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A Graphics Package for Meteorological Data

Version 1.5

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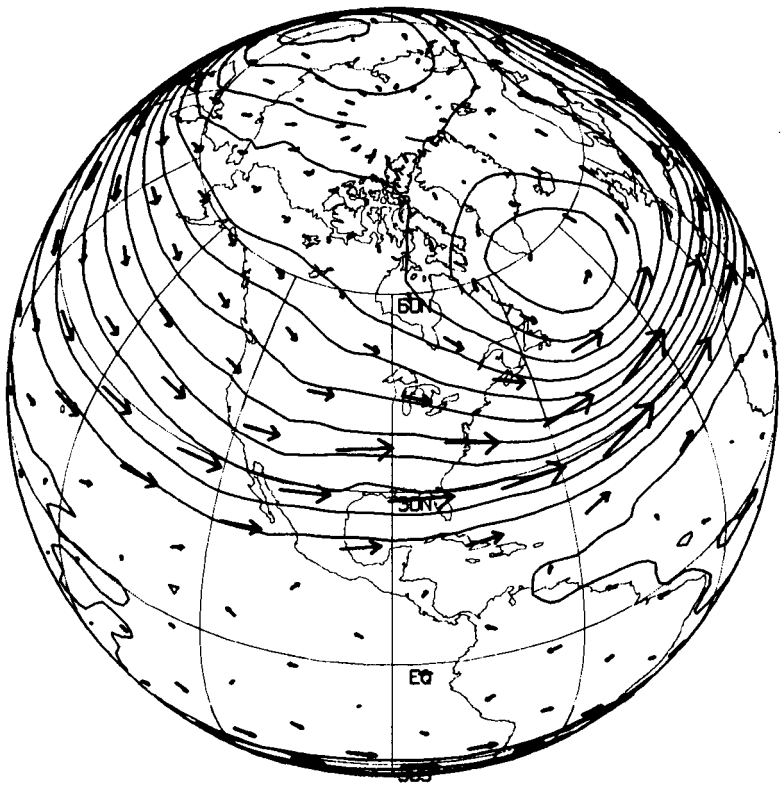
A GRAPHICS PACKAGE

FOR

METEOROLOGICAL DATA



NASA GODDARD SPACE FLIGHT CENTER
CODE 611

Version 1.5

FOREWORD

This plotting package was developed to simplify the task of plotting meteorological fields. To a large extent it represents a consolidation, refinement and repackaging of graphics routines which already exist in code 611. The present version produces plots on the QMS laser printers and is based on WOLFPLOT. Where necessary we have documented WOLFPLOT calls used in this package. Version 1.5 includes routines for contouring on cylindrical, polar and orthographic projections as well as a Mollweide (egg) background map . Vectors and shading are possible on all projections. Routines are included for contouring pressure-latitude and pressure-longitude fields with linear or log scales in pressure (interpolation to fixed grid interval is done automatically). We have also included a fairly general line plotting routine. We urge you to use these routines and welcome additional contributions to make this package more complete.

Contributors

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1 Introduction

There is presently an abundance of plotting software available to users in Code 611. Yet for the uninitiated user it is a bewildering and time consuming task to develop even the simplest types of meteorological maps. On the otherhand most experienced users have, over time, developed very sophisticated and customized routines to fit their own needs but which are often difficult to adapt to other needs. The present plotting package was designed in a way which should help to alleviate this situation by providing well documented and easy to use routines for common types of meteorological data.

The rest of this chapter discusses how to initialize and terminate the plotting package as well as how the page layout is handled. Chapter 2 provides the calls needed to override the default settings of such plotting attributes as line weight, undefined values, plot rotation, etc.. Chapter 3 describes the line plotting routine. Chapter 4 contains the various contouring packages and Chapter 5 describes how to obtain vectors fields. Chapter 6 provides some commonly used utilities. Appendix A gives the execs neeeded to run this package on the various systems and Appendix B displays the available shading patterns. Appendix C gives examples of the various plotting routines (both the source code and resulting plots).

If you wish to contribute to this plotting package we ask that you follow the general design of the packages contained in this manual. Contributions will be easiest to incorporate into the present package if it uses the WOLFPLOT package, however, we encourage any contributions regardless of the basic plotting package used. Variables that change with each call should be part of the argument list while other variables should have default values (set at initialization) which may be changed by the user through calls to separate routines (see chapter 2). Each contribution should include the argument list and a sample plot together with the source code which produced it.

1.1 Basics

The basic plotting routines are from the WOLFPLOT package. The package is initialized and default settings are established with

```
CALL PSETUP
```

To advance to the next page

```
CALL FRMADV
```

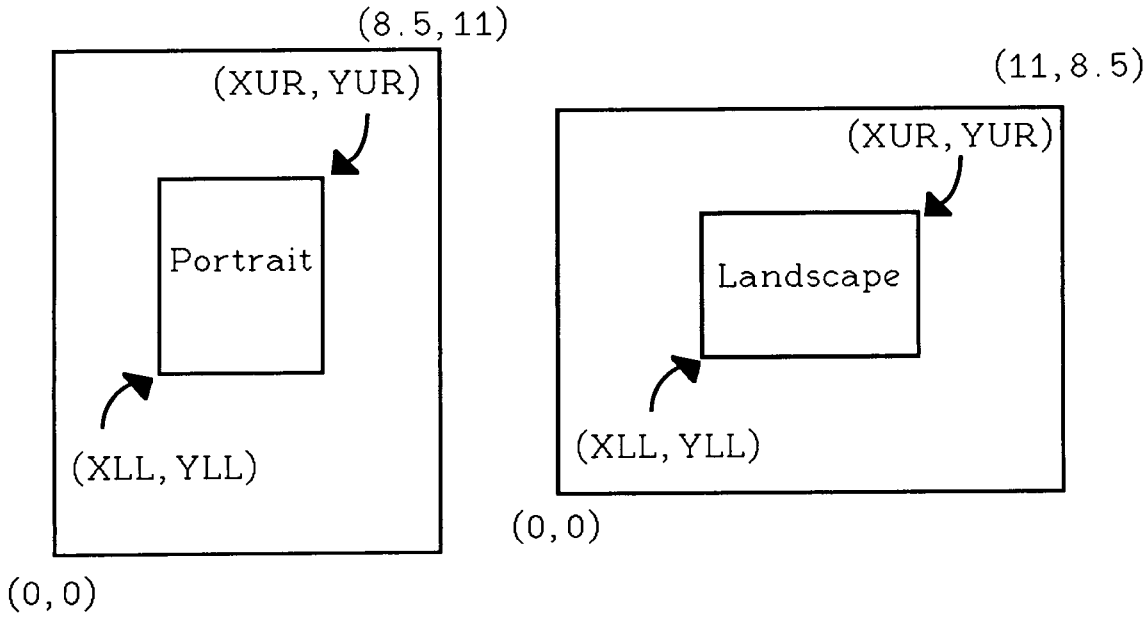
and to terminate plotting the user must

```
CALL ENDPLT
```

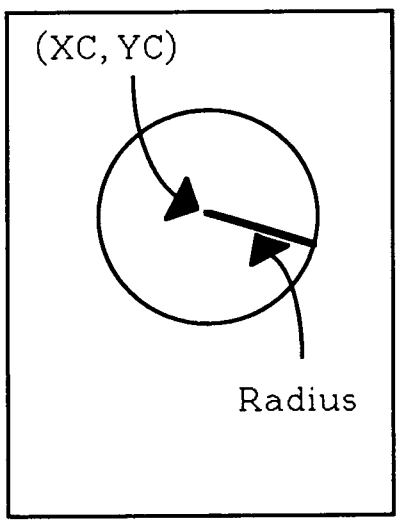
PSETUP and ENDPLT should be called only once.

1.2 Page Layout

Several plots may be put on a page by making multiple calls to the plotting routines before calling FRMADV. The position (in inches) of the plots on the page is determined by the arguments (XLL, YLL, XUR, YUR) as shown below for either portrait or landscape modes:



For polar, orthographic and egg maps the position and size is specified by the radius and the center as shown below:



The portrait and landscape modes are set by a call to ROTCAL as described in chapter 2. It should be noted that the (0,0) point is offset from the lower left corner of the page by about 3/8 " in both the x and y directions so that plot boundaries should stay within the limits ($0 \le x \le 7\ 3/4$) and ($0 \le y \le 10\ 1/4$).

2 Setting Plotting Attributes

This section gives the subroutine calls which provide control over various plotting attributes (eg. line width, shading, rotation). When called before the basic routines to be described in the later chapters, they will override the default settings. Once set, the attributes remain that way until reset by a subsequent call. In the following descriptions default values are printed with a bold face type.

i. Plot rotation (affects calls to all routines)

CALL ROTCAL (ROT)

where ROT =	**.FALSE.**	portrait mode (see Introduction)
	.TRUE.	landscape mode

ii. Line weight (affects contour lines and vectors; does not affect line plots)

CALL CONGLW (IGLW)

where IGLW = -2 (heaviest), -1, **0**, 1, 2 (lightest)

iii. Contour style (affects calls to all contouring routines)

CALL SETCTP (ICTP)

where ICTP=	1	all solid contours, regular line weight
	2	all dashed contours, regular weight
	3	all solid, even heavy line weight odd regular line weight
	4	positive solid, regular line weight negative dashed, regular line weight 0 contour solid, heavy line weight

iv. Contour label output (affects calls to all contouring routines)

CALL DMPLAB (ILBL)

where ILBL=	**0**	single set of contours on plot (dump all contour labels)
	1	first of two contour sets (do not dump contour labels yet)
	2	second of two contour sets (dump all contour labels)
	4	supress contour labels

v. Labeling algorithm (affects calls to contouring routines)

CALL LABTYP (ILAB)

where ILAB = **1** Puts contour labels at absolute maxima and minima in x (see page layout for definition of x direction) along a particular contour (works best for most global and/or noisy fields). Also places labels at contour endpoints.

