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An Ocean Model Processor for Climate Studies

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Preface

The purpose of this technical note is to describe and demonstrate the capabilities of an ocean model processor for climate studies. The processor is a tool for the analysis of history data from a particular family of oceanic general circulation models, and can be used for a wide class of ocean investigations ranging from eddy resolving modeling studies to global climate simulations. It is designed to execute within the NCAR Scientific Computing Division environment on the CRAY supercomputers using datasets which reside on the mass storage system.

The primary product from the processor is a two-dimensional contour analysis of data which was represented originally in the four dimensions of space and time. Data can be averaged over any dimension and plotted within any two-dimensional cross-section subset. Several examples are given in order to illustrate the capabilites of the processor.

This technical note does not provide a comprehensive description of the processor code or of the datasets upon which it operates.

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1. Introduction

The Ocean Processor (OP) is a tool for the analysis of data from oceanic general circulation models (OGCM) of the form described by Semtner (1974). One such model (e.g., Bryan, 1969; Meehl et al., 1982; Semtner, 1986; a derivation of basic model equations is contained in Washington and Parkinson, 1986) is used for climate ocean studies and carbon dioxide climatic impact research in the Climate Section of the Atmospheric Analysis and Prediction Division. A more sophisticated version of the Semtner (1974) model currently is under development as part of a joint project between scientists at NCAR and the Naval Postgraduate School (Monterey, California).

Most of the state variables which comprise an instantaneous sample from the ocean model integration are three-dimensional in space. Usually, a history of the model integration contains a time series of these three-dimensional datasets, and thus a fourth-dimension (time) becomes eligible for diagnostic analysis. The OP operates upon these four dimensions and is capable of performing the following functions:

(1) Time Averaging
(2) Zonal Averaging
(3) Meridional Averaging
(4) Vertical Averaging
(5) Horizontal Cross-Section Plotting
(6) Meridional Cross-Section Plotting
(7) Zonal Cross-Section Plotting
(8) Time Cross-Section Plotting
(9) Limited Area Plotting (cross-section enlargement, i.e., zoom)
(10) Color Plotting

The primary purpose of this technical note is to describe and demonstrate the processing options available with OP. The sections which follow describe the processing philosophy, the input datasets, the internal program parameters, and the user input options. A sample deck is given and several examples are shown which demonstrate the capabilities of OP.

It is **not** the purpose of this note to provide a comprehensive description of the OP code. Undoubtedly, more complicated data analyses can be performed through code modifications. Such modifications will probably require consultation with the author of this note.

Input to OP is limited to datasets which conform to the types which are used by the ocean models mentioned above. At the present time two such datasets are acceptable as input to OP.

OP is designed to execute within the NCAR Scientific Computing Division environment on the CRAY supercomputers using datasets which reside on the mass storage system. The code itself also resides on the mass storage system as an UPDATE program library. It employs the NCAR GKS graphics system. The primary product of OP - metacode plot files - can be disposed (by means of CRAY JCL) either to the Dicomed graphics processor or to a selected remote device for storage and subsequent display on a monitor with graphics capability.

The contents of this technical note represent a snapshot description of the capabilities of the OP code. The development of the processor is ongoing, and additional functions are planned. A few of these include diagnostic field computations (i.e., derived fields), field differences, generation of datasets which can be saved for subsequent OP analysis, and generation of datasets suitable as input into the *Interactive Data Analysis Processor* (IDAP).

2. Philosophy and Terminology

The major product from OP is a two-dimensional contour analysis of data which was represented originally in four dimensions. It is important that the user understand the data collapse procedure in order that he can successfully manipulate the input option requests to produce the desired result. The intent of this section is to outline the processing philosophy and terminology employed by OP.

Variables which are being processed within OP are usually available in four dimensions - three spatial dimensions and time (x, y, z, t). In this case x is longitude, y is latitude, z is depth in the ocean, and t is time. Single-leveled variables, for example, or variables which are constant in time are treated as subsets of the general four-dimensional dataset. The two dimensions which define the final product of the analysis of the full four-dimensional dataset are referred to as the **included** dimensions. The remaining two dimensions are defined as the **excluded** dimensions.

From the four-dimensional datasets, six primary two-dimensional analyses can be constructed. Within OP these six are defined as xy, xz, yz, xt, ty, and tz cross-sections. When the final cross-sections are constructed, the first dimension listed is the abscissa of the plot, and the second dimension is the ordinate. Thus, a yz construct is a zonal cross-section. Note that these six cross-sections are the only ones which OP is capable of producing.

The six primary cross-sections can be broken into two classes. The primary **spatial** cross-sections are comprised of the space dimensions only (xy, xz, and yz). The primary **temporal** cross-sections consist of time and one space dimension (xt, ty, and tz). The reason that spatial sections are distinguished from temporal sections involves definition of the excluded dimensions.

After the primary dimensions have been specified, the data are collapsed onto a two-dimensional plane by averaging the data in the excluded dimensions over specified **ranges**. If time is one of the excluded dimensions (a spatial cross-section), then OP offers the user the choice of either *averaging the data over time* followed by collapsing (space-averaging) the time average within the range of the excluded spatial dimension, or contructing primary sections *for each time requested* by collapsing the data within the range of the excluded spatial dimension. If time is a primary dimension (a temporal cross-section), then the data are collapsed within the ranges requested for the two excluded spatial dimensions.

Once the primary cross-section is constructed, OP offers the user the choice of plotting and analyzing the data within any subset of the full area comprising the included dimensions of the cross-section. The full area is defined by the input dataset.

3. Input Datasets

At the present time only two types of dataset formats are acceptable as input to OP. These formats are the ones used by the ocean models mentioned in the introduction section of this technical note.

One type of dataset format is used by the ocean model which is under development as part of a joint project between scientists at NCAR and the Naval Postgraduate School. It is identified in this note as format type `OGCM1`. These datasets are comprehensive; that is, they contain information within a header which fully describes the dataset contained in the history file.

The other dataset format type is utilized by the ocean models used for general climate ocean studies and carbon dioxide climatic impact research. It is identified in this note as format type `OGCM2`. These datasets are somewhat limited in their informational content, and have been included as input into OP for historical reasons. The format follows closely that found in Semtner (1974).

It is recommended that if one wishes to use OP with datasets which do not correspond to one of these two formats, then the data should be reformatted into the `OGCM1` type.

4. Program Parameterization

The OP code is parameterized through the `UPDATE` common deck `*COMDECK PARAM` with eight major parameters. In addition, a special set of parameters exist for those runs which involve OGCM2 datasets. They are contained in the UPDATE common deck *COMDECK POGCM2.

