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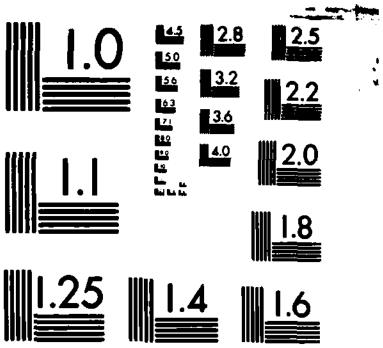

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ENVIRONMENTAL IMPACT RESEARCH PROGRAM

INSTRUCTION REPORT EL-85-1

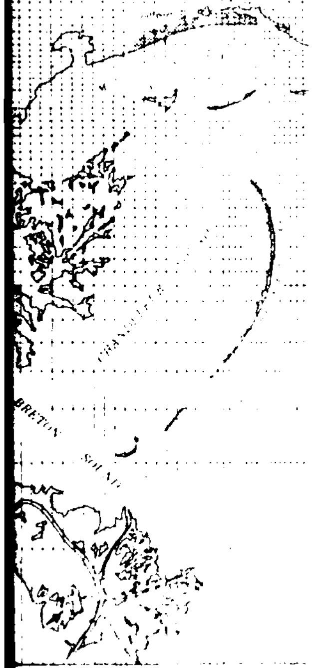
USER GUIDE FOR WIFM-SAL: A TWO-DIMENSIONAL VERTICALLY INTEGRATED, TIME-VARYING ESTUARINE TRANSPORT MODEL

by

Richard A. Schmalz, Jr.

Hydraulics Laboratory

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
PO Box 631
Vicksburg, Mississippi 39180-0631



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Prepared for DEPARTMENT OF THE ARMY
US Army Corps of Engineers
Washington, DC 20314-1000

Monitored by Environmental Laboratory
US Army Engineer Waterways Experiment Station
PO Box 631, Vicksburg, Mississippi 39180-0631

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REPORT DOCUMENTATION PAGE		**READ INSTRUCTIONS BEFORE COMPLETING FORM**
1. REPORT NUMBER Instruction Report EL-85-1	2. GOVT ACCESSION NO. A157446	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) USER GUIDE FOR WIFM-SAL: A TWO-DIMENSIONAL VERTICALLY INTEGRATED, TIME-VARYING ESTUARINE TRANSPORT MODEL		5. TYPE OF REPORT & PERIOD COVERED Final report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Richard A. Schmalz, Jr.		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Engineer Waterways Experiment Station Hydraulics Laboratory PO Box 631, Vicksburg, Mississippi 39180-0631		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Environmental Impact Research Program
11. CONTROLLING OFFICE NAME AND ADDRESS DEPARTMENT OF THE ARMY US Army Corps of Engineers Washington, DC 20314-1000		12. REPORT DATE March 1985
		13. NUMBER OF PAGES 111
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) US Army Engineer Waterways Experiment Station Environmental Laboratory PO Box 631, Vicksburg, Mississippi 39180-0631		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Available from National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Computerized simulation
Estuaries
Hydrodynamics
Mathematical models
Salinity

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

WIFM-SAL is preliminary to the development of comprehensive water quality models that may be used to assist in the analysis of water quality problems in shallow estuaries and embayments which may be considered vertically well mixed. The model is two dimensional in the horizontal and generates time-varying water surface elevations, velocities, and constituent fields over a space staggered grid. Units of measure are expressed in the English system (slug-ft-second).

(Continued)

20. ABSTRACT (Continued).

Results computed on a global grid may be employed as boundary conditions on a more spatially limited refined grid concentrated around the area of interest. In addition, the user may select either of two distinct transport schemes. Scheme 1 is a flux-corrected transport scheme capable of resolving sharp fronts without oscillation. Scheme 2 is a full, three time level scheme directly compatible with the three time level hydrodynamics. The telescoping grid capability in conjunction with the user selectable constituent transport scheme is an extremely powerful concept in real world transport problem solving.

Additional keywords: WIFM (WES Implicit Flooding Model); WES (Waterways Experiment Station); Computerized Simulation; Salinity; Subroutines; Input; output.

PREFACE

This report describes the development and application of a numerical transport model used as a basis for 2-D vertically averaged estuarine water quality models. The preparation of this report was sponsored by the Office, Chief of Engineers (OCE), under the Environmental Impact Research Program (EIRP). The Mobile District, CE, sponsored the Mississippi Sound Study, which is presented as a test application. Technical Monitors for EIRP were Dr. John Bushman and Mr. Earl Eiker of OCE and Mr. David B. Mathis, U. S. Army Water Resources Support Center.

The work presented in the report was conducted from July 1979 through June 1983 in the Wave Dynamics Division (WDD) of the Hydraulics Laboratory (HL) of the U. S. Army Engineer Waterways Experiment Station (WES) under the general supervision of Messrs. H. B. Simmons, Chief, HL, and Claude E. Chatham, Jr., Acting Chief, WDD. The WDD was transferred to the Coastal Engineering Research Center (CERC) of WES on 1 July 1983. From July through September 1983, work was performed in the WDD of CERC under the general supervision of Dr. R. W. Whalin, Chief, CERC, and Mr. Chatham, Chief, WDD. Dr. R. A. Schmalz, Jr., WDD, conducted the Mississippi Sound Study and prepared this report.

The preparation of this report was monitored by Mr. Ross W. Hall, Ecosystem Research and Simulation Division (ERSD), Environmental Laboratory (EL), under the general supervision of Mr. Don L. Robey, Chief, ERSD, and Dr. John Harrison, Chief, EL. Program Manager at WES for EIRP was Dr. Roger T. Saucier.

Commanders and Directors of WES during the conduct of this study and the preparation and publication of this report were COL Nelson P. Conover, CE, and COL Tilford C. Creel, CE. Technical Director was Mr. F. R. Brown.

This report should be cited as follows:

Schmalz, R. A., Jr. 1985. "User Guide for WIFM-SAL: A Two-Dimensional Vertically Integrated, Time-Varying Estuarine Transport Model," Instruction Report EL-85-1, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

CONTENTS

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
feet	0.3048	metres
feet per second	0.3048	metres per second
miles per hour (U. S. statute)	1.609347	kilometres per hour

USER GUIDE FOR WIFM-SAL: A TWO-DIMENSIONAL VERTICALLY INTEGRATED, TIME-VARYING ESTUARINE TRANSPORT MODEL

PART I: CAPABILITIES AND LIMITATIONS

1. The transport model WIFM-SAL was developed as a prerequisite requirement for water quality models to be used in the analysis of water quality problems in shallow estuaries and embayments which may be considered vertically well mixed thereby justifying a vertically integrated approach. The model is two-dimensional in the horizontal and generates time-varying water surface elevations, velocities, and constituent fields over a space staggered grid. Units of measure are expressed in the English system (slug-foot-second).

2. Two constituent transport schemes have been incorporated in the U. S. Army Engineer Waterways Experiment Station (WES) Implicit Flooding Model (WIFM) developed by Butler (1980). Constituent computations are performed at the same time step interval as employed in the hydrodynamic computations. Therefore, if desired, the user may develop the coding necessary to density couple the hydrodynamics if this is important for the problem of concern. Density coupling is not implemented in the model at this time.

3. An exponentially stretched grid system is used in WIFM-SAL allowing the user to increase resolution in specific areas where more computational detail is desired. This feature is particularly useful in modeling inlets and barrier island systems.

4. Since the constituent transport schemes are directly encoded within WIFM, this model must be used to provide the hydrodynamic description. Future work will be conducted to develop a separate transport-dispersion model, allowing for user selectable hydrodynamic input and transport scheme selection.

5. Although WIFM has been used extensively in moving boundary applications, the transport schemes assume a fixed land/sea boundary. Future work is needed to remove this restriction.

6. The constituent transport equation considered is for a passive scalar without source/sink terms. The extension to multiple (reacting) constituent systems remains to be developed.

7. WIFM-SAL allows the model user to employ results computed on a global grid as boundary conditions on a more spatially limited, refined grid

concentrated around the area of interest. In addition, the user may select either of two distinct transport schemes. Scheme 1 is a flux-corrected transport scheme capable of resolving sharp fronts without oscillation. Scheme 2 is a full, three time level scheme directly compatible with the three time level hydrodynamics. Scheme 1 requires approximately three times more computer time than scheme 2 but is more accurate than scheme 2 for sharp front problems.

8. However, on a coarse spatial resolution global grid covering a large area, scheme 2 results may be used in areas away from sharp fronts to provide boundary conditions for a more refined grid system encompassing the sharp front region of propagation. Scheme 1 may then be selected to resolve the sharp front over this refined grid. Thus, the telescoping grid capability in conjunction with the user selectable constituent transport scheme is an extremely powerful concept in real world transport problem solving.

PART II: THEORETICAL DEVELOPMENTS

9. Consider the instantaneous three-dimensional constituent transport equation. The time scales for which this equation applies are of much shorter duration than can be modeled. Therefore, the instantaneous equation is temporally averaged. Under the vertically integrated approach, the resulting equation is then depth averaged. The transport equation obtained is then transformed using an exponential stretch. Numerical approximations to the transformed equation are formulated followed by the development of relations for the effective dispersion coefficients.

Constituent Transport Equation in Cartesian Coordinates

10. The instantaneous constituent transport equation is

$$\frac{\partial s}{\partial t} + u \frac{\partial s}{\partial x} + v \frac{\partial s}{\partial y} + w \frac{\partial s}{\partial z} = \frac{\partial}{\partial x}\left(D_x \frac{\partial s}{\partial x}\right) + \frac{\partial}{\partial y}\left(D_y \frac{\partial s}{\partial y}\right) + \frac{\partial}{\partial z}\left(D_z \frac{\partial s}{\partial z}\right) \tag{1}$$

where

$x,y,z \equiv$ Cartesian coordinates

$u,v,w \equiv$ velocity components in the x- , y- , and z-directions, respectively

$t \equiv$ time

$s \equiv$ concentration of the material of concern

$D_x \equiv$ molecular diffusion coefficient in the x-direction

$D_y \equiv$ molecular diffusion coefficient in the y-direction

$D_z \equiv$ molecular diffusion coefficient in the z-direction

For a turbulent flow, the turbulent diffusion is much greater than the molecular diffusion. The following analogous formula holds where time averaging over the time scale of the turbulence has been performed.

$$\frac{\partial s}{\partial t} + u \frac{\partial s}{\partial x} + v \frac{\partial s}{\partial y} + w \frac{\partial s}{\partial z} = \frac{\partial}{\partial x}\left(K_x \frac{\partial s}{\partial x}\right) + \frac{\partial}{\partial y}\left(K_y \frac{\partial s}{\partial y}\right) + \frac{\partial}{\partial z}\left(K_z \frac{\partial s}{\partial z}\right) \tag{2}$$

where K_x, K_y, and K_z are turbulent diffusion coefficients. Equation 2 may be written in conservation form by adding s times the continuity equation (namely, zero) to the left-hand side to obtain

$$\frac{\partial s}{\partial t} + \frac{\partial (us)}{\partial x} + \frac{\partial (vs)}{\partial y} + \frac{\partial (ws)}{\partial z} = \frac{\partial}{\partial x}\left(K_x \frac{\partial s}{\partial x}\right) + \frac{\partial}{\partial y}\left(K_y \frac{\partial s}{\partial y}\right) + \frac{\partial}{\partial z}\left(K_z \frac{\partial s}{\partial z}\right) \tag{3}$$

This form of the equation is then depth integrated as described in Schmalz (1981a) to obtain:

$$\frac{\partial}{\partial t}(hs) + \frac{\partial}{\partial x}(hus) + \frac{\partial}{\partial y}(hvs) = \frac{\partial}{\partial x}\left(hK_x^* \frac{\partial s}{\partial x}\right) + \frac{\partial}{\partial y}\left(hK_y^* \frac{\partial s}{\partial y}\right) \tag{4}$$

where h is the water depth and K_x^* and K_y^* are effective dispersion coefficients.

Constituent Transport Equation in Transformed Coordinates

11. The transport equation is transformed from x - y space to $\alpha_1 - \alpha_2$ space by means of the following coordinate transformation as considered by Butler (1980).

$$x = a_1 + b_1 \alpha_1^{c_1} \rightleftharpoons \alpha_1 = \left(\frac{x - a_1}{b_1}\right)^{1/c_1} \tag{5}$$

$$y = a_2 + b_2 \alpha_2^{c_2} \rightleftharpoons \alpha_2 = \left(\frac{y - a_2}{b_2}\right)^{1/c_2} \tag{6}$$

The terms a_1, b_1, c_1, a_2, b_2, and c_2 are constants valid for different regions in the grid. Then for an arbitrary hydrodynamic variable $\rho(x,y,t)$

$$\frac{\partial \rho}{\partial x} = \frac{\partial \rho}{\partial \alpha_1}\frac{d\alpha_1}{dx} \qquad \frac{\partial \rho}{\partial y} = \frac{\partial \rho}{\partial \alpha_2}\frac{d\alpha_2}{dy} \tag{7}$$

$$\frac{\partial^2\rho}{\partial x^2} = \frac{\partial}{\partial\alpha_1}\left(\frac{\partial\rho}{\partial x}\right)\frac{d\alpha_1}{dx} = \frac{\partial}{\partial\alpha_1}\left(\frac{\partial\rho}{\partial\alpha_1}\frac{d\alpha_1}{dx}\right)\frac{d\alpha_1}{dx} = \frac{d\alpha_1}{dx}\left[\frac{\partial^2\rho}{\partial\alpha_1^2}\frac{d\alpha_1}{dx} + \frac{\partial\rho}{\partial\alpha_1}\frac{\partial}{\partial\alpha_1}\left(\frac{d\alpha_1}{dx}\right)\right] \qquad (8a)$$

$$\frac{\partial^2\rho}{\partial y^2} = \frac{\partial}{\partial\alpha_2}\left(\frac{\partial\rho}{\partial y}\right)\frac{d\alpha_2}{dy} = \frac{\partial}{\partial\alpha_2}\left(\frac{\partial\rho}{\partial\alpha_2}\frac{d\alpha_2}{dy}\right)\frac{d\alpha_2}{dy} = \frac{d\alpha_2}{dy}\left[\frac{\partial^2\rho}{\partial\alpha_2^2}\frac{d\alpha_2}{dy} + \frac{\partial\rho}{\partial\alpha_2}\frac{\partial}{\partial\alpha_2}\left(\frac{d\alpha_2}{dy}\right)\right] \qquad (8b)$$

If we introduce $\mu_1 = dx/d\alpha_1$ and $\mu_2 = dy/d\alpha_2$ then

$$\frac{\partial\rho}{\partial x} = \frac{1}{\mu_1}\frac{\partial\rho}{\partial\alpha_1} \qquad \frac{\partial\rho}{\partial y} = \frac{1}{\mu_2}\frac{\partial\rho}{\partial\alpha_2} \qquad (9)$$

$$\frac{\partial^2\rho}{\partial x^2} = \frac{1}{\mu_1}\left[\frac{1}{\mu_1}\frac{\partial^2\rho}{\partial\alpha_1^2} + \frac{\partial\rho}{\partial\alpha_1}\underline{\frac{\partial}{\partial\alpha_1}\left(\frac{1}{\mu_1}\right)}\right] \qquad (10)$$

$$\frac{\partial^2\rho}{\partial y^2} = \frac{1}{\mu_2}\left[\frac{1}{\mu_2}\frac{\partial^2\rho}{\partial\alpha_2^2} + \frac{\partial\rho}{\partial\alpha_2}\underline{\frac{\partial}{\partial\alpha_2}\left(\frac{1}{\mu_2}\right)}\right] \qquad (11)$$

Considering Equation 8a in an alternate manner

$$\frac{\partial^2\rho}{\partial x^2} = \frac{\partial}{\partial x}\left(\frac{\partial\rho}{\partial\alpha_1}\frac{d\alpha_1}{dx}\right) = \frac{\partial}{\partial x}\left(\frac{\partial\rho}{\partial\alpha_1}\right)\frac{d\alpha_1}{dx} + \frac{\partial\rho}{\partial\alpha_1}\frac{d^2\alpha_1}{dx^2} \qquad (12)$$

Noting $\partial/\partial x = (\partial/\partial\alpha_1)(d\alpha_1/dx) = (\partial/\partial\alpha_1)(1/\mu_1)$

$$\frac{\partial^2\rho}{\partial x^2} = \frac{\partial^2\rho}{\partial\alpha_1^2}\left(\frac{d\alpha_1}{dx}\right)^2 + \frac{\partial\rho}{\partial\alpha_1}\frac{d^2\alpha_1}{dx^2} \qquad (13)$$

Employing previous notation, Equation 13 is rewritten as follows:

$$\frac{\partial^2\rho}{\partial x^2} = \frac{\partial^2\rho}{\partial\alpha_1^2}\left(\frac{1}{\mu_1}\right)^2 + \frac{\partial\rho}{\partial\alpha_1}\frac{d}{dx}\left(\frac{1}{\mu_1}\right) \qquad (14)$$

Note, however, from the relation between $\partial/\partial x$ and $\partial/\partial\alpha_1$ we obtain

$$\frac{\partial^2\rho}{\partial x^2} = \frac{\partial^2\rho}{\partial\alpha_1^2}\left(\frac{1}{\mu_1}\right)^2 + \frac{\partial\rho}{\partial\alpha_1}\frac{d}{d\alpha_1}\left(\frac{1}{\mu_1}\right)\frac{1}{\mu_1} \tag{15}$$

This relation is equivalent to Equation 8.

12. If we consider a hydrodynamic variable $\rho(\alpha_1,\alpha_2,t)$ and let i^* , j^* , n be defined such that

$$\rho^n_{i^*,j^*} = \rho(i^*\Delta\alpha_2, j^*\Delta\alpha_1, n\Delta t) \tag{16}$$

Then let i , j , n be such that

$$\rho^n_{i,j} = \rho\left[a_2 + b_2(i^*\Delta\alpha_2)^{c_2} \ , \ a_1 + b_1(j^*\Delta\alpha_1)^{c_1} \ , \ n\Delta t\right] \tag{17}$$

We employ uniform spacing in $\alpha_1 - \alpha_2$ space and irregular spacing in $x - y$ space. We may evaluate the derivatives with respect to x and y as follows.

$$\left.\frac{\partial\rho}{\partial x}\right|^n_{i,j} = \left.\frac{\partial\rho}{\partial\alpha_1}\right|^n_{i^*,j^*} \left.\frac{d\alpha_1}{dx}\right|_{j^*} \tag{18}$$

where

$$\frac{d\alpha_1}{dx} = \frac{1}{c_1 b_1}\left(\frac{x - a_1}{b_1}\right)^{(1-c_1)/c_1} = f(x)$$

$$f\left(a_1 + b_1\alpha_1^{c_1}\right) = \frac{1}{c_1 b_1}\alpha_1^{(1-c_1)} = f(\alpha_1) \qquad \left.\frac{d\alpha_1}{dx}\right|_{j^*} = f(j^*\Delta\alpha_1)$$

and

$$\left.\frac{\partial\rho}{\partial y}\right|^n_{i,j} = \left.\frac{\partial\rho}{\partial\alpha_2}\right|^n_{i^*,j^*} \left.\frac{d\alpha_2}{dy}\right|_{i^*} \tag{19}$$

where

$$\frac{d\alpha_2}{dy} = \frac{1}{c_2 b_2}\left(\frac{y - a_2}{b_2}\right)^{(1-c_2)/c_2} = g(y)$$

$$g\left(a_2 + b_2\alpha_2^{c_2}\right) = \frac{1}{c_2 b_2}\,\alpha_2^{(1-c_2)} = g(\alpha_2) \qquad \left.\frac{d\alpha_2}{dy}\right|_{i*} = g(i*\Delta\alpha_2)$$

For the second derivative term we obtain

$$\left.\frac{\partial^2\rho}{\partial x^2}\right|_{i,j}^{n} = \left.\frac{d\alpha_1}{dx}\right|_{j}\left[\left.\frac{\partial^2\rho}{\partial\alpha_1}\right|_{i*,j*}^{n}\left.\frac{d\alpha_1}{dx}\right|_{j} + \left.\frac{\partial\rho}{\partial\alpha_1}\right|_{i*,j*}^{n}\left.\frac{d}{d\alpha_1}\left(\frac{d\alpha_1}{dx}\right)\right|_{j*}\right] \tag{20}$$

where

$$\frac{d}{d\alpha_1}\left(\frac{d\alpha_1}{dx}\right) = \frac{d}{d\alpha_1}\left[f\left(a_1 + b_1\alpha_1^{c}\right)\right] = \frac{(1 - c_1)}{c_1 b_1}\,\alpha_1^{-c_1} = h(\alpha_1)$$

$$\left.\frac{d}{d\alpha_1}\left(\frac{d\alpha_1}{dx}\right)\right|_{j*} = h(j*\Delta\alpha_1)$$

Similarly, for $\left.\frac{\partial^2\rho}{\partial y^2}\right|_{i,j}^{n}$. The underlined terms in Equations 10 and 11, although they may be computed exactly, are approximated using finite differencing on μ_1 and μ_2.

13. Transforming Equation 4 in $x - y$ space to $\alpha_1 - \alpha_2$ space we obtain the following result:

$$(ds)_t + \frac{(dus)_{\alpha_1}}{\mu_1} + \frac{(dvs)_{\alpha_2}}{\mu_2} = \frac{1}{\mu_1}\left[dK_{\alpha_1}\frac{(s)_{\alpha_1}}{\mu_1}\right]_{\alpha_1} + \frac{1}{\mu_2}\left[dK_{\alpha_2}\frac{(s)_{\alpha_2}}{\mu_2}\right]_{\alpha_2} \tag{21}$$

where d is introduced as the depth in place of h

$( )_t = \partial/\partial t$

$( )_{\alpha_1} = \partial/\partial\alpha_1$

$( )_{\alpha_2} = \partial/\partial\alpha_2$

Equation 21 is the relation that is the subject of numerical approximation.

Numerical Approximations

14. Schmalz (1983a, 1983b, 1983c) considered several alternate techniques for approximating Equation 21. The Flux Corrected Transport Scheme (FCT) was selected as the most accurate scheme and has been incorporated in the Waterways Experiment Station Implicit Flooding Model (WIFM). In addition a three time level explicit transport scheme was also incorporated in the model. A space staggered grid as shown in Figure 1 was employed in all of the formulations. The datum convention is presented in Figure 2.

