

A THREE-DIMENSIONAL MODEL FOR ESTUARIES AND COASTAL SEAS: VOLUME III, THE INTERIM PROGRAM

**PREPARED FOR THE OFFICE OF WATER RESEARCH
AND TECHNOLOGY, DEPARTMENT OF THE INTERIOR**

**JAN J. LEENDERTSE
SHIAO-KUNG LIU
ALFRED B. NELSON**

**R-1884-OWRT
OCTOBER 1975**

The work upon which this publication is based was supported wholly by funds provided by the United States Department of the Interior as authorized under the Water Resources Research Act of 1964, Public Law 88-379, as amended.

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PREFACE

In 1972 Rand proposed to perform the research necessary to develop a three-dimensional model for estuaries and coastal seas under the sponsorship of the Office of Water Research and Technology (OWRT) of the United States Department of the Interior. At the suggestion of OWRT, the study was planned for phasing of research and reporting over a three-year period. Two of the three phases have now been completed.

In the first phase, the principles of computation for the model were derived and reported.* It was shown that three-dimensional flows could be computed effectively with the model.

In the second phase, the model was extended to include the effects of temperature and salinity on the flow field, and a number of simulations were made of estuaries and bays in the United States.** Funding for the third phase is pending.

The present volume contains a program listing of the three-dimensional model, which has been requested of OWRT by a commercial firm. Although the program remains experimental and no instructions for usage have been prepared, we are making the listing available at this time at the request of OWRT.

Rand does not normally publish work in progress in its Report series, but in view of the scientific value of this program and its potential use by commercial firms, we are doing so in this case, thus placing our work in the public domain and making it available to all members of the public and private sectors simultaneously.

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* *A Three-Dimensional Model for Estuaries and Coastal Seas: Volume I, Principles of Computation*, The Rand Corporation, R-1417-OWRR, December 1973.

** *A Three-Dimensional Model for Estuaries and Coastal Seas: Volume II, Aspects of Computation*, The Rand Corporation, R-1764-OWRT, June 1975.

SUMMARY

A computer program of a three-dimensional model for estuaries and coastal seas is presented.

The program can perform numerical integration of the equations of motion, the equation of continuity, and the equations representing transport of salt and temperature. A complicated equation of state is used. Vertical mass and momentum transfer coefficients are computed from density and velocity information.

The program is experimental. The aspects of computation are described in R-1764-OWRT, *A Three-Dimensional Model for Estuaries and Coastal Seas: Volume II, Aspects of Computation*, by Jan J. Leendertse and Shiao-Kung Liu.

THE PROGRAM

The program which is listed on the following pages is written in FORTRAN and was developed on IBM 360 and 370 series machines.

The program is not fully developed, and is experimental. It is designed with a general application in mind, and as a result, many options are available. For example, the location and number of boundary conditions can be varied. Many of these options have not been tested.

