                                    MPLOT155
      AMAT(3)= CL*CP                                                    MPLOT156
      AMAT(4)= CL                                                       MPLOT157
      AMAT(5)=-SL*SP                                                    MPLOT158
      AMAT(6)= SL*CP                                                    MPLOT159
      AMAT(7)= 0.                                                       MPLOT160
      AMAT(8)= CP                                                       MPLOT161
      AMAT(9)= SP                                                       MPLOT162
      RETURN                                                            MPLOT163
      END                                                               MPLOT164
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE MPTRAJ (X,Y,Z,IX,NPT,RADIUS,MT,XX,YY,AMAT)             MPLOT167
      DIMENSION XX(1),YY(1)                                             MPLOT168
      DIMENSION MT(1),AMAT(1),VT(3)                                     MPLOT169
      DIMENSION X(1),Y(1),Z(1)                                          MPLOT170
      ID=NPT/100                                                        MPLOT171
      IF(ID)101,101,102                                                 MPLOT172
  101 NTOT=NPT                                                          MPLOT173
      IDX=IX                                                            MPLOT174
      GO TO 103                                                         MPLOT175
  102 II=NPT-100*ID                                                     MPLOT176
      IF(II-ID)104,104,105                                              MPLOT177
  104 NTOT=100                                                          MPLOT178
      GO TO 106                                                         MPLOT179
  105 ID=ID+1                                                           MPLOT180
      NTOT=NPT/ID                                                       MPLOT181
  106 IDX=ID*IX                                                         MPLOT182
  103 CONTINUE                                                          MPLOT183
      IBIZ=0                                                            MPLOT184
      DO15IE=1,2                                                        MPLOT185
      JBIZ=IBIZ+1                                                       MPLOT186
      JKK=(IE-1)*200                                                    MPLOT187
      L=0                                                               MPLOT188
      MM=-1                                                             MPLOT189
      DO 116 IG=JBIZ,NTOT                                               MPLOT190
      IBIZ=IG                                                           MPLOT191
      JDEX=32769-(IG-1)*IDX                                             MPLOT192
      LL=-MM                                                            MPLOT193
      VT(1)=AMAT(1)*X(JDEX)+AMAT(4)*Y(JDEX)+AMAT(7)*Z(JDEX)             MPLOT194
      VT(2)=AMAT(2)*X(JDEX)+AMAT(5)*Y(JDEX)+AMAT(8)*Z(JDEX)             MPLOT195
      VT(3)=AMAT(3)*X(JDEX)+AMAT(6)*Y(JDEX)+AMAT(9)*Z(JDEX)             MPLOT196
      VT(1)=VT(1)/RADIUS                                                MPLOT197
      VT(2)=VT(2)/RADIUS                                                MPLOT198
      VT(3)=VT(3)/RADIUS                                                MPLOT199
      IF(VT(3))16,17,17                                                 MPLOT200
   17 L=L+2                                                             MPLOT201
      JJJ=JKK+L-1                                                       MPLOT202
      XX(JJJ)=VT(1)                                                     MPLOT203
      YY(JJJ)=VT(2)                                                     MPLOT204
      GO TO 18                                                          MPLOT205
   16 SIZ= VT(1)*VT(1)+VT(2)*VT(2)                                      MPLOT206
      IF(SIZ-1.)22,20,20                                                MPLOT207
   20 L=L+2                                                             MPLOT208
      JJJ=JKK+L-1                                                       MPLOT209
      XX(JJJ)=VT(1)                                                     MPLOT210
      YY(JJJ)=VT(2)                                                     MPLOT211
      SIZ=SQRT(SIZ)                                                     MPLOT212
   21 CONTINUE                                                          MPLOT213
      JJJ=JKK+L                                                         MPLOT214
      XX(JJJ)=VT(1)/SIZ                                                 MPLOT215
      YY(JJJ)=VT(2)/SIZ                                                 MPLOT216
      GO TO 19                                                          MPLOT217
   18 SIZ=SQRT(VT(1)*VT(1)+VT(2)*VT(2)+VT(3)*VT(3))                     MPLOT218
      GO TO 21                                                          MPLOT219
   19 MM=1                                                              MPLOT220
      GO TO 116                                                         MPLOT221
   22 MM=-1                                                             MPLOT222
      IF(LL+MM)24,116,116                                               MPLOT223
  116 CONTINUE                                                          MPLOT224
   24 MT(IE)=L                                                          MPLOT225
      IF(NTOT-IBIZ)118,118,119                                          MPLOT226
  118 CONTINUE                                                          MPLOT227
      IF(IE-1)120,120,119                                               MPLOT228
  120 MT(2)=0                                                           MPLOT229
      GO TO 121                                                         MPLOT230
  119 CONTINUE                                                          MPLOT231
   15 CONTINUE                                                          MPLOT232
  121 CONTINUE                                                          MPLOT233
      RETURN                                                            MPLOT234
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      END                                                                MPLOT235
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE MPSCAL (XX,YY,MT,RAN,AVX,AVY, XMAR, YMAR)               MPLOT238
      DIMENSION XX(1),YY(1),MT(1),RAN(1)                                 MPLOT239
      CALL FMXMN (AA,ZA,XX(1),MT(1))                                     MPLOT240
      CALL FMXMN (AC,ZC,YY(1),MT(1))                                     MPLOT241
      IF(MT(2))123,123,124                                               MPLOT242
  123 ZB=ZA                                                              MPLOT243
      ZD=ZC                                                              MPLOT244
      AB=AA                                                              MPLOT245
      AD=AC                                                              MPLOT246
      GO TO 125                                                          MPLOT247
  124 CALL FMXMN (AB,ZB,XX(201),MT(2))                                   MPLOT248
      CALL FMXMN (AD,ZD,YY(201),MT(2))                                   MPLOT249
  125 RANX=AMAX1(AA,AB)-AMIN1(ZA,ZB)                                     MPLOT250
      RANY=AMAX1(AC,AD)-AMIN1(ZC,ZD)                                     MPLOT251
      AVX=(AMAX1(AA,AB)+AMIN1(ZA,ZB))/2.                                 MPLOT252
      AVY=(AMAX1(AC,AD)+AMIN1(ZC,ZD))/2.                                 MPLOT253
      REX=RANX/XMAR                                                      MPLOT254
      REY=RANY/YMAR                                                      MPLOT255
      RAN(1)=AMAX1(REX,REY)*.55*512.                                     MPLOT256
      DO 193 I=1,400                                                     MPLOT257
      XX(I)=XX(I)-AVX                                                    MPLOT258
  193 YY(I)=YY(I)-AVY                                                    MPLOT259
      RETURN                                                             MPLOT260
      END                                                                MPLOT261
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE MPDRAW (XX,YY,MT,ISEL)                                  MPLOT264
      DIMENSION XX(1),YY(1),MT(1)                                        MPLOT265
      DO96JK I=1,2                                                       MPLOT266
      IF(MT(JKI)-2)96,96,97                                              MPLOT267
   97 KK=MT(JKI)/2-1                                                     MPLOT268
      LNK=200*(JKI-1)+1                                                  MPLOT269
      CALL DRAWV (KK,1,XX(LNK),-2,YY(LNK),-2)                            MPLOT270
      CALL DRAWV (KK,1,XX(LNK+1),-2,YY(LNK+1),-2)                        MPLOT271
      IF(ISEL)95,95,94                                                   MPLOT272
   94 CONTINUE                                                           MPLOT273
      KK=KK+1                                                            MPLOT274
      CALL DRAWV (KK,0,XX(LNK),-1,YY(LNK),-1)                            MPLOT275
   95 CONTINUE                                                           MPLOT276
   96 CONTINUE                                                           MPLOT277
      RETURN                                                             MPLOT278
      END                                                                MPLOT279
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE MPHORZ (CONST,     IZZ,AVX,AVY,ZYT,ZYB,ZXX)             MPLOT282
      DIMENSION XD(181),YD(181),XPR(2),YPR(2)                            MPLOT283
      DO 30 I=1,361,2                                                    MPLOT284
      ANG=FLOAT(I)/57.29578                                              MPLOT285
      J=I/2+1                                                            MPLOT286
      XD(J)=COS(ANG)-AVX                                                 MPLOT287
      YD(J)=SIN(ANG)-AVY                                                 MPLOT288
   30 CONTINUE                                                           MPLOT289
      LNUM=2                                                             MPLOT290
      LTOT=0                                                             MPLOT291
      DO 93 I=1,181                                                      MPLOT292
      IF(ABS(XD(I))-ZXX)92,92,91                                         MPLOT293
   92 YZIP=YD(I)                                                         MPLOT294
      IF(YZIP+ZYB)91,1091,1091                                           MPLOT295
 1091 IF(YZIP-ZYT)90,91,91                                               MPLOT296
   90 XPR(LNUM)=XD(I)                                                    MPLOT297
      YPR(LNUM)=YD(I)                                                    MPLOT298
      LNUM=LNUM-1                                                        MPLOT299
      IF(LNUM)87,87,93                                                   MPLOT300
   87 N1X=NXV(XPR(1))                                                    MPLOT301
      N1Y=NYV(YPR(1))                                                    MPLOT302
      N2X=NXV(XPR(2))                                                    MPLOT303
      N2Y=NYV(YPR(2))                                                    MPLOT304
      CALL VECTOR(N1X,N1Y,N2X,N2Y)                                       MPLOT305
      LTOT=LTOT+1                                                        MPLOT306
      LNUM=1                                                             MPLOT307
      XPR(2)=XPR(1)                                                      MPLOT308
      YPR(2)=YPR(1)                                                      MPLOT309
      GO TO 93                                                           MPLOT310
   91 LNUM=2                                                             MPLOT311
   93 CONTINUE                                                           MPLOT312
      IF(LTOT-31)741,748,748                                             MPLOT313
  748 IF(LTOT-61)742,749,749                                             MPLOT314
  749 IF(LTOT-121)743,202,202                                            MPLOT315
  741 CONST=3.                                                           MPLOT316
      GO TO 201                                                          MPLOT317
  742 CONST=2.                                                           MPLOT318
      GO TO 201                                                          MPLOT319
  743 CONST=1.5                                                          MPLOT320
      GO TO 201                                                          MPLOT321