15. Let us introduce the following notation as a prelude to the approximations. Define for an arbitrary variable $F^k_{n,m}$, where $t = k\Delta t$, $y = n\Delta y$, $x = m\Delta x$:

$$\delta^k_t\left(F^k_{n,m}\right) = F^{k+1/2}_{n,m} - F^k_{n,m} \tag{22a}$$

$$\delta'^k_t\left(F^k_{n,m}\right) = F^{k+1}_{n,m} - F^k_{n,m} \tag{22b}$$

$$\delta_{\alpha_1}\left(F^k_{n,m}\right) = F^k_{n,m+1/2} - F^k_{n,m-1/2} \tag{22c}$$

$$\delta_{\alpha_2}\left(F^k_{n,m}\right) = F^k_{n+1/2,m} - F^k_{n-1/2,m} \tag{22d}$$

$$\overset{\alpha_1}{\overline{F}}_{n,m} = \frac{\left(F^k_{n,m+1/2} + F^k_{n,m-1/2}\right)}{2} \tag{22e}$$

$$\overset{\alpha_2}{\overline{F}}_{n,m} = \frac{\left(F^k_{n+1/2,m} + F^k_{n-1/2,m}\right)}{2} \tag{22f}$$

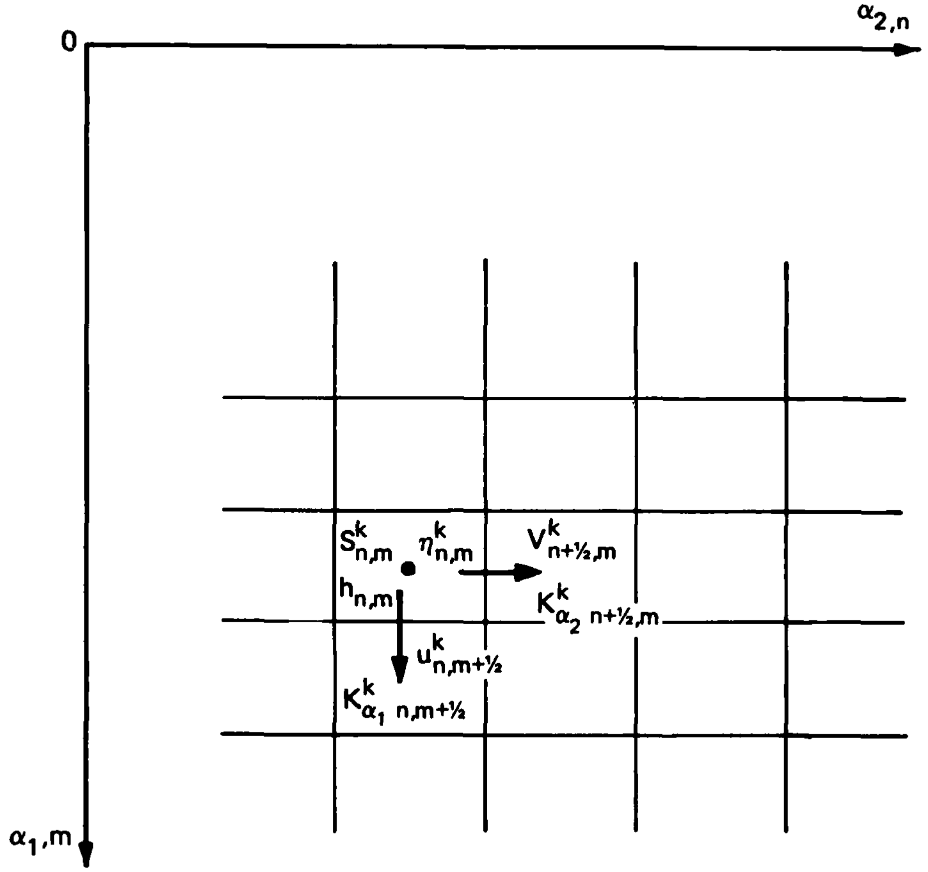

Figure 1. Space staggered finite difference grid in transformed coordinates

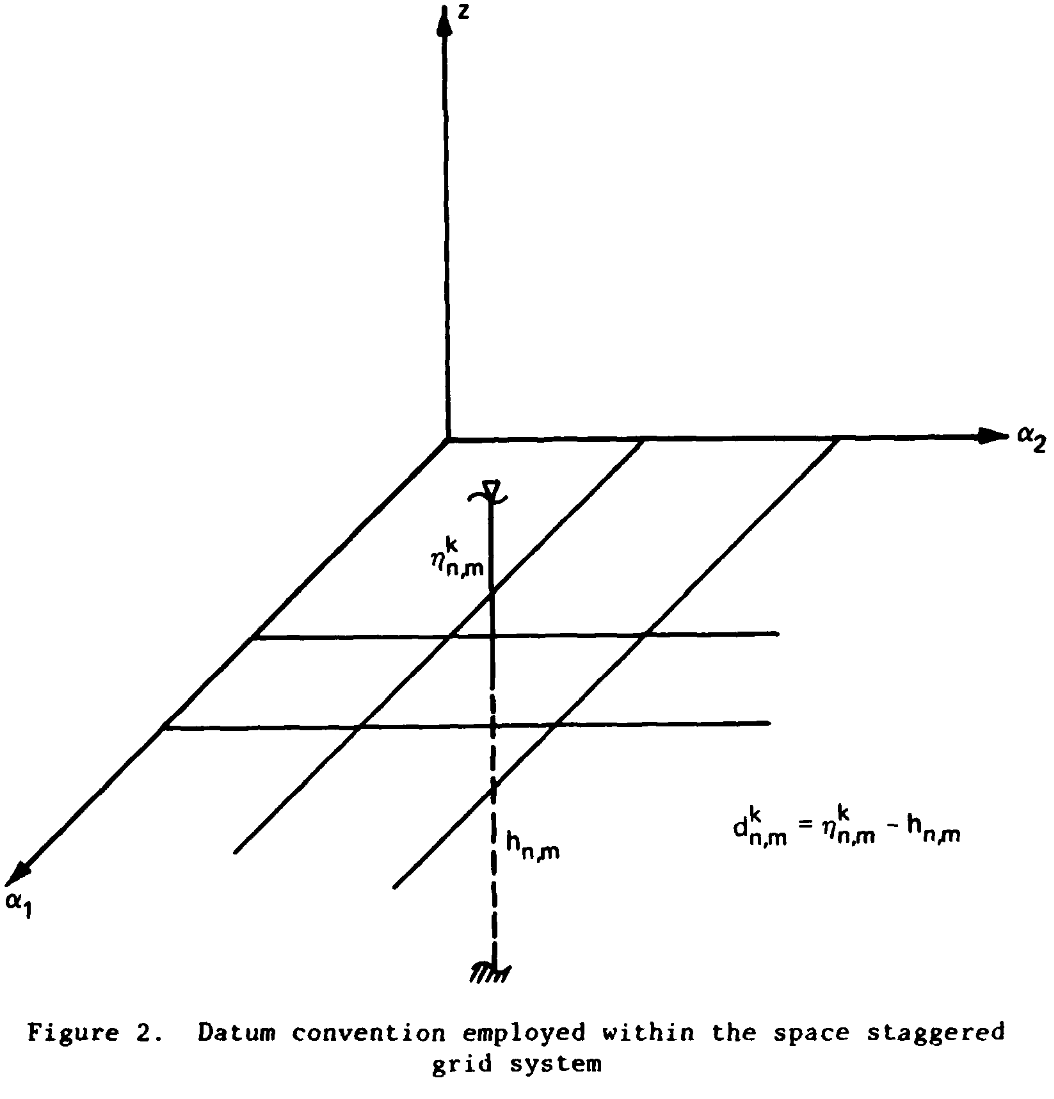

Figure 2. Datum convention employed within the space staggered grid system

Flux-corrected transport scheme

16. Two schemes are used in implementing this approach: a lower order in space nonoscillatory scheme and a higher order in space scheme subject to oscillation. In the method implemented, two time level implicit multioperational ADI schemes were employed. The forward time upwind space (FTUS) and forward time centered space (FTCS) schemes were used as the lower and higher order in space schemes, respectively, and are discussed in turn below. Finally, the necessary flux correction procedures are developed.

17. Leendertse FTCS multioperational scheme. The following finite difference equation is considered as an approximation to the nonlinear transport equation (21):

$$\begin{aligned}
&\delta'^{k}_{t}(ds) + \frac{\Delta t}{2\Delta\alpha_1(\mu_1)_m}\,\delta_{\alpha_1}\left(\overset{\alpha_1}{\overline{d}}{}^{k+1}\,\overset{\alpha_1}{\overline{s}}{}^{k+1}\,u^{k+1} + \overset{\alpha_1}{\overline{d}}{}^{k}\,\overset{\alpha_1}{\overline{s}}{}^{k}\,u^{k}\right)\\
&+ \frac{\Delta t}{2\Delta\alpha_2(\mu_2)_n}\,\delta_{\alpha_2}\left(\overset{\alpha_2}{\overline{d}}{}^{k+1}\,\overset{\alpha_2}{\overline{s}}{}^{k+1}\,v^{k+1} + \overset{\alpha_2}{\overline{d}}{}^{k}\,\overset{\alpha_2}{\overline{s}}{}^{k}\,v^{k}\right)\\
&- \frac{\Delta t}{2(\Delta\alpha_1)^2(\mu_1)_m}\,\delta_{\alpha_1}\left[\overset{\alpha_1}{\overline{d}}{}^{k+1}\,K^{k+1}_{\alpha_1}\,\frac{\delta_{\alpha_1}(s^{k+1})}{(\mu_1)_m} + \overset{\alpha_1}{\overline{d}}{}^{k}\,K^{k}_{\alpha_1}\,\frac{\delta_{\alpha_1}(s^{k})}{(\mu_1)_m}\right]\\
&- \frac{\Delta t}{2(\Delta\alpha_2)^2(\mu_2)_n}\,\delta_{\alpha_2}\left[\overset{\alpha_2}{\overline{d}}{}^{k+1}\,K^{k+1}_{\alpha_2}\,\frac{\delta_{\alpha_2}(s^{k+1})}{(\mu_2)_n} + \overset{\alpha_2}{\overline{d}}{}^{k}\,K^{k}_{\alpha_2}\,\frac{\delta_{\alpha_2}(s^{k})}{(\mu_2)_n}\right] = 0 \quad \text{at } (n,m)
\end{aligned} \tag{23}$$

The solution of the above semi-implicit difference scheme requires the inversion of a large unbanded matrix. In order to reduce computational effort, the following ADI multioperational difference equations are used.

18. The approximations for the X-Sweep may now be written as follows:

$$
\begin{aligned}
&\delta_t^k(ds) + \frac{\Delta t\ \delta_{\alpha_1}}{2\Delta\alpha_1(\mu_1)_m}\left(\frac{\alpha_1}{d^{k+1/2*}}\ \frac{\alpha_1}{s^{k+1/2*}}u^{k+1/2*}\right)\\
&- \frac{\Delta t\ \delta_{\alpha_1}}{2\Delta\alpha_1^2(\mu_1)_m}\left[\frac{\alpha_1}{d}^{k+1/2*}\ K_{\alpha_1}^{k+1/2*}\ \frac{\delta_{\alpha_1}(s^{k+1/2*})}{(\mu_1)_m}\right]\\
&+ \frac{\Delta t}{2(\mu_2)_n\Delta\alpha_2}\ \delta_{\alpha_2}\left(\frac{\alpha_2}{d^k}\ \frac{\alpha_2}{s^k}v^k\right)\\
&\qquad\qquad - \frac{\Delta t\ \delta_{\alpha_2}}{2\Delta\alpha_2^2(\mu_2)_n}\left[\frac{\alpha_1}{d}^k\ K_{\alpha_2}^k\ \frac{\delta_{\alpha_2}(s^k)}{(\mu_2)_n}\right] = 0 \quad \text{at } (n,m)
\end{aligned}
\tag{24}
$$

If we place all terms at time level $k+1/2*$ on the left-hand side of the equation and expand $K_x \equiv K_{\alpha_1}$

$$
\begin{aligned}
&(ds)_{n,m}^{k+1/2*} + \frac{\Delta t}{2\Delta\alpha_1(\mu_1)_m}\left[\frac{\left(\eta_{n,m+1}^{k+1/2*} - h_{n,m+1} + \eta_{n,m}^{k+1/2*} - h_{n,m}\right)}{2.}\ u_{n,m+1/2}^{k+1/2*}\ \frac{\left(s_{n,m+1}^{k+1/2*} + s_{n,m}^{k+1/2*}\right)}{2.}\right.\\
&\left.- \frac{\left(\eta_{n,m-1}^{k+1/2*} - h_{n,m-1} + \eta_{n,m}^{k+1/2*} - h_{n,m}\right)}{2.}\ u_{n,m-1/2}^{k+1/2*}\ \frac{\left(s_{n,m-1}^{k+1/2*} + s_{n,m}^{k+1/2*}\right)}{2.}\right]\\
&- \frac{\Delta t}{2\Delta\alpha_1^2(\mu_1)_m}\left[\frac{\left(\eta_{n,m+1}^{k+1/2*} - h_{n,m+1} + \eta_{n,m}^{k+1/2*} - h_{n,m}\right)}{2.}\ \frac{\left(s_{n,m+1}^{k+1/2*} - s_{n,m}^{k+1/2*}\right)}{(\mu_1)_{m+1/2}}\ K_{x_{n,m+1/2}}^{k+1/2*}\right.\\
&\qquad\qquad \left.- \frac{\left(\eta_{n,m-1}^{k+1/2*} - h_{n,m-1} + \eta_{n,m}^{k+1/2*} - h_{n,m}\right)}{2.}\ \frac{\left(s_{n,m}^{k+1/2*} - s_{n,m-1}^{k+1/2*}\right)}{(\mu_1)_{m-1/2}}\ K_{x_{n,m-1/2}}^{k+1/2*}\right]
\end{aligned}
\tag{25}
$$

Collecting all terms in Equation 23 at time level k denoting the result as B_m, we obtain $K_y \equiv K_{\alpha_2}$

$$
\begin{aligned}
B_m = (ds)^k_{n,m} &- \frac{\Delta t}{2\Delta\alpha_2(\mu_2)_n}\left[\frac{\left(\eta^k_{n+1,m} - h_{n+1,m} + \eta^k_{n,m} - h_{n,m}\right)}{2.} V^k_{n+1/2,m} \frac{\left(s^k_{n+1,m} + s^k_{n,m}\right)}{2.}\right. \\
&\left. - \frac{\left(\eta^k_{n-1,m} - h_{n-1,m} + \eta^k_{n,m} - h_{n,m}\right)}{2.} V^k_{n-1/2,m} \frac{\left(s^k_{n-1,m} + s^k_{n,m}\right)}{2.}\right] \\
&+ \frac{\Delta t}{2(\mu_2)_n(\Delta\alpha_2)^2}\left[\frac{\left(\eta^k_{n+1,m} - h_{n+1,m} + \eta^k_{n,m} - h_{n,m}\right)}{2.} \frac{\left(s^k_{n+1,m} - s^k_{n,m}\right)}{(\mu_2)_{n+1/2}} K^k_{y_{n+1/2,m}}\right. \\
&\left. - \frac{\left(\eta^k_{n-1,m} - h_{n-1,m} + \eta^k_{n,m} - h_{n,m}\right)}{2.} \frac{\left(s^k_{n,m} - s^k_{n-1,m}\right)}{(\mu_2)_{n-1/2}} K^k_{y_{n-1/2,m}}\right]
\end{aligned} \tag{26}
$$

In Equation 25 we define $-a_{n,m-1}$, $a_{n,m+1}$, and $a_{n,m}$ as follows

$$
-a_{n,m-1} = \frac{\Delta t\left(\frac{\alpha_1}{d}\right)^{k+1/2*}_{n,m-1/2}}{2\Delta\alpha_1(\mu_1)_m}\left[\frac{u^{k+1/2*}_{n,m-1/2}}{2.} + \frac{(K_x)^{k+1/2*}_{n,m-1/2}}{\Delta\alpha_1(\mu_1)_{m-1/2}}\right] \tag{27}
$$

$$
a_{n,m+1} = \frac{\Delta t\left(\frac{\alpha_1}{d}\right)^{k+1/2*}_{n,m+1/2}}{2\Delta\alpha_1(\mu_1)_m}\left[\frac{u^{k+1/2*}_{n,m+1/2}}{2} - \frac{(K_x)^{k+1/2*}_{n,m+1/2}}{\Delta\alpha_1(\mu_1)_{m+1/2}}\right] \tag{28}
$$

$$
\begin{aligned}
a_{n,m} = d^{k+1/2*}_{n,m} &+ \frac{\Delta t}{2\Delta\alpha_1(\mu_1)_m}\left[\frac{\left(\frac{\alpha_1}{du}\right)^{k+1/2*}_{n,m+1/2}}{2} - \frac{\left(\frac{\alpha_1}{du}\right)^{k+1/2*}_{n,m-1/2}}{2}\right] \\
&+ \frac{\Delta t}{2\Delta\alpha_1^2(\mu_1)_m}\left[\frac{\left(\frac{\alpha_1}{dK_x}\right)^{k+1/2*}_{n,m+1/2}}{(\mu_1)_{m+1/2}} + \frac{\left(\frac{\alpha_1}{dK_x}\right)^{k+1/2*}_{n,m-1/2}}{(\mu_1)_{m-1/2}}\right]
\end{aligned} \tag{29}
$$

19. Collecting all results we obtain the following interior equation for the X-Sweep

$$
a_{n,m-1}\, s^{k+1/2*}_{n,m-1} + a_{n,m}\, s^{k+1/2*}_{n,m} + a_{n,m+1}\, s^{k+1/2*}_{n,m+1} = B_m \tag{30}
$$

20. The approximations for the Y-Sweep may now be written as follows:

$$\delta_t^{k+1/2*}(ds) + \frac{\Delta t\delta_{\alpha_2}}{2\Delta\alpha_2(\mu_2)_n}\left(\frac{\alpha_2}{d^{k+1}}\frac{\alpha_2}{s^{k+1}}v^{k+1}\right) - \frac{\Delta t\delta_{\alpha_2}}{2\Delta\alpha_2^2(\mu_2)_n}\left[\frac{\alpha_2}{d^{k+1}}K_{\alpha_2}^{k+1}\frac{\delta_{\alpha_2}(s^{k+1})}{(\mu_2)_n}\right]$$

$$+ \frac{\Delta t\delta_{\alpha_1}}{2\Delta\alpha_1(\mu_1)_m}\left(\frac{\alpha_1}{d^{k+1/2*}}\frac{\alpha_1}{s^{k+1/2*}}u^{k+1/2*}\right) + \frac{\Delta t\delta_{\alpha_1}}{2\Delta\alpha_1^2(\mu_1)_m}\left[\frac{\alpha_1}{d^{k+1/2*}}K_{\alpha_1}^{k+1/2*}\frac{\delta_{\alpha_1}(s^{k+1/2*})}{(\mu_1)_m}\right] = 0 \quad \text{at} \quad (n,m) \qquad (31)$$

Expanding Equation 31 by employing Equation 22 and collecting terms at time level k+1 on the left-hand side and leaving terms at time level k+1/2* on the right-hand side, the following interior equation for the Y-Sweep is obtained:

$$a_{n-1,m}\, s_{n-1,m}^{k+1} + a_{n,m}\, s_{n,m}^{k+1} + a_{n+1,m}\, s_{n+1,m}^{k+1} = B_n \qquad (32)$$

where $\left(K_x \equiv K_{\alpha_1}\ ,\ K_y \equiv K_{\alpha_2}\right)$

$$-a_{n-1,m} = \frac{\Delta t\left(\frac{\alpha_2}{d}\right)_{n-1/2,m}^{k+1}}{2\Delta\alpha_2(\mu_2)_n}\left[\frac{v_{n-1/2,m}^{k+1}}{2} + \frac{(K_y)_{n-1/2,m}^{k+1}}{\Delta\alpha_2(\mu_2)_{n-1/2}}\right] \qquad (33)$$

$$a_{n+1,m} = \frac{\Delta t\left(\frac{\alpha_2}{d}\right)_{n+1/2,m}^{k+1}}{2\Delta\alpha_2(\mu_2)_n}\left[\frac{v_{n+1/2,m}^{k+1}}{2} - \frac{(K_y)_{n+1/2,m}^{k+1}}{\Delta\alpha_2(\mu_2)_{n+1/2}}\right] \qquad (34)$$

$$a_{n,m} = d_{n,m}^{k+1} + \frac{\Delta t}{2\Delta\alpha_2(\mu_2)_n}\left[\frac{\left(\frac{\alpha_2}{dv}\right)_{n+1/2,m}^{k+1}}{2} - \frac{\left(\frac{\alpha_2}{dv}\right)_{n-1/2,m}^{k+1}}{2}\right]$$

$$+ \frac{\Delta t}{2\Delta\alpha_2^2(\mu_2)_n}\left[\frac{\left(\frac{\alpha_2}{dK_y}\right)_{n+1/2,m}^{k+1}}{(\mu_2)_{n+1/2}} + \frac{\left(\frac{\alpha_2}{dK_y}\right)_{n-1/2,m}^{k+1}}{(\mu_2)_{n-1/2}}\right] \qquad (35)$$

$$B_n = (ds)_{n,m}^{k+1/2*} - \frac{\Delta t}{2(\mu_1)_m \Delta\alpha_1}\left[\left(\frac{\alpha_1}{d}\,\frac{\alpha_1}{s}\right)_{n,m+1/2}^{k+1/2*} u_{n,m+1/2}^{k+1/2*} - \left(\frac{\alpha_1}{d}\,\frac{\alpha_1}{s}\right)_{n,m-1/2}^{k+1/2*} u_{n,m-1/2}^{k+1/2*}\right]$$

$$+ \frac{\Delta t}{2(\mu_1)_m (\Delta\alpha_1)^2}\left[\left(\frac{\alpha_1}{dK_x}\right)_{n,m+1/2}^{k+1/2*} \frac{\left(s_{n,m+1}^{k=1/2*} - s_{n,m}^{k+1/2*}\right)}{(\mu_1)_{m+1/2}} - \left(\frac{\alpha_1}{dK_x}\right)_{n,m-1/2}^{k+1/2*} \frac{\left(s_{n,m}^{k+1/2*} - s_{n,m-1}^{k+1/2*}\right)}{(\mu_1)_{m-1/2}}\right] \quad (36)$$

21. Leendertse FTUS multioperational scheme. The following finite difference equation is considered as an approximation to the nonlinear transport equation (21):

$$\delta'^{k}_{t}(ds) + \frac{\Delta t}{2\Delta\alpha_1(\mu_1)_m}\,\delta_{\alpha_1}\left(\frac{\alpha_1}{d}^{k+1}\underline{u}_{s_1}^{k+1} u^{k+1} + \frac{\alpha_1}{d}^{k}\underline{u}_{s_1}^{k} u^{k}\right)$$

$$+ \frac{\Delta t}{2\Delta\alpha_2(\mu_2)_n}\,\delta_{\alpha_2}\left(\frac{\alpha_2}{d}^{k+1}\underline{v}_{s_2}^{k+1} v^{k+1} + \frac{\alpha_2}{d}^{k}\underline{v}_{s_2}^{k} v^{k}\right)$$

$$- \frac{\Delta t}{2(\Delta\alpha_1)^2(\mu_1)_m}\,\delta_{\alpha_1}\left[\frac{\alpha_1}{d}^{k+1} K_{\alpha_1}^{k+1} \frac{\delta_{\alpha_1}(s^{k+1})}{(\mu_1)_m} + \frac{\alpha_1}{d}^{k} K_{\alpha_1}^{k} \frac{\delta_{\alpha_1}(s^{k})}{(\mu_1)_m}\right] \quad (37)$$

$$- \frac{\Delta t}{2(\Delta\alpha_2)^2(\mu_2)_n}\,\delta_{\alpha_2}\left[\frac{\alpha_2}{d}^{k+1} K_{\alpha_2}^{k+1} \frac{\delta_{\alpha_2}(s^{k+1})}{(\mu_2)_n} + \frac{\alpha_2}{d}^{k} K_{\alpha_2}^{k} \frac{\delta_{\alpha_2}(s^{k})}{(\mu_2)_n}\right] = 0 \quad \text{at } (n,m)$$

22. The following upwind difference operators are used in the above equation and are defined at (n,m) as follows:

$$\underline{f}_{s_1}^{k} = \left\{\begin{array}{ll} s_{n,m-1/2}^{k} & f_{n,m}^{k} \geq 0 \\ s_{n,m+1/2}^{k} & f_{n,m}^{k} < 0 \end{array}\right\}$$

$$\underline{f}_{s_2}^{k} = \left\{\begin{array}{ll} s_{n-1/2,m}^{k} & f_{n,m}^{k} \geq 0 \\ s_{n+1/2,m}^{k} & f_{n,m}^{k} < 0 \end{array}\right\} \quad (38)$$

23. To effect the solution of this scheme, the inversion of an unbanded matrix is again required. Thus, an ADI scheme similar to the previous technique (upwind differencing is employed for the advective terms) is used. The necessary modifications for the X-Sweep are shown in Table 1 while those employed for the Y-Sweep are given in Table 2.

24. Flux correction procedures. If the factorization terms are ignored, the schemes above may be written in the following flux format:

$$d^{k+1}_{n,m} s^{I}_{n,m} = d^{k}_{n,m} s^{k}_{n,m} - \left[\Delta\alpha_1(\mu_1)_m \Delta\alpha_2(\mu_2)_n\right]^{-1} \left(F^{I}_{n+1/2,m} - F^{I}_{n-1/2,m} + F^{I}_{n,m+1/2} - F^{I}_{n,m-1/2}\right) \qquad (39)$$

where $t = k\Delta t$, $x = \sum_i (\mu_1)_i \Delta\alpha_1$, $y = \sum_i (\mu_2)_i \Delta\alpha_2$

$S^{k}_{n,m}$ ≡ concentration at location (n,m) at time level k

$\Delta\alpha_1(\mu_1)_m$ ≡ x space step at m

$\Delta\alpha_2(\mu_2)_n$ ≡ y space step at n

I ≡ general index at time level $k+1$, which we set to H or L for the higher or lower scheme, respectively

$F^{I}_{n\pm 1/2,m\pm 1/2}$ ≡ fluxes through the appropriate cell faces of cell (n,m). Form is dependent upon the finite difference formulation

We observe from Equation 39 that the difference between the higher and lower order scheme at (n,m) may be written as follows:

$$\left(S^{H}_{n,m} - S^{L}_{n,m}\right) = -\left[\Delta\alpha_1(\mu_1)_m \Delta\alpha_2(\mu_2)_n d^{k+1}_{n,m}\right]^{-1} \left[\left(F^{H}_{n+1/2,m} - F^{L}_{n+1/2,m}\right) - \left(F^{H}_{n-1/2,m} - F^{L}_{n-1/2,m}\right) + \left(F^{H}_{n,m+1/2} - F^{L}_{n,m+1/2}\right) - \left(F^{H}_{n,m-1/2} - F^{L}_{n,m-1/2}\right)\right] \qquad (40)$$

Note this difference may be expressed as an array of fluxes between adjacent grid points and is the condition required to effect the flux correction procedures as given by Zalesak (1979). We next develop the flux expressions for the higher (F^H) and lower (F^L) order schemes. In order to aid in notation, we make the following definition for an arbitrary variable, F :

Table 1

X-Sweep Modifications FTUS

Equation	FTCS	FTUS	
26	$\frac{\left(s^k_{n+1,m} + s^k_{n,m}\right)}{2}$	$s^k_{n,m}$	$v^k_{n+1/2,m} \geq 0$
		$s^k_{n+1,m}$	$v^k_{n+1/2,m} < 0$
26	$\frac{\left(s^k_{n-1,m} + s^k_{n,m}\right)}{2}$	$s^k_{n-1,m}$	$v^k_{n-1/2,m} \geq 0$
		$s^k_{n,m}$	$v^k_{n-1/2,m} < 0$
27	$\frac{u^{k+1/2*}_{n,m-1/2}}{2}$	$\max\left(0\ ,\ u^{k+1/2*}_{n,m-1/2}\right)$	
28	$\frac{u^{k+1/2*}_{n,m+1/2}}{2}$	$\min\left(0\ ,\ u^{k+1/2*}_{n,m+1/2}\right)$	
29	$\frac{\left(\frac{\alpha_1}{du}\right)^{k+1/2*}_{n,m+1/2}}{2}$	$\max\left[0\ ,\ \left(\frac{\alpha_1}{du}\right)^{k+1/2*}_{n,m+1/2}\right]$	
29	$\frac{\left(\frac{\alpha_1}{du}\right)^{k+1/2*}_{n,m-1/2}}{2}$	$\min\left[0\ ,\ \left(\frac{\alpha_1}{du}\right)^{k+1/2*}_{n,m-1/2}\right]$	

Table 2

Y-Sweep Modifications FTUS

Equation	FTCS	FTUS
33	$\frac{v^{k+1}_{n-1/2,m}}{2}$	$\max\left(0\ ,\ v^{k+1}_{n-1/2,m}\right)$
34	$\frac{v^{k+1}_{n+1/2,m}}{2}$	$\min\left(0\ ,\ v^{k+1}_{n+1/2,m}\right)$
35	$\frac{\left(\frac{\alpha_2}{dv}\right)^{k+1}_{n+1/2,m}}{2}$	$\max\left[0\ ,\ \left(\frac{\alpha_2}{dv}\right)^{k+1}_{n+1/2,m}\right]$
35	$\frac{\left(\frac{\alpha_2}{dv}\right)^{k+1}_{n-1/2,m}}{2}$	$\min\left[0\ ,\ \left(\frac{\alpha_2}{dv}\right)^{k+1}_{n-1/2,m}\right]$
36	$\left(\frac{\alpha_1}{d}\ \frac{\alpha_1}{s}\right)^{k+1/2*}_{n,m+1/2}$	$\frac{\alpha_1}{d}{}^{k+1/2*}_{n,m+1/2}\ s^{k+1/2*}_{n,m} \qquad u^{k+1/2*}_{n,m+1/2} \geq 0$
		$\frac{\alpha_1}{d}{}^{k+1/2*}_{n,m+1/2}\ s^{k+1/2*}_{n,m+1} \qquad u^{k+1/2*}_{n,m+1/2} < 0$
36	$\left(\frac{\alpha_1}{d}\ \frac{\alpha_1}{s}\right)^{k+1/2*}_{n,m-1/2}$	$\frac{\alpha_1}{d}{}^{k+1/2*}_{n,m-1/2}\ s^{k+1/2*}_{n,m-1} \qquad u^{k+1/2*}_{n,m-1/2} \geq 0$
		$\frac{\alpha_1}{d}{}^{k+1/2*}_{n,m-1/2}\ s^{k+1/2*}_{n,m} \qquad u^{k+1/2*}_{n,m-1/2} < 0$

$$F^{k+1/2}_{n,m} = \left(F^{k+1}_{n,m} + F^{k}_{n,m}\right)\Big/ 2 \tag{41}$$

25. For the higher order scheme we employ the FTCS scheme written in Equation 23 in which the factorization terms developed in the multioperational method are not shown. Equation 23 may be written in the form of Equation 39, where the total fluxes are presented as the sum of advective and diffusive fluxes.