Modeling with this program is difficult. The modeler has to be able to distinguish between computational effects and the actual physical processes occurring. Consequently, he has to have a thorough understanding of the type of fluid motion in the water body to be modeled and understand the behavior of the computational method. Experience in use is indispensable. This requires considerable time and computational effort, as the troublesome computational effects become prominent only with the large computational arrays which are required for proper resolution.

```
C  INSERT " COMMON" HEPE
  DIMENSION PRINT(42,60)
  DIMENSION UG1(42,60,7),UG2(42,60,7),UG3(42,60,7)
  DIMENSION VG1(42,60,7),VG2(42,60,7),VG3(42,60,7)
  DIMENSION SG1(42,60,7),SG2(42,60,7),SG3(42,60,7)
  DIMENSION TG1(42,60,7),TG2(42,60,7),TG3(42,60,7)
  DIMENSION SEG1(42,60),SEG2(42,60),SEG3(42,60)
  DIMENSION TITLE(20),DATE(4)
  DIMENSION BUF(100)
  DIMENSION WLMAX(20),WLMIN(20),CURMAX(3,6,20),CURMIN(3,6,20)
  DIMENSION MWL3(20),NWL3(20),TITWL3(5,20),ZWL3(20)
  DIMENSION MC3(20),KC3(20),TIIC3(5,20),ZCUR3(3,20),KC3(20)
  EQUIVALENCE (UG1(1,1,1),U(1,1,1,1))
  EQUIVALENCE (UG2(1,1,1),U(1,1,1,2))
  EQUIVALENCE (UG3(1,1,1),U(1,1,1,3))
  EQUIVALENCE (VG1(1,1,1),V(1,1,1,1))
  EQUIVALENCE (VG2(1,1,1),V(1,1,1,2))
  EQUIVALENCE (VG3(1,1,1),V(1,1,1,3))
  EQUIVALENCE (SG1(1,1,1),S(1,1,1,1))
  EQUIVALENCE (SG2(1,1,1),S(1,1,1,2))
  EQUIVALENCE (SG3(1,1,1),S(1,1,1,3))
  EQUIVALENCE (TG1(1,1,1),T(1,1,1,1))
  EQUIVALENCE (TG2(1,1,1),T(1,1,1,2))
  EQUIVALENCE (TG3(1,1,1),T(1,1,1,3))
  EQUIVALENCE (SEG1(1,1),SE(1,1,1))
  EQUIVALENCE (SEG2(1,1),SE(1,1,2))
  EQUIVALENCE (SEG3(1,1),SE(1,1,3))
  1  FORMAT (1X,'NU=',1PE12.5,' F=',1PE12.5,
  *      1X,'AMX=',1PE12.5,' AMY=',1PE12.5)
  2  FORMAT (20A4)
  3  FORMAT (4I10,3E10.0)
  4  FORMAT (7F10.0)
  5  FORMAT (4I10,5(1X,1PE12.5))
  6  FORMAT (7(1X,1PE12.5))
  7  FORMAT (1X,7I11)
  8  FORMAT (1X,72I1)
  9  FORMAT (20F4.0/2CF4.0)
  10 FORMAT (7E10.0)
  11 FORMAT (6(1X,1PE10.3))
  12 FORMAT (2I10,5A4)
  13 FORMAT (3I10,5A4)
  21 FORMAT (1H0,5X,'LMAX',9X,'M',9X,'N',6X,'KMAX',2X,'DT',11X,'DX',
  *      11X,'DY')
  22 FORMAT (1H0,2X,'F',12X,'AHX',10X,'AHY',10X,'AMX',10X,'AMY',
  *      10X,'NU',11X,'KAPA')
  23 FORMAT (1H0,2X,'RHO',10X,'RHOA',9X,'TEMP',9X,'THETA',8X,'PHI',
  *      10X,'WSPD')
  24 FORMAT (1H0,6X,'LP1',7X,'LP2',7X,'LP3',7X,'LP4')
  25 FORMAT (1H0,6X,'KHT',8X,'LC',5X,'LGBP',6X,'KLP2')
  26 FORMAT (1H0,2X,'CT',11X,'ST',11X,'SET',10X,'RMM1',9X,'RMM2')
  27 FORMAT (1H0,5X,'DEPTHS OF LEVELS 1 THROUGH KMAX')
  28 FORMAT (1H0,3X,'DEPTH ARRAY OF ESTUARY')
  29 FORMAT (1H0,5X,'LOCATION & TYPE OF OPENINGS',/,
  *      9X,'KB=(1,2,3,4)=(W,S,E,N)',/,
  *      9X,'KB.GT.0=TIDAL OPENING',/,
  *      9X,'KB.LT.0=WATER INPUT',/,
  *      8X,'IB',8X,'JB',8X,'KB',13X,'UV',8X,'UFLOS',8X,'UFLOT')
  30 FORMAT (1H0,2X,'RFSTART FREQUENCY',5X,'LHIST')
  31 FORMAT (1H0,'SALINITY AT LEVEL',I3,' IS BEING READ')
  32 FORMAT (1H0,2X,'CKH',10X,'AHXT',6X,'AHYT',4X,'SKIPT')
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*4X,'SRETIM',4X,'TRETIM')
33 FORMAT (1HC,5X,'MWL3',6X,'NWL3',4X,'TITWL3')
34 FORMAT (1HC,6X,'MC3',7X,'NC3',9X,'K',4X,'LITC3')
  READ (5,2) TITLE
  PRINT 2,TITLE
  READ (5,3) LMAX,M,N,KMAX,TD,DX,DY
  WRITE (6,21)
  WRITE (6,5) LMAX,M,N,KMAX,TD,DX,DY
  READ (5,3) LST,LRST,LHIST
  WRITE (6,30)
  WRITE (6,5) LST,LRST,LHIST
  READ (5,4) F,AHX,AHY,AMX,AMY,CNU,CKA
  WRITE (6,22)
  WRITE (6,6) F,AHX,AHY,AMX,AMY,CNU,CKA
  READ (5,10) CKH,AHXT,AHYT,SKIPT,SRETIM,TRETIM
  WRITE (6,32)
  WRITE (6,11) CKH,AHXT,AHYT,SKIPT,SRETIM,TRETIM
  READ (5,4) RHOM,RHCA,TEMP,THETA,PHI,WSPD
  WRITE (6,23)
  WRITE (6,6) RHOM,RHCA,TEMP,THETA,PHI,WSPD
  READ (5,3) LP1,LP2,IP3,LP4
  WRITE (6,24)
  WRITE (6,5) LP1,LP2,IP3,LP4
  READ (5,3) KHT,LC,IGREH,KLF2
  WRITE (6,25)
  WRITE (6,5) KHT,LC,IGREH,KLF2
  READ (5,4) CT,STMP,SFT,RMM1,RMM2
  WRITE (6,26)
  WRITE (6,6) CT,STMP,SFT,RMM1,RMM2
  READ (5,4) (HS(K),K=1,KMAX)
  WRITE (6,27)
  WRITE (6,6) (HS(K),K=1,KMAX)
  NOWL3=0
  WRITE (6,33)
110 CONTINUE
  NOWL3=NOWL3+1
  READ (5,12) MWL3(NOWL3),NWL3(NOWL3),(TITWL3(K,NOWL3),K=1,5)
  WRITE (6,12) MWL3(NOWL3),NWL3(NOWL3),(TITWL3(K,NOWL3),K=1,5)
  IF (MWL3(NOWL3)+NWL3(NOWL3).NE.0) GO TO 110
  NOWL3=NOWL3-1
  NOCUR3=0
120 CONTINUE
  NOCUR3=NOCUR3+1
  READ (5,12) MC3(NOCUR3),NC3(NOCUR3),(LITC3(K,NOCUR3),K=1,5)
  IF (MC3(NOCUR3)+NC3(NOCUR3).NE.0) GO TO 120
  NOCUR3=NOCUR3-1
  NHIST=0
  NAVDA=0
  MHIST=100
  NUNIT=11
  NWD=1
  NREC=1
  MONE=-1
  CWMAX=1.0E50
  IF (KHT.NE.0) GO TO 250
  DO 240 J=1,N
240 READ (5,8) (KH(J,I),I=1,M)
250 CONTINUE
  CALL SFTCON
  IF (LHIST.EQ.0) GO TO 253
  DO 252 I=1,NOCUR3
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IMC3=MC3(I)
INC3=NC3(I)
KC3(I)=KH(INC3,IMC3)
DO 252 II=1,3
DO 252 K=1,KMAX
CURMAX(II,K,I)=-CWMAX
CURMIN(II,K,I)=CWMAX
252 CONTINUE
DO 1001 I=1,NOWL3
WLMAX(I)=-CWMAX
WLMIN(I)=CWMAX
1001 CONTINUE
NOCON3=C
CALL TRANS (BUF,MHIST,TITLE,18,NREC,NWD,NUNIT,NAVDA,C)
CALL TRANS (BUF,MHIST,DATE,4,NREC,NWD,NUNIT,NAVDA,0)
CALL TRANS (BUF,MHIST,TD,1,NREC,NWD,NUNIT,NAVDA,C)
CALL TRANS (BUF,MHIST,LMAX,1,NREC,NWD,NUNIT,NAVDA,C)
CALL TRANS (BUF,MHIST,LHIST,1,NREC,NWD,NUNIT,NAVDA,C)
CALL TRANS (BUF,MHIST,MHIST,1,NREC,NWD,NUNIT,NAVDA,C)
CALL TRANS (BUF,MHIST,MONE,1,NREC,NWD,NUNIT,NAVDA,C)
CALL TRANS (BUF,MHIST,NOWL3,1,NREC,NWD,NUNIT,NAVDA,C)
CALL TRANS (BUF,MHIST,NOCUP3,1,NREC,NWD,NUNIT,NAVDA,0)
CALL TRANS (BUF,MHIST,NOCCN3,1,NREC,NWD,NUNIT,NAVDA,C)
CALL TRANS (BUF,MHIST,MONE,1,NREC,NWD,NUNIT,NAVDA,0)
CALL TRANS (BUF,MHIST,NWL3,NOWL3,NREC,NWD,NUNIT,NAVDA,0)
CALL TRANS (BUF,MHIST,NWL3,NOWL3,NREC,NWD,NUNIT,NAVDA,0)
CALL TRANS (BUF,MHIST,TITWL3,5*NOWL3,NREC,NWD,NUNIT,NAVDA,0)
CALL TRANS (BUF,MHIST,MC3,NOCUR3,NREC,NWD,NUNIT,NAVDA,0)
CALL TRANS (BUF,MHIST,NC3,NOCUR3,NREC,NWD,NUNIT,NAVDA,0)
CALL TRANS (BUF,MHIST,KC3,NOCUR3,NREC,NWD,NUNIT,NAVDA,0)
CALL TRANS (BUF,MHIST,TITC3,5*NOCUP3,NREC,NWD,NUNIT,NAVDA,0)
CALL TRANS (BUF,MHIST,NWD,1,NREC,NWD,NUNIT,NAVDA,0)
253 CONTINUE
WRITE (6,34)
DO 1000 I=1,NOCUR3
1000 WRITE (6,13) MC3(I),NC3(I),KC3(I),(TITC3(K,I),K=1,5)
WRITE (6,28)
DO 255 J1=1,N
J=N+1-J1
255 WRITE (6,8) (KH(J,I),I=1,M)
DO 275 I=1,M
DO 275 J=1,N
DO 275 L=1,3
IF (KH(J,I).EQ.0) GC TO 275
SE(J,I,L)=SET
275 CONTINUE
CALL RESAL
DO 260 IJ=1,100
IB(IJ)=0
JB(IJ)=0
KB(IJ)=0
UVB(IJ)=0.0
260 CONTINUE
WRITE (6,29)
DO 310 IJ=1,100
READ (5,3) IB(IJ),JB(IJ),KE(IJ),LB,UV,UFLCS(IJ),UFLCT(IJ)
