NASA CR-132870

Preliminary Draft, 10 July 1973

APPENDIX A

NGR-05-007-328

NUMERICAL SIMULATION OF THE WORLD OCEAN CIRCULATION

by

Kenzo Takano*, Yale Mintz and Young June Han

University of California, Los Angeles

Abstract

A multi-level model, based on the primitive equations, is developed for simulating the temperature and velocity fields produced in the world ocean by differential heating and surface wind stress. The model ocean has constant depth, free slip at the lower boundary, and neglects momentum advection; so that there is no energy exchange between the barotropic and baroclinic components of the motion, although the former influences the latter through temperature advection.

The ocean model was designed to be coupled to the UCLA atmospheric general circulation model, for the study of the dynamics of climate and climate changes. But here, the model is tested by prescribing the observed seasonally varying surface wind stress and the incident solar radiation, the surface air temperature and humidity, cloudiness and the surface wind speed, which, together with the predicted ocean surface temperature, determine the surface flux of radiant energy, sensible heat and latent heat. From an initial state, in which the temperature as a function of depth and latitude is given, the integration is carried forward over several decades of simulated time, which is longer than the adjustment time scale for the upper levels of the model. In this test, the model successfully simulates most of the large scale features of the world ocean circulation, including a good simulation of the ocean surface temperature.

N74-12150

(NASA-CR-132870) NUMERICAL SIMULATION OF THE WORLD OCEAN CIRCULATION (California Univ.) 58 p HC $5.00 CSCL 08C

89

Unclas G3/13 15438

---

* Permanent affiliation: Institute of Physical and Chemical Research, Wako-shi, Saitama-ken, Japan.

Introduction

Governing equations

With momentum advection neglected, and with the Boussinesq approximation for the density and incompressibility, the governing equations are

$$\frac{\partial \mathbb{V}}{\partial t} = -\frac{1}{\rho_o}\nabla p - 2\Omega\times\mathbb{V} + \mathbb{F} \; , \qquad (1)$$

$$\frac{\partial p}{\partial z} = -g\rho \; , \qquad (2)$$

$$\rho = \rho_o(1-\alpha\,|T-T_o|) \; , \qquad (3)$$

$$\frac{\partial T}{\partial t} + \nabla\cdot(T\mathbb{V}) + \frac{\partial}{\partial z}(Tw) = \frac{Q}{C} \; , \qquad (4)$$

and

$$\nabla\cdot\mathbb{V} + \frac{\partial w}{\partial z} = 0 \; , \qquad (5)$$

PRECEDING PAGE BLANK NOT FILMED

where $\mathbb{V}$ is horizontal velocity, w is vertical velocity, p is pressure, ρ is density and ρ_o is a constant, T is temperature and T_o is a constant, Ω is the earth's rotation vector, g is the acceleration of gravity, α is the coefficient of thermal expansion, and c is the specific heat of sea water. z is the positive upward vertical coordinate and t is time. $\mathbb{F}$ is the horizontal frictional force per unit mass and Q is the rate of heating per unit mass, which are taken as

$$\mathbb{F} = A_M \nabla^2 \mathbb{V} + K \frac{\partial^2 \mathbb{V}}{\partial z^2} \quad , \tag{6}$$

and

$$Q = c A_H \nabla^2 T + \frac{cK}{\delta} \frac{\partial^2 T}{\partial z^2} \quad , \tag{7}$$

where A_M is the coefficient of horizontal eddy viscosity, A_H is the coefficient of horizontal eddy heat diffusion, and K is the coefficient of both the vertical eddy viscosity and the vertical eddy heat diffusion. The coefficient δ (in 7) is defined as

$$\delta \begin{cases} = 1 \\ = 0 \end{cases} \quad \text{when} \quad \frac{\partial T}{\partial z} \begin{cases} \geq 0 \\ < 0 \end{cases} ,$$

as a parameterization of strong vertical mixing that restores a neutral stratification whenever a vertically unstable stratification developes.

The boundary conditions at the ocean bottom (z = H) are

$$w = 0 \quad , \tag{8}$$

$$\frac{\partial \mathbb{V}}{\partial z} = 0 \quad , \tag{9}$$

and

$$\frac{\partial T}{\partial z} = 0 \quad , \tag{10}$$

so that there is no vertical motion, no momentum transfer and no heat transfer across the lower boundary.

The boundary conditions at the ocean surface (z = 0) are

$$w = 0 , \tag{11}$$

$$\frac{\partial \mathbf{V}}{\partial z} = \frac{\mathcal{T}_s}{\rho_o K} , \tag{12}$$

and

$$\frac{\partial T}{\partial z} = \frac{Q_s}{c K \rho} , \tag{13}$$

where $\mathcal{T}_s$ is the vector wind stress and Q_s is the downward heat flux at the ocean surface. Setting w = 0 at the ocean surface filters out external gravity waves and allows the use of a long computational time step.

The boundary conditions at the lateral walls are zero normal velocity and zero tangential velocity, and zero heat transfer through the walls.

Calculational procedure

The assumption of no momentum advection, constant depth, and free slip at the lower boundary, decouples the barotropic component of the velocity (the vertical mean of the horizontal velocity) from the baroclinic component of the velocity (the deviation of the horizontal velocity from its vertical mean). The former is governed entirely by the wind stress curl and is independent of the heating, while the latter is governed by both the stress and the heating. There is no energy exchange between the two components, although the barotropic component affects the baroclinic component through the horizontal temperature advection (Eq. 4).

The barotropic component of the velocity is obtained by taking the curl of the vertical integral of Eq. 1, or

$$\frac{\partial \mathbb{M}}{\partial t} = -\frac{1}{\rho_o}\nabla \mathbb{P} - 2\Omega \times \mathbb{M} + \frac{\mathcal{T}_s}{\rho_o} + A_M \nabla^2 \mathbb{M} \,, \tag{14}$$

where

$$\mathbb{M} = \int_{-H}^{0} \mathbb{V}\, dz \qquad \text{and} \qquad \mathbb{P} = \int_{-H}^{0} p\, dz \,,$$

and

$$\frac{\partial}{\partial t}\nabla^2 \Phi = -f\,\frac{\partial \Phi}{a\partial \lambda} + \frac{1}{\rho_o}\,\mathbb{k}\cdot\nabla \times \mathcal{T}_s + A_M \nabla^4 \Phi \,, \tag{15}$$

where $\mathbb{k} \times \nabla \Phi = \mathbb{M}$ defines the stream function Φ of the vertically integrated velocity $\mathbb{M}$, $f = 2\,\Omega \sin\varphi$ is the coriolis parameter, λ is longitude and φ is latitude, $\mathbb{k}$ is unit vertical vector, and a is the Earth's radius. This vorticity equation, for the barotropic component of the velocity, is solved as an initial-value boundary-value problem in the way which is described below.

The baroclinic component of the velocity is obtained by substituting for $\mathbb{V} = \overline{\mathbb{V}} + \mathbb{V}'$ and $\nabla p = \overline{\nabla p} + (\nabla p)'$ in Eq. 1, where the bar denotes the vertical mean from $z = -H$ to $z = 0$, and the prime denotes the deviation from the vertical mean. Then, subtracting the vertical mean of Eq. 1, we obtain

$$\frac{\partial \mathbb{V}'}{\partial t} = -\frac{1}{\rho_o}(\nabla p)' - 2\Omega \times \mathbb{V}' + A_M \nabla^2 \mathbb{V}' + \left(K\,\frac{\partial^2 \mathbb{V}'}{\partial z^2} - \frac{\mathcal{T}_s}{\rho_o H}\right) , \tag{16}$$

which is the prediction equation for the baroclinic component of the velocity, The temperature is obtained from Eq. 4.

$(\nabla p)'$ is found by taking the horizontal gradient of Eq. 2, $\partial(\nabla p)/\partial z = -g\nabla\rho$, integrating over the entire depth of the ocean from an arbitrary value of ∇p at $z = -H$, and subtracting the vertical mean, $\overline{\nabla p}$. This insures that the vertical mean of $(\nabla p)'$ is identically zero.

The vertical velocity w is calculated by Eq. 5.

Grid structure, domain, and finite difference scheme

The finite difference calculations are made using spherical coordinates and the same grid structure that was used by Haney (1971a). As shown in Figure 1, the T, p, Φ, and w points are located at the coast lines. The $\overline{\mathbb{V}}$ and $\mathbb{V}'$ points match the distribution of the horizontal velocity points of the UCLA atmospheric general circulation model, and therefore include points on the equator. In the atmospheric model the horizontal grid size is 4° in latitude and 5° in longitude; but in the ocean model the zonal grid size is reduced to 2.5° in longitude to obtain a somewhat better resolution of the western boundary currents.

The model ocean is divided into five layers, which lie between 0, 70, 380, 960, 2020 and 4000 m in depth, and the horizontal velocities and temperatures are predicted for each layer. To calculate the vertical eddy diffusions of momentum and heat, these velocities and temperatures are attributed to the 20, 120, 640, 1280 and 2760 m depths. The vertical velocities are calculated at the interfaces of the five layers.

The horizontal domain extends from 66°S to 74°N, which excludes the Arctic Ocean. The northern boundary follows the edge of the continental shelf of the composite landmass of North and South America, Europe, Africa and Asia.

The southern boundary approximately follows the edge of the continental shelf of Antarctica. New Zealand, and Australia combined with New Guinea, are retained as islands.

The finite differencing scheme is the same as the one used by Haney (1971a), except that his nine point specification of the vorticity of the barotropic velocity component, which was almost the same as a 45° rotated five point scheme, is here replaced by the usual nearest five point scheme. This prevents a computationally false two grid point noise from being produced by the irregular lateral boundaries and irregular wind stress.

The time integration is carried forward by the leap-frog scheme, with the Euler-backward scheme applied every five time steps.

Prescribed parameters

The prescribed constant parameters are given in Table 1.

Table 1. Prescribed Constants

$g = 980\ cm/sec^2$	$T_o = 0^{\circ}C$
$\Omega = 7.29 \times 10^{-5} sec^{-1}$	$H = 4 \times 10^5 cm$
$R = 6.37 \times 10^8 cm$	$A_M = 10^9 cm^2/sec$
$c = 0.93\ cal/cm/degr$	$A_H = 2.5 \times 10^7 cm^2/sec$
$\alpha = 2.5 \times 10^{-4} degr^{-1}$	$K = 1\ cm^2/sec$
$\rho_o = 1 gm/cm^3$	$\Delta t = 40$ min, 8 hours

40 minutes is the time step for the integration of the vorticity equation for the barotropic velocity component, and 8 hours is the time step for the integration of the primitive equations for the baroclinic velocity component.

When the oceanic model will be coupled to the atmospheric general circulation model, the surface wind stress will be determined by the atmospheric model. But, here, for the purpose of testing the oceanic model, the surface wind stress is taken as the observed seasonally varying stress given by Hellerman (1967, 1968). Hellerman's values of the mean wind stress for the four seasons of the year (Dec-Jan-Feb; Mar-Apr-May; June-July-Aug; Sept-Oct-Nov) are subjectively interpolated and extrapolated to cover the domain of the oceanic model. A 1-2-1 zonal filter is used to remove some of the two grid interval noise in Hellerman's tabulations. Then, at each grid point, the four seasonal values of τ_s are used to calculate the annual mean and the amplitude and phase of the first annual harmonic of the stress; and from these parameters the surface wind stress is prescribed as a time varying function of the model year.

Q_s, the net downward heat flux at the oc ean surface, has four components,

$$Q_s = Q_I - (Q_B + Q_F + Q_L) \,, \tag{17}$$

where Q_I is the net downward flux of solar radiation, Q_B is the net upward flux of infrared radiation, Q_F is the net upward flux of sensible heat, and Q_L is the net upward flux of latent heat.

When the oceanic model will be coupled to the atmospheric general circulation model, the net fluxes of solar and infrared radiation at the ocean surface will depend on the atmospheric state parameters in the fairly complex way given by Katayama (1973). In the present test of the ocean model, however, we use the relatively simple formulations, given by Angstrom (1922) for the solar radiation flux,

$$Q_I = Q_{I_o} (1 - 0.7 \tfrac{C}{8})(1 - A_s) \,, \tag{18}$$

and by Brunt (1952) for the infrared radiation flux,

$$Q_B = \sigma T_s^4 \times 0.985\ [0.39 - 0.05\ e^{\frac{1}{2}}] \times [1 - 0.6\ (C/8)^2] \tag{19}$$

Where Q_{I_o} is the direct plus indirect solar radiation reaching the ground through a cloudless atmosphere, C is the number of octants of the sky covered by clouds, A_s is the albedo of the ocean surface, σ is the Stefan-Boltzman constant; and e is the vapor pressure of the air (in mb) at 10 m above the ocean surface.

The annual mean and the amplitude and phase of the first annual harmonic of Q_{I_o} are obtained from the Smithsonian Meteorological Tables (1966, tables 133 and 136), with an atmospheric transmission coefficient of 0.7. The albedo of the ocean surface is taken as 0.07.

The annual mean and the amplitude and phase of the first annual harmonic of the number of octants of the sky covered by clouds, C, are calculated from the charts in the cloud atlas of Miller (1971).

The annual mean and the amplitude and phase of the first annual harmonic of the atmospheric vapor pressure, e, are calculated from tabulations of the surface air dewpoint temperature in the atlases of Taljaard et. al. (1969) and Crutcher and Meserve (1970).

These time varying parameters are used, in Eqs. 18 and 19, to prescribe the net flux of solar radiation and to calculate the net flux of infrared radiation at the ocean surface.

For the sensible and latent heat fluxes, the formulations for the test calculations are nearly the same as those that will be used with the combined atmospheric and oceanic models,

$$Q_F = \rho_A C_D C_p |\mathbb{V}_A| (T_s - T_A)\ , \tag{20}$$

and

$$Q_L = \rho_A C_D L\ |\mathbb{V}_A| (q_s^* - q_A)\ , \tag{21}$$

where ρ_A is the surface air density, $C_D(= 1.23 \times 10^{-3})$ is the surface drag coefficient, C_p is the specific heat of air, $|\mathbb{V}_A|$ is the surface air speed, L is the latent heat of evaporization, q_s^* is the saturation water vapor mixing ratio at the ocean surface temperature, and q_A is the water vapor mixing ratio of the surface air.

The annual means and the phases and amplitudes of the first annual harmonics of T_A and q_A are calculated from tabulations of the surface air temperature and the surface air dewpoint temperature in the atlases of Taljaard et. al. (1969) and Crutcher and Meserve (1970). The annual mean and the phase and amplitude of the first annual harmonic of the surface (scalar) wind speed are calculated from data in the atlas of MacDonald (1934, charts 27 through 30).

The simulated barotropic circulation

The simulated baroclinic circulation

The simulated surface heat flux

Summary and conclusions

Acknowledgments

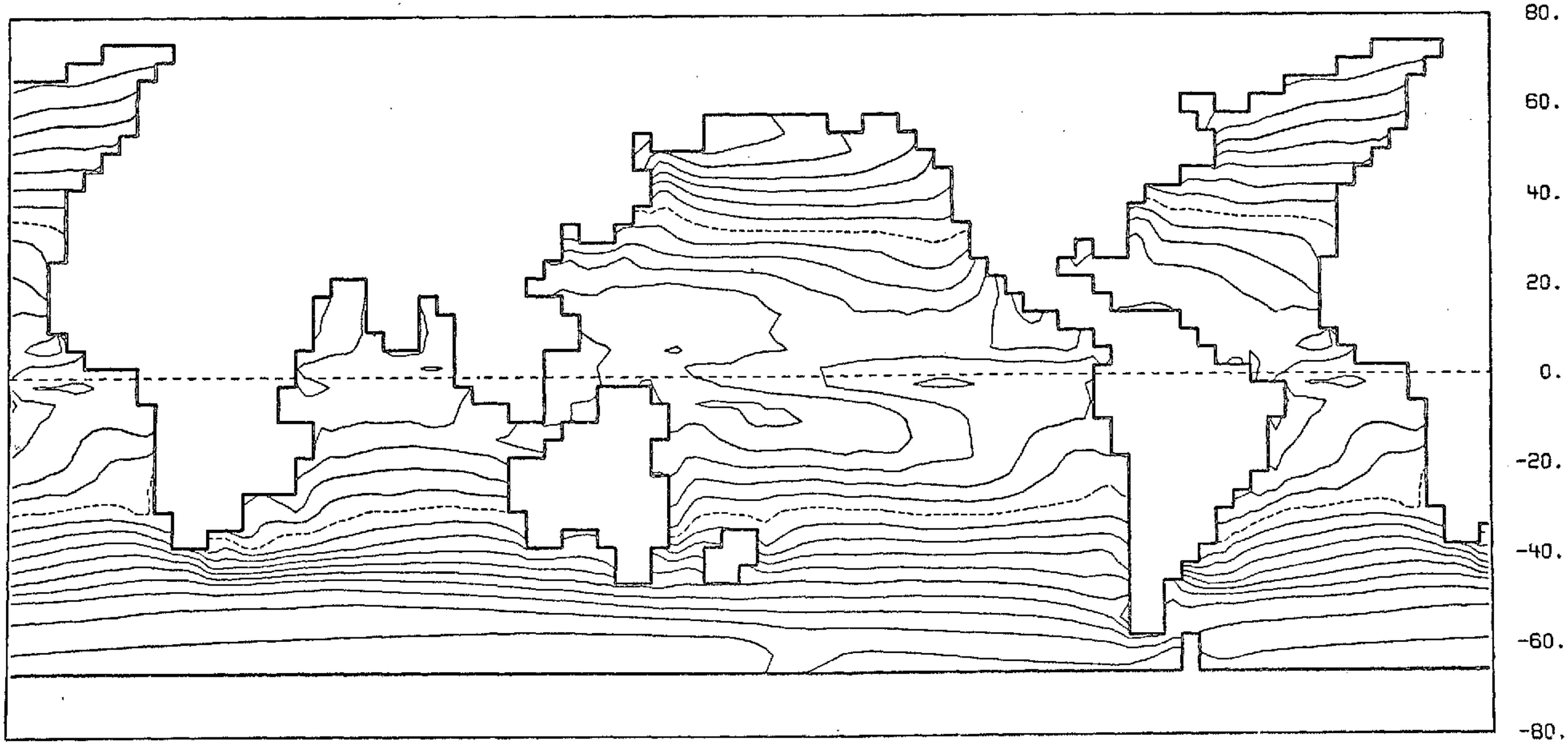
References

EXPERIMENT S1

DAY = 8773.7

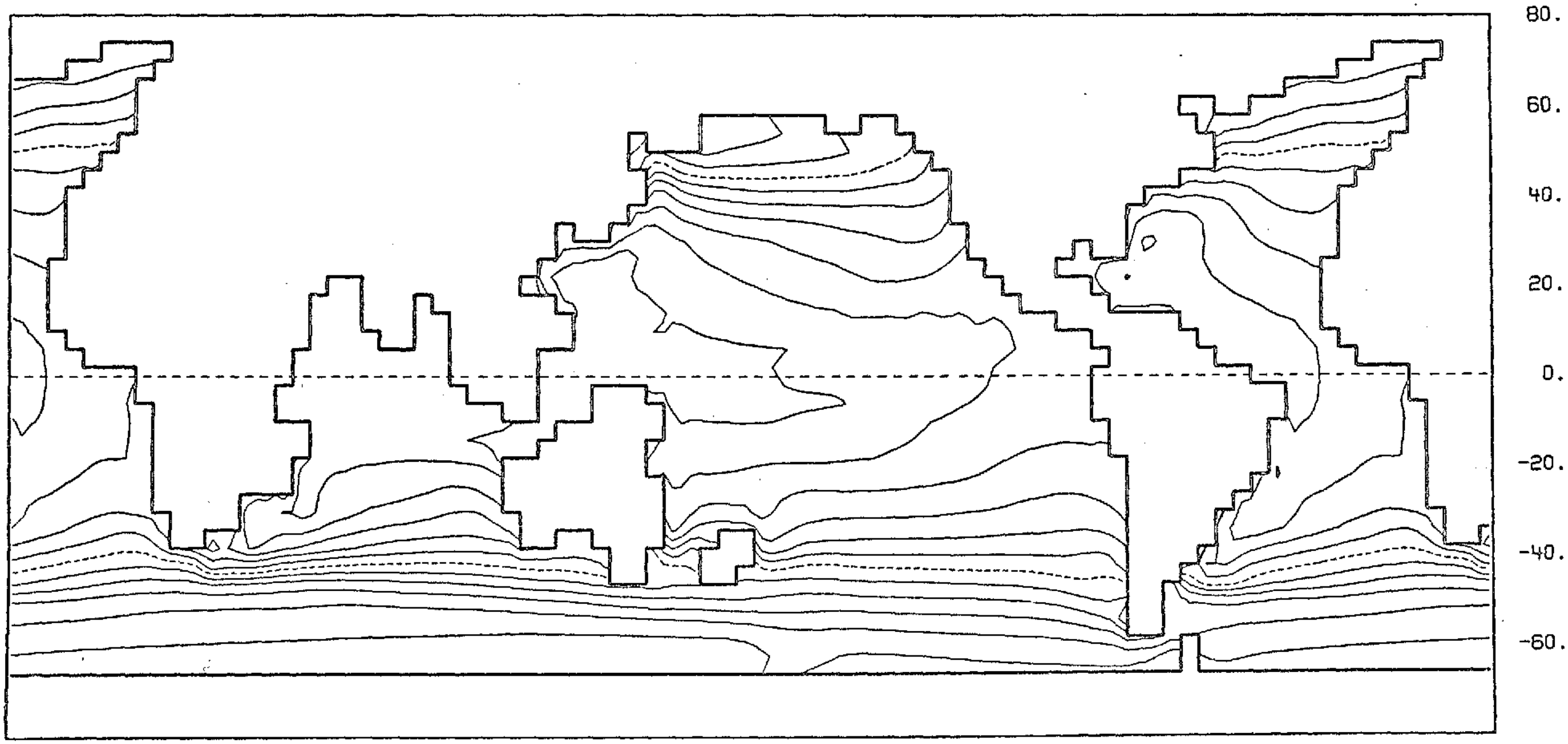
TEMPERATURE AT LEVEL 1 (DEG CENT)

CONTOUR INTERVAL = 2.0 (SOLID LINES) DASHED LINE = 20.0



EXPERIMENT S1 TEMPERATURE AT LEVEL 2 (DEG CENT)

DAY = 8773.7 CONTOUR INTERVAL = 2.0 DASHED LINE = 12.0



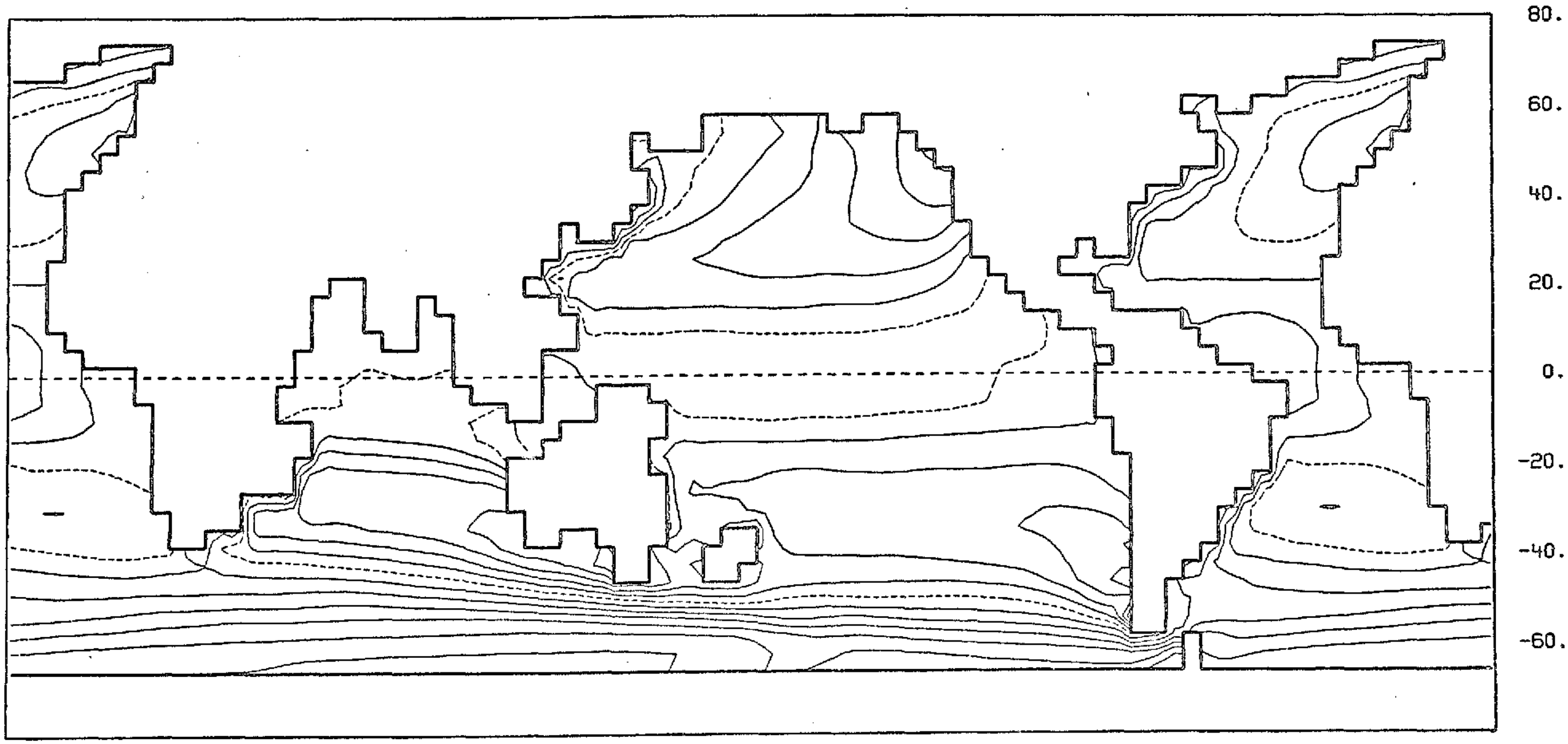
EXPERIMENT S1

DAY = 8773.7

TEMPERATURE AT LEVEL 3 (DEG CENT)

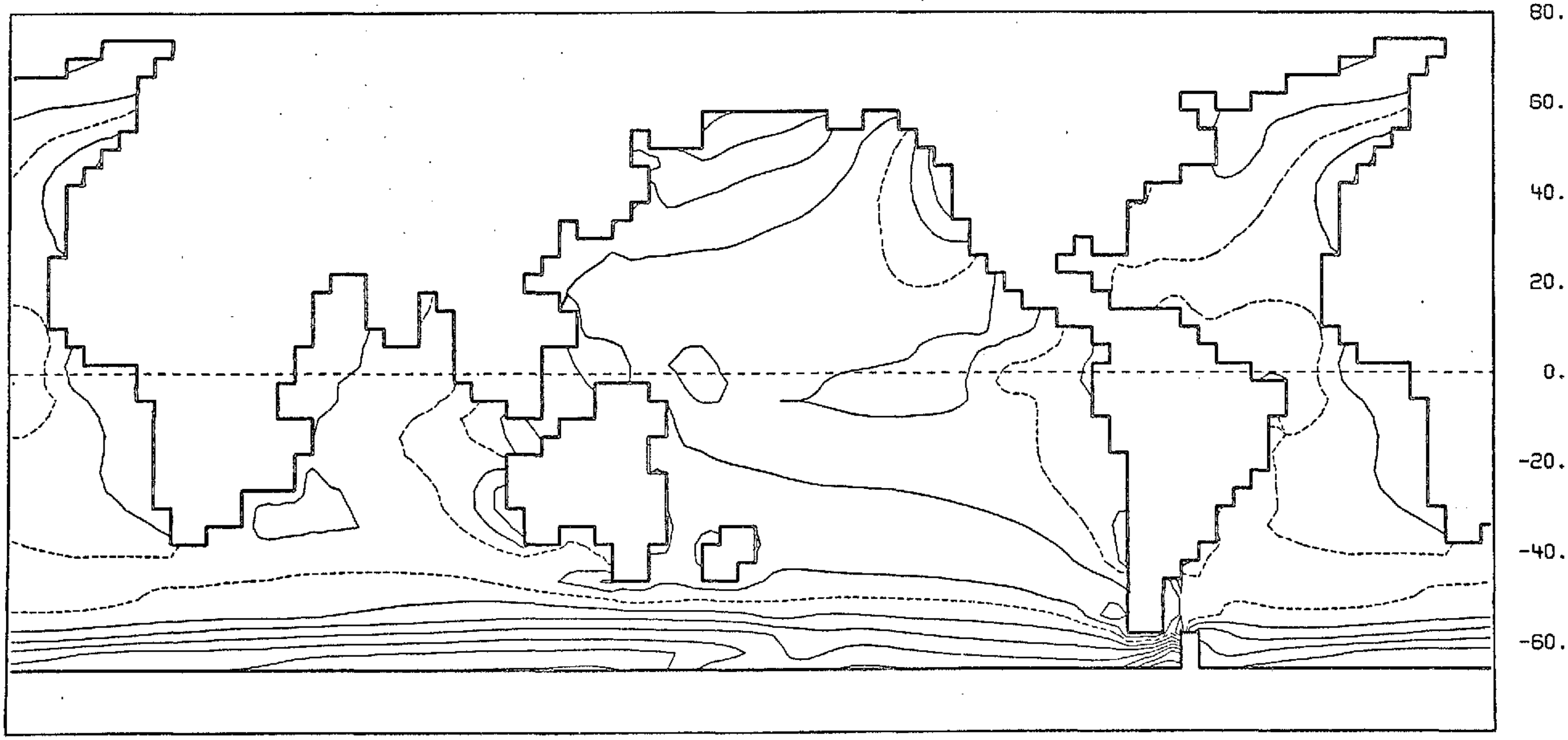
CONTOUR INTERVAL = 1.0

DASHED LINE = 7.0



EXPERIMENT S1 TEMPERATURE AT LEVEL 4 (DEG CENT)

DAY = 8773.7 CONTOUR INTERVAL = 0.5 (SOLID LINES) DASHED LINE = 3.5



5

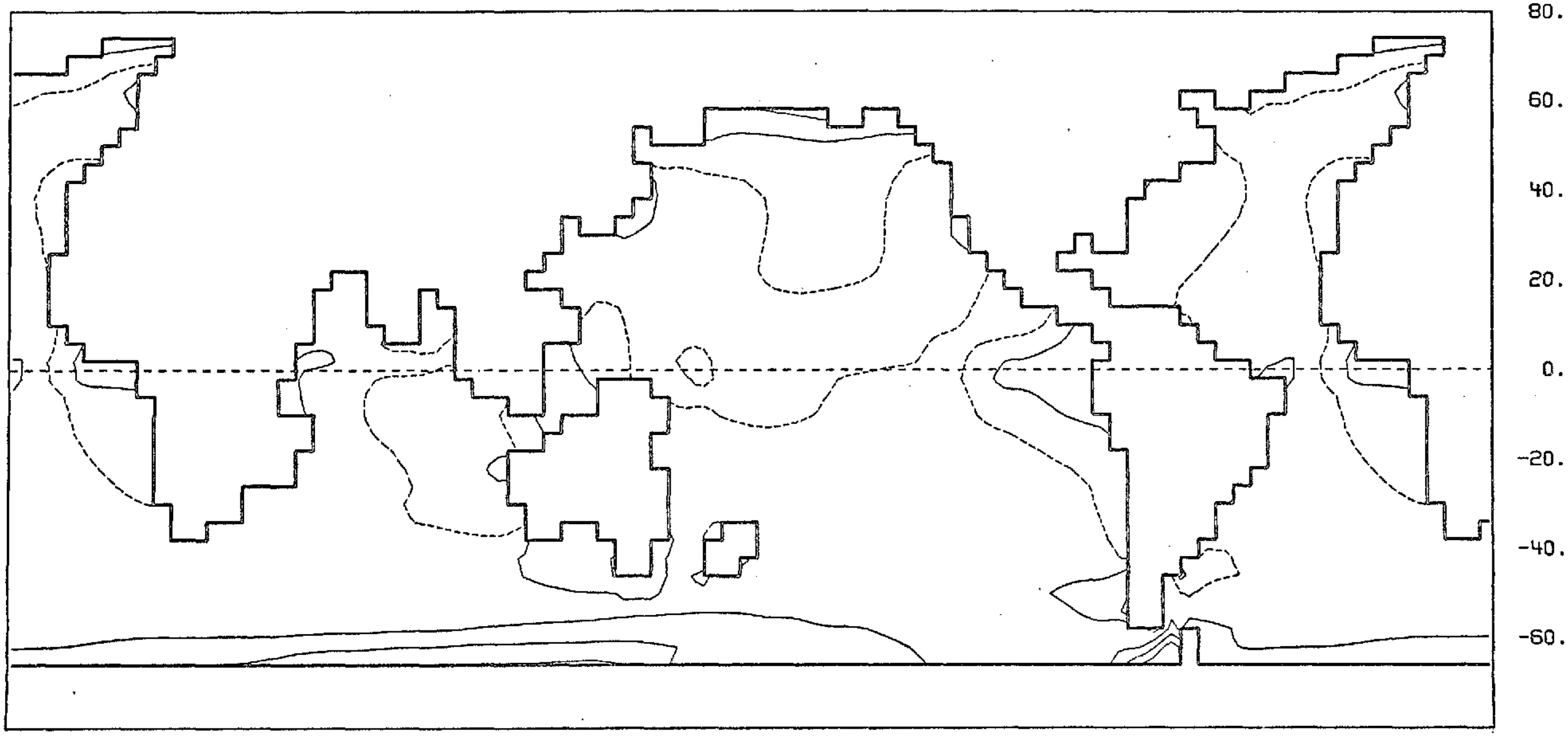
EXPERIMENT S1

DAY = 8773.7

TEMPERATURE AT LEVEL 5 (DEG CENT)