26. From Equation 23 one then obtains for the advective fluxes:

$$F^{H_A}_{n\pm 1/2,m} = v^{k+1/2}_{n\pm 1/2,m}\Delta t(\mu_1)_m\Delta\alpha_1\left[\left(\frac{S^H + S^k}{2}\right)_{n\pm 1,m} d^{k+1/2}_{n\pm 1,m} + \left(\frac{S^H + S^k}{2}\right)_{n,m} d^{k+1/2}_{n,m}\right]\Big/ 2 \tag{42}$$

$$F^{H_A}_{n,m\pm 1/2} = u^{k+1/2}_{n,m\pm 1/2}\Delta t(\mu_2)_n\Delta\alpha_2\left[\left(\frac{S^H + S^k}{2}\right)_{n,m\pm 1} d^{k+1/2}_{n,m\pm 1} + \left(\frac{S^H + S^k}{2}\right)_{n,m} d^{k+1/2}_{n,m}\right]\Big/ 2 \tag{43}$$

The diffusive fluxes are then given by the following relations $(K_x \equiv K_{\alpha_1}\ ,\ K_y \equiv K_{\alpha_1})$:

$$F^{H_0}_{n\pm 1/2,m} = \pm K_y{}^{k+1/2}_{n\pm 1/2,m}\ \frac{\Delta t(\mu_1)_m\Delta\alpha_1}{2} \times \frac{\left[(S^H + S^k)_{n,m} - (S^H + S^k)_{n\pm 1,m}\right]}{\Delta\alpha_2(\mu_2)_{n\pm 1/2}}\ \frac{\left(d^{k+1/2}_{n\pm 1,m} + d^{k+1/2}_{n,m}\right)}{2} \tag{44}$$

$$F^{H_0}_{n,m\pm 1/2} = \pm K^{k+1/2}_{x_{n,m\pm 1/2}} \frac{\Delta t(\mu_2)_n \Delta\alpha_2}{2} \times \frac{\left[(S^H + S^k)_{n,m} - (S^H + S^k)_{n,m\pm 1}\right]}{\Delta\alpha_1 (\mu_1)_{m\pm 1/2}} \frac{\left(d^{k+1/2}_{n,m\pm 1} + d^{k+1/2}_{n,m}\right)}{2} \tag{45}$$

27. For the lower order scheme, the FTUS scheme written in Equation 37 is employed. Factorization terms generated by the multioperational method are not considered. Equation 37 is written in the form of Equation 39. The total fluxes are presented as the sum of advective and diffusive fluxes.

28. From Equation 37 one obtains the following set of advective fluxes:

$$F^{L_A}_{n+1/2,m} = \left\{ \begin{matrix} v^{k+1/2}_{n+1/2,m} \geq 0 & v^{k+1/2}_{n+1/2,m} \Delta t(\mu_1)_m \Delta\alpha_1 \left(\frac{S^L + S^k}{2}\right)_{n,m} d^{k+1/2}_{n,m} \\ v^{k+1/2}_{n+1/2,m} < 0 & v^{k+1/2}_{n+1/2,m} \Delta t(\mu_1)_m \Delta\alpha_1 \left(\frac{S^L + S^k}{2}\right)_{n+1,m} d^{k+1/2}_{n+1,m} \end{matrix} \right\} \tag{46}$$

$$F^{L_A}_{n-1/2,m} = \left\{ \begin{matrix} v^{k+1/2}_{n-1/2,m} \geq 0 & v^{k+1/2}_{n-1/2,m} \Delta t(\mu_1)_m \Delta\alpha_1 \left(\frac{S^L + S^k}{2}\right)_{n-1,m} d^{k+1/2}_{n-1,m} \\ v^{k+1/2}_{n-1/2,m} < 0 & v^{k+1/2}_{n-1/2,m} \Delta t(\mu_1)_m \Delta\alpha_1 \left(\frac{S^L + S^k}{2}\right)_{n,m} d^{k+1/2}_{n,m} \end{matrix} \right\} \tag{47}$$

$$F^{L_A}_{n,m+1/2} = \left\{ \begin{matrix} u^{k+1/2}_{n,m+1/2} \geq 0 & u^{k+1/2}_{n,m+1/2} \Delta t(\mu_2)_n \Delta\alpha_2 \left(\frac{S^L + S^k}{2}\right)_{n,m} d^{k+1/2}_{n,m} \\ u^{k+1/2}_{n,m+1/2} < 0 & u^{k+1/2}_{n,m+1/2} \Delta t(\mu_2)_n \Delta\alpha_2 \left(\frac{S^L + S^k}{2}\right)_{n,m+1} d^{k+1/2}_{n,m+1} \end{matrix} \right\} \tag{48}$$

$$F^{L_A}_{n,m-1/2} = \left\{ \begin{matrix} u^{k+1/2}_{n,m-1/2} \geq 0 & u^{k+1/2}_{n,m-1/2} \Delta t(\mu_2)_n \Delta\alpha_2 \left(\frac{S^L + S^k}{2}\right)_{n,m-1} d^{k+1/2}_{n,m-1} \\ u^{k+1/2}_{n,m-1/2} < 0 & u^{k+1/2}_{n,m-1/2} \Delta t(\mu_2)_n \Delta\alpha_2 \left(\frac{S^L + S^k}{2}\right)_{n,m} d^{k+1/2}_{n,m} \end{matrix} \right\} \tag{49}$$

The diffusive fluxes are obtained from Equations 44 and 45 with H replaced by L .

29. The antidiffusive fluxes are then computed as follows:

$$A_{n\pm1/2,m} = F^{H_A}_{n\pm1/2,m} - F^{L_A}_{n\pm1/2,m} + F^{H_O}_{n\pm1/2,m} - F^{L_O}_{n\pm1/2,m} \qquad (50)$$

$$A_{n,m\pm1/2} = F^{H_A}_{n,m\pm1/2} - F^{L_A}_{n,m\pm1/2} + F^{H_O}_{n,m\pm1/2} - F^{L_O}_{n,m\pm1/2} \qquad (51)$$

In computing the difference between the diffusive fluxes (third and fourth terms in the above expressions), note that the terms with $S^k_{n,m}$ may be completely eliminated.

30. Next the maximum and minimum cell values are determined:

$$S^a_{n,m} = \max\left(S^k_{n,m}, S^L_{n,m}\right) \qquad S^b_{n,m} = \min\left(S^k_{n,m}, S^L_{n,m}\right) \qquad (52)$$

$$S^{max}_{n,m} = \max\left(S^a_{n-1,m}, S^a_{n,m}, S^a_{n+1,m}, S^a_{n,m-1}, S^a_{n,m+1}\right) \qquad (53)$$

$$S^{min}_{n,m} = \min\left(S^b_{n-1,m}, S^b_{n,m}, S^b_{n+1,m}, S^b_{n,m-1}, S^b_{n,m+1}\right) \qquad (54)$$

31. Next the sum of all antidiffusive fluxes into cell (n,m), $P^+_{n,m}$, is determined:

$$P^+_{n,m} = \max(0, A_{n-1/2,m}) - \min(0, A_{n+1/2,m})$$

$$+ \max(0, A_{n,m-1/2}) - \min(0, A_{n,m+1/2}) \qquad (55)$$

The maximum allowable mass into the cell, $Q^+_{n,m}$, is then computed as follows:

$$Q^+_{n,m} = \left(S^{max}_{n,m} - S^L_{n,m}\right)\left[(\mu_1)_m \Delta\alpha_1 (\mu_2)_n \Delta\alpha_2 d^{k+1}_{n,m}\right] \qquad (56)$$

32. Similarly, the sum of all antidiffusive fluxes out of cell (n,m), $P^-_{n,m}$, is determined:

$$P^-_{n,m} = \max(0,A_{n+1/2,m}) - \min(0,A_{n-1/2,m}) + \max(0,A_{n,m+1/2}) - \min(0,A_{n,m-1/2}) \tag{57}$$

The maximum allowable mass to leave the cell, $Q^-_{n,m}$, is then computed:

$$Q^-_{n,m} = \left(S^L_{n,m} - S^{\min}_{n,m}\right)\left[(\mu_1)_m \Delta\alpha_1 (\mu_2)_n \Delta\alpha_2 d^{k+1}_{n,m}\right] \tag{58}$$

33. The following ratios are next computed for use in determining the limiting coefficients:

$$R^+_{n,m} = \begin{Bmatrix} \min\left(1, Q^+_{n,m} \Big/ P^+_{n,m}\right) & P^+_{n,m} > 0 \\ 0 & P^+_{n,m} = 0 \end{Bmatrix} \tag{59}$$

$$R^-_{n,m} = \begin{Bmatrix} \min\left(1, Q^-_{n,m} \Big/ P^-_{n,m}\right) & P^-_{n,m} > 0 \\ 0 & P^-_{n,m} = 0 \end{Bmatrix} \tag{60}$$

The limiting coefficients are then given by

$$\begin{gathered} C_{n+1/2,m} = \begin{Bmatrix} \min\left(R^+_{n+1,m}, R^-_{n,m}\right) & A_{n+1/2,m} \geq 0 \\ \min\left(R^+_{n,m}, R^-_{n+1,m}\right) & A_{n+1/2,m} < 0 \end{Bmatrix} \\ C_{n,m+1/2} = \begin{Bmatrix} \min\left(R^+_{n,m+1}, R^-_{n,m}\right) & A_{n,m+1/2} \geq 0 \\ \min\left(R^+_{n,m}, R^-_{n,m+1}\right) & A_{n,m+1/2} < 0 \end{Bmatrix} \end{gathered} \tag{61}$$

34. The antidiffusive fluxes in Equations 50 and 51 are limited by multiplying by the limiting coefficients and the solution is advanced to the next time level:

$$S^{k+1}_{n,m} = S^{L}_{n,m} - \left[\Delta\alpha_1(\mu_1)_m \Delta\alpha_2(\mu_2)_n d^{k+1}_{n,m}\right]^{-1} C_{n+1/2,m}A_{n+1/2,m}$$
$$- C_{n-1/2,m}A_{n-1/2,m} + C_{n,m+1/2}A_{n,m+1/2} - C_{n,m-1/2}A_{n,m-1/2} \qquad (62)$$

We observe that for $C_{n+1/2,m} = C_{n,m\pm1/2} = 0$, $S^{k+1}_{n,m} = S^{L}_{n,m}$ and for $C_{n\pm1/2,m} = C_{n,m\pm1/2} = 1.0$, $S^{k+1}_{n,m} = S^{H}_{n,m}$.

35. The coding of the flux corrected transport procedures is presented in Subroutine CONC in Appendix A.

Three time level explicit scheme

36. In order to avoid the averaging of hydrodynamic quantities, which is performed when employing a two time level transport scheme with a three time level velocity scheme, a three time level explicit scheme is considered.

37. It is instructive to observe the form of the continuity equation employed in the multioperational hydrodynamic scheme.

X-Sweep:

$$\frac{1}{2\Delta t}\left(\eta^{*} - \eta^{k-1}\right)_{n,m} + \frac{1}{2\left(\mu_1\right)_m \Delta\alpha_1}\left[\left(u^{k+1} + u^{k-1}\right)\overset{\alpha_1}{\overline{d}}{}^{k}\Big|_{n,m+1/2} - \left(u^{k+1} + u^{k-1}\right)\overset{\alpha_1}{\overline{d}}{}^{k}\Big|_{n,m-1/2}\right]$$
$$+ \frac{1}{\left(\mu_2\right)_n \Delta\alpha_2}\left[v^{k-1}\overset{\alpha_2}{\overline{d}}{}^{k}\Big|_{n+1/2,m} - v^{k-1}\overset{\alpha_2}{\overline{d}}{}^{k}\Big|_{n-1/2,m}\right] = 0 \text{ at } (n,m) \qquad (63)$$

with

$$\overset{\alpha_1}{\overline{d}}_{n,m\pm1/2} = d^{k}_{n,m\pm1} + d^{k}_{n,m}$$

$$\overset{\alpha_2}{\overline{d}}_{n\pm1/2,m} = d^{k}_{n\pm1,m} + d^{k}_{n,m}$$

and

$$d^k_{n,m} = \eta^k_{n,m} - h_{n,m}$$

Y-Sweep:

$$\frac{1}{2\Delta t}\left(\eta^{k+1}_{n,m} - \eta^{*}_{n,m}\right) + \frac{1}{2\left(\mu_2\right)_n \Delta\alpha_2}\left[\left(v^{k+1} - v^{k-1}\right)\frac{\alpha_2}{d^k}\bigg|_{n+1/2,m} - \left(v^{k+1} - v^{k-1}\right)\frac{\alpha_2}{d^k}\bigg|_{n-1/2,m}\right] = 0 \qquad (64)$$

at (n,m)

where

$\Delta t \equiv$ time step length

$\eta^* \equiv$ water surface elevation at intermediate time level $*$

$\eta^{k\pm1}_{n,m} \equiv$ water surface elevation at time level $k\pm1$ at cell (n,m)

$\Delta\alpha_1 \equiv \alpha_1$ space increment

$\Delta\alpha_2 \equiv \alpha_2$ space increment

$u^{k+1}_{n,m+1/2} \equiv x - \alpha_1$ velocity component at time level $k+1$ at cell (n,m)

$u^{k-1}_{n,m+1/2} \equiv x - \alpha_1$ velocity component at time level $k-1$ at cell (n,m)

$v^{k+1}_{n+1/2,m} \equiv y - \alpha_2$ velocity component at time level $k+1$ at cell (n,m)

$v^{k-1}_{n+1/2,m} \equiv y - \alpha_2$ velocity component at time level $k-1$ at cell (n,m)

$d^k_{n,m} \equiv$ water depth at time level k at cell (n,m)

If we eliminate the intermediate level η^* ; e.g., solve for η^* in Equation 63 and substitute in Equation 64, we obtain:

$$\frac{\left(\eta^{k+1}_{n,m} - \eta^{k-1}_{n,m}\right)}{2\Delta t} + \frac{1}{2\left(\mu_1\right)_m \Delta\alpha_1}\left[\left(u^{k+1} + u^{k-1}\right)\frac{\alpha_1}{d^k}\bigg|_{n,m+1/2} - \left(u^{k+1} + u^{k-1}\right)\frac{\alpha_1}{d^k}\bigg|_{n,m-1/2}\right]$$

$$+ \frac{1}{2\left(\mu_2\right)_n \Delta\alpha_2}\left[\left(v^{k+1} + v^{k-1}\right)\frac{\alpha_2}{d^k}\bigg|_{n+1/2,m} - \left(v^{k+1} + v^{k-1}\right)\frac{\alpha_2}{d^k}\bigg|_{n-1/2,m}\right] = 0 \qquad (65)$$

at (n,m)

Since $d^k_{n,m} = \eta^k_{n,m} - h_{n,m}$, Equation 65 is a full three time level scheme. In order to develop a three time level volume consistent transport scheme, we <u>associate</u> in the advective terms $d^k_{n,m} S^k_{n,m} \equiv d^k_{n,m}$; e.g.,

$$\begin{aligned}
&\frac{\left(d^{k+1}_{n,m}S^{k+1}_{n,m} - d^{k-1}_{n,m}S^{k-1}_{n,m}\right)}{2\Delta t} + \frac{1}{2\left(\mu_1\right)_m \Delta\alpha_1}\left[\left(u^{k+1} + u^{k-1}\right) \overset{\alpha_1}{\overline{d}}{}^k \, \overset{\alpha_1}{\overline{s}}{}^k\Big|_{n,m+1/2} - \left(u^{k+1} + u^{k-1}\right) \overset{\alpha_1}{\overline{d}}{}^k \, \overset{\alpha_1}{\overline{s}}{}^k\Big|_{n,m-1/2}\right] \\
&+ \frac{1}{2\left(\mu_2\right)_n \Delta\alpha_2}\left[\left(v^{k+1} + v^{k-1}\right) \overset{\alpha_2}{\overline{d}}{}^k \, \overset{\alpha_2}{\overline{s}}{}^k\Big|_{n+1/2,m} - \left(v^{k+1} + v^{k-1}\right) \overset{\alpha_2}{\overline{d}}{}^k \, \overset{\alpha_2}{\overline{s}}{}^k\Big|_{n-1/2,m}\right] \\
&= + \frac{1}{\left(\mu_1\right)_m\left(\Delta\alpha_1\right)^2}\left[\overset{\alpha_1}{\overline{d}}{}^{k-1} K^{k-1}_{\alpha_1}\Big|_{n,m+1/2} \frac{\left(S^{k-1}_{n,m+1} - S^{k-1}_{n,m}\right)}{\left(\mu_1\right)_{m+1/2}} - \overset{\alpha_1}{\overline{d}}{}^{k-1} K^{k-1}_{\alpha_1}\Big|_{n,m-1/2} \frac{\left(S^{k-1}_{n,m} - S^{k-1}_{n,m-1}\right)}{\left(\mu_1\right)_{m-1/2}}\right] \\
&+ \frac{1}{\left(\mu_2\right)_n\left(\Delta\alpha_2\right)^2}\left[\overset{\alpha_2}{\overline{d}}{}^{k-1} K^{k-1}_{\alpha_2}\Big|_{n+1/2,m} \frac{\left(S^{k-1}_{n+1,m} - S^{k-1}_{n,m}\right)}{\left(\mu_2\right)_{n+1/2}} - \overset{\alpha_2}{\overline{d}}{}^{k-1} K^{k-1}_{\alpha_2}\Big|_{n-1/2,m} \frac{\left(S^{k-1}_{n,m} - S^{k-1}_{n-1,m}\right)}{\left(\mu_2\right)_{n-1/2}}\right]
\end{aligned} \qquad (66)$$

38. The stability properties of the above scheme were investigated for the range of conditions to be simulated in Mississippi Sound. The scheme was stable over this range of flow conditions. Details may be found in Schmalz (1984). The coding of the three time level scheme is presented in Subroutine CONCE in Appendix A.

Dispersion coefficient formulation

39. To close the numerical approximations to the two-dimensional, depth-averaged transport equation, relations for the effective dispersion coefficients may be developed in terms of flow field properties.

40. The effective disperison coefficients are assumed to have the following form:

$$K^*_x = C_x\sqrt{g}\,\frac{|u|h}{C} + D_x \ ; \quad K^*_y = C_y\sqrt{g}\,\frac{|v|h}{C} + D_y \qquad (67)$$

where

K^*_x, K^*_y ≡ effective dispersion coefficients in the x- and y-directions, respecitvely

g ≡ acceleration due to gravity

u, v ≡ velocity components in the x- and y-directions, respectively

h ≡ water depth

C ≡ Chezy coefficient

C_x, C_y ≡ dispersion factors in the x- and y-directions, respectively

D_x, D_y ≡ dispersion offsets due to wind effects in the x- and y-directions, respectively ($D_x, D_y > 0$)

For a unidirectional flow in an infinitely wide channel in the x-direction, Elder (1959) found $C_x = 5.93$ and $C_y = 0.23$. Harleman et al. (1959) has converted Taylor's result (1954) for pipe flow and determined $C_x = 14.3\sqrt{2}$. In attempting to apply these results to a two-dimensional flow problem the following approach is employed. Initially, C_x, C_y, D_x, and D_y are specified by the user as model input. The cell face conditions for each cell are examined independently in each coordinate direction. For a no-flux cell face condition, C_x or C_y and D_x or D_y are set to zero. For a standard flow condition, the advective flag system is examined to determine if the flow is restricted in the x- or y-direction. If the flow is restricted, C_x or C_y is reduced by a user-specified factor.

PART III: MODEL INPUT REQUIREMENTS

41. The constituent transport schemes are included with the hydrodynamics as separate subroutines in WIFM-SAL. Therefore, the model user must also be concerned with both the hydrodynamic input requirements as well as those of the transport computations. The complete input requirements for WIFM-SAL are presented in Appendix B and consist of 29 separate card groups. Constituent transport input requirements consist of the following categories:

a. Constituent Simulation Control.
b. Boundary Condition Control.
c. Boundary Condition Data.
d. Wind Data.
e. Constituent Initial Condition Data.
f. Dispersion Coefficient Data.
g. Output Control.

Each category will be discussed in detail below with reference to the appropriate card groups contained in Appendix B.

Constituent Simulation Control

42. This data group is contained in Card Group 2a. The model user sets ISAL = 1 to consider constituent transport in conjunction with the hydrodynamics. The desired transport scheme is selected by specifying ISALS. For ISALS = 1 , the FCT scheme is employed, while for ISALS = 2 , the full three time level explicit scheme is used. Constituent transport computations are initiated ISALC time steps after the start of the hydrodynamic computations. The user may set $\text{ISALC} \neq 0$ in order to allow for the hydrodynamic computations to be free from initial condition effects before considering constituent transport. CMAX and XMS are self-explanatory.

Boundary Condition Control

43. This data group is contained in Card Groups 3a and 3b. In Card Group 3a the user specifies the number of tidal elevation signals specified by tidal constituents. For a simulation over a global grid, NGLOB = 0 , and NTI is specified as the number of tidal boundary (water surface elevation and

constituent level) signals along the seaward boundary used for interpolation. For a simulation over a refined grid, NTI = 0 , and NGLOB is specified as the number of previously saved tidal signals (water surface elevations and constituent levels) generated from a global grid simulation to be used for cell-centered interpolation along the boundary of the refined grid.

44. In Card Group 3b, the user specifies the grid indices for the grid employed in the current simulation where the known tidal signals are available.

Boundary Condition Data

45. Boundary condition format is specified in Card Group 3. The user specifies ITID as the number of entries in the tidal (elevation and constituents level) input and/or flow (discharge and constituent level) input data tables. The number of time steps between entries in these tables is common and is specified as JTID.

46. In Card Groups 20c and 21b, the constituent levels associated with tidal and flow inputs are specified, respectively.

Wind Data

47. Detailed requirements will not be discussed here. Let it suffice to say that wind conditions may want to be considered when simulating constituent transport. The pertinent input variables requiring specification are as follows:

a. WA, THETA in Card Group 4.
b. NTABLE in Card Group 5.
c. WAT_i, $THAT_i$ in Card Group 6 (optional depending on wind format).

Constituent Initial Condition Data

48. In Card Group 13a, the user specifies a single format or combination of formats to be used for specifying the constituent initial condition. IDEPTH specifies the number of depth intervals used to interpolate based upon depth. If IDEPTH $\neq 0$, a set of initial constituent levels TMP_N are associated with depth values $D_{N,1}$ as specified in Card Group 13b. IFIELD

specifies the number of patches in which initial levels will be specified on a cell-by-cell basis. If IFIELD ≠ 0 , the limits of patch and the individual cell constituent levels are specified in turn for each patch in Card Group 13c. IZONE specifies that a number of zones in which the initial constituent level will be a constant will be assumed. If IZONE ≠ 0 , the number of zones, the limits of the zone, and the constant value of initial constituent level for the zone are specified in Card Group 13d.

49. There is considerable flexibility in specifying initial constituent levels. Each format may be used individually or to override the previous format. For example, the user may specify the initial conditions using depth interpolation. In selected areas of the grid where detailed information is available, the patch concept can be used to override the depth interpolation. In still different areas of the grid, the zone concept can be used to specify a uniform level.