Under normal circumstances, the OP parameters will not need to be modified because their default values will suffice. However, special circumstances may arise in which the default values must be changed in order that the storage requirements be allocated properly. A common reason to change a parameter, for example, could involve a change in the grid resolution of the model output.

The important parameters contained in *COMDECK PARAM are summarized in Table 4.1. Note that each parameter is defined as a **maximum** value. The default values are given. The UPDATE sequence number is also given so that the user can modify a parameter if the need arises.

The parameters contained in *COMDECK POGCM2 are summarized in Table 4.2. The parameter defaults and the UPDATE sequence number for each parameter are given.

The processing of OGCM2 datasets is an obvious example which demonstrates when the user may wish to change the OP parameters. The general parameters MIX and MJY can be set to the values of the OGCM2 parameters IMT and JMT. Parameter MKZ should be set to the value of (KM+1) because the OGCM2 definition of KM is for the number of vertical layers **not** the maximum number of vertical levels. These changes will greatly reduce the amount of memory allocated for OP and will result in quicker job turnaround and lower cost.

General OP Parameters			
Name	Description	Default Value	UPDATE Sequence
MIX	maximum number of grid points in the x-direction	162	PARAM.6
MJY	maximum number of grid points in the y-direction	42	PARAM.7
MKZ	maximum number of grid points in the z-direction	15	PARAM.8
MVARSM	maximum number of multi-leveled variables to be processed	2	PARAM.9
MVARSS	maximum number of single-leveled variables to be processed	1	PARAM.10
MAREAS	maximum number of areas to be processed for each cross-section requested	5	PARAM.11
MRANGES	maximum number of **excluded** dimension ranges to be processed for each cross-section requested	5	PARAM.12
MTIMES	maximum number of time samples to be processed in **temporal** cross-section plots	50	PARAM.13

Table 4.1. Parameters in *COMDECK PARAM.

OGCM2 OP Parameters			
Name	Description	Default Value	UPDATE Sequence
IMT	actual number of grid points in the x-direction in model output	74	POGCM2.6
JMT	actual number of grid points in the y-direction in model output	37	POGCM2.7
KM	number of vertical layers in the model output	4	POGCM2.8
NKMFLD	number of multi-leveled variables in the model output	4	POGCM2.9
NSLFLD	number of single-leveled variables in the model output	5	POGCM2.10
OGCM2N	northern latitude on model grid	87.5	POGCM2.11
OGCM2S	southern latitude on model grid	-87.5	POGCM2.12

Table 4.2. Parameters in `*COMDECK POGCM2`.

5. Input Control Keywords

The processing within OP is controlled by a series of user specified input control keywords. These are the user requests which appear at the end of the OP deck prior to the last end-of-file statement.

The input control keywords can be classified generally into four groups which address slightly different processing functions. They are the general processing requests, the spatial cross-section processing requests, the temporal cross-section processing requests, and the color plotting processing requests.

Table 5.1 lists the keywords used to control the general processing flow of OP. They are subdivided into *mandatory keywords* and *optional keywords*. The mandatory control keywords **must appear** and **be given** valid arguments or the OP processing will be aborted. Thus, the keywords TAPES, VARS, and either ITER or DAYS must appear among the users processing requests. The optional control keywords will default to predetermined values and do not have to be specified explicitly.

In conjunction with the keyword VARS, the variable names which should be used are dependent upon the type of ocean dataset being processed. For OGCM1 type datasets, the user should simply request the variable name abbreviation which appears on the history file header. For OGCM2 type datasets, the requested variable names must be given the appropriate abbreviation as listed in Table 5.2.

The control keywords used to request and specify spatial cross-section processing are given in Table 5.3. All of the partial keywords in Table 5.3 must be preceded by a two letter prefix which refers to the spatial cross-section being requested. For example, if a horizontal (xy) cross-section plot is desired, the ..PLOT keyword is XYPLOT. The keyword ...RNG requires that a third letter, the excluded spatial dimension, be included in the prefix (e.g., XYZRNG).

Keywords to control special features for the spatial cross-section processing are given in Table 5.4. They include two special keywords for horizontal (xy) cross-sections, and one special keyword for zonal (yz) cross-sections.

Table 5.5 contains the control keywords for temporal cross-section processing. As with the keywords which control the spatial cross-section processing, the partial temporal cross-section keywords in Table 5.5 must be preceded by a two letter prefix which identifies the temporal cross-section being requested.

The keywords for color plotting options are listed in Table 5.6. The numerical values for the colors correspond to a user established color table on a target graphics device.

It is important to note the subtle differences in a few of the keywords which request

General Processing Input			
Mandatory Keywords			
Keyword	Description	Default	Example
TAPES	mass storage system pathnames of input datasets; each entry must be 129 characters or less in length; first character **must** be a blank (' ')		TAPES=' OP/UGIH04', ' OP/UGIH05'
VARS	list of variables to be processed		VARS='T','P'
ITER	group of three iteration values; defines first iteration, last iteration, and increment between iterations to be processed; if third value is -1, all time samples between first and last iterations (inclusive) will be processed		ITER=0,5000,250
DAYS	used in place of ITER, defines days rather than iterations; real values		DAYS=10.0,30.0,-1.0
Optional Keywords			
Keyword	Description	Default	Example
TYPE	type of ocean model being processed; either 'OGCM1' or 'OGCM2'	'OGCM1'	TYPE='OGCM2'
TIMAVG	option to time average over the requested iterations; 'YES' or 'NO'	'NO'	TIMAVG='YES'
TITLE	user specified title which will appear on all film frames; maximum of 40 characters	blank	TITLE='Exp 29'
ITRACE	flag to control amount of printed diagnostic output; a value of 0 will cause minimum output; a value of 4 will permit maximum output	2	ITRACE=1
DEPTHS	layer depths for 'OGCM2' type ocean model (meters)	none	DEPTHS= 50., 450., 1500., 2000.

Table 5.1. General Processing Input Control Keywords .

OGCM2 Variable Abbreviations	
Variable	Abbreviation
Temperature	'T'
Salinity	'S'
U Velocity	'U'
V Velocity	'V'
W Velocity	'W'
Mass Stream Function	'P'
Bottom Topography	'TOPOG'
Sea Ice	'SEAICE'
Surface Heat Flux	'HF'
Surface Wind Stress X	'SX'
Surface Wind Stress Y	'SY'
Surface Precipitation minus Evaporation	'P-E'

Table 5.2. Variable Request Abbreviations for OGCM2 Datasets.