  202 IZZ=2                                                              MPLOT322
  201 CONTINUE                                                           MPLOT323
      RETURN                                                             MPLOT324
      END                                                                MPLOT325
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE MPGRID (GLAT,GLON,     AVX,AVY,AMAT,ZYT,ZYB,ZXX)        MPLOT328
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      DIMENSION AMAT(1),XPR(2),YPR(2),VT(3),PV(3)                       MPLOT329
      VLAT=GLAT                                                         MPLOT330
      VLON=GLON                                                         MPLOT331
      IF(VLON)1001,1002,1002                                            MPLOT332
 1001 VLON=360.+VLON                                                    MPLOT333
 1002 CONTINUE                                                          MPLOT334
      PMUL=-SIGN(1.,VLAT)                                               MPLOT335
      IMUL=(180.-ABS(VLAT))/2.+1.                                       MPLOT336
      IF(IMUL-86)6100,6101,6101                                         MPLOT337
 6100 INUL=5                                                            MPLOT338
      GO TO 6102                                                        MPLOT339
 6101 INUL=IMUL-81                                                      MPLOT340
 6102 CONTINUE                                                          MPLOT341
      PLON=0.                                                           MPLOT342
      DLAT= 2./57.29578                                                 MPLOT343
      DLON=10./57.29578                                                 MPLOT344
      DO85I=1,36                                                        MPLOT345
      IF(FLOAT(I-1)/9)-FLOAT(I-1)/9.)83,84,84                           MPLOT346
   83 PLAT=-80./57.29578*PMUL                                           MPLOT347
      IZL=IMUL-INUL                                                     MPLOT348
      GO TO 82                                                          MPLOT349
   84 PLAT=-90./57.29578*PMUL                                           MPLOT350
      IZL=IMUL                                                          MPLOT351
   82 CONTINUE                                                          MPLOT352
      LNUM=2                                                            MPLOT353
      COL=COS(PLON)                                                     MPLOT354
      SOL=SIN(PLON)                                                     MPLOT355
      DO81J=1,IZL                                                       MPLOT356
      COP=COS(PLAT)                                                     MPLOT357
      SOP=SIN(PLAT)                                                     MPLOT358
      VT(1)=COP*COL                                                     MPLOT359
      VT(2)=COP*SOL                                                     MPLOT360
      VT(3)=SOP                                                         MPLOT361
      PV(1)=AMAT(1)*VT(1)+AMAT(4)*VT(2)+AMAT(7)*VT(3)                   MPLOT362
      PV(2)=AMAT(2)*VT(1)+AMAT(5)*VT(2)+AMAT(8)*VT(3)                   MPLOT363
      PV(3)=AMAT(3)*VT(1)+AMAT(6)*VT(2)+AMAT(9)*VT(3)                   MPLOT364
      IF(PV(3)-.05)80,80,79                                             MPLOT365
   80 LNUM=2                                                            MPLOT366
      GO TO 81                                                          MPLOT367
   79 XPO=PV(1)-AVX                                                     MPLOT368
      IF(ABS(XPO)-ZXX)76,76,80                                          MPLOT369
   76 YPO=PV(2)-AVY                                                     MPLOT370
      IF(YPO+ZYB)80,1092,1092                                           MPLOT371
 1092 IF(YPO-ZYT)74,80,80                                               MPLOT372
   74 XPR(LNUM)=XPO                                                     MPLOT373
      YPR(LNUM)=YPO                                                     MPLOT374
      LNUM=LNUM-1                                                       MPLOT375
      IF(LNUM)81,750,81                                                 MPLOT376
  750 N1X=NXV(XPR(1))                                                   MPLOT377
      N1Y=NYV(YPR(1))                                                   MPLOT378
      N2X=NXV(XPR(2))                                                   MPLOT379
      N2Y=NYV(YPR(2))                                                   MPLOT380
      CALL VECTOR(N1X,N1Y,N2X,N2Y)                                      MPLOT381
      LNUM=1                                                            MPLOT382
      XPR(2)=XPR(1)                                                     MPLOT383
      YPR(2)=YPR(1)                                                     MPLOT384
   81 PLAT=PLAT+DLAT*PMUL                                               MPLOT385
   72 PLON=PLON+DLON                                                    MPLOT386
   85 CONTINUE                                                          MPLOT387
      PLAT=-80./57.29578                                                MPLOT388
      DELAT=10./57.29578                                                MPLOT389
      DO70I=1,17                                                        MPLOT390
      IF(I-3)69,68,50                                                   MPLOT391
   50 IF(I-6)68,67,51                                                   MPLOT392
   51 IF(I-13)67,68,52                                                  MPLOT393
   52 IF(I-16)68,69,69                                                  MPLOT394
   69 DLON=10./57.29578                                                 MPLOT395
      INUM=37                                                           MPLOT396
      GO TO 66                                                          MPLOT397
   68 DLON=5./57.29578                                                  MPLOT398
      INUM=73                                                           MPLOT399
      GO TO 66                                                          MPLOT400
   67 DLON=2./57.29578                                                  MPLOT401
      INUM=181                                                          MPLOT402
   66 COP=COS(PLAT)                                                     MPLOT403
      SOP=SIN(PLAT)                                                     MPLOT404
      LNUM=2                                                            MPLOT405
      PLON=0.                                                           MPLOT406
      DO65J=1,INUM                                                      MPLOT407
      COL=COS(PLON)                                                     MPLOT408
      SOL=SIN(PLON)                                                     MPLOT409
      VT(1)=COP*COL                                                     MPLOT410
      VT(2)=COP*SOL                                                     MPLOT411
      VT(3)=SOP                                                         MPLOT412
      PV(1)=AMAT(1)*VT(1)+AMAT(4)*VT(2)+AMAT(7)*VT(3)                   MPLOT413
      PV(2)=AMAT(2)*VT(1)+AMAT(5)*VT(2)+AMAT(8)*VT(3)                   MPLOT414
      PV(3)=AMAT(3)*VT(1)+AMAT(6)*VT(2)+AMAT(9)*VT(3)                   MPLOT415
      IF(PV(3))64,64,63                                                 MPLOT416
   64 LNUM=2                                                            MPLOT417
      GO TO 65                                                          MPLOT418
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      IF(LNUM)65,751,65                                                 MPLOT427
  751 N1X=NXV(XPR(1))                                                   MPLOT428
      N1Y=NYV(YPR(1))                                                   MPLOT429
      N2X=NXV(XPR(2))                                                   MPLOT430
      N2Y=NYV(YPR(2))                                                   MPLOT431
      CALL VECTOR(N1X,N1Y,N2X,N2Y)                                      MPLOT432
      LNUM=1                                                            MPLOT433
      XPR(2)=XPR(1)                                                     MPLOT434
      YPR(2)=YPR(1)                                                     MPLOT435
   65 PLON=PLON+DLON                                                    MPLOT436
   57 PLAT=PLAT+DELAT                                                   MPLOT437
   70 CONTINUE                                                          MPLOT438
      RETURN                                                            MPLOT439
      END                                                               MPLOT440
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE MPLETR (AMAT,AVX,AVY,ZYT,ZYB,ZXX)                      MPLOT443
      DIMENSION XZI(36),YZI(36),AMAT(1),PV(3),VT(3)                     MPLOT444
      DIMENSION WWWX(5)                                                 MPLOT445
      DATA (WWWX(I),I=1,5)(4HG       E       I       W       EQ      ) MPLOT446
      DLAT=30./57.29578                                                 MPLOT450
      DO55I=1,4                                                         MPLOT451
      FCT=(I-1)                                                         MPLOT452
      PLON=FCT*90./57.29578                                             MPLOT453
      PLAT=-75./57.29578                                                MPLOT454
      COL=COS(PLON)                                                     MPLOT455
      SOL=SIN(PLON)                                                     MPLOT456
      DO49J=1,6                                                         MPLOT457
      KK=6*(I-1)+J                                                      MPLOT458
      VT(1)=COS(PLAT)*COL                                               MPLOT459
      VT(2)=COS(PLAT)*SOL                                               MPLOT460
      VT(3)=SIN(PLAT)                                                   MPLOT461
      PV(1)=AMAT(1)*VT(1)+AMAT(4)*VT(2)+AMAT(7)*VT(3)                   MPLOT462
      PV(2)=AMAT(2)*VT(1)+AMAT(5)*VT(2)+AMAT(8)*VT(3)                   MPLOT463
      PV(3)=AMAT(3)*VT(1)+AMAT(6)*VT(2)+AMAT(9)*VT(3)                   MPLOT464
      IF(PV(3)-.1)46,46,47                                              MPLOT465
   47 XZI(KK)=PV(1)-AVX                                                 MPLOT466
      YZI(KK)=PV(2)-AVY                                                 MPLOT467
      GO TO 38                                                          MPLOT468
   46 XZI(KK)=1000.                                                     MPLOT469
   38 CONTINUE                                                          MPLOT470
      PLAT=PLAT+DLAT                                                    MPLOT471
   49 CONTINUE                                                          MPLOT472
   55 CONTINUE                                                          MPLOT473
      PLON=15./57.29578                                                 MPLOT474
      DO36J=1,12                                                        MPLOT475
      KK=24+J                                                           MPLOT476
      VT(1)=COS(PLON)                                                   MPLOT477
      VT(2)=SIN(PLON)                                                   MPLOT478
      VT(3)=0.                                                          MPLOT479
      PV(1)=AMAT(1)*VT(1)+AMAT(4)*VT(2)+AMAT(7)*VT(3)                   MPLOT480
      PV(2)=AMAT(2)*VT(1)+AMAT(5)*VT(2)+AMAT(8)*VT(3)                   MPLOT481
      PV(3)=AMAT(3)*VT(1)+AMAT(6)*VT(2)+AMAT(9)*VT(3)                   MPLOT482
      IF(PV(3)-.1)136,136,35                                            MPLOT483
  136 XZI(KK)=1000.                                                     MPLOT484
      GO TO 36                                                          MPLOT485
   35 XZI(KK)=PV(1)-AVX                                                 MPLOT486
      YZI(KK)=PV(2)-AVY                                                 MPLOT487
   36 PLON=PLON+DLAT                                                    MPLOT488
      DO801I=1,5                                                        MPLOT489
      IF(I-5)901,902,902                                                MPLOT490
  901 LTX=6                                                             MPLOT491
      GO TO 903                                                         MPLOT492
  902 LTX=12                                                            MPLOT493
  903 DO802J=1,LTX                                                      MPLOT494
      KK=6*(I-1)+J                                                      MPLOT495