Dispersion Coefficient Data

50. Dispersion factors and offsets due to wind effects are specified in turn for each coordinate direction in a zone format as shown in Card Group 13e.

51. The reduction factor applied to the dispersion factors in cases of flow restriction is specified in Card Group 17b.

Output Control

52. Snapshots of the entire constituent field are printed after completion of up to 32 user-specified time steps during the simulation. Time step completion data are read in Card Group 7 in the NPRINT array.

53. Alternatively, the user may examine constituent level histories at NGAGE locations at NFREQ time step intervals as specified in Card Group 5. The NGAGE locations are specified in terms of the grid indicies in Card Group 8.

PART IV: APPLICATION TO MISSISSIPPI SOUND

54. Both the FCT and the three time level schemes have been applied to the study of salinity distributions in Mississippi Sound by Schmalz (1984). The schemes were exercised on a global grid and also over a local refined grid. Wind sensitivity results for both grid applications are presented in turn below.

Global Grid Results

55. The horizontal salinity distribution was simulated within Mississippi Sound and adjacent areas employing an exponentially stretched global grid as shown in Figure 3. This grid employs 115 × 59 = 6785 cells. Maximum spatial resolution (approximately 3500 ft*) is obtained in the passes into Mississippi Sound. Depths within Mississippi Sound are relatively shallow (10-20 ft), except in the navigation channels, which are normally maintained at 30 to 35 ft. As a result, the gravity wave speed within the Sound is less than 38 fps, resulting in an explicit time step limit of approximately 100 sec. All simulation employed a 360-sec (6 min) time step, resulting in a maximum spatial Courant number of less than 4 within the Sound.

56. Hydrodynamics and salinity conditions over the period 20-24 Sep 1980 were simulated. Water surface elevations along the seaward boundary were obtained from a Gulf Tide Model developed by Reid and Whitaker (1981). Salinity transect data were available on 20 and 21 September. These values were located on the global grid and two rectangular areas were set up in which salinity values were visually interpolated from the located transect values. National Marine Fisheries data were obtained for cruises No. 106 (Apr 1980) and No. 112 (Nov 1980) of the OREGON II. These data provided a general understanding of salinity patterns in the vicinity of the Mississippi Delta. A deep sea vertically averaged value of 36 ppt was employed.

57. Initial conditions were assigned in a three step process as shown in Table 3. In step one, values were assigned based on cell water depth. In step two, salinity values were specified within Mississippi Sound based on salinity transect data. In step three, initial salinity values within

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* A table of factors for converting U. S. customary units of measurement to metric (SI) is presented on page 3.

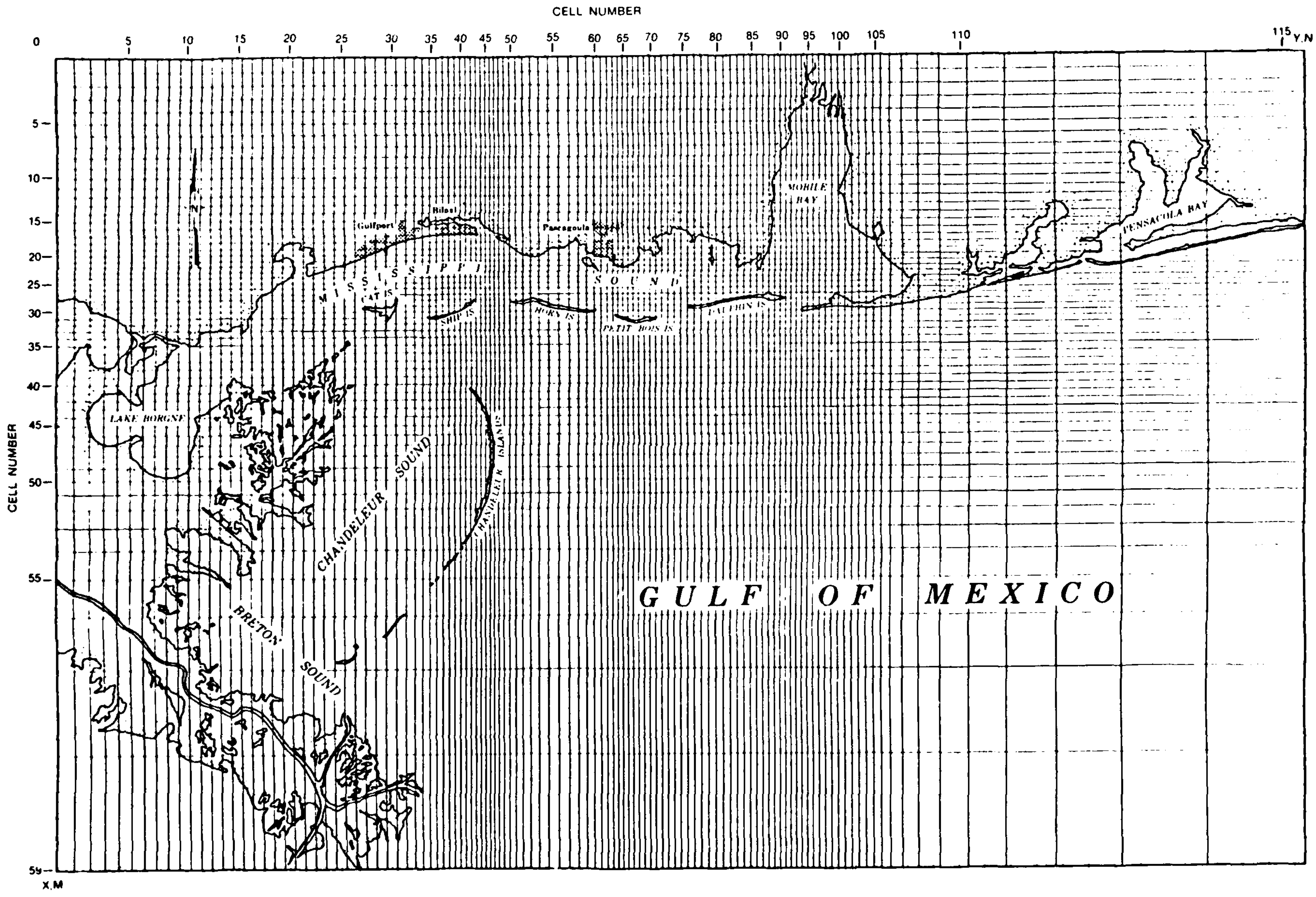

Figure 3. Mississippi Sound global grid

Lake Borgne were specified in a zone format. In this process, each succeeding step overrides the previous step values.

Table 3

Initial Salinity Conditions on the Global Grid

Water Depth ft	Initial Salinity Value, ppt
0-10	22.0
10-20	23.0
20-30	25.0
30-50	30.0
50-75	34.0
75-100	34.3
100-120	34.5
120-200	35.0
200-300	35.5
300-500	36.0

Salinity Grid-Cell-by-Grid-Cell Interpolated Limits

Patch	Global Grid Cell Range N	Global Grid Cell Range M
1	15-27	19-39
2	28-87	15-32

Salinity Zone Specified Initial Conditions

Zone	Global Grid Cell Range N	Global Grid Cell Range M	Salinity ppt
1	1-15	33-50	15

58. Salinity boundary conditions which remained constant over time are shown in Table 4. A cell-centered spatial interpolation similar to that employed for water surface elevations was used to determine salinity values along the seaward boundary.

Table 4

Global Grid Boundary Salinity Conditions

Tidal Signal	Global Grid Cell	Salinity Value, ppt
1	(115,58)	36
2	(115,56)	36
3	(115,50)	36
4	(115,37)	36
5	(115,22)	34
6	(31,59)	30
7	(42,59)	36
8	(57,59)	36
9	(73,59)	36
10	(87,59)	36
11	(103,59)	36
12	(110,59)	36
13	(112,59)	36
14	(115,59)	36
Freshwater Inflow		
1	(97,3)	0
2	(59,19)	24
3	(59,17)	24
4	(13,33)	15
5	(19,20)	17
6	(32,15)	23

59. Wind data reported by Raytheon Ocean Systems (1981) over the period are presented in Table 5. The spatially averaged wind speeds and directions shown were lagged 6 hr in order to investigate model sensitivity to wind. A constant drag coeffecient equal to 0.001 was used in the computations.

60. A total of 1200 time steps were used to simulate 120 hr of prototype time. Wind information input at 6-hr intervals was interpolated in time at each time step. Both salinity schemes were considered. The scheme 1 FCT results and the scheme 2 three time level results are shown in Table 6. The following previously calibrated effective dispersion coefficients are employed:

$$C_x = C_y = 10$$

$$D_x = D_y = 0$$

Reduction factor = 0.0388

Table 5

Wind Data for 20-24 Sep

Julian Day	GMT Hour	MET 1 Speed	MET 1 Direction	MET 3 Speed	MET 3 Direction	MET 4 Speed	MET 4 Direction	MET 5 Speed	MET 5 Direction	Average Speed/ Direction
	24	4.9	123	12.5	110	9.1	114	12.0	103	9.6/112
264	6	4.3	156	4.6	154	7.4	162	12.8	156	7.3/157
	12	4.1	154	3.4	46	3.1	122	10.3	100	5.2/105
	18	5.1	135	8.3	152	7.4	142	9.7	134	7.6/141
	24	4.7	145	6.8	156	4.5	157	7.3	152	5.8/152
265	6	4.7	141	9.3	148	7.8	142	13.3	163	8.7/148
	12	6.1	192	3.7	195	3.2	160	6.6	138	4.9/171
	18	4.8	130	8.1	158	6.5	135	6.6	144	6.5/142
	24	5.8	153	9.0	153	6.3	160	7.9	168	7.2/158
266	6	11.1	167	8.1	160	5.0	163	8.1	153	8.0/161
	12	7.1	176	4.0	184	3.7	162	7.3	148	5.5/167
	18	4.6	153	7.0	170	6.0	102	6.2	143	5.9/142
	24	6.9	154	8.9	165	6.6	167	8.0	177	7.6/166
267	6	7.0	172	4.9	181	3.0	164	3.8	171	4.6/172
	12	3.4	35	6.2	357	2.8	15	1.4	31	3.4/27
	18	4.7	123	8.7	147	9.1	87	3.9	77	6.6/108
	24	5.6	159	7.5	163	5.7	162	8.2	157	6.7/160
268	6	8.2	180	6.8	176	5.1	166	9.6	158	7.4/170
	12	2.9	147	4.1	73	3.7	161	6.2	166	4.2/137
	18	3.6	188	8.3	184	4.5	238	4.3	193	5.1/201
	24	5.2	154	7.5	156	5.4	145	8.9	156	6.7/153

Note: MET 2 was nonfunctioning this period.
MET 3 and MET 1 are "land" stations.
MET 4 and MET 5 are "island" stations.
Speed (MPH).
Direction (Magnetic).

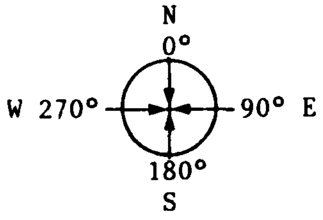

Table 6

Global Grid Wind Sensitivity Simulation

		20/21 Sep 1980		24 Sep 1980		
					Computed	
Transect Station	Global Grid Cell	Measured	Initial Condition	Measured	1	2
T26	(15,39)	16.0	16.0	14.2	19.8	20.2
T30	(16,35)	17.0	17.0	17.2	17.4	18.4
T28	(16,38)	17.3	17.0	15.1	17.8	17.9
T32	(18,33)	17.5	17.0	17.6	17.8	17.8
T24	(18,38)	19.2	19.0	19.3	20.2	20.0
T34	(20,31)	19.2	19.0	19.5	19.3	19.4
T22	(21,35)	23.7	24.0	21.8	23.7	24.1
T36	(23,29)	21.8	22.0	21.1	21.3	20.7
T20	(24,33)	24.9	25.0	24.1	25.3	25.3
T38	(26,29)	22.0	22.0	23.1	22.2	25.8
T40	(27,24)	22.4	22.0	21.0	22.3	22.4
T18	(27,33)	26.8	27.0	25.7	24.4	23.3
T42	(29,26)	23.7	24.0	23.0	23.1	23.1
T6	(29,20)	24.0	24.0	23.8	24.1	24.1
T8	(31,23)	24.8	25.0	23.9	25.0	25.2
T10	(32,26)	25.6	26.0	25.0	24.9	25.0
T12	(33,29)	27.3	27.0	25.5	25.5	25.5
T4	(34,23)	25.2	25.0	23.9	24.5	24.3
T14	(34,31)	28.3	28.0	27.1	25.5	24.4
T16	(34,32)	28.3	28.0	26.8	26.1	26.0
T2	(40,27)	26.1	26.0	25.6	26.1	26.4
T44	(49,21)	23.6	24.0	23.4	25.2	25.3
T46	(49,24)	26.9	27.0	26.2	25.9	25.5
T48	(49,27)	28.2	28.0	27.8	27.3	28.1
T50	(49,29)	28.3	28.0	28.7	27.4	27.2
T52	(53,25)	26.3	26.0	26.7	26.1	26.1
T54	(57,28)	27.3	27.0	27.6	28.9	28.9
T64	(59,21)	27.7	28.0	27.5	27.6	28.4
T62	(60,23)	28.5	28.0	26.8	27.9	28.3
T66	(62,22)	27.3	27.0	27.7	26.9	26.7
T60	(62,24)	28.1	28.0	29.1	27.2	27.2
T58	(62,28)	29.1	29.0	29.6	28.2	28.0
T56	(62,32)	29.7	30.0	30.3	30.1	29.5
T68	(67,26)	27.9	28.0	27.5*	28.1	28.2
T70	(71,28)	28.4	28.0	29.9*	28.2	28.1
T74	(75,26)	28.1	28.0	--	28.4	28.3
T72	(75,30)	28.7	29.0	28.5*	26.2	26.8
T76	(76,25)	26.6	27.0	--	28.2	28.1
T78	(81,25)	22.5	22.0	--	22.4	22.6
T80	(86,25)	22.9	23.0	--	22.6	22.9

* 28 Sep 1980.

In regions of the Sound, the scheme 1 and scheme 2 results are nearly identical and are in agreement with the calibration simulation and measured salinity values. However, in the vicinity of the upper Mobile Bay freshwater inflow, the results diverge as shown in Table 7. The scheme 1 results are nonnegative and exhibit no oscillations. The scheme 2 results exhibit oscillations behind the freshwater front.

Refined Grid Results

61. In order to investigate the salinity distribution in the vicinity of the Pascagoula Channel, the refined grid shown in Figure 4 was developed. This grid employs 49 × 28 = 1372 cells. Maximum spatial resolution of 300 ft is employed to represent the navigation channels. The configuration of the channel system is idealized in the grid in order to reduce the number of grid cells. A 60-sec time step was used, resulting in a maximum spatial Courant number of less than 8 within the grid system.

62. The 20-24 Sep 1980 period with 6-hr lagged wind considered on the global grid was studied on the refined grid. The salinity values computed in the global grid scheme 1 FCT simulation were saved and interpolated temporally and spatially to provide the boundary conditions for the refined grid simulation. Initial conditions over the refined grid were determined from transect data and input cell by cell. Zero salinity values for the Pascagoula River System were input for cells (8,1) and (16,1) in order to establish a freshwater front.

63. A time step of 60 sec was employed 7200 times in order to simulate 120 hr of prototype time. Wind information input at 6-hr intervals from Table 5 was interpolated in time at each time step. The scheme 1 FCT scheme was selected based upon its superior performance on the global grid. Wind lagged simulation results using the calibrated effective dispersion coefficients in paragraph 60 are nearly identical to the calibration simulation results and correspond to measured values as shown in Table 8. In order to obtain an estimate of the freshwater influence and movement of the front, the salinity field at the end of the simulation is shown in Table 9. Note the scheme 1 results are nonnegative and exhibit no oscillation. The flow pattern in the vicinity of the freshwater inflow at (16,1) is extremely complex. The averaging processes employed in coupling the two time level scheme 1 FCT with

Table 7

Upper Mobile Bay Simulation Results in the Global Grid After 120 Hr

Scheme 1 (Flux Corrected Transport)

M N	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.
3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2200.	2216.	1763.	114.	0.	52.	274.	2263.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2200.	2207.	2136.	1620.	955.	51.	1423.	2291.	2220.	2221.
7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2200.	2200.	2194.	2087.	1557.	1036.	1592.	2200.	2276.	2243.
8	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	0.	2201.	2200.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	0.	2200.	2200.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2170.	2276.	2293.	2294.
10	0.	0.	0.	0.	0.	0.	0.	0.	2201.	2200.	2209.	2226.	[illegible]	[illegible]	[illegible]	[illegible]	2277.	2288.	2269.	2260.
11	0.	0.	0.	0.	0.	0.	0.	2201.	2201.	2200.	2195.	2236.	2280.	2308.	2297.	2255.	2298.	2283.	2217.	0.
12	0.	0.	0.	0.	0.	0.	0.	2202.	2200.	2211.	2228.	2233.	2295.	2309.	2292.	2283.	2258.	2241.	2216.	0.
13	0.	0.	0.	0.	0.	0.	0.	2202.	2215.	2234.	2260.	2246.	2276.	2312.	2297.	2293.	2252.	2211.	2209.	2208.
14	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	0.	2203.	2206.	2261.	2276.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2282.	2269.	2267.	2213.
15	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2210.	2230.	2279.	2277.	[illegible]	[illegible]	[illegible]	[illegible]	2301.	[illegible]	2284.	[illegible]	2209.

Scheme 2 (Explicit Three Time Level)

M N	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	0.	0.	[illegible]	[illegible]	[illegible]	0.	0.	0.	0.	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	[illegible]	0.
4	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	0.	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	0.
5	0.	0.	0.	0.	0	0.	0	0.	0	0.	2197.	2257.	1777.	-24.	-475.	307.	706.	2940.	0.	0.
6	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	2200.	2205.	2149.	1621.	1219.	-109.	1572.	2300.	2193.	2220.
7	0.	0.	0.	0.	0	0.	0	0	0	0.	2200.	2200.	2194.	2117.	2029.	1234.	1674.	2218.	2271.	2248.
8	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	0.	[illegible]	0.	2201.	2200.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2277.	[illegible]	2328.
10	0.	0.	[illegible]	[illegible]	[illegible]	0.	0.	0.	2201.	2210.	2205.	2227.	[illegible]	[illegible]	[illegible]	2276.	2278.	2298.	2287.	2199.
11	0.	0.	0.	0.	0	0	0	2196	2213	2143.	2184	2235.	2263.	2324.	2304.	2330.	2337.	2286.	2166.	0.
12	0.	0.	0.	0.	0.	0.	0.	2199.	2182.	2251.	2203.	2132.	2298.	2339.	2276.	2268.	2227.	2253.	2212.	0.
13	0.	0.	0.	0.	0.	0.	0.	2202.	2217.	2229.	2315.	2256.	2286.	2317.	2290.	2263.	2249.	2163.	2209.	2195.
14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2201.	2204.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	2209.	2226.	2265.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2300.	[illegible]	2298.	2203.	2198.

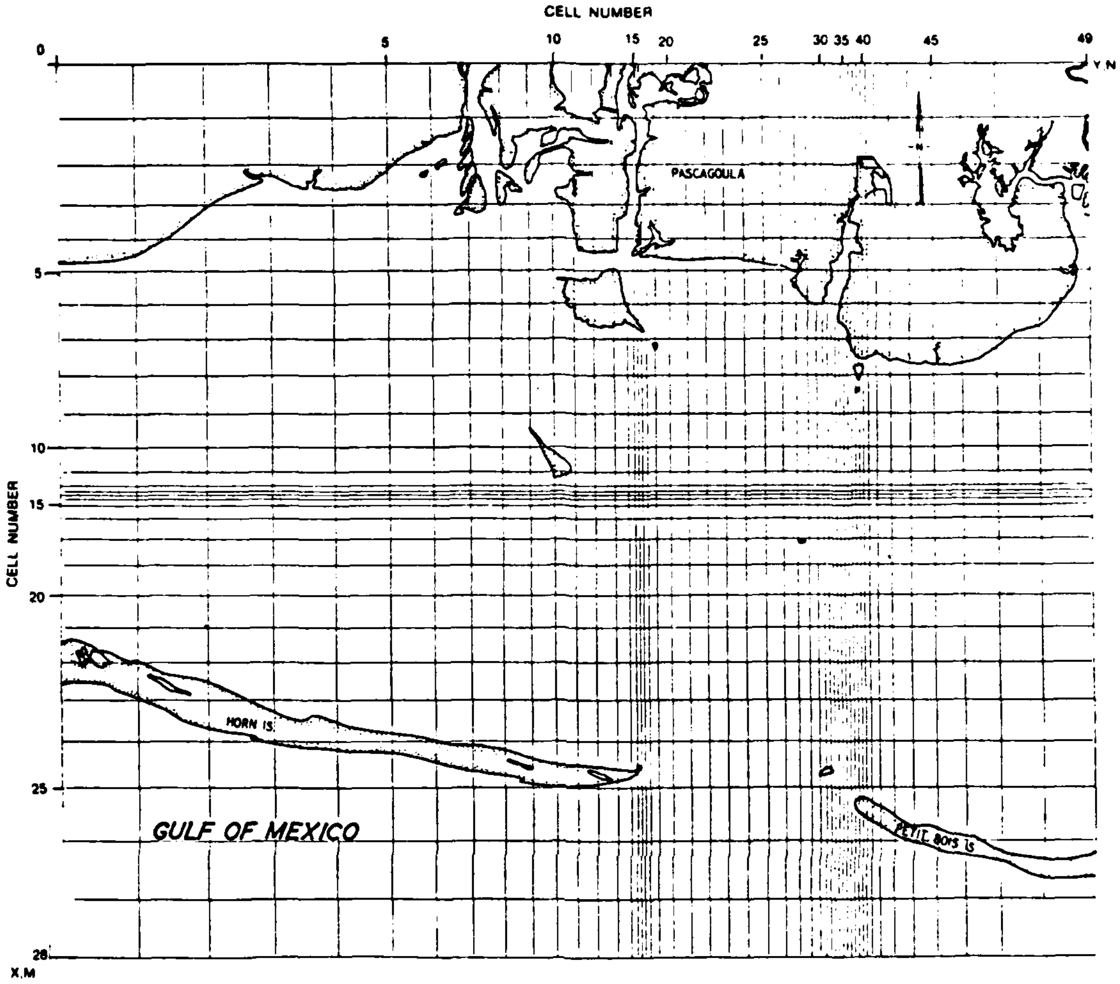

Figure 4. Pascagoula Channel System refined grid

Table 8

Refined Grid Wind Sensitivity Simulation

Transect Station	Refined Grid Cell	20/21 Sep 1980 Measured	20/21 Sep 1980 Initial Condition	24 Sep 1980 Measured	24 Sep 1980 Computed Scheme 1
T54	(8,22)	27.3	27.0	27.6	28.8
T64	(17,6)	27.7	28.0	27.5	28.3
T62	(24,9)	28.5	29.0	26.8	27.7
T66	(31,7)	27.3	27.0	27.7	27.9
T60	(33,7)	28.1	27.0	29.1	27.8
T58	(36,23)	29.1	29.0	29.6	27.7
T56	(34,26)	29.7	30.0	30.3	28.0
T68	(49,19)	27.9	28.0	27.5*	28.0

* 28 Sep 1980.