Spatial Cross-Section Processing Input (XY-, XZ-, YZ-)			
Keyword	Description	Default	Example
..PLOT	type of cross-section request; either 'YES' or 'NO'	'NO'	XYPLOT='YES'
..AREA	cross-section area; request as [**west, east, south, north**] or [**west, east, top, bottom**] or [**south, north, top, bottom**]; multiple areas allowed	full area of dataset	XZAREA= -180.,180., 0.,400., 130.,290.,50.,300.
...RNG	range of **excluded** dimension; request as [**lower range, upper range,** 'I' or 'A']; 'I' ('A') to process (average) all individual points within the range; 'A' is assumed; multiple ranges allowed	none	XZYRNG= -60.,-60., -60.,-20.,'A', -20., 20.,'I', 20., 60.
..CINT	contour interval specification; request as [**variable, excluded dimension value, interval**]; all ranges at and greater than value specified will be given that interval unless additional triplet specified; if interval is negative, no plot is produced	chosen by OP	XYCINT= 'T', 0., 4.0, 'T',250., 2.5, 'U', 75.,20.0
..CDIV	contour dividing value; either for dashed or two-color plots; request similar to ..CINT	0.0	YZCDIV= 'T',180.,13.5
..CSCA	contour label scale factor; request similar to ..CINT	1.0	XYCSCA= 'U',0.0,10.0
..ZERO	include zero contour; either 'YES' or 'NO'	'YES'	YZZERO='NO'
..DLIN	dash specified contours (..CDIV); either 'YES' or 'NO'	'YES'	XZDLIN='NO'
..DPAT	10-bit dashed contour pattern	1252B	YZDPAT=666B
..ULC	number of unlabeled contours between labeled contours	0	XZULC=2

Table 5.3. Spatial Cross-Section Processing Input Control Keywords.

Spatial Cross-Section Processing Input			
Special Horizontal Cross-Section Keywords			
Keyword	Description	Default	Example
XYPROJ	type of projection; 'RECT' is cylindrical equidistant; (no other options presently available)	'RECT'	XYPROJ='RECT'
XYDOT	dotted continental outlines; either 'YES' or 'NO'	'NO'	XYDOT='YES'
Special Zonal Cross-Section Keywords			
Keyword	Description	Default	Example
YZYPOS	positive direction of abscissa; 'YES' for southern-most latitude at left; 'NO' for northern-most latitude at left	'YES'	YZYPOS='NO'

Table 5.4. Special Spatial Cross-Section Processing Input Control Keywords.

Temporal Cross-Section Processing Input (TY-, TZ-, XT-)			
Keyword	Description	Default	Example
..PLOT	type of cross-section request; either 'YES' or 'NO'	'NO'	TYPLOT='YES'
..AREA	spatial part of cross-sectional area; request as [**west, east**], or [**south, north**], or [**top, bottom**]; all times requested will be analyzed; only one area allowed	full area of dataset	XTAREA=-180.,180.
..RNGS	range of **excluded** spatial dimensions; request as [**west, east, south, north**], or [**west, east, top, bottom**], or [**south, north, top, bottom**]; multiple ranges allowed; averaging always implied	none	XTRNGS= -60.,-60., 0.,400., -60.,-20.,250.,1000.
..CINT	contour interval specification; request as [**variable, interval**]; variable will be given requested interval; if contour interval is negative, no plot is produced	chosen by OP	TYCINT='T', 4.0, 'U',20.0
..CDIV	contour dividing value; either for dashed or two-color plots; request similar to ..CINT	0.0	TZCDIV='T',13.5
..CSCA	contour label scale factor; request similar to ..CINT	1.0	XTCSCA='U',10.0
..ZERO	include zero contour; either 'YES' or 'NO'	'YES'	TYZERO='NO'
..DLIN	dash specified contours (..CDIV); either 'YES' or 'NO'	'YES'	TZDLIN='NO'
..DPAT	10-bit dashed contour pattern	1252B	XTDPAT=666B
..ULC	number of unlabeled contours between labeled contours	0	TZULC=2

Table 5.5. Temporal Cross-Section Processing Input Control Keywords.

Color Plotting Input			
Keyword	Description	Default	Example
CLCNTNT	color of continental outlines in xy cross-sections	'001'	CLCNTNT='008'
CLCTRGE	color of contours greater than or equal to dividing value	'001'	CLCTRGE='003'
CLCTRLT	color of contours less than dividing value	'001'	CLCTRLT='004'
CLLABEL	color of plot labels and borders	'001'	CLLABEL='002'
CLHIGHS	color of marked highs	'001'	CLHIGHS='005'
CLLOWS	color of marked lows	'001'	CLLOWS='006'
CLPNTVL	color of values plotted with marked highs and lows	'001'	CLPNTVL='007'

Table 5.6. Color Plotting Input Control Keywords.

spatial or temporal cross-section processing. The differences originate from the definitions used to characterize a spatial or temporal cross-section. One major difference between the two cross-section types involves the specification of the general processing keyword `TIMAVG`. For spatial cross-sections, the `TIMAVG` request will dictate whether individual time samples or a time average will be presented. For temporal cross-sections, the `TIMAVG` request makes no difference - all individual time samples will be presented on the cross-sectional plots.

The `..AREA` request for spatial cross-sections must contain four values - two for each **included** spatial dimension. The order of the value pairs should be alphabetical (i.e., xy, xz, or yz). For temporal cross-sections, the `..AREA` request contains only two values - the **included** spatial dimension. All of the requested time samples will be included in the temporal cross-section analysis. Multiple areas (up to the maximum specified by the parameter `MAREAS`) are allowed for spatial cross-sections, while only one area can be requested for temporal cross-sections.

The keyword option `...RNG` for spatial cross-sections specifies the **range** of the **excluded** spatial dimension only. The **range** of time is dictated by the specification of the general processing keyword `TIMAVG`. If `TIMAVG` is `'YES'`, all time samples requested are averaged, then presented on a single spatial cross-section; otherwise, if `TIMAVG` is `'NO'`, a spatial cross-section plot is produced for each time sample requested. The keyword `..RNGS` for temporal cross-sections is used to specify the **ranges** of the two **excluded** spatial dimensions. Averaging is always implied for the `..RNGS` values unless only one point exists within the requested range. The value pairs should be given alphabetically (i.e., xy, xz, or yz).

For all keywords which involve the specification of a geographical area or a range of an excluded dimension, the user should adhere to the following conventions. Longitudinal values should be between -360.0 and 360.0 with the 'western' value listed first. Latitudinal values should be between -90.0 and 90.0 with the 'southern' value listed first. Ocean depths (positive implied) should be in meters with the 'top' level listed first.