CONTOUR INTERVAL = 0.5 (SOLID LINES)

DASHED LINE = 2.0

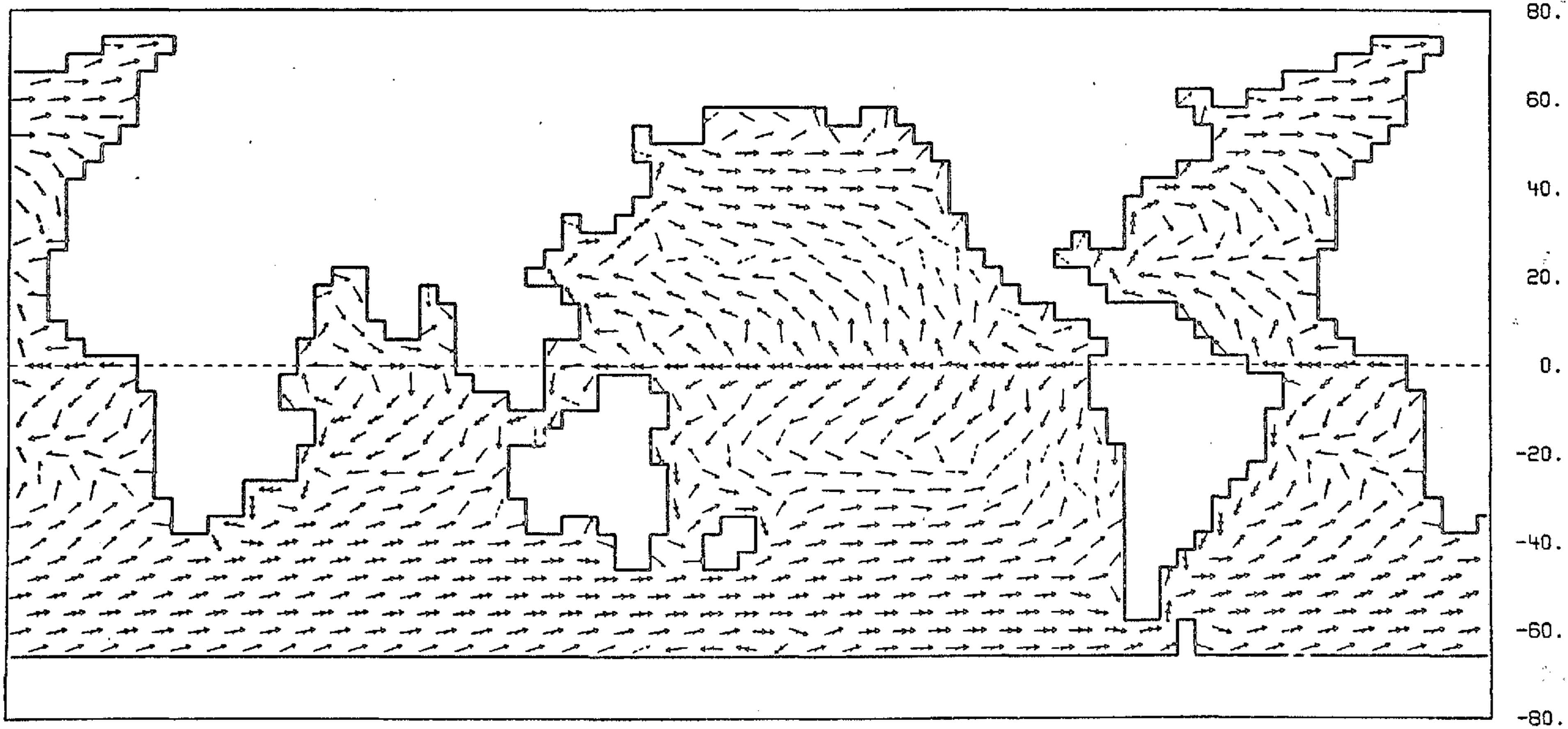


16

6

EXPERIMENT S1 HORIZONTAL VELOCITY AT LEVEL 1 (CM/SEC)

DAY = 8773.7 0.0 0.6 1.2 2.5 4.9 9.8 19.6 39.2 78.4



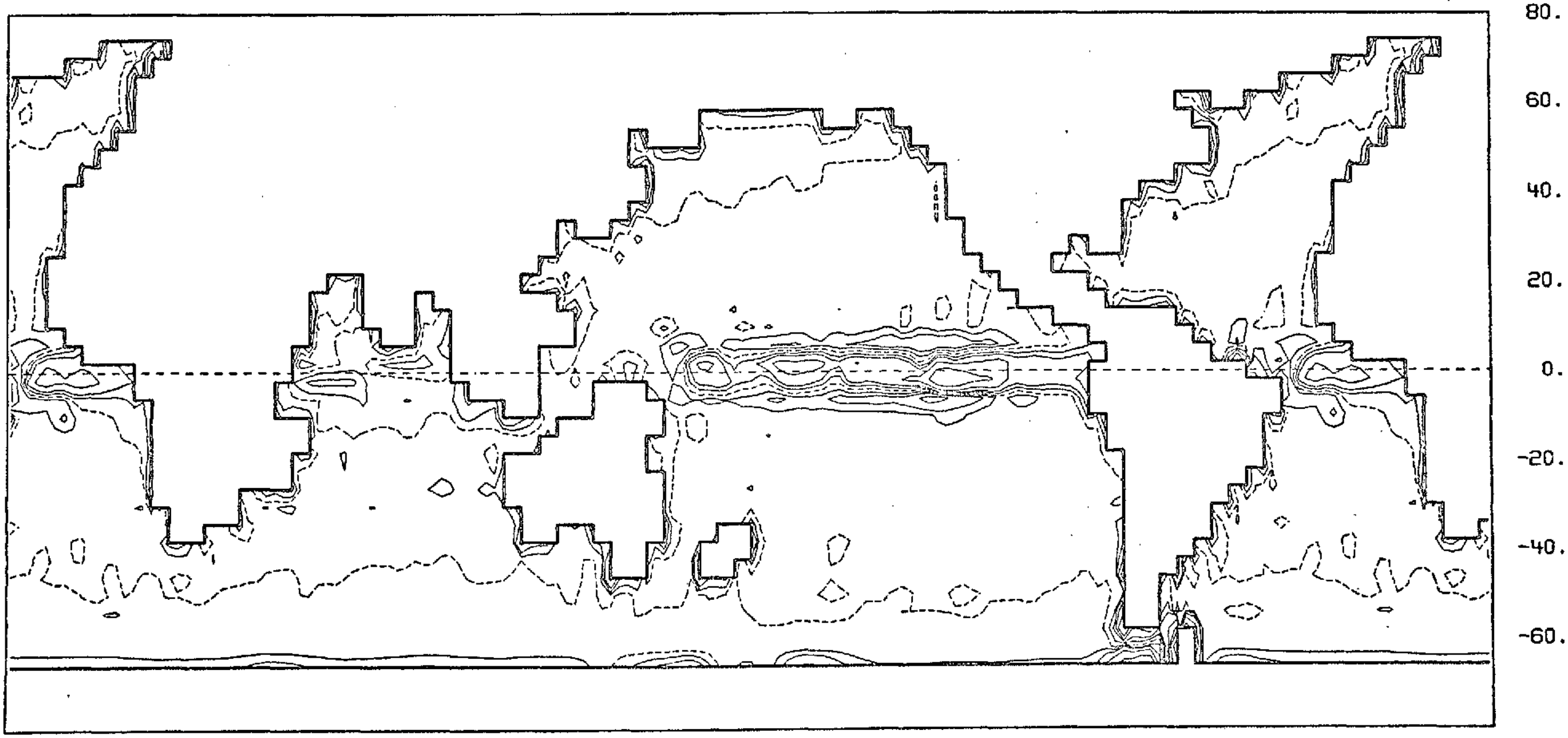
EXPERIMENT S1

DAY = 8773.7

VERTICAL VELOCITY AT LEVEL 1.5 (CM/DAY)

CONTOUR LINES 0, 25, 50, 100, 200, 400, 800

DASHED LINE = 0.0

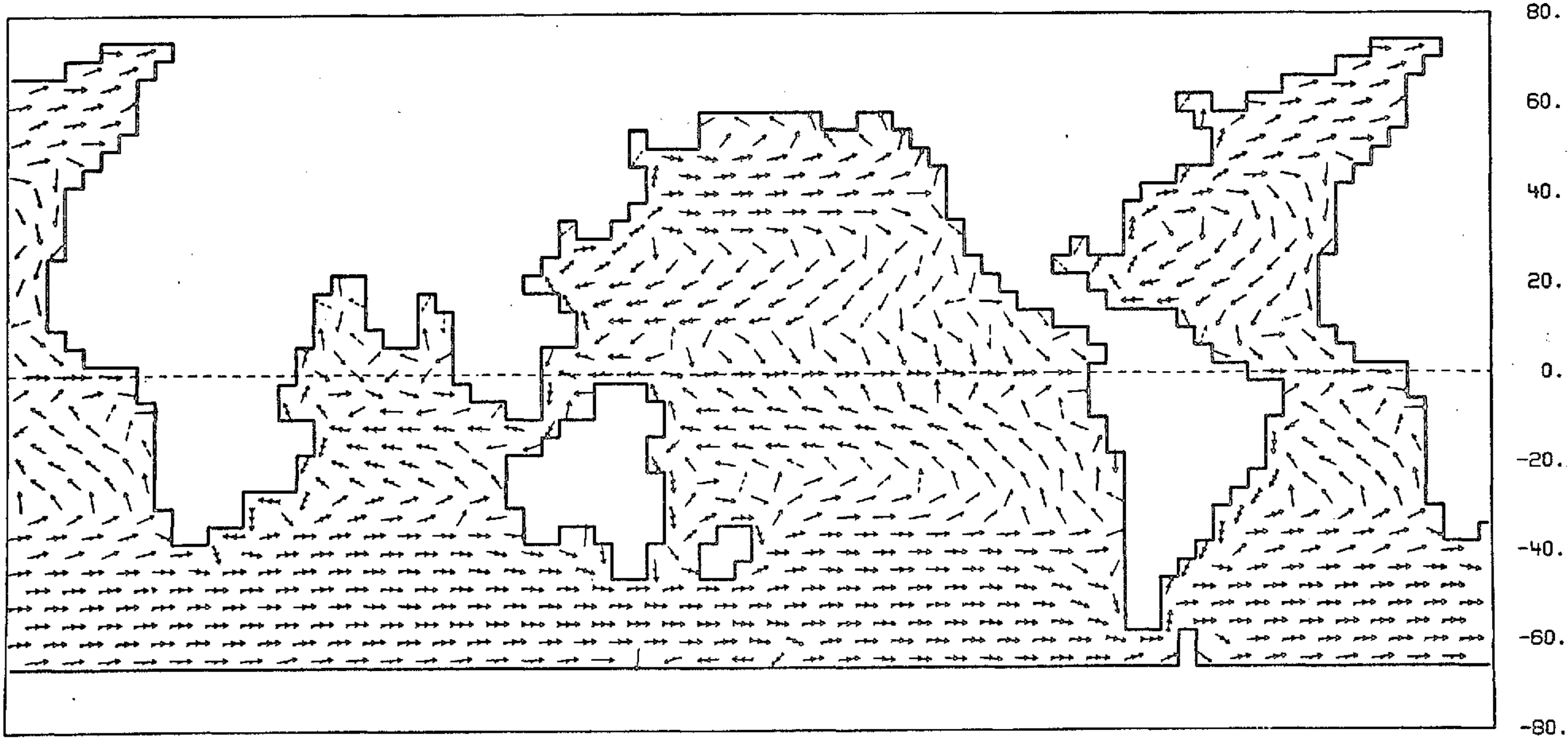


EXPERIMENT S1

DAY = 8773.7

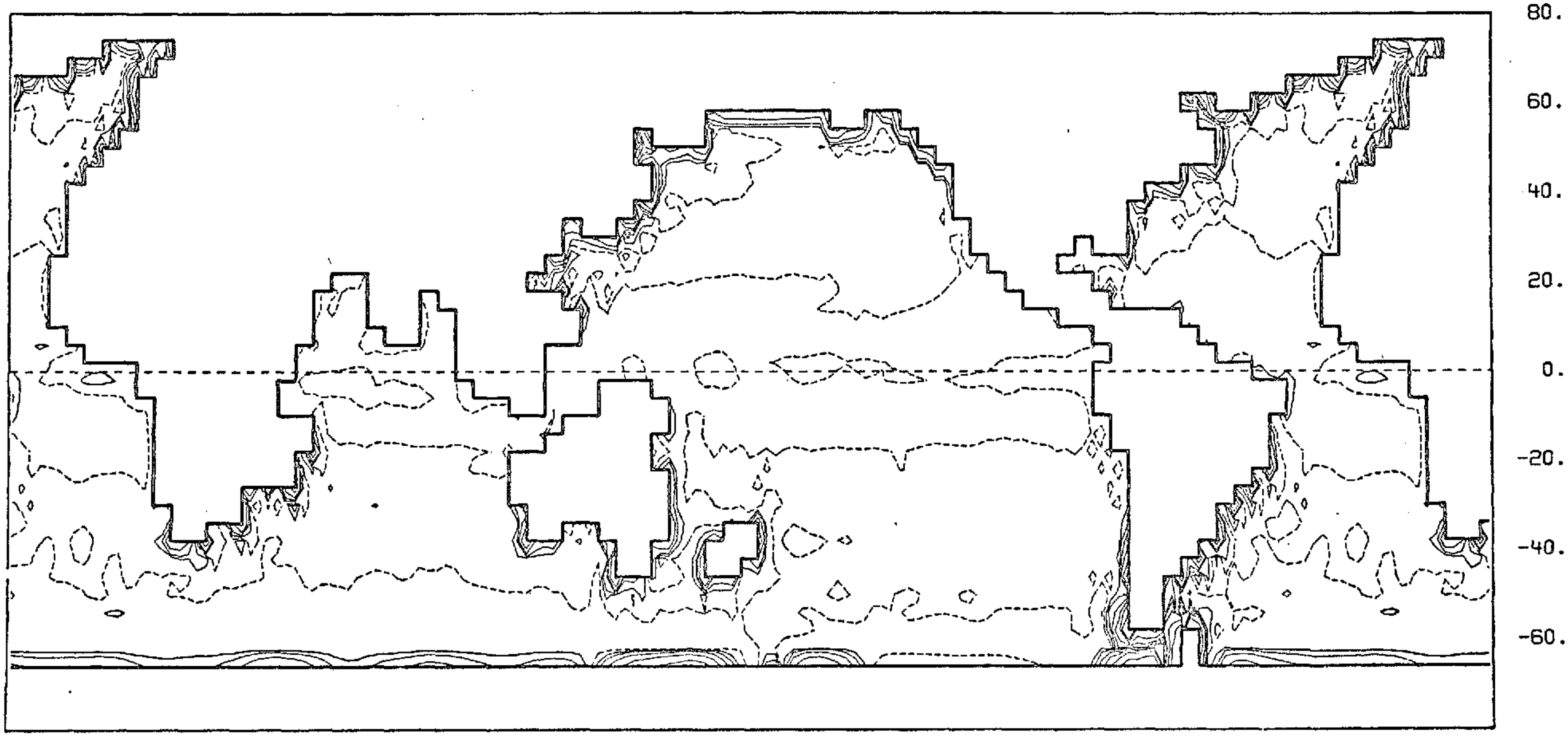
HORIZONTAL VELOCITY AT LEVEL 2 (CM/SEC)

0.0 → 0.2 → 0.5 → 1.0 → 2.0 → 3.9 → 7.9 → 15.8 → 31.6

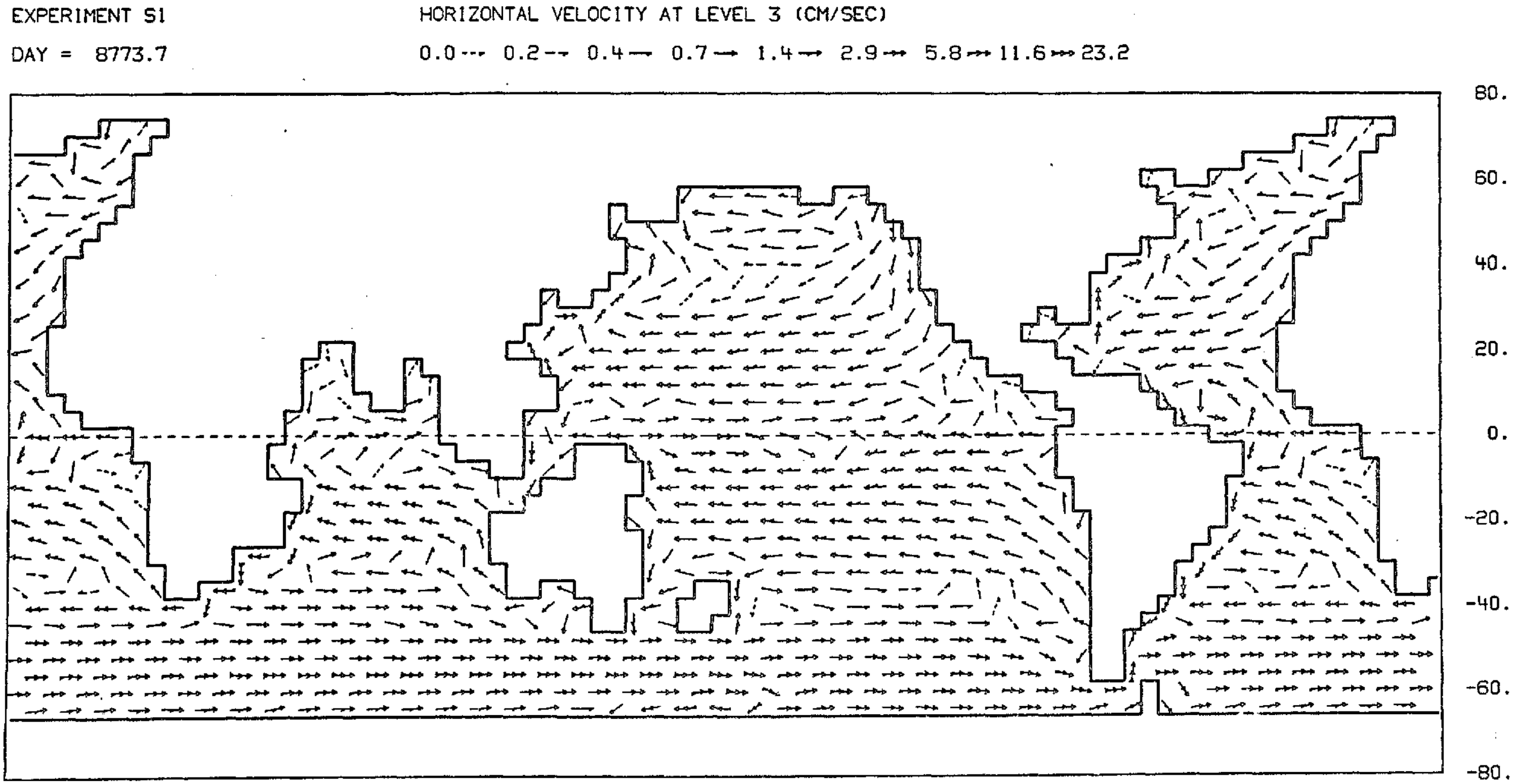


EXPERIMENT S1 VERTICAL VELOCITY AT LEVEL 2.5 (CM/DAY)

DAY = 8773.7 CONTOUR LINES 0, 25, 50, 100, 200, 400, 800 DASHED LINE = 0.0



10



EXPERIMENT S1
DAY = 8773.7
HORIZONTAL VELOCITY AT LEVEL 3 (CM/SEC)
0.0 0.2 0.4 0.7 1.4 2.9 5.8 11.6 23.2
80.
60.
40.
20.
0.
-20.
-40.
-60.
-80.

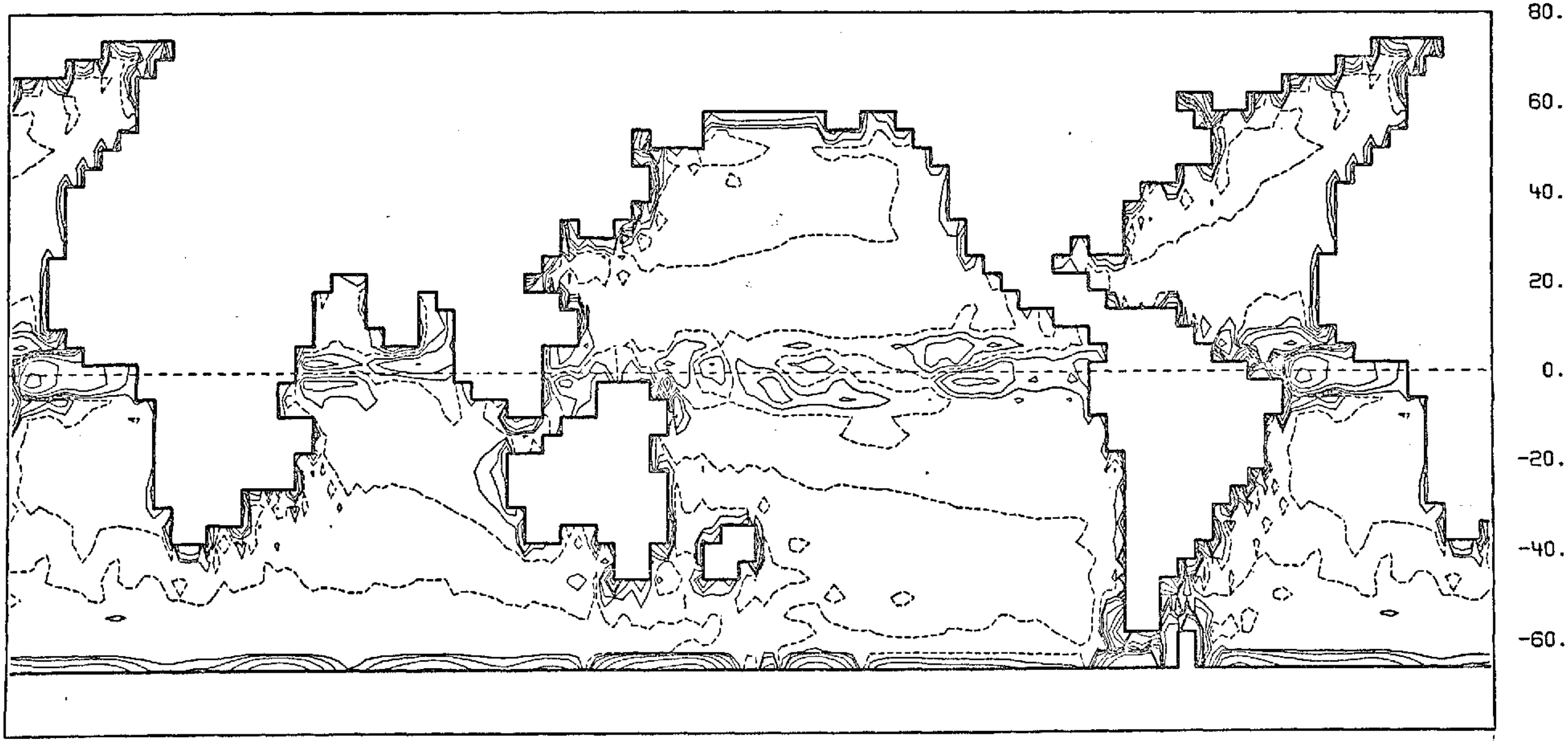
EXPERIMENT S1

DAY = 8773.7

VERTICAL VELOCITY AT LEVEL 3.5 (CM/DAY)

CONTOUR LINES 0, 25, 50, 100, 200, 400, 800

DASHED LINE = 0.0

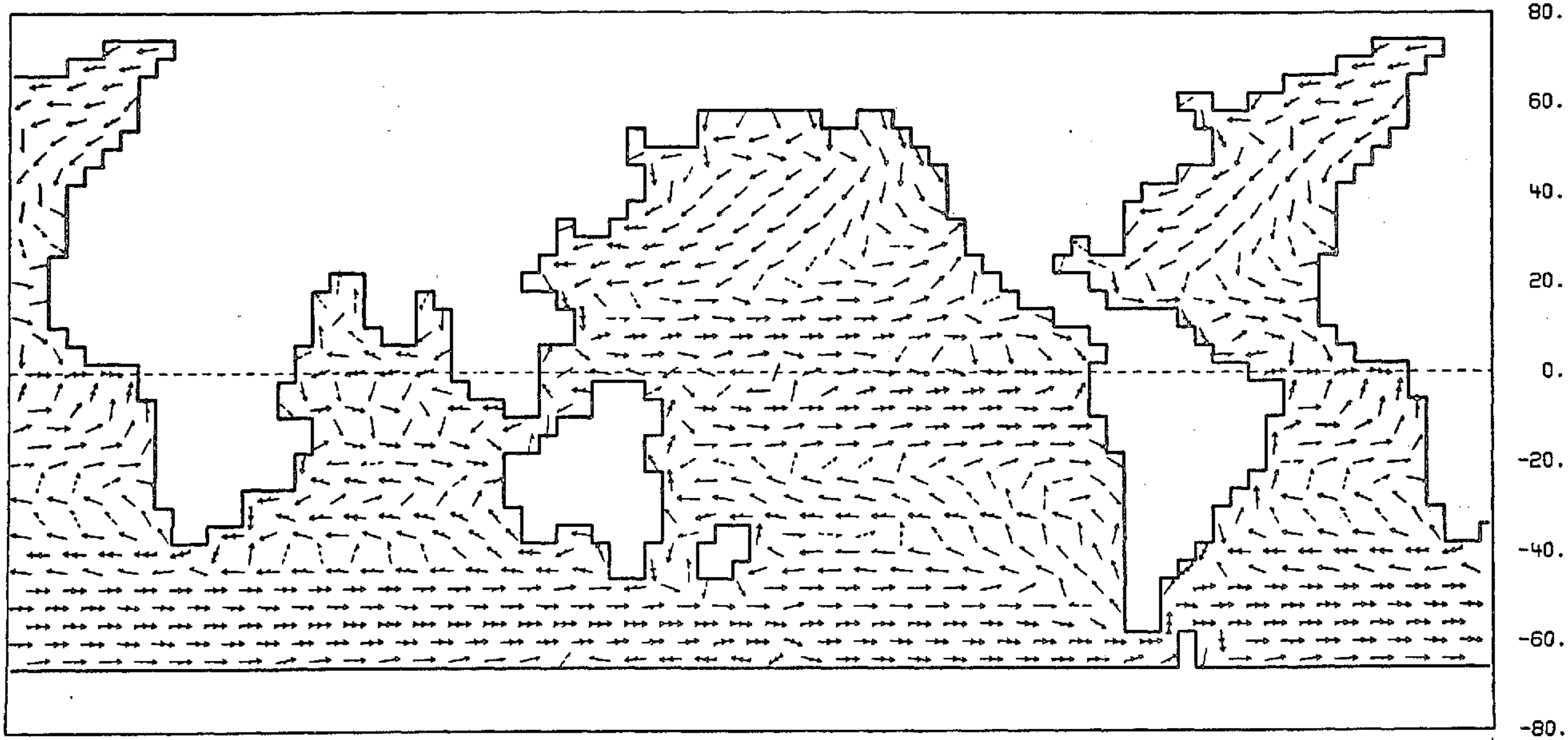


EXPERIMENT S1

DAY = 8773.7

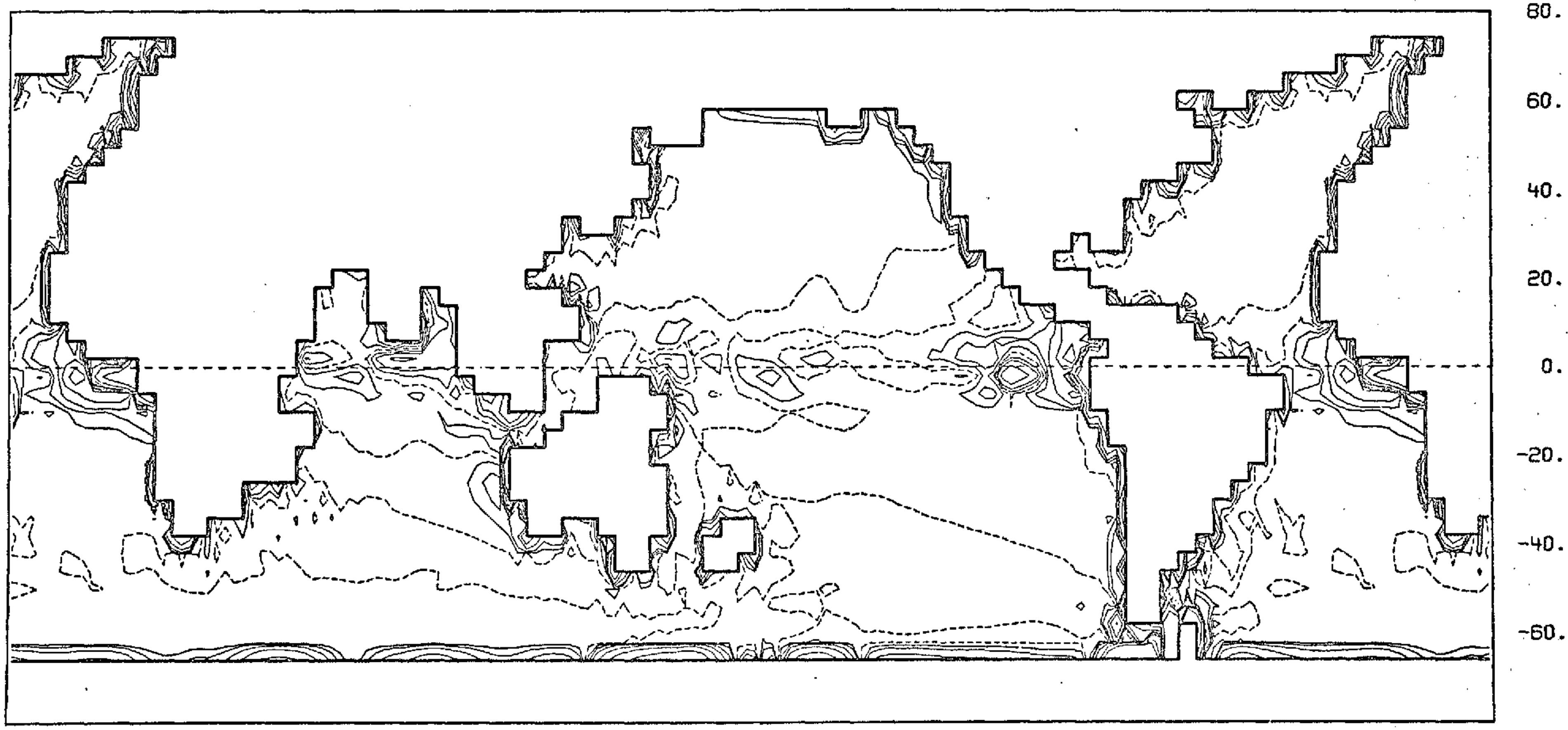
HORIZONTAL VELOCITY AT LEVEL 4 (CM/SEC)