      IF(ABS(XZI(KK))-ZXX)803,804,804                                   MPLOT496
  803 YZIP=YZI(KK)                                                      MPLOT497
      IF(YZIP+ZYB)804,804,816                                           MPLOT498
  816 IF(YZIP-ZYT)805,804,804                                           MPLOT499
  805 CONTINUE                                                          MPLOT500
   42 NX=NXV(XZI(KK))                                                   MPLOT501
      NY=NYV(YZI(KK))                                                   MPLOT502
      CALL TSP(NX-8,48,NY)                                              MPLOT503
      CALL HORAM(WWWX(I),2)                                             MPLOT504
      CALL STPTYP                                                       MPLOT505
  806 CONTINUE                                                          MPLOT508
  804 CONTINUE                                                          MPLOT509
  802 CONTINUE                                                          MPLOT510
  801 CONTINUE                                                          MPLOT511
      RETURN                                                            MPLOT512
      END                                                               MPLOT513
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
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      SUBROUTINE MPPOLE (AMAT,AVX,AVY,HL,VL,ZYT,ZYB,ZXX)                MPLOT516
      DIMENSION AMAT(1)                                                 MPLOT517
      YPO=SIGN(1.,AMAT(9))*AMAT(8)-AVY                                  MPLOT518
      XPO=-AVX                                                          MPLOT519
      IF(ABS(XPO)-(ZXX-4.*HL))1330,1330,1401                            MPLOT520
 1330 IF(YPO+ZYB-1.6*VL)1401,1333,1333                                  MPLOT521
 1333 IF(YPO-ZYT+1.6*VL)1332,1332,1401                                  MPLOT522
 1332 POX=XPO-3.*HL                                                     MPLOT523
      POY=YPO+VL                                                        MPLOT524
      NX=NXV(POX)                                                       MPLOT525
      NY=NYV(POY)                                                       MPLOT526
      CALL TSP(NX,48,NY)                                                MPLOT527
      IF(AMAT(9))1400,1401,1402                                         MPLOT528
 1400 CALL C4020H                                                       MPLOT529
      PRINT 1                                                           MPLOT529
 1    FORMAT(5HSOUTH)                                                   MPLOT529
      GO TO 1411                                                        MPLOT530
 1402 CALL C4020H                                                       MPLOT531
      PRINT 2                                                           MPLOT531
 2    FORMAT(5HNORTH)                                                   MPLOT531
 1411 POX=XPO-2.5*HL                                                    MPLOT532
      POY=YPO-VL                                                        MPLOT533
      NX=NXV(POX)                                                       MPLOT534
      NY=NYV(POY)                                                       MPLOT535
      CALL TSP(NX,48,NY)                                                MPLOT536
      CALL C4020H                                                       MPLOT536
      PRINT 3                                                           MPLOT536
 3    FORMAT(5HPOLE )                                                   MPLOT536
 1401 CONTINUE                                                          MPLOT537
      CALL TSP(4,38,1015)                                               MPLOT537
      CALL C4020H                                                       MPLOT537
      PRINT 4                                                           MPLOT537
 4                                                              FORMAT(MPLOT537
     1127HRTHOGRAPHIC PROJECTION                                        MPLOT537
     2                                ILLUSION OF DEPTH AND PERSPECTIVE)MPLOT537
      CALL STPTYP                                                       MPLOT537
      RETURN                                                            MPLOT538
      END                                                               MPLOT539
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE MPSHOR (LCOAST,AMAT,AVX,AVY,ZYT,ZYB,ZXX,RAG)           MPLOT542
      DIMENSION XPR(2),YPR(2)                                           MPLOT543
      COMMON  /SHORES/  NCOAST, CLAT(8338), CLONG(8338), NCIND
      DIMENSION AMAT(1),PV(3),V(3)                                      MPLOT545
      DATA  DTOR(0.017453293)
      BRAG=(RAG/170.1)**2                                               MPLOT546
      IF(NCIND)330,333,330                                              MPLOT547
 330  READ  (LCOAST)  NCOAST,(CLAT(J),CLONG(J),J=1,NCOAST)             MPLOT548
      NCIND = 0                                                         MPLOT549
 333  LNUM=2                                                            MPLOT550
      DO 602 J=1,NCOAST                                                 MPLOT551
      V(1)=COS(CLAT(J)*DTOR)*COS(CLONG(J)*DTOR)                         MPLOT552
      V(2)=COS(CLAT(J)*DTOR)*SIN(CLONG(J)*DTOR)                         MPLOT552
      V(3)=SIN(CLAT(J)*DTOR)                                            MPLOT552
      IF(V(2))664,663,664                                               MPLOT553
 663  IF(V(3))664,665,664                                               MPLOT554
 665  LNUM=2                                                            MPLOT555
      GO TO 602                                                         MPLOT556
 664  PV(1)=V(1)*AMAT(1)+V(2)*AMAT(4)+V(3)*AMAT(7)-AVX                  MPLOT557
      PV(2)=V(1)*AMAT(2)+V(2)*AMAT(5)+V(3)*AMAT(8)-AVY                  MPLOT558
      PV(3)=V(1)*AMAT(3)+V(2)*AMAT(6)+V(3)*AMAT(9)                      MPLOT559
      IF(PV(3))665,665,20                                               MPLOT560
   20 IF(ABS(PV(1))-ZXX)21,665,665                                      MPLOT561
   21 IF(PV(2)-ZYT)22,665,665                                           MPLOT562
   22 IF(PV(2)+ZYB)665,666,666                                          MPLOT563
 666  IF(LNUM-2)667,668,667                                             MPLOT564
 667  IF((XPR(2)-PV(1))**2+(YPR(2)-PV(2))**2-BRAG)602,602,668           MPLOT565
 668  XPR(LNUM)=PV(1)                                                   MPLOT566
      YPR(LNUM)=PV(2)                                                   MPLOT567
      LNUM=LNUM-1                                                       MPLOT568
      IF(LNUM)602,670,602                                               MPLOT569
 670  N1X=NXV(XPR(1))                                                   MPLOT570
      N1Y=NYV(YPR(1))                                                   MPLOT571
      N2X=NXV(XPR(2))                                                   MPLOT572
      N2Y=NYV(YPR(2))                                                   MPLOT573
      CALL VECTOR(N1X,N1Y,N2X,N2Y)                                      MPLOT574
      LNUM=1                                                            MPLOT575
      XPR(2)=XPR(1)                                                     MPLOT576
      YPR(2)=YPR(1)                                                     MPLOT577
 602  CONTINUE                                                          MPLOT578
      RETURN                                                            MPLOT581
      END                                                               MPLOT582
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE MPTITL (KEY,T,NYMAR)                                   MPLOT585
      DIMENSION T(1)                                                    MPLOT586
      NNX=512-32*KEY                                                    MPLOT587
      NNY=NYMAR+24                                                      MPLOT588
      CALL TSP(NNX,48,NNY)                                              MPLOT589
      DO 10 I=1,KEY                                                     MPLOT589
      CALL HORAM(T(I),8)                                                MPLOT589
 10   CONTINUE                                                          MPLOT589
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```
      GO TO 1-1,2                                                       MPLOT597
      CALL VECTOR(NXMAR,NYMAR,MXMAR,NYMAR)                              MPLOT598
      CALL VECTOR(NXMAR,MYMAR,MXMAR,MYMAR)                              MPLOT599
      CALL VECTOR(MXMAR,MYMAR,MXMAR,NYMAR)                              MPLOT600
      CALL VECTOR(NXMAR,MYMAR,NXMAR,NYMAR)                              MPLOT601
   10 CONTINUE                                                          MPLOT602
      RETURN                                                            MPLOT603
      END                                                               MPLOT604
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE FMXMN (A,Z,X,N)                                        MPLOT607
      DIMENSION X(1)                                                    MPLOT608
      A=X(1)                                                            MPLOT609
      Z=X(1)                                                            MPLOT610
      DO10I=1,N                                                         MPLOT611
      IF(A-X(I))11,10,12                                                MPLOT612
   11 A=X(I)                                                            MPLOT613
      GO TO 10                                                          MPLOT614
   12 IF(Z-X(I))10,10,13                                                MPLOT615
   13 Z=X(I)                                                            MPLOT616
   10 CONTINUE                                                          MPLOT617
      RETURN                                                            MPLOT618
      END                                                               MPLOT619
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE DRAWV (K,L,X,IX,Y,IY)                                  MPLOT622
C *** K    = NUMBER OF VECTORS TO BE DRAWN.                             MPLOT623
C *** L    = AN OPTION.  IF                                             MPLOT624
C          L = 0, EVERY OTHER POINT WILL BE JOINED BY A LINE.           MPLOT625
C *** X    = LOCATION OF FIRST X-COORDINATE.                            MPLOT626
C *** IX   = NUMBER OF CELLS TO COUNT TO GET TO NEXT X-LOCATION.        MPLOT627
C *** Y    = SIMILAR TO X                                               MPLOT628
C *** IY   = SIMILAR TO IX                                              MPLOT629
      DIMENSION X(1),Y(1)                                               MPLOT630
      IF(K) 11,11,12                                                    MPLOT631
   12 M=IABS(L-2)                                                       MPLOT632
      N=M*K                                                             MPLOT633
      DO 10 I=1,N,M                                                     MPLOT634
      JX=32769-(I-1)*IX                                                 MPLOT635
      JY=32769-(I-1)*IY                                                 MPLOT636
      KX=JX-IX                                                          MPLOT637
      KY=JY-IY                                                          MPLOT638
      NX=NXV(X(JX))                                                     MPLOT639
      MX=NXV(X(KX))                                                     MPLOT640
      NY=NYV(Y(JY))                                                     MPLOT641
      MY=NYV(Y(KY))                                                     MPLOT642
   10 CALL VECTOR(NX,NY,MX,MY)                                          MPLOT643
   11 RETURN                                                            MPLOT644
      END                                                               MPLOT645
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      FUNCTION NXV(X)
      COMMON  /SCOMON/  IFRAME,NCOPY,CPX,CPY,RAD,SCFX,SCFY
      NXV=CPX+X*SCFX
      RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      FUNCTION NYV(Y)
      COMMON  /SCOMON/  IFRAME,NCOPY,CPX,CPY,RAD,SCFX,SCFY
      NYV=CPY-Y*SCFY
      RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE XSCALV(X)
      COMMON  /SCOMON/  IFRAME,NCOPY,CPX,CPY,RAD,SCFX,SCFY
      SCFX=RAD/X
      RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE YSCALV(Y)
      COMMON  /SCOMON/  IFRAME,NCOPY,CPX,CPY,RAD,SCFX,SCFY
      SCFY=RAD/Y
      RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE MPCOD(NX,NY,ALAT,ALONG,IND)
C     CONVERTS  ALAT  AND  ALONG  (DEGREES PLUS NORTH AND EAST)
C     TO CHARACTRON UNITS  NX  AND  NY.