Table 9

Pascagoula River Vicinity Simulation Results After 120 Hr on the Refined Grid

Scheme 1 (Flux Corrected Transport)

M N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0	0.	2377	10	0.	2404.	2403.	0.	0.	0.	2079.	861.	2687.	0.	0.	0.
3	0.	0.	0.	0.	0.	2195.	1640.	276.	2571.	2480.	2405.	0.	0.	0.	827.	853.	1403.	0.	0.	0.
4	0.	0.	2330.	2214.	1014	1833.	1766.	1081.	2480	2474.	2563.	0.	0.	0.	2461.	741.	2183.	0.	0.	0.
5	0.	2409.	2402.	2631.	2475	2417	2671.	1467.	2530	2660.	2663.	2687.	2711.	2518.	2547.	779.	1665.	0.	0.	0.
6	2443.	2440.	2516.	2795.	2794.	2814.	2814.	2778.	2750.	2720.	2565.	0.	0.	2090.	2431.	1994.	2626.	2783.	2800.	2800.
7	2433.	2445.	2577.	2743.	2739.	2750.	2775.	2728.	2693.	2589.	2448.	0.	0.	2102.	2369.	2124.	2479.	2584.	2737.	2735.
8	2422.	2450.	2590.	2760.	2750.	2767.	2764.	2730.	2624.	2432.	2319.	2296.	2279.	2193.	2367.	1956.	1833.	1892.	2383.	2556.
9	2465.	2455.	2629.	2746.	2719	2754.	2777.	2814.	2813.	2714.	2379.	2270.	2265.	2266.	2459.	1897.	1860.	2097.	2172.	2319.
10	2459.	2464.	2700.	2731.	2700	2705.	2746	2807.	2820.	2796.	2791.	2719.	2520.	2394.	2459.	1957.	2044.	2205.	2342.	2468.
11	2545.	2546.	2724.	2712.	2701	2713	2742	2764.	2792.	2740.	0.	2605.	2601	2513.	2405.	2077.	2190.	2298.	2430.	2379.
12	2578.	2594.	2724.	2702.	2702.	2715.	2772.	2826.	2801.	2747.	2726.	2750.	2648.	2516.	2479.	2212.	2249.	2249.	2354.	2377.
13	2598.	2607.	2724.	2659.	2707.	2727.	2751.	2826.	2823.	2783.	2792.	2739.	2739.	2712.	2499.	2259.	2262.	2255.	2296.	2303.
14	2606.	2610.	2724.	2699.	2706.	2725.	2772.	2627.	2805.	2788.	2810.	2740.	2715.	2576.	2379.	2274.	2276.	2267.	2277.	2277.
15	2616.	2614.	2724.	2699.	2706	2727.	2791	2827.	2809.	2802.	2812.	2727.	2707.	2711.	2420.	2264.	2275.	2262.	2310.	2420.
16	2627.	2614.	2724.	2699.	2706.	2725.	2775.	2827.	2810.	2797.	2816.	2751.	2707.	2596.	2364.	2400.	2274.	2306.	2397.	2366.
17	2641.	2623.	2724.	2659.	2706.	2730.	2752.	2828.	2813.	2802.	2819.	2759.	2737.	2703.	2383.	2457.	2407.	2405.	2439.	2499.
18	2684.	2623.	2721.	2659.	2711.	2737.	2785.	2831.	2810.	2815.	2819.	2836.	2838.	2842.	2689.	2650.	2742.	2677.	2797.	2793.
19	2702.	2664.	2718.	2699.	2715.	2751.	2803.	2843.	2811.	2824.	2836.	2855.	2878.	2655.	2827.	2843.	2845.	2839.	2836.	2816.
20	2725.	2706.	2705.	2705.	2721.	2782.	2825.	2851.	2814.	2829.	2838.	2868.	2885.	2875.	2863.	2866.	2856.	2853.	2838.	2828.
21	2658.	2657.	2702.	2705.	2731.	2811.	2836.	2867.	2845.	2894.	2898.	2885.	2892.	2889.	2870.	2867.	2854.	2851.	2840.	2836.
22	2669.	2655.	2702.	2710.	2752	2847.	2864	2860.	2878.	2915.	2906.	2896.	2918	2891.	2676.	2876.	2870.	2873.	2973.	2999.
23	0.	0.	2702.	2716.	2771.	2876.	2876.	2914.	2923.	2931.	2906.	2910.	2937.	2925.	2918.	2923.	2915.	2919.	2909.	2911.
24	2693.	2701.	0.	2730.	2792.	2874.	2856.	2913.	2943.	2948.	2944.	2931.	2947.	2946.	2950.	2941.	2947.	2939.	2943.	2934.
25	2746.	2792.	2861.	2907.	2835.	2873.	0.	0.	2923.	2945.	2953.	2954.	2957.	2956.	2953.	2953.	2956.	2952.	2948.	2937.
26	2772.	2949.	3011.	2930.	2916.	2986.	2946.	2963.	2974.	2977.	2970.	2970.	2971.	2964.	2966.	2967.	2968.	2969.	2968.	2970.
27	2831.	2973.	3019.	3019.	2987.	2986.	2981	2988.	2985.	2978.	2976.	2975.	2982.	2994.	2996.	2996.	2997.	2997.	2997.	3000.
28	3040.	2970.	2998.	3024.	2990.	2992.	2993.	2994.	2991.	2989.	2987.	2980.	2973.	2967.	2964.	2962.	2960.	2960.	2960.	2960.

the three time level hydrodynamics may contribute to the unusual distribution over cells (15-17,1). These effects are usually local and the two time level scheme 1 FCT resolves the edge of the freshwater front. Additional research is warranted to flux-correct scheme 2 thereby eliminating the above averaging of hydrodynamic variables necessary in scheme 1.

64. The input data for this simulation are presented in Appendix C. Typical output from the salinity computations embodied within WIFM is shown in Appendix D.

Computer Requirements

65. The resources required for both the hydrodynamics and the salinity computations are shown in Table 10. Scheme 1 is more accurate but requires nearly three times more computer time than does scheme 2. In general a very large scientific computation oriented machine should be utilized for applications employing the number of cells in the Mississippi Sound study.

Table 10

CRAY I-S Requirements

Simulation	Grid	Number of Time Steps	Total Field Length (Octal)	CPUS
Scheme 1 (FCT)	Global	1200	1606064	619
Scheme 1 (FCT)	Refined	7200	776152	777
Scheme 2 (Three Time Level)	Global	1200	1601756	340
Scheme 2 (Three Time Level)	Refined	7200	776266	475

66. The job control language (JCL) for a global grid and refined grid simulation is presented in Appendix E. It should be noted that the JCL shown is for the CRAY I-S Cray Operating System 1.09 as implemented at Kirtland Air Force Base, New Mexico.

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APPENDIX A: SUBROUTINE LISTINGS

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4475     1. CLINK LIST                                                              CAL.453
4476     2.      SUBROUTINE CONC                                                    CONC.2
4477     3.      PARAMETER (ND=5,N6=60)                                             CONC.3
4478     4.      PARAMETER (NUMPT=1372,NDIM=45,MDIM=26,NFPTS=1)                     CAL.5
4479     5.      PARAMETER (IFRC=605,IDXS=20,IFLT=1,ITCS=40,JPUT=7205,JFLS=2)       CAL.6
4480     6.      LOGICAL ITAFL,IPT,IDUMP                                         SCALAR.2
4481     7.      COMMON /V1/ NPA,NPAX,NTIL,NFLC,ITIL,JTIL,INITL,NP1,NP2,NP3,NPR, SCALAR.3
4482            1 NPK,MAXTIP,INTAP,IDELAY,IFLCT,NGAGE,N1,M1,NX1,MX1,ISTEP,KK,    SCALAR.4
4483            2 ITIME,IP1,IPP,AFREQ,IRECK,IXFAN,NPX,MSURF,NXX,NYY,N2P,NDTAP,   SCALAR.5
4484            3 JFO,KREST,KS1,KS2,KS3,KS4,KS5,KS6,ANPCT,MSKP,MOLY,ITAPE,IPT,   2/2/81.1
4485            4 IDUMP,INC,KBT,KFT,KTT,ITYP,INDX,ICIR,KUV,KTRANS,NBG,MEG,KSB    SCALAR.7
4486            5 ,IRESTP,NCONT,IOVER,IFLVL,NN,INFT,NSTP,NTSB,NWAT,NAL,PLIM      SCALAR.8
4487            6 ,NS2,MS2,LEVEL,NDX,NZO,NCCNAT,IVFLCT,ICFLCT,IHOT,ISLRG,NTABLE, SCALAR.9
4488            7 IPOND,NCHAN,NCS,ITHM,ICELL,KCH,NDMX                            SCALAR.10
4489            8 ,NCON                                                         12/22/81.1
4490     8.      COMMON /V2/ TAL,DT,DX,DY,DX2,DY2,G,G2,ALAT,XI,WA,THETA,EPSD,   SCALAR.11
4491            1 EPSD2,EPSD3,EPSD4,EPSD6,DCCN1,RCTA,SIXTH,F1,PI180,TSX,TSY,    SCALAR.12
4492            2 ADV,VIS,UMEX,UMAXC,SINIT,AFSD,IFRC,TPE,                        SCALAR.13
4493            3 XLAND,XSCOUR,SMAX,TZ1,TAUX,TAUY,FF,DXF,DYF,ZN1,ZN2             SCALAR.14
4494            4 ,XO,YO,XL1,YL1,DCON2,WATERR,CLIMIT                             SCALAR.15
4495            5 ,GTSX,GTSY,EGT,EGT2,FF2,GCDX,GCDY,G2T,GT,XI2                   SCALAR.16
4496            6 ,FXS,FYS,FATPS,ISAL,ISALS,ISALC,CMAX,XMS,IFETR                    CAL.1
4497     9.      COMMON/V6/ IBARX(200),IBARY(200),IBART(200),IBARR(200,5),        FLODRY.2
4498            1  ITIDE(200),IFLOW(20),ITRAPS(20),ICFAN(10),XCFAN(200,2)        FLODRY.3
4499            1   ,INT(200),F1(200),ITC1(200),ITC2(200)                       12/22/81.4
4500    10.      COMMON /V7/ XMAN(20),ZB(20),CE(20),CC(20),CAYD(20),CD(20)        FLODRY.4
4501            *    ,CANPY1(20),CANPY2(20)                                      FLODRY.5
4502    11.    1 COMMON /AA4/ IFLOOD(NFPTS),ZFU(NFPTS),ZFV(NFPTS),CHZ(NFPTS),     FLODRY.6
4503            1  IPAS(NFPTS)                                                   FLODRY.7
4504    12.      DIMENSION JFLOD(NFPTS)                                           FLODRY.8
4505    13.      EQUIVALENCE (JFLOD(1),CHZ(1))                                    FLODRY.9
4506    14.      COMMON /AA1/ SEE(NDIM,MDIM),SE(NDIM,MDIM),SEM(NDIM,MDIM)        EUVMC2D.2
4507    15.      COMMON /AA2/ UP(NDIM,MDIM),U(NDIM,MDIM),UM(NDIM,MDIM),F(NDIM,MDIM) EUVMC2D.3
4508    16.      COMMON /AA3/ VP(NDIM,MDIM),V(NDIM,MDIM),VM(NDIM,MDIM),C(NDIM,MDIM) EUVMC2D.4
4509    17.      COMMON /AA7/ FRIC(IFRC,IDXS),SURFE(IPUT,ITCS),DCHRGE(JPUT,JFLS),   ARRAY.2
4510            2  ,CONE(IFLT,ITCS),COND(JPUT,JFLS)                                TEST.1
4511    18.      COMMON /AA5/ ICU(NDIM,MDIM),ICV(NDIM,MDIM),JSB(NDIM,MDIM)       ARRAY2D.2
4512    19.      COMMON /AA6/ FXX(NDIM,MDIM),FYY(NDIM,MDIM),PFEL(NDIM,MDIM),     ARRAY2D.3
4513            1  ISTORE(NDIM,MDIM)                                             ARRAY2D.4
4514    20.      DIMENSION PTAB(1,1)                                             ARRAY2D.5
4515    21.      EQUIVALENCE (PTAB(1,1),ICU(1,1))                                ARRAY2D.6
4516    22.       COMMON/V15/GL1(500),GL2(500),GL3(500),GL4(500),GL5(500)           MISC.2
4517    23.      COMMON/V8/ NV(150),XMU(300),YMU(300),IIBAY(20),JJBAY(20),R1(20),   MISC.3
4518            1               R2(20),AS(20),ALL(20)                               MISC.4
4519            1  ,XMUT(300),YMUT(300)                                             MISC.5
4520    24.      COMMON /V9/ A(150),B(150),P(150),Q(150),R(150),S(150),ISB(150)     MISC.6
4521            1  ,D1(150),FX(150),FY(150),PAIM(150),VISC(150),ADVE(150),ADVC(150) MISC.7
4522    25.      COMMON /V10/ IL1(150),IL2(150),IV1(150),IV2(150)                   MISC.8
4523            1   ,NGHD(300),NCLGB,THE1,THE2,THE3,THE4                             CAL.3
4524    26.      COMMON /V11/ TPUC(150),ILCN(50),LCX(50),NDX(50)                   MISC.10
4525            1 ,WAT(50),TPT(50),NCARD(50)                                       MISC.11
4526    27.      INTEGER COAST                                                     MISC.12
4527    28.      COMMON /AA8/ SGRID(1,1),IGRID(1,1),COAST(1),SURPLT(1,1)           MISC.13
4528    29.      COMMON/CALC/TMP1(150),TMP2(150),TMP3(150),TMP4(150),TMP5(150),     TEST.4
4529            1  TMP6(150)                                                        TEST.5
4530    30.      DIMENSION AL(150),BL(150),APL(150),PPL(150),CK(150)                 CAL.4
4531            1  ,UT(150)                                                       12/22/81.6
4532    31.      EQUIVALENCE (AL(1),A(1)),(BL(1),B(1)),(APL(1),VISC(1)),          12/22/81.7
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 4533                1  (APL(1),ACVE(1)),(DK(1),ADVC(1)),(LI(1),FX(1))              12/22/81.8
 4534     32.        DIMENSION APP(150),APH(150),AF(150),EF(150)                   12/22/81.9
 4535     33.        EQUIVALENCE (APP(1),TMP1(1)),(APP(1),TMP2(1)),(AH(1),TPPS(1)), 12/22/81.10
 4536                1 (BM(1),TPF4(1))                                              12/22/81.11
 4537     34.        COMMON/EMASS/AB(2),SUMB(2),SUPTB                               12/22/81.12
 4538     35.        COMMON/CONC/CN(NDIM,MDIM),CFL(NLIM,MLIM),CNFL(NDIM,MLIM),      12/22/81.17
 4539                1  CPH(NLIM,MLIM),CNPH(NLIM,MLIM),CX(NDIM,MDIM),CY(NDIM,MDIM), 12/22/81.18
 4540                2  DKXX(NDIM,MDIM),DKYY(NDIM,MDIM),FLLX(NDIM,MDIM),FLLY(NDIM,MDIM) 12/22/81.19
 4541                3,RM(NDIM,MDIM),RP(NDIM,MDIM)                                      CAL.8
 4542     36.        COMMON/COPT/IDEBUG,ALL,BLU,BLL,BLU                                 CAL.454
 4543     37.        MM=MAX0(KK-1,1)                                                12/22/81.236
 4544     38.        IF(NFLG.EQ.0)GO TO 50                                          12/22/81.237
 4545     39.        DO 60 I=1,KCV                                                  12/22/81.238
 4546     40.        IP=IFLOW(I)                                                        CONC.23
 4547     41.        INDX=IP/1000000                                                    CONC.24
 4548     42.        IP=IP-1000000*INDX                                                 CONC.25
 4549     43.        N=IP/1000                                                          CONC.26
 4550     44.        M=IP-1000*N                                                        CONC.27
 4551     45.        INDX=INDX-INDX/100*100                                             CONC.28
 4552     46.        IDIR=INDX/10                                                       CONC.29
 4553     47.        INDX=INDX-10*IDIR                                                  CONC.30
 4554     48.        T1=(COND(KK,INDX)+COND(MM,INDX))*.5                            12/22/81.239
 4555     49.        T2=COND(KK,INDX)                                               12/22/81.240
 4556     50.        IF(KK-1.EQ.ISALC)CN(N,M)=COND(MM,INDX)                             CAL.455
 4557     51.        CFL(N,M)=T1                                                    12/22/81.241
 4558     52.        CPH(N,M)=T1                                                    12/22/81.242
 4559     53.        CNPL(N,M)=T2                                                   12/22/81.243
 4560     54.  60    CNPH(N,M)=T2                                                   12/22/81.244
 4561     55.  50    IF(NTID.EQ.0)GO TO 100                                         12/22/81.245
 4562     56.        DO 70 I=1,KIT                                                  12/22/81.246
 4563     57.        IP=ITILE(I)                                                        CONC.37
 4564     58.        INDX=IP/1000000                                                    CONC.38
 4565     59.        IP=IP-1000000*INDX                                                 CONC.39
 4566     60.        N=IP/1000                                                          CONC.40
 4567     61.        M=IP-1000*N                                                        CONC.41
 4568     62.        IF(INT(I))6005,6006,6005                                           CAL.456
 4569     63.  6005  T1=(1.-FI(I))*CONE(MM,ITG1(I))+FI(I)*CONE(MM,ITG2(I))              CAL.457
 4570     64.        T2=(1.-FI(I))*CONE(KK,ITG1(I))+FI(I)*CONE(KK,ITG2(I))              CAL.458
 4571     65.        IF(KK-1.EQ.ISALC)CN(N,M)=T1                                        CAL.459
 4572     66.        T1=.5*(T1+T2)                                                      CAL.460
 4573     67.        GO TO 6010                                                         CAL.461
 4574     68.  6006  INDX=INDX-INDX/100*100                                             CAL.462
 4575     69.        IDIR=INDX/10                                                       CONC.43
 4576     70.        INDX=INDX-10*IDIR                                                  CONC.44
 4577     71.        T1=(CONE(KK,INDX)+CONE(MM,INDX))*.5                            12/22/81.247
 4578     72.        T2=CONE(KK,INDX)                                               12/22/81.248
 4579     73.        IF(KK-1.EQ.ISALC)CN(N,M)=CONE(MM,INDX)                             CAL.463
 4580     74.  6010  CFL(N,M)=T1                                                        CAL.464
 4581     75.        CPH(N,M)=T1                                                    12/22/81.250
 4582     76.        CNPL(N,M)=T2                                                   12/22/81.251
 4583     77.  70    CNPH(N,M)=T2                                                   12/22/81.252
 4584     78.  100   IF(NGLOB.EQ.0)GO TO 105                                            CAL.465
 4585     79.        IF(TME-TME4)102,102,103                                            CAL.466
 4586     80.  103   TME3=TME4                                                          CAL.467
 4587     81.        DO 104 I=1,NGLCB                                                   CAL.468
 4588     82.  104   GL4(I)=GL5(I)                                                      CAL.469
 4589     83.        READ(34)TME4,(GL5(I),I=1,NGLCB)                                    CAL.470
 4590     84.  102   DO [illegible] I=1,NGLCB                                           CAL.471
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 4591     89. 100  GL3(I)=GL4(I)+(TME-TME3)*(GL5(I)-GL4(I))/(TME4-TME3)           CAL.472
 4592     86.      IF(IPT)PRINT 5005,TME3,(GL4(I),I=1,NGLCB)                      CAL.473
 4593     87.      IF(IPT)PRINT 5005,TME4,(GL5(I),I=1,NGLCB)                      CAL.474
 4594     88. 5005 FORMAT(* TIME (GG)=*,F8.2,1X,*GLOBAL GRID SALINITY LEVELS*,/,  CAL.475
 4595             1  (5X,10(F6.2,5X),/))                                          CAL.476
 4596     89.      IF(IPT)PRINT 5000,TME,(GL3(I),I=1,NGLCB)                       CAL.477
 4597     90. 5000 FORMAT(*   TIME *,F6.2,1X,*TIME INTR. GLOBAL GRID SALINITY*,/,  CAL.478
 4598             1  (5X,10(F6.2,5X),/))                                          CAL.479
 4599     91.      DO 106 I=1,KTT                                                 CAL.480
 4600     92.      IP=ITIDE(I)                                                    CAL.481
 4601     93.      INDX=IP/1000000                                                CAL.482
 4602     94.      IP=IP-1000000*INDX                                             CAL.483
 4603     95.      N=IP/1000                                                      CAL.484
 4604     96.      M=IP-1000*N                                                    CAL.485
 4605     97.      T1=CN(N,M)                                                     CAL.486
 4606     98.      T2=(1.-FI(I))*GL3(ITG1(I))+FI(I)*GL3(ITG2(I))                  CAL.487
 4607     99.      CFL(N,M)=(T2+T1)*.5                                            CAL.488
 4608    100.      CPH(N,M)=CFL(N,M)                                              CAL.489
 4609    101.      CNPL(N,M)=T2                                                   CAL.490
 4610    102. 106  CNPH(N,M)=T2                                                   CAL.491
 4611    103. 105  DO 4001 M=1,MMAX                                               CAL.492
 4612    104.      IU2(M)=ICU(1,M)/10                                             CONC.50
 4613    105. 4001 IV2(M)=ICV(1,M)/10                                             CONC.51
 4614          C   BEGIN FIRST CYCLE -- LOOP ON N                                 CONC.52
 4615    106.      DO 77 N=2,N1                                                   CONC.53
 4616    107.      TSYY=.5*TSY/YNU(2*N-1)                                         CONC.54
 4617    108.      TSYYM=1./(YNU(2*N-2)*DY)                                 12/22/81.254
 4618    109.      TSYYP=1./(YNU(2*N)*DY)                                   12/22/81.255
 4619    110.      DO 130 M=1,MMAX                                                CONC.61
 4620    111.      IU1(M)=IU2(M)                                                  CONC.62
 4621    112.  130 IV1(M)=IV2(M)                                                  CONC.63
 4622    113.      DO 4002 M=1,MMAX                                               CONC.64
 4623    114.      IU2(M)=ICU(N,M)/10                                             CONC.65
 4624    115. 4002 IV2(M)=ICV(N,M)/10                                             CONC.66
 4625    116.      MG=1                                                           CONC.67
 4626          C   FIND BEGINNING OF COMPUTATIONAL LINE                           CONC.69
 4627    117. 25   DO 110 MZ=MG,MMAX                                        12/22/81.256
 4628    118.      MM=MZ                                                          CONC.74
 4629    119.      L1=IU2(MZ)                                                     CONC.75
 4630    120.      IF(L1.LT.1.OR.L1.GT.9) GO TO 351                               CONC.76
 4631    121.      GO TO(114,114,351,111,114,111,110,113,115),L1                  CONC.77
 4632    122.  114 IF((IV2(MZ).EQ.6).OR.(IV1(MZ).EQ.6)) GO TO 195                 CONC.78
 4633    123.      IF((IV2(MZ).EQ.4).OR.(IV1(MZ).EQ.4)) GO TO 185                 CONC.79
 4634    124.  110 CONTINUE                                                       CONC.80
 4635    125.      GO TO 77                                                       CONC.81
 4636    126.  111 IBF=1                                                          CONC.82
 4637    127.      MS=MM                                                          CONC.83
 4638    128.      GO TO 119                                                      CONC.84
 4639    129.  113 IBF=2                                                    12/22/81.257
 4640    130.      MS=MM+1                                                        CONC.86
 4641    131.      GO TO 119                                                      CONC.87
 4642    132.  115 IBF=3                                                    12/22/81.258
 4643    133.      MS=MM+1                                                        CONC.89
 4644    134.  119 MSS=MS-1                                                       CONC.90
 4645    135.      DO 118 M=1,MMAX                                                CONC.94
 4646    136.      TMP5(M)=0.                                                     CONC.95
 4647    137.  118 TMP6(M)=0.                                                     CONC.96
 4648          C   [illegible] END OF LINE [illegible]                            CONC.[illegible]
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   4649     138.        DO 120 MZ=MS,MMAX                                        CONC.98
   4650     139.        MM=MZ                                                    CONC.99
   4651     140.        L1=IU2(MZ)                                               CONC.100
   4652     141.        IF(L1.LT.1.OR.L1.GT.9) GO TO 351                         CONC.101
   4653     142.        GO TO (121,121,351,124,121,120,120,123,125),L1           12/22/81.259
   4654     143. 124    IQ=ICU(N,MM)-L1*10                                       CONC.104
   4655     144.        TMP5(MZ)=CH(IQ)                                          CONC.105
   4656     145.        TMP6(MZ)=AMAX1((SE(N,MM)+SE(N,MM+1))*.5-ZE(IQ),APSC)     CONC.106
   4657     146.   120  CONTINUE                                                 CONC.107
   4658     147.        PRINT 6000,N,MS,ITIME                                    CONC.108
   4659     148. 6000   FORMAT(*-N MS ITIME *,3I10)                              CONC.109
   4660     149.        STOP                                                     CONC.110
   4661     150.   121  IBL=1                                                    CONC.111
   4662     151.        ME=MM                                                    CONC.112
   4663     152.        GO TO 129                                                CONC.113
   4664     153. 123    IBL=2                                                    12/22/81.260
   4665     154.        ME=MM-1                                                  CONC.115
   4666     155.        GO TO 129                                                CONC.116
   4667     156. 125    IBL=3                                                    12/22/81.261
   4668     157.        ME=MM-1                                                  CONC.118
   4669     158.   129  MEE=ME+1                                                 CONC.119
   4670           C     SET BOUNDARY CONDITION AT BEGINNING                      CONC.123
   4671     159.        GO TO (140,142,142),IBF                                  CONC.124
   4672     160.   140  P(MSS)=0.                                                CONC.125
   4673     161.        Q(MSS)=0.                                                CONC.126
   4674     162.        R(MSS)=1.                                                12/22/81.262
   4675     163.        S(MSS)=0.                                                12/22/81.263
   4676     164.        GO TO 150                                                CONC.127
   4677     165. 142    P(MSS)=0.                                                CONC.128
   4678     166.        Q(MSS)=CPL(N,MSS)                                        12/22/81.264
   4679     167.        R(MSS)=0.                                                12/22/81.265
   4680     168.        S(MSS)=CPR(N,MSS)                                        12/22/81.266
   4681     169. 150    DO 167 M=MSS,ME                                          12/22/81.267
   4682     170.        DI(M)=CVMGN(TMP6(M),.25*(SE(N,M)+SE(N,M+1)+SEP(N,M)+SEP(N,M+1))-.512/22/81.268
   4683                1*(H(N,M)+H(N,M+1)),TMP6(M))                             12/22/81.269
   4684     171.        CBAR=CVMGN(2.*TMP5(M), C(N,M)+C(N,M+1) ,TMP5(M))         12/22/81.270
   4685     172.        T1=UF(N,M)*U(N,M)                                        12/22/81.271
   4686     173.        UT(M)=T1                                                 12/22/81.272
   4687     174. 167    DK(M)=CX(N,M)*ABS(T1)*DI(M)/CBAR+CVMGZ(0.,DKXX(N,M),T1)  12/22/81.273
   4688     175.        DO 160 M=MS,ME                                           CONC.142
   4689     176.        DBAR1=SE(N,M)+SE(N+1,M)-H(N,M)-H(N+1,M)                  CONC.143
   4690     177.        DKY=CY(N,M)*ABS(V(N,M))*DBAR1/(C(N+1,M)+C(N,M))+CVMGZ(0.,DKYY(N,M)12/22/81.274
   4691                1,V(N,M))                                                12/22/81.275
   4692     178.        DBAR2=SE(N,M)+SE(N-1,M)-H(N,M)-H(N-1,M)                  CONC.146
   4693     179.        DKYM=CY(N-1,M)*ABS(V(N-1,M))*DBAR2/(C(N-1,M)+C(N,M))     12/22/81.276
   4694               1+CVMGZ(0.,DKYY(N-1,M),V(N-1,M))                          12/22/81.277
   4695     180.        TSXX=.5*TSX/XMU(2*M-1)                                   CONC.149
   4696     181.        TSXXM=1./(XMU(2*M-2)*DX)                                 12/22/81.278
   4697     182.        TSXXP=1./(XMU(2*M)*DX)                                   12/22/81.279
   4698     183.        C1=.5*UT(M-1)                                            12/22/81.280
   4699     184.        C2=.5*UT(M)                                              12/22/81.281
   4700     185.        V1=AMAX1(0.,C1)                                          12/22/81.282
   4701     186.        V2=AMIN1(0.,C2)                                          12/22/81.283
   4702     187.        V3=AMIN1(0.,C1)                                          12/22/81.284
   4703     188.        V4=AMAX1(0.,C2)                                          12/22/81.285
   4704     189.        C1=2.*CVMGP(CN(N,M),CN(N+1,M),V(N,M))                    12/22/81.286
   4705     190.        C2=2.*CVMGP(CN(N-1,M),CN(N,M),V(N-1,M))                  12/22/81.287
   4706     191.        TP1=-TSXX*DI(M-1)[illegible]                             12/22/81.288
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  4707    192.        TP2=DK(M-1)*TSXXM                                12/22/81.289
  4708    193.        TP3=TSXX*D1(M)                                   12/22/81.290
  4709    194.        TP4=DK(M)*TSYXP                                  12/22/81.291
  4710    195.        TP5=.5*(SE(N,M)+SEP(N,M))-F(N,M)                 12/22/81.292
  4711    196.        TP6=(SE(N,M)-H(N,M))*CN(N,M)                     12/22/81.293
  4712    197.        TP7=2.*DKY*(CN(N+1,M)-CN(N,M))*TSYYP             12/22/81.294
  4713    198.        TP8=2.*DKYM*(CN(N,M)-CN(N-1,M))*TSYYP            12/22/81.295
  4714    199.        AML(M)=TP1*(V1+TP2)                              12/22/81.296
  4715    200.        APL(M)=TP3*(V2-TP4)                              12/22/81.297
  4716    201.        AL(M)=TP5+TSXX*(D1(M)*(V4+TP4)-D1(M-1)*(V3-TP2)) 12/22/81.298
  4717    202.        BL(M)=TP6-.25*TSYY*(DBAR1*(C1*V(N,M)-TP7)        12/22/81.299
  4718              1   -DBAR2*(C2*V(N-1,M)-TP8))                    12/22/81.300
  4719    203.        V1=.25*DT(M-1)                                   12/22/81.301
  4720    204.        V2=.25*DT(M)                                     12/22/81.302
  4721    205.        C1=CN(N+1,M)+CN(N,M)                             12/22/81.303
  4722    206.        C2=CN(N-1,M)+CN(N,M)                             12/22/81.304
  4723    207.        AMM(M)=TP1*(V1+TP2)                              12/22/81.305
  4724    208.        APM(M)=TP3*(V2-TP4)                              12/22/81.306
  4725    209.        AM(M)=TP5+TSXX*(D1(M)*(V2+TP4)-D1(M-1)*(V1-TP2)) 12/22/81.307
  4726    210. 160    BM(M)=TP6-.25*TSYY*(DBAR1*(C1*V(N,M)-TP7)-DBAR2*(C2*V(N-1,M)-TP8))12/22/81.308
  4727    211.        DO 4160 M=MS,ME                                      CONC.196
  4728    212.        C1=1./(AL(M)-APL(M)*P(M-1))                      12/22/81.309
  4729    213.        P(M)=APL(M)*C1                                   12/22/81.310
  4730    214.        Q(M)=(BL(M)-AML(M)*Q(M-1))*C1                    12/22/81.311
  4731    215.        C2=1./(AM(M)-AMM(M)*R(M-1))                      12/22/81.312
  4732    216.        R(M)=APM(M)*C2                                   12/22/81.313
  4733    217. 4160   S(M)=(BM(M)-AMM(M)*S(M-1))*C2                    12/22/81.314
  4734         C   BOUNDARY CONDITION AT UPPER END                       CONC.203
  4735    218.        GO TO (170,180,180),IBL                          12/22/81.315
  4736    219. 170    CPL(N,ME)=0.                                     12/22/81.316
  4737    220.        CPM(N,ME)=0.                                     12/22/81.317
  4738    221. 180    DO 181 J=MS,ME                                   12/22/81.318
  4739    222.        M=ME+MS-J                                        12/22/81.319
  4740    223.        CPL(N,M)=-P(M)*CPL(N,M+1)+Q(M)                   12/22/81.320
  4741    224. 181    CPM(N,M)=-R(M)*CPM(N,M+1)+S(M)                   12/22/81.321
  4742    225.        MO=MFE                                           12/22/81.322
  4743    226.        GO TO 186                                        12/22/81.323
  4744         C   COMPUTATIONAL LINE DEGENERATES TO A SINGLE CELL       CONC.210
  4745    227. 185    DBAR1=SE(N,MM)+SE(N+1,MM)-F(N,MM)-F(N+1,MM)      12/22/81.324
  4746    228.        DKY=CY(N,MM)*ABS(V(N,MM))*DBAR1/(C(N+1,MM)+C(N,MM))  12/22/81.325
  4747              1   +CVMGZ(0.,DKYY(N,MM),V(N,MM))                     CAL.493
  4748    229.        DBAR2=SE(N,MM)+SE(N-1,MM)-F(N,MM)-F(N-1,MM)          CONC.216
  4749    230.        DKYM=CY(N-1,MM)*ABS(V(N-1,MM))*DBAR2/(C(N-1,MM)+C(N,MM))  12/22/81.327
  4750              1   +CVMGZ(0.,DKYY(N-1,MM),V(N-1,MM))            12/22/81.328
  4751    231.        TP5=1./(.5*(SE(N,MM)+SEP(N,MM))-F(N,MM))         12/22/81.329
  4752    232.        TP6=(SE(N,MM)-H(N,MM))*CN(N,MM)                  12/22/81.330
  4753    233.        TP7=2.*DKY*(CN(N+1,MM)-CN(N,MM))*TSYYP           12/22/81.331
  4754    234.        TP8=2.*DKYM*(CN(N,MM)-CN(N-1,MM))*TSYYP          12/22/81.332
  4755    235.        C1=2.*CVMGP(CN(N,MM),CN(N+1,MM),V(N,MM))         12/22/81.333
  4756    236.        C2=2.*CVMGP(CN(N-1,MM),CN(N,MM),V(N-1,MM))       12/22/81.334
  4757    237.        CPL(N,MM)=(TP6-.25*TSYY*(DBAR1*(C1*V(N,MM)-TP7)  12/22/81.335
  4758              1   -DBAR2*(C2*V(N-1,MM)-TP8)))*TP5              12/22/81.336
  4759    238.        C1=CN(N+1,MM)+CN(N,MM)                           12/22/81.337
  4760    239.        C2=CN(N-1,MM)+CN(N,MM)                           12/22/81.338
  4761    240.        CPM(N,MM)=(TP6-.25*TSYY*(DBAR1*(C1*V(N,MM)-TP7)  12/22/81.339
  4762              1   -DBAR2*((C2*V(N-1,MM)-TP8)))*TP5             12/22/81.340
  4763    241.        MO=MM+1                                              CONC.248
  4764    242. 186    IF(MO.LT.MMAX) GO TO 25                              CONC.250
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CONC     FAGE 6                 CN=ALLPPGRSV2                 06/20/83  NX=V  09:11:41      CFT 105F(04/14/83)  PAGE 7