0.0 0.1 0.3 0.6 1.2 2.4 4.8 9.5 19.1



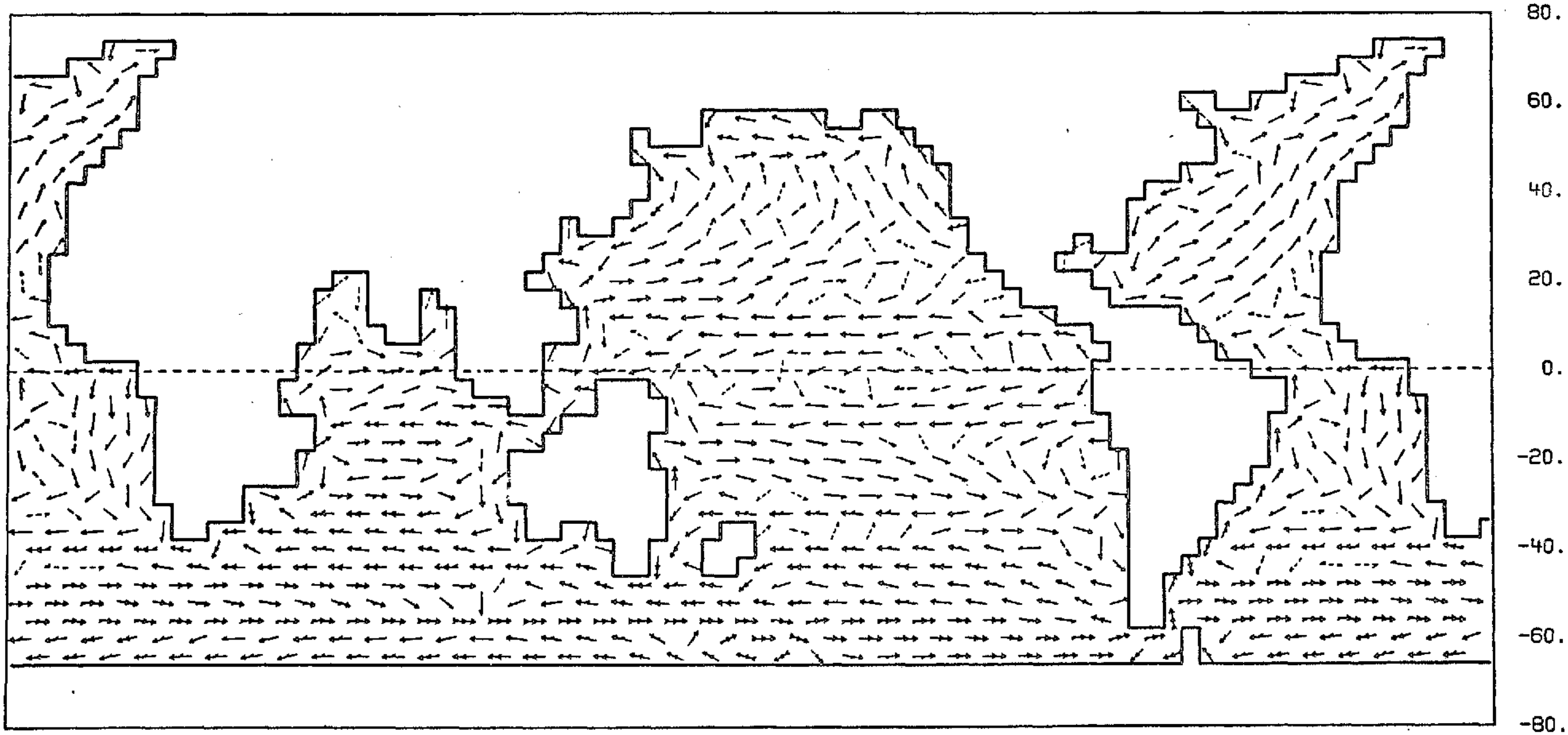
EXPERIMENT S1 VERTICAL VELOCITY AT LEVEL 4.5 (CM/DAY)

DAY = 8773.7 CONTOUR LINES 0, 25, 50, 100, 200, 400, 800 DASHED LINE = 0.0



EXPERIMENT S1 HORIZONTAL VELOCITY AT LEVEL 5 (CM/SEC)

DAY = 8773.7 0.0 0.1 0.2 0.4 0.8 1.6 3.3 6.6 13.1



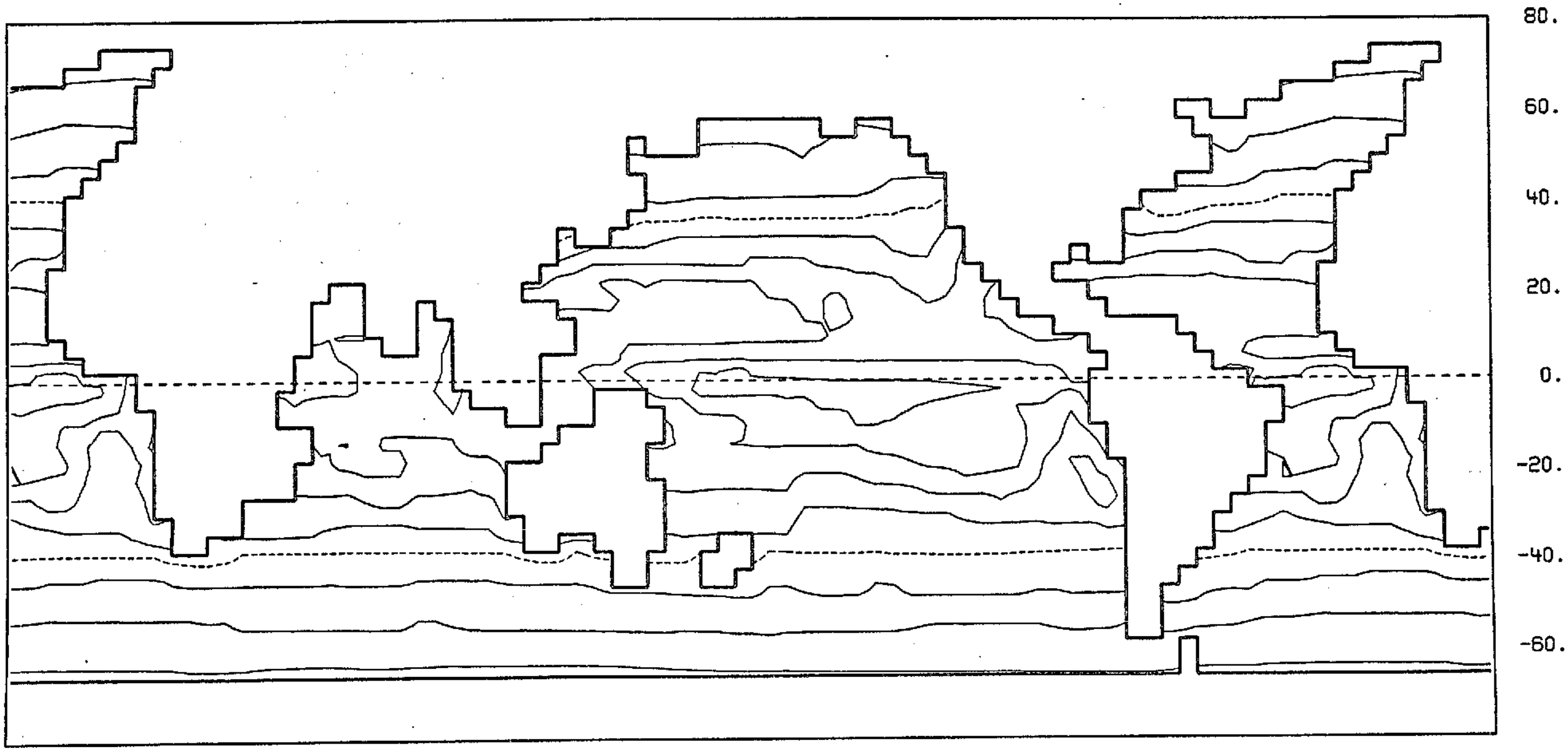
EXPERIMENT S1

DAY = 8773.7

SURFACE RADIATION FLUX (CAL/CM**2/DAY)

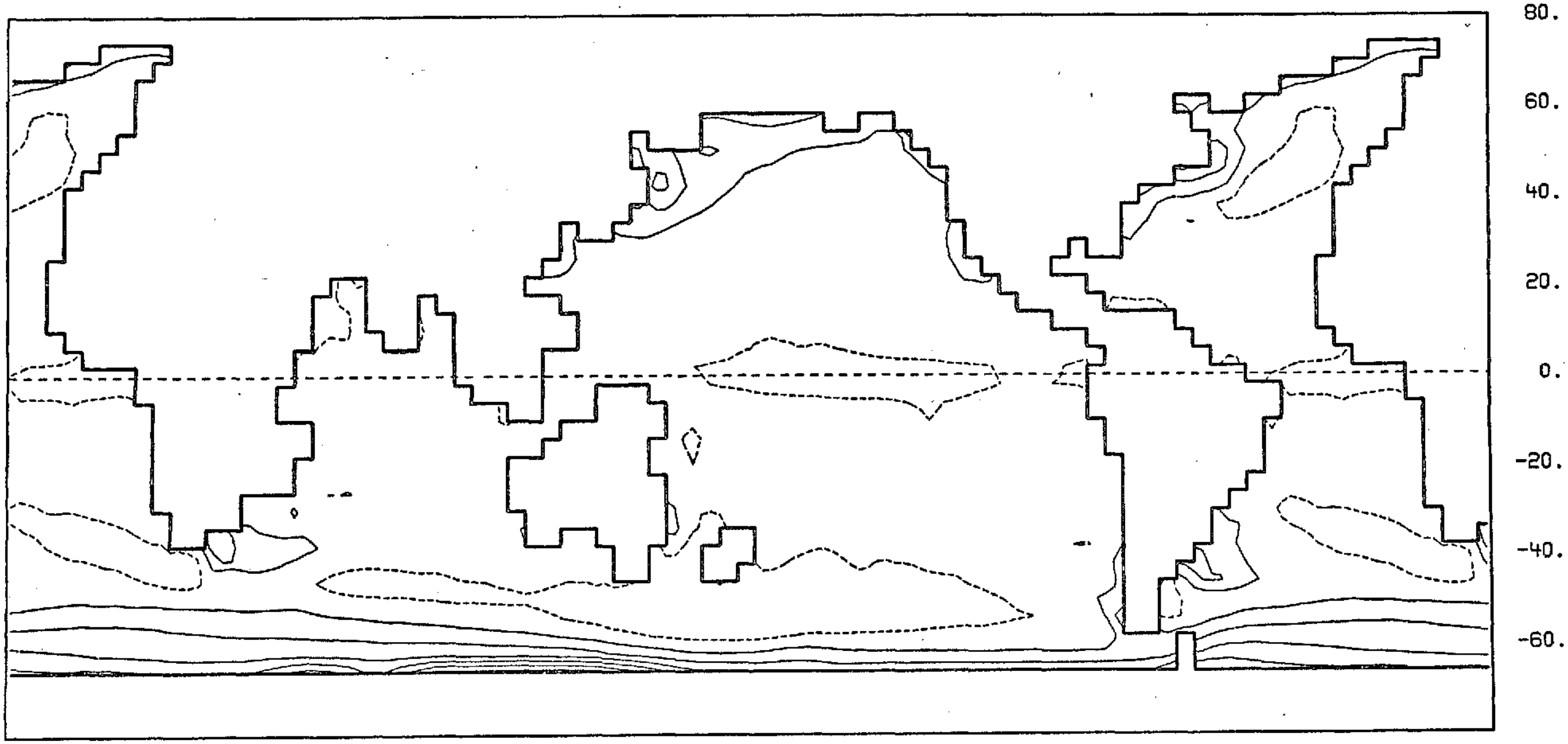
CONTOUR INTERVAL = 60.0

DASHED LINE = 180.0



EXPERIMENT S1 SURFACE SENSIBLE HEAT FLUX (CAL/CM**2/DAY)

DAY = 8773.7 CONTOUR INTERVAL = 60.0 DASHED LINE = 0.0



17

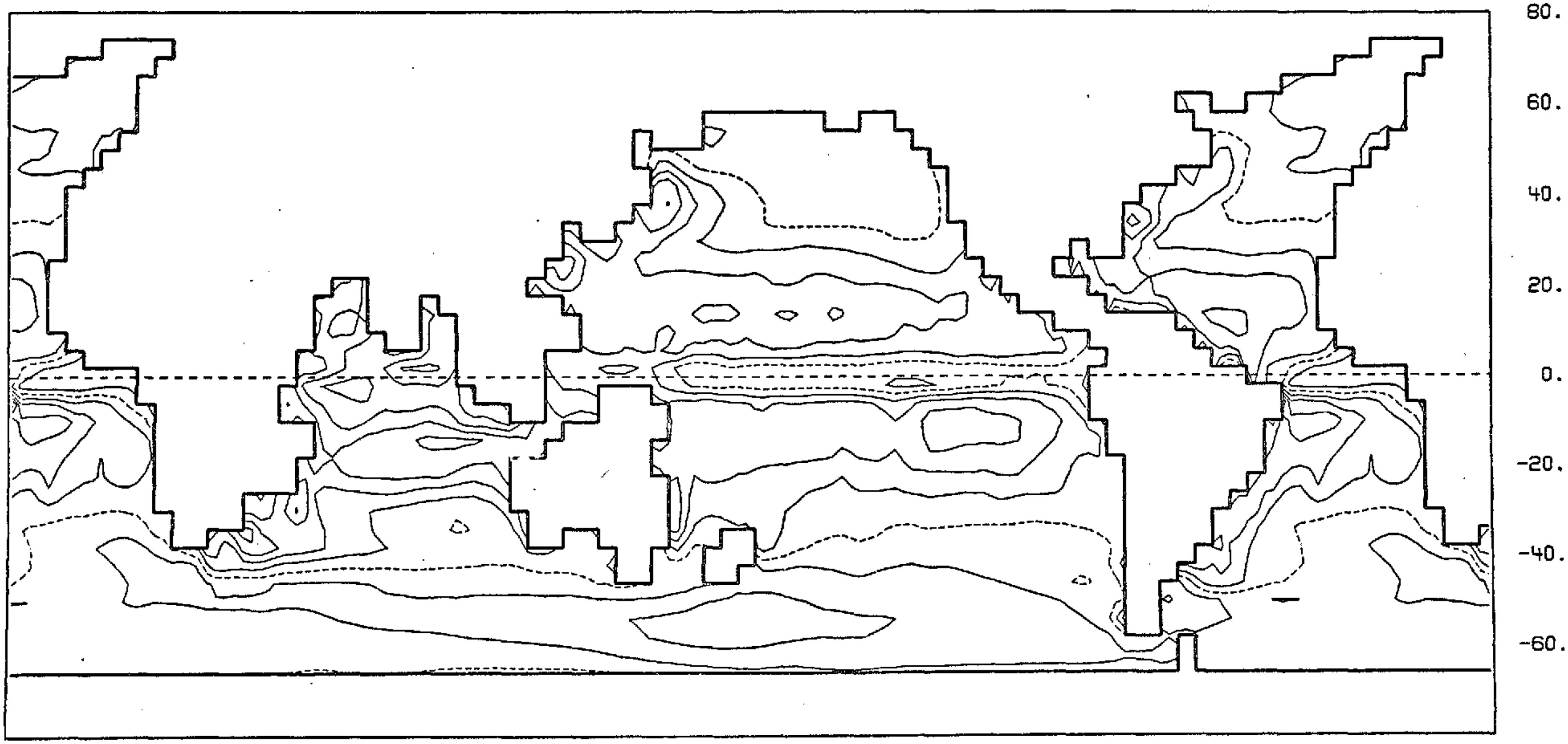
EXPERIMENT 51

DAY = 8773.7

SURFACE LATENT HEAT FLUX (CAL/CM**2/DAY)

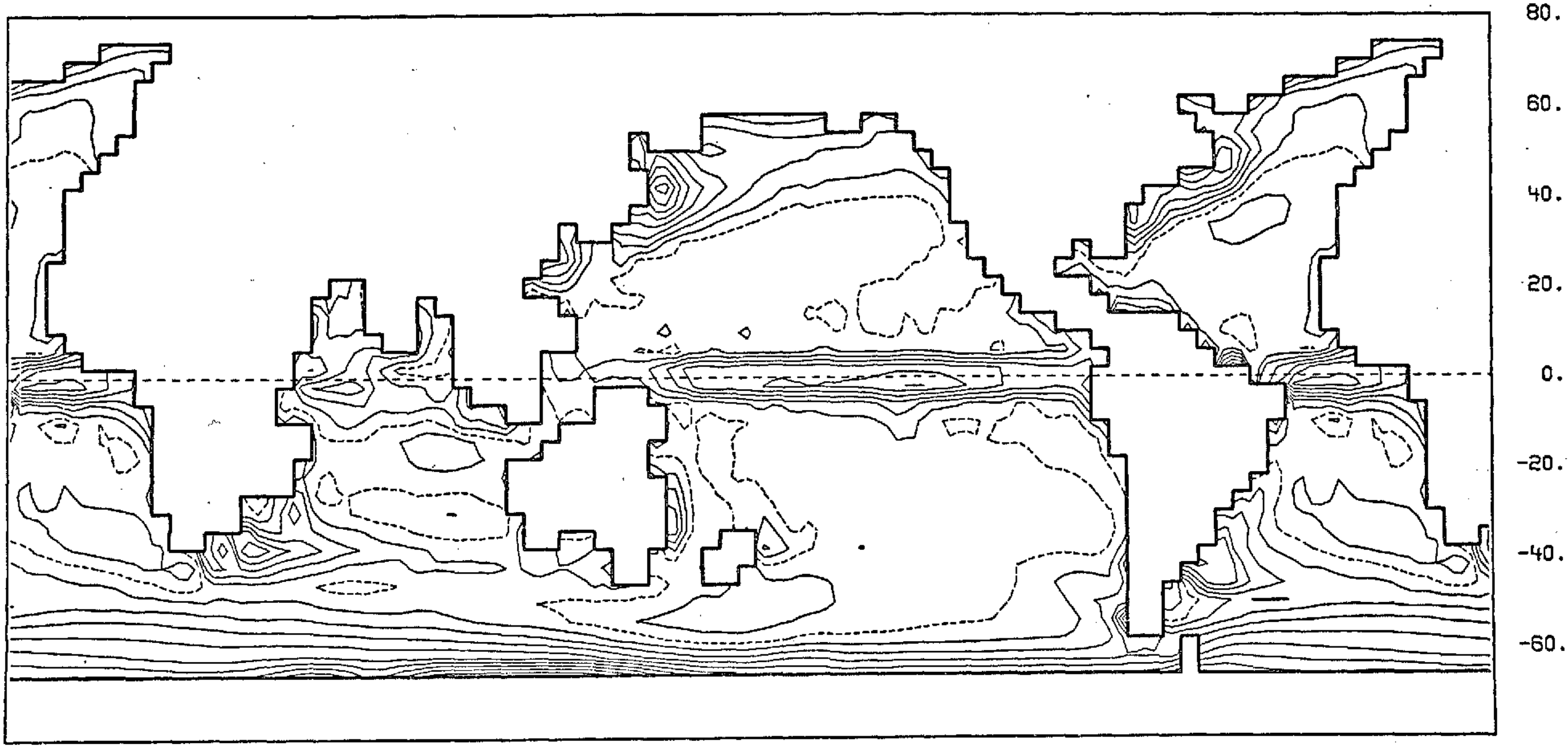
CONTOUR INTERVAL = 60.0

DASHED LINE = 180.0



EXPERIMENT S1 TOTAL SURFACE HEAT FLUX (CAL/CM**2/DAY)

DAY = 8773.7 CONTOUR INTERVAL = 60.0 DASHED LINE = 0.0



19

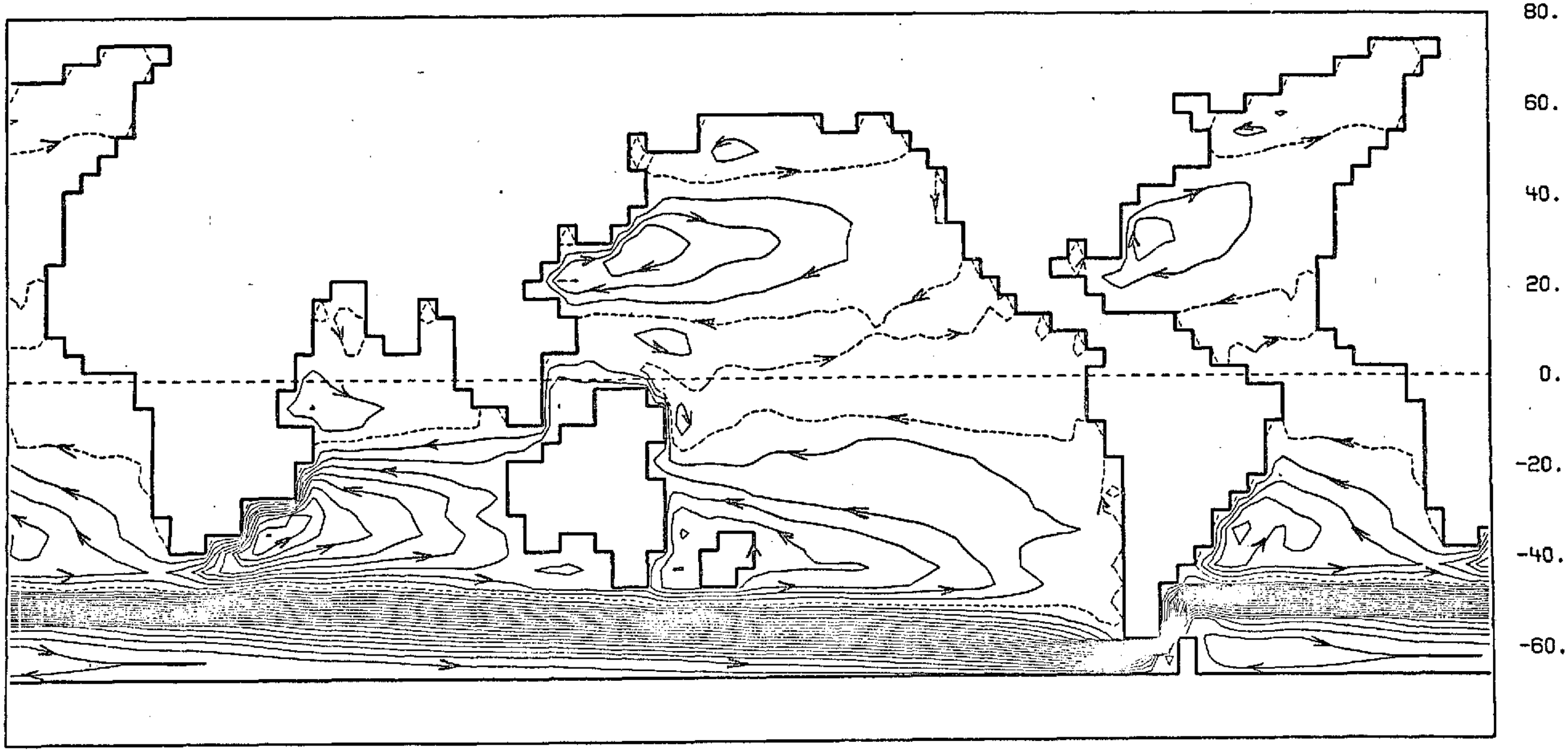
EXPERIMENT S1

DAY = 0.0

STREAM LINES OF HORIZONTAL TRANSPORT (10**12 CM**3/SEC)