The `..AREA` and `...RNG` or `..RNGS` requests will conform to the following conditions:

(1) for the `..AREA` requested, if there are less than two data points in either direction a diagnostic will be printed and no plot produced;

(2) the `..AREA` requested will comprise the **exact** boundaries of the plot, and the area contoured will include all points which lie **on or inside** the boundaries;

(3) if a requested `...RNG` or `..RNGS` contains no data points, a diagnostic will be printed and no plot produced;

(4) if a requested `...RNG` or `..RNGS` contains only one point, and

averaging was specified or implied, the single point will be processed as an individual point;

(5) for requested ...RNG in individual mode ('I'), if that point does not exist in the dataset, the next **numerically lower** point will be processed in the 'I' mode;

(6) for requested ...RNG or ..RNGS, when averaging is performed, the integral is computed over the exact **requested** range using all points within the range (with proper cosine weighting in the latitudinal direction).

The specification of the contour interval, contour dividing value, and contour label scale factor keywords ..CINT, ..CDIV, and ..CSCA are slightly different for spatial and temporal cross-section requests. For spatial cross-sections, these keywords are composed of a triplet which identify the variable, a range level value, and the specification. The range level value indicates that all points at that level and greater are given the specification contained in the triplet. When an average of several levels is requested, the lower and upper range levels are averaged in order to seek a specification. If a variable appears in two or more triplets, the specification for a particular range level is extracted from the triplet which contains the next lower range level value (i.e., the *at that level and greater* rule strictly applies). For temporal cross-sections, the keywords are used to identify only the variable and specification.

The use of the input control keywords is demonstrated later in this technical note through numerous examples of output from OP.

6. Sample Deck

A sample deck which can be used to create similar decks with which to run OP is given below. This deck includes an example of how modifications are made to the program library to change a few of the OP parameter statements. Note that the current OP program library file is not given. It is recommended that the user obtain the current OP program library file name from the author prior to using the processor.

```
JOB,JN=jobname,US=uuuupppppppp,T=20,OLM=600,*MS,CL=FG1.
ACCOUNT,AC=uuuupppppppp.
*
* ====> Acquire the OP Program Library.
*
ACQUIRE,DN=PL,MF=MS,PDN=name,ID=OP,TEXT='FLNM=/BETTGE/OP/name'.
*
* ====> Update - Compile - Load - Execute
*
UPDATE,P=PL,I,F.
CFT,I=$CPL,L=0.
LDR.
*
* ====> Dispose the plot file.
*
DISPOSE,DN=$PLT,DC=ST,MF=IO,DF=BI,TEXT='FLNM=OP,FLTY=CO2PLOT'.
*
EXIT.
*
\EOF
*/
*/ Resolution Modifications.
*ID RESMOD1
*DELETE PARAM.6,7
C   Maximum number of grid points in x direction.
      PARAMETER (MIX=80)
C   Maximum number of grid points in y direction.
      PARAMETER (MJY=40)
*/
\EOF
C
C Input Control Keywords
C
ENDOFDATA
\EOF
```

7. OP Examples

This section contains examples of the plots produced from several jobs which used OP. These plots illustrate many of the capabilites of OP.

A list of the input control keywords appears first followed by the cross-section output from OP. There is at least one example for each of the six cross-sections which OP is capable of producing.

Example 1. Horizontal (xy) Cross-Section.

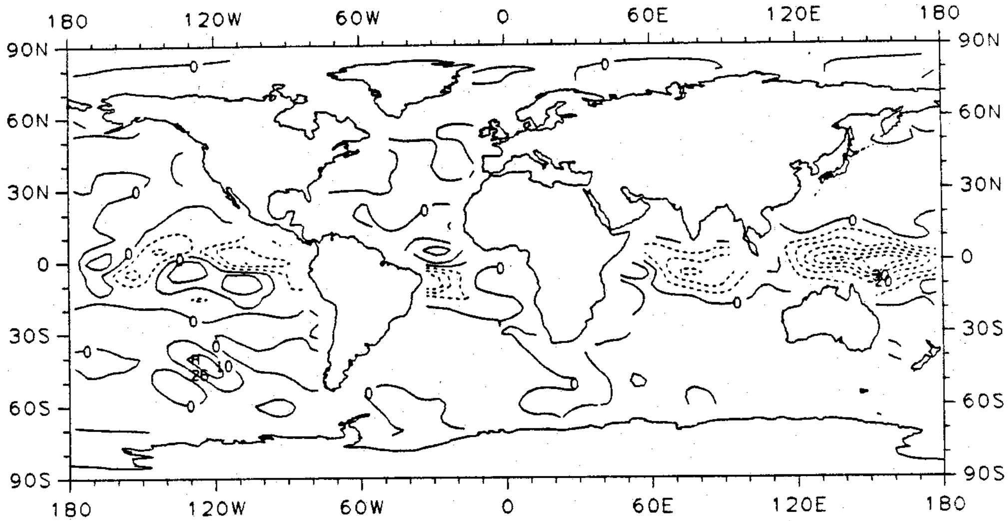
```
C
C    General Processing
C
   TAPES=' /LEO/MFE/OCAVG01'
   VARS='U'
   ITER=708624,708624,0
   TYPE='OGCM2'
   TIMAVG='NO'
   TITLE='U VELOCITY (CM/SEC) EXPERIMENT 11B'
C
C    OGCM2 Ocean Layer Depths (Meters)
C
   DEPTHS=    50.0 ,
             450.0 ,
            1500.0 ,
            2000.0
C
C    Horizontal Cross-Sections
C
   XYPLOT='YES'
   XYPROJ='RECT'
   XYZERO='YES'
   XYDLIN='YES'
   XYDPAT=1252B,
   XYDOT='NO'
   XYULC=0
   XYCINT= 'U',  0.0,10.0
         , 'U',100.0,1.0
   XYCDIV= 'U',0.0,0.0
   XYCSCA= 'U',0.0,1.0
   XYAREA=-180.0,180.0,-90.0,90.0
   XYZRNG=0.0,300.0,'I'
C
```