C        FOR IND = 1  POINT ON THE FRAME
C        FOR IND = 2  POINT HIDDEN BY THE EARTH
C
      DIMENSION T(3)
    1 IND=1
      CALL MPLOT(X,Y,Z,0,0,ALAT,ALONG,0.5,NX,NY,T,3)
      IF(Z)2,2,3
    2 IND=2
    3 RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      FUNCTION SPACE(X1,Y1,X2,Y2)
C     COMPUTES THE DISTANCE FROM (X1,Y1) TO (X2,Y2)
      SPACE=SQRT((X2-X1)**2+(Y2-Y1)**2)
      RETURN
      END
T        SUBTYPE,DATA
```

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B       JOB,2LV067AF41oC4Y*O  ALAN DOUGLAS  BLACKNEST                    DBNEST
B       TYPE,COMPILE,F4
T       SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE TIMSER(TITLE,X,N,DELA,IF)
C
C        THIS ROUTINE PLOTS N VALUES OF THE ARRAY X. DELA IS THE
C     SAMPLING INTERVAL AND IF IS AN INDICATOR WHICH SPECIFIES THE TYPE
C     OF SC4020 OUTPUT REQUIRED.
C         IF IF=1 OUTPUT IS ON MICROFILM
C            IF=2 OUTPUT IS ON HARD COPY
C            IF=3 OUTPUT IS ON BOTH MICROFILM AND HARD COPY.
C
C        TITLE IS A 20 ELEMENT ARRAY CARRYING DATA FOR ANNOTATING THE
C     OUTPUT GRAPHS. THE TITLE ARRAY IS SET UP AS FOLLOWS
C
C          TITLE(1)  - UNUSED
C          TITLE(2)  - UNUSED
C          TITLE(3)  - CONTAINS 8 HOLLERITH CHARACTERS GIVING THE UNITS
C                      OF THE TIME SERIES E.G. SECONDS
C          TITLE(4)  - UNUSED
C          TITLE(5)  - UNUSED
C
C          TITLE(6)  -)
C            .        )CONTAINS 80 HOLLERITH CHARACTERS GIVING A TITLE TO
C            .        )THE GRAPH
C          TITLE(15) -)
C          TITLE(16)   CONTAINS 8 HOLLERITH CHARACTERS GIVING DATE
C          TITLE(17) -)
C            .        )CONTAINS 24 HOLLERITH CHARACTERS GIVING A SUBTITLE
C          TITLE(19) -)TO THE GRAPH
C          TITLE(20) - UNUSED
C
C
C
      DIMENSION X(N), TITLE(20)
      DATA  SECS(8HSECS    )
C
      CALL AMAX(X,N,XMAX)
      CALL AMIN(X,N,XMIN)
      XRG=XMAX-XMIN
      RANGE=300./XRG
      IF(DELA.EQ..04444.AND.TITLE(3).EQ.SECS)GO TO 20
      S=6.
      IF(N.LE.100)S=7.
      R=0.
    3 IF(DELA.LT.(10.**R*.OOOOOOI))GO TO 2
      R=R+1.
      GO TO 3
    2 IF(R.LT.1.)GO TO 99
      INTER = 10.**(8.-R)*DELA + 0.5
      AINTER = FLOAT(INTER)/(10.**(S-R))
      ANXL=(6.*AINTER)/DELA
      GO TO 4
C
   20 AINTER=5.
      ANXL=675.
C
    4 NXL=ANXL
      NXS=3*NXL
      CONST=600./ANXL
      NT=N/NXS
      NT=NT+1
C
      DO 10 I=1,NT
      CALL ADVFLM(IF)
      IBEGIN=(I-1)*NXS+1
      IEND=NXS
      IF(I*NXS.GT.N)IEND=N-((I-1)*NXS)
      CALL RECORF(X(IBEGIN),1,IEND,XMIN,RANGE,CONST,AINTER,TITLE,NXL)
      CALL ENDFME
 10   CONTINUE
C
      CALL FINISH
   99 RETURN
      END
C
T       SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE RECORF(X,IBEGIN,IEND,XMIN,RANGE,CONST,AINTER,TITLE,NXL)
C
      INTEGER  XPLOT1, XPLOT2, TPLOT1, TPLOT2
C
      DIMENSION X(IEND), TITLE(20)
C
      CALL TSP(120,48,8)
C
      DO 1 I=6,15
      CALL HGRAM(TITLE(I),8)
 1    CONTINUE
      CALL TSP(120,48,24)
      DO 30 I=17,19
```

```
      CALL HORAM(TITLE(I),8)
   30 CONTINUE
C
      DO 5 I=1,3
      BASE=340*I-170
      CALL VECTOR(111,BASE,911,BASE)
      POS=BASE+40.
      CALL TSP(801,48,POS)
      CALL HORAM(TITLE(3),8)
      BASEL=BASE+12.
      BASEY=BASEL+20.
C
      DO 10 J=1,7
      ANMBR=FLOAT(J-1)*AINTER
      AMARK=(FLOAT((J-1)*5)*80.)/3. + 111.
      CALL VECTOR(AMARK,BASE,AMARK,BASEL)
      AMARK=AMARK-40.
      CALL TSP(AMARK,48,BASEY)
      CALL C4020F(ANMBR,6,1)
 10   CONTINUE
 5    CONTINUE
C
C
      IBEGI1=IBEGIN+1
      XPLOT1=320.-(X(IBEGIN)-XMIN)*RANGE
      TPLOT1=111.
      DO 15  I=IBEGI1,IEND
      ILINE=(I-1)/NXL + 1
      XPLOT2=340.*FLOAT(ILINE) - (X(I)-XMIN)*RANGE - 20.
      TPLOT2=FLOAT(I-IBEGIN-((ILINE-1)*NXL))*CONST + 111.
      IF(I.EQ.(NXL+1).OR.I.EQ.(2*NXL+1))GO TO 20
      CALL VECTOR(TPLOT1,XPLOT1,TPLOT2,XPLOT2)
   20 XPLOT1=XPLOT2
      TPLOT1=TPLOT2
 15   CONTINUE
C
      CALL TSP(939,48,23)
      CALL HORAM(TITLE(16),8)
C
      RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE AMAX (X,N,XMAX)
C
C     FINDS MAXIMUM VALUE OF ARRAY X
C
C
      DIMENSION X(N)
C
      KQ = 1
    2 KP = KQ
    5 IF(KQ -N)3,4,4
    3 KQ = KQ + 1
      IF(X(KP) - X(KQ))2,5,5
    4 XMAX = X(KP)
      RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE AMIN (X,N,XMIN)
C
C     FINDS MINIMUM VALUE OF ARRAY X
C
C
      DIMENSION X(N)
C
      KQ = 1
    5 KP = KQ
    2 IF(KQ-N)3,4,4
    3 KQ = KQ + 1
      IF(X(KP) - X(KQ))2,5,5
    4 XMIN = X(KP)
      RETURN
      END
```

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B       JOB,2LV067AF41604Y30  ALAN DOUGLAS  BLACKNEST                    DBNEST
B       TYPE,COMPILE,F4
T       SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE CHAN(N,NC,IF,IND)
C
C
C        THIS PACKAGE PLOTS UP TO 20 CHANNELS OF A DOUBLE SUBSCRIPTED
C     ARRAY, X(I,J) WHERE J DEFINES THE CHANNEL NUMBER AND I THE SAMPLE
C     NUMBER IN THE JTH CHANNEL. THE DATA IS ASSUMED TO BE SAMPLED AT
C     EQUAL INTERVALS.