ILAB = 2 Puts contour labels at relative maxima and minima in x (see page layout for definition of x direction) along a particular contour (works best for smooth fields such as zonal cross sections). Does not place labels at contour endpoints.

vi. Shading

To turn shading on for a specified data interval

CALL CONSHD (CMIN,CMAX,ISHDT)

where CMIN= minimum value to be shaded
CMAX= maximum value to be shaded
ISHDT= shade type (1 to 18, see Appendix B)

The shading consists of 9 patterns of stippling and 9 patterns of hatching shown in Appendix B. Each additional call to this routine (up to 20) will add the specified shading type and interval. Cross hatching can be done by specifying horizontal and vertical hatching over the same data range. Shading is turned off for all the shading intervals with

CALL CLRSHD

vii. Undefined value (affects calls to contouring, line and vector routines)

CALL SETUND (XVAL)

where XVAL = **-999.**

3 Line Plots

The following routine produces a single line with either logrithmic or linear scales. Multiple lines can easily be plotted by subsequent calls to EZLINE before calling FRMADV. The first call must be

LNPLT(FLD,XVAL,IM,XMIN,XMAX,YMIN,YMAX,XLL,YLL,XUR,YUR,DXT,DYT,
DXL,DYL,FMTX,FMTY,NLTYP,CHAR,INTCH,TITLX,TITLY,LOGP)

FLD(IM)	:	input data array (REAL)
XVAL(IM)	:	x-axis values for data points (REAL)
IM	:	number of data points in x-direction (INTEGER) (IM <= 5000)
XMIN,XMAX	:	minimum and maximum values for x-axis grid (REAL) (need not be minimum or maximum of XVAL)
YMIN,YMAX	:	minimum and maximum value for y-axis grid (REAL) (need not be minimum or maximum of FLD)
XLL, YLL	:	position of lower left corner of grid in inches (REAL)
XUR, YUR	:	position of upper right corner of grid in inches (REAL)
DXT, DYT	:	increment for x-axis and y-axis tic mark (REAL)
DXL, DYL	:	increment for x-axis and y-axis tic mark label (REAL) For log plots (LOGP > 0), DXL/DXT is equal to the no. of tic marks and labels per cycle for the x-axis and similarly for DYL/DYT and the y-axis. Note that only the ratio matters, otherwise DXL,DXT,DYL, DYT are not used for the log scale.
FMTX	:	format of x-axis grid label (CHARACTER*5) (e.g. 'fw.d)' or 'iw) ')
FMTY	:	format of y-axis grid label (CHARACTER*5)
NLTYP	:	dash line type (see below)
CHAR[1]	:	character label for line (CHARACTER*1)
INTCH	:	increment for plotting character on line (INTEGER)
TITLX	:	title for x-axis with '$' as last character (CHARACTER*80)
TITLY	:	title for y-axis with '$' as last character (CHARACTER*80)
LOGP	:	plot type indicator (INTEGER) 0 = linear 1 = log base10 in x-axis 2 = log base 10 in y-axis 3 = log - log > 4 not applicable

[1] To specify the size of the character label,

CALL PTSIZE(SCH)

where

SCH = **0.75** (SCH=1.0 is the standard size and corresponds to 1/8 inch)

The specified value will stay in effect until the next call to PTSIZE

NLTYP is an integer index indicating a line type. There are 10 line types (and no line) to choose from. The line plot example in the Appendix C shows the line types.

0	:	no line
1	:	thin solid line
2	:	thin dotted line
3	:	thin short dash
4	:	thin dash-dot
5	:	thin long dash
6	:	thick solid line
7	:	thick dotted line
8	:	thick short dash
9	:	thick dash-dot
10	:	thick long dash

To add another line to the plot

CALL EZLINE (FLD,XVAL,IM,NLTYP,CHAR,INTCH)

where the arguments are as in LNPLT.

4 Contouring

This chapter gives a description of the calling statement for each of the basic contouring routines. Examples are given in Appendix C.

4.1 Cylindrical map

For the cylindrical maps limited-area plots may be produced quite easily by specifying the desired latitude and longitude domain using the arguments BLON,ELON,BLAT,ELAT. However, it is important to note that the input data is assumed to be whatever subset of the globe that was specified by BLON,ELON,BLAT,ELAT.

PRNTCL (DATA, CINT, BLON, ELON, BLAT, ELAT, NX, NY, XLL, YLL, XUR, YUR, SC, INCX, INCY, PLTXL, PLTYL, GCON)

DATA (NX, NY)	: input data array (REAL)
CINT	: contour interval (REAL) (contouring is suppressed if CINT is ≤ 0)
BLON	: beginning longitude (REAL)
ELON	: ending longitude (REAL) The range of longitudes specified by BLON and ELON may not be greater than 360°. BLON may be >= ELON and the western hemisphere may be specfied by either (-180 to 0) or (180 to 360).
BLAT	: beginning latitude (REAL)
ELAT	: ending latitude (REAL). If BLAT=ELAT no map is produced
NX	: number of points in longitude direction (INTEGER)
NY	: number of points in latitude direction (INTEGER)
XLL, YLL	: position of lower left corner of plot in inches (REAL) (0,0) is the bottom left corner of page in portrait mode.
XUR, YUR	: position of upper right corner of plot in inches (REAL) (8.5,11.0) is the upper right corner of page in portrait mode.
SC	: sample contour (up to 20 contours will be done on either side of this contour value). If SC is set to UNDF then a suitable value will be chosen for you: this will be zero if the field is of two signs (REAL)
INCX	: latitude increment for x-label (INTEGER)
INCY	: longitude increment for y-label (INTEGER)
PLTXL	: determines if x-label and legend is written (LOGICAL)
PLTYL	: determines if y-label and legend is written (LOGICAL)
GCON	: determines if contour interval is geometric (LOGICAL) (nth contour is CINT $^{(n-1)}$ x SC)

4.2 Polar Stereographic map

For the polar plots the data (DATA(i,j)) is assumed to be global with DATA(1, j) = DATA(NX, j). Latitude increases with j and longitude increases with i starting at the dateline. It is assumed that pole values are excluded. Eg. if your data array (Z) includes pole values and is dimensioned Z(ni,nj), the first argument in the call to PRNTST should be Z(1,2) and NY = nj-2. The first data point DATA(1,1) will then be at longitude -180 and latitude (180/(NY+1)) - 90.

PRNTST (DATA,WORK, CINT, CLON, CLAT, NX, NY, XC,YC, RADIUS, SC, GCON)

DATA (NX, NY)	: input data array
WORK(LEN)	: work array where LEN = NX * NY
CINT	: contour interval (REAL) = 0 background map and grid only < 0 grid and plot (no map) > 0 grid and plot and map
CLON	: longitude of top of map (-180 to 180) (REAL)
CLAT	: | CLAT | = distance from pole in degrees latitude. CLAT > 0 for Northern Hemisphere, CLAT< 0 for Southern Hemisphere. If CLAT=0 no map is produced.
NX	: number of points in longitude direction (INTEGER) starting from -180
NY	: number of points in latitude direction (INTEGER) NY is the northern-most latitude and it is assumed the pole points are not included
XC,YC	: location on page of center of plot in inches (REAL)
RADIUS	: radial dimension of plot in inches (REAL)
SC	: sample contour (up to 20 contours will be done on either side of this contour value). If SC is set to UNDF then a suitable value will be chosen for you: this will be zero if the field is of two signs (REAL)
GCON	: determines if contour interval is geometric (LOGICAL) nth contour is CINT $^{(n-1)}$ x SC

Currently, hatching patterns have not been implemented for polar stereographic map backgrounds.

4.3 Orthographic map

For the orthographic plots the data (DATA(i,j)) is assumed to be global with DATA(1, j) = DATA(NX, j). Latitude increases with j and longitude increases with i starting at the dateline. It is assumed that pole values are excluded. Eg. if your data array (Z) includes pole values and is dimensioned Z(ni,nj), the first argument in the call to PRNTOR should be Z(1,2) and NY = nj-2. The first data point DATA(1,1) will then be at longitude -180 and latitude (180/(NY+1)) - 90.

PRNTOR (DATA, WORK, CINT, CLON, CLAT, NX, NY, XC,YC, RADIUS, SC, GCON)

DATA (NX, NY)	: input data array (REAL)
WORK(LEN)	: work array where LEN=NX x NY
CINT	: contour interval (REAL) = 0 background map and grid only < 0 grid and plot (no map) > 0 grid and plot and map
CLON	: longitude at which the plot will be centered (-180 to 180) (REAL)
CLAT	: latitude at which the plot will be centered
NX	: number of points in longitude direction (INTEGER)
NY	: number of points in latitude direction (INTEGER)
XC,YC	: location on page of center of plot in inches (REAL)
RADIUS	: radial dimension of plot in inches (REAL)
SC	: sample contour (up to 20 contours will be done on either side of this contour value). If SC is set to UNDF then a suitable value will be chosen for you: this will be zero if the field is of two signs (REAL)
GCON	: determines if contour interval is geometric nth contour is CINT $^{(n-1)}$ x SC (LOGICAL)

Currently, hatching patterns have not been implemented for orthographic map backgrounds.

4.4 Egg map

The egg maps have equal area elliptical meridians. The data (DATA(i,j)) is assumed to be global with DATA(1, j) = DATA(NX, j). Latitude increases with j and longitude increases with i starting at the dateline. It is assumed that pole values are excluded. Eg. if your data array (Z) includes pole values and is dimensioned Z(ni,nj), the first argument in the call to PRNTEG should be Z(1,2) and NY = nj-2. The first data point DATA(1,1) will then be at longitude -180 and latitude (180/(NY+1)) - 90.

PRNTEG (DATA, WORK, CINT, CLON, NX, NY, XC,YC, DIAM, SC, INCX, INCY, GCON)

DATA (NX, NY)	: input data array (REAL)
WORK(LEN)	: work array where LEN=NX x NY
CINT	: contour interval (REAL) = 0 background map and grid only < 0 grid and plot (no map) > 0 grid and plot and map
CLON	: longitude at which the plot will be centered (-180 to 180) (REAL)
NX	: number of points in longitude direction (INTEGER)
NY	: number of points in latitude direction (INTEGER)
XC,YC	: location on page of center of plot in inches (REAL)
DIAM	: length of major axis in inches (REAL)
SC	: sample contour (up to 20 contours will be done on either side of this contour value). If SC is set to UNDF then a suitable value will be chosen for you: this will be zero if the field is of two signs (REAL)
INCX	: increment of latitude circles (INTEGER)
INCY	: longitude increment of meridians (INTEGER)
GCON	: determines if contour interval is geometric nth contour is CINT $^{(n-1)}$ x SC (LOGICAL)

Currently, hatching patterns have not been implemented for egg map backgrounds.

4.5 Cross-sections

For latitude/pressure cross sections call

MAPLTP(DATA,WORK,CINT,SC,NX,NY,XMIN,XMAX,YFST,YLST,XLL,YLL,XUR,YUR,
RINCX,PLTXL,PLTYL,GCON,PSTR,LOGP,LOGI,NYN,PLAB,NPL)

For longitude/pressure cross sections the argument list is the same and the subroutine name is

MAPLNP (.....)