ITERATION 708624

OGCM2 COUPLED OCEAN MODEL

U VELOCITY

LEVEL 25.0M



U VELOCITY (CM/SEC) EXPERIMENT 11B

CONTOUR INTERVAL = 10.0
SCALE FACTOR = 1.00

FIELD MINIMUM = -58.3
FIELD MAXIMUM = 25.7

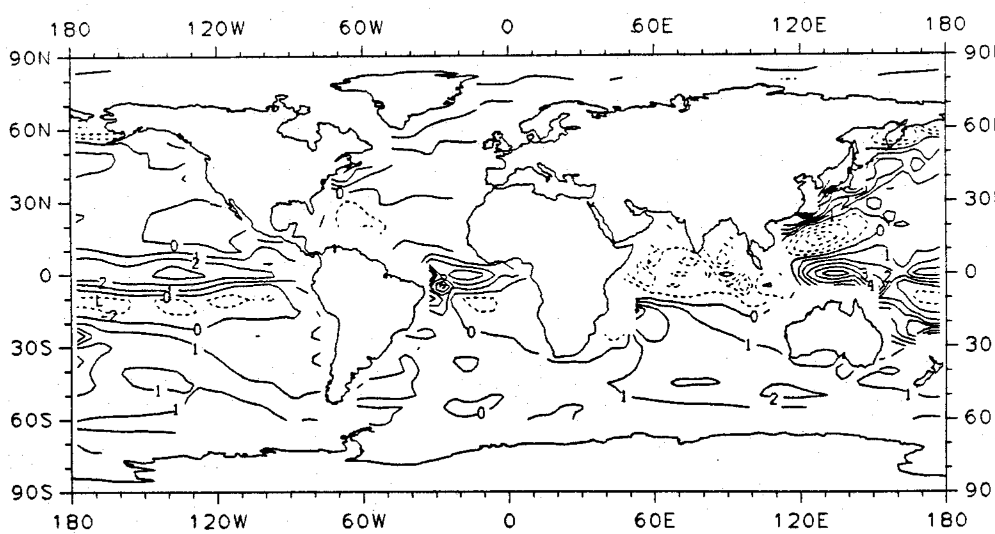
87.03.18
11.02.17

ITERATION 708624

OGCM2 COUPLED OCEAN MODEL

U VELOCITY

LEVEL 275.0M



U VELOCITY (CM/SEC) EXPERIMENT 11B

CONTOUR INTERVAL = 1.00
SCALE FACTOR = 1.00

FIELD MINIMUM = -4.56
FIELD MAXIMUM = 7.67

87.03.18
11.02.17

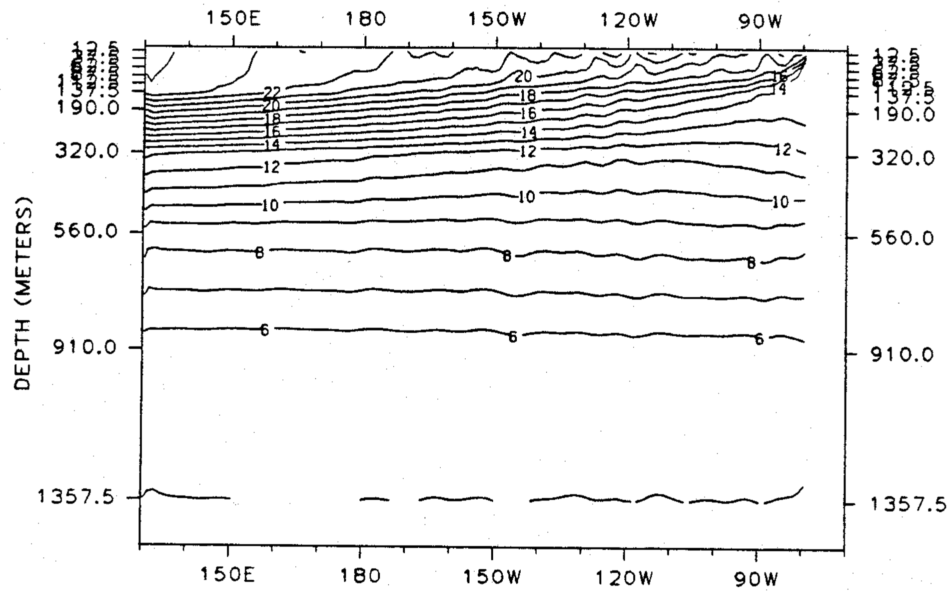
Example 2. Meridional (xz) Cross-Section.

```
C
C    General Processing
C
     TAPES=' /CHERVIN/UGIH05'
          ,' /CHERVIN/UGIH15'
     VARS='T'
     ITER=2500,20000,2500
     TYPE='OGCM1'
     TIMAVG='YES'
     TITLE='EQUATORIAL TEMPERATURE PROFILE'
C
C    Meridional Cross-Sections
C
     XZPLOT='YES'
     XZULC=1
     XZCINT= 'T',-20.0,1.0
     XZAREA=130.0,290.0,0.0,1500.0
           ,130.0,290.0,0.0, 400.0
     XZYRNG=-5.0,5.0,'A'
C
```

CASE 5 TIME AVERAGE 2500 - 20000

EQUATORIAL BASIN VARIABLE GRID IN MERIDIONAL DIRECTION, ONE DEGREE IN THE ZONAL

TEMPERATURE LATITUDINAL INTEGRAL (4.7S-4.7N)



EQUATORIAL TEMPERATURE PROFILE

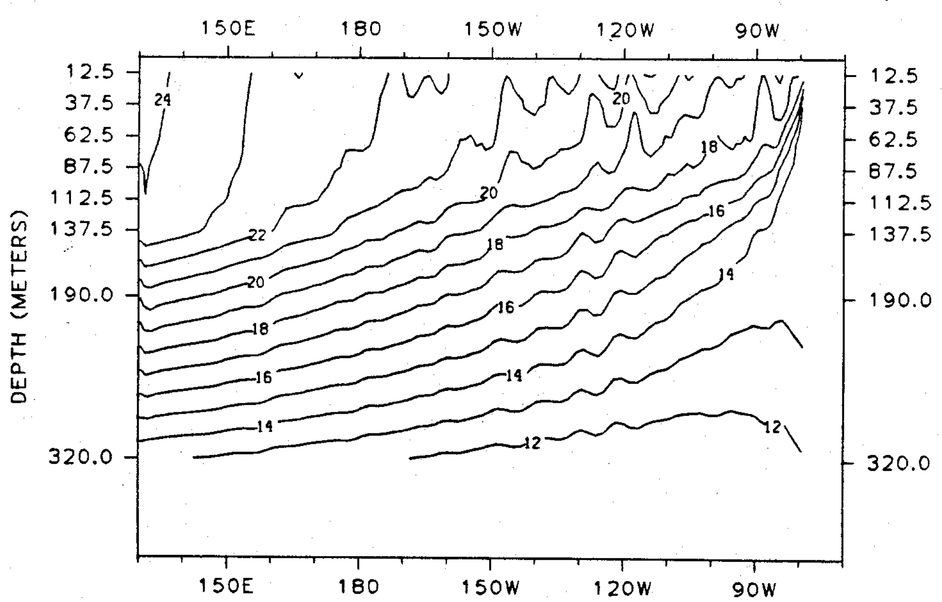
CONTOUR INTERVAL = 1.00 FIELD MINIMUM = 4.91
SCALE FACTOR = 1.00 FIELD MAXIMUM = 24.8