C
C        FIVE CHANNELS ARE PLOTTED TO A FRAME, THE TIME AXIS IS PARALLEL
C     TO THE Y AXIS OF THE PLOTTER.
C
C        THE PACKAGE USES THE COMMONS -
C
C     COMMON X(3400,20)
C
C     COMMON /GRAPH/ TITLE(35), DELA
C
C      X IS THE ARRAY TO BE PLOTTED, TITLE IS AN ARRAY FOR ANNOTATING
C     THE OUTPUT AND DELA IS THE SAMPLING INTERVAL OF THE TIME SERIES.
C        THE TITLE ARRAY IS MADE UP AS FOLLOWS -
C
C         TITLE(1)  -)
C           .       -)
C           .       -)
C         TITLE(J)  -) EACH ELEMENT CARRIES AN 8 CHARACTER TITLE
C           .       -) DESCRIBING THE DATA IN THE CHANNEL
C           .       -)
C         TITLE(20) -)
C
C         TITLE(21) -)
C           .       -) CARRIES 80 HOLLERITH CHARACTERS GIVING A TITLE TO
C           .       -) THE OUTPUT
C         TITLE(30) -)
C
C         TITLE(31) - CARRIES 8 HOLLERITH CHARACTERS GIVING UNITS OF THE
C                     TIME SERIES
C         TITLE(32) - CARRIES 8 HOLLERITH CHARACTERS GIVING DATE  OF
C                     PROCESSING
C
C           IF IS AN INDICATOR TO SPECIFY THE OUTPUT REQUIRED
C
C         IF IF =1 OUTPUT IS ON MICROFILM
C            IF =2 OUTPUT IS ON HARD COPY
C            IF =3 OUTPUT IS ON BOTH MICROFILM AND HARD COPY
C
C           IND IS AN INDICATOR IF SET TO 1 THE MAXIMUM AMPLITUDE IN
C     EACH CHANNEL IS SCALED TO THE FULL RANGE AVAILABLE, IF SET TO 2
C     THE MAXIMUM RANGE OF THE X ARRAY IS SCALED TO THE FULL RANGE
C     AVAILABLE.
C           SETTING IND TO 1 DESTROYS THE ORIGINAL DATA IN THE X ARRAY,
C     PLOTTING USING CHAN SHOULD THEREFORE BE DONE ONLY WHEN ALL
C     REQUIRED COMPUTATION HAS BEEN CARRIED OUT ON X - THIS RESTRICTION
C     DOES NOT APPLY IF IND IS 2.
C
      COMMON X(3400,20)
C
C
      DIMENSION BMAX(25), BMIN(25)
C
C
      GO TO(15,16),IND
 15   XMAX=1.
      XMIN=0.
C
   16 DO 10 I=1,NC
      GO TO(30,31),IND
 30   CALL AMAX(X(1,I),N,ZMAX)
      CALL AMIN(X(1,I),N,ZMIN)
      ZRG=ZMAX-ZMIN
C
      DO 11 K=1,N
      X(K,I)=(X(K,I)-ZMIN)/ZRG
 11   CONTINUE
      GO TO 10
C
 31   CALL AMAX(X(1,I),N,BMAX(I))
      CALL AMIN(X(1,I),N,BMIN(I))
 10   CONTINUE
C
      GO TO(32,33),IND
 33   CALL AMAX(BMAX,NC,XMAX)
      CALL AMIN(BMIN,NC,XMIN)
C
 32   N55=(NC-1)/5+1
      NN=5
      PRINT 666,N55,NN,NC,N,XMAX,XMIN
 666  FORMAT(4(2X,I5),2X,2F10.3)
```

```
      CALL SCHAN(XMAX,XMIN,N)
      CALL TCHAN(N)
      CALL EXPAND
C
      DO 981 I=1,N55
      NC5=(I-1)*5+1
      IF(I.EQ.N55)NN=NC-NC5+1
      CALL PMULTI(N,NN,NC5,IF)
 981  CONTINUE
      CALL REDUCE
      RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE PMULTI(N,NN,NC5,IF)
C
C
      COMMON X(3400,20)
C
      COMMON/GRAPH/TITLE(35),DELA
C
      COMMON/POUT/NT,NXL,RANGE,CONST,AINTER,
     1TT(3400),XMIN
C
      DIMENSION ATITLE(5)
C
      DATA(ATITLE(I),I=1,4)(32H      TIME MARKS AT INTERVALS OF )
C
      NC=NN
      IZ=NC5
      NM=NT
      DO 10 I=1,NT
      IF(I.GT.NM)GO TO 99
      CALL ADVFLM(IF)
      CALL TSP(939,48,8)
      CALL HORAM(TITLE(32),8)
      CALL TSP(100,48,8)
C
      DO 11 L=21,30
      CALL HORAM(TITLE(L),8)
 11   CONTINUE
C
      CALL TSP(1014,48,124)
C
      DO 12 L=1,4
      CALL VERAM(ATITLE(L),8)
 12   CONTINUE
C
      CALL TSP(956,48,640)
      CALL C4020F(AINTER,8,3)
      CALL TSP(1014,48,648)
      CALL VERAM(TITLE(31),8)
C
      IBEGIN=(I-1)*NXL+1
      IEND=NXL
      IF(I*NXL.GT.N)IEND=N-((I-1)*NXL)
C
      DO 50 J=1,NC
      JA=J
      K=J+IZ-1
      XPOS=1000.-FLOAT(JA-1)*200.
      CALL TSP(XPOS,48,20)
      CALL VERAM(TITLE(K),8)
      PRINT 666,X(IBEGIN,K),IEND,JA,XMIN,RANGE,CONST
 666  FORMAT(2X,F10.5,2(2X,I5),3(2X,F10.5))
      CALL PEN(X(IBEGIN,K),IEND,JA,XMIN,RANGE,CONST)
 50   CONTINUE
C
      CALL PEN(TT(IBEGIN),IEND,5,0.0,1.,CONST)
      CALL ENDFME
 10   CONTINUE
      CALL FINISH
 99   RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE SCHAN(XMAX,XMIN,N)
C
C
      COMMON/GRAPH/TITLE(35),DELA
C
      COMMON/POUT/NT,NXL,RANGE,CONST,AINTER,
     1TT(3400),XX
C
      DATA SECS(8HSECS     )
C
      XRG=XMAX-XMIN
      XX=XMIN
      RANGE=200./XRG
      IF(DELA.EQ..04444.AND.TITLE(31).EQ.SECS)GO TO 20
      S=6.
      IF(N.LE.100)S=7.
```

```
      R=0.
  3   IF(DELA.LT.(10.**R*.0C00001))GO TO 2
      R=R+1.
      GO TO 3
  2   IF(R.LT.1.)GO TO 99
      INTER=10.**(8.-R)*DELA+0.5
      AINTER=FLOAT(INTER)/(10.**(5-R))
      ANXL=(8.*AINTER)/DELA
      GO TO 4
C
 20   AINTER=5.
      ANXL=1125.
C
  4   NXL=ANXL
      CONST=1000./ANXL
      NT=N/NXL+1
C
   99 RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE TCHAN(N)
C
      COMMON/GRAPH/TITLE(35), DELA
C
      COMMON/POUT/NT,NXL,RANGE,CONST,AINTER,
     1TT(3400),XMIN
C
      DO 1 I=1,N
      TT(I)=0.
  1   CONTINUE
C
      LT=(FLOAT(N)*DELA)/AINTER+1.
      TT(2)=25.
      AD=AINTER/DELA
C
      DO 2 I=1,LT
      LL=FLOAT(I-1)*AD+1.
      TT(LL)=25.
  2   CONTINUE
C
      RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE PEN(X,IEND,JA,XMIN,RANGE,CONST)
C
C
      DIMENSION X(IEND)
C
      INTEGER  XPLOT1, XPLOT2, TPLOT1, TPLOT2
C
      AJ=812. - FLOAT(JA-1)*200.
      XPLOT1=AJ + (X(1) - XMIN)*RANGE
      TPLOT1=19.
C
      DO 15 I=2,IEND
      XPLOT2=AJ + (X(I) - XMIN)*RANGE
      TPLOT2=FLOAT(I-1)*CONST + 19.
      CALL VECTOR(XPLOT1,TPLOT1,XPLOT2,TPLOT2)
      XPLOT1=XPLOT2
      TPLOT1=TPLOT2
   15 CONTINUE
      RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE AMAX (X,N,XMAX)
C
C     FINDS MAXIMUM VALUE OF ARRAY X
C
C
      DIMENSION X(N)
C
      KQ = 1
    2 KP = KQ
    5 IF(KQ -N)3,4,4
    3 KQ = KQ + 1
      IF(X(KP) - X(KQ))2,5,5
    4 XMAX = X(KP)
      RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE AMIN (X,N,XMIN)
C
C     FINDS MINIMUM VALUE OF ARRAY X
C
C
      DIMENSION X(N)
C
      KQ = 1
    5 KP = KQ
    2 IF(KQ-N)3,4,4
    3 KQ = KQ + 1
      IF(X(KP) - X(KQ))2,5,5
    4 XMIN = X(KP)
      RETURN
      END
```

```
B         JOB,2LVD67AF41602Y*O  ALAN DOUGLAS  BLACKNEST                    DBNEST
B         TYPE,COMPILE,F4
T         SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE CARGRF(X,Y,N)
C
C
C        THIS PACKAGE PLOTS N POINTS THE CARTESIAN CO-ORDINATES OF THE
C     JTH POINT BEING SPECIFIED AS X(J),Y(J).