  4765    243.      77 CONTINUE                                                             CONC.255
  4766    244.         DO 4003 N=1,NMAX                                                12/22/81.341
  4767    245.         IU2(N)=ICU(N,1)/10                                                   CONC.292
  4768    246.    4003 IV2(N)=ICV(N,1)/10                                                   CONC.293
  4769          C    BEGIN SECOND CYCLE ---LOOP ON M                                        CONC.294
  4770    247.         DO 68 M=2,M1                                                         CONC.295
  4771    248.         TSXA=.5*TSX/XMU(2*M-1)                                               CONC.296
  4772    249.         TSXXM=1./(XMU(2*M-2)*DX)                                        12/22/81.342
  4773    250.         TSXXP=1./(XMU(2*M)*DX)                                          12/22/81.343
  4774    251.         DO 230 N=1,NMAX                                                      CONC.303
  4775    252.         IU1(N)=IU2(N)                                                        CONC.304
  4776    253.     230 IV1(N)=IV2(N)                                                        CONC.305
  4777    254.         DO 4004 N=1,NMAX                                                     CONC.306
  4778    255.         IU2(N)=ICU(N,M)/10                                                   CONC.307
  4779    256.    4004 IV2(N)=ICV(N,M)/10                                                   CONC.308
  4780    257.         NO=1                                                                 CONC.309
  4781          C    FIND BEGINNING OF COMPUTATIONAL LINE                                   CONC.311
  4782    258.  35     DO 210 NZ=NO,NMAX                                               12/22/81.344
  4783    259.         NN=NZ                                                                CONC.316
  4784    260.         L1=IV2(NZ)                                                           CONC.317
  4785    261.         IF(L1.LT.1.OR.L1.GT.9) GO TO 351                                     CONC.318
  4786    262.         GO TO (214,214,391,211,214,211,210,213,215),L1                       CONC.319
  4787    263.     214 IF((IU2(NZ).EQ.6).OR.(IU1(NZ).EQ.6)) GO TO 285                       CONC.320
  4788    264.         IF((IU2(NZ).EQ.4).OR.(IU1(NZ).EQ.4)) GO TO 285                       CONC.321
  4789    265.     210 CONTINUE                                                             CONC.322
  4790    266.         GO TO 68                                                             CONC.323
  4791    267.     211 IBF=1                                                                CONC.324
  4792    268.         NS=NN                                                                CONC.325
  4793    269.         GO TO 219                                                            CONC.326
  4794    270.  213    IBF=2                                                           12/22/81.345
  4795    271.         NS=NN+1                                                              CONC.328
  4796    272.         GO TO 219                                                            CONC.329
  4797    273.  215    IBF=3                                                           12/22/81.346
  4798    274.         NS=NN+1                                                              CONC.331
  4799    275.     219 NSS=NS-1                                                             CONC.332
  4800    276.         DO 218 N=1,NMAX                                                      CONC.336
  4801    277.         TMP5(N)=0.                                                           CONC.337
  4802    278.     218 TMP6(N)=0.                                                           CONC.338
  4803          C    FIND END OF LINE                                                       CONC.339
  4804    279.         DO 220 NZ=NS,NMAX                                                    CONC.340
  4805    280.         NN=NZ                                                                CONC.341
  4806    281.         L1=IV2(NZ)                                                           CONC.342
  4807    282.         IF(L1.LT.1.OR.L1.GT.9) GO TO 351                                     CONC.343
  4808    283.         GO TO (221,221,391,224,221,220,220,223,225),L1                  12/22/81.347
  4809    284.  224    IQ=ICV(NN,M)-L1*10                                                   CONC.346
  4810    285.         TMP5(NZ)=CB(IQ)                                                      CONC.347
  4811    286.         TMP6(NZ)=AMAX1((SE(NN,M)+SE(NN+1,M))*.5-ZB(IQ),APSD)                 CONC.348
  4812    287.     220 CONTINUE                                                             CONC.349
  4813    288.         PRINT 6001,M,NS,ITIME                                                CONC.350
  4814    289.  6001   FORMAT(' M NS ITIME ',3I10)                                          CONC.351
  4815    290.         STOP                                                                 CONC.352
  4816    291.     221 IBL=1                                                                CONC.353
  4817    292.         NE=NN                                                                CONC.354
  4818    293.         GO TO 229                                                            CONC.355
  4819    294.  223    IBL=2                                                           12/22/81.348
  4820    295.         NE=NN-1                                                              CONC.357
  4821    296.         GO TO 229                                                            CONC.358
  4822    297.     225 IBL=3                                                           12/22/81.349
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  4823    298.          NE=NN-1                                                                 CCNC.360
  4824    299.     225  NEE=NE+1                                                                CCNC.361
  4825            C     SET BOUNDARY CONDITION AT BEGINNING                                     CCNC.365
  4826    300.          GO TO(240,242,242),IBF                                                  CCNC.366
  4827    301.     240  P(NSS)=0.                                                               CCNC.367
  4828    302.          Q(NSS)=0.                                                               CCNC.368
  4829    303.          R(NSS)=0.                                                           12/22/81.350
  4830    304.          S(NSS)=0.                                                           12/22/81.351
  4831    305.          GO TO 250                                                               CCNC.369
  4832    306.     242  P(NSS)=0.                                                               CCNC.370
  4833    307.          Q(NSS)=CNPL(NSS,M)                                                  12/22/81.352
  4834    308.          R(NSS)=0.                                                           12/22/81.353
  4835    309.          S(NSS)=CNFF(NSS,M)                                                  12/22/81.354
  4836    310.     250  DO 267 N=NSS,NE                                                     12/22/81.355
  4837    311.          D1(N)=CVMGN(TMF6(N),.5*(SLP(N+1,M)+SLP(N,M)-H(N,M)-H(N+1,M)),      12/22/81.356
  4838                 1TMP6(N))                                                            12/22/81.357
  4839    312.          CBAR=CVMGN(TMP5(N),.5*(C(N+1,M)+C(N,M)),TMP5(N))                    12/22/81.358
  4840    313.     267  DK(N)=CY(N,M)*ABS(VP(N,M))*L1(N)/CEAN+CVMGZ(0.,DKYY(N,M),VP(N,M)) 12/22/81.359
  4841    314.          DO 270 N=NS,NE                                                          CCNC.384
  4842    315.          DBAR1=.25*(SL(N,M)+SL(N,M+1)+SLP(N,M)+SLP(N,M+1))-.5*(H(N,M)+          CCNC.385
  4843                 1H(N,M+1))                                                               CCNC.386
  4844    316.          T1=UP(N,M)+U(N,M)                                                   12/22/81.360
  4845    317.          DKX=CX(N,M)*ABS(T1)*DBAR1/(C(N,M)+C(N,M+1))                         12/22/81.361
  4846               1   +CVMGZ(0.,DKXX(N,M),T1)                                            12/22/81.362
  4847    318.          DBAR2=.25*(SL(N,M)+SL(N,M-1)+SLP(N,M)+SLP(N,M-1))-.5*(H(N,M)           CCNC.389
  4848                 1+H(N,M-1))                                                              CCNC.390
  4849    319.          T2=UP(N,M-1)+U(N,M-1)                                               12/22/81.363
  4850    320.          DKXM=CX(N,M-1)*ABS(T2)*DBAR2/(C(N,M)+C(N,M-1))                      12/22/81.364
  4851               1   +CVMGZ(0.,DKXX(N,M-1),T2)                                          12/22/81.365
  4852    321.          TSYY=.5*TSY/YNL(2*N-1)                                                  CCNC.395
  4853    322.          TSYYM=1./(YNL(2*N-2)*DY)                                            12/22/81.366
  4854    323.          TSYYP=1./(YNL(2*N)*DY)                                              12/22/81.367
  4855    324.          V1=AMAX1(0.,VP(N-1,M))                                              12/22/81.368
  4856    325.          V2=AMIN1(0.,VP(N,M))                                                12/22/81.369
  4857    326.          V3=AMIN1(0.,VP(N-1,M))                                              12/22/81.370
  4858    327.          V4=AMAX1(0.,VP(N,M))                                                12/22/81.371
  4859    328.          C1=2.*CVMGF(CFL(N,M),CFL(N,M+1),T1)                                 12/22/81.372
  4860    329.          C2=2.*CVMGF(CFL(N,M-1),CFL(N,M),T2)                                 12/22/81.373
  4861    330.          TP1=-TSYY*D1(N-1)                                                   12/22/81.374
  4862    331.          TP2=DK(N-1)*TSYYM                                                   12/22/81.375
  4863    332.          TP3=TSYY*D1(N)                                                      12/22/81.376
  4864    333.          TP4=DK(N)*TSYYP                                                     12/22/81.377
  4865    334.          TP5=SLP(N,M)-H(N,M)                                                 12/22/81.378
  4866    335.          TP6=.5*(SLP(N,M)+SL(N,M))-H(N,M)                                    12/22/81.379
  4867    336.          TP7=4.*DKX*TSXXP                                                    12/22/81.380
  4868    337.          TP8=4.*DKXM*TSXXM                                                   12/22/81.381
  4869    338.          AML(N)=TP1*(V1+TP2)                                                 12/22/81.382
  4870    339.          APL(N)=TP3*(V2-TP4)                                                 12/22/81.383
  4871    340.          AL(N)=TP5+TSYY*(D1(N)*(V4+TP4)-D1(N-1)*(V3-TP2))                    12/22/81.384
  4872    341.          BL(N)=TP6*CPL(N,M)-.25*TSXX*(DBAR1*(C1*T1-TP7*(CPL(N,M+1)-          12/22/81.385
  4873               1   CPL(N,M)))-DBAR2*(C2*T2-TP8*(CPL(N,M)-CPL(N,M-1))))                12/22/81.386
  4874    342.          V1=.5*VP(N-1,M)                                                     12/22/81.387
  4875    343.          V2=.5*VP(N,M)                                                       12/22/81.388
  4876    344.          C1=CFH(N,M)+CFH(N,M+1)                                              12/22/81.389
  4877    345.          C2=CFH(N,M)+CFH(N,M-1)                                              12/22/81.390
  4878    346.          AMH(N)=TP1*(V1+TP2)                                                 12/22/81.391
  4879    347.          APH(N)=TP3*(V2-TP4)                                                 12/22/81.392
  4880    348.          AH(N)=TP5+TSYY*(D1(N)*(V2+TP4)-D1(N-1)*(V1-TP2))                    12/22/81.393
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  4881     349. 260   BH(N)=TF6*CFH(N,M)-.25*TSXA*(DBAR1*(C1*T1-TF7*(CFH(N,M+1)-   12/22/81.394
  4882              1  CPH(N,M)))-DBAR2*(C2*T2-TF8*(CFH(N,M)-CFH(N,M-1))))           12/22/81.395
  4883     350.       DO 2160 N=NS,NE                                                     CONC.446
  4884     351.       C1=1./(AL(N)-APL(N)*P(N-1))                                      12/22/81.396
  4885     352.       P(N)=APL(N)*C1                                                   12/22/81.397
  4886     353.       Q(N)=(BL(N)-APL(N)*Q(N-1))*C1                                    12/22/81.398
  4887     354.       C2=1./(AH(N)-APH(N)*R(N-1))                                      12/22/81.399
  4888     355.       R(N)=APH(N)*C2                                                        CAL.494
  4889     356. 2160  S(N)=(BH(N)-APH(N)*S(N-1))*C2                                         CAL.495
  4890          C ..BOUNDARY CONDITIONS AT UPPER END                                     CONC.453
  4891     357.       GO TO (270,280,260),IBL                                          12/22/81.402
  4892     358. 270   CNPH(NEL,M)=0.                                                   12/22/81.403
  4893     359.       CNPL(NEL,M)=0.                                                   12/22/81.404
  4894     360. 280   DO 281 J=NS,NE                                                   12/22/81.405
  4895     361.       N=NE+NS-J                                                        12/22/81.406
  4896     362.       CNPL(N,M)=-P(N)*CNPL(N+1,M)+Q(N)                                 12/22/81.407
  4897     363. 281   CNPH(N,M)=-R(N)*CNPH(N+1,M)+S(N)                                 12/22/81.408
  4898     364.       NC=NEE                                                           12/22/81.409
  4899     365.       GO TO 286                                                        12/22/81.410
  4900          C   COMPUTATIONAL LINE DEGENERATES TO A SINGLE CELL                         CONC.459
  4901     366. 285   DBAR1=.25*(SEP(NN,M)+SEP(NN,M+1)+SE(NN,M)+SE(NN,M+1))-.5*(H(NN,M) 12/22/81.411
  4902              1+H(NN,M+1))                                                          CONC.463
  4903     367.       T1=UP(NN,M)+U(NN,M)                                              12/22/81.412
  4904     368.       DPX=CX(NN,M)*ABS(T1)*DBAR1/(C(NN,M+1)+C(NN,M))                   12/22/81.413
  4905              1  +CVMGZ(0.,DKX)(NN,M),T1)                                        12/22/81.414
  4906     369.       DBAR2=.25*(SEP(NN,M)+SEP(NN,M-1)+SE(NN,M)+SE(NN,M-1))-.5*(H(NN,M)+  CONC.466
  4907              1H(NN,M-1))                                                           CONC.467
  4908     370.       T2=UP(NN,M-1)+U(NN,M-1)                                          12/22/81.415
  4909     371.       DKXM=CX(NN,M-1)*ABS(T2)*DBAR2/(C(NN,M-1)+C(NN,M))                12/22/81.416
  4910              1  +CVMGZ(0.,DKXX(NN,M-1),T2)                                      12/22/81.417
  4911     372.       TP5=1./(SEP(NN,M)-H(NN,M))                                       12/22/81.418
  4912     373.       TP6=.5*(SEP(NN,M)+SE(NN,M))-H(NN,M)                              12/22/81.419
  4913     374.       TP7=4.*DKX*TSXXP                                                 12/22/81.420
  4914     375.       TP8=4.*DKXM*TSXXM                                                12/22/81.421
  4915     376.       C1=2.*CVMGP(CPL(NN,M),CPL(NN,M+1),T1)                            12/22/81.422
  4916     377.       C2=2.*CVMGP(CPL(NN,M-1),CPL(NN,M),T2)                            12/22/81.423
  4917     378.       CNPL(NN,M)=(TP6*CPL(NN,M)-.25*TSXX*(DBAR1*(C1*T1-TP7*            12/22/81.424
  4918              1  (CPL(NN,M+1)-CPL(NN,M)))-DBAR2*(C2*T2-TP8*                      12/22/81.425
  4919              2  (CPL(NN,M)-CPL(NN,M-1)))))*TP5                                  12/22/81.426
  4920     379.       C1=CPH(NN,M+1)+CPH(NN,M)                                         12/22/81.427
  4921     380.       C2=CPH(NN,M)+CPH(NN,M-1)                                         12/22/81.428
  4922     381.       CNPH(NN,M)=(TP6*CPH(NN,M)-.25*TSXX*(DBAR1*(C1*T1-TP7*            12/22/81.429
  4923              1  (CPH(NN,M+1)-CPH(NN,M)))-DBAR2*(C2*T2-TP8*                      12/22/81.430
  4924              1  (CPH(NN,M)-CPH(NN,M-1)))))*TP5                                  12/22/81.431
  4925     382.       NC=NN+1                                                          12/22/81.432
  4926     383. 286   IF(NC.LT.MMAX)GO TO 35                                                CONC.515
  4927     384.  88   CONTINUE                                                              CONC.516
  4928     385.       IF(ITIPL.GE.IDEBUG)CALL DEBUG(1)                                      CAL.496
  4929     386.       DO 1 M=1,M1                                                           CAL.497
  4930     387.       DO 1 N=1,N1                                                           CAL.498
  4931     388.       IF(C(N,M))1,1,2                                                       FCT.28
  4932     389. 2     DP1=.5*(SEP(N,M)+SE(N,M))-H(N,M)                                      FCT.29
  4933     390.       DP2=.5*(SEP(N+1,M)+SE(N+1,M))-H(N+1,M)                                FCT.30
  4934     391.       VLL=(VP(N,M)+V(N,M))/2.                                               FCT.31
  4935     392.       V1=VLL*TAU*XPL(L+M-1)*DX                                              FCT.32
  4936     393.       C1=(CNPH(N+1,M)+CN(N+1,M)+CNPH(N,M)+CN(N,M))*.25                      FCT.33
  4937              1  -CVMGP((CNPL(N,M)+CN(N,M))/2.,(CNPL(N+1,M)+CN(N+1,M))/2.,VLL)      FCT.34
  4938     394.       FLUY(N,M)=V1*(DP1+DP2)*C1*.5                                          FCT.35
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 4939    395.      DISP=CY(N,M)*ABS(VEL)*(DP1+DP2)/(C(N+1,M)+C(N,M))                    FCT.36
 4940             1  +CVMGZ(C.,DKYY(N,M),VEL)                                           FCT.37
 4941    396.      FLUY(N,M)=FLUY(N,M)-TAU*XML(2*M-1)*DX*DISP*(DP1+DP2)*                FCT.38
 4942             1  (CNPH(N+1,M)+CNPL(N,M)-CNPH(N,M)-CNPL(N+1,M))/(4.*YNL(2*N)*DY)     FCT.39
 4943    397.      DP2=.5*(SEP(N,M+1)+SE(N,M+1))-F(N,M+1)                               FCT.40
 4944    398.      VEL=(UF(N,M)+U(N,M))/2.                                              FCT.41
 4945    399.      V1=VEL*TAU*YML(2*N-1)*DY                                             FCT.42
 4946    400.      C1=(CNPH(N,M+1)+CN(N,M+1)+CNPH(N,M)+CN(N,M))*.25                     FCT.43
 4947             1  -CVMGP((CNPL(N,M)+CN(N,M))/2.,(CNPL(N,M+1)+CN(N,M+1))/2.,VEL)      FCT.44
 4948    401.      FLUX(N,M)=V1*(DP1+DP2)*C1*.5                                         FCT.45
 4949    402.      DISP=CX(N,M)*ABS(VEL)*(DP1+DP2)/(C(N,M+1)+C(N,M))                    FCT.46
 4950             1  +CVMGZ(0.,DKXX(N,M),VEL)                                           FCT.47
 4951    403.      FLUX(N,M)=FLUX(N,M)-TAU*YML(2*N-1)*DY*DISP*(DP1+DP2)*                FCT.48
 4952             1  (CNPH(N,M+1)+CNPL(N,M)-CNPH(N,M)-CNPL(N,M+1))/(4.*XML(2*M)*DX)     FCT.49
 4953    404. 1    CONTINUE                                                             FCT.71
 4954          C      SET ANTI-DIFFUSIVE FLUXES TO ZERO ON BOUNDARIES             12/22/81.433
 4955    405.      NB(1)=KLV                                                      12/22/81.434
 4956    406.      NB(2)=KIT                                                      12/22/81.435
 4957    407.      DO 40 J=1,2                                                    12/22/81.436
 4958    408.      IF(NB(J))40,40,41                                              12/22/81.437
 4959    409. 41   DO 3 I=1,NB(J)                                                 12/22/81.438
 4960    410.      IF(J-1)15,16,15                                                12/22/81.439
 4961    411. 16   IP=IFLOW(I)                                                    12/22/81.440
 4962    412.      GO TO 17                                                       12/22/81.441
 4963    413. 15   IP=ITIDE(I)                                                    12/22/81.442
 4964    414. 17   INDX=IP/1000000                                                12/22/81.443
 4965    415.      IP=IP-1000000*INDX                                             12/22/81.444
 4966    416.      N=IP/1000                                                      12/22/81.445
 4967    417.      M=IP-1000*N                                                    12/22/81.446
 4968    418.      I4=INDX/100                                                    12/22/81.447
 4969    419.      IF=INDX-100*I4                                                 12/22/81.448
 4970    420.      IDIR=IF/10                                                     12/22/81.449
 4971    421.      IF(IDIR-1)4,55,4                                               12/22/81.450
 4972    422. 55   FLUX(N,M-I4)=0.                                                12/22/81.451
 4973    423.      GO TO 3                                                        12/22/81.452
 4974    424. 4    FLUY(N-I4,M)=0.                                                12/22/81.453
 4975    425. 3    CONTINUE                                                       12/22/81.454
 4976    426. 40   CONTINUE                                                       12/22/81.455
 4977          C      COMPUTE UPDATED FLUX CORRECTED SOLUTION                           FCT.72
 4978    427.      DO 5 M=2,M1                                                          CAL.499
 4979    428.      DO 5 N=2,N1                                                          CAL.500
 4980    429.      RM(N,M)=0.                                                           CAL.501
 4981    430.      RP(N,M)=0.                                                           CAL.502
 4982    431.      IF(C(N,M))5,5,12                                                     CAL.503
 4983    432. 12   IF(ICU(N,M) /10.EQ.7)GO TO 5                                         CAL.504
 4984    433.      IF(ICV(N,M)/10.EQ.7)GO TO 5                                          CAL.505
 4985    434.      C0=CN(N,M)                                                           CAL.506
 4986    435.      ML1=M-1                                                              CAL.507
 4987    436.      MU1=M+1                                                              CAL.508
 4988    437.      NU1=N+1                                                              CAL.509
 4989    438.      NL1=N-1                                                              CAL.510
 4990    439.      C1=CVMGT( CN(N,M),  CN(N,ML1),C(N,ML1).LE.0..OR.ICU(N,ML1)/10.EQ.    CAL.511
 4991            1 1)                                                                   CAL.512
 4992    440.      C2=CVMGT(  CN(N,M),  CN(N,MU1),C(N,MU1).LE.0..OR.ICU(N,M)/10.EQ.1)   CAL.513
 4993    441.      C3=CVMGT(  CN(N,M),  CN(NL1,M),C(NL1,M).LE.0..OR.ICV(NL1,M)/10.EQ.   CAL.514
 4994            1 1)                                                                   CAL.515
 4995    442.      C4=CVMGT(  CN(N,M),  CN(NU1,M),C(NU1,M).LE.0..OR.ICV(N,M)/10.EQ.1)   CAL.516
 4996    443.      VMA =AMAX1(C0,C1,C2,C3,C4)                                           CAL.517
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  4997    444.         WMI =AMIN1(C0,C1,C2,C3,C4)                                          CAL.518
  4998    445.         C0=CNPL(N,M)                                                        CAL.519
  4999    446.         C1=CVMGT(CNPL(N,M),CNPL(N,ML1),C(N,ML1).LE.0..OR.ICU(N,ML1)/10.EQ.  CAL.520
  5000                1 1)                                                                 CAL.521
  5001    447.         C2=CVMGT(CNPL(N,M),CNPL(N,MU1),C(N,ML1).LE.0..OR.ICU(N,M)/10.EQ.1)  CAL.522
  5002    448.         C3=CVMGT(CNPL(N,M),CNPL(NL1,M),C(NL1,M).LE.0..OR.ICV(NL1,M)/10.EQ.  CAL.523
  5003                1 1)                                                                 CAL.524
  5004    449.         C4=CVMGT(CNPL(N,M),CNPL(NL1,M),C(NL1,M).LE.0..OR.ICV(N,M)/10.EQ.1)  CAL.525
  5005    450.         WMAX=AMAX1(C0,C1,C2,C3,C4,WMA)                                      CAL.526
  5006    451.         WMIN=AMIN1(C0,C1,C2,C3,C4,WMI)                                      CAL.527
  5007    452.         VOL=DX*DY*XMU(2*M-1)*YNU(2*N-1)*(SEP(N,M)-F(N,M))                   FCT.97
  5008    453.         PP=AMAX1(0.,FLUY(N,M-1))-AMIN1(0.,FLUX(N,M))                    12/22/81.456
  5009                1  +AMAX1(0.,FLUY(N-1,M))-AMIN1(0.,FLUY(N,M))                        FCT.99
  5010    454.         IF(PP)8,6,7                                                         CAL.528
  5011    455.  7      QQ=(WMAX-C0)*VOL                                                    CAL.529
  5012    456.         RP(N,M)=AMIN1(1.,QQ/PP)                                             CAL.530
  5013    457.  6      PP=AMAX1(0.,FLUX(N,M))-AMIN1(0.,FLUX(N,M-1))                        CAL.531
  5014                1  +AMAX1(0.,FLUY(N,M))-AMIN1(0.,FLUY(N-1,M))                        FCT.106
  5015    458.         IF(PP)5,5,8                                                         CAL.532
  5016    459.  8      QQ=(C0-WMIN)*VOL                                                    CAL.533
  5017    460.         RM(N,M)=AMIN1(1.,QQ/PP)                                             CAL.534
  5018    461.  5      CONTINUE                                                            CAL.535
  5019    462.         DO 10 M=2,M1                                                        CAL.536
  5020    463.         DO 10 N=2,N1                                                        CAL.537
  5021    464.         IF(C(N,M))10,10,13                                                  CAL.538
  5022    465.  13     IF(ICU(N,M)/10.EQ.7)GO TO 10                                        CAL.539
  5023    466.         IF(ICV(N,M)/10.EQ.7)GO TO 10                                        CAL.540
  5024    467.         CXU=CVMGP(AMIN1(RP(N,M+1),RM(N,M)),AMIN1(RM(N,M+1),RP(N,M)),        CAL.541
  5025                1  FLUX(N,M))                                                        CAL.542
  5026    468.         CXL=CVMGP(AMIN1(RP(N,M),RM(N,M-1)),AMIN1(RM(N,M),RP(N,M-1)),        CAL.543
  5027                1  FLUX(N,M-1))                                                      CAL.544
  5028    469.         CYU=CVMGP(AMIN1(RP(N+1,M),RM(N,M)),AMIN1(RM(N+1,M),RP(N,M)),        CAL.545
  5029                1  FLUY(N,M))                                                        CAL.546
  5030    470.         CYL=CVMGP(AMIN1(RP(N,M),RM(N-1,M)),AMIN1(RM(N,M),RP(N-1,M)),        CAL.547
  5031                1  FLUY(N-1,M))                                                      CAL.548
  5032    471.         DENOM=DX*DY*XMU(2*M-1)*YNU(2*N-1)*(SEP(N,M)-F(N,M))                 FCT.118
  5033    472.         CNPM(N,M)=CNPL(N,M)-(CXU*FLUX(N,M)-CXL*FLUX(N,M-1)                  FCT.121
  5034                1  +CYU*FLUY(N,M)-CYL*FLUY(N-1,M))/DENOM                             FCT.122
  5035    473.  10     CONTINUE                                                            CAL.549
  5036    474.         IF(ITIME.GE.IDEBUG)CALL DEBUG(2)                                    CAL.550
  5037    475.         RETURN                                                              FCT.126
  5038    476.  351    PRINT 352,L1,ITIME,MM,NN,M,N                                    12/22/81.463
  5039    477.  352    FORMAT(/5X,'FLAG ARRAY PROBLEM',/,10X,6I10/1H1)                 12/22/81.464
  5040    478.         CALL PRCRID(C,NMAX,MMAX,2,1.)                                   12/22/81.465
  5041    479.         STOP                                                            12/22/81.466
  5042    480.         END                                                                 FCT.127
CONC                VECTOR LOOP BEGINS AT SEQ. NO.      81, P=     426D
CONC                VECTOR LOOP BEGINS AT SEQ. NO.      84, P=     457C