87.02.05
13.03.02

CASE 5 TIME AVERAGE 2500 - 20000

EQUATORIAL BASIN VARIABLE GRID IN MERIDIONAL DIRECTION, ONE DEGREE IN THE ZONAL

TEMPERATURE LATITUDINAL INTEGRAL (4.7S-4.7N)



EQUATORIAL TEMPERATURE PROFILE

CONTOUR INTERVAL = 1.00 FIELD MINIMUM = 11.1
SCALE FACTOR = 1.00 FIELD MAXIMUM = 24.8

87.02.05
13.03.02

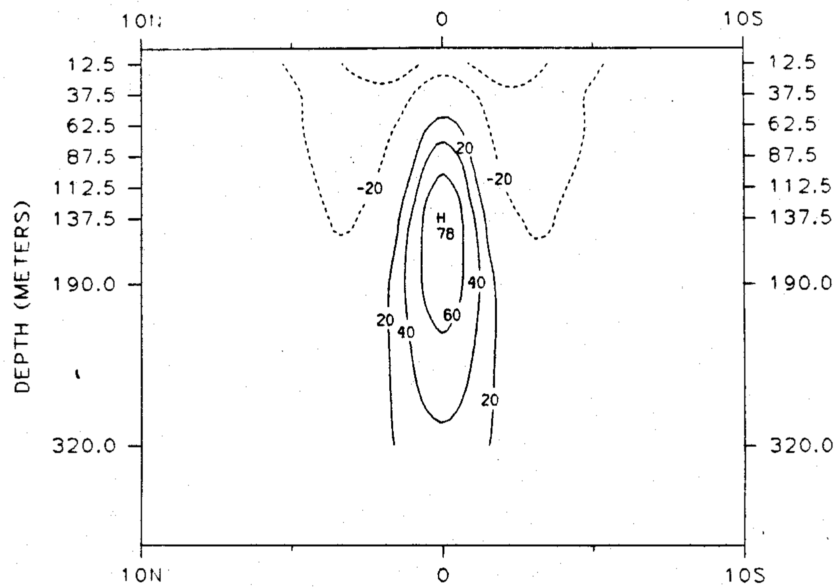
Example 3. Zonal (yz) Cross-Section.

```
C
C    General Processing
C
   TAPES=' /CHERVIN/UGIH05'
        ,' /CHERVIN/UGIH15'
   VARS='U'
   ITER=2500,20000,2500
   TYPE='OGCM1'
   TIMAVG='YES'
   TITLE='EQUATORIAL UNDERCURRENT IN OGCM1'
C
C    Zonal Cross-Sections
C
   YZPLOT='YES'
   YZYPOS='NO'
   YZZERO='NO'
   YZCINT= 'U',0.0,20.0
   YZAREA=-10.0,10.0,0.0,400.0
   YZXRNG=180.0,180.0,'I'
         ,190.0,260.0,'A'
C
```

CASE 5 TIME AVERAGE 2500 - 20000

EQUATORIAL BASIN VARIABLE GRID IN MERIDIONAL DIRECTION, ONE DEGREE IN THE ZONAL

U VELOCITY LONGITUDE 180.0



EQUATORIAL UNDERCURRENT IN OGCM1

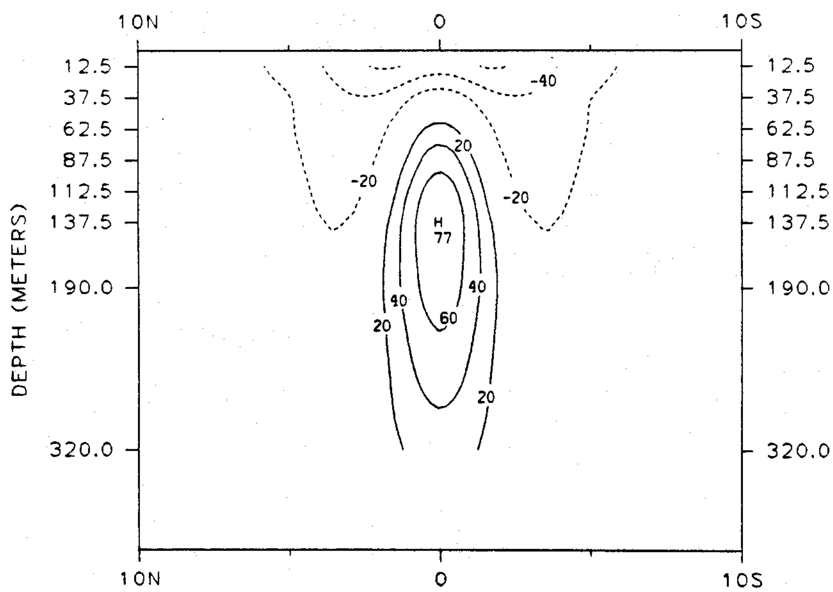
CONTOUR INTERVAL = 20.0 FIELD MINIMUM = -52.6
SCALE FACTOR = 1.00 FIELD MAXIMUM = 78.1

87.03.18
13.14.09

CASE 5 TIME AVERAGE 2500 - 20000

EQUATORIAL BASIN VARIABLE GRID IN MERIDIONAL DIRECTION, ONE DEGREE IN THE ZONAL

U VELOCITY LONGITUDE INTEGRAL (170.0W-100.0W)



EQUATORIAL UNDERCURRENT IN OGCM1

CONTOUR INTERVAL = 20.0 FIELD MINIMUM = -62.0
SCALE FACTOR = 1.00 FIELD MAXIMUM = 76.9

87.03.18
13.14.09

Example 4. Time-Depth (tz) Cross-Section.