CONTOUR INTERVAL = 10.0

DASHED LINE = 0.0



```
C
C        BAROTROPIC CIRCULATION IN A MULTI-CONNECTED GLOBAL OCEAN

     MPP=0 IF THE FOUR NEARESR SURRCUNDING POINTS ARE WATER POINTS,
        =1 IF ONE OF THE FOUR NEAREST SURROUNDING POINTS IS ON THE
           COAST OF THE MAIN LANDMASS (AFRICA, EUROPE, ASIA),
        =3 INSIDE THE ANTARCTICA,
        =30 ON THE COAST OF THE ANTARCTICA,
        =4 INSIDE AUSTRALIA,
        =40 ON THE COAST OF AUSTRALIA,
        =5 INSIDE NEWZEALAND,
        =50 ON THE COAST OF NEWZEALAND.
       MULTIPLY THE STREAM FUNCTION VALUES BY R*H (R=EARTH'S
       RADIUS, H=OCEAN DEPTH) TO GET THE STREAM FUNCTION VALUES
       FOR THE VOLUME TRANSPORT (INTEGRAL OF THE HORIZONTAL VELOCITY
       OVER THE WHOLE DEPTH.
     MQQ=1 FOR THE WATER POINTS,
        =2 FOR THE MAIN LAND MASS,
        =3 FOR THE ANTARCTICA,
        =4 FOR AUSTRALIA,
        =5 FOR NEWZEALAND.
       THE SUBROUTINE HAJIME SPECIFY THE SHAPE OF THE OCEAN (MPP AND
       MQQ), THE WIND STRESS TO COMPUTE ITS CURL AND OTHER CONSTANTS
       AS WELL AS THE INITIAL FIELD OF THE STREAM FUNCTION.
       THE SUBROUTINE RESID GIVES THE CHANGE OF THE SUM OF THE
       RESIDUALS (RES) AT EACH SEPARATE LAND MASS WHICH TAKES PLACE
       BY THE UNIT INCREASE OF THE STREAM FUNCTION AT EACH SEAPARATE
       LAND MASS POINT, JUST AS IN CASE OF THE BLCCK RELAXATION.
       F AND G DENOTE THE STREAM FUNCTION AT TIME STEP N+1, N,
       RESPECTIVELY, XU,XV,U, AND V THE BAROTROPIC COMPONENTS AT TIME
       STEPS N+1, N, RESPECTIVELY.
       WIND STRESS CURL=-TW/(2.0*Y*X(J))/R*H
       X,XM,Y=GRID SIZE
       AH=COEFFICIENT OF EDDY VISCOSITY
       DT IS THE TIME STEP.
       H IS THE OCEAN DEPTH.  CD IS THE TIME (DAY).
       E IS THE WORKING SPACE FOR RELAXATION.
       IM DENOTES THE EASTERNMOST POINTS TO BE SWEPT. (EX. 146)
       JM DENOTES THE NORTHERNMOST PONTS TO BE SWEPT.
       THE BACKWARD DIFFERENCING SCHEME IN TIME APPLIES EVERY MAT
       TIME STEPS. MATS CONTROLS THE SWITCHING FROM THE LEAP-FROG TO
       BACKWARD OF FROM THE BACKWARD TO LEAP-FROG SCHEMES.
       PRINTING IS DONE EVERY NPRINT TIME STEPS.
       WRINTING IN MAGNETIC TAPE IS DONE EVERY NTAPE TIME STEPS.
       WHEN (IN) EQUALS ONE, THE IMAG-TH RECORD IN THE MAGNETIC TAPE
       IS PICKED UP, AND THE INTEGRATION GOES ON UNTIL NN=NEND.
       REL=RELAXATION ACCURACY
       WIND STRESS CURL=-TW(I,J)*H (DEPTH)/(2.0*Y*X(J)*RAD) RAD=
       RADIUS OF THE EARTH)
       IND(1)=30  ANTARCTIC COAST
       IND(2)=40  AUSTRALIA COAST
       IND(3)=50  NEWZEALAND COAST
       INDIN(1)=3  ANTARCTIC INLAND
       INDIN(2)=4  AUSTRALIA INLAND
       INDIN(3)=5  NEWZEALAND INLAND

       FIGURE 1 EXPLAINS THE MEANING OF LX1,LX2, LY1 AND LY2.


       X=LX1 ______***_______________  X=LX2
       Y=LY2|      ***               | Y=LY2
            |      ***               |
C           |      ***               |
```

```
C            |          ***                         |
C            ****************************
C            |          ***                         |
C            |          ** ISLAND                   |
C            |          **                          |
C            |          **                          |
C            |          **                          |
C       X=LX1|          **                          |   X=LX2
C       Y=LY1_______**________________________   Y=LY1
C
C                       FIG. 1
C       L,KA,KB SPECIFY THE STREAM FUNCTION POINTS TO BE SWEPT AND
C       OTHER LAND POINTS TO BE SKIPPED.
C       FIGURE 2 EXPLAINS THEIR MEANINGS.
C           * POINT TO BE SWEPT
C
C
C       J=4 KA(1,J)***KB(1,J)       KA(2,J)*****KB(2,J)   KA(3,J)****KB(3,J)
C                             L(J)=3
C
C                                     FIG.2
C
C
C       THE COMPUTATION STOPS IF THE NERGY EXCEEDS A CERTAIN VALUE, OR
C       IF THE NUMBER OF ITERATION IN RELAXATION EXCEEDS A CERTAIN VALUE.
C       THESE VALUES ARE SPECIFIED IN THE PROGRAM. THEY SHOULD BE CHANGED
C       IF NECESSARY.
C       THE COEFFICIENT OF THE OVER-RELAXATION IS GIVEN AT THE BEGIN-
C       NING.
C
C
      COMMON AH,DT,Y,H,REL,XM(39),FJU(39),X(39),F(147,39),E(147,39),
     1U(147,39),V(147,39),G(147,39),XU(147,39),XV(147,39),TW(147,39),CD,
     2BET(39),Y4,CCY,AR,ARY,RES(3), DDT,
     3MAT,L(39),LV(39),LA(10,37),LB(10,37),KA(10,37),KB(10,37),MATS,
     4MPP(147,39),MQQ(147,39),INDIN(3),IND(3),NRES(3),
     5LX1(3),LX2(3),LY1(3),LY2(3),IM,JM,IMP1,JMP1,IMM1
      SOR=1.775
      SOR=1.875
      SOR=1.825
      SOR=1.85
      SOR1=SOR-1.0
      READ(5,1000) IN
 1000 FORMAT(I5)
      IF(IN.EQ.1) GO TO 1001
      CALL HAJIME
      CALL RESID
      CD=0.0
      NN=0
      MAG=0
      GO TO 5555
 1001 CONTINUE
      READ(5,1000) IMAG
      IF(IMAG.EQ.1) GO TO 77
      DO 7 J=2,IMAG
      READ(10)
    7 CONTINUE
   77 READ(10)  XU,XV,F,G,U,V,TW,MPP,MQQ,L,KA,KB,LV,LA,LB,AH,DT,MAT,
     1Y,REL,XM,FJU,X,BET,LX1,LX2,LY1,LY2,IND,INDIN,NN,NEND,RES,
     2NRES,ARY,AR,Y4,E,CCY,MATS,CD,IM,JM,IMP1,JMP1,IMM1,MAG
 5555 CONTINUE
      AH=1.0E9
      AH=3.0E8
      AR=AH/6.37E8/6.37E8
      ARY=AR/Y
      IMAG=NN+1
```

```
      ANN=0.0
      READ(5,5) NEND,MAT,NPRINT,NTAPE,DT,REL
    5 FORMAT(4I5,2E15.7)
      WRITE(6,6) IMAG,NEND,DT,REL,AH,MAT,NTAPE,NPRINT
    6 FORMAT(1H ,16HTIME STEP  FROM I5,2X,3HTO I5,2X,3HDT=E15.7,2X,4HREL
     1=E15.7,2X,3HA H=E15.7,2X,4HMAT=I3/1H ,5HTAPE=I4,5X,6HPRINT=I4)
   20 DAY=DT/0.864E5
      MQQ(49,5)=1
      MQQ(50,5)=1
      MQQ(49,3)=3
      MQQ(50,3)=3
   39 NN=NN+1
      CD=CD+DAY
      NNN=(NN/MAT)*MAT
      IF(NNN.EQ.NN) GO TO 25
      MATS=0
      DDT=DT
      DO 1 J=3,JM
      DO 2 I=1,IMP1
      R=G(I,J)
      G(I,J)=F(I,J)
      F(I,J)=R
    2 CONTINUE
    1 CONTINUE
      GO TO 26
   25 MATS=1
      DDT=DT*0.5
      DO 42 J=3,JM
      DO 43 I=1,IMP1
      U(I,J)=XU(I,J)
      V(I,J)=XV(I,J)
      G(I,J)=F(I,J)
   43 CONTINUE
   42 CONTINUE
   26 CONTINUE
      DO 30 J=3,JM
      JP1=J+1
      JM1=J-1
      JM2=J-2
      XMJ=XM(J)
      XM1=XM(JM1)
      C1=Y/XMJ
      S1=Y/XM1
      CB=X(JP1)/Y
      CS=X(J)/Y
      B=X(JM1)/Y
      BETJ=BET(J)*CCY
      LJ=L(J)
      DO 31 LL=1,LJ
      II=KA(LL,J)
      MM=KB(LL,J)
      DO 310 I=II,MM
      IP1=I+1
      IM1=I-1
      IM2=I-2
      UIJ=U(I,J)
      VIJ=V(I,J)
      UP1J=U(IP1,J)
      UM1J=U(IM1,J)
      UIP1=U(I,JP1)
      UM1P1=U(IM1,JP1)
      UIM1=U(I,JM1)
      UM1M1=U(IM1,JM1)
      UP1M1=U(IP1,JM1)
      UIM2=U(I,JM2)
      VIM2=V(I,JM2)
```

```
      UM2J=U(IM2,J)
      VM2J=V(IM2,J)
      UM1M2=U(IM1,JM2)
      VM1M2=V(IM1,JM2)
      UM2M1=U(IM2,JM1)
      VM2M1=V(IM2,JM1)
      VP1J=V(IP1,J)
      VM1J=V(IM1,J)
      VIP1=V(I,JP1)
      VIM1=V(I,JM1)
      VM1P1=V(IM1,JP1)
      VM1M1=V(IM1,JM1)
      VP1M1=V(IP1,JM1)
      MP=MPP(I,J)
      IF(MP.EQ.0) GO TO 304
      IF(MP.EQ.30) GO TO 304
      IF(MP.EQ.50) GO TO 304
      IF(MQQ(IP1,J).NE.2) GO TO 27
      UP1J=-UIJ
      VP1J=-VIJ
   27 IF(MQQ(I,JP1).NE.2) GO TO 271
      UIP1=-UIJ
      VIP1=-VIJ
  271 IF(MQQ(IM1,JP1).NE.2) GO TO 272
      UM1P1=-UM1J
      VM1P1=-VM1J
  272 IF(MQQ(IM2,J).NE.2) GO TO 28
      UM2J=-UM1J
      VM2J=-VM1J
   28 IF(MQQ(IM2,JM1).NE.2) GO TO 29
      UM2M1=-UM1M1
      VM2M1=-VM1M1
   29 IF(MQQ(IM1,JM2).NE.2) GO TO 291
      UM1M2=-UM1M1
      VM1M2=-VM1M1
  291 IF(MQQ(I,JM2).NE.2) GO TO 292
      UIM2=-UIM1
      VIM2=-VIM1
  292 IF(MQQ(IP1,JM1).NE.2) GO TO 303
      UP1M1=-UIM1
      VP1M1=-VIM1
  303 CONTINUE
  304 DF=-BET J       *(XV(I,J)+XV(IM1,J)+XV(IM1,JM1)+XV(I,JM1))*0.25
      SS=(C1*(UM1J+UIJ-UM2J-UP1J)-(UIP1-UIJ+UM1P1-UM1J)*CB+2.0*CS*
     1(UIJ-UIM1+UM1J-UM1M1)+S1*(UP1M1+UM2M1-UIM1-UM1M1)-(UIM1-UIM2+UM1M1
     2-UM1M2)*B )*ARY+TW(I,J)+DF
      DF=CS*(VIJ-VIM1-VM1J+VM1M1)
        SS=   AR/XMJ*(C1*(-3.0*(VIJ-VM1J)+VP1J-VM2J)-DF
     1+(VIP1-VIJ-VM1P1+VM1J)*CB)+AR/XM1*(S1*(3.0*(VM1M1-VIM1)+VP1M1
     2-VM2M1)+(VM1M1-VM1M2-VIM1+VIM2)*B +DF)+SS
    4 E(I,J)=-SS*DDT
  310 CONTINUE
   31 CONTINUE
      E(2,J)=E(IM,J)
      E(IMP1,J)=E(3,J)
   30 CONTINUE
      IP=0
   37 IP=IP+1
C*****ISLANDS
      MAR=0
C*****ANTARCTICA
C*****NEWZEALAND
C*****AUSTRALIA
      DO 5021 K=1,3
      RESK=RES(K)
      MP=IND(K)
```

```
      MPMP=INDIN(K)
      II=LX1(K)
      IG=LX2(K)
      IM2=LY1(K)
      JM2=LY2(K)
      R=0.0
      DO 5016 J=IM2,JM2
      DO 5015 I=II,IG
      IF(MPP(I,J).NE.MP) GO TO 5015
      R=R+E(I,J)
 5015 CONTINUE
 5016 CONTINUE
      IF(ABS( R ).LE.REL) GO TO 5021
      DF=-R/RESK
      MAR=MAR+1
      IF(K.EQ.1) IM2=2
      DO 5022 J=IM2,JM2
      JP1=J+1
      JM1=J-1
      CS=Y/X(J)
      CB= 2.0*(CS+1.0/CS)
      SS=X(JP1)/Y
      C1=X(JM1)/Y
      DO 5023 I=II,IG
      MPPIJ=MPP(I,J)
      MMMM=(MPPIJ-MP)*(MPPIJ-MPMP)
      IF(MMMM.NE.0) GO TO 5023
      F(I,J)=F(I,J) +DF
      IM1=I-1
      IP1=I+1
      CCC=DF*CS
      E(I,JP1)=E(I,JP1) +SS*DF
      E(I,JM1)=E(I,JM1) +C1*DF
      E(IP1,J)=E(IP1,J) +CCC
      E(IM1,J)=E(IM1,J) +CCC
      E(I,J)=E(I,J) -CB*DF
 5023 CONTINUE
 5022 CONTINUE
      IF(K.EQ.2) GO TO 5021
      IF(K.EQ.1) GO TO 5024
      DO 5026 J=8,12
      E(2,J)=E(IM,J)
 5026 CONTINUE
      GO TO 5021
 5024 CONTINUE
      E(IMP1,5)=E(3,5)
      E(2,5)=E(IM,5)
      CCC=DF*Y/X(4)
      E(3,4)=E(3,4) +CCC
      E(IM,4)=E(IM,4) +CCC
      E(IMP1,4)=E(3,4)
      E(2,4)=E(IM,4)
 5021 CONTINUE
C*****NEWZEALAND
C*****ANTARCTICA
      DO 32 J=4,JM
      JM1=J-1
      JP1=J+1
      XJ=X(J)
      CS=Y/XJ
      SS=X(JP1)/Y
      C1=X(JM1)/Y
      CB=2.0*(CS+XJ/Y)
      LJ=L(J)
      DO 33 LL=1,LJ
      TT=KA(LL,J)
```

```
      MM=KB(LL,J)
      DO 330 I=II,MM
      IF(MPP(I,J).GE.3) GO TO 330
      R=E(I,J)
      IF(ABS(R).LE.REL) GO TO 330
      MAR=MAR+1
      DF=R/CB*SOR
      E(I,J)=-R*SOR1
      F(I,J)=F(I,J)+DF
      IP1=I+1
      CCC=DF*CS
      E(IP1,J)=E(IP1,J)+CCC
      IM1=I-1
      E(IM1,J)=E(IM1,J)+CCC
      E(I,JP1)=E(I,JP1)+SS*DF
      E(I,JM1)=E(I,JM1)+C1*DF
      IF(I.NE.3) GO TO 331
      E(IMP1,JP1)=E(3,JP1)
      E(IMP1,JM1)=E(3,JM1)
      E(IMP1,J)=E(3,J)
      E(IM,J)=E(2,J)
      GO TO 330
  331 IF(I.NE.IM) GO TO 332
      E(2,J)=E(IM,J)
      E(2,JP1)=E(IM,JP1)
      E(2,JM1)=E(IM,JM1)
      E(3,J)=E(IMP1,J)
      GO TO 330
  332 IF(I.NE.4) GO TO 333
      E(IMP1,J)=E(3,J)
      GO TO 330
  333 IF(I.NE.IMM1) GO TO 330
      E(2,J)=E(IM,J)
  330 CONTINUE
   33 CONTINUE
   32 CONTINUE
      IF(MAR.EQ.0) GO TO 36
      IF(IP.GT.1000) GO TO 1112
      IF(IP.NE.1) GO TO 37
      WRITE(6,38) IP,MAR
   38 FORMAT(1H ,7X,6HKAISU=I5,5X,12HTEN NO KAZU=I5)
      GO TO 37
   36 EN=0.0
      WRITE(6,38) IP,MAR
      DO 70 J=3,JM
      F(1,J)=F(IMM1,J)
      F(2,J)=F(IM,J)
      F(IMP1,J)=F(3,J)
   70 CONTINUE
      DO 23 J=3,JM
      JM1=J-1
      JP1=J+1
      XMJ=XM(J)*2.0
      DF=XMJ*Y4
      LVJ=LV(J)
      DO 24 LJ=1,LVJ
      II=LA(LJ,J)
      IG=LB(LJ,J)
      DO 244 I=II,IG
      IP1=I+1
      U(I,J)=XU(I,J)
      V(I,J)=XV(I,J)
      XU(I,J)=
     1        (F(I,J)+F(IP1,J)-F(I,JP1)-F(IP1,JP1))/CCY
      XV(I,J)=
     1        (F(IP1,J)+F(IP1,JP1)-F(I,J)-F(I,JP1))/XMJ
```

```
      EN=EN+DP*(XU(I,J)**2+XV(I,J)**2)
  244 CONTINUE
   24 CONTINUE
      XU(IMP1,J)=XU(3,J)
      XV(IMP1,J)=XV(3,J)
      U(IMP1,J)=U(3,J)
      V(IMP1,J)=V(3,J)
      XU(2,J)=XU(IM,J)
      XV(2,J)=XV(IM,J)
      XU(1,J)=XU(IMM1,J)
      XV(1,J)=XV(IMM1,J)
      U(2,J)=U(IM,J)
      V(2,J)=V(IM,J)
      U(1,J)=U(IMM1,J)
      V(1,J)=V(IMM1,J)
   23 CONTINUE
      WRITE(6,34)   NN,CD,EN,F(1,3)
   34 FORMAT(1H ,5HSTEP=I5,5X,5HTIME=E15.7,5X,7HENERGY=E15.7,5X,4HACC=F7
     1.4)
      IF(EN.GT.5.0E1) GO TO 1111
      IF(NN.GE.NEND) GO TO 88
      IF(MATS.NE.0) GO TO 10
      IF(NN.NE.((NN/NTAPE)*NTAPE))  GO TO 9
      MAG=MAG+1
      WRITE(10) XU,XV,F,G,U,V,TW,MPP,MQQ,L,KA,KB,LV,LA,LB,AH,DT,MAT,
     1Y,REI,XM,FJU,X,BET,LX1,LX2,LY1,LY2,IND,INDIN,NN,NEND,RES,
     2NRES,ARY,AR,Y4,E,CCY,MATS,CD,IM,JM,IMP1,JMP1,IMM1,MAG
      WRITE(6,8) MAG
    9 IF(NN.EQ.((NN/NPRINT)*NPRINT))  GO TO 88
   10 ENN=EN
      IF(MATS.EQ.0) GO TO 39
      MATS=MATS+1
      IF(MATS.EQ.3) GO TO 46
      DO 44 J=3,JM
      DO 45 I=1,IMP1
      F(I,J)=G(I,J)
      U(I,J)=XU(I,J)
      V(I,J)=XV(I,J)
   45 CONTINUE
   44 CONTINUE
      GO TO 26
   46 DO 47 J=3,JM
      DO 48 I=1,IMP1
      R=F(I,J)
      F(I,J)=G(I,J)
      G(I,J)=R
   48 CONTINUE
   47 CONTINUE
      DO 49 J=3,JM
      JP1=J+1
      XMJ=XM(J)*2.0
      LVJ=LV(J)
      DO 55 LJ=1,LVJ
      II=LA(LJ,J)
      IG=LB(LJ,J)
      DO 550 I=II,IG
      IP1=I+1
      U(I,J)=
     1         (F(I,J)+F(IP1,J)-F(I,JP1)-F(IP1,JP1))/CCY
      V(I,J)=
     1         (F(IP1,J)+F(IP1,JP1)-F(I,J)-F(I,JP1))/XMJ
  550 CONTINUE
   55 CONTINUE
      U(1,J)=U(IMM1,J)
      V(1,J)=V(IMM1,J)
      U(2,J)=U(IM,J)
```

```
      V(2,J)=V(1M,J)
      U(IMP1,J)=U(3,J)
      V(IMP1,J)=V(3,J)
   49 CONTINUE
      MATS=0
      NN=NN+1
      DDT=DT
      NNT=NNT+1
      CD=CD+DAY
      GO TO 39
   88 K=1
      MP=-1
  613 MP=MP+1
      MM=K-MP
      IG=18*MP+3
      IF(MM.EQ.0) GO TO 614
      II=IG+17
      GO TO 615
  614 II=38
  615 WRITE(6,701)
  701 FORMAT(1H0,15HSTREAM FUNCTION)
      DO 702 J=1,IMP1
      WRITE(6,703) J,(F(J,I),I=IG,II)
  703 FORMAT(1H ,I3,1X,18F7.4)
  702 CONTINUE
      IF(MM.NE.0) GO TO 613
      IF(NN.LT.NEND) GO TO 10
      MAG=MAG+1
      WRITE(10) XU,XV,F,G,U,V,TW,MPP,MQQ,L,KA,KB,LV,LA,LB,AH,DT,MAT,
     1Y,REL,XM,FJU,X,BET,LX1,LX2,LY1,LY2,IND,INDIN,NN,NEND,RES,
     2NRES,ARY,AR,Y4,E,CCY,MATS,CD,IM,JM,IMP1,JMP1,IMM1,MAG
      WRITE(6,8) MAG
    8 FORMAT(1H0,32HNO. OF RECORDS IN MAGNETIC TAPE=I3)
      GO TO 1111
 1112 WRITE(6,38) IP,MAR
 1111 STOP
      END
      SUBROUTINE RESID
      RETURN
      END
      SUBROUTINE HAJIME
      RETURN
      END
      SUBROUTINE RESID
      COMMON AH,DT,Y,H,REL,XM(39),FJU(39),X(39),F(147,39),E(147,39),
     1U(147,39),V(147,39),G(147,39),XU(147,39),XV(147,39),TW(147,39),CD,
     2BET(39),Y4,CCY,AR,ARY,RES(3), DDT,
     3MAT,L(39),LV(39),LA(10,37),LB(10,37),KA(10,37),KB(10,37),MATS,
     4MPP(147,39),MQQ(147,39),INDIN(3),IND(3),NRES(3),
     5LX1(3),LX2(3),LY1(3),LY2(3),IM,JM,IMP1,JMP1,IMM1
      DO 1 K=1,3
      DO 8 J=1,JMP1
      DO 9 I=1,IMP1
      E(I,J)=0.0
    9 CONTINUE
    8 CONTINUE
      S=0.0
      I1=LX1(K)
      I2=LX2(K)
      J1=LY1(K)
      J2=LY2(K)
      MIN=IND(K)
      MININ=INDIN(K)
      NUM=0
      IF(K.EQ.1) J1=2
      DO 3 J=J1,J2
```

```
      JM1=J-1
      JP1=J+1
      CS=Y/X(J)
      C1=X(JM1)/Y
      SS=X(JP1)/Y
      CB=-2.0*(CS+1.0/CS)
      DO 4 I=I1,I2
      MP=MPP(I,J)
      MMM=(MP-MIN)*(MP-MININ)
      IF(MMM.NE.0) GO TO 4
      IP1=I+1
      IM1=I-1
      NUM=NUM+1
      E(I,J)=E(I,J)+CB
      E(IP1,J)=E(IP1,J)+CS
      E(IM1,J)=E(IM1,J)+CS
      E(I,JP1)=E(I,JP1)+SS
      E(I,JM1)=E(I,JM1)+C1
    4 CONTINUE
    3 CONTINUE
      IF(K.GE.2) GO TO 10
      J1=3
      DO 11 J=3,3
      CS=Y/X(J)
      E(3,J)=E(3,J)+CS
      E(IM,J)=E(IM,J)+CS
   11 CONTINUE
   10 CONTINUE
      DO 5 J=J1,J2
      DO 6 I=I1,I2
      IF(MPP(I,J).EQ.MIN) S=S+E(I,J)
    6 CONTINUE
    5 CONTINUE
      NRES(K)=NUM
      RES(K)=S
      WRITE(6,7) K,NUM,S
    7 FORMAT(1H ,2HK=I2,2X,12HGRID POINTS=I3,2X,4HRES=E15.7)
    1 CONTINUE
      DO 16 J=1,18
      DO 17 I=1,IMP1
      IF(MQQ(I,J).EQ.1) GO TO 17
      MP=MPP(I,J)
      IF(MP.EQ.2) GO TO 17
      IF(MP.EQ.((MP/3)*3)) GO TO 18
      IF(MP.EQ.((MP/4)*4)) GO TO 19
      MQQ(I,J)=5
      GO TO 17
   18 MQQ(I,J)=3
      GO TO 17
   19 MQQ(I,J)=4
   17 CONTINUE
   16 CONTINUE
      WRITE(6,15) (I,I=1,38)
   15 FORMAT(1H ,4X,38I3)
      DO 12 I=1,IMP1
      WRITE(6,14) I,(MPP(I,J),J=1,38)
      WRITE(6,13) I,(MQQ(I,J),J=1,38)
   12 CONTINUE
   13 FORMAT(1H ,I3,3X,38I3)
   14 FORMAT(1H ,I3,2X,38I3)
      RETURN
      END
      SUBROUTINE HAJIME
C
C         DATA:
C                   IM,JM,IMH,JMH
```

```
C            OCEAN SHAPE (SUBROUTINE SHAPE 1)
C            X,DX,DY (DX AND DY ARE THE GRID SIZES IN LONGITUDE AND
C            LATITUDE (DEGREES), RESPECTIVELY. Y IS THE LATITUDE
C            CORRESPONDING TO J=0).
C            AH,H, REL,DT,MAT
C            IT: IT=1  WIND STRESS IS READ TO COMPUTE THE WIND STRESS CURL.
C                IT=2  WIND STRESS CURL IS GIVEN FROM CARDS, A MAGNETIC
C                      TAPE, OR THE SUBROUTINE CURL.
C
      COMMON AH,DT,Y,H,REL,XM(39),FJU(39),X(39),F(147,39),E(147,39),
     1U(147,39),V(147,39),G(147,39),XU(147,39),XV(147,39),TW(147,39),CD,
     2BET(39),Y4,CCY,AR,ARY,RES(3), DDT,
     3MAT,L(39),LV(39),LA(10,37),LB(10,37),KA(10,37),KB(10,37),MATS,
     4MPP(147,39),MQQ(147,39),INDIN(3),IND(3),NRES(3),
     5LX1(3),LX2(3),LY1(3),LY2(3),IM,JM,IMP1,JMP1,IMM1
      DIMENSION L1(9),WE(147,39),WN(147,39),C(39)
      EQUIVALENCE (U(1),WE(1)), (V(1),WN(1))
      READ(5,40) IM,JM,IMH,JMH
   40 FORMAT(4I5)
      IMP1=IM+1
      IMM1=IM-1
      JMP1=JM+1
C     CALL SHAPE1
      CALL SHAPE 1
      DO 548 J=1,MM
      DO 549 I=1,IMP1
      F(I,J)=0.0
      G(I,J)=0.0
      U(I,J)=0.0
      V(I,J)=0.0
      XU(I,J)=0.0
      XV(I,J)=0.0
  549 CONTINUE
  548 CONTINUE
      READ(5,18) Y,DX,DY
   18 FORMAT(3F10.0)
      P=3.1415926/180.0
      DX=DX*P
      MM=JM+2
      DO 100 I=1,MM
      AR=(Y+DY*FLOAT(I))*P
      F1=COS(AR)
      X(I)=DX*F1
      C(I)=F1
      BET(I)=F1*X(I)*14.58E-5
  100 CONTINUE
      Y=DY*P
      CD=14.58/(DX*Y)
      DO 9997 J=1,JMP1
      XM(J)=(X(J)+X(J+1))/2.0
      FJU(J)=CD*(X(J)-X(J+1))
 9997 CONTINUE
      READ(5,16) AH,H,REL,DT,MAT
   16 FORMAT(4E15.7,I5)
      WRITE(6,17) AH,H,REL
   17 FORMAT(1H ,15HEDDY VISCOSITY=E15.7,10X,6HDEPTH=E15.7,10X,
     115HRELAX ACCURACY=E15.7)
      READ(5,10) IT
   10 FORMAT(I5)
      GO TO (1,2), IT
    1 CONTINUE
C     CALL WIND
      CALL WIND
      P=0.01/4.0E5
      DO 540 J=JMH,JMP1
      XMJ=XM(J)
```

```
      JM1=J-1
      XM1=XM(JM1)
      DO 541 I=IMH,IM
      IM1=I-1
      TW(I,J)=(XMJ*(-WE(I,J)-WE(IM1,J))+XM1*(WE(I,JM1)+WE(IM1,JM1))
     1     + Y*(WN(I,J)+WN(I,JM1)-WN(IM1,J)-WN(IM1,JM1)))*P
  541 CONTINUE
      TW(1,J)=TW(IMM1,J)
      TW(2,J)=TW(IM,J)
      TW(IMP1,J)=TW(IMH,J)
  540 CONTINUE
      GO TO 3
    2 CONTINUE
C     CALL CURL
      CALL CURL
      READ(5,6004) (TW(I,J),I=3,IM)
 6004 FORMAT(5E15.7)
      TW(IMP1,J)=TW(3,J)
      TW(2,J)=TW(IM,J)
      TW(1,J)=TW(IMM1,J)
    3 CONTINUE
C     INITIAL GUESS
      DO 4000 J=4,JM
      CJ=1.0/(C(J)*Y*14.58E-5)/4.0
      LJ=L(J)
      DO 360 LL=1,LJ
      II=KA(LL,J)
      IG=KB(LL,J)
      MP=II+IG
  362 DO 361 I=II,IG
      MM=MP-I
      K=MM+1
      P=F(K,J)-(TW(MM,J)+TW(K,J))*CJ
      F(MM,J)=P
  361 CONTINUE
      IF(II.NE.3) GO TO 360
      F(IMP1,J)=F(3,J)
  360 CONTINUE
      F(1,J)=F(IMM1,J)
      F(2,J)=F(IM,J)
 4000 CONTINUE
C     INITIAL GUESS
      CCC=2.0*Y
      DO 4049 J=3,JM
      JP1=J+1
      LJ=LV(J)
      DO 4058 LL=1,LJ
      II=LA(LL,J)
      IG=LB(LL,J)
      DO 4053 I=II,IG
      IP1=I+1
      P=(F(I,J)+F(IP1,J)-F(I,JP1)-F(IP1,JP1))/CCC
      U(I,J)=P
      XU(I,J)=P
      P=(F(IP1,J)+F(IP1,JP1)-F(I,J)-F(I,JP1))/XMJ
      V(I,J)=P
      XV(I,J)=P
 4053 CONTINUE
 4058 CONTINUE
      XU(IMP1,J)=XU(3,J)
      XV(IMP1,J)=XV(3,J)
      XU(2,J)=XU(IM,J)
      XV(2,J)=XV(IM,J)
      XU(1,J)=XU(IMM1,J)
      XV(1,J)=XV(IMM1,J)
      U(IMP1,J)=U(3,J)
```

```
      V(IMP1,J)=V(3,J)
      U(2,J)=U(IM,J)
      V(2,J)=V(IM,J)
      U(1,J)=U(IMM1,J)
      V(1,J)=V(IMM1,J)
 4049 CONTINUE
      AR=AH/6.37E8/6.37E8
      ARY=AR/Y
      CCY=2.0*Y
      Y4=Y*0.25
      RETURN
      END
      SUBROUTINE SHAPE1
C         SUBROUTINE TO BE USED FOR THE BAROTROPIC PART OF THE WORLD OCEAN
C         CIRCULATION WHEN THE SHAPE OF THE OCEAN IS CHANGED.
C         DATA:  LV, LA AND LB FOR MQQ.
C                MM, M1(K),M2(K) AND M3(K) FOR MPP.
C         LV, LA AND LB ARE THE SAME AS THOSE USED FOR THE SUBROUTINE
C         SHAPE 2 (BAROCLINIC  PART), BUT THE DATA FOR MPP ARE DIFFERENT
C         FROM THOSE USED FOR THE SHAPE2.