   AT SEQUENCE NUMBER -     95.
PRNAME CONC     COMMENT -    DEPENDENCY INVOLVING ARRAY BCPLB IN SEQUENCE NUMBER 100 ****************************** PR0010027D
CONC                VECTOR LOOP BEGINS AT SEQ. NO.     103, P=     601C
CONC                VECTOR LOOP BEGINS AT SEQ. NO.     110, P=     626D
CONC                VECTOR LOOP BEGINS AT SEQ. NO.     113, P=     654A
CONC                VECTOR LOOP BEGINS AT SEQ. NO.     135, P=     744A
CONC                VECTOR LOOP BEGINS AT SEQ. NO.     165, P=    1060B
CONC                VECTOR LOOP BEGINS AT SEQ. NO.     175, P=    1131D
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5043    1.    SUBROUTINE CCFCL                                                  CAL.551
5044    2.    PARAMETER (NUMPT=1272,NCIP=45,MCIP=22,NFPTS=1)                    CAL.5
5045    3.    PARAMETER (IFRC=605,IDXS=20,IFUT=1,ITCS=40,JPUT=7205,JFLS=2)      CAL.6
5046    4.    LOGICAL ITAPE,IFT,IDUMP                                           SCALAR.2
5047    5.    COMMON /V1/ NMAX,MMAX,NTID,NFLC,ITID,JTID,INITL,NP1,NP2,NP3,NPR,  SCALAR.3
5048          1 MPR,MAXTIP,NTAP,IDELAY,IFLCT,NCALF,N1,M1,NX1,MX1,ISTEP,KK,     SCALAR.4
5049          2 ITAPE,IP1,IPP,NPREG,IRECK,IXPAN,NPX,PSURF,NXX,NYY,NZP,NDTAP,    SCALAR.5
5050          3  JPO,NREST,KS1,KS2,KS3,KS4,KS5,KS6,NNPCT,MSKP,MDLY,ITAPE,IFT,  2/2/81.1
5051          4 IDUMP,INC,KBT,KFT,KTT,ITYP,INDX,ICIR,KUV,KTRANS,NBG,MBG,KSB    SCALAR.7
5052          5 ,IRESTR,NCCAT,IOVER,IFLVL,KL,INFT,NSTP,NTSW,NWAT,KAC,PLIM      SCALAR.8
5053          6 ,NS2,MS2,LEVEL,NDX,N2D,ACCWAT,IVPLCT,ICPLCT,IPOT,ISLRE,NTABLE, SCALAR.9
5054          7 IFCRD,ACHAN,MCG,ITRM,IGLCF,KCF,NDAX                             SCALAR.10
5055          8  ,NCON                                                        12/22/81.1
5056    6.    COMMON /V2/ TAU,LT,DX,DY,DX2,DY2,G,G2,ALAT,X1,WA,THETA,EPSD,      SCALAR.11
5057          1 EPSD2,EPSD3,EPSD4,EPSDE,CCCKI,FCTA,SIXTH,FI,PI180,TSX,TSY,     SCALAR.12
5058          2 ADV,VIS,DMPX,DMAXG,SINIT,APSU,TPRC,TPE,                        SCALAR.13
5059          3 XLAND,XSCCUM,SMAX,TZ1,TAUX,TAUY,FF,DXP,DYP,ZN1,ZN2             SCALAR.14
5060          4 ,XU,YU,XU1,YU1,DCCN2,WATERR,DLIMIT                             SCALAR.15
5061          5 ,GTSX,GTSY,EGT,EGT2,FF2,GCLX,GCCY,C2T,CT,XI2                   SCALAR.16
5062          6  ,FXS,FYS,FATPS,TSAL,ICALS,ISALC,CMAX,XMS,IFETR                  CAL.1
5063    7.    COMMON /AA1/ SEP(NUMPT),SE(NUMPT),SEP(NUMPT)                      EUVHCID.2
5064    8.    COMMON /AA2/ UP(NUMPT),U(NUMPT),UM(NUMPT),H(NUMPT)                EUVHCID.3
5065    9.    COMMON /AA3/ VP(NUMPT),V(NUMPT),VM(NUMPT),C(NUMPT)                EUVHCID.4
5066   10.    COMMON /AA7/ FRIC(IFRC,IDXS),SURFF(IFUT,ITCS),DCHNGE(JPUT,JFLS)     ARRAY.2
5067          2  ,CONE(IPUT,ITCS),CUND(JPUT,JFLS)                                 TEST.1
5068   11.    COMMON /AA5/ ICU(NUMPT),ICV(NUMPT),ISB(NUMPT)                     ARRAYID.2
5069   12.    COMMON /AA6/ FXX(NUMPT),FYY(NUMPT),FPEC(NUMPT),ISTCRE(NUMPT)      ARRAYID.3
5070   13.    COMMON/V15/GL1(500),GL2(500),GL3(500),GL4(500),GL5(500)             MISC.2
5071   14.    COMMON/V8/ NV(150),XMU(300),YAL(300),IBAY(20),NBAY(20),R1(20),      MISC.3
5072          1         R2(20),AS(20),ACL(20)                                     MISC.4
5073          1  ,XPUT(300),YALT(300)                                             MISC.5
5074   15.    COMMON /V5/ A(150),B(150),F(150),G(150),R(150),S(150),ISP(150)      MISC.6
5075          1  ,DI(150),FX(150),FY(150),PATP(150),VISC(150),ADVB(150),ADVC(150) MISC.7
5076   16.    COMMON /V10/ IL1(150),IU2(150),IV1(150),IV2(150)                    MISC.8
5077          1  ,NGBD(300),NGLOB,TME1,TME2,TME3,TME4                              CAL.3
5078   17.    COMMON /V11/ TPOL(150),TCCN(50),LDX(50),KDX(50)                     MISC.10
5079          1 ,WAT(50),TFT(50),NCARD(50)                                        MISC.11
5080   18.    INTEGER CCAST                                                       MISC.12
5081   19.    COMMON /AA8/ SGNIC(1,1),TGRIC(1,1),CCAST(1),SURPLT(1,1)             MISC.13
5082   20.    COMMON/CALC/TMP1(150),TMP2(150),TMP3(150),TMP4(150),TMP5(150),      TEST.4
5083          1  TMP6(150)                                                        TEST.5
5084   21.    DIMENSION AL(150),BL(150),AFL(150),APL(150),BK(150)                  CAL.4
5085          1  ,UT(150)                                                     12/22/81.6
5086   22.    EQUIVALENCE (AL(1),A(1)),(BL(1),B(1)),(AFL(1),VISC(1)),         12/22/81.7
5087          1  (AML(1),ADVB(1)),(BK(1),ADVC(1)),(UT(1),FX(1))               12/22/81.8
5088   23.    DIMENSION AMH(150),APH(150),AH(150),BH(150)                     12/22/81.9
5089   24.    EQUIVALENCE (APH(1),TMP1(1)),(AMH(1),TMP2(1)),(AH(1),TMP3(1)),  12/22/81.10
5090          1  (BH(1),TMP4(1))                                              12/22/81.11
5091   25.    COMMON/CMASS/ND(2),SUMB(2),SLPTB                                12/22/81.12
5092   26.    COMMON/V6/ IBARX(200),IBARY(200),IBART(200),IBARR(200,5),         FLODRY.2
5093          1  ITIDE(200),IFLOW(60),ITRANS(20),ICFAN(10),XCHAN(200,2)         FLODRY.3
5094          1  ,INT(200),F1(200),ITG1(200),ITG2(200)                        12/22/81.4
5095   27.    COMMON /V7/ XPAN(20),ZB(20),CB(20),CC(20),CAYD(20),CD(20)         FLODRY.4
5096          *     ,CANFY1(20),CANFY2(20)                                      FLODRY.5
5097   28.    COMMON /AA4/ IFLOOD(NFPTS),ZFU(NFPTS),ZFV(NFPTS),CHZ(NFPTS),      FLODRY.6
5098          1  IFAS(NFPTS)                                                    FLODRY.7
5099   29.    DIMENSION JFLOD(NFPTS)                                            FLODRY.8
5100   30.    EQUIVALENCE (JFLOD(1),CHZ(1))                                     FLODRY.9
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 5101     31.          COMMON/EMASSE/SLMHL(2,2),SLMTEE(2),ITERP                    CAL.559
 5102     32.          COMMON/CONC/CN(NUMPT),CNM(NUMPT),CNFL(NUMPT),               CAL.560
 5103                 1CPH(NUMPT),CNP(NUMPT),CX(NUMPT),CY(NUMPT),                  CAL.561
 5104                 2DKXX(NUMPT),DKYY(NUMPT),FLUX(NUMPT),FLUY(NUMPT),            CAL.562
 5105                 3RP(NUMPT),PP(NUMPT)                                         CAL.563
 5106     33.          COMMON/LOPT/IDEBUG,NLL,ALL,FLL,NLU                          CAL.564
 5107           C STATEMENT FUNCTION DEFINITION                                    CAL.565
 5108     34.          DF(DIF1,DIF2,VLL,DEPTH,CHEZY)=DIF1+ABS(VLL)*DEPTH/CHEZY     CAL.566
 5109                 1+CVMGZ(0.,DIF2,VEL)                                         CAL.567
 5110     35.          SBAR(S1,S2)=.5*(S1+S2)                                      CAL.568
 5111           C DETERMINE BOUNDARY CONDITIONS                                    CAL.569
 5112           C                                                                  CAL.570
 5113           C FLOW BOUNDARY CONCENTRATIONS                                     CAL.571
 5114           C                                                                  CAL.572
 5115     36.          MM=MAX0(KK-1,1)                                             CAL.573
 5116     37.          MM1=MAX0(MP-1,1)                                            CAL.574
 5117     38.          DO 60 I=1,KUV                                               CAL.575
 5118     39.          IP=IFLOW(I)                                                 CAL.576
 5119     40.          INDX=IP/1000000                                             CAL.577
 5120     41.          IP=IP-1000000*INDX                                          CAL.578
 5121     42.          N=IP/1000                                                   CAL.579
 5122     43.          M=IP-1000*N                                                 CAL.580
 5123     44.          INDX=INDX-INDX/100*100                                      CAL.581
 5124     45.          IDIR=INDX/10                                                CAL.582
 5125     46.          INDX=INDX-10*IDIR                                           CAL.583
 5126     47.          LL=(M-1)*NMAX+N                                             CAL.584
 5127     48.          CNP(LL)=CONC(KK,INDX)                                       CAL.585
 5128     49.          IF(KK-1.NE.ISALC)GO TO 60                                   CAL.586
 5129     50.          CNM(LL)=CONC(MM1,INDX)                                      CAL.587
 5130     51.          CN(LL)=CONC(MM,INDX)                                        CAL.588
 5131     52. 60       CONTINUE                                                    CAL.589
 5132           C ELEVATION BOUNDARY CONCENTRATIONS                                CAL.590
 5133     53.          IF(NGLOB.EQ.0)GO TO 105                                     CAL.591
 5134     54.          IF(TME-TME4)102,102,103                                     CAL.592
 5135     55. 103      TME3=TME4                                                   CAL.593
 5136     56.          DO 104 I=1,NGLOB                                            CAL.594
 5137     57. 104      GL4(I)=GL5(I)                                               CAL.595
 5138     58.          READ(34)TME4,(GL5(I),I=1,NGLOB)                             CAL.596
 5139     59. 102      DO 108 I=1,NGLOB                                            CAL.597
 5140     60. 108      GL3(I)=GL4(I)+(TME-TME3)*(GL5(I)-GL4(I))/(TME4-TME3)        CAL.598
 5141     61.          IF(IPT)PRINT 5005,TME3,(GL4(I),I=1,NGLOB)                   CAL.599
 5142     62.          IF(IPT)PRINT 5005,TME4,(GL5(I),I=1,NGLOB)                   CAL.600
 5143     63. 5005     FORMAT(*   TIME (HC) *,F8.2,1X,*GLOBAL GRID SALINITY LEVELS*,/,  CAL.601
 5144                1  (5X,10(F8.2,5X),/))                                        CAL.602
 5145     64.          IF(IPT)PRINT 5000,TME,(GL3(I),I=1,NGLOB)                    CAL.603
 5146     65. 5000     FORMAT(*  TIME *,F8.2,1X,*TIME INTR. GLOBAL GRID SALINTY*,/,   CAL.604
 5147                1  (5X,10(F8.2,5X),/))                                        CAL.605
 5148     66. 105      DO 50 I=1,KTT                                               CAL.606
 5149     67.          IP=ITIDE(I)                                                 CAL.607
 5150     68.          INDX=IP/1000000                                             CAL.608
 5151     69.          IP=IP-1000000*INDX                                          CAL.609
 5152     70.          N=IP/1000                                                   CAL.610
 5153     71.          M=IP-1000*N                                                 CAL.611
 5154     72.          LL=(M-1)*NMAX+N                                             CAL.612
 5155     73.          IF(INT(I)) 6005,6006,6005                                   CAL.613
 5156     74. 6005     IF(NGLOB.GT.0)GO TO 106                                     CAL.614
 5157     75.          CNP(LL)=(1.-FI(I))*CONC(KK,ITG1(I))+FI(I)*CONC(KK,ITG2(I))  CAL.615
 5158     76.          IF(KK-1.NE.ISALC)GO TO 50                                   CAL.616
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SOURCE     PAGE 3             CREAFLPPURSV2              06/20/83  PX=V  07:11:41      CFT 105F(04/14/83)  PAGE 15

  5159      77.        CNP(LL)=(1.-FI(I))*CONE(PP1,ITG1(I))+FI(I)*CONE(MM1,ITG2(I))           CAL.617
  5160      78.        CN(LL)=(1.-FI(I))*CONE(PP,ITG1(I))+FI(I)*CONE(MM,ITG2(I))              CAL.618
  5161      79.        GO TO 50                                                               CAL.619
  5162      80.  106   CNP(LL)=(1.-FI(I))*GL3(ITG1(I))+FI(I)*GL3(ITG2(I))                     CAL.620
  5163      81.        GO TO 50                                                               CAL.621
  5164      82.  6000  INDX=INDX-INDY/100*100                                                 CAL.622
  5165      83.        IDIR=INDX/10                                                           CAL.623
  5166      84.        INDX=INDX-10*IDIR                                                      CAL.624
  5167      85.        CNP(LL)=CONE(KK,INDX)                                                  CAL.625
  5168      86.        IF(KK-1.NE.ISALC)GO TO 50                                              CAL.626
  5169      87.        CNM(LL)=CONE(PP1,INDX)                                                 CAL.627
  5170      88.        CN(LL)=CONE(PP,INDX)                                                   CAL.628
  5171      89.  50    CONTINUE                                                               CAL.629
  5172           C COMPUTE FLUXES                                                             CAL.630
  5173      90.        DO 1 M=1,M1                                                            CAL.631
  5174      91.        IT=(M-1)*NMAX                                                          CAL.632
  5175      92.        CY1=TAU*XML(2*M-1)*DX                                                  CAL.633
  5176      93.        CY2=2.*CY1/LY                                                          CAL.634
  5177      94.        DO 1 N=1,N1                                                            CAL.635
  5178      95.        I=IT+N                                                                 CAL.636
  5179      96.        IF(C(I)) 1,1,2                                                         CAL.637
  5180      97.  2     IPM=I+NMAX                                                             CAL.638
  5181      98.        IPN=I+1                                                                CAL.639
  5182      99.        CX1=TAU*YNL(2*N-1)*DY                                                  CAL.640
  5183     100.        CX2=2.*CX1/LX                                                          CAL.641
  5184     101.        DBARX=SBAR(SEP(I)-F(I),SEP(IPM)-F(IPM))                                CAL.642
  5185     102.        FLUX(I)=CX1*(UP(I)+UM(I))*SBAR(SE(I)-M(I),SE(IPM)-M(IPM))*             CAL.643
  5186                1SBAR(CN(I),CN(IPM))-CX2*DBARX*DF(CX(I),DKXX(I),                        CAL.644
  5187                2UM(I),DBARX,SBAR(C(I),C(IPM)))*(CNP(IPM)-CNP(I))/XMU(2*M)              CAL.645
  5188     103.        DBARY=SBAR(SEP(I)-F(I),SEP(IPN)-F(IPN))                                CAL.646
  5189     104.        FLUY(I)=CY1*(VP(I)+VM(I))*SBAR(SE(I)-M(I),SE(IPN)-M(IPN))              CAL.647
  5190                1*SBAR(CN(I),CN(IPN))-CY2*DBARY*DF(CY(I),DKYY(I),                       CAL.648
  5191                2VM(I),DBARY,SBAR(C(I),C(IPN)))*(CNP(IPN)-CNM(I))/YMU(2*N)              CAL.649
  5192     105.  1     CONTINUE                                                               CAL.650
  5193           C COMPUTE UPDATED SOLUTION                                                   CAL.651
  5194     106.        DO 5 M=2,M1                                                            CAL.652
  5195     107.        IT=(M-1)*NMAX                                                          CAL.653
  5196     108.        CX1=XMU(2*M-1)*DX                                                      CAL.654
  5197     109.        DO 5 N=2,N1                                                            CAL.655
  5198     110.        I=IT+N                                                                 CAL.656
  5199     111.        IF(C(I)) 5,5,6                                                         CAL.657
  5200     112.  6     IF(ICU(I)/10.EQ.7) GO TO 5                                             CAL.658
  5201     113.        IF(ICV(I)/10.EQ.7) GO TO 5                                             CAL.659
  5202     114.        IMM=I-NMAX                                                             CAL.660
  5203     115.        IMN=I-1                                                                CAL.661
  5204     116.        VOL=CX1*YNL(2*N-1)*DY*(SEP(I)-F(I))                                    CAL.662
  5205     117.        CX2=(SEM(I)-M(I))/(SEP(I)-F(I))                                        CAL.663
  5206     118.        CNP(I)=CX2*CNP(I)-(FLUX(I)-FLUX(IMM)+FLUY(I)-FLUY(IMN))/VOL            CAL.664
  5207     119.  5     CONTINUE                                                               CAL.665
  5208           C UPDATE BOUNDARY FLUX MASS ACCOUNTING                                       CAL.666
  5209     120.        ITERM=1                                                                CAL.667
  5210     121.        IF(MOD(ITIME,2).EQ.0) ITERP=2                                          CAL.668
  5211     122.        NB(1)=KLV                                                              CAL.669
  5212     123.        NB(2)=KIT                                                              CAL.670
  5213     124.        SUMTME(ITERP)=0.                                                       CAL.671
  5214     125.        DO 40 J=1,2                                                            CAL.672
  5215     126.        IF(NB(J)) 40,40,41                                                     CAL.673
  5216     127.  41    DO 3 I=1,NB(J)                                                         CAL.674
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CONCE     PAGE 4                 CN=AELPPGNSVZ              06/20/83  PX=V  09:11:41      CFT 105F(04/14/83)  PAGE 16