DATA(NX,NY) : input data to be plotted (for latitude plots it is assumed the first index increases to the north)

WORK(NX,NYN) : output data at constant pressure (LOGP false) or log pressure (LOGP true) intervals. For MAPLNP the data is reversed in the latitude direction so that the North Pole is on the left of the plot.

NX : number of latitudes/longitudes

NY : number of levels of input data

CINT : contour interval (REAL)
if CINT = 0 background only (no contouring is done)
if CINT < 0 interpolation is done (returned in WORK) but no plot

SC : sample contour (up to 20 contours will be done on either side of this contour value). If SC is set to UNDF then a suitable value will be chosen for you: this will be zero if the field is of two signs (REAL)

YFST, YLST : bottom and top pressure level of plot and WORK array (REAL) if these are not the first and last value in PSTR data values outside this range will be set to UNDF

XMIN, XMAX : minimum and maximum latitudes/longitudes

XLL, YLL : position of lower left corner of plot in inches (REAL) (0,0) is the bottom left corner of page in portrait mode.

XUR, YUR : position of upper right corner of plot in inches (REAL) (8.5,11.0) is the upper right corner of page in portrait mode.

RINCX : increment for x-label (REAL)

PLTXL : determines if x-label and legend is written (LOGICAL)

PLTYL : determines if y-label and legend is written (LOGICAL)

GCON : determines if contour interval is geometric (LOGICAL)
nth contour is $CINT^{(n-1)}$ x SC

PSTR(NY) : array containing pressure levels of input data

LOGP : log plot in vertical if true, otherwise linear

LOGI : interpolation is done linear in LOG_{10} (p) if true, otherwise linear in pressure (LOGICAL)
Note: if LOGP is true interpolation is always done linear in LOG_{10} (p)

NYN : number of points to which to interpolate (3 <= NYN <= 200)

PLAB(NPL) : array containing pressure values for y-labels

NPL : number of y labels

For general x/pressure cross sections the argument list has two additional arguments and the subroutine name is

MAPGXP (.....,XLGD,XFRMT)

XLGD : x legend (CHARACTER*80)

XFRMT : format of x-axis grid label (CHARACTER*5)
(e.g. 'fw.d)' or 'iw) ')

4.6 General contouring

For general contour plots call

PRNTHD (DATA,CINT,SC,NX,NY,XBEG,XEND,YBEG,YEND,XLL,YLL,XUR,YUR,
IPTY,XINC,YINC,XFRMT,YFRMT,XLGD,YLGD,PLTXL,PLTYL,GCON)

DATA(NX,NY)	:	data array to be plotted (DATA(1,1) is in the lower left hand corner)
NX	:	number of x values
NY	:	number of y values
CINT	:	contour interval (REAL) if CINT ≤ 0 no contouring is done
SC	:	sample contour (up to 20 contours will be done on either side of this contour value). If SC is set to the undefined value. then a suitable value will be chosen for you: this will be zero if the field is of two signs (REAL)
XBEG, XEND	:	beginning and ending x value
YBEG, YEND	:	beginning and ending y value
XLL, YLL	:	position of lower left corner of plot in inches (REAL) (0,0) is the bottom left corner of page in portrait mode.
XUR, YUR	:	position of upper right corner of plot in inches (REAL) (8.5,11.0) is the upper right corner of page in portrait mode.
IPTY	:	<= 0 general plot = 2 assumes x axis is latitude (XLGD not used) = 3 assumes x axis is longitude (XLGD not used)
XINC	:	tic mark and label increment for x-label (REAL) (XINC should be < 0 if XBEG > XEND)
YINC	:	tic mark and label increment for y-label (REAL) (YINC should be < 0 if YBEG > YEND)
XFRMT	:	format of x-axis grid label (CHARACTER*5) (e.g. 'fw.d)' or 'iw) ')
YFRMT	:	format of y-axis grid label (CHARACTER*5)
XLGD	:	x legend (CHARACTER*80)
YLGD	:	y legend (CHARACTER*80)
PLTXL	:	determines if x-label and legend is written (LOGICAL)
PLTYL	:	determines if y-label and legend is written (LOGICAL)
GCON	:	determines if contour interval is geometric (LOGICAL) nth contour is $CINT^{(n-1)}$ x SC

5 Vectors

Vectors may be superimposed on backgrounds produced with PRNTCL, PRNTHD, PRNTOR and PRNTST*. First call the approriate contouring routine (set CINT=0 if you do not want contours) and then call

WINDS (U,V,NX,NY,IINC,JINC,SV,XLEN,YLEN,USTD)

U (NX,NY)	:	x-component of vector
V (NX,NY)	:	y-component of vector
IINC	:	increment in x-direction for vector placement
JINC	:	increment in y-direction for vector placement
SV	:	value of standard vector
XLEN	:	x-length of plot (inches) (XUR-XLL in PRNTCL or PRNTHD)
YLEN	:	y-length of plot (inches) (YUR-YLL in PRNTCL or PRNTHD)
USTD	:	character string of length 20. "$" must be last character (used for labeling the standard vector) e.g. USTD='50 m/s$'

The line weight of the vectors may be changed by calling CONGLW and undefined values may be set by calling SETUND (see section 2).

* Note that vectors may also be superimposed on backgrounds produced with MAPLTP, MAPLNP and MAPGSP. Here one must call WINDS with the vertically interpolated vector components. These are in the WORK array returned in the MAPXXX routines above (See example vi in Appendix C).

6. Utilities

6.1 Adding a title

This utility allows you to place a title anywhere on the page:

```
CALL WRTTIT (TITLE, SIZE, XLOC, YLOC, IYSHFT, IJUST)
```

where

TITLE	:	CHARACTER*80 (put $ sign as last character)
SIZE	:	size of the characters as fraction of standard size (STANDARD SIZE = 1.0 corresponds to 1/8 inch)
XLOC	:	x-position of label (see chapter 1.2)
YLOC	:	y-position of label (see chapter 1.2)
IYSHFT	:	0 will place note at y-position = YLOC +n will shift placement up n one-half character sizes -n will shift placement down n one-half character sizes
IJUST	:	**0** title is centered on XLOC -1 title is right justified at XLOC +1 title is left justified at XLOC

6.2 Adding a note

To place a small note on the far left hand side:

```
CALL WRTLB2 (NOTE, YLL, IYSHFT)
```

where

NOTE	:	CHARACTER*80 (put $ sign as last character)
YLL	:	y-position of label (see chapter 1.2)
IYSHFT	:	0 will place note at YLL and far left side +n will shift placement up n one-half character sizes -n will shift placement down n one-half character sizes

6.3 Maximum/ minimum value

This routine computes the maximum and minimum value of an array of data ignoring any undefined values.:

CALL MXMN (DATA, IM, AMN, AMX)

where

DATA	:	input array
IM	:	number of elements in DATA
AMN :	:	minimum value
AMX :	:	maximum value

7. Appendices

A. Sample EXECs

Under CMS the plotting instructions are written to file number 80 which in the examples below was named QMS2 DATA A. You are free to name these as you wish (eg. PLOT FILE E, where E is a temporary disk). The exec which sends the file to the printers is called QMS. In these examples it is executed as part of the main exec (EXEC QMS QMS2 DATA A (CC). However, in practice it is often desirable to do this separately, after you are sure that the job ran as expected.

For the V7 the exec is set up to automatically send the plot files to the QMS.

i. V6

```
LINKTO F401U   191 22O M
LINKTO WOLFPLOT 191 221 N
LINKTO PROD01   191 256 O
LINKTO F400D   192 252 Q
GLOBAL TXTLIB VFORTLIB GMSFLIB PLOTSUBS DOTYSUBS WOLFPLOT
GLOBAL LOADLIB VFLODLIB
FORTVS PLOTV6 (NOPRINT OPT(2)
FI * CLEAR
FI 20 * DSN SYS5 WOLF WRLDATA1 MAP DATA(RECFM VBS LRECL 200 BLOCK 13030
FI 80 DISK QMS2 DATA A (RECFM F LRECL 133 BLOCK 133
LOAD PLOTV6 PRNTYY5 WOLFQMS QMDEV (NOMAP CLEAR
START
EXEC QMS QMS2 DATA A (CC
EXEC RELD M N O Q
```