C        THE PACKAGE USES THE COMMON --
C
C     COMMON /GRFF/ TITLE(20),XMAX,XMIN,YMAX,YMIN,INDX,INDY,IND,IDOT,
C    1ANSTR1,IF,XLIMIT,YLIMIT,SCALX,SCALY
C
C       THE TITLE ARRAY CARRIES INFORMATION FOR ANNOTATING THE OUTPUT
C     GRAPH. THIS ARRAY IS SET UP AS FOLLOWS
C
C          TITLE(1)  -)
C            .        )CONTAINS 24 HOLLERITH CHARACTERS GIVING THE UNITS
C          TITLE(3)  -)OF THE ABSCISSAE
C
C          TITLE(4)   )CONTAINS 16 HOLLERITH CHARACTERS GIVING THE UNITS
C          TITLE(5)   )OF THE ORDINATE
C          TITLE(6)  -)
C            .        )CONTAINS 80 HOLLERITH CHARACTERS GIVING A TITLE TO
C            .        )THE GRAPH
C          TITLE(15) -)
C
C          TITLE(16) -CONTAINS 8 HOLLERITH CHARACTERS GIVING DATE OF
C                     PROCESSING
C          TITLE(17) -)
C            .        )UNUSED
C          TITLE(20) -)
C
C          XMAX )SET BOTH TO ZERO IF PROGRAM TO CHOOSE THE ABSCISSAE
C          XMIN )SCALE. OTHERWISE SET TO CHOSEN LIMITS OF ABSCISSAE SCALE
C
C          YMAX )SET BOTH TO ZERO IF PROGRAM TO CHOOSE THE ORDINATE SCALE
C          YMIN )OTHERWISE SET TO CHOSEN VALUES OF ORDINATE SCALE
C
C        INDX IS AN INDICATOR FOR PLOTTING THE ABSCISSAE ON A LOG SCALE
C          INDX=1 ABSCISSAE ON LINEAR SCALE
C          INDX=2 ABSCISSAE ON LOG SCALE
C
C        INDY IS A SIMILAR INDICATOR FOR THE ORDINATE SCALE
C
C        IND IS AN INDICATOR FOR CONTROLLING FRAME CALLS AND FINISH CALLS
C          IND=0 CARGRF CALLS ADVFLM AND FINISH
C             =1 CARGRF CALLS ADVFLM BUT NOT FINISH
C             =2 CARGRF CALLS FINISH BUT NOT ADVFLM
C             =3 CARGRF CALLS NEITHER FINISH NOR ADVFLM
C
C        IDOT IS THE SC4020 CODE OF THE REQUIRED PLOTTING SYMBOL
C
C        ANSTR1 INDICATES WHETHER THE PLOTTED POINTS HAVE TO BE JOINED UP
C          ANSTR1=1. POINTS NOT JOINED
C                 =2. POINTS JOINED
C
C        IF SPECIFIES TYPE OF OUTPUT
C          IF=1 OUTPUT ON MICROFILM
C            =2 OUTPUT ON HARD COPY
C            =3 OUTPUT ON BOTH MICROFILM AND HARD COPY
C
C
C
      REAL INSTR1
C
      COMMON /GRFF/ TITLE(20), XMAX, XMIN,YMAX, YMIN, INDX, INDY, IND,
     1IDOT, ANSTR1, IF, XLIMIT, YLIMIT, SCALX, SCALY
C
      DIMENSION X(N), Y(N)
C
      INTEGER PLACEX, PLACEY, XPLOT1, XPLOT2, YPLOT1, YPLOT2
C
      DATA AJOIN(8HJOIN    ), BLANK(8H        )
C
C
C
      INSTR1=BLANK
      IF(ANSTR1.EQ.2.)INSTR1=AJOIN
      INDA=IND+1
C
      GO TO (55,60), INDX
   60 POSXT=POSMIN(X,N)
      POSX=ALOG10(POSXT)
      POSXT=POSXT*0.9999
      DO 201 I=1,N
      IF(X(I).LE.0.0)X(I)=POSXT
  201 CONTINUE
      CALL CLOG(X,N)
   55 GO TO (65,70), INDY
```

```
   70 POSYT=POSMIN(Y,N)
      POSY=ALOG10(POSYT)
      POSYT=POSYT*0.9999
      DO 202 I=1,N
      IF(Y(I).LE.0.0)Y(I)=POSYT
  202 CONTINUE
      CALL CLOG(Y,N)
   65 IF((XMAX-XMIN).GT.1.0E-7)GO TO 199
      CALL AMAX(X,N,XMAX)
      CALL AMIN(X,N,XMIN)
  199 IF((YMAX-YMIN).GT.1.0E-7)GO TO 200
      CALL AMIN(Y,N,YMIN)
      CALL AMAX(Y,N,YMAX)
  200 GO TO (888,888,889,889),INDA
  888 CALL ADVFLM(IF)
  889 CALL EXPHVY(123,27,923)
      CALL SCALEN(X,XLIMIT,SCALX,PLACEX,XFACTR,N,XMAX,XMIN)
      CALL SCALEN(Y,YLIMIT,SCALY,PLACEY,YFACTR,N,YMAX,YMIN)
      GO TO (777,777,778,778),INDA
  777 CALL VECTOR(115,923,1003,923)
      CALL VECTOR(123,931,123,43)
C
      DO 5 I=1,11
      FACTOR=FLOAT(I-1)*80.
      XSCAL=203.+FACTOR
      YSCAL=43.+FACTOR
      CALL VECTOR(XSCAL,923,XSCAL,931)
      CALL VECTOR(115,YSCAL,123,YSCAL)
 5    CONTINUE
C
  778 IGUIDE = 1
      IDRAW = 1
      IF(INDX.EQ.2.AND.X(1).LT.POSX)IGUIDE=2
      IF(INDY.EQ.2.AND.Y(1).LT.POSY)IGUIDE=2
      GO TO (998,999),IGUIDE
  998 XPLOT1=(X(1)-XLIMIT)*SCALX + 123.
      YPLOT1=923.-(Y(1)-YLIMIT)*SCALY
      CALL PLOT(XPLOT1,IDOT,YPLOT1)
      IDRAW=2
      IF(INSTR1.NE.AJOIN)IDRAW=1
  999 IGUIDE=1
C
      DO 10 I=2,N
      IF(INDY.EQ.2.AND.Y(I).LT.POSY)IGUIDE=2
      IF(INDX.EQ.2.AND.X(I).LT.POSX)IGUIDE=2
      GO TO (997,996),IGUIDE
  997 XPLOT2=(X(I)-XLIMIT)*SCALX + 123.
      YPLOT2=923.-((Y(I)-YLIMIT)*SCALY)
      CALL PLOT(XPLOT2,IDOT,YPLOT2)
      GO TO (995,994),IDRAW
  994 CALL VECTOR(XPLOT1,YPLOT1,XPLOT2,YPLOT2)
  995 YPLOT1=YPLOT2
      XPLOT1=XPLOT2
      IGUIDE=1
      IDRAW=2
      IF(INSTR1.NE.AJOIN)IDRAW=1
      GO TO 10
  996 IDRAW=1
      IGUIDE=1
 10   CONTINUE
C
C
C
      GO TO (779,779,780,780),INDA
  779 Y4=4.*YFACTR
      X4 = 4.*XFACTR
C
      DO 30 I=1,3
      F=(I-1)
      YLIM=YLIMIT+F*Y4
      GO TO (21,31),INDY
   31 YLIM=10.**YLIM
   21 XLIM=XLIMIT+F*X4
      GO TO (22,32),INDX
   32 XLIM=10.**XLIM
   22 YPOS=915.-F*320.
      XPOS=52.+F*320.
      CALL TSP(12,48,YPOS)
      GO TO (23,33),INDY
   33 CALL C4020E(YLIM,11,2)
      GO TO 41
   23 CALL C4020F(YLIM,13,PLACEY)
   41 CALL TSP(XPOS,48,942)
      GO TO (24,34),INDX
   34 CALL C4020E(XLIM,11,2)
      GO TO 30
   24 CALL C4020F(XLIM,13,PLACEX)
 30   CONTINUE
C
      CALL TSP(48,48,291)
```

```
      CALL VERAM(TITLE(4),8)
      CALL VERAM(TITLE(5),8)
C
      CALL TSP(760,48,958)
      CALL HORAM(TITLE(1),8)
      CALL HORAM(TITLE(2),8)
      CALL HORAM(TITLE(3),8)
C
      CALL TSP(130,48,23)
      DO 25 I=6,15
      CALL HORAM(TITLE(I),8)
 25   CONTINUE
C
      CALL TSP(939,48,23)
      CALL HORAM(TITLE(16),8)
C
  780 GO TO (990,991,990,991),INDA
  990 CALL FINISH
  991 CALL ENDFME
      RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE SCALEN(X,XLIMIT,SCALX,IPLACE,FACTOR,N,XMAX,XMIN)
C
C
C     COMPUTES SCALING VALUES FOR CARGRF
C
C
      DIMENSION X(N)
C
      XRG=XMAX-XMIN
C
      R=0.
 1    IF(XRG.LT.(10.**R*.0000001))GO TO 2
      R=R+1.
      GO TO 1
    2 IF(R.LT.1.)GO TO 15
      FACTOR=(10.**(R-1.)*.000000125)
      S=0.
 3    IF(XRG.LE.FACTOR*(2.**S))GO TO 4
      S=S+1.