C         LX1, LX2, LY1, LY2 WHICH SPECIFY THE AREAS INCLUDING THE SEPARATE
C         ISLANDS.
      COMMON AH,DT,Y,H,REL,XM(39),FJU(39),X(39),F(147,39),E(147,39),
     1U(147,39),V(147,39),G(147,39),XU(147,39),XV(147,39),TW(147,39),CD,
     2BET(39),Y4,CCY,AR,ARY,RES(3), DDT,
     3MAT,L(39),LV(39),LA(10,37),LB(10,37),KA(10,37),KB(10,37),MATS,
     4MPP(147,39),MQQ(147,39),INDIN(3),IND(3),NRES(3),
     5LX1(3),LX2(3),LY1(3),LY2(3),IM,JM,IMP1,JMP1,IMM1
      IMM1=IM-1
      IMP1=IM+1
      JMM1=JM-1
      JMP1=JM+1
      JMH=3
      IMH=3
      DO 30 J=1,JM
      DO 31 I=1,IMP1
      MQQ(I,J)=2
   31 CONTINUE
   30 CONTINUE
      DO 32 J=3,JMM1
      READ(5,33)  M
   33 FORMAT(I2)
      READ(5,34) (LA(I,J),LB(I,J),I=1,M)
   34 FORMAT(7(2I4,2X))
      DO 35 I=1,M
      II=LA(I,J)
      IG=LB(I,J)
      DO 36 N=II,IG
      MQQ(N,J)=1
   36 CONTINUE
   35 CONTINUE
      LV(J)=M
      MQQ(1,J)=MQQ(IMM1,J)
      MQQ(2,J)=MQQ(IM,J)
      MQQ(IMP1,J)=MQQ(3,J)
   32 CONTINUE
      DO 3006 J=3,38
      READ(5,3007)  MM
 3007 FORMAT(I2)
      READ(5,3008)  (M1(K),M2(K),M3(K),K=1,MM)
 3008 FORMAT(8(2I4,I2))
      DO 3009 K=1,MM
      K5=M1(K)
      K6=M2(K)
      K7=M3(K)
      DO 3010 I=K5,K6
```

```
      MPP1(I,J)=K7
 3010 CONTINUE
 3009 CONTINUE
 3006 CONTINUE
      DO 3011 J=3,38
      READ(5,3007) MM
      L1(J)=MM
      READ(5,3012) (KA1(LL,J),KB1(LL,J),LL=1,MM)
 3012 FORMAT(16I5)
 3011 CONTINUE
      DO 6003 J=1,JMP1
      MPP1(1,J)=MPP1(IMM1,J)
      MPP1(2,J)=MPP1(IM,J)
      MPP1(IMP1,J)=MPP1(3,J)
 6003 CONTINUE
      DO 6004 J=3,JM
      JP1=J+1
      JM1=J-1
      DO 6005 I=3,IM
      IF(MPP1(I,J).GT.1) GO TO 6005
      IF(MPP1(I-1,J).EQ.2) GO TO 6005
      IF(MPP1(I,JP1).EQ.2) GO TO 6005
      IF(MPP1(I,JM1).EQ.2) GO TO 6005
      IF(MPP1(I+1,J).EQ.2) GO TO 6005
      MPP1(I,J)=0
 6005 CONTINUE
      MPP1(IMP1,J)=MPP1(3,J)
      MPP1(2,J)=MPP1(IM,J)
      MPP1(1,J)=MPP1(IMM1,J)
 6004 CONTINUE
      WRITE(6,6016) (J,J=3,38)
 6016 FORMAT(1H ,5X,38I3/)
      DO 6012 I=1,IMP1
      WRITE(6,6014) I,(MPP1(I,J),J=3,38)
      WRITE(6,6015) (MQQ(I,J),J=3,38)
 6012 CONTINUE
 6014 FORMAT(1H ,I3,2X,38I3)
 6015 FORMAT(1H ,6X,38I3)
      READ(5,2) (LX1(K),LX2(K),LY1(K),LY2(K),K=1,3)
    2 FORMAT(4I5)
      RETURN
      END
      SUBROUTINE WIND
      COMMON AH,DT,Y,H,REL,XM(39),FJU(39),X(39),F(147,39),E(147,39),
     1U(147,39),V(147,39),G(147,39),XU(147,39),XV(147,39),TW(147,39),CD,
     2BET(39),Y4,CCY,AR,ARY,RES(3), DDT,
     3MAT,L(39),LV(39),LA(10,37),LB(10,37),KA(10,37),KB(10,37),MATS,
     4MPP(147,39),MQQ(147,39),INDIN(3),IND(3),NRES(3),
     5LX1(3),LX2(3),LY1(3),LY2(3),IM,JM,IMP1,JMP1,IMM1
      DIMENSION WE(147,7),WN(147,7)
      RETURN
      END
      SUBROUTINE CURL
      RETURN
      END
```

```
C
C        BAROTROPIC CIRCULATION IN A MULTI-CONNECTED GLOBAL OCEAN
C
C     MPP=0 IF THE FOUR NEARESR SURROUNDING POINTS ARE WATER POINTS,
C        =1 IF ONE OF THE FOUR NEAREST SURROUNDING POINTS IS ON THE
C           COAST OF THE MAIN LANDMASS (AFRICA, EUROPE, ASIA),
C        =3 INSIDE THE ANTARCTICA,
C        =30 ON THE COAST OF THE ANTARCTICA,
C        =4 INSIDE AUSTRALIA,
C        =40 ON THE COAST OF AUSTRALIA,
C        =5 INSIDE NEWZEALAND,
C        =50 ON THE COAST OF NEWZEALAND.
C      MULTIPLY THE STREAM FUNCTION VALUES BY R*H (R=EARTH'S
C      RADIUS, H=OCEAN DEPTH) TO GET THE STREAM FUNCTION VALUES
C      FOR THE VOLUME TRANSPORT (INTEGRAL OF THE HORIZONTAL VELOCITY
C      OVER THE WHOLE DEPTH.
C     MQQ=1 FOR THE WATER POINTS,
C        =2 FOR THE MAIN LAND MASS,
C        =3 FOR THE ANTARCTICA,
C        =4 FOR AUSTRALIA,
C        =5 FOR NEWZEALAND.
C      THE SUBROUTINE HAJIME SPECIFY THE SHAPE OF THE OCEAN (MPP AND
C      MQQ), THE WIND STRESS TO COMPUTE ITS CURL AND OTHER CONSTANTS
C      AS WELL AS THE INITIAL FIELD OF THE STREAM FUNCTION.
C      THE SUBROUTINE RESID GIVES THE CHANGE OF THE SUM OF THE
C      RESIDUALS (RES) AT EACH SEPARATE LAND MASS WHICH TAKES PLACE
C      BY THE UNIT INCREASE OF THE STREAM FUNCTION AT EACH SEAPARATE
C      LAND MASS POINT, JUST AS IN CASE OF THE BLOCK RELAXATION.
C      F AND G DENOTE THE STREAM FUNCTION AT TIME STEP N+1, N,
C      RESPECTIVELY, XU,XV,U, AND V THE BAROTROPIC COMPONENTS AT TIME
C      STEPS N+1, N, RESPECTIVELY.
C      WIND STRESS CURL=-TW/(2.0*Y*X(J))/R*H
C      X,XM,Y=GRID SIZE
C      AH=COEFFICIENT OF EDDY VISCOSITY
C      DT IS THE TIME STEP.
C      H IS THE OCEAN DEPTH.  CD IS THE TIME (DAY).
C      E IS THE WORKING SPACE FOR RELAXATION.
C      IM DENOTES THE EASTERNMOST POINTS TO BE SWEPT. (EX. 146)
C      JM DENOTES THE NORTHERNMOST PONTS TO BE SWEPT.
C      THE BACKWARD DIFFERENCING SCHEME IN TIME APPLIES EVERY MAT
C      TIME STEPS. MATS CONTROLS THE SWITCHING FROM THE LEAP-FROG TO
C      BACKWARD OF FROM THE BACKWARD TO LEAP-FROG SCHEMES.
C      PRINTING IS DONE EVERY NPRINT TIME STEPS.
C      WRINTING IN MAGNETIC TAPE IS DONE EVERY NTAPE TIME STEPS.
C      WHEN (IN) EQUALS ONE, THE IMAG-TH RECORD IN THE MAGNETIC TAPE
C      IS PICKED UP, AND THE INTEGRATION GOES ON UNTIL NN=NEND.
C      REL=RELAXATION ACCURACY
C      WIND STRESS CURL=-TW(I,J)*H (DEPTH)/(2.0*Y*X(J)*RAD)  RAD=
C      RADIUS OF THE EARTH)
C      IND(1)=30  ANTARCTIC COAST
C      IND(2)=40  AUSTRALIA COAST
C      IND(3)=50  NEWZEALAND COAST
C      INDIN(1)=3  ANTARCTIC INLAND
C      INDIN(2)=4  AUSTRALIA INLAND
C      INDIN(3)=5  NEWZEALAND INLAND
C
C      FIGURE 1 EXPLAINS THE MEANING OF LX1,LX2, IY1 AND LY2.
C
C
C      X=LX1 _______***________________  X=LX2
C      Y=LY2|       ***                |  Y=LY2
C           |       ***                |
C           |       ***                |
```

```
C           |                           |
C           ****************************
C           |       ***                 |
C           |       ** ISLAND           |
C           |       **                  |
C           |       **                  |
C           |       **                  |
C       X=LX1|      **                  |  X=LX2
C       Y=LY1_______**__________________   Y=LY1
C
C                     FIG.1
C       L,KA,KB SPECIFY THE STREAM FUNCTION POINTS TO BE SWEPT AND
C       OTHER LAND POINTS TO BE SKIPPED.
C       FIGURE 2 EXPLAINS THEIR MEANINGS.
C           * POINT TO BE SWEPT
C
C
C       J=4 KA(1,J)***KB(1,J)     KA(2,J)*****KB(2,J)   KA(3,J)****KB(3,J)
C                           L(J)=3
C
C                                     FIG.2
C
C
C       THE COMPUTATION STOPS IF THE NERGY EXCEEDS A CERTAIN VALUE, OR
C       IF THE NUMBER OF ITERATION IN RELAXATION EXCEEDS A CERTAIN VALUE.
C       THESE VALUES ARE SPECIFIED IN THE PROGRAM. THEY SHOULD BE CHANGED
C       IF NECESSARY.
C       THE COEFFICIENT OF THE OVER-RELAXATION IS GIVEN AT THE BEGIN-
C       NING.
C
C
      COMMON AH,DT,Y,H,REL,XM(39),FJU(39),X(39),F(147,39),E(147,39),
     1U(147,39),V(147,39),G(147,39),XU(147,39),XV(147,39),TW(147,39),CD,
     2BET(39),Y4,CCY,AR,ARY,RES(3), DDT,
     3MAT,L(39),LV(39),LA(10,37),LB(10,37),KA(10,37),KB(10,37),MATS,
     4MPP(147,39),MQQ(147,39),INDIN(3),IND(3),NRES(3),
     5LX1(3),LX2(3),LY1(3),LY2(3),IM,JM,IMP1,JMP1,IMM1
      SOR=1.775
      SOR=1.875
      SOR=1.825
      SOR=1.85
      SOR1=SOR-1.0
      READ(5,1000) IN
 1000 FORMAT(I5)
      IF(IN.EQ.1) GO TO 1001
      CALL HAJIME
      CALL RESID
      CD=0.0
      NN=0
      MAG=0
      GO TO 5555
 1001 CONTINUE
      READ(5,1000) IMAG
      IF(IMAG.EQ.1) GO TO 77
      DO 7 J=2,IMAG
      READ(10)
    7 CONTINUE
   77 READ(10)  XU,XV,F,G,U,V,TW,MPP,MQQ,L,KA,KB,LV,LA,LB,AH,DT,MAT,
     1Y,REL,XM,FJU,X,BET,LX1,LX2,LY1,LY2,IND,INDIN,NN,NEND,RES,
     2NRES,ARY,AR,Y4,E,CCY,MATS,CD,IM,JM,IMP1,JMP1,IMM1,MAG
 5555 CONTINUE
      AH=1.0E9
      AH=3.0E8
      AR=AH/6.37E8/6.37E8
      ARY=AR/Y
      IMAG=NN+1
```

```
      NN=0.0
      READ(5,5) NEND,MAT,NPRINT,NTAPE,DT,REL
    5 FORMAT(4I5,2E15.7)
      WRITE(6,6) IMAG,NEND,DT,REL,AH,MAT,NTAPE,NPRINT
    6 FORMAT(1H ,16HTIME STEP  FROM I5,2X,3HTO I5,2X,3HDT=E15.7,2X,4HREL
     1=E15.7,2X,3HAH=E15.7,2X,4HMAT=I3/1H ,5HTAPE=I4,5X,6HPRINT=I4)
   20 DAY=DT/0.864E5
      MQQ(49,5)=1
      MQQ(50,5)=1
      MQQ(49,3)=3
      MQQ(50,3)=3
   39 NN=NN+1
      CD=CD+DAY
      NNN=(NN/MAT)*MAT
      IF(NNN.EQ.NN) GO TO 25
      MATS=0
      DDT=DT
      DO 1 J=3,JM
      DO 2 I=1,IMP1
      R=G(I,J)
      G(I,J)=F(I,J)
      F(I,J)=R
    2 CONTINUE
    1 CONTINUE
      GO TO 26
   25 MATS=1
      DDT=DT*0.5
      DO 42 J=3,JM
      DO 43 I=1,IMP1
      U(I,J)=XU(I,J)
      V(I,J)=XV(I,J)
      G(I,J)=F(I,J)
   43 CONTINUE
   42 CONTINUE
   26 CONTINUE
      DO 30 J=3,JM
      JP1=J+1
      JM1=J-1
      JM2=J-2
      XMJ=XM(J)
      XM1=XM(JM1)
      C1=Y/XMJ
      S1=Y/XM1
      CB=X(JP1)/Y
      CS=X(J)/Y
      B=X(JM1)/Y
      BETJ=BET(J)*CCY
      LJ=L(J)
      DO 31 LL=1,LJ
      II=KA(LL,J)
      MM=KB(LL,J)
      DO 310 I=II,MM
      IP1=I+1
      IM1=I-1
      IM2=I-2
      UIJ=U(I,J)
      VIJ=V(I,J)
      UP1J=U(IP1,J)
      UM1J=U(IM1,J)
      UIP1=U(I,JP1)
      UM1P1=U(IM1,JP1)
      UIM1=U(I,JM1)
      UM1M1=U(IM1,JM1)
      UP1M1=U(IP1,JM1)
      UIM2=U(I,JM2)
      VIM2=V(I,JM2)
```

```
      UM2J=U(IM2,J)
      VM2J=V(IM2,J)
      UM1M2=U(IM1,JM2)
      VM1M2=V(IM1,JM2)
      UM2M1=U(IM2,JM1)
      VM2M1=V(IM2,JM1)
      VP1J=V(IP1,J)
      VM1J=V(IM1,J)
      VIP1=V(I,JP1)
      VIM1=V(I,JM1)
      VM1P1=V(IM1,JP1)
      VM1M1=V(IM1,JM1)
      VP1M1=V(IP1,JM1)
      MP=MPP(I,J)
      IF(MP.EQ.0) GO TO 304
      IF(MP.EQ.30) GO TO 304
      IF(MP.EQ.50) GO TO 304
      IF(MQQ(IP1,J).NE.2) GO TO 27
      UP1J=-UIJ
      VP1J=-VIJ
   27 IF(MQQ(I,JP1).NE.2) GO TO 271
      UIP1=-UIJ
      VIP1=-VIJ
  271 IF(MQQ(IM1,JP1).NE.2) GO TO 272
      UM1P1=-UM1J
      VM1P1=-VM1J
  272 IF(MQQ(IM2,J).NE.2) GO TO 28
      UM2J=-UM1J
      VM2J=-VM1J
   28 IF(MQQ(IM2,JM1).NE.2) GO TO 29
      UM2M1=-UM1M1
      VM2M1=-VM1M1
   29 IF(MQQ(IM1,JM2).NE.2) GO TO 291
      UM1M2=-UM1M1
      VM1M2=-VM1M1
  291 IF(MQQ(I,JM2).NE.2) GO TO 292
      UIM2=-UIM1
      VIM2=-VIM1
  292 IF(MQQ(IP1,JM1).NE.2) GO TO 303
      UP1M1=-UIM1
      VP1M1=-VIM1
  303 CONTINUE
  304 DF=-BET J        *(XV(I,J)+XV(IM1,J)+XV(IM1,JM1)+XV(I,JM1))*0.25
      SS=(C1*(UM1J+UIJ-UM2J-UP1J)-(UIP1-UIJ+UM1P1-UM1J)*CB+2.0*CS*
     1(UIJ-UIM1+UM1J-UM1M1)+S1*(UP1M1+UM2M1-UIM1-UM1M1)-(UIM1-UIM2+UM1M1
     2-UM1M2)*B )*ARY+TW(I,J)+DF
      DF=CS*(VIJ-VIM1-VM1J+VM1M1)
        SS=    AR/XMJ*(C1*(-3.0*(VIJ-VM1J)+VP1J-VM2J)-DF
     1+(VIP1-VIJ-VM1P1+VM1J)*CB)+AR/XM1*(S1*(3.0*(VM1M1-VIM1)+VP1M1
     2-VM2M1)+(VM1M1-VM1M2-VIM1+VIM2)*B +DF)+SS
    4 E(I,J)=-SS*DDT
  310 CONTINUE
   31 CONTINUE
      E(2,J)=E(IM,J)
      E(IMP1,J)=E(3,J)
   30 CONTINUE
      IP=0
   [illegible]7 IP=IP+1
C*****ISLANDS
      MAR=0
C*****ANTARCTICA
C*****NEWZEALAND
C*****AUSTRALIA
      DO 5021 K=1,3
      RESK=RES(K)
      MP=IND(K)
```

```
      MPMP=INDIM(K)
      II=LX1(K)
      IG=LX2(K)
      IM2=LY1(K)
      JM2=LY2(K)
      R=0.0
      DO 5016 J=IM2,JM2
      DO 5015 I=II,IG
      IF(MPP(I,J).NE.MP) GO TO 5015
      R=R+E(I,J)
 5015 CONTINUE
 5016 CONTINUE
      IF(ABS( R ).LE.REL) GO TO 5021
      DF=-R/RESK
      MAR=MAR+1
      IF(K.EQ.1) IM2=2
      DO 5022 J=IM2,JM2
      JP1=J+1
      JM1=J-1
      CS=Y/X(J)
      CB= 2.0*(CS+1.0/CS)
      SS=X(JP1)/Y
      C1=X(JM1)/Y
      DO 5023 I=II,IG
      MPPIJ=MPP(I,J)
      MMMM=(MPPIJ-MP)*(MPPIJ-MPMP)
      IF(MMMM.NE.0) GO TO 5023
      F(I,J)=F(I,J)+DF
      IM1=I-1
      IP1=I+1
      CCC=DF*CS
      E(I,JP1)=E(I,JP1)+SS*DF
      E(I,JM1)=E(I,JM1)+C1*DF
      E(IP1,J)=E(IP1,J)+CCC
      E(IM1,J)=E(IM1,J)+CCC
      E(I,J)=E(I,J)-CB*DF
 5023 CONTINUE
 5022 CONTINUE
      IF(K.EQ.2) GO TO 5021
      IF(K.EQ.1) GO TO 5024
      DO 5026 J=8,12
      E(2,J)=E(IM,J)
 5026 CONTINUE
      GO TO 5021
 5024 CONTINUE
      E(IMP1,5)=E(3,5)
      E(2,5)=E(IM,5)
      CCC=DF*Y/X(4)
      E(3,4)=E(3,4)+CCC
      E(IM,4)=E(IM,4)+CCC
      E(IMP1,4)=E(3,4)
      E(2,4)=E(IM,4)
 5021 CONTINUE
C*****NEWZEALAND
C*****ANTARCTICA
      DO 32 J=4,JM
      JM1=J-1
      JP1=J+1
      XJ=X(J)
      CS=Y/XJ
      SS=X(JP1)/Y
      C1=X(JM1)/Y
      CB=2.0*(CS+XJ/Y)
      LJ=L(J)
      DO 33 LL=1,LJ
      II=KA(LL,J)
```

```
      MM=KB(LL,J)
      DO 330 I=II,MM
      IF(MPP(I,J).GE.3)  GO TO 330
      R=E(I,J)
      IF(ABS(R).LE.REL)  GO TO 330
      MAR=MAR+1
      DF=R/CB*SOR
      E(I,J)=-R*SOR1
      F(I,J)=F(I,J) +DF
      IP1=I+1
      CCC=DF*CS
      E(IP1,J)=E(IP1,J) +CCC
      IM1=I-1
      E(IM1,J)=E(IM1,J) +CCC
      E(I,JP1)=E(I,JP1) +SS*DF
      E(I,JM1)=E(I,JM1) +C1*DF
      IF(I.NE.3)  GO TO 331
      E(IMP1,JP1)=E(3,JP1)
      E(IMP1,JM1)=E(3,JM1)
      E(IMP1,J)=E(3,J)
      E(IM,J)=E(2,J)
      GO TO 330
  331 IF(I.NE.IM)  GO TO 332
      E(2,J)=E(IM,J)
      E(2,JP1)=E(IM,JP1)
      E(2,JM1)=E(IM,JM1)
      E(3,J)=E(IMP1,J)
      GO TO 330
  332 IF(I.NE.4)  GO TO 333
      E(IMP1,J)=E(3,J)
      GO TO 330
  333 IF(I.NE.IMM1)  GO TO 330
      E(2,J)=E(IM,J)
  330 CONTINUE
   33 CONTINUE
   32 CONTINUE
      IF(MAR.EQ.0)  GO TO 36
      IF(IP.GT.1000)  GO TO 1112
      IF(IP.NE.1)  GO TO 37
      WRITE(6,38)  IP,MAR
   38 FORMAT(1H ,7X,6HKAISU=I5,5X,12HTEN NO KAZU=I5)
      GO TO 37
   36 EN=0.0
      WRITE(6,38)  IP,MAR
      DO 70 J=3,JM
      F(1,J)=F(IMM1,J)
      F(2,J)=F(IM,J)
      F(IMP1,J)=F(3,J)
   70 CONTINUE
      DO 23 J=3,JM
      JM1=J-1
      JP1=J+1
      XMJ=XM(J) *2.0
      DF=XMJ*Y4
      LVJ=LV(J)
      DO 24 LJ=1,LVJ
      II=LA(LJ,J)
      IG=LB(LJ,J)
      DO 244 I=II,IG
      IP1=I+1
      U(I,J)=XU(I,J)
      V(I,J)=XV(I,J)
      XU(I,J)=
     1        (F(I,J) +F(IP1,J) -F(I,JP1)-F(IP1,JP1))/CCY
      XV(I,J)=
     1        (F(IP1,J)+F(IP1,JP1)-F(I,J)-F(I,JP1))/XMJ
```

```
      EN=EN+DL*(XU(I,J)**2+XV(I,J)**2)
  244 CONTINUE
   24 CONTINUE
      XU(IMP1,J)=XU(3,J)
      XV(IMP1,J)=XV(3,J)
      U(IMP1,J)=U(3,J)
      V(IMP1,J)=V(3,J)
      XU(2,J)=XU(IM,J)
      XV(2,J)=XV(IM,J)
      XU(1,J)=XU(IMM1,J)
      XV(1,J)=XV(IMM1,J)
      U(2,J)=U(IM,J)
      V(2,J)=V(IM,J)
      U(1,J)=U(IMM1,J)
      V(1,J)=V(IMM1,J)
   23 CONTINUE
      WRITE(6,34)  NN,CD,EN,F(1,3)
   34 FORMAT(1H ,5HSTEP=I5,5X,5HTIME=E15.7,5X,7HENERGY=E15.7,5X,4HACC=F7
     1.4)
      IF(EN.GT.5.0E1) GO TO 1111
      IF(NN.GE.NEND) GO TO 88
      IF(MATS.NE.0) GO TO 10
      IF(NN.NE.((NN/NTAPE)*NTAPE)) GO TO 9
      MAG=MAG+1
      WRITE(10) XU,XV,F,G,U,V,IW,MPP,MQQ,L,KA,KB,LV,LA,LB,AH,DT,MAT,
     1Y,REL,XM,FJU,X,BET,LX1,LX2,LY1,LY2,IND,INDIN,NN,NEND,RES,
     2NRES,ARY,AR,Y4,E,CCY,MATS,CD,IM,JM,IMP1,JMP1,IMM1,MAG
      WRITE(6,8) MAG
    9 IF(NN.EQ.((NN/NPRINT)*NPRINT)) GO TO 88
   10 ENN=EN
      IF(MATS.EQ.0) GO TO 39
      MATS=MATS+1
      IF(MATS.EQ.3) GO TO 46
      DO 44 J=3,JM
      DO 45 I=1,IMP1
      F(I,J)=G(I,J)
      U(I,J)=XU(I,J)
      V(I,J)=XV(I,J)
   45 CONTINUE
   44 CONTINUE
      GO TO 26
   46 DO 47 J=3,JM
      DO 48 I=1,IMP1
      R=F(I,J)
      F(I,J)=G(I,J)
      G(I,J)=R
   48 CONTINUE
   47 CONTINUE
      DO 49 J=3,JM
      JP1=J+1
      XMJ=XM(J)*2.0
      LVJ=LV(J)
      DO 55 LJ=1,LVJ
      II=LA(LJ,J)
      IG=LB(LJ,J)
      DO 550 I=II,IG
      IP1=I+1
      U(I,J)=
     1          (F(I,J)+F(IP1,J)-F(I,JP1)-F(IP1,JP1))/CCY
      V(I,J)=
     1          (F(IP1,J)+F(IP1,JP1)-F(I,J)-F(I,JP1))/XMJ
  550 CONTINUE
   55 CONTINUE
      U(1,J)=U(IMM1,J)
      V(1,J)=V(IMM1,J)
      U(2,J)=U(IM,J)
```

```
      V(2,J)=V(IM,J)
      U(IMP1,J)=U(3,J)
      V(IMP1,J)=V(3,J)
   49 CONTINUE
      MATS=0
      NN=NN+1
      DDT=DT
      NNT=NNT+1
      CD=CD+DAY
      GO TO 39
   88 K=1
      MP=-1
  613 MP=MP+1
      MM=K-MP
      IG=18*MP+3
      IF(MM.EQ.0) GO TO 614
      II=IG+17
      GO TO 615
  614 II=38
  615 WRITE(6,701)
  701 FORMAT(1H0,15HSTREAM FUNCTION)
      DO 702 J=1,IMP1
      WRITE(6,703) J,(F(J,I),I=IG,II)
  703 FORMAT(1H ,I3,1X,18F7.4)
  702 CONTINUE
      IF(MM.NE.0) GO TO 613
      IF(NN.LT.NEND) GO TO 10
      MAG=MAG+1
      WRITE(10) XU,XV,F,G,U,V,TW,MPP,MQQ,L,KA,KB,LV,LA,LB,AH,DT,MAT,
     1Y,REL,XM,FJU,X,BET,LX1,LX2,LY1,LY2,IND,INDIN,NN,NEND,RES,
     2NRES,ARY,AR,Y4,E,CCY,MATS,CD,IM,JM,IMP1,JMP1,IMM1,MAG
      WRITE(6,8) MAG
    8 FORMAT(1H0,32HNO. OF RECORDS IN MAGNETIC TAPE=I3)
      GO TO 1111
 1112 WRITE(6,38) IP,MAR
 1111 STOP
      END
      SUBROUTINE RESID
      RETURN
      END
      SUBROUTINE HAJIME
      RETURN
      END
      SUBROUTINE RESID
      COMMON AH,DT,Y,H,REL,XM(39),FJU(39),X(39),F(147,39),E(147,39),
     1U(147,39),V(147,39),G(147,39),XU(147,39),XV(147,39),TW(147,39),CD,
     2BET(39),Y4,CCY,AR,ARY,RES(3), DDT,
     3MAT,L(39),LV(39),LA(10,37),LB(10,37),KA(10,37),KB(10,37),MATS,
     4MPP(147,39),MQQ(147,39),INDIN(3),IND(3),NRES(3),
     5LX1(3),LX2(3),LY1(3),LY2(3),IM,JM,IMP1,JMP1,IMM1
      DO 1 K=1,3
      DO 8 J=1,JMP1
      DO 9 I=1,IMP1
      E(I,J)=0.0
    9 CONTINUE
    8 CONTINUE
      S=0.0
      I1=LX1(K)
      I2=LX2(K)
      J1=LY1(K)
      J2=LY2(K)
      MIN=IND(K)
      MININ=INDIN(K)
      NUM=0
      IF(K.EQ.1) J1=2
      DO 3 J=J1,J2
```

```
      JM1=J-1
      JP1=J+1
      CS=Y/X(J)
      C1=X(JM1)/Y
      SS=X(JP1)/Y
      CB=-2.0*(CS+1.0/CS)
      DO 4 I=I1,I2
      MP=MPP(I,J)
      MMM=(MP-MIN)*(MP-MININ)
      IF(MMM.NE.0) GO TO 4
      IP1=I+1
      IM1=I-1
      NUM=NUM+1
      E(I,J)=E(I,J)+CB
      E(IP1,J)=E(IP1,J)+CS
      E(IM1,J)=E(IM1,J)+CS
      E(I,JP1)=E(I,JP1)+SS
      E(I,JM1)=E(I,JM1)+C1
    4 CONTINUE
    3 CONTINUE
      IF(K.GE.2) GO TO 10
      J1=3
      DO 11 J=3,3
      CS=Y/X(J)
      E(3,J)=E(3,J)+CS
      E(IM,J)=E(IM,J)+CS
   11 CONTINUE
   10 CONTINUE
      DO 5 J=J1,J2
      DO 6 I=I1,I2
      IF(MPP(I,J).EQ.MIN) S=S+E(I,J)
    6 CONTINUE
    5 CONTINUE
      NRES(K)=NUM
      RES(K)=S
      WRITE(6,7) K,NUM,S
    7 FORMAT(1H ,2HK=I2,2X,12HGRID POINTS=I3,2X,4HRES=E15.7)
    1 CONTINUE
      DO 16 J=1,18
      DO 17 I=1,IMP1
      IF(MQQ(I,J).EQ.1) GO TO 17
      MP=MPP(I,J)
      IF(MP.EQ.2) GO TO 17
      IF(MP.EQ.((MP/3)*3)) GO TO 18
      IF(MP.EQ.((MP/4)*4)) GO TO 19
      MQQ(I,J)=5
      GO TO 17
   18 MQQ(I,J)=3
      GO TO 17
   19 MQQ(I,J)=4
   17 CONTINUE
   16 CONTINUE
      WRITE(6,15) (I,I=1,38)
   15 FORMAT(1H ,4X,38I3)
      DO 12 I=1,IMP1
      WRITE(6,14) I,(MPP(I,J),J=1,38)
      WRITE(6,13) I,(MQQ(I,J),J=1,38)
   12 CONTINUE
   13 FORMAT(1H ,I3,3X,38I3)
   14 FORMAT(1H ,I3,2X,38I3)
      RETURN
      END
      SUBROUTINE HAJIME
C
C         DATA:
C                   IM,JM,IMH,JMH
```

```
C             OCEAN SHAPE (SUBROUTINE SHAPE 1)
C             X,DX,DY  (DX AND DY ARE THE GRID SIZES IN LONGITUDE AND
C             LATITUDE (DEGREES), RESPECTIVELY. Y IS THE LATITUDE
C             CORRESPONDING TO J=0).
C             AH,H, REL,DT,MAT
C             IT: IT=1  WIND STRESS IS READ TO COMPUTE THE WIND STRESS CURL.
C                 IT=2  WIND STRESS CURL IS GIVEN FROM CARDS, A MAGNETIC
C                       TAPE, OR THE SUBROUTINE CURL.
C
      COMMON AH,DT,Y,H,REL,XM(39),FJU(39),X(39),F(147,39),E(147,39),
     1U(147,39),V(147,39),G(147,39),XU(147,39),XV(147,39),TW(147,39),CD,
     2BET(39),Y4,CCY,AR,ARY,RES(3), DDT,
     3MAT,L(39),LV(39),LA(10,37),LB(10,37),KA(10,37),KB(10,37),MATS,
     4MPP(147,39),MQQ(147,39),INDIN(3),IND(3),NRES(3),
     5LX1(3),LX2(3),LY1(3),LY2(3),IM,JM,IMP1,JMP1,IMM1
      DIMENSION L1(9),WE(147,39),WN(147,39),C(39)
      EQUIVALENCE (U(1),WE(1)),  (V(1),WN(1))
      READ(5,40) IM,JM,IMH,JMH
   40 FORMAT(4I5)
      IMP1=IM+1
      IMM1=IM-1
      JMP1=JM+1
C     CALL SHAPE1
      CALL SHAPE 1
      DO 548 J=1,MM
      DO 549 I=1,IMP1
      F(I,J)=0.0
      G(I,J)=0.0
      U(I,J)=0.0
      V(I,J)=0.0
      XU(I,J)=0.0
      XV(I,J)=0.0
  549 CONTINUE
  548 CONTINUE
      READ(5,18) Y,DX,DY
   18 FORMAT(3F10.0)
      P=3.1415926/180.0
      DX=DX*P
      MM=JM+2
      DO 100 I=1,MM
      AR=(Y+DY*FLOAT(I))*P
      F1=COS(AR)
      X(I)=DX*F1
      C(I)=F1
      BET(I)=F1*X(I)*14.58E-5
  100 CONTINUE
      Y=DY*P