ii. 3081

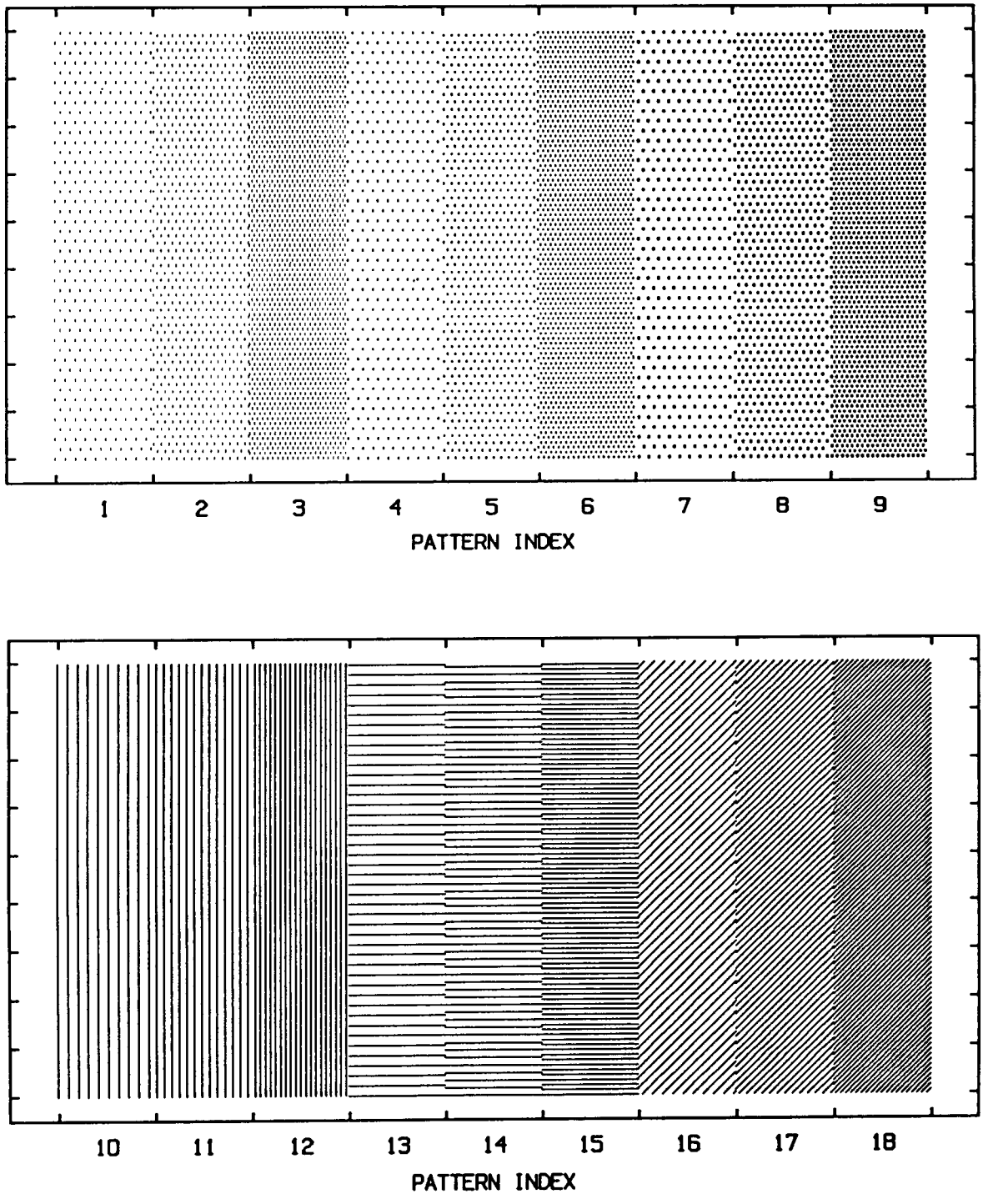
```
REL L (DET
REL M (DET
REL O (DET
EXEC LINKTO W3RIR   191 222 O
EXEC MASSTOR
GLOBAL TXTLIB VFORTLIB GMSFLIB PLOTSUBS DOTYSUBS WOLFPLOT CMSLIB
GLOBAL LOADLIB VFLODLIB
FORTVS PLOTML  (NOPRINT OPT(2)
FI * CLEAR
FI 20 DISK WRLDATA1 DATA M (RECFM VBS LRECL 200 BLOCK 13030
FI 80 DISK QMS2 DATA A (RECFM F LRECL 133 BLOCK 133
LOAD PLOTML PRNTYY5 WOLFQMS QMDEV (NOMAP CLEAR START
EXEC QMS QMS2 DATA A (CC
REL L (DET
REL M (DET
REL O (DET
```

iii. V7

This example reads data from an MVS disk file (08). The plot file (80) is sent directly to the QMS.

```
//F4SDSWGN JOB (W0501,V420,10),'SCHUBERT',CLASS=A,
//       REGION=4800K,MSGLEVEL=(2,1),TIME=(15,0)
/*JOBPARM LINES=150
/*ROUTE PRINT VPFVM.F4SDS
/*OUTPUT PLOT DEST=VPFVM.F4QMS
//COMPILE EXEC PROC=FORTVC,FVREGN=1500K,FVPOPT=2
//FORT.SYSIN DD *
=WGNE2 FORTRAN *
=GCMVECTR FORTRAN *
/*
//LKED     EXEC PGM=IEWL,REGION=3000K,COND=(4,LT),
//         PARM='LET,NOLIST,NOMAP,NOXREF,SIZE=(2000K,65K)'
//SYSPRINT    DD SYSOUT=*
//SYSLIB      DD DSN=SYS1.VALTLIB,DISP=SHR
//            DD DSN=SYS1.VFORTLIB,DISP=SHR
//            DD DSN=SYS1.FORTGMSF.LOAD,DISP=SHR
//            DD DSN=SYS5.WOLF.PLTOLD.LOAD,DISP=SHR
//            DD DSN=SYS5.DUMMY.LOAD,DISP=SHR    FOR SYSLIB OVERRIDE
//SYSLIN      DD DSN=&&LOADSET,DISP=(MOD,PASS)
//            DD DSN=W3JSW.TEST.TEXTLIB(WOLFQMS),DISP=SHR
//            DD DSN=W3JSW.TEST.TEXTLIB(PLOTSUBS),DISP=SHR
//            DD DSN=W3JSW.TEST.TEXTLIB(DOTYSUBS),DISP=SHR
//            DD DSN=F4SDS.GRAPH1.TEXTLIB(PRNTYY5),DISP=SHR
//            DD DSN=W3JSW.TEST.TEXTLIB(QMDEV),DISP=SHR
//SYSUT1      DD UNIT=SYSDA,SPACE=(CYL,(1,1))
//SYSLMOD     DD DSN=&&GOSET(MAIN),DISP=(NEW,PASS),UNIT=SYSDA,
//            SPACE=(CYL,(1,1,1))
//*
//GO        EXEC PGM=*.LKED.SYSLMOD,REGION=3000K,COND=(8,LT)
//STEPLIB     DD DSN=SYS1.VFLODLIB,DISP=SHR
//FT05F001    DD DDNAME=SYSIN
//FT06F001    DD SYSOUT=*
//FT08F001    DD DSN=W3CKP.GLAT1.DATA(JAN),DISP=SHR
//FT80F001    DD SYSOUT=(P,,PLOT),
//            DCB=(RECFM=FBA,LRECL=133,BLKSIZE=133)
//GO.FT20F001 DD DSN=SYS5.WOLF.WRLDATA1.MAP.DATA,DISP=SHR
/*
```