WRITE (6,5) IB(IJ),JB(IJ),KB(IJ),LB,UV,UFLCS(IJ),UFLCT(IJ)
IF (IB(IJ).EQ.0) GC TO 320
IBT=IB(IJ)
JBT=JB(IJ)
UVB(IJ)=UV
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KI1=0
IF (IABS(KB(IJ)).GT.2) KI1=1
KI2=1-KI1
IF (KB(IJ).GT.0) GO TO 305
KBT=-KB(IJ)
IF (MOD(KBT,2).EQ.0) GO TO 270
U(JBT,IBT,1,L1)=UV
U(JBT,IBT,1,L2)=UV
U(JBT,IBT,1,L3)=UV
S(JBT,IBT+KI1,1,L1)=-S(JBT,IBT+KI2,1,L1)+UFLOS(IJ)+UFLOS(IJ)
S(JBT,IBT+KI1,1,L2)=-S(JBT,IBT+KI2,1,L2)+UFLOS(IJ)+UFLOS(IJ)
S(JBT,IBT+KI1,1,L3)=-S(JBT,IBT+KI2,1,L3)+UFLOS(IJ)+UFLOS(IJ)
T(JBT,IBT+KI1,1,L1)=-T(JBT,IBT+KI2,1,L1)+UFLOT(IJ)+UFLOT(IJ)
T(JBT,IBT+KI1,1,L2)=-T(JBT,IBT+KI2,1,L2)+UFLOT(IJ)+UFLOT(IJ)
T(JBT,IBT+KI1,1,L3)=-T(JBT,IBT+KI2,1,L3)+UFLOT(IJ)+UFLOT(IJ)
SE(JBT,IBT+KI1,L1)=-SE(JBT,IBT+KI2,L1)
SE(JBT,IBT+KI1,L2)=-SE(JBT,IBT+KI2,L2)
SE(JBT,IBT+KI1,L3)=-SE(JBT,IBT+KI2,L3)
GO TO 310
270 CONTINUE
V(JBT,IBT,1,L1)=UV
V(JBT,IBT,1,L2)=UV
V(JBT,IBT,1,L3)=UV
S(JBT+KI1,IBT,1,L1)=-S(JBT+KI2,IBT,1,L1)+UFLOS(IJ)+UFLOS(IJ)
S(JBT+KI1,IBT,1,L2)=-S(JBT+KI2,IBT,1,L2)+UFLOS(IJ)+UFLOS(IJ)
S(JBT+KI1,IBT,1,L3)=-S(JBT+KI2,IBT,1,L3)+UFLOS(IJ)+UFLOS(IJ)
T(JBT+KI1,IBT,1,L1)=-T(JBT+KI2,IBT,1,L1)+UFLOT(IJ)+UFLOT(IJ)
T(JBT+KI1,IBT,1,L2)=-T(JBT+KI2,IBT,1,L2)+UFLOT(IJ)+UFLOT(IJ)
T(JBT+KI1,IBT,1,L3)=-T(JBT+KI2,IBT,1,L3)+UFLOT(IJ)+UFLOT(IJ)
SE(JBT+KI1,IBT,L1)=-SE(JBT+KI2,IBT,L1)
SE(JBT+KI1,IBT,L2)=-SE(JBT+KI2,IBT,L2)
SE(JBT+KI1,IBT,L3)=-SE(JBT+KI2,IBT,L3)
GO TO 310
305 CONTINUE
S(JBT,IBT+KI1,1,L1)=S(JBT,IBT+KI2,1,L1)+UFLOS(IJ)+UFLOS(IJ)
S(JBT,IBT+KI1,1,L2)=S(JBT,IBT+KI2,1,L2)+UFLOS(IJ)+UFLOS(IJ)
S(JBT,IBT+KI1,1,L3)=S(JBT,IBT+KI2,1,L3)+UFLOS(IJ)+UFLOS(IJ)
T(JBT,IBT+KI1,1,L1)=T(JBT,IBT+KI2,1,L1)+UFLOT(IJ)+UFLOT(IJ)
T(JBT,IBT+KI1,1,L2)=T(JBT,IBT+KI2,1,L2)+UFLOT(IJ)+UFLOT(IJ)
T(JBT,IBT+KI1,1,L3)=T(JBT,IBT+KI2,1,L3)+UFLOT(IJ)+UFLOT(IJ)
KBST = KH(JBT,IBT)
DO 308 K=1,KBST
SINI(K,IJ)=S(JBT,IBT,K,1)
TINI(K,IJ)=T(JBT,IBT,K,1)
308 CONTINUE
310 CONTINUE
320 CONTINUE
L=0
L3=MOD(L,3)+1
L2=MOD(L3,3)+1
L1=MOD(L2,3)+1
WRITE (8) TITLE
WRITE (8) KMAX,LMAX,M,N,DX,DY,TD,HS,KH,C
WINCH=1.0
IF (LST.EQ.0) GO TO 300
I=10
301 CONTINUE
READ (I) L,L1,L2,L3,IB,JB,KB,UVB,KH,HS
READ (I) CPO,CIAM,CIAM0,CP1,CLAM1,RHOT,FMM1,RMM2
READ (I) M,MM1,MM2,N,NM1,NM2,DX,DY,EDX,EDY,RDXS,RDYS
READ (I) DT,DT2,DT4,CNU,GRAV,KMAX,CKA,ANX,ANY,AMX,AMY,P
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READ (I) RHOM, RHCM2, ALPHO, TEMP, THETA, FHCA, WSPD, PHI, WINCH
READ (I) C, RHOZ, HZ, UFLOS, UFIOT
READ (I) W, TAUX, TAUY
READ (I) PGRAX, PGRAY, FHO
READ (I) U
READ (I) V
READ (I) S
READ (I) T
READ (I) SE
IF (L.LT.LST) GO TO 301
READ (5,4) F, WSPD
WRITE (6,6) F, WSPD
GO TO 620
300 CONTINUE
PRINT 5, L
DT=TD
DT2=TD2
DT4=TD4
IF (L.LE.0) GO TO 325
IF (MOD(L,LC).NE.0) GO TO 375
325 CONTINUE
DT2=TD
DT4=TD2
L3=L2
375 CONTINUE
CALL DSVP
IF (MOD(L,LP3).EQ.0) CALL PRNT5 (SE, 'ZETA', M, N, L1, L)
IF (MOD(L,LP3).EQ.0) CALL PRNT6 (V, 'V', M, N, KMAP, L1, 1, L)
IF (MOD(L,LP3).EQ.0) CALL PRNT6 (U, 'U', M, N, KMAP, L1, 1, L)
IF (MOD(L,LP1).NE.0) GO TO 500
SEM=0.0
TOM=0.0
SAL=0.0
TFM=0.0
DO 400 I=1, M
DO 400 J=1, N
DO 390 K=1, KMAX
TEM=TEM+T (J, I, K, L1)
390 SAL=SAL+S (J, I, K, L1)
IF (ABS (SE (J, I, L1)) .GT. SEM) SEM=ABS (SE (J, I, L1))
TOM=TOM+SE (J, I, L1)
400 NSE (J, I)=SE (J, I, L1)
WRITE (6,6) TOM, SAL, TEM
CALL PRNT1 (SE, 'ZETA', M, N, L1, L)
CALL PRNT2 (V, 'V', M, N, KMAP, L1, 1, L)
CALL PRNT2 (U, 'U', M, N, KMAP, L1, 1, L)
IF (L.EQ.0) GO TO 425
IF (MOD(L,LP2).NE.0) GO TO 425
DO 422 KK=1, KLP2
DO 421 J=1, N
DO 421 I=1, M
421 PRINT (J, I)=T (J, I, KK, L1)-TEMP
CALL PRNT4 (PRINT, 'TEMPERATURE', M, N, KK, L)
422 CONTINUE
DO 420 KK=1, KLP2
DO 410 J=1, N
DO 410 I=1, M
410 PRINT (J, I)=S (J, I, KK, L1)-STMP
CALL PRNT4 (PRINT, 'SALINITY', M, N, KK, L)
420 CONTINUE
425 CONTINUE
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500 CONTINUE
  IF (LHIST.EQ.0) GO TO 560
  IF (MOD(L,LHIST).NE.0) GO TO 560
  CALL TRANS (BUF,MHIST,L,1,NREC,NWD,NUNIT,NAVDA,0)
  DO 510 NH=1,NOWL3
  IH=MWL3(NH)
  JH=NWL3(NH)
  ZWL3(NH)=SE(JH,IH,I1)
  IF (ZWL3(NH).GT.WLMAX(NH)) WLMAX(NH)=ZWL3(NH)
  IF (ZWL3(NH).LT.WLMIN(NH)) WLMIN(NH)=ZWL3(NH)
510 CONTINUE
  CALL TRANS (BUF,MHIST,ZWL3,NOWL3,NREC,NWD,NUNIT,NAVDA,0)
  DO 530 NH=1,NOCUR3
  IH=MC3(NH)
  JH=NC3(NH)
  K1=KC3(NH)
  ZCUR3(1,1)=W(JH,IH,1)
  IF (ZCUR3(1,1).GT.CURMAX(1,1,NH)) CURMAX(1,1,NH)=ZCUR3(1,1)
  IF (ZCUR3(1,1).LT.CURMIN(1,1,NH)) CURMIN(1,1,NH)=ZCUR3(1,1)
  DO 520 K=1,K1
  ZCUR3(2,K)=U(JH,IH,K,I1)
  ZCUR3(3,K)=V(JH,IH,K,I1)
  ZCUR3(1,K+1)=W(JH,IH,K+1)
  IF (ZCUR3(2,K).GT.CURMAX(2,K,NH)) CURMAX(2,K,NH)=ZCUR3(2,K)
  IF (ZCUR3(2,K).LT.CURMIN(2,K,NH)) CURMIN(2,K,NH)=ZCUR3(2,K)
  IF (ZCUR3(3,K).GT.CURMAX(3,K,NH)) CURMAX(3,K,NH)=ZCUR3(3,K)
  IF (ZCUR3(3,K).LT.CURMIN(3,K,NH)) CURMIN(3,K,NH)=ZCUR3(3,K)
  IF (ZCUR3(1,K+1).GT.CURMAX(1,K+1,NH))
  *   CURMAX(1,K+1,NH)=ZCUR3(1,K+1)
  IF (ZCUR3(1,K+1).LT.CURMIN(1,K+1,NH))
  *   CURMIN(1,K+1,NH)=ZCUR3(1,K+1)
520 CONTINUE
  CALL TRANS (BUF,MHIST,ZCUR3,3*K1+1,NREC,NWD,NUNIT,NAVDA,0)
530 CONTINUE
  WRITE (6,3) NREC,NWD
560 CONTINUE
  IF (MOD(L,LGRPH).NE.0) GO TO 600
  IF (L1.NE.1) GO TO 570
  WRITE (8) L,SEG1
  DO 561 K=1,KMAX
  WRITE (8) ((W(J,I,K),J=1,N),I=1,M)
  WRITE (8) ((UG1(J,I,K),J=1,N),I=1,M)
  WRITE (8) ((VG1(J,I,K),J=1,N),I=1,M)
  WRITE (8) ((SG1(J,I,K),J=1,N),I=1,M)
  WRITE (8) ((TG1(J,I,K),J=1,N),I=1,M)
561 CONTINUE
  KK=KMAX+1
  WRITE (8) ((W(J,I,KK),J=1,N),I=1,M)
  GO TO 600
570 CONTINUE
  IF (L1.NE.2) GO TO 580
  WRITE (8) L,SEG2
  DO 571 K=1,KMAX
  WRITE (8) ((W(J,I,K),J=1,N),I=1,M)
  WRITE (8) ((UG2(J,I,K),J=1,N),I=1,M)
  WRITE (8) ((VG2(J,I,K),J=1,N),I=1,M)
  WRITE (8) ((SG2(J,I,K),J=1,N),I=1,M)
  WRITE (8) ((TG2(J,I,K),J=1,N),I=1,M)
571 CONTINUE
  KK=KMAX+1
  WRITE (8) ((W(J,I,KK),J=1,N),I=1,M)
```

```
GO TO 600
580 CONTINUE
WRITE (8) L,SE33
DO 581 K=1,KMAX
WRITE (8) ((W(J,I,K),J=1,N),I=1,M)
WRITE (8) ((UG3(J,I,K),J=1,N),I=1,M)
WRITE (8) ((VG3(J,I,K),J=1,N),I=1,M)
WRITE (8) ((SG3(J,I,K),J=1,N),I=1,M)
WRITE (8) ((TG3(J,I,K),J=1,N),I=1,M)
581 CONTINUE
KK=KMAX+1
WRITE (8) ((W(J,I,KK),J=1,N),I=1,M)
600 CONTINUE
L=L+1
IF (LRST.EQ.0) GO TO 620
IF (MOD(L,LRST).NE.0) GO TO 620
WRITE (9) L,L1,L2,L3,IB,JB,KB,UVE,KH,HS
WRITE (9) CPO,CLAM,CLAMC,CP1,CLAM1,RHCT,RMM1,RMM2
WRITE (9) M,MM1,MM2,N,NM1,NM2,DX,DY,RDX,RDY,RDYS
WRITE (9) DT,DT2,D14,CNU,GRAV,KMAX,CKA,AHK,AHY,AMX,AMY,F
WRITE (9) RHOM,RHOM2,ALPHC,TEMP,THETA,RHOA,WSPD,PHI,WINCH
WRITE (9) C,RHOZ,H7,UFLOS,UFLOT
WRITE (9) W,TAUX,TAUY
WRITE (9) PGRAX,PGRAY,RHO
WRITE (9) U
WRITE (9) V
WRITE (9) S
WRITE (9) T