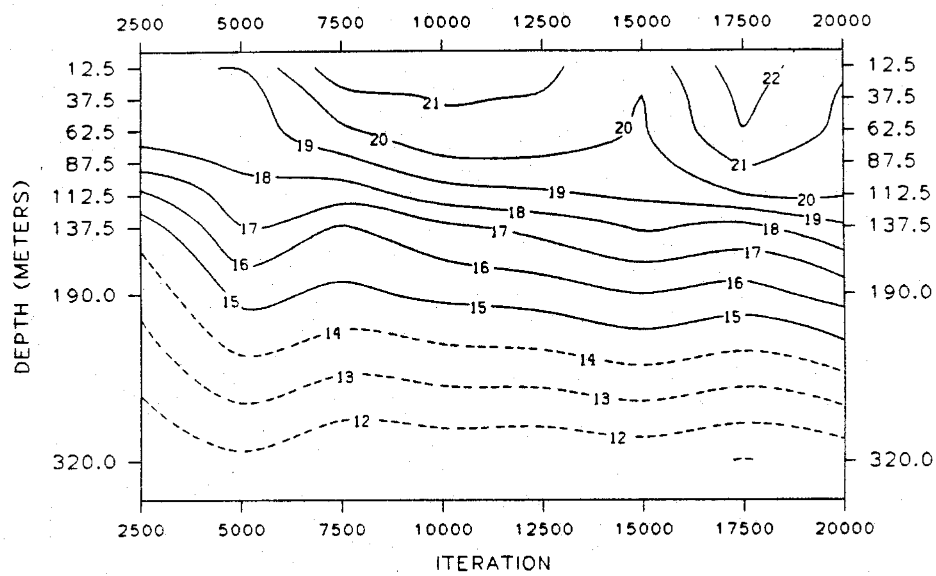
```
C
C    General Processing
C
     TAPES=' /CHERVIN/UGIH05'
          ,' /CHERVIN/UGIH15'
     VARS='T','U'
     ITER=2500,20000,2500
     TYPE='OGCM1'
     TIMAVG='NO'
     TITLE='OGCM1 TWO YEAR INTEGRATION'
C
C    Time-Depth Cross-Sections
C
     TZPLOT='YES'
     TZZERO='NO'
     TZDLIN='YES'
     TZDPAT=666B
     TZCINT= 'T',1.0
           , 'U',10.0
     TZCDIV= 'T',15.0
           , 'U',0.0
     TZAREA=0.0,350.0
     TZRNGS=230.0,230.0,-5.0,5.0
C
```

CASE 5

EQUATORIAL BASIN VARIABLE GRID IN MERIDIONAL DIRECTION, ONE DEGREE IN THE ZONAL

LONGITUDE 129.5W

TEMPERATURE LATITUDINAL INTEGRAL (4.7S–4.7N)



CONTOUR INTERVAL = 1.00 FIELD MINIMUM = 11.0
SCALE FACTOR = 1.00 FIELD MAXIMUM = 22.6
OGCM1 TWO YEAR INTEGRATION

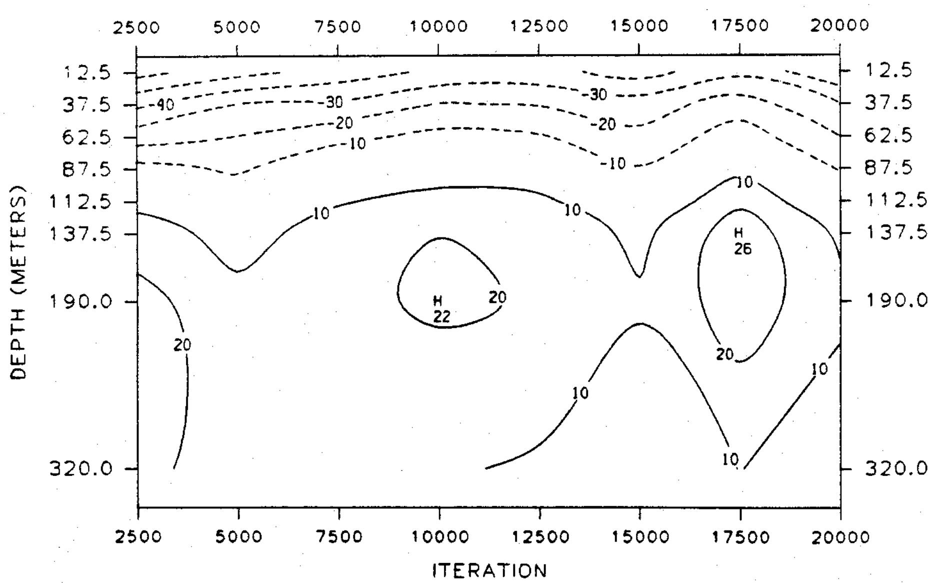
87.03.18
13.30.15

CASE 5

EQUATORIAL BASIN VARIABLE GRID IN MERIDIONAL DIRECTION, ONE DEGREE IN THE ZONAL

LONGITUDE 129.5W

U VELOCITY LATITUDINAL INTEGRAL (4.7S–4.7N)



CONTOUR INTERVAL = 10.0 FIELD MINIMUM = -63.3
SCALE FACTOR = 1.00 FIELD MAXIMUM = 25.6
OGCM1 TWO YEAR INTEGRATION

87.03.18
13.30.15

Example 5. Time-Latitude (ty) Cross-Section.

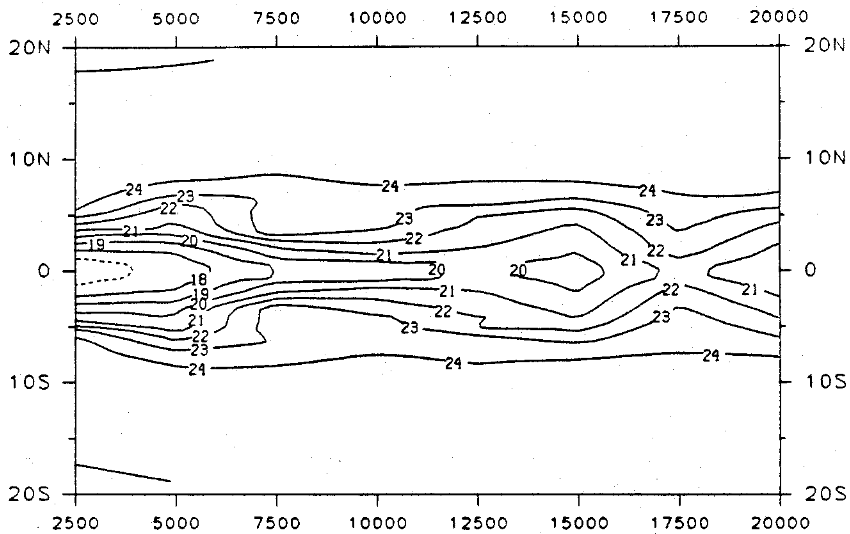
```
C
C    General Processing
C
      TAPES=' /CHERVIN/UGIH05'
           ,' /CHERVIN/UGIH15'
      VARS='T'
      ITER=2500,20000,2500
      TYPE='OGCM1'
      TIMAVG='NO'
      TITLE='OGCM1 TWO YEAR INTEGRATION'
C
C    Time-Lat Cross-Sections
C
      TYPLOT='YES'
      TYDLIN='YES'
      TYCINT= 'T',1.0
      TYCDIV= 'T',18.0
      TYAREA=-20.0,20.0
      TYRNGS=230.0,230.0, 0.0, 25.0
            ,230.0,230.0,75.0,100.0
C
```