B. **Shading patterns**



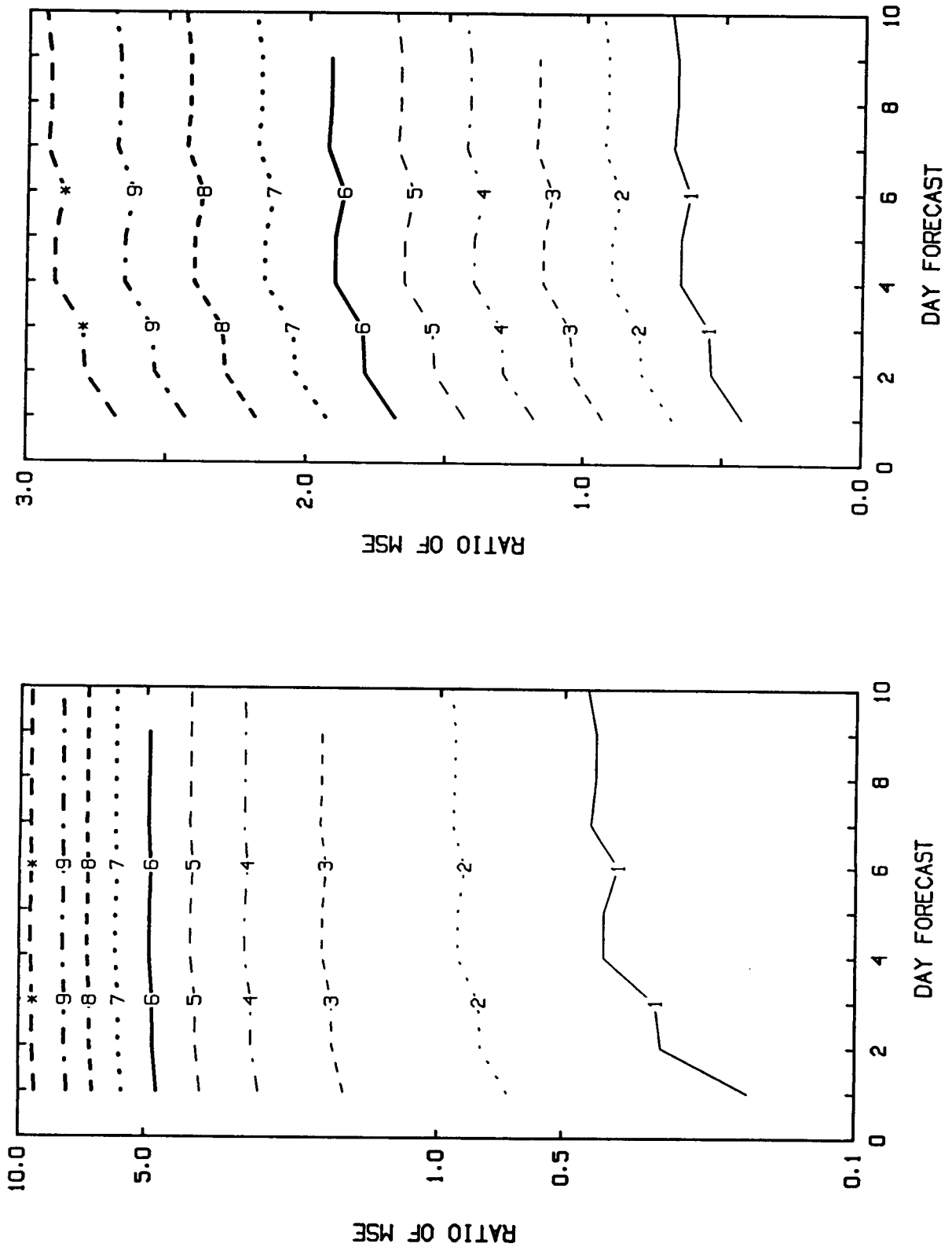
C. Examples

i. Sample line plot

```
C THIS PROGRAM PRODUCES 2 LINE PLOTS ON ONE PAGE IN
C LANDSCAPE MODE.  THE FIRST IS ON A SEMI-LOG SCALE AND THE
C SECOND HAS LINEAR SCALES.  THE CURVES SHOW OFF THE 10 LINE
C TYPES AVAILABLE
C
      PARAMETER (IM=10,NLN=10)
      REAL XVAL(IM),FLD(IM)
      CHARACTER*1 CHAR(NLN),CHAX
      CHARACTER*30 TITLY/'RATIO OF MSE$'/
      CHARACTER*30 TITLX/'DAY FORECAST$'/
      CHARACTER*5 FMTX/'I3)  '/
      CHARACTER*5 FMTY/'F4.1)'/
C
      DATA  XVAL/1.,2.,3.,4.,5.,6.,7.,8.,9.,10./
      DATA   CHAR/'1','2','3','4','5','6','7','8','9','*'/
C
C *** INITIALIZE PLOTTING ROUTINES
C
      CALL  PSETUP
C
C  LANDSCAPE
C
      CALL ROTCAL(.TRUE.)
C
C  SEMI LOG PLOTS
C
      XLL=1.5
      XUR=4.5
      YLL=1.
      YUR=6.5
      XMIN=0.
      XMAX=10.
      YMIN=0.1
      YMAX=10.
      DXT=1.0
      DYT=1.0
      DXL = 2.*DXT
      DYL = 2.*DYT
      INTCH = 2
C
      CHAX=CHAR(1)
      INTCH=3
      NLTYP=1
      READ (8) FLD
      CALL LNPLT (FLD,XVAL,IM,XMIN,XMAX,YMIN,YMAX,XLL,YLL,XUR,YUR,
     $            DXT,DYT,DXL,DYL,FMTX,FMTY,NLTYP,CHAX,INTCH,TITLX,TITLY,2)
C
      DO 20 NT=2,NLN
      CHAX=CHAR(NT)
      NLTYP=NT
      INTCH=3
```

```
      READ(8) FLD
      CALL EZLINE (FLD,XVAL,IM,NLTYP,CHAX,INTCH)
20    CONTINUE
C
      REWIND 8
C
C  LINEAR PLOTS
C
      XLL=6.0
      XUR=9.0
      XMIN=0.
      XMAX=10.
      YMIN=0.0
      YMAX=3.0
      DXT=1.0
      DYT=0.5
      DXL = 2.*DXT
      DYL = 2.*DYT
      INTCH = 2
C
      CHAX=CHAR(1)
      INTCH=3
      READ(8) FLD
      NLTYP=NT
      CALL LNPLT (FLD,XVAL,IM,XMIN,XMAX,YMIN,YMAX,XLL,YLL,XUR,YUR,
     $            DXT,DYT,DXL,DYL,FMTX,FMTY,NLTYP,CHAX,INTCH,TITLX,TITLY,0)
      DO 30 NT=2,NLN
      CHAX=CHAR(NT)
      READ(8) FLD
      NLTYP=NT
      INTCH=3
      CALL EZLINE (FLD,XVAL,IM,NLTYP,CHAX,INTCH)
30    CONTINUE
      CALL ENDPLT
      STOP
      END
```

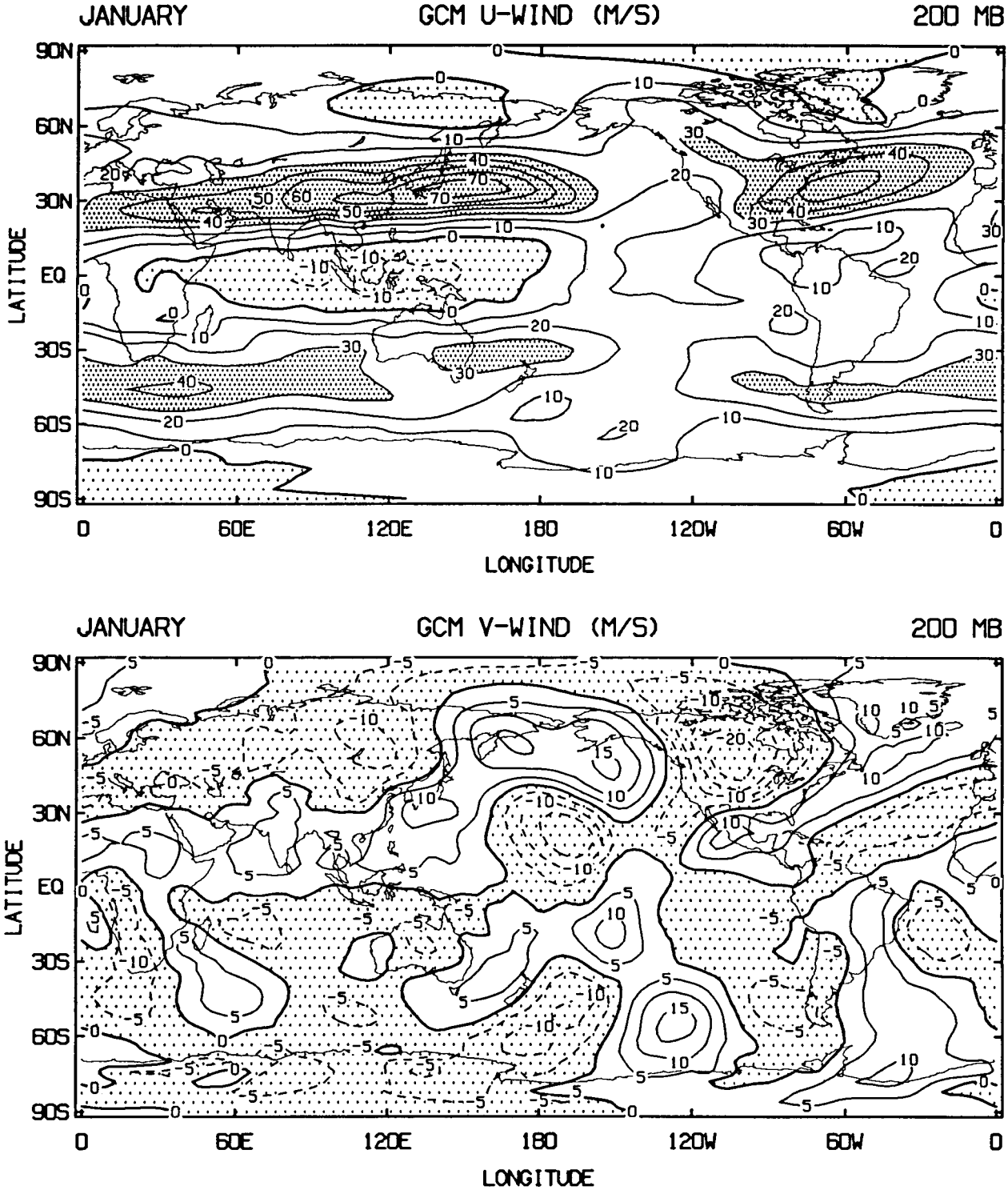
Figure 1. Sample line plot. (Basic routines: LNPLT, EZLINE)



ii. Sample cylindrical map

```
      PARAMETER(IMP=73,JM=46)
      REAL T1(IMP,JM)
      LOGICAL GCON,PLTXL,PLTYL,ROT
      CHARACTER*80 T1A,T1B,T1C
C
      BLON=0.
      ELON=360.
      BLAT=-90.
      ELAT=90.
      INCX=60
      INCY=30
      PLTXL=.TRUE.
      PLTYL=.TRUE.
      XLL=1.3
      XUR=7.3
      CALL PSETUP
C
      READ(8) T1
      YLL=6.0
      YUR=9.0
      T1A='JANUARY$'
      T1B='GCM U-WIND (M/S)$'
      T1C='200 MB$'
      SC1=0.
      CINT1=10.
      CALL CONSHD(-1000.,0.,4)
      CALL CONSHD(30.,1000.,6)
      CALL PRNTCL(T1,CINT1,BLON,ELON,BLAT,ELAT,IMP,JM,XLL,YLL,
     *     XUR,YUR,SC1,INCX,INCY,PLTXL,PLTYL,GCON)
C
      CALL WRTTIT(T1A,1.0,XLL,YUR,2,1)
      XLOC=(XLL+XUR)/2.0
      CALL WRTTIT(T1B,1.0,XLOC,YUR,2,0)
      CALL WRTTIT(T1C,1.0,XUR,YUR,2,-1)
C
      READ(8) T1
      YLL=2.0
      YUR=5.0
      T1A='JANUARY$'
      T1B='GCM V-WIND (M/S)$'
      T1C='200 MB$'
      SC1=0.
      CINT1=5.
C
      CALL PRNTCL(T1,CINT1,BLON,ELON,BLAT,ELAT,IMP,JM,XLL,YLL,
     *     XUR,YUR,SC1,INCX,INCY,PLTXL,PLTYL,GCON)
C
      CALL WRTTIT(T1A,1.0,XLL,YUR,2,1)
      XLOC=(XLL+XUR)/2.0
      CALL WRTTIT(T1B,1.0,XLOC,YUR,2,0)
      CALL WRTTIT(T1C,1.0,XUR,YUR,2,-1)
      CALL ENDPLT
      STOP
      END
```

Figure 2. Sample contouring and shading on a world background map using a cylindrical projection. (Basic routines: PRNTCL)