WRITE (9) SE
620 CONTINUE
IF (L.GT.LMAX) GO TO 700
L3=MOD(L,3)+1
L2=MOD(L3,3)+1
L1=MOD(L2,3)+1
IF (SEM.GT.1.0E3) GO TO 700
CALL SESUV
WINCH=0.0
GO TO 300
700 CONTINUE
IF (LHIST.EQ.0) STOP
CALL TRANS (BUF,MHIST,WLMAX,NOWL3,NPEC,NWD,NUNIT,NAVDA,0)
CALL TRANS (BUF,MHIST,WLMIN,NOWL3,NREC,NWD,NUNIT,NAVDA,0)
KCUR=3*KMAX*NOCUR3
CALL TRANS (BUF,MHIST,CURMAX,KCUR,NREC,NWD,NUNIT,NAVDA,0)
CALL TRANS (BUF,MHIST,CURMIN,KCUR,NREC,NWD,NUNIT,NAVDA,0)
IF (NAVDA.EQ.0) WRITE (NUNIT) BUF
IF (NAVDA.NE.0) WRITE (NUNIT'NAVDA) BUF
WRITE (6,6) BUF
STOP
END
SUBROUTINE TRANS (A,LREC,B,ITM,NREC,NWD,NUNIT,NAVDA,IO)
DIMENSION A(LREC),P(ITM)
DEFINE FILE 50 (50,100,L,NAVDA)
1 FORMAT (10(14,1PE12.5))
IF (IO.EQ.0) GO TO 400
IF (NREC.NE.0) GO TO 25
IF (NAVDA.EQ.0) GO TO 10
READ (NUNIT'NAVDA) A
NREC=NAVDA
GO TO 50
10 CONTINUE
```



```
      READ (NUNIT,END=800) A
      NREC=2
      GO TO 50
25  CONTINUE
      IF (NAVDA.EQ.0) GO TO 50
      IF (NAVDA.EQ.NREC) GO TO 50
      READ (NUNIT,NAVDA) A
50  CONTINUE
      DO 300 I=1,LTM
      B(I)=A(NWD)
      NWD=NWD+1
      IF (NWD.LE.LREC) GO TO 200
      NWD=1
      NREC=NREC+1
      IF (NAVDA.EQ.0) GO TO 100
      READ (NUNIT,NAVDA) A
      GO TO 200
100 CONTINUE
      READ (NUNIT,END=800) A
200 CONTINUE
300 CONTINUE
      IF (NAVDA.NE.0) NREC=NAVDA
      RETURN
400 CONTINUE
      DO 700 I=1,LIM
      A(NWD)=B(I)
      NWD=NWD+1
      IF (NWD.LE.LREC) GO TO 600
      NWD=1
      NREC=NREC+1
      IF (NAVDA.EQ.0) GO TO 500
      WRITE (NUNIT,NAVDA) A
      GO TO 600
500 CONTINUE
      WRITE (NUNIT) A
600 CONTINUE
700 CONTINUE
      IF (NAVDA.NE.0) NREC=NAVDA
      RETURN
800 CONTINUE
      IO=-1
      RETURN
      END
      SUBROUTINE SETCON
C  INSERT "COMMON" HERE
      PI=3.14159265
      ALPHC=.698
      GRAV=980.
      PHI=PI*PHI/180.
      L1=1
      L2=2
      L3=3
      MM1=M-1
      MM2=M-2
      NM1=N-1
      KMAP=KMAX+1
      KMAP=KMAX
      NM2=N-2
      RDX=1.0/DX
      RDY=1.0/DY
      RDXS=RDY*FDX
```

```
RDYS=RDY*RDY
RHOM2=RHOM+RHOM
TD2=TD+TD
TD4=TD2+TD2
CP0=5890.+38.*TEMP-.375*TEMP*TEMP
CLAM=1779.5+11.25*TEMP-.0745*TEMP*TEMP
CLAM0=3.8+.01*TEMP
DO 200 I=1,M
DO 200 J=1,N
IF (KHI.NE.0) KH(J,I)=KHT
IF (I.EQ.1) KH(J,I)=C
IF (I.EQ.MM1) KH(J,I)=0
IF (I.EQ.M) KH(J,I)=C
IF (J.EQ.1) KH(J,I)=C
IF (J.EQ.NM1) KH(J,I)=0
IF (J.EQ.N) KH(J,I)=C
C(J,I)=CT
RHOZ(J,I)=0.0
HZ(J,I)=0.0
W(J,I,1)=0.0
PAUX(J,I,1)=0.0
TAUY(J,I,1)=0.0
DO 100 K=1,KMAX
W(J,I,K+1)=0.0
TAUX(J,I,K+1)=C.0
TAUY(J,I,K+1)=0.0
PGRAX(J,I,K)=0.0
PGRAY(J,I,K)=0.0
RHO(J,I,K)=0.0
DO 100 I=1,3
U(J,I,K,L)=0.0
V(J,I,K,L)=0.0
S(J,I,K,L)=STMP
T(J,I,K,L)=TEMP
100 CONTINUE
DO 200 L=1,3
SE(J,I,L)=C.0
200 CONTINUE
RETURN
END
SUBROUTINE DSVP
C INSERT "COMMON" HERE
IF (WINCH.EQ.0.0) GO TO 50
IF (L.GT.1) GO TO 1002
DO 1000 IIIII=1,30
1000 PRINT 1001
1001 FORMAT (1K,'DSVP')
1002 CONTINUE
IF (L.LE.3) GO TO 50
WSPD=WSPD*51.447192
STRESS=THETA*RHOZ*WSPD*(WSPD)
TAUXS=STRESS*SIN(PHI)
TAUYS=STRESS*COS(PHI)
50 CONTINUE
DO 75 I=1,M
DO 75 J=1,N
K1=KH(J,I)
IF (K1.EQ.0) GO TO 75
DO 70 K=1,K1
CP0=5890.+38*T(J,I,K,I1)-.375*T(J,I,K,I1)*T(J,I,K,I1)
CLAM=1779.5+11.25*T(J,I,K,I1)-.0745*T(J,I,K,I1)*T(J,I,K,I1)
```

```
CLAM0=3.8+0.01*TT(J,I,K,L1)
CP1=CP0+3.0*S(J,I,K,L1)
CLAM1=CLAM-CLAM0*S(J,I,K,I1)
RHOT=CP1/(CLAM1+ALFEO*CP1)-RHOM
RHO(J,I,K)=RHOT
70 CONTINUE
75 CONTINUE
DO 250 I=2,MM1
  IP1=I+1
  IM1=I-1
  DO 250 J=2,NM1
    K=KH(J,I)
    IF (K.EQ.0) GO TO 250
    JP1=J+1
    JM1=J-1
    KR=KH(J,IP1)
    KT=KH(JP1,I)
    W0=0.0
    RHOB=RHOM+.5*(RHO(J,I,K)+RHO(J,IP1,K))
    TAUJ(J,I,1)=TAUJS/EHCB
    TAUJ(J,I,1)=TAUJS/EHCB
    CB=.5*(C(J,I)+C(J,IP1))
    CB=CB*CB
    UB=U(J,I,K,L2)
    UU=UB*UB
    VB=.25*(V(J,I,K,L2)+V(J,IP1,K,L2)+V(JM1,I,K,L2)+V(JM1,IP1,K,L2))
    VV=VB*VB
    TAUJ(J,I,K+1)=GRAV*EHCB*UB*SQRT(UU+VV)/CB
    CB=.5*(C(J,I)+C(JP1,I))
    CB=CB*CB
    UP=.25*(U(J,I,K,L2)+U(J,IM1,K,L2)+U(JP1,I,K,L2)+U(JP1,IM1,K,L2))
    UU=UB*UB
    VB=V(J,I,K,L2)
    VV=VB*VB
    RHOB=RHOM+.5*(RHO(J,I,K)+RHO(JP1,I,K))
    TAUJ(J,I,K+1)=GRAV*EHCB*VB*SQRT(UU+VV)/CB
    IF (KR.LT.1) GO TO 80
    RHOT=.5*(RHO(J,I,1)+RHO(J,IP1,1)+RHOM2)
    PGRAX(J,I,1)=GRAV*RIX*(RHOT*(SE(J,IP1,L1)-SE(J,I,L1))
    *
    *      +(HS(1)+.5*(SE(J,I,L1)+SE(J,IP1,L1)))
    *      *(RHO(J,IP1,1)-RHO(J,I,1)))
80 CONTINUE
  IF (KT.LT.1) GO TO 100
  RHOT=.5*(RHO(J,I,1)+RHO(JP1,I,1)+RHOM2)
  PGRAY(J,I,1)=GRAV*EDY*(RHOT*(SE(JP1,I,L1)-SE(J,I,L1))
  *
  *      +(HS(1)+.5*(SE(J,I,L1)+SE(JP1,I,L1)))
  *      *(RHO(JP1,I,1)-RHO(J,I,1)))
100 CONTINUE
  IF (K.NE.1) GO TO 150
  SEH=SE(J,I,L1)+HS(1)+HS(1)
  HR=SEH+SE(J,IP1,L1)
  HL=SEH+SE(J,IM1,L1)
  HT=SEH+SE(JP1,I,L1)
  HB=SEH+SE(JM1,I,L1)
  W0=W0+.5*(RDX*(HR*U(J,I,K,L1)-HL*U(J,IM1,K,L1))
  +
  +RDY*(HT*V(J,I,K,L1)-HB*V(JM1,I,K,L1)))
  GO TO 200
150 CONTINUE
  WC=W0+HS(K)*(RDX*(U(J,I,K,L1)-U(J,IM1,K,L1))
  *
  *      +RDY*(V(J,I,K,L1)-V(JM1,I,K,L1)))
200 CONTINUE
```

```
W(J,I,K)=-W0
KP1=K
K=K-1
IF (K.EQ.C) GO TO 250
HTX=HS(K)+HS(KP1)
HTY=HTX
HTS=HTX
IF (KR.GE.KP1) HTX=HTX+HS(KP1)
IF (KR.GE.K) HTX=HTX+HS(K)
IF (KT.GE.KP1) HTY=HTY+HS(KP1)
IF (KT.GE.K) HTY=HTY+HS(K)
IF (K.NE.1) GO TO 225
HTX=HTX+SE(J,I,L2)
HTY=HTY+SE(J,I,L2)
IF (KR.NE.0) HTX=HTX+SE(J,IP1,L2)
IF (KT.NE.0) HTY=HTY+SE(JP1,I,L2)
HTS=HTS+SE(J,I,L2)
225 CONTINUE
DRHOX=-((FHO(J,I,K)+RHO(J,IP1,K))-(RHO(J,I,KP1)
*+RHO(J,IP1,KP1)))/HTX
DRHOY=-((RHO(J,I,K)+RHO(JP1,I,K))-(RHO(J,I,KP1)
*+RHO(JP1,I,KP1)))/HTY
DUDZ=(U(J,I,K,L2)-U(J,I,KP1,L2))/(HTX*0.5)
DVDZ=(V(J,I,K,L2)-V(J,I,KP1,L2))/(HTY*0.5)
RIX=(GRAV*DRHOX)/(PHCP*DUDZ*DUDZ+.000001)
RIY=(GRAV*DRHOY)/(PHCB*DVDZ*DVDZ+.000001)
IF (RIX.GT. 5.) RIX= 5.
IF (RIY.GT. 5.) RIY= 5.
IF (PIX.LT.-5.) RIX=-5.
IF (PIY.LT.-5.) RIY=-5.
HTX=.0625*HTX*HTX
HTY=.0625*HTY*HTY
UB=.5*(U(J,I,K,L1)+U(J,I,KP1,L1))
VB=.5*(V(J,I,K,L1)+V(J,I,KP1,L1))
WBX=(W(J,I,KP1)+W(J,IP1,KP1))*0.5
WBY=(W(J,I,KP1)+W(JP1,I,KP1))*0.5
DU=U(J,I,K,L2)-U(J,I,KP1,L2)
DV=V(J,I,K,L2)-V(J,I,KP1,L2)
UBK=.25*(U(J,I,K,L2)+U(J,IM1,K,L2)+U(JP1,I,K,L2)+U(JP1,IM1,K,L2))
UBKP=.25*(U(J,I,KP1,L2)+U(J,IM1,KP1,L2)
*+U(JP1,I,KP1,L2)+U(JP1,IM1,KP1,L2))
VBK=.25*(V(J,I,K,L2)+V(J,IP1,K,L2)+V(JM1,I,K,L2)+V(JM1,IP1,K,L2))
VBKP=.25*(V(J,I,KP1,L2)+V(J,IP1,KP1,L2)
*+V(JM1,I,KP1,L2)+V(JM1,IP1,KP1,L2))
DUB=UBK-UBKP
DVB=VBK-VBKP
RHOB=RHOH+.5*(RHO(J,I,K)+RHO(J,I,KP1))
CNU1= CNU
TAUX(J,I,KP1)=(DU*(CNU1*EXP(-RMM1*RIX)+CNU*
*SQRT(DU*DU+DVB*DVB))/HTX-UB*WBX)*PHCB
TAUY(J,I,KP1)=(DV*(CNU1*EXP(-RMM1*RIY)+CNU*
*SQRT(DUB*DUB+DV*DV))/HTY-VB*WBY)*RHOB
GO TO 100
250 CONTINUE
DO 400 K=2,KMAX
KM1=K-1
DO 300 I=1,M