      GO TO 3
 4    FACTOR=(FACTOR*(2.**S))/10.
C
C
      XLIMIT=XMIN/FACTOR
      LIMITX=XLIMIT-.99999
      XLIMIT=FLOAT(LIMITX)*FACTOR
      IF(XMIN.LT.XLIMIT)XLIMIT=XLIMIT-FACTOR
      SCALX=80./FACTOR
      IPLACE=11.-R
      IF(IPLACE.LT.1)IPLACE=1
C
   15 RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      FUNCTION POSMIN(X,N)
C
C
      DIMENSION X(N)
C
C
C     FINDS MINIMUM POSITIVE VALUE OF ARRAY X
C
C
      IND = 0
      DO 10 I=1,N
      IF(X(I).LE.0.0)GO TO 10
      IND=I
      GO TO 1
   10 CONTINUE
    1 IF(IND.NE.0)GO TO 7
      PRINT 20
   20 FORMAT(4X,118HAN ARRAY FROM WHICH THE SMALLEST POSITIVE VALUE WAS
     1REQUESTED WAS ALL NEGATIVE. YOUR JOB HAS THEREFORE BEEN TERMINATED
     2)
      CALL EXIT
    7 KQ=IND
    5 KP=KQ
    2 IF(KQ-N)3,4,4
    3 KQ=KQ+1
      IF(X(KQ).LE.0.0)GO TO 2
      IF(X(KP)-X(KQ))2,5,5
    4 POSMIN=X(KP)
      RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE CLOG(X,N)
C
C     CONVERTS ARRAY X TO COMMON LOGS
```

```
C
C
      DIMENSION X(N)
C
      DO 1  I = 1,N
      X(I) = ALOG10(X(I))
    1 CONTINUE
      RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE AMAX (X,N,XMAX)
C
C     FINDS MAXIMUM VALUE OF ARRAY X
C
C
      DIMENSION X(N)
C
      KQ = 1
    2 KP = KQ
    5 IF(KQ -N)3,4,4
    3 KQ = KQ + 1
      IF(X(KP) - X(KQ))2,5,5
    4 XMAX = X(KP)
      RETURN
      END
T        SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE AMIN (X,N,XMIN)
C
C     FINDS MINIMUM VALUE OF ARRAY X
C
C
      DIMENSION X(N)
C
      KQ = 1
    5 KP = KQ
    2 IF(KQ-N)3,4,4
    3 KQ = KQ + 1
      IF(X(KP) - X(KQ))2,5,5
    4 XMIN = X(KP)
      RETURN
      END
```

```
B         JOB,2LV067AF41602Y*O  ALAN DOUGLAS  BLACKNEST                    DBNEST
B         TYPE,COMPILE,F4
T         SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE DOTLIN(X1,Y1,X2,Y2)
C
C
C       DRAWS A DOTTED LINE FROM X1,Y1 TO X2,Y2
C
      XH=X1
      YH=Y1
      XL=X2
      YL=Y2
      IF(X1.GT.X2)GO TO 2
      XH=X2
      YH=Y2
      XL=X1
      YL=Y1
    2 YY=YH-YL
      YHH=YH
      YLL=YL
      IF(YH.GT.YL)GO TO 3
      YY=YL-YH
      YLL=YH
      YHH=YL
    3 XX=XH-XL
      XY=SQRT(YY*YY + XX*XX)
      IF(XY.GT.10.)GO TO 4
      XP2=XL + XX/2.
      YP2=YLL + YY/2.
      CALL PLOT(XP2,42,YP2)
      RETURN
C
    4 IF(XH.NE.XL)GO TO 5
      CALL AXDL(YY,YL,XH,2)
      RETURN
C
    5 IF(YH.NE.YL)GO TO 6
      CALL AXDL(XX,XL,YH,1)
      RETURN
C
    6 CTHET=(XH-XL)/XY
      STHET=(YH-YL)/XY
      AN=(XY+2.)/4. - 1.
      N=AN
      COR=(XY - 4.*FLOAT(N))/2.
C
      DO 10 I=1,N
      D=COR + FLOAT(I-1)*4.
      XP=XL + D*CTHET
      YP=YL + D*STHET
      CALL PLOT(XP,42,YP)
   10 CONTINUE
      RETURN
      END
T         SUBTYPE,FORTRAN,LMAP,LSTRAP
      SUBROUTINE AXDL(X,XL,Y,IND)
C
C     DRAWS DOTTED LINES PARALLEL TO AXES
C
      AN=(X + 2.)/4. - 1.
      N=AN
      XCOR=(X-4.*FLOAT(N))/2.
C
      DO 5 I=1,N
      XP=XL + XCOR + FLOAT(I-1)*4.
      GO TO (3,4),IND
    3 CALL PLOT(XP,42,Y)
      GO TO 5
    4 CALL PLOT(Y,42,XP)
    5 CONTINUE
C
      RETURN
      END
```

APPENDIX C

LISTING OF SHORE LINE CO-ORDINATES

```
8336                                                                                                **260000
8350S180 0W*8420S17E 0W*8430S174 0W*8440S170 0W*8455S166 0W*8525S163 0W**260001
8525S158 0W*8535S152 0W*8520S146 0W*8450S147 0W*8430S151 0W*84 0S15330W**260002
8330S153 0W*83 0S154 0W*8230S154 0W*82 0S154 0W*8130S15430W*8110S153 0W**260003
81 0S150 0W*8055S14630W*8040S14530W*8020S148 0W*80 0S150 0W*7940S15230W**260004
7915S155 0W*7850S157 0W*7830S158 0W*7825S15640W*7830S15430W*7810S15430W**260005
78 5S15640W*7750S158 0W*7730S15820W*7710S15840W*77 0S157 0W*7710S154 0W**260006
7735S153 0W*7750S15C30W*7740S148 0W*7715S146 0W*7645S146 0W*7620S14620W**260007
7555S1464 0W*7550S144 0W*7535S142 0W*7545S14040W*7525S140 0W*7515S13820W**260008
75 0S1364 0W*7445S13530W*7445S133 0W*75 0S132 0W*7525S13050W*7545S12940W**260009
76 0S128 0W*76 0S127 0W*7540S12650W*7510S12620W*7440S12530W*7420S12430W**260010
7350S1234 0W*7515S12340W*7515S12220W*7345S12120W*74 0S120 0W*7335S120 0W**260011
7340S1104 0W*734CS11640W*7350S11620W*741CS11740W*7440S11740W*7510S11620W**260012
7515S1134 0W*75 CS11220W*7430S11230W*74 0S11240W*7340S112 0W*74 0S11130W**260013
7430S111 0W*75 CS11020W*7510S10840W*744CS10830W*7430S10930W*74 0S10930W**260014
74 0S1084 0W*7420S10C8 0W*7440S10830W*75 5S10730W*75 5S10C 0W*7455S10430W**260015
7435S1043 0W*7435S10240W*7445S10120W*75 0S100 0W*7445S 9930W*7420S10120W**260016
74 0S10040W*7345S10130W*7330S10130W*7335S100 0W*7325S 99 0W*73 5S100 0W**260017
7315S1012 0W*7245S10230W*7240S10120W*73 0S10130W*7255S 9940W*7320S 9830W**260018
73 5S 98 0W*7325S 9730W*7345S 9730W*7345S 9620W*7325S 96 0W*73 5S 96 0W**260019
7255S 9730W*7230S 9830W*7210S 9940W*7155S101 0W*7145S 9950W*72 0S 9820W**260020
7150S 97 0W*72 5S 9540W*7225S 9540W*7235S 94 0W*7245S 9215W*7255S 9030W**260021
7255S 8845W*7255S 87 0W*73 5S 8530W*7255S 8420W*7250S 83 0W*7255S 8115W**260022
73 0S 7930W*7315S 7830W*7250S 7840W*7225S 78 0W*7235S 7630W*7250S 75 0W**260023
73 0S 74 0W*7330S 7430W*7325S 73 0W*7320S 7130W*7310S 70 0W*73 5S 6830W**260024
7250S 6730W*7220S 67 0W*7150S 67 0W*7130S 6730W*7055S 6730W*7025S 66 0W**260025
70 0S 6630W*6925S 6630W*6925S 6720W*69 5S 6640W*6850S 6720W*6830S 6650W**260026
66 5S 6650W*6745S 6730W*6725S 6730W*6745S 6830W*6745S 6915W*6720S 6920W**260027
6655S 6840W*6640S 6750W*67 5S 6740W*67 0S 67 0W*6720S 6620W*6650S 6620W**260028
6635S 6530W*6615S 6550W*6555S 65 0W*6530S 64 0W*65 5S 64 0W*6510S 63 0W**260029
6445S 6240W*6440S 6140W*6415S 6130W*64 0S 61 0W*6350S 5940W*6335S 5850W**260030
6320S 58 0W*6315S 5710W*6335S 5640W*6335S 5720W*6350S 5810W*6350S 5715W**260031
6425S 5720W*6420S 5810W*64 0S 5840W*6430S 59 0W*6420S 5940W*6440S 6030W**260032
65 0S 6120W*6525S 62 0W*6545S 6210W*66 5S 6220W*6630S 6240W*6615S 6330W**260033
6630S 64 0W*6655S 6340W*6655S 6440W*6720S 6520W*6750S 6530W*68 5S 6450W**260034
6620S 6520W*6845S 6450W*6845S 6340W*69 5S 6240W*6940S 6220W*7010S 62 0W**260035
7035S 6130W*7055S 6140W*7110S 61 0W*7135S 6050W*72 0S 6140W*7220S 6050W**260036
7240S 61 0W*73 0S 5950W*7320S 6010W*7325S 6130W*7345S 61 0W*7420S 6040W**260037
7440S 6140W*75 5S 6140W*7510S 63 0W*7540S 63 0W*76 5S 6340W*7630S 6530W**260038
77 0S 6720W*7710S 65 0W*77 5S 6230W*77 5S 60 0W*7715S 5740W*7735S 56 0W**260039
7755S 5340W*7815S 5140W*7830S 4920W*7845S 4740W*7850S 44 0W*7850S 41 0W**260040
7845S 3830W*7820S 3620W*7750S 35 0W*7730S 3320W*7710S 3140W*7650S 30 0W**260041
7630S 2820W*76 5S 27 0W*7540S 26 0W*7520S 24 0W*7445S 2340W*7425S 2220W**260042
74 5S 2040W*7345S 1920W*7325S 1740W*73 5S 1620W*7255S 1440W*7250S 1330W**260043