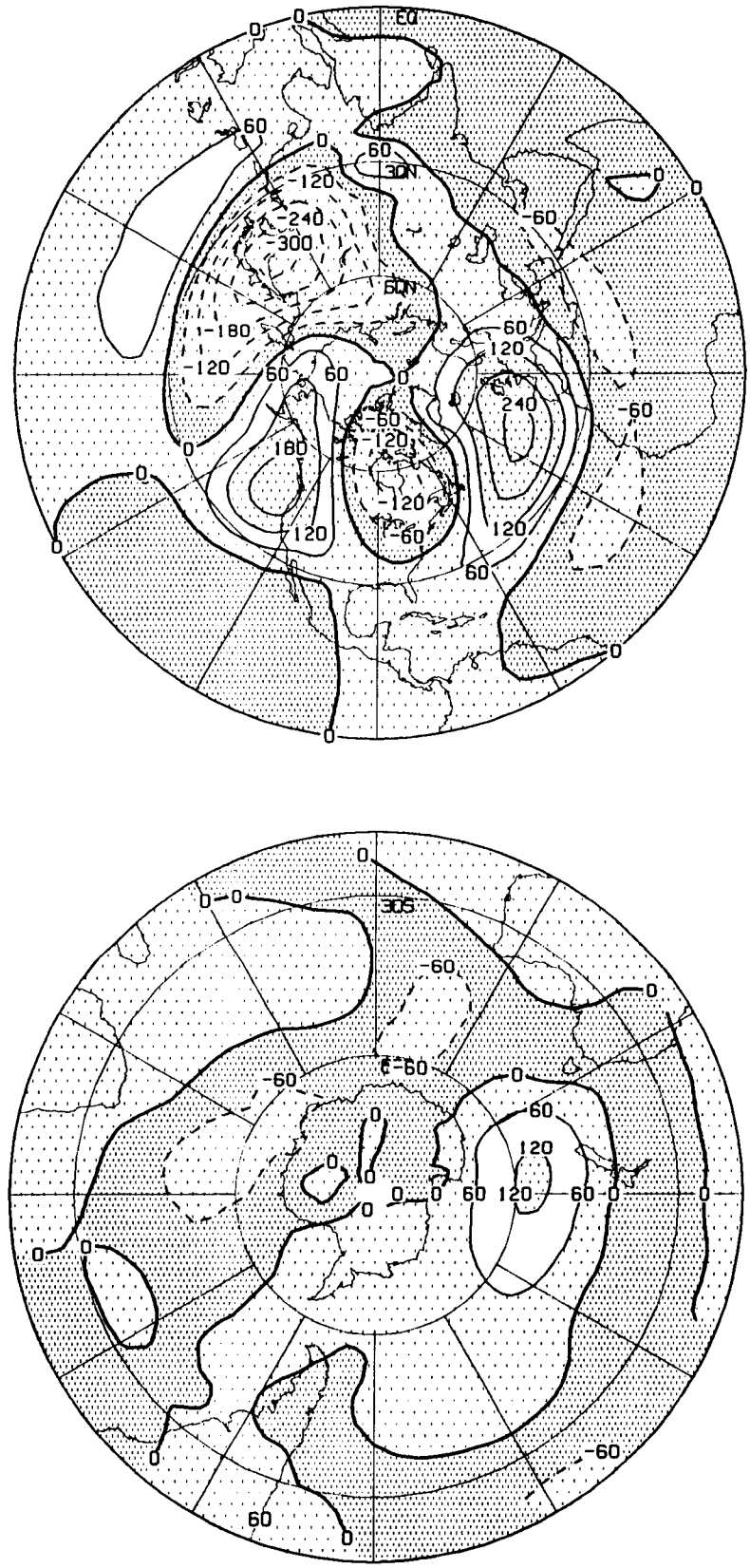


iii. Sample polar stereographic map

```
      PARAMETER (NX=73,NY=46)
      REAL*4 T1(NX,NY),WORK(NX,NY)
      LOGICAL GCON
C
      CALL PSETUP
C
      READ(8) T1
C
      CINT1=60.0
      SC1=0.0
C
      ALB=90.0
      PHI=90.0
      Y00=7.50
      X00=4.25
      RAD=2.0
      CALL CONSHD (-400.,60.,1)
      CALL CONSHD (-60.,0.,3)
      CALL CONSHD (120.,400.,11)

C
C  DATA ARRAY HAS POLE VALUES AND IS ALREADY WRAPPED (T1(1,J)=T1(73,J))
C
      CALL PRNTST (T1(1,2),WORK,CINT1,ALB,PHI,NX,NY-2,X00,Y00,RAD,SC1,GCON)
      PHI=-70.0
      Y00=3.00
      X00=4.25
      CALL PRNTST (T1(1,2),WORK,CINT1,ALB,PHI,NX,NY-2,X00,Y00,RAD,SC1,GCON)
      CALL ENDPLT
      STOP
      END
```

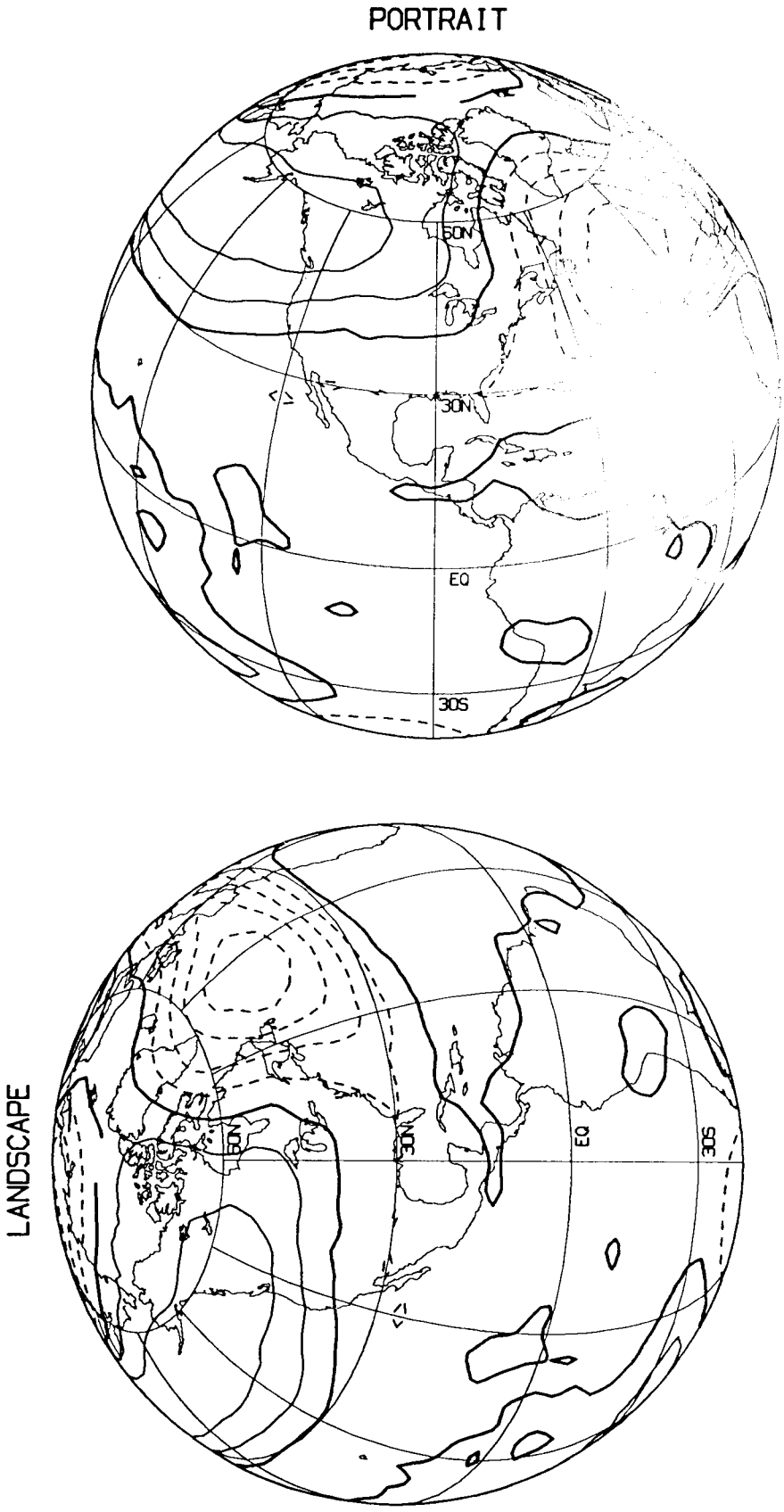
Figure 3. Sample contouring and shading on a background map using a polar stereographic projection. (Basic routines: PRNTST)



iv. Sample orthographic map

```
      PARAMETER (IMP=73,JM=46)
      REAL T1(IMP,JM),WK(IMP,JM)
      LOGICAL GCON,PLTXL,PLTYL,ROT
      CHARACTER*80 T1A,T1B,T1C
C
      CALL PSETUP
      X0=4.25
      Y0=7.5
      RAD=2.
      T1B='PORTRAIT$'
      GCON=.FALSE.
      SC1=0.
      CINT1=60.
      CLT1= 30.
      CLN1=-90.
C
C  SUPPRESS CONTOUR LABELS
C
      CALL DMPLAB(4)
C
      CALL PRNTOR(T1(1,2),WK,CINT1,CLN1,CLT1,IMP,JM-2,X0,Y0,RAD,SC1,GCON)
C
      CALL WRTTIT(T1B,1.0,X0,YUR,2,0)
C
      CALL ROTCAL(.TRUE.)
      T1B='LANDSCAPE$'
      X0=3.0
      Y0=3.75
C
      CALL PRNTOR(T1(1,2),WK,CINT1,CLN1,CLT1,IMP,JM-2,X0,Y0,RAD,SC1,GCON)
C
      CALL WRTTIT(T1B,1.0,X0,YUR,2,0)
C
      CALL ENDPLT
      STOP
      END
```

Figure 4. Sample contouring on a background map using an orthographic projection. (Basic routines: PRNTOR)