DO 300 J=1,N
RHOZ(J,I)=RHO(J,I,K)+FHO(J,I,KM1)
H=0.0
IF (KH(J,I).GE.KM1) H=HS(KM1)
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```
IF (KH(J,I).GE.K) H=H+HS(K)
IF (K.EQ.2) H=H+SE(J,I,L1)
HZ(J,I)=H
300 CONTINUE
DO 350 I=1,MM1
IP1=I+1
DO 350 J=1,NM1
JP1=J+1
K1=KH(J,I)
IF (K1.LT.K) GO TO 350
KR=KH(J,IP1)
KT=KH(JP1,I)
IF (KR.LT.K) GO TO 325
PGRAX(J,I,K)=PGRAX(J,I,KM1)
*      +.125*GRAV*(HZ(J,I)+HZ(J,IP1))*RDX*(RHOZ(J,IP1)-RHOZ(J,I))
325 CONTINUE
IF (KT.LT.K) GO TO 350
PGRAY(J,I,K)=PGRAY(J,I,KM1)
*      +.125*GRAV*(HZ(J,I)+HZ(JP1,I))*RDY*(RHOZ(JP1,I)-RHOZ(J,I))
350 CONTINUE
400 CONTINUE
RETURN
END
SUBROUTINE SESUV
C  INSERT " COMMON" HERE
11  FORMAT(' SESUV:  SE COMPUTED')
12  FORMAT(' SESUV:  LEVEL ONE DEPTHS COMPUTED')
13  FORMAT(' SESUV:  HEAT & SALINITY COMPUTED')
14  FORMAT(' SESUV:  E-W VELOCITY COMPUTED')
15  FORMAT(' SESUV:  N-S VELOCITY COMPUTED')
16  FORMAT(' SESUV:  LEVELS SWITCHED')
17  FORMAT(' SESUV:  INFLCW PARAMS SFT')
18  FORMAT(' SESUV:  OPEN BOUND. CONC. SET')
19  FORMAT(1X,'HS',2I10,9(1X,1F10.3))
DO 100 I=1,M
DO 100 J=1,N
SE(J,I,L1)=SE(J,I,L3)+DT2*W(J,I,1)
100 CONTINUE
LASTCK = 10
IF (L.LF.LASTCK) WRITE(6,11)
CALL TIDAL
DO 300 I=2,MM2
IM1=I-1
IP1=I+1
IP2=I+2
DO 300 J=2,NM2
K1=KH(J,I)
IF (K1.EQ.0) GO TO 300
BND1=1.0
BND2=1.0
BND3=1.0
BND4=1.0
DO 400 IJ=1,100
IF (IB(IJ).EQ.0) GO TO 500
IF (IB(IJ).NE.I) GO TO 350
IF (JB(IJ).EQ.J) GO TO 450
350 CONTINUE
IF (IABS(KB(IJ)).NE.3) GO TO 370
IF (JB(IJ).NE.J) GO TO 400
IF (IB(IJ).EQ.I+1) GO TO 460
GO TO 400
```

```
370 CONTINUE
    IF (IABS(KB(IJ)).NE.4) GO TO 400
    IF (IB(IJ).NE.I) GO TO 400
    IF (JB(IJ).EQ.J+1) GO TO 460
    GO TO 400
400 CONTINUE
    GO TO 500
450 CONTINUE
    BND1=0.0
    IF (KB(IJ).LT.0) GO TO 460
    IF (KB(IJ).EQ.1) BND4=0.0
    IF (KB(IJ).EQ.2) BND3=0.0
    IF (KB(IJ).LT.3) GO TO 460
    BND3=0.0
    BND4=0.0
460 CONTINUE
    BND2=0.0
500 CONTINUE
    JM1=J-1
    JP1=J+1
    JP2=J+2
    KR=KH(J,IP1)
    KT=KH(JP1,I)
    H=HS(1)
    H2=H+H
    K=1
    KP1=2
    KQ1=KP1
    IF (K1.EQ.K) KQ1=K
    HS1=H+SF(J,I,L1)
    HBU1=H2+SF(J,I,L1)+SF(J,IP1,L1)
    HBV1=H2+SF(J,I,L1)+SF(JP1,I,L1)
    HSR=H+SF(J,IP1,L3)
    HC=H+SF(J,I,L3)
    HSL=H+SF(J,IM1,L3)
    HST=H+SF(JP1,I,L3)
    HSB=H+SF(JM1,I,L3)
    HBR=H2+SF(J,IP1,L2)+SF(J,IP2,L2)
    HB=H2+SF(J,I,L2)+SF(J,IP1,L2)
    HBL=H2+SF(J,IM1,L2)+SF(J,I,L2)
    HR=H2+SF(J,I,L2)+SF(JP1,I,L2)
    HBRT=H2+SF(J,IP1,L2)+SF(JP1,IP1,L2)
    HBLB=H2+SF(JM1,I,L2)+SF(J,I,L2)
    HBTR=H2+SF(J,IP1,L2)+SF(JM1,IP1,L2)
    HBTR=H2+SF(JP1,I,L2)+SF(JP1,IP1,L2)
    HETL=H2+SF(JP1,IM1,L2)+SF(JP1,I,L2)
    HET=H2+SF(JP1,I,L2)+SF(JP2,I,L2)
    HBLLT=H2+SF(J,IM1,L2)+SF(JP1,IM1,L2)
    HBR3=H2+SF(J,IP1,L3)+SF(J,IP2,L3)
    HB3=H2+SF(J,I,L3)+SF(J,IP1,L3)
    HBL3=H2+SF(J,IM1,L3)+SF(J,I,L3)
    HBTR3=H2+SF(JP1,I,L3)+SF(JP1,IP1,L3)
    HBB3=H2+SF(JM1,I,L3)+SF(JM1,IP1,L3)
    HBRT3=H2+SF(J,IP1,L3)+SF(JP1,IP1,L3)
    HBLT3=H2+SF(J,I,L3)+SF(JP1,I,L3)
    HBLLT3=H2+SF(J,IM1,L3)+SF(JP1,IM1,L3)
    HPT3=H2+SF(JP1,I,L3)+SF(JP2,I,L3)
    HBLB3=H2+SF(JM1,I,L3)+SF(J,I,L3)
    Q1=0.0
    Q3=0.0
    HQ=.5*(H+HS(KQ1))
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```
IF (L.LF.LASTCK) WRITE (6,12)
200 CONTINUE
IF (HQ.EQ.0.0) GO TO 1000
IF (HS1.EQ.0.0) GO TO 1000
IF (HBU1.EQ.0.0) GO TO 1000
IF (HBV1.EQ.0.0) GO TO 1000
IF (RHO(J,I,K)+RHO(J,IP1,K)+RHOM2.EQ.0.0) GO TO 1000
IF (RHO(J,I,K)+RHO(JP1,I,K)+RHOM2.EQ.0.0) GO TO 1000
GO TO 1010
1000 PRINT 1001,I,J,K,L,HQ,HS1,HBU1,HBV1
PRINT 1002,RHOM2,RHO(J,I,K),RHO(J,IP1,K),RHO(JP1,I,K)
1001 FORMAT (1H0,'SESUV I.C.',4I10,4(1X,1PE12.5))
1002 FORMAT (10X,'RHO',4(1X,1PE12.5))
1010 CONTINUE
HTX=HS(K)+HS(KP1)
HTY=HTX
HTS=HTX
IF (KR.GE.KP1) HTX=HTX+HS(KP1)
IF (KR.GE.K) HTX=HTX+HS(K)
IF (KT.GE.KP1) HTY=HTY+HS(KP1)
IF (KT.GE.K) HTY=HTY+HS(K)
IF (K.NE.1) GO TO 2250
HTX=HTX+SE(J,I,L2)
HTY=HTY+SE(J,I,L2)
IF (KR.NE.0) HTX=HTX+SE(J,IP1,L2)
IF (KT.NE.0) HTY=HTY+SE(JP1,I,I2)
HTS=HTS+SE(J,I,L2)
2250 CONTINUE
IF (L.LE.LASTCK) WRITE (6,19) I,J,Q2,Q4,CKA,CKH,RMM2,RICH,
* HQ,W(J,I,KP1),DUVDZ
RHOB=RHOM+.5*(RHO(J,I,K)+RHO(J,I,KP1))
DRHO=-(RHO(J,I,K)-RHO(J,I,KP1))/(0.5*HMS)
DUVDZ=(SQRT(0.250*(U(J,IM1,K,L2)+U(J,I,K,I2))*
* (U(J,IM1,K,L2)+U(J,I,K,L2))+0.250*(V(JM1,I,K,L2)+
* V(J,I,K,L2))*(V(JM1,I,K,L2)+V(J,I,K,I2))-SQRT(
* 0.250*(U(J,IM1,KP1,L2)+U(J,I,KP1,I2))*
* (U(J,IM1,KP1,L2)+U(J,I,KP1,L2))+0.250*(V(JM1,I,KP1,L2)+
* V(J,I,KP1,L2))*(V(JM1,I,KP1,L2)+V(J,I,KP1,I2))))/(0.5*HMS)
RICH=(GRAV*DRHO)/(SHCB*DUVDZ*DUVDZ+.CCCCC1)
IF (RICH.GT. 5.) RICH= 5.
IF (RICH.LT.-5.) RICH=-5.
IF (L.LE.LASTCK) WRITE (6,19) I,J,Q2,Q4,CKA,CKH,RMM2,RICH,
* HQ,W(J,I,KP1),DUVDZ
CKA1= CKA
Q2=(CKA* EXP(-RMM2*RICH)+CKA1 *DUVDZ)
* (S(J,I,K,L3)-S(J,I,KQ1,L3))/HQ
* -0.5*W(J,I,KP1)*(S(J,I,K,L2)+S(J,I,KQ1,I2))
CKH1= CKH
Q4=(CKH* EXP(-RMM2*RICH)+CKH1 *DUVDZ)
* (T(J,I,K,L3)-T(J,I,KQ1,L3))/HC
* -0.5*W(J,I,KP1)*(T(J,I,K,L2)+T(J,I,KQ1,I2))
IF (L.LE.LASTCK) WRITE (6,19) I,J,Q2,Q4,CKA,CKH,RMM2,RICH,
* HQ,W(J,I,KP1),DUVDZ
IF (BND1.EQ.0.0) GO TO 210
T1=RDY*(HB*U(J,I,K,L2)*(S(J,I,K,L2)+S(J,IP1,K,L2))
* -HBL*U(J,IM1,K,L2)*(S(J,IM1,K,L2)+S(J,I,K,L2)))
T2=RDY*(HR*V(J,I,K,L2)*(S(J,I,K,L2)+S(JP1,I,K,L2))
* -HBLB*V(JM1,I,K,L2)*(S(JM1,I,K,I2)+S(J,I,K,L2)))
HSK=(HC+HC)*S(J,I,K,I3)
T3=(HSP*S(J,IP1,K,I3)-HSK+HSL*S(J,IM1,K,L3))*AHX*RDYS
T4=(HST*S(JP1,I,K,I3)-HSK+HSB*S(JM1,I,K,I3))*AHY*RDYS
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IF (L.IE.LASTCK) WRITE (6,19) I,J,Q2,Q4,CKA,CKH,RMM2,RICH,
* HQ,W(J,I,KE1),DUVDZ
DHS=-.25*(T1+T2)+Q1-Q2+T3+T4
T1=RDY*(HB*U(J,I,K,L2)*(T(J,I,K,L2)+T(J,IP1,K,L2))
* -HBL*U(J,IM1,K,L2)*(T(J,IM1,K,L2)+T(J,I,K,L2)))
T2=RDY*(HR*V(J,I,K,L2)*(T(J,I,K,L2)+T(JP1,I,K,L2))
* -HBLB*V(JM1,I,K,L2)*(T(JM1,I,K,L2)+T(J,I,K,L2)))
HTK=(HC+HC)*T(J,I,K,L3)
T3=(HSP*T(J,IP1,K,L3)-HTK+HSL*T(J,IM1,K,L3))*AHK1*ADXS
T4=(HS1*T(JP1,I,K,L3)-HTK+HSB*T(JM1,I,K,L3))*AHYT*RDYS
DHT=-.25*(T1+T2)+Q3-Q4+T3+T4
GO TO 211
210 CONTINUE
DHS=Q1-Q2
DHT=Q3-Q4
211 CONTINUE
S(J,I,K,L1)=(HC*S(J,I,K,L3)+DT2*DHS)/HS1
T(J,I,K,L1)=(HC*T(J,I,K,L3)+DT2*DHT)/HS1
IF (L.IE.LASTCK) WRITE (6,13)
IF (BND3.EQ.0.0) GO TO 225
IF (BND2.EQ.0.0) GO TO 215
IF (K.ST.KR) GO TO 225
215 CONTINUE
TAUZ=TAUX(J,I,KE1)-TAUX(J,I,K)
T6=(HB*PGRAX(J,I,K)+TAUZ+TEUZ)/(RHO(J,I,K)+PHO(J,IP1,K)+RHOM2)
IF (BND2.EQ.0.0) GO TO 220
T1=(U(J,I,K,L2)+U(J,IP1,K,L2))
* *(HBE*U(J,IP1,K,L2)+HB*U(J,I,K,L2))
T2=(U(J,IM1,K,L2)+U(J,I,K,L2))
* *(HB*U(J,I,K,L2)+HBI*U(J,IM1,K,L2))
T3=(U(J,I,K,L2)+U(JP1,I,K,L2))
* *(HR*V(J,I,K,L2)+HEET*V(J,IP1,K,L2))
T4=(U(J,I,K,L2)+U(JM1,I,K,L2))