CASE 5

EQUATORIAL BASIN VARIABLE GRID IN MERIDIONAL DIRECTION, ONE DEGREE IN THE ZONAL

LONGITUDE 129.5W

TEMPERATURE LEVEL 12.5M



CONTOUR INTERVAL = 1.00 FIELD MINIMUM = 16.4
SCALE FACTOR = 1.00 FIELD MAXIMUM = 25.0

OGCM1 TWO YEAR INTEGRATION

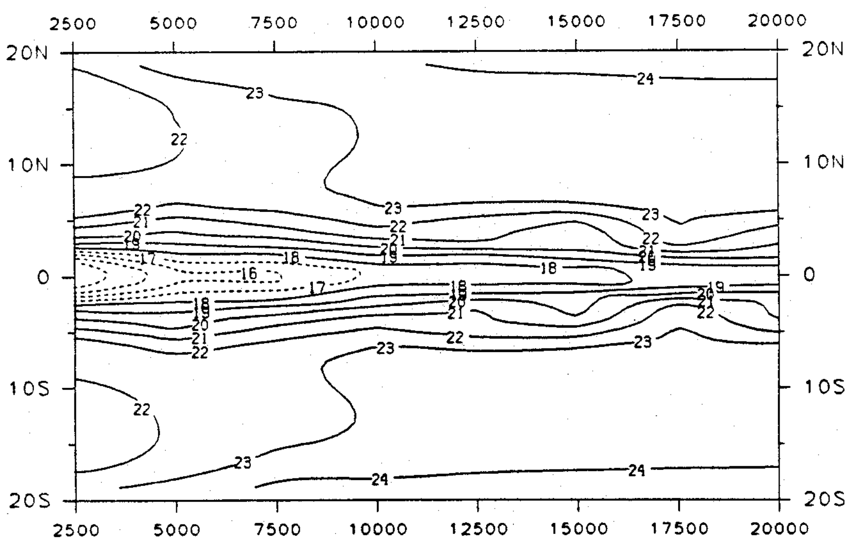
87.03.18
14.07.36

CASE 5

EQUATORIAL BASIN VARIABLE GRID IN MERIDIONAL DIRECTION, ONE DEGREE IN THE ZONAL

LONGITUDE 129.5W

TEMPERATURE LEVEL 87.5M



CONTOUR INTERVAL = 1.00 FIELD MINIMUM = 13.2
SCALE FACTOR = 1.00 FIELD MAXIMUM = 24.3

OGCM1 TWO YEAR INTEGRATION

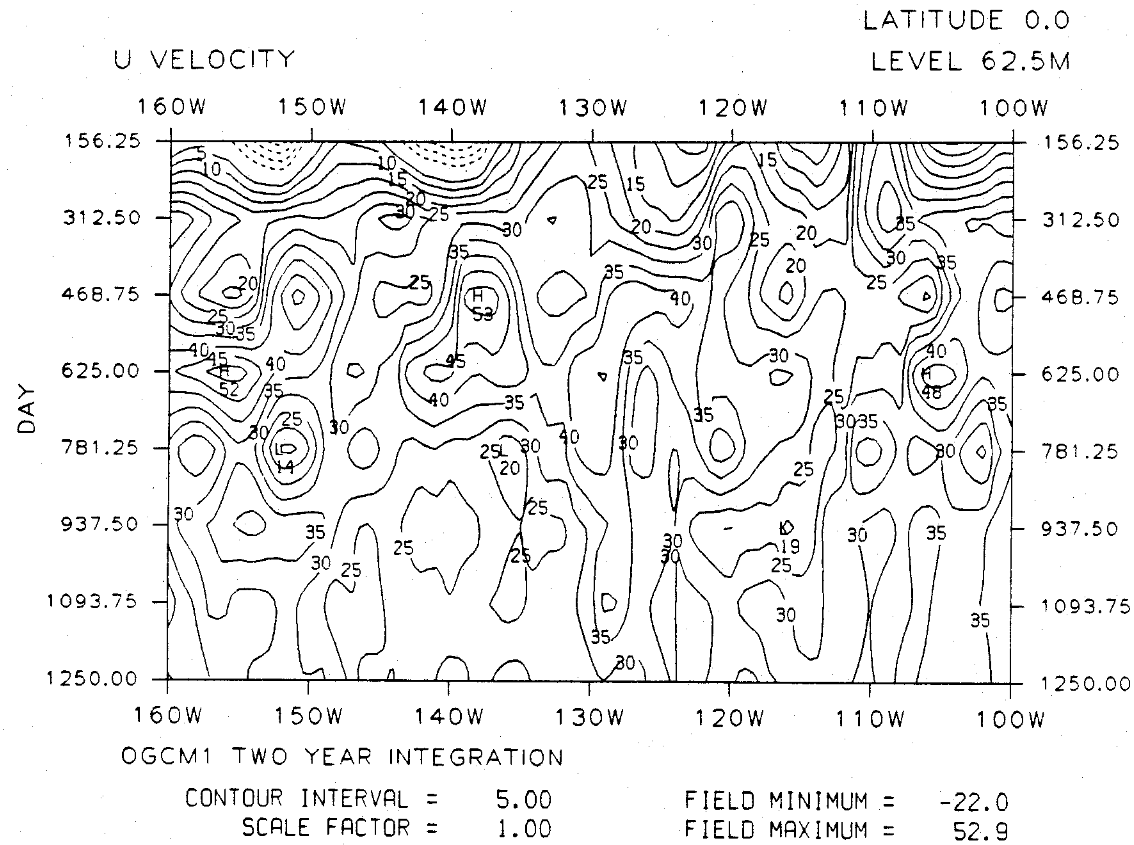
87.03.18
14.07.36

Example 6. Longitude-Time (xt) Cross-Section.

```
C
C    General Processing
C
   TAPES=' /CHERVIN/UGIH05'
        ,' /CHERVIN/UGIH15'
   VARS='U'
   DAYS=156.25,1250.0,156.25
   TYPE='OGCM1'
   TIMAVG='NO'
   TITLE='OGCM1 TWO YEAR INTEGRATION'
C
C    Meridional Cross-Sections
C
   XTPLOT='YES'
   XTZERO='NO'
   XTCINT= 'U',5.0
   XTAREA=200.0,260.0
   XTRNGS=0.0,0.0,62.5,62.5
C
```

CASE 5

EQUATORIAL BASIN VARIABLE GRID IN MERIDIONAL DIRECTION, ONE DEGREE IN THE ZONAL



87.03.18
14.45.19

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