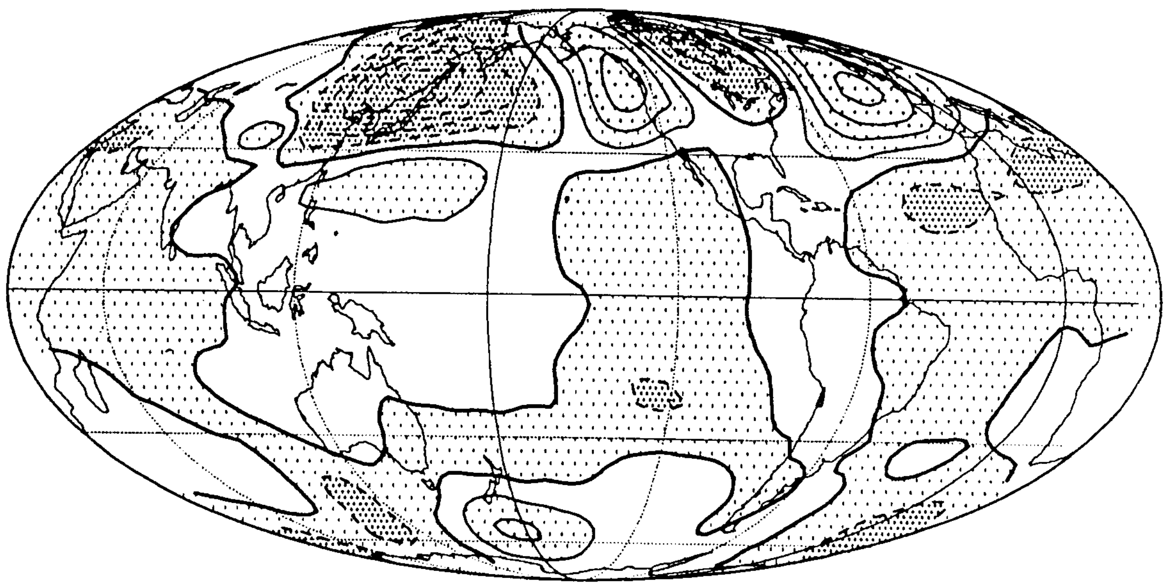
v. Sample egg map

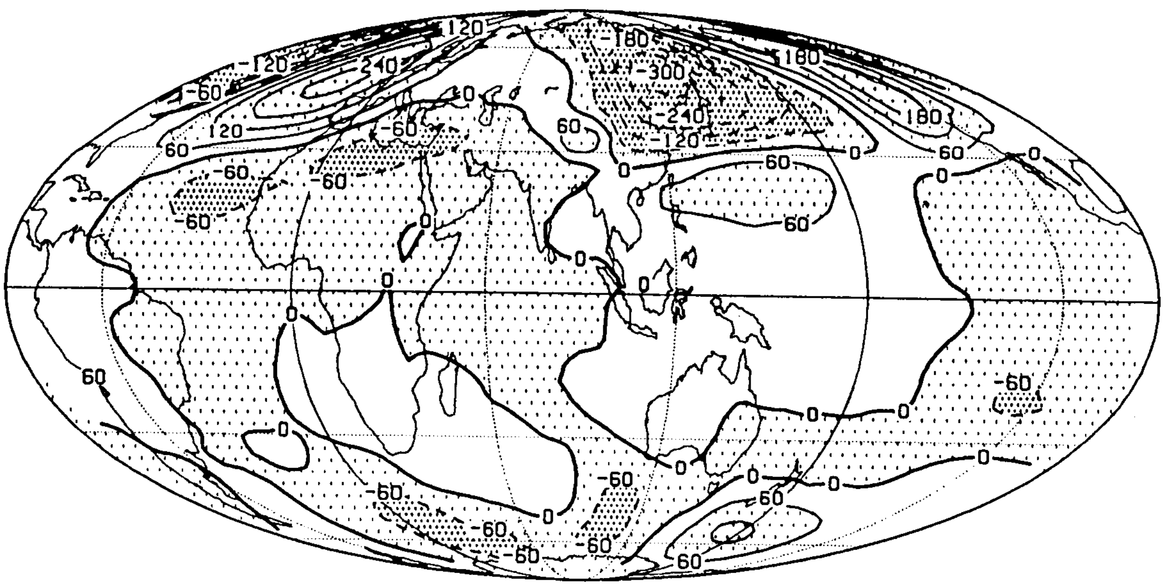
```
      PARAMETER (IMP=73,JM=46)
      REAL T1(IMP,JM),WK(IMP,JM)
      LOGICAL GCON,PLTXL,PLTYL,ROT
      CHARACTER*80 T1A,T1B,T1C
C
      CALL PSETUP
      X0=3.75
      Y0=3.0
      DIAM=6.
      GCON=.FALSE.
      SC1=0.
      CINT1=60.
      CLN1=90.
      INCX=60
      INCY=30
      CALL CLRSHD
      CALL CONSHD (-500.,-60.,6)
      CALL CONSHD (-60.,0.,1)
      CALL CONSHD (60.,120.,10)
      CALL CONSHD (120.,560.,13)
C
C USE LABELING ALGORITHM WHICH DOES NOT LABEL END POINTS
C
      CALL LABTYP(2)

C
C
      CALL PRNTEG(T1(1,2),WK,CINT1,CLN1,IMP,JM-2,X0,Y0,DIAM,SC1,
     *                  INCX,INCY,GCON)
C
      X0=3.75
      Y0=7.5

C  SUPPRESS CONTOUR LABELS
C
      CALL DMPLAB(4)
      CLN1=-150.
C
      CALL PRNTEG(T1(1,2),WK,CINT1,CLN1,IMP,JM-2,X0,Y0,DIAM,SC1,
     *                  INCX,INCY,GCON)
C
      CALL ENDPLT
      STOP
      END
```

Figure 5. Sample contouring on an egg map.
(Basic routines: PRNTEG)



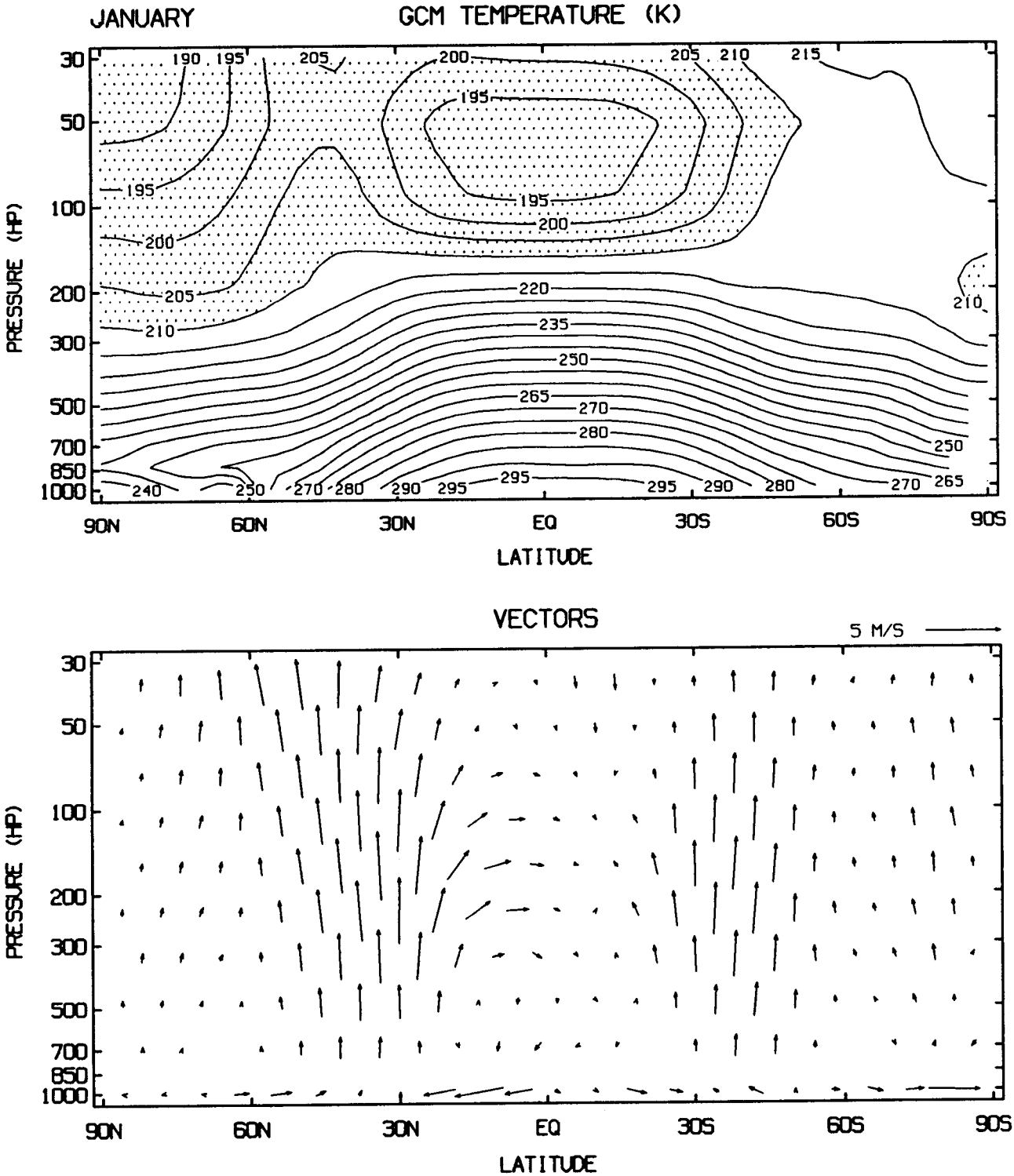


vi. Sample cross section

```
      PARAMETER (JM=46,NL=10,NLN=20, NLP=9)
C
      REAL UZ(JM,NL),VZ(JM,NL),TZ(JM,NL),PLEV(NL)
      REAL UZI(JM,NLN),VZI(JM,NLN), WORK(JM,NLN)
      REAL PLEVP(NLP)
      LOGICAL GCON,PLTXL,PLTYL,ROT,LOGP,LOGI
      CHARACTER*80 T1A,T1B,T1C
       CHARACTER*20 USTD1
      DATA PLEV/1000.,850.,700.,500.,400.,300.,200.,100.,50.,30./
      DATA PLEVP/1000.,850.,700.,500.,300.,200.,100.,50.,30./
C
C PLEV ARE THE NL PRESSURE LEVELS OF INPUT DATA
C PLEVP ARE THE NLP PRESSURE LEVELS LABELED ON THE PLOTS (INPUT)
C
      READ(8) TZ
      READ(8) UZ
      READ(8) VZ
C
      CALL PSETUP
      GCON=.FALSE.
      XLL=1.3
      XUR=7.3
      YLL=6.0
      YUR=9.0
      T1A='JANUARY$'
      T1B='GCM TEMPERATURE (K)$'
      T1C=' $'
      SC1=260.
      CINT1=5.
      CALL CONSHD(0.,210.,4)
      YBOT=1000.
      YTOP=30.
      BLAT=-90.
      ELAT=90.
      LOGP=.TRUE.
      LOGI=.TRUE.
      RINCX=30.
      PLTXL=.TRUE.
      PLTYL=.TRUE.
C
      CALL MAPLTP(TZ,WORK,CINT1,SC1,JM,NL,BLAT,ELAT,YBOT,YTOP,XLL,YLL
     *      XUR,YUR,RINCX,PLTXL,PLTYL,GCON,PLEV,LOGP,LOGI,NLN,PLEVP,NLP)
C
      CALL WRTTIT(T1A,1.0,XLL,YUR,2,1)
      XLOC=(XLL+XUR)/2.0
      CALL WRTTIT(T1B,1.0,XLOC,YUR,2,0)
      CALL WRTTIT(T1C,1.0,XUR,YUR,2,-1)
      CALL CLRSHD
```

```
C PRODUCE VECTORS:  FIRST CALL MAPLTP WITH CINT=0 TO GET BACKGROUND
C
      YLL=2.0
      YUR=5.0
      T1A=' $'
      T1B='VECTORS$'
      T1C=' $'
      SC1=0.
      CINT1=0.
      CALL MAPLTP(UZ,UZI,CINT1,SC1,JM,NL,BLAT,ELAT,YBOT,YTOP,XLL,YLL,
     *      XUR,YUR,RINCX,PLTXL,PLTYL,GCON,PLEV,LOGP,LOGI,NLN,PLEVP,NLP)
C
C
C NOW  INTERPOLATE  V SET CINT<0. SO NO PLOT IS PRODUCED
C
      CINT=-1.
      CALL MAPLTP(VZ,VZI,CINT1,SC1,JM,NL,BLAT,ELAT,YBOT,YTOP,XLL,YLL,
     *      XUR,YUR,RINCX,PLTXL,PLTYL,GCON,PLEV,LOGP,LOGI,NLN,PLEVP,NLP)
C
C
      SV1=5.
      USTD1='5 M/S$'
      LINC=2
      JINC=2
      XLEN=XUR-XLL
      YLEN=YUR-YLL
      CALL WINDS (VZI,UZI,JM,NLN,JINC,LINC,SV1,XLEN,YLEN,USTD1)
C
      CALL WRTTIT(T1A,1.0,XLL,YUR,2,1)
      XLOC=(XLL+XUR)/2.0
      CALL WRTTIT(T1B,1.0,XLOC,YUR,2,0)
      CALL WRTTIT(T1C,1.0,XUR,YUR,2,-1)
 C
      CALL ENDPLT
      STOP
      END
```