* *(HBIE*V(JM1,I,K,L2)+HBE*V(JM1,IP1,K,L2))
T5=F*HE*(V(J,I,K,L2)+V(J,IP1,K,L2)+V(JM1,I,K,L2)+V(JM1,IP1,K,L2))
T7=(HBE*U(J,IP1,K,L3)-(HB3+HB3)*U(J,I,K,L3)+HEL3*U(J,IM1,K,L3))
* *AMX*ADXS
T8=(HBE*U(JP1,I,K,L3)-(HB3+HB3)*U(J,I,K,L3)+HBE*U(JM1,I,K,L3))
* *AMY*RDYS
DHU=.125*(T5-FDX*(T1-T2)-PLY*(T3-T4))-T6+.5*(T7+T8)
GO TO 221
220 CONTINUE
DHU=-T6
221 CONTINUE
U(J,I,K,L1)=(HB3*U(J,I,K,L3)+DT4*DHU)/HEU1
IF (L.IE.LASTCK) WRITE (6,14)
225 CONTINUE
IF (BND4.EQ.0.0) GO TO 250
IF (BND2.EQ.0.0) GO TO 227
IF (K.ST.KT) GO TO 250
227 CONTINUE
TAUY=TAUX(J,I,KE1)-TAUX(J,I,K)
T6=(HR*PGRAY(J,I,K)+TAUZ+TAUY)/(RHO(J,I,K)+RHO(JP1,I,K)+RHOM2)
IF (BND2.EQ.0.0) GO TO 230
T1=(V(J,I,K,L2)+V(JP1,I,K,L2))
* *(HBT*V(JP1,I,K,L2)+HR*V(J,I,K,L2))
T2=(V(JM1,I,K,L2)+V(J,I,K,L2))
* *(HR*V(J,I,K,L2)+HBIB*V(JM1,I,K,L2))
T3=(V(J,I,K,L2)+V(J,IP1,K,L2))
* *(HBT*U(JP1,I,K,L2)+HB*U(J,I,K,L2))
T4=(V(J,IM1,K,L2)+V(J,I,K,L2))

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* *(HBT1*U(JP1,IM1,K,I2)+HEL*U(J,IM1,K,I2))
  T5=F*HP*(U(J,I,K,L2)+U(J,IM1,K,L2)+U(JP1,I,K,L2)+U(JP1,IM1,K,L2))
  T7=(HBT3*V(JP1,I,K,I3)-(HBT3+HBLT3)*V(J,I,K,I3)
*   +HBLB3*V(JM1,I,K,I3))*AMY*RDYS
  T8=(HBT3*V(J,IP1,K,I3)-(HBT3+HBLT3)*V(J,I,K,I3)
*   +HBLLT3*V(J,IM1,K,I3))*AMX*RDXS
  DHV=.125*(-T5-RDY*(T1-T2)-RDX*(T3-T4))-T6+.5*(T7+T8)
  GO TO 231
230 CONTINUE
  DHV=-T6
231 CONTINUE
  V(J,I,K,L1)=(HBLT3*V(J,I,K,L3)+DT4*DHV)/HBV1
  IF (L.LE.LASTCK) WRITE (6,15)
250 CONTINUE
  K=K+1
  IF (K.GT.K1) GO TO 300
  KP1=K+1
  KQ1=KP1
  IF (K1.FO.K) KQ1=K
  H=HS(K)
  H2=H+H
  HS1=H
  HBU1=H2
  HBV1=H2
  HSR=H
  HC=H
  HSL=H
  HST=H
  HSB=H
  HBR=H2
  HB=H2
  HBI=H2
  HR=H2
  HBRT=H2
  HBLB=H2
  HBRB=H2
  HBTR=H2
  HBTL=H2
  HBT=H2
  HBLLT=H2
  HBR3=H2
  HB3=H2
  HBL3=H2
  HBTR3=H2
  HBB3=H2
  HBRT3=H2
  HBLT3=H2
  HBLLT3=H2
  HBT3=H2
  HBLB3=H2
  Q1=Q2
  Q3=Q4
  HQ=.5*(H+HS(KP1))
  IF (L.LE.LASTCK) WRITE (6,16)
  GO TO 200
300 CONTINUE
  DO 310 IJ=1,100
  IF (IB(IJ).FO.0) GO TO 320
  IBT=IB(IJ)
  JBT=JB(IJ)
  KI1=0
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```
IF (IABS(KB(IJ)).GT.2) KI1=1
KI2=1-KI1
IF (KB(IJ).GT.0) GO TO 305
KBT=-KB(IJ)
IF (MOD(KBT,2).EQ.0) GO TO 303
S(JBT,IBT+KI1,1,L1)=-S(JBT,IBT+KI2,1,L1)+UFLOS(IJ)+UFLOS(IJ)
T(JBT,IBT+KI1,1,L1)=-T(JBT,IBT+KI2,1,L1)+UFLOT(IJ)+UFLOT(IJ)
SE(JBT,IBT+KI1,L1)=-SE(JBT,IBT+KI2,L1)
U(JBT,IBT,1,L1)=UVB(IJ)
GO TO 310
303 CONTINUE
S(JBT+KI1,IBT,1,L1)=-S(JBT+KI2,IBT,1,L1)+UFLOS(IJ)+UFLOS(IJ)
T(JBT+KI1,IBT,1,L1)=-T(JBT+KI2,IBT,1,L1)+UFLOT(IJ)+UFLOT(IJ)
SE(JBT+KI1,IBT,L1)=-SE(JBT+KI2,IBT,L1)
V(JBT,IBT,1,L1)=UVB(IJ)
GO TO 310
305 CONTINUE
KI4=KH(JBT,IBT)
KI3=KH(JBT,IBT+1)
IF(KI1.NE.0) KI3=KH(JBT,IBT-1)
IF(KI3.LT.KI4) KI4=KI3
KI3=KI1
IF (KI4.EQ.0) GO TO 310
DO 345 K=1, KI4
IF (KI3.EQ.0) GO TO 340
KI1=0
KI2=-1
IF (U(JBT,IBT-1,K,I1).GT.0.0) GO TO 335
IF (U(JBT,IBT-2,K,I2).LT.0.0) GO TO 330
325 LTURN(K,IJ)=L-1
STURN(K,IJ)=S(JBT,IBT+KI2,K,L2)
TTURN(K,IJ)=T(JBT,IBT+KI2,K,L2)
IF(STURN(K,IJ).NE.0.0) GO TO 330
IF(TTURN(K,IJ).NE.0.0) GO TO 330
WRITE (6,326) JBT,IBT,KI2
326 FORMAT (1X,'SALINITY = 0 AT J=',I3,2X,'I=',I3,I3)
330 CONTINUE
IF (LTURN(K,IJ).LT.C) GO TO 325
SFRAC = (DT*(L-LTURN(K,IJ)))/(SFETIM*3600.)
TFRAC = (DT*(L-LTURN(K,IJ)))/(TFETIM*3600.)
IF (SFRAC .GT. 1.0) SFRAC = 1.0
IF (TFRAC .GT. 1.0) TFRAC = 1.0
S(JBT,IBT+KI1,K,L1)=STURN(K,IJ) + (SINI(K,IJ) -STURN(K,IJ))
* *SIN(1.570796327*SFRAC)
T(JBT,IBT+KI1,K,L1)=TTURN(K,IJ) + (TINI(K,IJ) -TTURN(K,IJ))
* *SIN(1.570796327*TFRAC)
GO TO 345
335 CONTINUE
LTURN(K,IJ)=-1
SGRAD=(S(JBT,IBT+KI2,K,L2)-S(JBT,IBT+KI1,K,L2))*RDX
TGRAD=(T(JBT,IBT+KI2,K,L2)-T(JBT,IBT+KI1,K,L2))*PDX
S(JBT,IBT+KI1,K,L1)=S(JBT,IBT+KI1,K,L2)
* +SGRAD*DT*U(JBT,IBT+KI2,K,L2)
T(JBT,IBT+KI1,K,L1)=T(JBT,IBT+KI1,K,L2)
* +TGRAD*DT*U(JBT,IBT+KI2,K,L2)
GO TO 345
340 IF (U(JBT,IBT+KI1,K,I1).LT.0.0) GO TO 335
IF (U(JBT,IBT+KI2,K,I1).GT.0.0) GO TO 330
GO TO 325
345 CONTINUE
IF (L.LE. LASTCK) WRITE (6,18)
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310 CONTINUE
320 CONTINUE
  RETURN
  END
  SUBROUTINE PRNT1 (X,BX,M,N,L1,L)
  DIMENSION X(N,M,3)
  1 FORMAT (1H1,10X,A4,5X,'TIME=',I6)
  2 FORMAT (I4,1X,21F6.1)
  3 FORMAT (3X,21I6)
  I2=0
100 CONTINUE
  I1=I2+1
  I2=I2+21
  IF (I1.GT.M) RETURN
  IF (I2.GT.M) I2=M
  PRINT 1,BX,L
  PRINT 3,(I,I=I1,I2)
  DO 200 J1=1,N
  J=N+1-J1
200 PRINT 2,J,(X(J,I,L1),I=I1,I2)
  GO TO 100
  END
  SUBROUTINE PRNT2 (X,BX,M,N,K,L1,K1,L)
  DIMENSION X(N,M,K,3)
  1 FORMAT (1H1,10X,A4,5X,'TIME=',I6,5X,'LEVEL',I3)
  2 FORMAT (I4,1X,21F6.1)
  3 FORMAT (3X,21I6)
  I2=0
100 CONTINUE
  I1=I2+1
  I2=I2+21
  IF (I1.GT.M) RETURN
  IF (I2.GT.M) I2=M
  PRINT 1,BX,L,K1
  PRINT 3,(I,I=I1,I2)
  DO 200 J1=1,N
  J=N+1-J1
200 PRINT 2,J,(X(J,I,K1,I1),I=I1,I2)
  GO TO 100
  END
  SUBROUTINE PRNT3 (X,BX,M,N,K,K1,L)
  DIMENSION X(N,M,K)
  1 FORMAT (1H1,10X,A4,5X,'TIME=',I6,5X,'LEVEL',I3)
  2 FORMAT (I4,1X,21F6.2)
  3 FORMAT (3X,21I6)
  I2=0
100 CONTINUE
  I1=I2+1
  I2=I2+21
  IF (I1.GT.M) RETURN
  IF (I2.GT.M) I2=M
  PRINT 1,BX,L,K1
  PRINT 3,(I,I=I1,I2)
  DO 200 J1=1,N
  J=N+1-J1
200 PRINT 2,J,(X(J,I,K1),I=I1,I2)
  GO TO 100
  END
  SUBROUTINE PRNT4 (X,BX,M,N,K1,L)
  DIMENSION X(N,M)
  1 FORMAT (1H1,10X,A4,5X,'TIME=',I6,5X,'LEVEL',I3)
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```
2 FORMAT (I4,1X,21F6.2)
3 FORMAT (3X,21I6)
  I2=0
100 CONTINUE
  I1=I2+1
  I2=I2+21
  IF (I1.GT.M) RETURN
  IF (I2.GT.M) I2=M
  PRINT 1,BX,L,K1
  PRINT 3,(I,I=I1,I2)
  DO 200 J1=1,N
  J=N+1-J1
200 PRINT 2,J,(X(J,I),I=I1,I2)
  GO TO 100
  END
  SUBROUTINE PRNT5 (X,BX,M,N,L1,L)
  DIMENSION X(N,M,3)
  1 FORMAT (1H1,10X,A4,5X,'TIME=',I6)
  2 FORMAT (I4,10(1X,1FF11.4))
  3 FORMAT (6X,10(I3,9X))
  I2=0
100 CONTINUE
  I1=I2+1
  I2=I2+10
  IF (I1.GT.M) RETURN
  IF (I2.GT.M) I2=M
  PRINT 1,BX,L
  PRINT 3,(I,I=I1,I2)
  DO 200 J1=1,N
  J=N+1-J1
200 PRINT 2,J,(X(J,I,I1),I=I1,I2)
  GO TO 100
  END
  SUBROUTINE PRNT6 (X,BX,M,N,K,L1,K1,I)
  DIMENSION X(N,M,K,3)
  1 FORMAT (1H1,10X,A4,5X,'TIME=',I6,5X,'LEVEL',I3)
  2 FORMAT (I4,10(1X,1FF11.4))
  3 FORMAT (6X,10(I3,9X))
  I2=0
100 CONTINUE
  I1=I2+1
  I2=I2+10
  IF (I1.GT.M) RETURN
  IF (I2.GT.M) I2=M
  PRINT 1,BX,L,K1
  PRINT 3,(I,I=I1,I2)
  DO 200 J1=1,N
  J=N+1-J1
200 PRINT 2,J,(X(J,I,K1,I1),I=I1,I2)
  GO TO 100
  END
  SUBROUTINE RESAL
C  INSERT " COMMON" HERE
  9 FORMAT (20F4.0/20F4.0)
  31 FORMAT (1H0,'SALINITY AT LEVEL',I3,' IS BEING READ')
  DO 150 K=1,KMAX
  WRITE (6,31) K
  DO 140 J=1,N
  READ (5,9) (S(J,I,K,1),I=1,M)
  READ (5,9) NULL
140 CONTINUE
```