      CD=14.58/(DX*Y)
      DO 9997 J=1,JMP1
      XM(J)=(X(J)+X(J+1))/2.0
      FJU(J)=CD*(X(J)-X(J+1))
 9997 CONTINUE
      READ(5,16) AH,H,REL,DT,MAT
   16 FORMAT(4E15.7,I5)
      WRITE(6,17) AH,H,REL
   17 FORMAT(1H ,15HEDDY VISCOSITY=E15.7,10X,6HDEPTH=E15.7,10X,
     115HRELAX ACCURACY=E15.7)
      READ(5,10) IT
   10 FORMAT(I5)
      GO TO  (1,2), IT
    1 CONTINUE
C     CALL WIND
      CALL WIND
      P=0.01/4.0E5
      DO 540 J=JMH,JMP1
      XMJ=XM(J)
```

```
      JM1=J-1
      XM1=XM(JM1)
      DO 541 I=IMH,IM
      IM1=I-1
      TW(I,J)=(XMJ*(-WE(I,J)-WE(IM1,J))+XM1*(WE(I,JM1)+WE(IM1,JM1))
     1     + Y*(WN(I,J)+WN(I,JM1)-WN(IM1,J)-WN(IM1,JM1)))*P
  541 CONTINUE
      TW(1,J)=TW(IMM1,J)
      TW(2,J)=TW(IM,J)
      TW(IMP1,J)=TW(IMH,J)
  540 CONTINUE
      GO TO 3
    2 CONTINUE
C     CALL CURL
      CALL CURL
      READ(5,6004) (TW(I,J),I=3,IM)
 6004 FORMAT(5E15.7)
      TW(IMP1,J)=TW(3,J)
      TW(2,J)=TW(IM,J)
      TW(1,J)=TW(IMM1,J)
    3 CONTINUE
C     INITIAL GUESS
      DO 4000 J=4,JM
      CJ=1.0/(C(J)*Y*14.58E-5)/4.0
      LJ=L(J)
      DO 360 LL=1,LJ
      II=KA(LL,J)
      IG=KB(LL,J)
      MP=II+IG
  362 DO 361 I=II,IG
      MM=MP-I
      K=MM+1
      P=F(K,J)-(TW(MM,J)+TW(K,J))*CJ
      F(MM,J)=P
  361 CONTINUE
      IF(II.NE.3) GO TO 360
      F(IMP1,J)=F(3,J)
  360 CONTINUE
      F(1,J)=F(IMM1,J)
      F(2,J)=F(IM,J)
 4000 CONTINUE
C     INITIAL GUESS
      CCC=2.0*Y
      DO 4049 J=3,JM
      JP1=J+1
      LJ=LV(J)
      DO 4058 LL=1,LJ
      II=LA(LL,J)
      IG=LB(LL,J)
      DO 4053 I=II,IG
      IP1=I+1
      P=(F(I,J)+F(IP1,J)-F(I,JP1)-F(IP1,JP1))/CCC
      U(I,J)=P
      XU(I,J)=P
      P=(F(IP1,J)+F(IP1,JP1)-F(I,J)-F(I,JP1))/XMJ
      V(I,J)=P
      XV(I,J)=P
 4053 CONTINUE
 4058 CONTINUE
      XU(IMP1,J)=XU(3,J)
      XV(IMP1,J)=XV(3,J)
      XU(2,J)=XU(IM,J)
      XV(2,J)=XV(IM,J)
      XU(1,J)=XU(IMM1,J)
      XV(1,J)=XV(IMM1,J)
      U(IMP1,J)=U(3,J)
```

```
      V(IMP1,J)=V(3,J)
      U(2,J)=U(IM,J)
      V(2,J)=V(IM,J)
      U(1,J)=U(IMM1,J)
      V(1,J)=V(IMM1,J)
 4049 CONTINUE
      AR=AH/6.37E8/6.37E8
      ARY=AR/Y
      CCY=2.0*Y
      Y4=Y*0.25
      RETURN
      END
      SUBROUTINE SHAPE1
C         SUBROUTINE TO BE USED FOR THE BAROTROPIC PART OF THE WORLD OCEAN
C         CIRCULATION WHEN THE SHAPE OF THE OCEAN IS CHANGED.
C         DATA:  LV, LA AND LB FOR MQQ.
C                MM, M1(K),M2(K) AND M3(K) FOR MPP.
C         LV, LA AND LB ARE THE SAME AS THOSE USED FOR THE SUBROUTINE
C         SHAPE 2 (BAROCLINIC  PART), BUT THE DATA FOR MPP ARE DIFFERENT
C         FROM THOSE USED FOR THE SHAPE2.
C         LX1, LX2, LY1, LY2 WHICH SPECIFY THE AREAS INCLUDING THE SEPARATE
C         ISLANDS.
      COMMON AH,DT,Y,H,REL,XM(39),FJU(39),X(39),F(147,39),E(147,39),
     1U(147,39),V(147,39),G(147,39),XU(147,39),XV(147,39),TW(147,39),CD,
     2BET(39),Y4,CCY,AR,ARY,RES(3), DDT,
     3MAT,L(39),LV(39),LA(10,37),LB(10,37),KA(10,37),KB(10,37),MATS,
     4MPP(147,39),MQQ(147,39),INDIN(3),IND(3),NRES(3),
     5LX1(3),LX2(3),LY1(3),LY2(3),IM,JM,IMP1,JMP1,IMM1
      IMM1=IM-1
      IMP1=IM+1
      JMM1=JM-1
      JMP1=JM+1
      JMH=3
      IMH=3
      DO 30 J=1,JM
      DO 31 I=1,IMP1
      MQQ(I,J)=2
   31 CONTINUE
   30 CONTINUE
      DO 32 J=3,JMM1
      READ(5,33)  M
   33 FORMAT(I2)
      READ(5,34) (LA(I,J),LB(I,J),I=1,M)
   34 FORMAT(7(2I4,2X))
      DO 35 I=1,M
      II=LA(I,J)
      IG=LB(I,J)
      DO 36 N=II,IG
      MQQ(N,J)=1
   36 CONTINUE
   35 CONTINUE
      LV(J)=M
      MQQ(1,J)=MQQ(IMM1,J)
      MQQ(2,J)=MQQ(IM,J)
      MQQ(IMP1,J)=MQQ(3,J)
   32 CONTINUE
      DO 3006 J=3,38
      READ(5,3007)  MM
 3007 FORMAT(I2)
      READ(5,3008)  (M1(K),M2(K),M3(K),K=1,MM)
 3008 FORMAT(8(2I4,I2))
      DO 3009 K=1,MM
      K5=M1(K)
      K6=M2(K)
      K7=M3(K)
      DO 3010 I=K5,K6
```

```
      MPP1(I,J)=K7
 3010 CONTINUE
 3009 CONTINUE
 3006 CONTINUE
      DO 3011 J=3,38
      READ(5,3007) MM
      L1(J)=MM
      READ(5,3012) (KA1(LL,J),KB1(LL,J),LL=1,MM)
 3012 FORMAT(16I5)
 3011 CONTINUE
      DO 6003 J=1,JMP1
      MPP1(1,J)=MPP1(IMM1,J)
      MPP1(2,J)=MPP1(IM,J)
      MPP1(IMP1,J)=MPP1(3,J)
 6003 CONTINUE
      DO 6004 J=3,JM
      JP1=J+1
      JM1=J-1
      DO 6005 I=3,IM
      IF(MPP1(I,J).GT.1) GO TO 6005
      IF(MPP1(I-1,J).EQ.2) GO TO 6005
      IF(MPP1(I,JP1).EQ.2) GO TO 6005
      IF(MPP1(I,JM1).EQ.2) GO TO 6005
      IF(MPP1(I+1,J).EQ.2) GO TO 6005
      MPP1(I,J)=0
 6005 CONTINUE
      MPP1(IMP1,J)=MPP1(3,J)
      MPP1(2,J)=MPP1(IM,J)
      MPP1(1,J)=MPP1(IMM1,J)
 6004 CONTINUE
      WRITE(6,6016) (J,J=3,38)
 6016 FORMAT(1H ,5X,38I3/)
      DO 6012 I=1,IMP1
      WRITE(6,6014) I,(MPP1(I,J),J=3,38)
      WRITE(6,6015) (MQQ(I,J),J=3,38)
 6012 CONTINUE
 6014 FORMAT(1H ,I3,2X,38I3)
 6015 FORMAT(1H ,6X,38I3)
      READ(5,2) (LX1(K),LX2(K),LY1(K),LY2(K),K=1,3)
    2 FORMAT(4I5)
      RETURN
      END
      SUBROUTINE WIND
      COMMON AH,DT,Y,H,REL,XM(39),FJU(39),X(39),F(147,39),E(147,39),
     1U(147,39),V(147,39),G(147,39),XU(147, 39),XV(147,39),TW(147,39),CD,
     2BET(39),Y4,CCY,AR,ARY,RES(3), DDT,
     3MAT,L(39),LV(39),LA(10,37),LB(10,37),KA(10,37),KB(10,37),MATS,
     4MPP(147,39),MQQ(147,39),INDIN(3),IND(3),NRES(3),
     5LX1(3),LX2(3),LY1(3),LY2(3),IM,JM,IMP1,JMP1,IMM1
      DIMENSION WE(147,7),WN(147,7)
      RETURN
      END
      SUBROUTINE CURL
      RETURN
      END
```

```
C      MPP
C       MPP=1 IF THE FOUR NEAREST SURROUNDING POINTS ARE WATER-POINT,
C          =2 ON THE LAND (EXCLUDING THE COAST LINE).
C       FOR THE COAST-POINTS, REFER TO FIG.1.
C
C                 14
C           34XXXXXXXXXXXXXX33
C             XXXXXLANDXXXXX
C             XXXXXXXXXXXXXX
C             XX22      21XX
C           11XX          XX13
C             XX          XX
C             XX23      24XX
C             XXXXXXXXXXXXXX
C           31XXXXXXXXXXXXXX32
C                 12
C
C              FIG.1
C
C      MQQ
C
C       MQQ=1 IF THE FOUR NEARESR SURROUNDING POINTS ARE WATER-POINT,
C          =2 ON THE LAND.
C       IN OTHER CASES, REFER TO FIG.2.
C
C                1112
C             XXXXXXXXXXXXXX
C             XXXXXLANDXXXXX
C             XXXXXXXXXXXXXX
C             XX1221  2211XX
C             XX          XX
C         2111XX          XX1121
C             XX          XX
C             XX1122  2112XX
C             XXXXXXXXXXXXXX
C             XXXXXXXXXXXXXX
C                1211
C
C              FIG.2
C
       COMMON T(147,39,5),TT(147,39,5),SP(147,39),AT(5),UU(147,39,5),
      1VV(147,39,5),U(147,39,5),V(147,39,5),W(147,39,5),UB(147,39),
      2VB(147,39),WE(147,39),WN(147,39),Q(39),YJA(38),XHT(38),XHS(38),
      3 XMY(38), Z(5),X(39),XM(39),FU(39),FJU(39),ZZ(6),H,AZ,AH,DT,AL,
      4GAM,Y,YY,B,BR,HH,H2,AZHH,R2,AHY,AHRB,AH2,BB,BB2,AAA,BBR,DDT,A1,UV,
      5UUU,VVV,RRH,AQ,GAM2,AL2,BUN,BY,AN,AMRR ,GAMGAM,AIAL,BAN, KMP1,
      6MPP(147,39),MQQ(147,39),IM,JM,KM,IMM1,JMM1,KMM1,IMP1,JMP1,MAT,
      7 NK,NNNN,IMH,JMH,MATS,L(39),KA(10,39),KB(10,39),LV(39),NEND,
      8LA(10,39),LB(10,39),NN,TE(147,46),UN(147,39),TD(147,46),RN(147,39)
      *,CL(147,39)
        DIMENSION UHEAD(39),THEAD(39)
       DIMENSION QE(147,39),QH(147,39),QSH(147,39)
       COMMON /TEMP/ QE,QH,QSH,ZQE,ZQH,ZSH,ZRN
       DIMENSION ZQE(39),ZQH(39)
       LOGICAL STOP
       REAL KK
             DIMENSION ZRN(39),ZSH(39)
       DIMENSION ZT(39,5),ZW(39,5),UZ(39,5),VZ(39,5)
       EQUIVALENCE(ZT(1),UZ(1)),(ZW(1),VZ(1)),(ZT(1),W(1)),(ZW(1),W(196))
       DIMENSION ICTL(7),RCTL(2)  , FIELD(18)
       DATA ICTL/1,6,9,1,18,7,2/
       DATA RCTL /0.001,60./
C
```

```
7777  FORMAT('1',30X,'EXPERIMENT VS CALCULATED RADIATION')
      UHEAD(1) = -72.
      THEAD(1) = -74.
      DO 88 I=2,39
      UHEAD(I) = UHEAD(1) + 4.*(I-1)
      THEAD(I) = THEAD(1) + 4.*(I-1)
88    CONTINUE
C
      NNNN=0
      READ(5,9) KT
      READ(5,9) IN
    9 FORMAT(I5)
      IF(IN.EQ.0) GO TO 11
   17  READ(KT,END=92)
     *             TT,UU,VV,T,U,V,AT,SP,W,UB,VB,X,XM,Q,FU,FJU,DT,AZ,AH,WE,
     1WN,BAN,AL,GAM,Y,YY,R,RR,HH,H2,AZHH,BUN,R2,AHY,AHPE,AH2,PB,PB2,
     2AAA,BBB,DDT,A1,UV,UUU,VVV,RRH,AQ,GAM2,AL2,RY,AMRP,GAMGAM,ALAL,
     3H,Z,ZZ,AM,XJA,XHT,XHS,XMY, CD,
     4MPP,MQQ,KA,KB,L,LA,LB,LV,MATS,NEND,NK,NNNN,MAT,IM,JM,KM,IMH,IMM1,
     5IMP1,KMP1,KMM1,JMM1,JMP1,NN,JMH,MAG,TE,TD,RN
     6,QE,QH,QSH,CL,UN
      GO TO 17
   92 BACK SPACE KT
      IF(MAG.LT.34) GO TO 94
      REWIND KT
      KT = KT + 1
      MAG=0
94    CONTINUE
  73  READ(10,END=74) UB,VB
      GO TO 73
   74 REWIND 10
      DO 2222 I=1,145
      WRITE(6,7000) I,(UN(I,J),J=3,20)
 2222 CONTINUE
      DO 4444 I=1,145
      WRITE(6,7000) I,(UN(I,J),J=21,38)
 4444 CONTINUE
      WRITE(6,890)  (THEAD(J),J=3,20)
      DO 7040 I=1,147
      WRITE(6,7000) I, (TE(I,J),J=3,20)
 7040 CONTINUE
      WRITE(6,890)  (THEAD(J),J=21,38)
      DO 7034 I=1,147
      WRITE(6,7000) I, (TE(I,J),J=21,38)
 7034 CONTINUE
      CL(1,3)=6.00
      CL(2,3)=6.00
      CL(145,3)=6.00
      CL(146,3) = 6.
      CL(147,3) = 6.
      DO 3333 I=1,145
      WRITE(6,7000) I,(CL(I,J),J=3,20)
 3333 CONTINUE
      DO 5555 I=1,145
      WRITE(6,7000) I,(CL(I,J),J=21,38)
 5555 CONTINUE
      FA=400000.
      DO 311 I=1,147
      WE(I,3)=1.16*FA
      WE(I,4)=1.72*FA
      WE(I,5)=1.83*FA
      WE(I,6)=1.90*FA
      WE(I,7)=1.83*FA
      WE(I,8)=1.50*FA
      WE(I,9)=1.10*FA
      WE(I,10)=0.72*FA
```

```
      WE(I,11)=-0.50*FA
      WE(I,12)=-0.07*FA
      WE(I,13)=-0.30*FA
      WE(I,14)=-0.52*FA
      WE(I,15)=-0.60*FA
      WE(I,16)=-0.60*FA
      WE(I,17)=-0.52*FA
      WE(I,18)=-0.38*FA
      WE(I,19)=-0.30*FA
      WE(I,20)=-0.24*FA
      WE(I,21)=-0.26*FA
      WE(I,22)=-0.38*FA
      WE(I,23)=-0.50*FA
      WE(I,24)=-0.53*FA
      WE(I,25)=-0.40*FA
      WE(I,26)=-0.14*FA
      WE(I,27)=0.10*FA
      WE(I,28)=0.42*FA
      WE(I,29)=0.61*FA
      WE(I,30)=0.74*FA
      WE(I,31)=0.78*FA
      WE(I,32)=0.63*FA
      WE(I,33)=0.48*FA
      WE(I,34)=0.14*FA
      WE(I,35)=+0.01*FA
      WE(I,36)=-0.04*FA
      WE(I,37)=-0.13*FA
  311 CONTINUE
      AH=2.5E7
      AHY=AH*Y
      AHRR=AH/RR
      AH2=AH/(YY*RR)
      AL=0.25E-3
      ALAL=AL*2.0
      AL2=AL/2.0
      AZ=1.0
      AZHH=AZ/HH
      GAMGAM=25.0*H/(AZ*0.864E5)
      WRITE(6,7777)
      WRITE(6,9005)
 9005 FORMAT(1H0,21HBAROTROPIC COMPONENTS/)
      WRITE(6,9110)
 9110 FORMAT(1X,'UB')
      WRITE(6,9004) (J,J=3,21)
 9004 FORMAT(1H0,4X,19(2X,I2,2X)/)
      DO 9000 I=1,147
      WRITE(6,9001) I,(UB(I,J),J=3,21),I
 9000 CONTINUE
      WRITE(6,7777)
      WRITE(6,9004) (J,J=20,38)
      DO 9002 I=1,147
      WRITE(6,9001) I,(UB(I,J),J=20,38),I
 9002 CONTINUE
      WRITE(6,7777)
      WRITE(6,9200)
 9200  FORMAT(1X,'VB')
      WRITE(6,9004) (J,J=3,21)
      DO 9006 I=1,147
      WRITE(6,9001) I,(VB(I,J),J=3,21),I
 9006 CONTINUE
      WRITE(6,7777)
      WRITE(6,9004) (J,J=20,38)
      DO 9007 I=1,147
      WRITE(6,9001) I,(VB(I,J),J=20,38),I
 9007 CONTINUE
 9001 FORMAT(1H ,I3,1X,19F6.2,1X,I3)
```

```
      WRITE(6,9100) (Q(J),J=3,38)
 9100 FORMAT(1H0,18F6.2/1H ,18F6.2/)
      IF(NK.NE.3) GO TO 492
      GO TO 5
   11 CONTINUE
      NN=0
      CD=0.0
      NK=3
      MAG=0
      CALL PREP
      CALL PREPA
      CALL GEOST
    5 READ(5,3) MATS, NEND, NPRINT, NTAPE, DT
    3 FORMAT(4I5,E15.7)
      WRITE(6,6) NPRINT,NTAPE
6     FORMAT('  NPRINT = ',I5,'    NTAPE = ',I5)
      WRITE(6,8) KT, MAG, CD
8     FORMAT(' KT = ',I2,' MAG = ',I2,' CD = ',F7.1)
      DTD=DT/0.864E5
      K=NN+1
      NEND=NEND+K
      WRITE(6,4)  K, NEND, MATS, DT,AZ,AM,AH
    4 FORMAT(' ','TIME STEP  FROM ',I5,3X,'TO ',I5,5X,'MATS=',I3,5X,
     X 'DT=',4E15.7/)
      IF(DT.LT.10.) STOP 100
      DDT=DT*2.0
      DO 111 J=JMH,JMM1
      XJ=FJU(J)*DDT
      XJA(J)=XJ*AAA
      XHT(J)=1.0/(1.0+XJA(J)**2)
      XHS(J)=XJ*BBB
      XMY(J)=Y*XM(J)
  111 CONTINUE
      IF(NN.GT.0) GO TO 251
      CALL CONTI
      MAT=2
      WRITE(2) TT
      REWIND 2
      WRITE(3) U,V
      REWIND 3
      DDT=DT
      GO TO 253
  251 NN=NN+1
      CD=CD+DTD
      NNN=(NN/MATS)*MATS
      IF(NNN.NE.NN) GO TO 250
      MAT=1
      WRITE(6,2)
    2 FORMAT(1H ,5HBEGIN)
  250 CONTINUE
  253 CALL THERME
      CALL EQA
      CALL CONTI
      WRITE (6,7013) UUU,VVV,UV,NN,CD
 7013 FORMAT(1H ,7HENERGY=3(E15.7,3X),5HSTEP=I5,2X,4HDAY=F10.2)
      IF(MAT.NE.0) GO TO 7019
      CALL WTO(STOP)
      IF (STOP) NEND=10
      IF(NN.GE.NEND) GO TO 7015
      IF(((NN/NTAPE )*NTAPE ).NE.NN) GO TO 7025
      IF(NN.EQ.0) GO TO 7019
7015  MAG = MAG+1
      WTM = 0.0
      GQSH = 0.0
      GQE=0.0
      GQH = 0.0
```

```
      GRN = 0.
      DO 2001 J=3,38
      DXYP = X(J) * Y
      CLAT = ABS(DXYP)
      KK=0.
      ZQH(J) = 0.
      ZQE(J) = 0.0
      ZZZ=0.
      ZRN(J) = 0.
      DO 2002 I=3,146
      IF (MPP(I,J).GT.1.AND.MPP(I,J).LE.5) GO TO 9011
      UM=UN(I,J)*51.48
       TEIJ=TE(I,J)
      TIJ= T(I,J,1)
      TW=TD(I,J)+273.15
  123 TS=T(I,J,1)+273.15
      PCB=1013.25*0.1
      ESS=10.0**(8.4051-2353.0/TS)
      ESD=10.0**(8.4051-2353.0/TW)
      QS=0.622*ESS/(PCB-ESS)
      QA=0.622*ESD/(PCB-ESD)
      IF(((TIJ-TEIJ)+0.609* TS*(QS-QA)).LT.0.0)  GO TO 334
  332 CU=0.033
      CO=1.23*0.001
      GO TO 133
  334 CU=0.018
      CO=0.41*0.001
133   QH(I,J)=-1.2*0.001*.24*CO*UM*(TIJ-TEIJ)*0.864E5
      QE(I,J)=-1.2*0.001*CO*595.*UM*(QS-QA)*0.864E5
      RN(I,J)=RN(I,J)*0.864E5
      QSH(I,J)=RN(I,J)+QH(I,J)+QE(I,J)
      GQSH = GQSH+QSH(I,J)*CLAT
      GQE = GQE + QE(I,J)*CLAT
      GQH = GQH + QH(I,J)*CLAT
      GRN = GRN + RN(I,J) * CLAT
      WTM = WTM+CLAT
      KK=KK+1.
      ZZZ = QSH(I,J) + ZZZ
      ZQH(J) = QH(I,J) + ZQH(J)
      ZQE(J) = QE(I,J) + ZQE(J)
      ZRN(J) = RN(I,J) + ZRN(J)
      GO TO 2002
9011  QSH(I,J) = 0.
      QE(I,J)=0.
      QH(I,J)=0.
 2002  CONTINUE
      KK = 1./KK
      ZSH(J) = ZZZ*KK
      ZQE(J) = ZQE(J) *KK
      ZQH(J) = ZQH(J)*KK
      ZRN(J) = ZRN(J) * KK
 2001  CONTINUE
      WTM = 1./WTM
      GQSH = GQSH*WTM
      GQE = GQE*WTM
      GQH = GQH*WTM
      GRN = GRN*WTM
      WRITE(KT)
     *           TT,UU,VV,T,U,V,AT,SP,W,UB,VB,X,XM,Q,FU,FJU,DT,AZ,AH,WE,
     1WN,BAN,AL,GAM,Y,YY,R,RP,HH,H2,AZHH,BUN,R2,AHY,AHPP,AH2,BB,BB2,
     2AAA,BBB,DDT,A1,UV,UUU,VVV,RRH,AQ,GAM2,AL2,RY,AMRR,GAMGAM,ALAL,
     3H,Z,ZZ,AM,XJA,XHT,XHS,XMY, CD,
     4MPP,MQQ,KA,KB,L,LA,LB,LV,MATS,NEND,NK,NNNN,MAT,IM,JM,KM,IMH,IMM1,
     5IMP1,KMP1,KMM1,JMM1,JMP1,NN,JMH,MAG,TE,TD,RN
     *,QE,QH,QSH,CL,UN
      ENDFILE KT
```

```
      BACKSPACE KT
      WRITE(6,1) MAG
    1 FORMAT(1H ,35HNUMBER OF RECORDS IN MAGNETIC TAPE=I2)
      IF(NN.GE.NEND) GO TO 7014
      IF(MAG.GE.34) GO TO 93
 7025 IF(UV.GT.1.0E26) GO TO 7014
      IF(((NN/NPRINT)*NPRINT).NE.NN) GO TO 7019
 7014 WRITE(6,7020) NN,CD
 7020 FORMAT(1H ,11HTIME(STEP)=I8,5X,10HTIME(DAY)=E15.7)
      DO 300 K=1,5
      KK=0.
      DO 301 J=3,38
      UZSUM=0.
      VZSUM=0.
      DO 303 I=3,146
      IF(MQQ(I,J).LE.5.AND.MQQ(I,J).NE.1) GO TO 303
      KK=KK+1.
      UZSUM=UZSUM+U(I,J,K)
      VZSUM=VZSUM+V(I,J,K)
  303 CONTINUE
      IF(KK.LT.1.)GO TO 300
      UZ(J,K)=UZSUM/KK
      VZ(J,K)=VZSUM/KK
  301 CONTINUE
  300 CONTINUE
      DO 7009 K=1,KM
      WRITE(6,7777)
      WRITE(6,7010) K, CD
 7010  FORMAT(1X,'UU AT K = ',I1,'  DAY ',F7.1)
      WRITE(6,890) (UHEAD(J),J=3,20)
      DO 7011 I=IMH,IM
      WRITE(6,7012) I,(UU(I,J,K),J=3,20)
 7012 FORMAT(1H ,I3,1X,18F7.2)
 7011 CONTINUE
      WRITE(6,7778) (UZ(J,K),J=3,20)
      WRITE(6,7777)
      WRITE(6,7010) K,CD
      WRITE(6,890) (UHEAD(J),J=21,38)
      DO 7022 I=IMH,IM
      WRITE(6,7012) I,(UU(I,J,K),J=21,38)
 7022 CONTINUE
      WRITE(6,7778) (UZ(J,K),J=21,38)
 7009 CONTINUE
      DO 7070 K=1,KM
      WRITE(6,7777)
      WRITE(6,7053) K,CD
      WRITE(6,890) (UHEAD(J),J=3,20)
 7053 FORMAT(1X,'VV AT K = ',I1,'  DAY ',F7.1)
      DO 7021 I=IMH,IM
      WRITE(6,7012) I,(VV(I,J,K),J=3,20)
 7021 CONTINUE
      WRITE(6,7778) (VZ(J,K),J=3,20)
 890  FORMAT(/5X,18F7.2/)
      WRITE(6,7777)
      WRITE(6,7053) K,CD
      WRITE(6,890) (UHEAD(J),J=21,38)
      DO 7023 I=IMH,IM
      WRITE(6,7012) I,(VV(I,J,K),J=21,38)
 7023 CONTINUE
      WRITE(6,7778) (VZ(J,K),J=21,38)
 7070 CONTINUE
      DO 200 K=1,KM
      DO 201 J=3,38
       KK=0.
       WZSUM=0.
       TZSUM=0.
```

```
      DO 203 I=3,I46
      IF(MPP(I,J).GT.1.AND. MPP(I,J).LE.5) GO TO 203
      KK=KK+1.
      WZSUM=WZSUM+W(I,J,K)
      TZSUM=TZSUM+TT(I,J,K)
 203  CONTINUE
      IF(KK.LT.1.)GO TO  200
      ZW(J,K)=WZSUM/KK
      ZT(J,K)=TZSUM/KK
 201  CONTINUE
 200  CONTINUE
      DO 7005 K=1,KM
      WRITE(6,7777)
      WRITE (6,7006) K
 7006 FORMAT(1H ,17HTEMPERATURE AT K=I1)
      WRITE(6,890)  (THEAD(J),J=3,20)
      DO 7050 I=IMH,IM
      WRITE(6,7000) I,(TT(I,J,K),J=3,20)
 7050 CONTINUE
      WRITE(6,7778) (ZT(J,K),J=3,20)
      WRITE(6,7777)
      WRITE(6,7006) K
      WRITE(6,890) (THEAD(J),J=21,38)
      DO 7051 I=IMH,IM
      WRITE(6,7000) I,(TT(I,J,K),J=21,38)
 7051 CONTINUE
      WRITE(6,7778) (ZT(J,K),J=21,38)
 7005 CONTINUE
      DO 7002 K=2,KM
      FK = K-.5
      WRITE(6,7777)
      WRITE(6,7001) FK,CD
 7001 FORMAT(1X,'VERTICAL VELOCITY AT K = ',F4.1,'   DAY ',F7.1)
      WRITE(6,890)  (THEAD(J),J=3,20)
      DO 7003 I=IMH,IM
      WRITE(6,7000) I,(W(I,J,K),J=3,20)
 7000 FORMAT(1H ,I3,1X,18F7.2)
 7003 CONTINUE
      WRITE(6,7778) (ZW(J,K),J=3,20)
      WRITE(6,7777)
      WRITE(6,7001) FK,CD
      WRITE(6,890) (THEAD(J),J=21,38)
      DO 7024 I=IMH,IM
      WRITE(6,7000) I,(W(I,J,K),J=21,38)
 7024 CONTINUE
      WRITE(6,7778) (ZW(J,K),J=21,38)
 7778 FORMAT(/30X,'ZONAL MEANS'//5X,18F7.2)
 7002 CONTINUE
      IF(UV.GT.1.0E26) STOP 792
      WRITE(6,7777)
      WRITE(6,9016) CD
 9016 FORMAT(1X,'SURFACE HEAT FLUX(CAL PER DAY)   DAY = ',F7.1/)
      WRITE(6,9020) GQSH
 9020 FORMAT(' GLOBAL MEAN = ',F10.3)
      CALL PRINT(QSH,ZSH,THEAD,ICTL,RCTL)
      WRITE(6,7777)
      WRITE(6,9017)
 9017 FORMAT(' LATENT HEAT FLUX')
      WRITE(6,9020) GQE
      CALL PRINT(QE,ZQE,THEAD,ICTL,RCTL)
      WRITE(6,7777)
      WRITE(6,9018)
 9018 FORMAT(' SENSIBLE HEAT FLUX')
      WRITE(6,9020) GQH
      CALL PRINT(QH,ZQH,THEAD,ICTL,RCTL)
      WRITE(6,7777)
```

```
      WRITE(6,9023)
9023   FORMAT(' SURFACE RADIATION FLUX (CAL/CM**2/DAY)')
      WRITE(6,9020) GRN
      CALL PRINT(RN,ZRN,THEAD,ICTL,RCTL)
      IF(NN.GE.NEND) GO TO 2501
 7019 CONTINUE
      IF(MAT.EQ.0) GO TO 251
      MAT=MAT+1
      IF(MAT.LT.8) GO TO 7017
      DDT=DT*2.0
      GO TO 251
 7017 DDT=DT
      IF(MAT.EQ.3) GO TO 20
      IF(MAT.EQ.4) NK=3
      IF(MAT.EQ.5) GO TO 21
      IF(MAT.EQ.6) NK=3
      GO TO 250
   20 NK=1
      MAT=7
      NK=3
      GO TO 22
   21 NK=2
   22 NN=NN+1
      CD=CD+DTD
      GO TO 250
 2501 CONTINUE
      DO 3005 J=3,37
      LJ =LV(J)
      DO 3005 M1=1,LJ
      II = LA(M1,J)
89    FORMAT('0',4X,19F6.1/)
      IG = LB(M1,J)
      DO 3005 I=II,IG
      UU(I,J,1) = UU(I,J,1)*Z(1)+UU(I,J,2)*Z(2)+UU(I,J,3)*Z(3)
     X  + UU(I,J,4)*Z(4) + UU(I,J,5)*Z(5)
      VV(I,J,1) = VV(I,J,1)*Z(1)+VV(I,J,2)*Z(2)+VV(I,J,3)*Z(3)
     X  + VV(I,J,4)*Z(4) + VV(I,J,5)*Z(5)
3005  CONTINUE
3004  FORMAT(' ',I3,1X,19F6.3,1X,I3)
      WRITE(6,7777)
      WRITE(6,3001)
3001  FORMAT('  UUBAR '/)
      WRITE(6,89) (UHEAD(J),J=3,21)
      DO 3006 I=3,146
3006  WRITE(6,3004) I,(UU(I,J,1),J=3,21),I
      WRITE(6,89) (UHEAD(J),J=20,38)
      DO 3007 I=3,146
3007  WRITE(6,3004) I,(UU(I,J,1),J=20,38),I
      WRITE(6,7777)
      WRITE(6,3002)
3002  FORMAT('  VVBAR'/)
      WRITE(6,89) (UHEAD(J),J=3,21)
      DO 3008 I=3,146
3008  WRITE(6,3004) I,(VV(I,J,1),J=3,21),I
      WRITE(6,89) (UHEAD(J),J=20,38)
      DO 3009 I=3,146
3009  WRITE(6,3004) I,(VV(I,J,1),J=20,38),I
   92 STOP
   93 REWIND KT
      KT=KT+1
      MAG = 0
      GO TO 7015
      END
      SUBROUTINE PRINT(FI,ZSP,THEAD,ICTL,RCTL)
      DIMENSION THEAD(39)
      DIMENSION FIELD(18),ZSP(39),FI(147,39),ICTL(7),RCTL(2)
```

```
7777   FORMAT('1',30X,'EXPERIMENT 50 ')
7012   FORMAT(' ',I3,1X,18F7.2)
890    FORMAT(/5X,18F7.2/)
7778   FORMAT(/30X,'ZONAL MEANS'//5X,18F7.2)