Figure 6. a) Sample contouring and shading and b) vectors on a latitude/pressure background. (Basic routines: MAPLNP, WINDS)

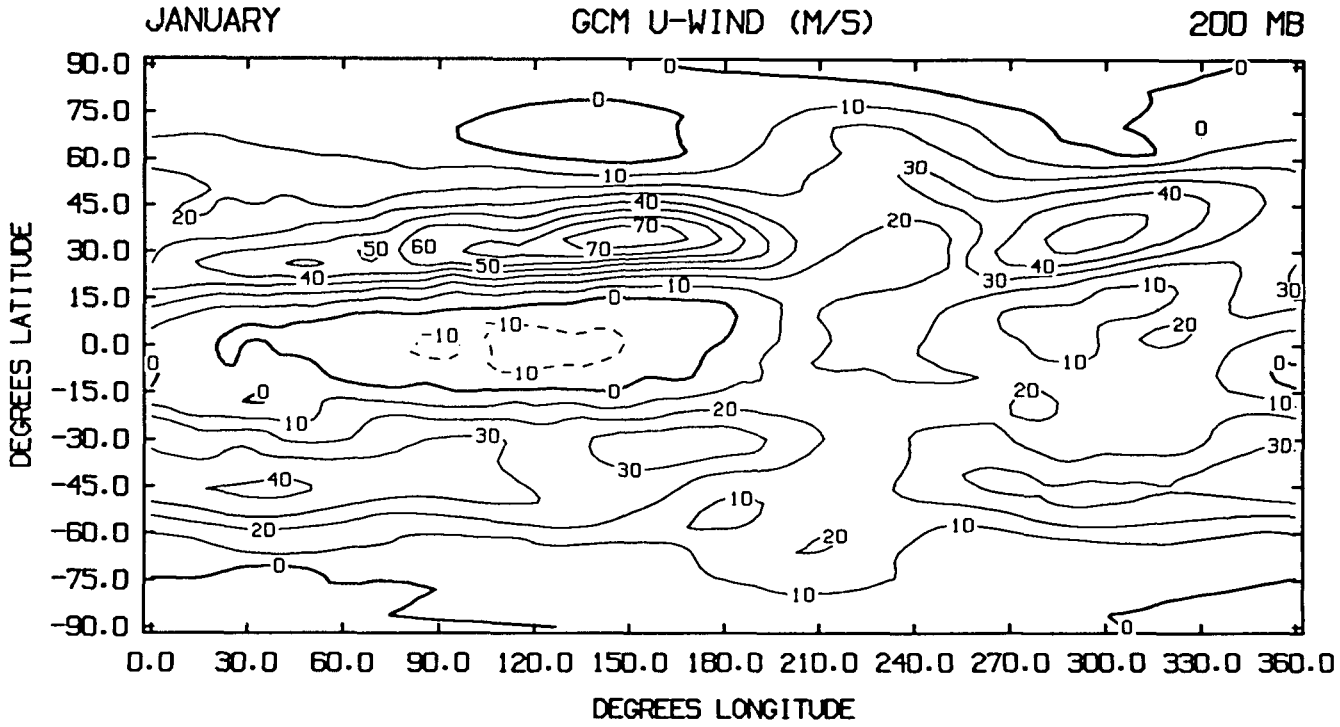


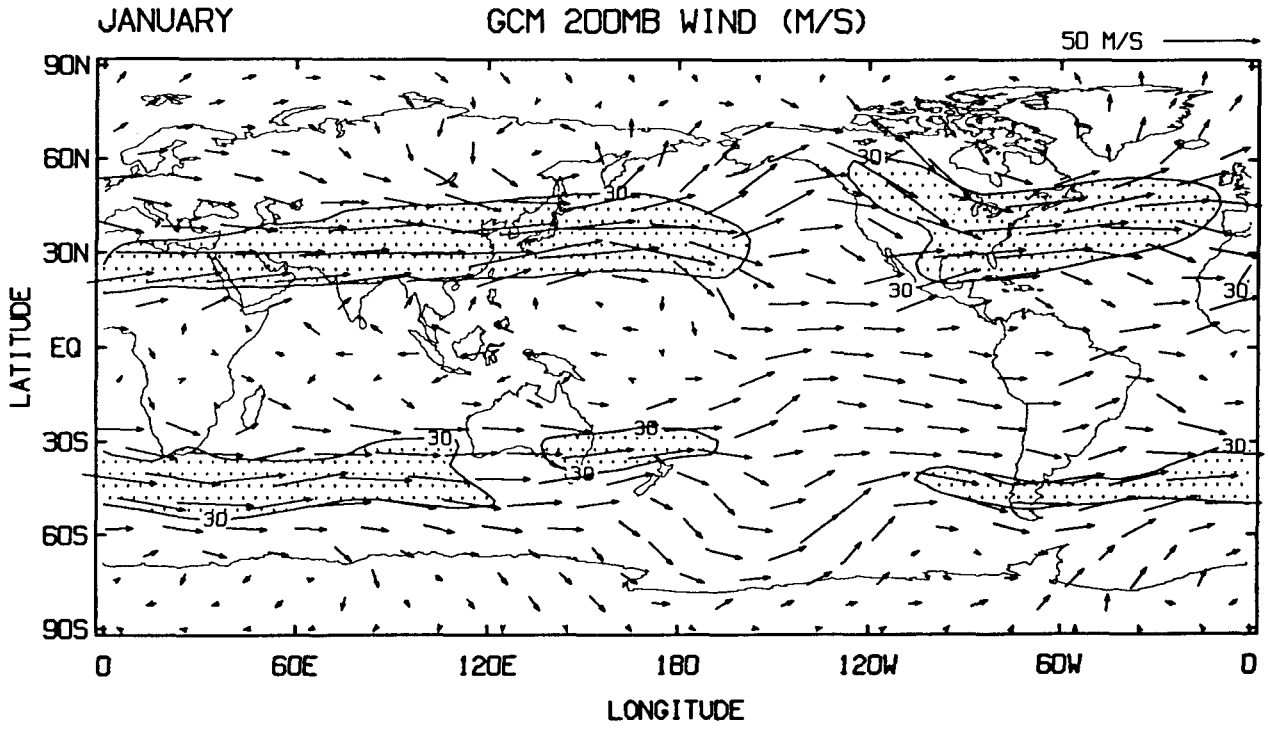
vii. Sample general contour plot

```
      PARAMETER (IMP=73,JM=46)
      REAL T1(IMP,JM)
      LOGICAL GCON,PLTXL,PLTYL,ROT
      CHARACTER*80 T1A,T1B,T1C
      CHARACTER*5 XFRMT,YFRMT
      CHARACTER*80 XLGND,YLGND
C
      YLL=6.0
      YUR=9.0
      T1A='JANUARY$'
      T1B='GCM U-WIND (M/S)$'
      T1C='200 MB$'
      GCON=.FALSE.
      SC1=0.
      CINT1=10.
      XB=0.
      XE=360.
      YB=-90.
      YE=90.
      XINC=30.
      YINC=15.
      XFRMT='F5.1)'
      YFRMT='F5.1)'
      XLGND='DEGREES LONGITUDE$'
      YLGND='DEGREES LATITUDE$'
      PLTXL=.TRUE.
      PLTYL=.TRUE.
C
      CALL PSETUP
C
      CALL PRNTHD (T1,CINT1,SC1,IMP,JM,XB,XE,YB,YE,XLL,YLL,XUR,YUR,0,
     *          XINC,YINC,XFRMT,YFRMT,XLGND,YLGND,PLTXL,PLTYL,GCON)
C
      CALL WRTTIT(T1A,1.0,XLL,YUR,2,1)
       XLOC=(XLL+XUR)/2.0
      CALL WRTTIT(T1B,1.0,XLOC,YUR,2,0)
      CALL WRTTIT(T1C,1.0,XUR,YUR,2,-1)
C
      CALL ENDPLT

      STOP
      END
```

Figure 7. a) Simple general contouring and b) shading with superimposed vectors.
(Basic routines: PRNTHD, WINDS).





viii. Sample vector plot

```
C  THIS PROGRAM PRODUCES A CONTOURED (WITH SHADING) FIELD WITH
C  SUPERIMPOSED VECTORS
      PARAMETER (IMP=73,JM=46)
      DIMENSION U(IMP,JM),V(IMP,JM),S(IMP,JM)
      LOGICAL GCON,PLTXL,PLTYL,ROT
      CHARACTER*80 T1A,T1B
      CHARACTER*20 USTD
C
       GCON=.FALSE.
       BLON=0.
       ELON=360.
       BLAT=-90.
       ELAT=90.
       INCX=60
       INCY=30
       PLTXL=.TRUE.
       PLTYL=.TRUE.
       T1A='JANUARY$'
       T1B='GCM 200MB WIND (M/S)$'
       SV=50.
       USTD='50 M/S$'
       IINC=4
       JINC=2
C
       READ(8) U
       READ(8) V
C
       CALL PSETUP
C
C  COMPUTE MAGNITUDE OF WIND
C
       CALL MAG(U,V,S,IMP,JM)
       XLL=1.3
       XUR=7.3
       YLL=2.0
       YUR=5.0
       SC=30.
       CINT=100.
       CALL CONSHD (30.,100.,4)
C
       CALL PRNTCL(S,CINT,BLON,ELON,BLAT,ELAT,IMP,JM,XLL,YLL,
     *         XUR,YUR,SC,INCX,INCY,PLTXL,PLTYL,GCON)
C
       XLEN=XUR-XLL
       YLEN=YUR-YLL
       CALL WINDS (U,V, IMP,JM,IINC,JINC,SV,XLEN,YLEN,USTD)
       CALL WRTTIT(T1A,1.0,XLL,YUR,2,1)
       XLOC=(XUR+XLL)/2.0
       CALL WRTTIT(T1B,1.0,XLOC,YUR,2,0)
       STOP
       END
```

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16. Abstract

A plotting package has been developed to simplify the task of plotting meteorological data. This document provides the calling sequences and examples of high level yet flexible routines which allow contouring, vectors and shading of cylindrical, polar, orthographic and Mollweide (egg) projections. Routines are also included for contouring pressure-latitude and pressure-longitude fields with linear or log scales in pressure (interpolation to fixed grid interval is done automatically). We have also included a fairly general line plotting routine. The present version (1.5) produces plots on QMS laser printers and uses graphics primitives from WOLFPLOT.

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