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150 CONTINUE
    DO 160 K=1,KMAX
    DO 160 I=1,M
    DO 160 J=1,N
    DO 160 L=2,3
    S(J,I,K,L)=S(J,I,K,1)
160 CONTINUE
    RETURN
    END
    SUBROUTINE TIDAL
C   INSERT "COMMON" HERE
    SCALE=1.0
    XL=L
    FM2=0.080515
    FS2=0.0833333
    FN2=0.0789889
    FK2=0.0835421
    FK1=0.0417885
    FO1=0.0387295
    FP1=0.0415454
    A1=-9.9640377
    B1=-0.56035
    A2=0.958902
    B2=6.8229465
    A3=-4.8331776
    B3=5.9684812
    A4=-.063865
    B4=1.8288855
    A5=-3.5957235
    B5=-2.2468565
    A6=-3.2999429
    B6=-4.2237389
    B7=-1.6971906
    A7=-1.0197752
    TX=0.0017453*L*DT-428.26
    SETIDE  =A1*COS(FM2*TX)+B1*SIN(FM2*TX)
*   +A2*COS(FS2*TX)+B2*SIN(FS2*TX)
*   +A3*COS(FN2*TX)+B3*SIN(FN2*TX)
*   +A4*COS(FK2*TX)+B4*SIN(FK2*TX)
*   +A5*COS(FK1*TX)+B5*SIN(FK1*TX)
*   +A6*COS(FO1*TX)+B6*SIN(FO1*TX)
*   +A7*COS(FP1*TX)+B7*SIN(FP1*TX)
    DO 110 IJ=1,100
    IF (IB(IJ).EQ.0) GO TO 120
    IBT=IB(IJ)
    JBT=JB(IJ)
    KI1=0
    IF (IABS(KB(IJ)).GT.2) KI1=1
    KI2=1-KI1
    IF (KB(IJ).GT.0) GO TO 105
    KBT=-KB(IJ)
    IF (MOD(KBT,2).EQ.0) GO TO 103
    SE(JBT,IBT+KI1,L1)=-SE(JBT,IBT+KI2,L1)
    GO TO 110
103 CONTINUE
    SE(JBT+KI1,IBT,L1)=-SE(JBT+KI2,IBT,L1)
    GO TO 110
105 CONTINUE
    SE(JBT,IBT,L1)=SETIDE
110 CONTINUE
120 CONTINUE
```

RETURN
END

C THE FOLLOWING "COMMON" IS TO BE INSERTED IN SUBPROGRAMS AS INDICATED
C