       WRITE(6,890)  (THEAD(J),J=3,20)
       CALL SHADE (ICTL,RCTL,0.)
       DO 9013 I=3,146
       DO 701 J=3,20
       J1 = J-2
701    FIELD(J1) = FI(I,J)
       CALL SHADE(0,0.,FIELD(1))
       WRITE(6,7012)  I,FIELD
 9013  CONTINUE
       WRITE(6,7778) (ZSP(J),J=3,20)
       WRITE(6,7777)
       WRITE(6,890) (THEAD(J),J=21,38)
       CALL SHADE (ICTL,RCTL,0.)
       DO 9015 I=3,146
       DO 702  J=21,38
       J1 = J-20
702    FIELD(J1) = FI(I,J)
       CALL SHADE(0,0.,FIELD(1))
       WRITE(6,7012)  I,FIELD
 9015  CONTINUE
       WRITE(6,7778) (ZSP(J),J=21,38)
       RETURN
       END
       SUBROUTINE ADJUST
       COMMON T(147,39,5),TT(147,39,5),SP(147,39),AT(5),UU(147,39,5),
      1VV(147,39,5),U(147,39,5),V(147,39,5),W(147,39,5),UB(147,39),
      2VB(147,39),WE(147,39),WN(147,39),Q(39),XJA(38),XHT(38),XHS(38),
      3 XMY(38), Z(5),X(39),XM(39),FU(39),FJU(39),ZZ(6),H,AZ,AH,DT,AL,
      4GAM,Y,YY,R,RR,HH,H2,AZHH,R2,AHY,AHPR,AH2,BB,BB2,AAA,BBB,DDT,A1,UV,
      5UUU,VVV,RRH,AQ,GAM2,AL2,BUN,RY,AM,AMRR ,GAMGAM,ALAL,BAN, KMP1,
      6MPP(147,39),MQQ(147,39),IM,JM,KM,IMM1,JMM1,KMM1,IMP1,JMP1,MAT,
      7 NK,NNNN,IMH,JMH,MATS,L(39),KA(10,39),KB(10,39),LV(39),NEND,
      8LA(10,39),LB(10,39),NN,TE(147,46),UN(147,39),TD(147,46),RN(147,39)
      *,CL(147,39)
       MR=0
    41 KP1=1
       MAR=0
    40 IF(KP1.EQ.KM)  GO TO 50
       K=KP1
       KP1=K+1
       B=(AT(K)-AT(KP1))/(ABS(AT(K)))
       IF(B.GE.-5.0E-6)  GO TO 40
       DZ1=Z(K)
       DZ2 = Z(KP1)
       AVT=(AT(KP1)*DZ2+AT(K)*DZ1)/(DZ2+DZ1)
       AT(KP1)=AVT
       AT(K)=AVT
       MAR=1
       GO TO 40
    50 IF(MAR.EQ.0)  GO TO 51
       MR=MR+1
       IF(MR.LT.1000) GO TO 41
       WRITE(6,1)  (AT(I),I=1,KM)
     1 FORMAT(1H ,23HTOO MANY OPER IN ADJUST,5E15.7)
    51 RETURN
       END
       SUBROUTINE EQA
       COMMON T(147,39,5),TT(147,39,5),SP(147,39),AT(5),UU(147,39,5),
      1VV(147,39,5),U(147,39,5),V(147,39,5),W(147,39,5),UB(147,39),
      2VB(147,39),WE(147,39),WN(147,39),Q(39),XJA(38),XHT(38),XPS(38),
      3 XMY(38), Z(5),X(39),XM(39),FU(39),FJU(39),ZZ(6),H,AZ,AH,DT,AL,
      4GAM,Y,YY,R,RR,HH,H2,AZHH,R2,AHY,AHPR,AH2,BB,BB2,AAA,BBB,DDT,A1,UV,
```

```
     5UUU,VVV,RRH,AQ,GAMZ,ALZ,BUN,RI,AM,AMFH ,GAMGAM,ALAL,...,
     6MPP(147,39),MQQ(147,39),IM,JM,KM,IMM1,JMM1,KMM1,IMP1,JMP1,MAT,
     7 NK,NNNN,IMH,JMH,MATS,L(39),KA(10,39),KB(10,39),LV(39),NEND,
     8LA(10,39),LB(10,39),NN,TE(147,46),UN(147,39),TD(147,46),PN(147,39)
     *,CL(147,39)
      DIMENSION SEN(147,39,5)
      EQUIVALENCE (W(1),SEN(1))
      COMMON/TEMP/TEN(146,38,5)
      DO 3000 J=JMH,JMM1
      JP1=J+1
      JM1=J-1
      XMJ=XM(J)
      XMJ1=XM(JM1)
      XJ=X(J)
      XJP1=X(JP1)
      XJ1=X(JM1)
      AD=A1*XJ/XMJ*0.3
      AC=A1*XJP1/XMJ*0.3
      AB=AMRR/(XMJ*XMJ)*0.3
      RXMJ=R*XMJ
      LJ=LV(J)
      DO 4002 M1=1,LJ
      II=LA(M1,J)
      IG=LB(M1,J)
      DO 3001 I=II,IG
      MQ=MQQ(I,J)
      IP1=I+1
      IM1=I-1
C*****COMPUTAITON OF PRESSURE
      GO TO (1,2,3), NK
    3 CONTINUE
      SP0=SP(I,J)-SP(IP1,JP1)
      SP1=SP(IP1,J)-SP(I,JP1)
      PXBIJ=SP1-SP0
      PYBIJ=-SP1-SP0
      GO TO 4
    1 PXBIJ=(SP(IP1,JP1)-SP(I,JP1))*2.0
      PYBIJ=(SP(IP1,JP1)-SP(IP1,J))*2.0
      GO TO 4
    2 PXBIJ=(SP(IP1,J)-SP(I,J))*2.0
      PYBIJ=(SP(I,JP1)-SP(I,J))*2.0
    4 CONTINUE
C*****COMPUTATION OF PRESSURE
      WEIJ=WE(I,J)
      WNIJ=WN(I,J)
      DO 3002 K=1,KM
      KP1=K+1
      ZK=Z(K)
      ZZ1=ZZ(KP1)
      KM1=K-1
      ZZK=ZZ(K)
 5555 HS=V(I,J,K)
      HT=U(I,J,K)
      UM1J=U(IM1,J,K)
      VM1J=V(IM1,J,K)
      UP1J=U(IP1,J,K)
      VP1J=V(IP1,J,K)
      UIP1=U(I,JP1,K)
      VIP1=V(I,JP1,K)
      UIM1=U(I,JM1,K)
      VIM1=V(I,JM1,K)
 5556 UIJ=HT
      VIJ=HS
      AX=AZHH/ZK
      IF(K.EQ.1) GO TO 3003
      DUZ=(U(I,J,KM1)-HT)/ZZK
```

```
      DVZ=(V(I,J,KM1)-HS)/ZZK
      IF(K.NE.KM) GO TO 3004
      DUZP1=0.0
      DVZP1=0.0
      GO TO 3009
 3003 DUZ=WEIJ
      DVZ=WNIJ
 3004 DUZP1=(HT-U(I,J,KP1))/ZZ1
      DVZP1=(HS-V(I,J,KP1))/ZZ1
 3009 HT=AX*(DUZ-DUZP1-WEIJ*ZK)
      HS=AX*(DVZ-DVZP1-WNIJ*ZK)
      IF(MQ.EQ.1) GO TO 3008
      IF(MQ.EQ.1211) GO TO 1211
      IF(MQ.EQ.1112) GO TO 1112
      IF(MQ.EQ.1121) GO TO 1121
      IF(MQ.EQ.2211) GO TO 2211
      IF(MQ.EQ.2112) GO TO 2112
      IF(MQ.EQ.1221) GO TO 1221
      IF(MQ.EQ.1122) GO TO 1122
      IF(MQ.EQ.2121) GO TO 2121
      IF(MQ.EQ.1212) GO TO 1212
      IF(MQ.EQ.2221) GO TO 2221
      IF(MQ.EQ.2212) GO TO 2212
      IF(MQ.EQ.1222) GO TO 1222
      IF(MQ.EQ.2122) GO TO 2122
 2111 UP1J=-UIJ
      VP1J=-VIJ
      GO TO 3008
 1211 UIP1=-UIJ
      VIP1=-VIJ
      GO TO 3008
 1121 UM1J=-UIJ
      VM1J=-VIJ
      GO TO 3008
 1112 VIM1=-VIJ
      UIM1=-UIJ
      GO TO 3008
 2221 UP1J=-UIJ
      VP1J=-VIJ
      UIP1=-UIJ
      VIP1=-VIJ
      UM1J=-UIJ
      VM1J=-VIJ
      GO TO 3008
 2212 UP1J=-UIJ
      VP1J=-VIJ
      VIP1=-VIJ
      UIP1=-UIJ
      UIM1=-UIJ
      VIM1=-VIJ
      GO TO 3008
 1222 UIP1=-UIJ
      VIP1=-VIJ
      UM1J=-UIJ
      VM1J=-VIJ
      UIM1=-UIJ
      VIM1=-VIJ
      GO TO 3008
 2122 UP1J=-UIJ
      VP1J=-VIJ
      UM1J=-UIJ
      VM1J=-VIJ
      UIM1=-UIJ
      VIM1=-VIJ
      GO TO 3008
 2211 UP1J=-UIJ
```

```
      VP1J=-VIJ
      UIP1=-UIJ
      VIP1=-VIJ
      GO TO 3008
 2121 UP1J=-UIJ
      VP1J=-VIJ
      UM1J=-UIJ
      VM1J=-VIJ
      GO TO 3008
 2112 UP1J=-UIJ
      VP1J=-VIJ
      UIM1=-UIJ
      VIM1=-VIJ
      GO TO 3008
 1221 UIP1=-UIJ
      VIP1=-VIJ
      UM1J=-UIJ
      VM1J=-VIJ
      GO TO 3008
 1212 UIP1=-UIJ
      VIP1=-VIJ
      UIM1=-UIJ
      VIM1=-VIJ
      GO TO 3008
 1122 UM1J=-UIJ
      VM1J=-VIJ
      UIM1=-UIJ
      VIM1=-VIJ
 3008 HT=HT+AB*(UP1J+UM1J-2.0*UIJ)+AC*(UIP1-UIJ)-AD*(UIJ-UIM1)
      HS=HS+AB*(VP1J+VM1J-2.0*VIJ)+AC*(VIP1-VIJ)-AD*(VIJ-VIM1)
      IF(K.NE.1 ) GO TO 4000
      PA=0.0
      PB=0.0
      GO TO 4001
 4000 GO TO (5,6,7),NK
    5 PA=PA+ZZK* ALAL*(T(I,JP1,K)+T(I,JP1,KM1)-T(IP1,JP1,K)-T(IP1,JP1,K
     1M1))
      PB=PB+ZZK* ALAL*(T(IP1,J,K)+T(IP1,J,KM1)-T(IP1,JP1,K)-T(IP1,JP1,KM
     11))
      GO TO 4001
    6 PA=PA+ZZK* ALAL*(T(I,J,K)+T(I,J,KM1)-T(IP1,J,K)-T(IP1,J,KM1))
      PB=PB+ZZK* ALAL*(T(I,J,K)+T(I,J,KM1)-T(I,JP1,K)-T(I,JP1,KM1))
      GO TO 4001
    7 CONTINUE
      P1=T(I,JP1,K)+T(I,JP1,KM1)-T(IP1,J,K)-T(IP1,J,KM1)
      P2=T(I,J,K)+T(I,J,KM1)-T(IP1,JP1,K)-T(IP1,JP1,KM1)
      PA=PA+Z Z K * AL*(P1+P2)
      PB=PB+Z Z K * AL*(P2-P1)
 4001 TEN(I,J,K)=((-PA*AQ+PXBIJ)/ R XMJ +HT)*DDT
      SEN(I,J,K)=((-PB*AQ+PYBIJ)/ R Y +HS)*DDT
 3002 CONTINUE
 3001 CONTINUE
 4002 CONTINUE
 3000 CONTINUE
      UUU=0.0
      VVV=0.0
      IF(MAT.EQ.0) GO TO 3010
      IF(MAT.EQ.((MAT/2)*2)) GO TO 3012
      IF(MAT.EQ.1) GO TO 3013
C     MAT=3,5,7
 3011 READ(3) U,V
      REWIND 3
      DO 3106 J=JMH,JMM1
      XJ1=XJA(J)/2.0
      HT=1.0/(1.0+XJ1**2)
      HS=XHS(J)/2.0
```

```
      XMJN=XMY(J)
      LJ=LV(J)
      DO 4005 M1=1,LJ
      II=LA(M1,J)
      IG=LB(M1,J)
      DO 3107 I=II,IG
      DO 3108 K=1,KM
      VL=XMJN*Z(K)
      AIJ=U(I,J,K)
      BIJ=V(I,J,K)
      AUZ=AIJ+TEN(I,J,K)+HS*BIJ
      AVZ=BIJ+SEN(I,J,K)-HS*AIJ
      P1=(AUZ+XJ1*AVZ)*HT
      P2=(AVZ-XJ1*AUZ)*HT
      UU(I,J,K)=P1
      VV(I,J,K)=P2
      UUU=UUU+P1*P1*VL
      VVV=VVV+P2*P2*VL
 3108 CONTINUE
 3107 CONTINUE
 4005 CONTINUE
 3106 CONTINUE
   10 DO 8 K=1,KM
      DO 12 J=JMH,JMM1
      UU(2,J,K)=UU(IM,J,K)
      VV(2,J,K)=VV(IM,J,K)
      UU(IMP1,J,K)=UU(3,J,K)
      VV(IMP1,J,K)=VV(3,J,K)
   12 CONTINUE
    8 CONTINUE
      READ(2) T
      REWIND 2
      IF(MAT.EQ.7) GO TO 3120
      WRITE(3) UU,VV
      REWIND 3
      DO 3999 K=1,KM
      DO 3998 J=JMH,JMM1
      DO  3997 I=1,IMP1
      U(I,J,K)=UU(I,J,K)
      V(I,J,K)=VV(I,J,K)
 3997 CONTINUE
 3998 CONTINUE
 3999 CONTINUE
      GO TO 11
C     MAT=1
 3013 DO 3100 J=JMH,JMM1
      LJ=LV(J)
      XJ1=XJA(J)
      HT=XHT(J)
      HS=XHS(J)
      XMJN=XMY(J)
      DO 4003 M1=1,LJ
      II=LA(M1,J)
      IG=LB(M1,J)
      DO 3101 I=II,IG
      DO 3102 K=1,KM
      VL=XMJN*Z(K)
      AIJ=U(I,J,K)
      BIJ=V(I,J,K)
      AUZ=AIJ    +TEN(I,J,K)+HS*BIJ
      AVZ=BIJ+SEN(I,J,K)-HS*AIJ
      AIJ=(AUZ+XJ1*AVZ)*HT
      BIJ=(AVZ-XJ1*AUZ)*HT
      UU(I,J,K)=AIJ
      VV(I,J,K)=BIJ
      UUU=UUU+AIJ*AIJ*VL
```

```
      VVV=VVV+BIJ*BIJ*VL
 3102 CONTINUE
 3101 CONTINUE
 4003 CONTINUE
 3100 CONTINUE
      GO TO 10
C     MAT=2,4,6
   12 DO 3103 J=JMH,JMM1
      XJ1=XJA(J)/2.0
      HT=1.0/(1.0+XJ1*XJ1)
      HS=XHS(J)  /2.0
      LJ=LV(J)
      XMJN=XMY(J)
      DO 4004 M1=1,LJ
      II=LA(M1,J)
      IG=LB(M1,J)
      DO 3104 I=II,IG
      DO 3105 K=1,KM
      VL=XMJN*Z(K)
      AIJ=U(I,J,K)
      BIJ=V(I,J,K)
      AUZ=AIJ+TEN(I,J,K)+HS*BIJ
      AVZ=BIJ+SEN(I,J,K)-HS*AIJ
      P1=(AUZ+XJ1*AVZ)*HT
      P2=(AVZ-XJ1*AUZ)*HT
      U(I,J,K)=P1
      UU(I,J,K)=P1
      V(I,J,K)=P2
      VV(I,J,K)=P2
      UUU=UUU+P1*P1*VL
      VVV=VVV+P2*P2*VL
 3105 CONTINUE
 3104 CONTINUE
 4004 CONTINUE
 3103 CONTINUE
      DO 3113 K=1,KM
      DO 3114 J=JMH,JM
      DO 3115 I=2,IMP1
      T(I,J,K)=TT(I,J,K)
 3115 CONTINUE
 3114 CONTINUE
 3113 CONTINUE
      GO TO 3120
C      MAT=0
 3010 DO 3109 J=JMH,JMM1
      XJ1=XJA(J)
      HT=XHT(J)
      HS=XHS(J)
      XMJN=XMY(J)
      LJ=LV(J)
      DO 4006 M1=1,LJ
      II=LA(M1,J)
      IG=LB(M1,J)
      DO 3110 I=II,IG
      DO 3111 K=1,KM
      VL=Z(K)*XMJN
      AIJ=U(I,J,K)
      BIJ=V(I,J,K)
      U(I,J,K)=UU(I,J,K)
      V(I,J,K)=VV(I,J,K)
      AUZ=AIJ    +TEN(I,J,K)+HS*BIJ
      AVZ=BIJ+SEN(I,J,K)-HS*AIJ
      P1=(AUZ+XJ1*AVZ)*HT
      P2=(AVZ-XJ1*AUZ)*HT
       UU(I,J,K)=P1
      VV(I,J,K)=P2
```

```
      UUU=UUU+P1*P1*VL
      VVV=VVV+P2*P2*VL
 3111 CONTINUE
 3110 CONTINUE
 4006 CONTINUE
 3109 CONTINUE
 [illegible]20 CONTINUE
      DO 4007 K=1,KM
      DO 4008 J=JMH,JMM1
      U(2,J,K)=U(IM,J,K)
      V(2,J,K)=V(IM,J,K)
      UU(2,J,K)=UU(IM,J,K)
      VV(2,J,K)=VV(IM,J,K)
      U(IMP1,J,K)=U(3,J,K)
      V(IMP1,J,K)=V(3,J,K)
      UU(IMP1,J,K)=UU(3,J,K)
      VV(IMP1,J,K)=VV(3,J,K)
 4008 CONTINUE
 4007 CONTINUE
   11 UUU=UUU*RRH
      VVV=VVV*RRH
      UV=UUU+VVV
      RETURN
      END
      SUBROUTINE CONTI
      COMMON T(147,39,5),TT(147,39,5),SP(147,39),AT(5),UU(147,39,5),
     1VV(147,39,5),U(147,39,5),V(147,39,5),W(147,39,5),UB(147,39),
     2VB(147,39),WE(147,39),WN(147,39),Q(39),XJA(38),XHT(38),XHS(38),
     3 XMY(38), Z(5),X(39),XM(39),FU(39),FJU(39),ZZ(6),H,AZ,AH,DT,AL,
     4GAM,Y,YY,R,RR,HH,H2,AZHH,B2,AHY,AHPR,AH2,BB,BP2,AAA,BBB,DDT,A1,UV,
     5UUU,VVV,RRH,AQ,GAM2,AL2,BUN,RY,AM,AMRR ,GAMGAM,ALAL,BAN, KMP1,
     6MPP(147,39),MQQ(147,39),IM,JM,KM,IMM1,JMM1,KMM1,IMP1,JMP1,MAT,
     7 NK,NNNN,IMH,JMH,MATS,L(39),KA(10,39),KB(10,39),LV(39),NEND,
     8LA(10,39),LB(10,39),NN,TF(147,46),UN(147,39),TD(147,46),PN(147,39)
     *,CL(147,39)
      DIMENSION WWW(10)
    5 DO 1000 J=3,JM
      XJ=X(J)
      JM1=J-1
      XMJ=XM(J)
      XM1=XM(JM1)
      WT=1.0/(XJ*Y)
      B=XMJ*WT
      CCC=XM1*WT
      LJ=L(J)
      DO 1 M1=1,LJ
      II=KA(M1,J)
      IG=KB(M1,J)
      DO 1001 I=II,IG
      MP=MPP(I,J)
      IM1=I-1
      IF(MP.EQ.1) GO TO 1200
 1999 IF(MP.EQ.11) GO TO 1011
      IF(MP.EQ.12) GO TO 1012
      IF(MP.EQ.13) GO TO 1013
      IF(MP.EQ.14) GO TO 1014
      IF(MP.EQ.21) GO TO 1021
      IF(MP.EQ.22) GO TO 1022
      IF(MP.EQ.23) GO TO 1023
      IF(MP.EQ.24) GO TO 1024
      IF(MP.EQ.31) GO TO 1031
      IF(MP.EQ.32) GO TO 1032
      IF(MP.EQ.34) GO TO 1034
 1033 DO 1113 K=1,KMM1
      WWW(K)=((UU(I,J,K)+UU(I,JM1,K)-UU(IM1,J,K))/XJ
     1+(VV(I,J,K)+VV(IM1,J,K))*B-VV(I,JM1,K)*CCC)*BAN*Z(K)
```

```
 1113 CONTINUE
      GO TO 1998
 1200 DO 1003 K=1,KMM1
      WWW(K)=(((UU(I,J,K)+UU(I,JM1,K)-UU(IM1,J,K)-UU(IM1,JM1,K))/XJ
     1+(VV(I,J,K)+VV(IM1,J,K))*B-(VV(I,JM1,K)+VV(IM1,JM1,K))*CCC)/2.0
     2)*Z(K)
 1003 CONTINUE
      GO TO 1998
 1011 DO 1004 K=1,KMM1
      WWW(K)=(-(UU(IM1,J,K)+UU(IM1,JM1,K))/XJ+VV(IM1,J,K)*B
     1-VV(IM1,JM1,K)*CCC)*Z(K)
 1004 CONTINUE
      GO TO 1998
 1012 DO 1005 K=1,KMM1
      WWW(K)=((UU(I,JM1,K)-UU(IM1,JM1,K))/XJ-
     1(VV(I,JM1,K)+VV(IM1,JM1,K))*CCC)*Z(K)
 1005 CONTINUE
      GO TO 1998
 1013 DO 1006 K=1,KMM1
      WWW(K)=((UU(I,J,K)+UU(I,JM1,K))/XJ+VV(I,J,K)*B-VV(I,JM1,K)*CCC)*
     1Z(K)
 1006 CONTINUE
      GO TO 1998
 1014 DO 1007 K=1,KMM1
      WWW(K)=((UU(I,J,K)-UU(IM1,J,K))/XJ+(VV(I,J,K)+VV(IM1,J,K))*B)*Z(K)
 1007 CONTINUE
      GO TO 1998
 1021 DO 1008 K=1,KMM1
      WWW(K)=(-UU(IM1,JM1,K)/XJ-VV(IM1,JM1,K)*CCC)*2.0*Z(K)
 1008 CONTINUE
      GO TO 1998
 1022 DO 1009 K=1,KMM1
      WWW(K)=(UU(I,JM1,K)/XJ-VV(I,JM1,K)*CCC)*2.0*Z(K)
 1009 CONTINUE
      GO TO 1998
 1023 DO 1109 K=1,KMM1
      WWW(K)=2.0*Z(K)*(UU(I,J,K)/XJ +VV(I,J,K)*B)
 1109 CONTINUE
      GO TO 1998
 1024 DO 1110 K=1,KMM1
      WWW(K)=2.0*Z(K)*(-UU(IM1,J,K)/XJ +VV(IM1,J,K)*B)
 1110 CONTINUE
      GO TO 1998
 1031 DO 1111 K=1,KMM1
      WWW(K)=((UU(I,JM1,K)-UU(IM1,J,K)-UU(IM1,JM1,K))/XJ+VV(IM1,J,K)*B
     1-(VV(I,JM1,K)+VV(IM1,JM1,K))*CCC)*BAN*Z(K)
 1111 CONTINUE
      GO TO 1998
 1032 DO 1112 K=1,KMM1
      WWW(K)=((UU(I,J,K)+UU(I,JM1,K)-UU(IM1,JM1,K))/XJ
     1          -(VV(IM1,JM1,K)+VV(I,JM1,K))*CCC+VV(I,J,K)*B)*BAN*Z(K)
 1112 CONTINUE
      GO TO 1998
 1034 DO 1114 K=1,KMM1
      WWW(K)=((UU(I,J,K)-UU(IM1,JM1,K)-UU(IM1,J,K))/XJ
     1+(VV(I,J,K)+VV(IM1,J,K))*B-VV(IM1,JM1,K)*CCC)*BAN*Z(K)
 1114 CONTINUE
 1998 WT=0.0
      DO 1997 K=1,KMM1
      W1=WT+WWW(K)
       W(I,J,K+1)=W1
      WT=W1
 1997 CONTINUE
 1001 CONTINUE
    1 CONTINUE
 1000 CONTINUE
```

```
 9999 RETURN
      END
      SUBROUTINE THERME
      COMMON T(147,39,5),TT(147,39,5),SP(147,39),AT(5),UU(147,39,5),
     1VV(147,39,5),U(147,39,5),V(147,39,5),W(147,39,5),UB(147,39),
     2VB(147,39),WB(147,39),WN(147,39),Q(39),XJA(38),XHT(38),XHS(38),
     3 XMY(38), Z(5),X(39),XM(39),FU(39),FJU(39),ZZ(6),H,AZ,AH,DT,AL,
     4GAM,Y,YY,R,RP,HH,H2,AZBH,R2,AHY,AHPR,AH2,BB,BB2,AAA,BBB,DDT,A1,UV,
     5UUU,VVV,RRH,AQ,GAM2,AL2,BUN,RY,AM,AMRF ,GAMGAM,ALAL,BAN, KMP1,
     6MPP(147,39),MQQ(147,39),IM,JM,KM,IMM1,JMM1,KMM1,IMP1,JMP1,MAT,
     7 NK,NNNN,IMH,JMH,MATS,L(39),KA(10,39),KB(10,39),LV(39),NEND,
     8LA(10,39),LB(10,39),NN,TE(147,46),UN(147,39),TD(147,46),RN(147, 39)
     *,CL(147,39)
      COMMCN/TEMP/TFN(147,39,5)
      HG=H*490.0
      IF(MAT.NE.8) GO TO 6
      MAT=0
      WRITE(6,234) NN
  234 FORMAT(1H ,3HEND,4X,5HTIME=I6)
    6 CONTINUE
      SBC=8.3E-11*0.01666
      DO 20 J=JMH,JM
      JM1=J-1
      QJ=Q(J)
      XJ=X(J)
      JP1=J+1
      AA=1.0/(R2*XJ)
      AA2=AA/2.0
      XJ1=X(JM1)
      XMJ=XM(J)
      XMJ1=XM(JM1)
      BB2=XMJ*AA2/Y
      AH22=AH2*XMJ/XJ
      BB1=BB2*2.0
      CC2=XMJ1*AA2/Y
      CC=CC2*2.0
      AHM=AH Y/XJ
      AH1=AHRR/(XJ*XJ)
      AH3=AH2*XMJ1/X J
      LJ=L(J)
      DO 4011 M1=1,LJ
      II=KA(M1,J)
      IG=KB(M1,J)
      DO 21 I=II,IG
      UM=UN(I,J)*51.48
      TEIJ=TE(I,J)
      CLN=CL(I,J)*0.125
      MP=MPP(I,J)
      RSN=QJ*(1.-0.7*CLN)
C*****COMPUTATICN OF PRESSURE***********************
      PZ=0.0
      PZ1=0.0
      DO 4018 K=1,KMM1
      KP1=K+1
      PZ=PZ-ZZ(KP1)*AL2*(TT(I,J,K)+TT(I,J,KP1))
      PZ1=PZ1+PZ*Z(KP1)
 4018 CONTINUE
      SP(I,J)=PZ1*HG
      IP1=I+1
      IM1=I-1
      UBIJ=UB(I,J)
      UBM1J=UB(IM1,J)
      UBIM1=UB(I,JM1)
      VBIJ=VB(I,J)
      VBM1J=VB(IM1,J)
      VBIM1=VB(I,JM1)
```

```
      UBM1M1=UB(IM1,JM1)
      VBM1M1=VB(IM1,JM1)
      TA=TE(I,J)+273.15
      TW=TD(I,J)+273.15
  123 TS=T(I,J,1)+273.15
      PCB=1013.25*0.1
      ESS=10.0**(8.4051-2353.0/TS)
      ESD=10.0**(8.4051-2353.0/TW)
      RLN=SBC*TS**4*0.985*(0.39-0.05*SQRT(ESD*10.))*(1.-0.6*CLN**2)
      RNS=RSN-RLN
      RN(I,J)=RNS
      QS=0.622*ESS/(PCB-ESS)
      QA=0.622*ESD/(PCB-ESD)
      DO 22 K=1,KM
      KP1=K+1
      ZZ1=ZZ(KP1)
      ZZK=ZZ(K)
      ZK=Z(K)
C     VERTICAL DIFFUSION(HT,HS) AND VERTICAL ADVECTION(WT,WS)
      WIJ=W(I,J,K)
      CC1=1.0/(R2*ZK)
      KM1=K-1
      TTP1J=TT(IP1,J,K)
      TTM1J=TT(IM1,J,K)
      TTIP1=TT(I,JP1,K)
      TTIM1=TT(I,JM1,K)
      TTIJ=TT(I,J,K)
      TIJ=T(I,J,K)
      IF(K.EQ.1.AND.((TIJ-TEIJ)+0.609*TS *(QS-QA)).GE.0.0)  GO TO 333
      IF(K.EQ.1) GO TO 334
      TXIJ=(T(I,J,KM1)-TIJ)/ZZK
      WT=    (TTIJ+TT(I,J,KM1))*WIJ
      IF(K.NE.KM) GO TO 2003
      TYIJ=0.0
      PK=0.0
      PK1=0.0
      GO TO 2004
  333 CU=0.033
      CO=1.23*0.001
      GO TO 133
  334 CU=0.018
      CO=0.41*0.001
  133 QH=1.2*0.001*0.24*CO*UM*(TIJ-TEIJ)
      QE=1.2*0.001*CO*595.*UM*(QS-QA)
      TXIJ=(RNS-QH-QE)*H/AZ
      WT=0.0
 2003 TYIJ=(TIJ-T(I,J,KP1))/ZZ1
      WIJP= W(I,J,KP1)
      PK=(TTIJ+TT(I,J,KP1))*WIJP
 2004 HS=AZHH/ZK
      WT=(WT-PK)*CC1
      HT=HS*(TXIJ-TYIJ)
C     HORIZONTAL DIFFUSION(HT,HS) AND HORIZONTAL ADVECTION (WT,WS)
      TXIJ=(T(IP1,J,K)-TIJ)*AH1
      TXM1J=(TIJ-T(IM1,J,K))*AH1
      TYIJ=(T(I,JP1,K)-TIJ)*AH22
      TYIM1=(TIJ-T(I,JM1,K))*AH3
      VIJ=VV(I,J,K)+VBIJ
      VM1J=VV(IM1,J,K)+VBM1J
      VIM1=VV(I,JM1,K)+VBIM1
      VM1M1=VV(IM1,JM1,K)+VBM1M1
      UIJ=UU(I,J,K)+UBIJ
      UM1J=UU(IM1,J,K)+UBM1J
      UIM1=UU(I,JM1,K)+UBIM1
      UM1M1=UU(IM1,JM1,K)+UBM1M1
      IF(MP.EQ.1) GO TO 2001
```

```
      IF(MP.EQ.11)  GO TO 2011
      IF(MP.EQ.12)  GO TO 2012
      IF(MP.EQ.13)  GO TO 2013
      IF(MP.EQ.14)  GO TO 2014
      IF(MP.EQ.21)  GO TO 2021
      IF(MP.EQ.23)  GO TO 2023
      IF(MP.EQ.24)  GO TO 2024
      IF(MP.EQ.31)  GO TO 2031
      IF(MP.EQ.32)  GO TO 2032
      IF(MP.EQ.34)  GO TO 2034
      IF(MP.EQ.22)  GO TO 2022
 2033 F=UIJ+UIM1
      G=(VIJ+VM1J)*BB2
      FF=VIM1*CC2
      WT=WT+(((TTIJ+TTP1J)*F                -(TTIJ+TTM1J)*UM1J)*AA2+
     1(TTIJ+TTIP1)*G              -(TTIJ+TTIM1)*FF        )*BUN
      HT=HT+(TXIJ+TYIJ-(TXM1J+TYIM1)/2.0)*BUN
      GO TO 2005
 2001 F=UIJ+UIM1
      G=(VIJ+VM1J)*BB2
      FF=UM1J+UM1M1
      GG=(VIM1+VM1M1)*CC2
      WT=WT+((TTIJ+TTP1J)*F         -(TTIJ+   TTM1J)*FF             )*AA2
     1+(TTIJ+TTIP1)*G              -(TTIJ+TTIM1)*GG
      HT=TXIJ-TXM1J+TYIJ-TYIM1+HT
      GO TO 2005
 2011 F=(UM1M1+UM1J)*AA
      G=VM1J*BB1
      FF=VM1M1*CC
      WT=WT-(TTIJ+TTM1J)*F                   +(TTIJ+TTIP1)*G
     1-(TTIJ+TTIM1)*FF
      HT=-TXM1J*2.0+TYIJ-TYIM1+HT
      GO TO 2005
 2012 F=(VIM1+VM1M1)*CC
      WT=WT+((TTIJ+TTP1J)*UIM1-(TTIJ+TTM1J)*UM1M1)*AA
     1-(TTIJ+TTIM1)*F
      HT=TXIJ-TXM1J-TYIM1*2.0+HT
      GO TO 2005
 2013 F=(UIJ+UIM1)*AA
      G=VIJ*BB1
      FF=VIM1*CC
      WT=WT+(TTIJ+TTP1J)*F                 +(TTIJ+TTIP1)*G
     1-(TTIJ+TTIM1)*FF
      HT=TXIJ*2.0+TYIJ-TYIM1+HT
      GO TO 2005
 2014 F=(VIJ+VM1J)*BB1
      WT=WT+((TTIJ+TTP1J)*UIJ-(TTIJ+TTM1J)*UM1J)*AA
     1+(TTIJ+TTIP1)*F
      HT=TXIJ-TXM1J+TYIJ*2.0+HT
      GO TO 2005
 2021 F=UM1M1*AA
      G=VM1M1*CC
      WT=WT-(TTIJ+TTM1J)*F         *2.0-(TTIJ+TTIM1)*G         *2.0
      HT=HT-(TXM1J+TYIM1)*2.0
      GO TO 2005
 2022 F=UIM1*AA
      G=VIM1*CC
      WT=WT+((TTIJ+TTP1J)*F         -(TTIJ+TTIM1)*G         )*2.0
      HT=(TXIJ-TYIM1)*2.0+HT
      GO TO 2005
 2023 F=UIJ*AA
      G=VIJ*BB1
      WT=WT+((TTIJ+TTP1J)*F        +(TTIJ+TTIP1)*G        )*2.0
      HT=(TXIJ+TYIJ)*2.0+HT
      GO TO 2005
 2024 F=UM1J*AA
```

```
      G=VB1J*BB1
      WT=WT-((TTIJ+TTM1J)*F          -(TTIJ+TTIP1)*G          )*2.0
      HT=(TYIJ-TXM1J)*2.0+HT
      GO TO 2005
 2031 F=UM1M1+UM1J
      G=VM1J*BB2
      FF=(VIM1+VM1M1)*CC2
      WT=WT+(((TTIJ+TTP1J)*UIM1-(TTIJ+TTM1J)*F                )*AA2+
     1(TTIJ+TTIP1)*G          -(TTIJ+TTIM1)*FF                 )*BUN
      HT=((TXIJ+TYIJ)/2.0-TXM1J-TYIM1)*BUN+HT
      GO TO 2005
 2032 F=UIM1+UIJ
      G=VIJ*BB2
      FF=(VIM1+VM1M1)*CC2
      WT=WT+(((TTIJ+TTP1J)*F              -(TTIJ+TTM1J)*UM1M1)*AA2+
     1(TTIJ+TTIP1)*G          -(TTIJ+TTIM1)*FF                )*BUN
      HT=((TYIJ-TXM1J)/2.0+TXIJ-TYIM1)*BUN+HT
      GO TO 2005
 2034 G=(VIJ+VM1J)*BB2
      F=VM1M1*CC2
      FF=UM1J+UM1M1
      WT=WT+(((TTIJ+TTP1J)*UIJ-(TTIJ+TTM1J)*FF                )*AA2+
     1(TTIJ+TTIP1)*G                 -(TTIJ+TTIM1)*F          )*BUN