7255S 1220W*7215S 1120W*7155S 1110W*7140S 12 0W*7120S 1210W*7110S 1130W**260044
7115S 11 0W*7115S 1030W*71 0S 945W*7110S 9 0W*7125S 840W*7150S 830W**260045
7140S 720W*7125S 740W*71 5S 720W*7050S 740W*7045S 650W*7040S 550W**260046
71 0S 550W*7120S 6 0W*7120S 430W*7115S 3 0W*7040S 3 0W*7020S 320W**260047
7015S 230W*7025S 140W*7040S 1 0W*71 0S 130W*7115S 040W*7130S 0 0E**260048
7115S 120E*7055S 240E*7035S 330E*7020S 440E*7020S 620E*70 5S 720E**260049
70 5S 840E*7010S 10 0E*70 5S 1120E*70 5S 1240E*7010S 1420E*7010S 1540E**260050
7010S 17 0E*7010S 1820E*7020S 20 0E*7025S 2130E*7035S 23 0E*7025S 2440E**260051
7010S 2520E*7010S 27 0E*6955S 2820E*6950S 30 0E*6935S 3120E*6930S 32 0E**260052
6930S 3330E*69 0S 3320E*6840S 3330E*6835S 3420E*6855S 35 0E*6920S 36 0E**260053
6930S 37 0E*6935S 3820E*70 5S 3840E*6940S 3920E*6930S 3950E*6910S 3950E**260054
6850S 40 0E*6830S 4120E*6810S 42 0E*6750S 4320E*6745S 4430E*6740S 46 0E**260055
6735S 47 0E*6740S 4810E*6725S 4830E*6725S 4920E*6750S 4950E*6735S 5030E**260056
67 0S 5010E*6630S 5030E*6615S 5130E*6555S 5210E*6550S 5340E*6555S 5510E**260057
6615S 56 0E*6625S 5710E*6640S 5710E*6645S 5620E*6655S 57 0E*67 0S 56 0E**260058
6710S 59 0E*6730S 5920E*6720S 6040E*6735S 6140E*6740S 6240E*6730S 6340E**260059
6735S 65 0E*6745S 6620E*6750S 6740E*6750S 6840E*6740S 6930E*6810S 6930E**260060
6635S 70 0E*69 0S 7030E*6910S 6930E*6935S 6950E*70 5S 6950E*7030S 7040E**260061
7025S 7140E*70 5S 71 0E*6945S 7220E*6935S 7330E*6940S 7430E*6950S 7530E**260062
6930S 7610E*6910S 7710E*69 5S 78 0E*6830S 7820E*6815S 79 0E*68 0S 8030E**260063
6750S 8140E*6720S 8230E*6710S 8340E*67 0S 85 0E*6650S 8620E*6640S 8740E**260064
6645S 8830E*6645S 8940E*6640S 91 0E*6630S 92 0E*6635S 93 0E*6635S 94 0E**260065
6630S 95 0E*6640S 96 0E*6630S 97 0E*6640S 9740E*6630S 9830E*6635S 9920E**260066
6625S100 0E*6625S10040E*66 5S10130E*6550S10240E*6555S104 0E*66 5S105 0E**260067
6615S106 0E*6630S107 0E*6635S108 0E*6650S109 0E*6635S10930E*6640S11020E**260068
6625S11040E*66 5S11040E*6555S11140E*6550S11240E*6545S11340E*66 0S11430E**260069
6620S11530E*6630S11630E*6645S11740E*6650S119 0E*6650S12020E*6640S12130E**260070
6625S12230E*6645S12320E*6645S12420E*6630S12450E*6635S12550E*6615S12630E**260071
6615S127 0E*6630S12740E*6655S12820E*67 0S129 0E*6710S12930E*6655S130 0E**260072
6620S130 0E*66 5S13050E*6610S132 0E*66 5S13320E*6610S13420E*66 5S13520E**260073
6620S13620E*6620S13720E*6630S13820E*6635S13920E*6640S14030E*6645S142 0E**260074
67 0S14230E*6650S14320E*67 0S14420E*6730S14420E*6735S145 0E*6730S146 0E**260075
6750S14650E*6815S147 0E*6825S14820E*6815S149 0E*6830S15020E*6820S151 0E**260076
6840S15130E*6835S15240E*6835S15420E*69 5S155 0E*6920S156 0E*69 0S15630E**260077
69 5S15730E*6915S15840E*6930S160 0E*6940S161 0E*70 5S161 0E*7030S16110E**260078
7050S16140E*7035S16210E*7010S16220E*70 5S16320E*7035S16310E*7035S16440E**260079
7030S166 0E*7050S16720E*7110S16840E*7130S170 0E*7110S17010E*7140S171 0E**260080
72 0S17010E*7230S17030E*7250S16940E*7310S16830E*7315S167 0E*7340S167 0E**260081
74 5S16640E*7410S16520E*7430S16520E*7450S16420E*7510S163 0E*7540S16240E**260082
76 5S16240E*7630S163 0E*7655S16320E*7720S16340E*7745S16340E*78 0S16440E**260083
7825S166 0E*7830S164 0E*7845S16130E*7910S160 0E*7940S160 0E*80 0S160 0E**260084
8030S16020E*81 0S16020E*8130S161 0E*8155S16220E*8225S164 0E*8250S166 0E**260085
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1020S14945E*1040S150 0E*1035S15035E*101CS15045E*10 5S15010E* 955S14945E**261335
935S150 0E* 935S14935E* 925S149 5E* 9 0S14915E* 9 5S14835E* 835S14815E**261336
8 0S14810E* 745S14740E* 715S14710E* 650S147 0E* 645S14725E* 640S14750E**261337
610S14750E* 550S14725E* 555S14650E* 535S14615E* 530S14545E* 455S14545E**261338
430S14525E* 415S145 0E* 355S14430E* 340S144 0E* 325S14330E* 320S143 0E**261339
3 5S14225E* 255S142 0E* 245S14130E* 235S141 0E* 220S14025E* 220S140 0E**261340
210S13930E* 2 CS139 0E* 140S13825E* 125S13755E* 140S13715E* 2 5S137 0E**261341
210S13630E* 235S136 5E* 255S13550E* 320S13535E* 320S13510E* 3 0S13445E**261342
230S13435E* 220S13410E* 150S134 0E* 120S13410E* 040S13355E* 040S13315E**261343
020S13250E* 020S13210E* 040S13150E* 05CS13115E* 120S13050E*999999999999**261344
1325N12025E*13 0N12045E*1230N12055E*121CN12110E*1230N12135E*13 0N12135E**261345
1320N12115E*1325N12050E*1325N12025E*999999999999*1230N12420E*12 0N12430E**261346
1145N125 0E*1120N12450E*1125N12425E*105CN12425E*1045N12445E*1010N12445E**261347
1015N12515E*1040N125 0E*11 5N125 0E*11 5N12540E*1140N12530E*12 5N12530E**261348
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 955S16030E* 940S16050E* 920S16015E* 915S15930E*999999999999*1010S16115E**261370
1040S16145E*1045S16220E*1020S162 0E*1010S16115E*999999999999*1445S16645E**261371
1515S16650E*1540S16650E*1530S16720E*15 0S16710E*1515S167 0E*1445S16645E**261372
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2220S16040E*2220S16710E*22 0S16650E*2140S16630E*2130S166 0E*2110S16540E**261375
2045S16520E*2030S16445E*2015S16415E*999999999999*4346S17650W**4354S17630W**261376
4410S17635W*4348S17610W*4346S17650W*999999999999*18 0S17720E*1810S17745E**261377
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1630S17940E*1610S17950E*1625S17910E*1635S17835E*999999999999*1325S17255W**261380
1345S17240W*1345S172 8W*14 0S17155W*14 0S17120W*1350S17140W*1345S172 8W**261381
1330S17212W*1325S17255W*999999999999*1728S14935W*1744S14930W*1750S14910W**261382
1732S14920W*1728S14935W*999999999999*2150N16014W*2159N160 6W*2154N160 6W**261383
2150N16014W*999999999999*22 2N15949W*2154N15937W*2154N15923W*2213N15918W**261384
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19 8N15531W*1916N15518W*1920N155 0W*1931N15448W*1941N155 1W*1955N155 8W**261389
20 3N15522W*2016N15553W*999999999999*999999999999*                    **261390

END OF TAPE WRITTEN
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APPENDIX D

TABLE OF PLOTTING SYMBOLS AND EQUIVALENT SC4020(DECIMAL) CODES

Dec. Code	Symbol	Dec. Code	Symbol
00	Zero	32	Minus -
01	1	33	J
02	2	34	K
03	3	35	L
04	4	36	M
05	5	37	N
06	6	38	O
07	7	39	P
08	8	40	Q
09	9	41	R
10	Partial Derivative ∂	42	Plotting Dot .
11	Equal to =	43	Dollar Sign $
12	Quote "	44	Asterisk *
13	Prime '	45	Gamma (Lower Case) γ
14	Delta (Lower Case) δ	46	Tilde ~
15	Alpha (Lower Case) α	47	Lower Case d. (Differential)
16	Plus +	48	Blank
17	A	49	Slash /
18	B	50	S
19	C	51	T
20	D	52	U
21	E	53	V
22	F	54	W
23	G	55	X
24	H	56	Y
25	I	57	Z
26	Pi (Lower Case) π	58	Degree °
27	Period .	59	Comma ,
28	Parenthesis (Right))	60	Parenthesis (Left) (
29	Beta (Lower Case) β	61	Integral Sign ∫
30	Plus or Minus ±	62	Sigma (Upper Case) Σ
31	Question Mark ?	63	Alignment Frame □

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