```
COMMON CPC,CLAM,CLAMC,CP1,CIAM1,RHOT
COMMON M,MM1,MM2,N,NM1,NM2,DX,DY,RDX,RDY,RDXS,RDYS
COMMON DT,DT2,DT4,CNU,L,L1,L2,L3,GRAV,KMAX,CKA,AHX,AHY,AMX,AMY,P
COMMON RHOM,RHOM2,ALPH0,TEMP,THETA,RHCA,WSPD,PHI,WINCH
COMMON PI,KMAP,TD,TL2,TD4,KHT,CT,CKH,AHXT,AHYT
COMMON RMM1,RMM2
COMMON U(42,60,7,3),V(42,60,7,3),S(42,60,7,3),T(42,60,7,3)
COMMON W(42,60,8),TAUX(42,60,8),TAUY(42,60,8)
COMMON PGRAY(42,60,7),PGRAY(42,60,7),BHC(42,60,7)
COMMON SE(42,60,3),KH(42,60),C(42,60),HS(7)
COMMON RHOZ(42,60),HZ(42,60),NSE(42,60)
COMMON IB(100),JB(100),KB(100),UVB(100)
COMMON UFLOS(100),UFLOT(100)
COMMON STMP,LTURN(10,100),STURN(10,100),SET ,TTURN(10,100)
COMMON SINI(10,100),TINI(10,100),SRETIM,TRETIM
DOUBLE PRECISION CP0,CLAM,CLAMC,CP1,CIAM1,RHOT
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VARIABLES

U East-west velocity component
V North-south velocity component
W Vertical velocity
S Salinity
T Temperature
RHO Density
PGRAX East-west pressure gradient
PGRAY North-south pressure gradient
SE Water level

CONSTANTS

TD Seconds/time step
DX Gridsize, east-west
DY Gridsize, north-south
PHI Wind direction
WSPD Wind speed
THETA Wind stress coefficient
F Coriolis parameter
C Chezy term
AHX Horizontal eddy coefficient in X direction
AHY Horizontal eddy coefficient in Y direction
AMX Mass diffusion coefficient in X direction
AMY Mass diffusion coefficient in Y direction
CNU Vertical viscosity coefficient
CKA Vertical salt diffusion coefficient
CKH Vertical heat diffusion coefficient
AHXT Horizontal heat diffusion coefficient in X direction
AHYT Horizontal heat diffusion coefficient in Y direction
HS Layer thickness