      HT=((TXIJ-TYIM1)/2.0-TXM1J+TYIJ)*BUN+HT
 2005 TEN(I,J,K)=DDT*(HT-WT/0.93)
   22 CONTINUE
   21 CONTINUE
 4011 CONTINUE
   20 CONTINUE
      IF(MAT.EQ.0) GO TO 2036
      IF(MAT.EQ.((MAT/2)*2)) GO TO 2037
      IF(MAT.EQ.1) GO TO 2038
C      MAT=3,5,7
 2035 READ(2) TT
      REWIND 2
      DO 38 J=JMH,JM
      LJ=L(J)
      DO 4014 M1=1,LJ
      II=KA(M1,J)
      IG=KB(M1,J)
      DO 39 I=II,IG
      DO 40 K=1,KM
      AT(K)=TT(I,J,K)+TEN(I,J,K)
   40 CONTINUE
      CALL ADJUST
      DO 41 K=1,KM
      TT(I,J,K)=AT(K)
   41 CONTINUE
   39 CONTINUE
 4014 CONTINUE
   38 CONTINUE
      IF(MAT.EQ.7) GO TO 2500
    9 DO 2 K=1,KM
      DO 3 J=JMH,JM
      TT(IMP1,J,K)=TT(3,J,K)
      TT(2,J,K)=TT(IM,J,K)
      T(2,J,K)=T(IM,J,K)
      T(IMP1,J,K)=T(3,J,K)
    3 CONTINUE
    2 CONTINUE
      WRITE(2) TT
      REWIND 2
      GO TO 10
C      MAT=1
 2038 DO 30 J=JMH,JM
      LJ=L(J)
```

```
      DO 4012 M1=1,LJ
      II=KA(M1,J)
      IG=KB(M1,J)
      DO 31 I=II,IG
      DO 32 K=1,KM
      AT(K)=T(I,J,K)+TEN(I,J,K)
   32 CONTINUE
      CALL ADJUST
      DO 33 K=1,KM
      T(I,J,K)=TT(I,J,K)
      TT(I,J,K)=AT(K)
   33 CONTINUE
   31 CONTINUE
 4012 CONTINUE
   30 CONTINUE
      GO TO 9
C      MAT=2,4,6
 2037 DO 34 J=JMH,JM
      LJ=L(J)
      DO 4013 M1=1,LJ
      II=KA(M1,J)
      IG=KB(M1,J)
      DO 35 I=II,IG
      DO 36 K=1,KM
      AT(K)=T(I,J,K)+TEN(I,J,K)
   36 CONTINUE
      CALL ADJUST
      DO 37 K=1,KM
      TT(I,J,K)=AT(K)
   37 CONTINUE
   35 CONTINUE
 4013 CONTINUE
   34 CONTINUE
      GO TO 2500
C      MAT=0
 2036 DO 42 J=JMH,JM
      LJ=L(J)
       DO 4015 M1=1,LJ
      II=KA(M1,J)
      IG=KB(M1,J)
      DO 43 I=II,IG
      DO 44 K=1,KM
      AT(K)=T(I,J,K)+TEN(I,J,K)
   44 CONTINUE
      CALL ADJUST
      DO 45 K=1,KM
      T(I,J,K)=TT(I,J,K)
      TT(I,J,K)=AT(K)
   45 CONTINUE
   43 CONTINUE
 4015 CONTINUE
   42 CONTINUE
 2500 CONTINUE
      DO 4016 K=1,KM
      DO 4017 J=JMH,JM
      T(2,J,K)=T(IM,J,K)
      TT(2,J,K)=TT(IM,J,K)
      T(IMP1,J,K)=T(3,J,K)
      TT(IMP1,J,K)=TT(3,J,K)
 4017 CONTINUE
 4016 CONTINUE
   10 DO 4019 J=JMH,JM
      SP(IMP1,J)=SP(3,J)
 4019 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE PRSP
      RETURN
      END
      SUBROUTINE GEOST
      RETURN
      END
      SUBROUTINE PREPA
      RETURN
      END
      SUBROUTINE  SHADE(ICTL,RCTL,BVAL)
C
      REAL  RCTL(2), BVAL(44), ALIN(132), BLIN(132)
      INTEGER  ICTL(8)
      LOGICAL*1  BLANK/' '/, LP/'('/, QM/''''/, RP/')'/
      LOGICAL*1  FRSTLN, DATAL, NSHADE, COND, CLIN(137), CTBL(20)
C
C*********************************************************************
C     CALL SHADE (ICTL, RCTL, RFIELD)                                 *
C*********************************************************************
C     ICTL(1)   ...  CALL CODE                                        *
C               =0  -NORMAL INTRA-FIELD CALL                          *
C                    (ONLY RFIELD IS USED, ICTL(2) THRU ICTL(8) AND   *
C                    RCTL ARE IGNORED)                                *
C               =1  -BEGINNING-OF-FIELD CALL                          *
C                    (ONLY ICTL AND RCTL PARAMETERS ARE USED, RFIELD  *
C                    IS IGNORED)                                      *
C     ICTL(2)   ...  OUTPUT TAPE NUMBER                               *
C     ICTL(3)   ...  LEFT (SHADE) MARGIN                              *
C     ICTL(4)   ...  NUMBER OF SHADING LINES                          *
C     ICTL(5)   ...  NUMBER OF FIELDS                                 *
C     ICTL(6)   ...  FIELD WIDTH                                      *
C     ICTL(7)   ...  DOES THE CALLING PROGRAM PRINT INTERSPERSED DATA *
C               =1  -NO                                               *
C               =2  -YES                                              *
C     ICTL(8)   ...  IGNORED                                          *
C.....................................................................*
C     RCTL(1)   ...  CYCLE POINT                                      *
C     RCTL(2)   ...  SHADE INTERVAL                                   *
C.....................................................................*
C     RFIELD    ...  ONE DIMENSIONAL VECTOR WITH NUMERIC INFORMATION  *
C                    TO BE SHADED                                     *
C*********************************************************************
      IF (ICTL(1) .NE. 0) GO TO 1000
      XL=(BVAL(1)-CP)/SINT
      M2=LM
      IF (COND) GO TO 3100
      BLIN(LM)=(XL-ALIN(LM))/VDIVS
 3021 DO 3029 K=LF,NF,ISKP
      M1=M2+1
      M2=M2+IFW
      XR=((BVAL(K)-CP)/SINT-XL)/FW
      DO 3029 J=M1,M2
      XL=XL+XR
 3029 BLIN(J)=(XL-ALIN(J))/VDIVS
 3051 DO 3059 L=1,NSL
 3041 DO 3049 K=LM,MR
      ALIN(K)=ALIN(K)+BLIN(K)
      TBLC=AMOD(ALIN(K),TLEN)+1.
      IF (TBLC .LT. 1.) TBLC=TBLC+TLEN
      IT=TBLC
 3049 CLIN(K+2)=CTBL(IT)
 3059 WRITE (NTP,CLIN)
      IF (.NOT.DATAL) RETURN
 3061 DO 3069 K=LM,MR
 3069 ALIN(K)=ALIN(K)+BLIN(K)
      RETURN
```

```
3100 IF (NSHADE) GO TO 2000
     COND=.FALSE.
     ALIN(LM)=XL
3121 DO 3129 K=LF,NF,ISKP
     M1=M2+1
     M2=M2+IFW
     XR=((BVAL(K)-CP)/SINT-XL)/FW
     DO 3129 J=M1,M2
     XL=XL+XR
3129 ALIN(J)=XL
     IF (DATAL) RETURN
3141 DO 3149 K=LM,MR
     TBLC=AMOD(ALIN(K),TLEN)+1.
     IF (TBLC .LT. 1.) TBLC=TBLC+TLEN
     IT=TBLC
3149 CLIN(K+2)=CTBL(IT)
     WRITE (NTP,CLIN)
     RETURN
2000 IF (FRSTLN) GO TO 2030
2011 DO 2019 L=1,NSL
2019 WRITE (NTP,CLIN)
2030 FRSTLN=.FALSE.
     RETURN
C*********************************************************************
1000 CONTINUE
     ISKP=ICTL(1)
     LF=ISKP+1
     NTP=ICTL(2)
     LM=ICTL(3)
     NSL=ICTL(4)
     NF=ICTL(5)
     IFW=ICTL(6)
     DATAL=ICTL(7).NE.1
     VDIVS=NSL
     IF (DATAL) VDIVS=VDIVS+1.
     IF (LM.LT.2) LM=2
     IF (IFW.LT.2) IFW=2
     FW=IFW
     NS=(NF-1)/ISKP+1
     MR=LM+(NS-1)*IFW
     IF (MR.LE.LL) GO TO 1011
     NF=(LL-LM)/IFW*ISKP+1
     NS=(NF-1)/ISKP+1
     MR=LM+(NS-1)*IFW
1011 CP=RCTL(1)
     SINT=RCTL(2)
     FRSTLN=.TRUE.
     COND=.TRUE.
     NSHADE=SINT.EQ.0.
     IF (.NOT.NSHADE) GO TO 1021
     SINT=1.
     CP=0.
     MR=1
     LM=1
1021 DO 1029 I=1,LM
1029 CLIN(I+2)=BLANK
     CLIN(1)=LP
     CLIN(2)=QM
     CLIN(MR+3)=QM
     CLIN(MR+4)=RP
     RETURN
     DATA LL/132/
     DATA  TLEN/20.0/, CTBL/1H0,1H ,1H1,1H ,1H2,1H ,1H3,1H ,1H4,1H
    *, 1H5,1H ,1H6,1H ,1H7,1H ,1H8,1H ,1H9,1H /
     END
```

```
      SUBROUTINE PREP
C
C        DATA: IM,JM,KM,IMH,JMH
C              OCEAN SHAPE (SUBROUTINE SHAPE2)
C              H, Z(I)
C              AZ,AM,AH
C              WE,WN (GIVEN FROM CARDS, OR A TAPE OR THE SUBROUTINE WIND)
C              Q(J)  (HEATING FUNCTION, REFERENCE ATMOSPHERIC TEMPERATURE)
C              AT(K)  (INITIAL TEMPERATURE)
C              UB,VB (GIVEN FROM CARDS, OR A MAGNETIC TAPE, OR THE SUBROUTINE
C              BARO)
C              BB,AAA,BBB (AAA:GRID SIZE IN LATITUDE, BBB:GRID SIZE IN
C              LONGITUDE. BOTH IN DEGREES. BB IS THE LATITUDE CORRESPOND-
C              ING TO J=0.)
C
      COMMON T(147,39,5),TT(147,39,5),SP(147,39),AT(5),UU(147,39,5),
     1VV(147,39,5),U(147,39,5),V(147,39,5),W(147,39,5),UB(147,39),
     2VB(147,39),WE(147,39),WN(147,39),Q(39),XJA(38),XHT(38),XHS(38),
     3 XMY(38), Z(5),X(39),XM(39),FU(39),FJU(39),ZZ(6),H,AZ,AH,DT,AL,
     4GAM,Y,YY,R,RR,HH,H2,AZHH,R2,AHY,AHRR,AH2,BB,BB2,AAA,BBB,DDT,A1,UV,
     5UUU,VVV,RRH,AQ,GAM2,AL2,BUN,RY,AM,AMRR ,GAMGAM,ALAL,BAN, KMP1,
     6MPP(147,39),MQQ(147,39),IM,JM,KM,IMM1,JMM1,KMM1,IMP1,JMP1,MAT,
     7 NK,NNNN,IMH,JMH,MATS,L(39),KA(10,39),KB(10,39),LV(39),NEND,
     8LA(10,39),LB(10,39)
      READ(5,80) IM,JM,KM,IMH,JMH
   80 FORMAT(5I5)
      JMP1=JM+1
      JMM1=JM-1
      IMP1=IM+1
      IMM1=IM-1
      KMM1=KM-1
C     CALL SHAPE2
      CALL SHAPE2
      DO 47 K=1,KM
      DO 48 J=1,JMP1
      DO 49 I=1,IMP1
      UU(I,J,K)=0.0
      VV(I,J,K)=0.0
      W(I,J,K)=0.0
      U(I,J,K)=0.0
      V(I,J,K)=0.0
      TT(I,J,K)=0.0
      T(I,J,K)=0.0
   49 CONTINUE
   48 CONTINUE
   47 CONTINUE
      READ(5,81) H, (Z(I),I=1,KM)
   81 FORMAT(E15.7,5F10.2)
      WRITE(6,13)  (Z(I),I=1,KM)
   13 FORMAT(1H ,19HDEPTHS FOR T, U, V=5F10.5)
      KMP1=KM+1
      ZZ(1)=-2.0*Z(1)
      DO 82 I=2,KM
      ZZ(I)=Z(I-1)-Z(I)
   82 CONTINUE
      ZZ(KMP1)=2.0*(1.0+Z(KM))
      DO 83 I=1,KM
      Z(I)=(ZZ(I)+ZZ(I+1))/2.0
   83 CONTINUE
      WRITE(6,33) H,(Z(I),I=1,KM)
   33 FORMAT(1H ,2HH=E15.7,2X,2HZ=6E15.7)
      WRITE(6,21)  (ZZ(I),I=1,KMP1)
   21 FORMAT(1H ,3HZZ=7E15.7)
```

```
      READ(5,84) AZ,AM,AH
   84 FORMAT(3E15.7)
 4567 DO 4568 J=1,39
      DO 4569 I=1,IMP1
      WE(I,J)=0.0
      WN(I,J)=0.0
 4569 CONTINUE
 4568 CONTINUE
C      CALL WIND
      CALL WIND
      AL=H/AZ
      DO 2000 J=1,JMP1
      DO 2001 I=1,IMP1
      WE(I,J)=WE(I,J)*AL
      MP=MPP(I,J)
      IF(MP.LE.1) GO TO 2003
      IF(MP.GT.5) GO TO 2003
      DO 2002 K=1,KM
      T(I,J,K)=0.0
      TT(I,J,K)=0.0
      W(I,J,K)=444.444
 2002 CONTINUE
 2003 IF(MQQ(I,J).NE.2) GO TO 2001
      DO 2004 K=1,KM
      U(I,J,K)=333.333
      UU(I,J,K)=333.333
      VV(I,J,K)=444.444
      V(I,J,K)=444.444
 2004 CONTINUE
 2001 CONTINUE
 2000 CONTINUE
      READ(5,5)  (Q(J),J=JMH,JM)
    5 FORMAT(12F5.0)
      DO 5094 J=3,38
      READ(5,5095) (AT(K),K=1,KM)
 5095 FORMAT(5F10.2)
      LJ=L(J)
      DO 5096 LL=1,LJ
      IM1=KA(LL,J)
      IP1=KB(LL,J)
      DO 97 I=IM1,IP1
      DO 98 K=1,KM
      T(I,J,K)=AT(K)
      TT(I,J,K)=AT(K)
   98 CONTINUE
   97 CONTINUE
 5096 CONTINUE
 5094 CONTINUE
      DO 200 J=3,38
      DO 201 K=1,KM
      T(IMP1,J,K)=T(3,J,K)
      TT(IMP1,J,K)=TT(3,J,K)
      T(2,J,K)=T(IM,J,K)
      TT(2,J,K)=TT(IM,J,K)
  201 CONTINUE
  200 CONTINUE
C     CALL BARO
      CALL BARO
C     AL=COEFFICIENT OF THERMAL EXPANSION
    3 AL=0.2E-3
      ALAL=AL*2.0
C     HEAT FLUX ACROSS THE SEA SURFACE IS SPECIFIED AS 70.0*(Q(J)-
C     TT(I,J,1)) CAL/DAY
      GAMGAM=H*70.0/(AZ*0.864E5)
      R=6.37E8
      READ(5,1) BB,AAA,BBB
```

```
    1 FORMAT(3F10.0)
      HH=3.1415926/180.0
      RY=AAA*HH
      Y=HH*BBB
      DO 10 I=1, JMP1
      A1=(BB+BBB*FLOAT(I))*HH
      X(I)=RY*COS(A1)
   10 CONTINUE
      CD=14.58E-5/(Y*RY)
      DO 9997 J=1,38
      XM(J)=(X(J)+X(J+1))/2.0
      FJU(J)=CD*(X(J)-X(J+1))
 9997 CONTINUE
      H2=H*2.0
      YY=Y*Y
C     AAA AND BBB ARE WEIGHTS IN THE IMPLICIT SVHEME FOR THE INERTIA
C     OSCILLATION
      AAA=0.6
      BBB=0.4
      RR=R*R
      RRH=RR*H
      AL2=AL/2.0
      HH=H*H
      AZHH=AZ/HH
      R2=R*2.0
      AHY=AH*Y
      AQ=245.0*H
      BB=YY*RR
      A1=AM/BB
      AHRR=AH/RR
      BUN=4.0/3.0
      BAN=2.0/3.0
      AMRR=AM/RR
      AH2=AH/BB
      RY=R*Y
      BB=1.0/(Y*R)
      BB2=BB/2.0
      RETURN
      END
      SUBROUTINE BARO
      RETURN
      END
      SUBROUTINE WIND
      RETURN
      END
      SUBROUTINE SHAPE2
      COMMON T(147,39,5),TT(147,39,5),SP(147,39),AT(5),UU(147,39,5),
     1VV(147,39,5),U(147,39,5),V(147,39,5),W(147,39,5),UB(147,39),
     2VB(147,39),WE(147,39),WN(147,39),Q(39),XJA(38),XHT(38),XHS(38),
     3 XMY(38), Z(5),X(39),XM(39),FU(39),FJU(39),ZZ(6),H,AZ,AH,DT,AL,
     4GAM,Y,YY,R,RR,HH,H2,AZHH,R2,AHY,AHRR,AH2,BB,BB2,AAA,BBB,DDT,A1,UV,
     5UUU,VVV,RRH,AQ,GAM2,AL2,BUN,RY,AM,AMRR ,GAMGAM,ALAL,BAN, KMP1,
     6MPP(147,39),MQQ(147,39),IM,JM,KM,IMM1,JMM1,KMM1,IMP1,JMP1,MAT,
     7 NK,NNNN,IMH,JMH,MATS,L(39),KA(10,39),KB(10,39),LV(39),NEND,
     8LA(10,39),LB(10,39),NN
C        SUBROUTINE TO BE USED WHEN THE OCEAN SHAPE IS CHANGED.
C
C      MPP
C       MPP=1 IF THE FOUR NEAREST SURROUNDING POINTS ARE WATER-POINT,
C          =2 ON THE LAND (EXCLUDING THE COAST LINE).
C       FOR THE COAST-POINTS, REFER TO FIG.1.
C                  14
C          34XXXXXXXXXXXXXX33
C            XXXXXLANDXXXXX
C            XXXXXXXXXXXXXX
C            XX22        21XX
```

```
C         11XX             XX13
C          XX             XX
C          XX23       24XX
C          XXXXXXXXXXXXXX
C        31XXXXXXXXXXXXXX32
C               12
C
C             FIG.1
C
C     MQQ
C
C      MQQ=1 IF THE FOUR NEARESR SURROUNDING POINTS ARE WATER-POINT,
C         =2 ON THE LAND.
C      IN OTHER CASES, REFER TO FIG.2.
C
C              1112
C          XXXXXXXXXXXXXX
C          XXXXXLANDXXXXX
C          XXXXXXXXXXXXXX
C          XX1221   2211XX
C          XX           XX
C      2111XX           XX1121
C          XX           XX
C          XX1122   2112XX
C          XXXXXXXXXXXXXX
C          XXXXXXXXXXXXXX
C              1211
C
C             FIG.2
C
C        BAROCLINIC PART ONLY. LV(J), LA(I,J), AND LB(I,J) SHOULD BE READ
C        FROM DATA CARDS. THEN, L(J), KA(I,J), KB(I,J), MQQ(I,J) AND
C        MPP(I,J) ARE DETERMINED IN THIS SUBROUTINE.
C        THE DATA LV, LA AND LB USED HERE ARE IDENTICAL TO THE DATA LV,
C        LA AND LB TO BE USED FOR THE BAROTROPIC PART, BUT IT IS NOT
C        THE CASE WITH L, KA AND KB. L, KA AND KB ARE DIFFERENT FROM
C        EACH OTHER IN BOTH PARTS.
      IMM1=IM-1
      IMP1=IM+1
      JMM1=JM-1
      JMP1=JM+1
      JMH=3
      IMH=3
      DO 30 J=1,JM
      DO 31 I=1,IMP1
      MQQ(I,J)=2
   31 CONTINUE
   30 CONTINUE
      DO 32 J=3,JMM1
      READ(5,33) M
   33 FORMAT(I2)
      READ(5,34) (LA(I,J),LB(I,J),I=1,M)
   34 FORMAT(7(2I4,2X))
      DO 35 I=1,M
      II=LA(I,J)
      IG=LB(I,J)
      DO 36 N=II,IG
      MQQ(N,J)=1
   36 CONTINUE
   35 CONTINUE
      LV(J)=M
      MQQ(1,J)=MQQ(IMM1,J)
      MQQ(2,J)=MQQ(IM,J)
      MQQ(IMP1,J)=MQQ(3,J)
   32 CONTINUE
      DO 1 J=2,JM
```

```
      JM1=J-1
      DO 2 I=3,IM
      IM1=I-1
      IF(MQQ(I,J).EQ.1) GO TO 3
      IF(MQQ(IM1,J) .EQ. 1) GO TO 3
       IF (MQQ(IM1,JM1).EQ.1) GO TO 3
      IF(MQQ(I,JM1) .EQ. 1) GO TO 3
      MPP(I,J)=2
      GO TO 2
    3 MPP(I,J)=1
    2 CONTINUE
      MPP(1,J)=MPP(IMM1,J)
      MPP(2,J)=MPP(IM,J)
      MPP(IMP1,J)=MPP(3,J)
    1 CONTINUE
      DO 4 J=3,JMM1
      MM=LV(J)
      WRITE(6,9) J,LV(J),(LA(I,J),LB(I,J),I=1,MM)
    9 FORMAT(1H ,20I5)
    4 CONTINUE
      DO 11 I=3,IM
      WRITE(6,12) I,(MPP(I,J),J=3,JM)
      WRITE(6,13) (MQQ(I,J),J=3,JM)
   12 FORMAT(1H ,I3,2X,38I3)
   13 FORMAT(1H ,6X,38I3)
   11 CONTINUE
      DO 18 J=3,JM
      MM=0
      MP=MPP(3,J)
      IF(MP.EQ.2) GO TO 70
      II=3
      MM=MM+1
   70 DO 50 I=4,IMM1
      MPPIJ=MPP(I,J)
      IF(MPPIJ.EQ.MP) GO TO 60
      GO TO (16 ,200), MPPIJ
   16 II=I
      MM=MM+1
      GO TO 60
  200 KA(MM,J)=II
      KB(MM,J)=I-1
   60 MP=MPPIJ
   50 CONTINUE
      IF(MPP(IM,J).EQ.2) GO TO 80
      KA(MM,J)=II
      KB(MM,J)=IM
   80 L(J)=MM
      WRITE(6,9) J,L(J),(KA(I,J),KB(I,J),I=1,MM)
   18 CONTINUE
      DO 8004 J=JMH,JM
      JP1=J+1
      JM1=J-1
      DO 8005 I=IMH,IM
      IF(MPP(I,J).EQ.2) GO TO 8005
      IP1=I+1
      IM1=I-1
      K=0
      IF(MQQ(I,J).EQ.2) K=K+1000
      IF(MQQ(IM1,J).EQ.2) K=K+100
      IF(MQQ(IM1,JM1).EQ.2) K=K+10
      IF(MQQ(I,JM1).EQ.2) K=K+1
      IF(K.EQ.0) GO TO 8005
      IF(K.EQ.11) GO TO 42
      IF(K.EQ.1100) GO TO 1100
      IF(K.EQ.110) GO TO 110
      IF(K.EQ.1001) GO TO 1001
```

```
      IF(K.EQ.1110)  GO TO 1110
      IF(K.EQ.1101)  GO TO 1101
      IF(K.EQ.111)  GO TO 111
      IF(K.EQ.1011)  GO TO 1011
      IF(K.EQ.10)  GO TO 40
      IF(K.EQ.1)  GO TO 41
      IF(K.EQ.1000)  GO TO 1000
      IF(K.EQ.100)  GO TO 100
  100 MPP(I,J)=32
      GO TO 8005
 1000 MPP(I,J)=31
      GO TO 8005
   41 MPP(I,J)=34
      GO TO 8005
   40 MPP(I,J)=33
      GO TO 8005
 1011 MPP(I,J)=24
      GO TO 8005
  111 MPP(I,J)=23
      GO TO 8005
 1101 MPP(I,J)=21
      GO TO 8005
 1110 MPP(I,J)=22
      GO TO 8005
 1001 MPP(I,J)=11
      GO TO 8005
  110 MPP(I,J)=13
      GO TO 8005
 1100 MPP(I,J)=12
 8005 CONTINUE
 8004 CONTINUE
      DO 7501 J=2,JMM1
      JP1=J+1
      JM1=J-1
      DO 7500 I=2,IM
      IF(MQQ(I,J).EQ.2)  GO TO 7500
      IP1=I+1
      IM1=I-1
      K=1111
      IF(MQQ(IP1,J).EQ.2)  K=1000+K
      IF(MQQ(I,JP1).EQ.2)  K=K+100
      IF(MQQ(IM1,J).EQ.2)  K=K+10
      IF(MQQ(I,JM1).EQ.2)  K=K+1
      IF(K.EQ.1111)  K=1
      MQQ(I,J)=K
 7500 CONTINUE
      MPP(1,J)=MPP(IMM1,J)
      MQQ(1,J)=MQQ(IMM1,J)
      MPP(IMP1,J)=MPP(3,J)
      MQQ(IMP1,J)=MQQ(3,J)
      MPP(2,J)=MPP(IM,J)
      MQQ(2,J)=MQQ(IM,J)
 7501 CONTINUE
      MPP(1,JM)=MPP(IMM1,JM)
      MPP(2,JM)=MPP(IM,JM)
      MPP(IMP1,JM)=MPP(3,JM)
      DO 9000 I=1,IMP1
      WRITE(6,12) I,(MPP(I,J),J=3,JM)
      WRITE(6,13)  (MQQ(I,J),J=3,JM)
 9000 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE GEOST
      COMMON T(147,39,5),TT(147,39,5),SP(147,39),AT(5),UU(147,39,5),
     1VV(147,39,5),U(147,39,5),V(147,39,5),W(147,39,5),UB(147,39),
     2VB(147,39),WE(147,39),WN(147,39),Q(39),XJA(38),XHT(38),XHS(38),
     3 XMY(38), Z(5),X(39),XM(39),FU(39),FJU(39),ZZ(6),H,AZ,AH,DT,AL,
     4GAM,Y,YY,R,RR,HH,H2,AZHH,R2,AHY,AHRR,AH2,BB,BB2,AAA,BBB,DDT,A1,UV,
     5UUU,VVV,RRH,AQ,GAM2,AL2,BUN,RY,AM,AMRR ,GAMGAM,ALAL,BAN, KMP1,
     6MPP(147,39),MQQ(147,39),IM,JM,KM,IMM1,JMM1,KMM1,IMP1,JMP1,MAT,
     7 NK,NNNN,IMH,JMH,MATS,L(39),KA(10,39),KB(10,39),LV(39),NEND,
     8LA(10,39),LB(10,39),NN
      HG=H*490.0
      JJ=0
      DO 20 J=JMH,JM
      LJ=L(J)
      DO 4011 M1=1,LJ
      II=KA(M1,J)
      IG=KB(M1,J)
      DO 21 I=II,IG
      PZ=0.0
      PZ1=0.0
      DO 4018 K=1,KMM1
      KP1=K+1
      PZ=PZ-ZZ(KP1)*AL2*(TT(I,J,K)+TT(I,J,KP1))
      PZ1=PZ1+PZ*Z(KP1)
 4018 CONTINUE
      SP(I,J)=PZ1*HG
   21 CONTINUE
 4011 CONTINUE
   20 CONTINUE
      DO 4019 J=JMH,JM
      SP(IMP1,J)=SP(3,J)
 4019 CONTINUE
      DO 3000 J=JMH,JMM1
      FJUJ=FJU(J)
      IF(ABS(FJUJ).LE.1.0E-7) GO TO 3
      JP1=J+1
      RXMJ=R*XM(J)
      R1=RXMJ*FJUJ
      RX=RY*FJUJ
      GO TO 4
    3 JJ=J
      GO TO 3000
    4 LJ=LV(J)
      DO 4002 M1=1,LJ
      II=LA(M1,J)
      IG=LB(M1,J)
      DO 3001 I=II,IG
      IP1=I+1
      SP0=SP(I,J)-SP(IP1,JP1)
      SP1=SP(IP1,J)-SP(I,JP1)
      PXBIJ=SP1-SP0
      PYBIJ=-SP1-SP0
      DO 3002 K=1,KM
      ZZK=ZZ(K)
      KM1=K-1
      IF(K.NE.1) GO TO 4000
      PA=0.0
      PB=0.0
      GO TO 4001
 4000 CONTINUE
      P1=T(I,JP1,K)+T(I,JP1,KM1)-T(IP1,J,K)-T(IP1,J,KM1)
      P2=T(I,J,K)+T(I,J,KM1)-T(IP1,JP1,K)-T(IP1,JP1,KM1)
      PA=PA-ZZK*AL*(P1-P2)
```

```
      PB=PB+DZK*AL*(P2-P1)
 4001 CONTINUE
      PV=(PA*AQ-PXBIJ)/R1
      PU=(-PB*AQ+PYBIJ)/RX
      U(I,J,K)=PU
      UU(I,J,K)=PU
      V(I,J,K)=PV
      VV(I,J,K)=PV
 3002 CONTINUE
 3001 CONTINUE
 4002 CONTINUE
 3000 CONTINUE
      IF(JJ.EQ.0) GO TO 7
      JM1=JJ-1
      JP1=JJ+1
      DO 5 I=IMH,IM
      IF(MQQ(I,JJ).EQ.2) GO TO 5
      DO 6 K=1,KM
      PA=UU(I,JM1,K)
      PB=UU(I,JP1,K)
      PU=VV(I,JM1,K)
      PV=VV(I,JP1,K)
      IF(PA.GT.200.0) PA=0.0
      IF(PB.GT.200.0) PB=0.0
      IF(PU.GT.200.0) PU=0.0
      IF(PV.GT.200.0) PV=0.0
      AU=(PA+PB)/2.0
      AV=(PU+PV)/2.0
      UU(I,JJ,K)=AU
       U(I,JJ,K)=AU
      VV(I,JJ,K)=AV
       V(I,JJ,K)=AV
    6 CONTINUE
    5 CONTINUE
    7 DO 4007 K=1,KM
      DO 4008 J=JMH,JMM1
      U(2,J,K)=U(IM,J,K)
      V(2,J,K)=V(IM,J,K)
      UU(2,J,K)=UU(IM,J,K)
      VV(2,J,K)=VV(IM,J,K)
      U(IMP1,J,K)=U(3,J,K)
      V(IMP1,J,K)=V(3,J,K)
      UU(IMP1,J,K)=UU(3,J,K)
      VV(IMP1,J,K)=VV(3,J,K)
 4008 CONTINUE
 4007 CONTINUE
      CALL CONTI
      DO 7002 K=2,KM
      WRITE (6,7001) K
 7001 FORMAT(1H ,23HVERTICAL VELOCITY AT K=I1)
      DO 7003 I=IMH,IM
      WRITE(6,7000) I,(W(I,J,K),J=3,20)
 7000 FORMAT(1H ,I3,1X,18F7.2)
 7003 CONTINUE
      DO 7024 I=IMH,IM
      WRITE(6,7000) I,(W(I,J,K),J=21,38)
 7024 CONTINUE
 7002 CONTINUE
      DO 7009 K=1,KM
      WRITE(6,7010) K
 7010 FORMAT(1H ,7HU AT K=I1)
      DO 7011 I=IMH,IM
      WRITE(6,7012) I,(UU(I,J,K),J=3,20)
 7012 FORMAT(1H ,I3,2X,18F5.0)
 7011 CONTINUE
      DO 7022 I=IMH,IM
```

```
      WRITE(6,7012) I,(UU(I,J,K),J=21,38)
7022  CONTINUE
      DO 7021 I=IMH,IM
      WRITE(6,7012) I,(VV(I,J,K),J=3,20)
7021  CONTINUE
      DO 7023 I=IMH,IM
      WRITE(6,7012) I,(VV(I,J,K),J=21,38)
7023  CONTINUE
7009  CONTINUE
      RETURN
      END
```