  5217     128.         IF(J-1) 15,16,15                                                   CAL.675
  5218     129.      16 IP=IFLOW(I)                                                        CAL.676
  5219     130.         GO TO 17                                                           CAL.677
  5220     131.      15 IP=ITIDE(I)                                                        CAL.678
  5221     132.      17 INDX=IP/1000000                                                    CAL.679
  5222     133.         IP=IP-1000000*INDX                                                 CAL.680
  5223     134.         NN=IP/1000                                                         CAL.681
  5224     135.         MM=IP-1000*NN                                                      CAL.682
  5225     136.         I4=INDX/100                                                        CAL.683
  5226     137.         IP=CVMGZ(1,-I4,I4)                                                 CAL.684
  5227     138.         SIGN=FLOAT(IP)                                                     CAL.685
  5228     139.         IP=INDX-100*I4                                                     CAL.686
  5229     140.         IDIR=IP/10                                                         CAL.687
  5230     141.         IF(IDIR-1)94,95,94                                                 CAL.688
  5231     142. 95      N=NN                                                               CAL.689
  5232     143.         M=MM-I4                                                            CAL.690
  5233     144.         LL=(M-1)*NMAX+N                                                    CAL.691
  5234     145.         SUMBE(J,ITERM)=SUMBE(J,ITERM)+SIGN*FLUX(LL)                        CAL.692
  5235     146.         GO TO 3                                                            CAL.693
  5236     147. 94      N=NN-I4                                                            CAL.694
  5237     148.         M=MM                                                               CAL.695
  5238     149.         LL=(M-1)*NMAX+N                                                    CAL.696
  5239     150.         SUMBE(J,ITERM)=SUMBE(J,ITERM)+SIGN*FLUY(LL)                        CAL.697
  5240     151.       3 CONTINUE                                                           CAL.698
  5241     152.      40 SUMTBE(ITERM)=SUMTBE(ITERM)+SUMBE(J,ITERM)                         CAL.699
  5242            C TEST FOR CALL TO DEBUG SUBROUTINE                                      CAL.700
  5243     153.         IF(ITIME.GE.IDEBUG)CALL DEBUG                                      CAL.701
  5244     154.         RETURN                                                             CAL.702
  5245     155.         END                                                                CAL.703
CONCE              VECTOR LOOP BEGINS AT SEQ. NO.       56, F=      167C
CONCE              VECTOR LOOP BEGINS AT SEQ. NO.       59, F=      220F
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APPENDIX B: WIFM-SAL INPUT REQUIREMENTS

Card Group (Format)		Variable	Description
1 (16I5)	Required	NDTAP	Input tape unit
1a (8A8)	Required	ITL	Identification title card, up to 64 character, the 1st 8 are the plot identification
2 (16I5)	Required	NMAX	Horizontal grid dimension (i.e., number of cells in the n-direction)
		MMAX	Vertical grid dimension, number of cells in the m-direction
Restart conditions: system geometry and boundary imput tables ARE NOT read in hot start conditions: INITL = 0 system geometry and boundary input MUST be read in; η , u , and v are all that has been saved		INITL	0--initial condition 1--restart conditions (omit card groups 6, 13-18, and 23) -m--as for 0, but saves restart data every m tau
		IOVER	Control variable 1--simulation 0--reads input only
		IFLVL	0--flow formulation 1--velocity
		LEVEL	Number of time levels
		ISURG	0--tidal circulation 1--storm surge-horizontal coastline 2--storm surge-vertical coastline
		IFETR	0--no feathering of tidal elevation, boundary elevations, and freshwater discharges 1--feathering of the above quantities
		IHOT	0--normal run -1--hot start information previously saved for η,u,v initial conditions on logical unit 2 will be used n--save hot start conditions at itime = n on logical unit 21 Note η is surface elevation u is x-component of velocity v is y-component of velocity itime is the number of time steps elapsed

Card Group (Format)	Variable	Description
2a Required (3I5,2F10.0)	ISAL	1--salinity simulation 0--not simulating salinity
Use a blank card for this group when you are not simulating salinity	ISALS	1--FCT scheme 2--3 Time Level Explicit Scheme
	ISALC	number of time steps into the simulation, when salinity starts
	CMAX	Maximum salinity concentration allowable, in ppt. If CMAX is exceeded, error message is output
	XMS	Scale factor by which salinity concentrations are multiplied for printout (dimensionless)
3 Required (16I5)	ITID	Number of entries in tidal input table or flow input table
	JTID	Number of τ's between entries in the tidal or flow input tables. Note: if tidal constituents are used, set ITID equal to the number of τ's in the tidal scenerio. Set ITJD = 1 . Cannot mix constituent or tabular entries.
	NTID	Number of distinct tidal inputs (total number)
	NFLO	Number of distinct discharge input (total number)
Pertains only to velocity grid	NP1 NP2 NP3	These are print controls for the output grid--grid is printed from N = NP1 to N = NP2 in steps of NP3 NP1 and NP2 are horizontal indices All vertical values for each N NP3 is the increment
	NPR	Overrides NP1,NP2,NP3 2--print full grid of η only -2--print full grid for η,u,v 1--print from NP1 to NP2, η only -1--print from NP1 to NP2, η,u,v
	MPR	Additional print control 1--print flag arrays only -1--print flag arrays, flood, barrier, and tidal or flow data 2--print flag arrays, depths, and Chezy -2--print all
	MSURF	Counter Prints surface elevation and discharge in increments of the values of MSURF

Card Group (Format)		Variable	Description
3 (16I5) (Continued)			
			KS1,KS2,KS3,KS4 are flooding control
		KS1	m--hold cell face CLOSED for $m\tau$'s
		KS2	m--hold cell face OPEN for $m\tau$'s
		KS3	m--hold SUBMERGED barrier characteristic for $m\tau$'s
		KS4	m--hold OVERTOPPING BARRIER characteristic for $m\tau$'s
		KS5	Leave blank, not used at present
		KS6	m--updates wind routine every $m\tau$'s
3a (16I5)	Required	NCON	Number of tide gages for which tidal constituents must be specified
		NGLOB	Number of global grid tidal boundary signals used for cell-centered interpolation along the refined grid boundary
		NTI	Number of tidal boundary signals used for cell-centered interpolation along the seaward boundary
3b (16I5)	Optional	IGX_i	Location expressed in m (grid coordinate) for <u>each</u> tidal signal, i = 1,NT
NT = NTI + NGLOB Omit if NT = 0		IGY_i	Location expressed in m (grid coordinate) for <u>each</u> tidal signal, i = 1,NT
3c Use only if NCON.GT.0		IYEAR	Start time of simulation
		IMONTH	Start time of simulation
Omit if NCON.EQ.0		IDAY	Start time of simulation
		IHR	Start time of simulation
3d (37I1) Omit if NCON.EQ.0		ICONST	Refers to array NCONST which contains 37 constituents. To choose how many constituents you wish to consider, code this variable 1--consider 0--skip
3e (16I5) Omit if NCON.EQ.0		NC_j	j varies from 1 to NCONT where NCONT is the element number of the <u>specific</u> constituent you want considered from array NCONST

Card Group (Format)	Variable	Description
4 (8F10.0) Required	TAU	Time step length, i.e. Δt (sec)
Note: See IXPAN in card group 5. Code DX and DY. 1 map inch = X number of feet when card group 6 will be utilized Example: Map scale 1:40000 CX = 3333.	*DX	Vertical spatial stepsize (minimum stepsize for α space) from map scale use 1 in. = ____ ft
	*DY	Horizontal spatial stepsize (ft) 1 in. = ____ ft
	G	Acceleration of gravity set to 32.2 (ft^2/sec)
	ALAT	Average latitude of the study region, + for Northern hemisphere (•) - for Southern hemisphere
	XI	Constant rate of rainfall (inches/day)
	WA	Constant wind velocity (no N/S wind) -1--variable wind as a function of time only. (Note: card group 11 is needed to complete wind information) -2--variable wind as a function of space and time. (Provided by subroutine FETCHW.) (Note: omit card group 11)
	THETA	Constant wind direction in degrees Use meteorological definition, i.e. NORTH is 0° EAST is 90° SOUTH is 180° WEST is 270° or the number of hours between entries of wind table if WA = -1
	EPSD	ε_d is minimum amount of water defining a dry cell (in feet)
	APSD	ε_b is minimum amount of water over a barrier for submergence (in feet)
	DCON1 NVGD 1 MLW	Value to add to water depths to translate them to the model datum which is usually NVGD datum (in feet). Depths are negative, thus a - DCON1 will deepen
	*DMPX	Value of land elevation assigned artificially to areas that will never flood (in feet) control value to cutoff, depth checking within WIFM; i.e., this is the MAX land elevation digitized

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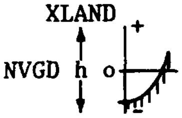
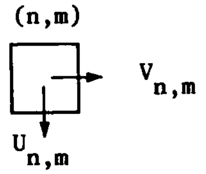
* Related to XLAND as follows: DMPX is used in digitizing the grid--XLAND < DMPX defines highest potential flood level elevation.

Card Group (Format)	Variable	Description
4 (8F10.0) (Continued)	ROTA	Angle of x-axis as measured counterclockwise from EAST = 0° (in degrees)
	TPRO	Start of prototype time for beginning of run (i.e., time of day in hours)
	ADV	0--no advective or viscosity terms 1--include advective terms, linearize at boundary 2--include advective terms, use approximation at closed bounds
	VIS	ε--viscosity coefficient multiplier; it is dimensionless and if equal to ϕ omits the viscosity coefficient usually set to 1 for initial runs
Note: XLAND < DMPX defines maximum potential flood level elevation	XLAND 	A value of h (i.e., land or water bottom elevation with respect to NVGD datum); greater than XLAND defines a cell that will never flood (in feet) XLAND > 0
	XSCOUR	A value of h < XSCOUR defines a cell that will never go dry (feet) 0 < XSCOUR
	SMAX	If η > SMAX , cease computation and print η (η is surface elevation) (ft)
	SINIT	Set η = SINIT as initial conditions (normally Q). Note: SINIT = 999 , the code will compute inverted barometer effect (ft)
	DMAXG	Positive bound on maximum total water depth that will be experienced during simulation (in feet) (for control of length of friction table)
	DCON2 NVGD - msl	Value to add to tidal input values to translate them to model datum (NVGD) in feet
	DLIMIT	Negative value serving as an artificial cutoff value on water depths (h) (negative since h < 0) in feet
5 (16IS) Required	MAXTIM	Number to τ's to run simulation
	INTAP	m--save η,u,v on logical unit 1 every mτ -1--no data is saved

Card Group (Format)		Variable	Description
5 (16I5) (Continued)		IDELAY	Delay saving data on logical unit 1 until ITIME = IDELAY (Note: ITIME counts the number of time steps)
Note: Set these variables to zero; subroutines to accomplish printer plots have been removed from the program, but can be supplied upon District request	If these plug controls are set to zero, omit card group 10	IPLOT	≠0--printer plots of elevation hydrographs will be made 0--no plots
		IVPLOT	≠0--printer plots of velocity magnitude hydrographs will be made 0--no plots
		ICPLOT	≠0--printer plots of peak surge elevation along the coast will be made 0--no plots
		IXPAN	≠0--read in variable grid expansion coefficients in card group 6 which will be the output file from program GRID saved on tape 7 0--indicates constant spatial step input this step size in card group 4 in DX and DY variables
		NGAGE	Number of locations where you want data saved, omit card groups 8 and 9 if NGAGE = 0 . Card group 8 is gage locations if NGAGE = 0 , NFREQ = 0
		NFREQ	Frequency to print hydrodynamics at gage points (every NFREQ τ's)
		KREST	Start run at ITIME = KREST. Set to zero except for restart run
		NZP	Number of corrections to input depth grid; omit card group 14 if NZP = 0
		NZQ	Number of corrections to input coded friction grid; omit card group 16 if NZQ = 0
		MDTAP	Logical unit for depth and coded friction input data (normally 5)
		NTABLE	Length of wind input data; i.e., number of entries in the table
		IGLOB	n--save boundary conditions (on logical unit 25) from Global Grid at n points (cells) for later use as forcing conditions to an embedded grid (will need card group 29 to locate indices) 0--no saving for later use

Card Group (Format)		Variable	Description
6 (4G20.11)	Optional	ANG	Dummy variable for the first value of GRID output
This group is created by program GRID on tape 7 and is omitted if IXPAN = 0 or INITL = 1		YNU_i	Expansion coefficients for n-direction (horizontal) of the variable grid = 1, NYY NYY = 2*NMAX (dimensionless)
		XNU_i	Expansion coefficients for vertical direction (indirect) of the variable grid i = 1 , NXX NXX = 2*MMAX (dimensionless)
7 (16I5)	Required	NPRINT	Time step index to print grid an array of 32 elements thus allowing up to 32 printouts (array must be filled, so two cards are required to satisfy the read)
8 (16I5) Omit if NGAGE = 0	Optional	$NPOT_i$	Horizontal indices of locations (i.e. gage) where you want data saved; location is expressed in terms of the horizontal dimension of the grid (N values) i = 1 , NGAGE
		$MPOT_i$	Vertical indices of gage locations (M values) i = 1 , NGAGE
9 (16I5) Omit if NGAGE = 0 $\bar{\bar{v}} = \frac{1}{4} (V_{n,m} + V_{n-1,m} + V_{n,m+1} + V_{n=1,m+1})$ $\bar{\bar{u}} = \frac{1}{4} (U_{n,m} + U_{n,m-1} + U_{n+1,m} + V_{n+1,m-1})$ $\bar{u} = \frac{1}{2} (U_{n,m} + U_{n,m-1})$  $\bar{v} = \frac{1}{2} (V_{n,m} + V_{n-1,m})$	Optional	$IGAGE_i$	Codes for methods of computing flows at gage points i = 1, NGAGE 1--u,$\bar{\bar{v}}$ 2--$\bar{\bar{u}}$,v 3--$\bar{\bar{u}}$,$\bar{\bar{v}}$ default $\left\{ \begin{array}{l} \bar{\bar{v}} = \text{4pt avg of v at u)} \\ \bar{\bar{u}} = \text{4 pt avg u at v} \end{array} \right.$ 4--u,v 5--u 6--v 7--$\bar{u}$ 8--$\bar{v}$
10 (5I5,2F5.0) Omit <u>all</u> if: IPLOT = 0 ICPLOT = 0 and IVPLOT = 0	Optional		These groups are actually three different sets of variables, each set associated with a type of <u>printer</u> plot to control format of plots; variable list and descriptions are not included Subroutines have been removed from the code, but can be supplied upon District request

Card Group (Format)		Variable	Description
10a (16I5)	Optional		IPLOT--controller for elevation hydrographs IVPLOT--controller for velocity magnitude hydrographs ICPLOT--controller for peak surge elevations (along the coast) plot → Ref: card group 5
11 (16F5.2) Omit if WA NE-1 ref group 4	Optional	WAT_i	Variable wind velocity (mph) i = 1 , NWAT, NWAT = THETA (see group 4)
		THT_i	Corresponding wind direction measured from North as THT (deg) i = 1, NWAT
12 (10E8.1)	Required		This card group codes terrain and barrier characteristics. Each variable in this card group has 20 values
		$XMAN_i$	Manning's coefficient for each code i (i = 1,20) used for defining friction (Note: value of code (1) is used for all water outside the computational boundaries). This array must be ordered in the same manner as the depth zones defined in card group 15. For example--lowest value to highest value of Manning's coupled with depth zones of deep to shallow (i is dimensionless)
		ZB_i	Barrier height for each code i = 1,20 . This array is referenced by card group 17 variable INDX (ft)
		CB_i	Chezy coefficient to approximate a barrier of overtipping for each code i = 1,20 ($\sqrt{g}$, $ft^{1/2}$, sec) $C_b = \frac{1.49}{n_b}(\varepsilon_b)^{1/6}$
		CO_i	Admittance coefficient for overtopping barrier ($\sqrt{g}$, $ft^{1/2}$/sec) usual range (3-5) i = 1,20
		$CAYD_i$	Recession coefficient for draining of flood cell--keyed by friction codes (fraction of water depth to be allowed to drain within one time step) i = 1,20

Card Group (Format)		Variable	Description
12 (10E8.1) (Continued)		CD_i	Admittance coefficient for limiting movement of water onto flood cells--keyed by friction codes ($\sqrt{g}$, ft$^{1/2}$/sec) usual range (3-5) i = 1,20
		$CANPY1_i$ $CANPY_2$	Canopy coefficients for flooding--used to increase Manning's n friction coefficient over heavily vegetated marshes. (C_1 dimensionless) (C_2 is in feet) $\eta_c = \eta_b\left(1 + C_1 e^{-d^2/C_2}\right)$ for $d < 5$ ft Set $C_1 = 0$, and $C_2 = 1$ for nonuse. i = 1,20
13 (10F8.0) Omit only if INITL.EQ.1	Required	TMP_n	Depth grid array; depths at center of each grid cell. For row M of depths n = 1 , NMAX, start a new card for each M : units of measure (ft) negative in sign
13a (16I5)	Optional	Include only if ISAL ≠ 0	
		IDEPTH	Number of depth intervals employed to interpolate initial salinity condition based upon depth
		IFIELD	Number of patches in which initial salinity conditions will be input on a cell-by-cell basis
		IZONE	Number of zones in which the initial salinity condition will be a constant
		Include if IDEPTH ≠ 0	
13b (16F5.1)	Optional	TMP_N	Salinity initial value array, N = 1 , IDEPTH (ppt)
		D(N,1)	Depth value array, N = 1 , IDEPTH + 1 (ft)
13c (16I5)	Optional	Repeat IFIELD times. Include only if IFIELD ≠ 0	
		NL	Lower horizontal limit of patch i (n-coordinate of cell)
		NU	Upper horizontal limit of patch i (n-coordinate of cell)
		ML	Lower vertical limit of patch i (m-coordinate of cell)

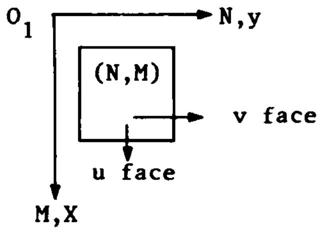
Card Group (Format)	Variable	Description
13c (16I5) (Continued)	MU	Upper vertical limit of patch i (*m-coordinate of cell*) Repeat (ML - MU) + 1 times
(16F5.1)	CN(N,M), N = NL,NU	Initial salinity concentration (ppt)
13d Required Omit only if INITL.EQ.1		Card groups 13d and 13e are ref. Subroutine CONST to read in five different sets of values for the following conditions:
13e		CN--initial salinity values (in ppt) required only for IZONE $\neq 0$ CX--dispersion factor in the X-dir (dimensionless) DKXX--dispersion offset in the X-dir (ft^2/sec) CY--dispersion factor in the Y-dir (dimensionless) DKYY--dispersion offset in the Y-dir (ft^2/sec)
	The variables for the card group are:	
(4I5,F10.0)	NZ	Number of zones covering the grid 1st card
(4I5,F10.0)	NL	Lower horizontal index of zone 2nd card
	NU	Upper horizontal index of zone
	ML	Lower vertical index of zone
	MU	Upper vertical index of zone
	R	Value of CN, CX, DKXX, CY, or DKYY to be read in. This is a single value for the set of cells defined N = L,u , M = L,u ; i.e., cells (N,M) where $NL \leq N \leq Nu$ and $ML \leq M \leq Mu$
	Repeat the two cards of this group until all initial condition variables above are satisfied.	
14 Optional (2I5,F5.1)	N	Corrections to individual cell depths Horizontal index of cell
Omit if NZP.EQ.0 or INITL.EQ.1	M	Vertical index of cell
	DNM	Corrected depth of cell (ft) negative in sign, digitized depth without model datum correction, usually reference is nautical charts, MLW or MLLW Gulf Coast Datum

Card Group (Format)		Variable	Description
15 (35I2)	Required	N	If N = 77 , the next card begins the friction codes for all cells in the grid
Groups 15, 15a, or 15a alternate are required unless INITL = 0			If N ≠ 77 , subroutine FRICTN is called. N is the number of depths used to develop the friction codes and the card which follows begins the definition of depth ranges
		Within SUBROUTINE FRICTN	
15a (8F10.1)	Required	DP_i	Depths to define ranges of depths which correspond to the Manning's n in the XMAN array, used to develop the friction codes (see group 12)
In this group--the scheme operates to assign a Manning's n based on depth Omit if INITL.EQ.1			i = 1, ND (Note: N = ND and LE.21) DA's are negative values and must be put in the same relative order as the values of Manning's n in XMAN. (Note: deep to shallow if lowest to highest is the order of Manning's n) (ft)
15a (35I2)	Required	Use this group if SUBROUTINE FRICTN is <u>not</u> used. This alternate group 15a is the friction codes and is related to card group 12 (XMAN)	
In this group the scheme operates to allow <u>you</u> to assign the Manning's n Omit if INITL.EQ.1		$ITIDE_M$	This variable is read within a DO LOOP where N = 1,NMAX ... M = 1,MMAX ITIDE is a number for <u>each</u> cell in the grid between 1 and 20 corresponding to the elements of array XMAN which you wish to assign to <u>each</u> cell. The loops operate to assign values by columns
16 (4I5)	Optional		Used for corrections to <u>coded</u> friction grid for individual cells
Omit if NZQ.EQ.0 or INITL.EQ.1		N	Horizontal cell index
		M	Vertical cell index
		MAN(N,M)	Number 1 to 20 to correspond to the elements of array XMAN desired

The code sets up flag areas (internal flags) for each u and v cell face (see diagram following) in the grid based upon depth field and advection code (ADV is set equal to 0, 1, or 2).

Card Group 17 provides for establishing the codes for boundary flags and card group 18 provides for correction to the internal flags.

Card Group (Format)		Variable	Description
17a (3I2,6I4) Omit only if INITL.EQ.1	Required	ITYP	Barrier type codes 1--exposed barrier at all times 2--overtopping barrier 4--submerged barrier 8--tidal input 9--flow input 99--exit this group of input, leave remainder of card blank <u>UNLESS</u> you wish to make corrections to the ICU and ICV flag arrays <u>then</u> leave INDX and IDIR blank and set I1 ≠ 0 and include card group 18. It should be set to the number of corrections to be made
		INDX	Value is from 1 to 20, keyed to element of array ZB in card group 12 to set barrier heights if ITYP is set to 1, 2, or 4 For ITYP set to 8, value is from 1 to NTID (NTID is the total number of tidal input signals), i.e., identifies <u>which</u> tidal input For ITYP set to 9, value is from 1 up to NFLD to identify which flow input
		IDIR	1--flow direction is through u cell face 2--flow direction is through v cell face
		I1 I2 I3	Locator grid indices for barrier, tidal input, or flow input For a u face feature: I1 is the row (M) I2 is the beginning column (N) I3 is the ending column (N) For a v face feature: I1 is the column (N) I2 is the beginning row (M) I3 is the ending row (M)



Card Group (Format)		Variable	Description
17a (3I2,6I4) (Continued)		I4	Used with tidal or flow input only, otherwise leave blank 0--input directed toward the right or bottom of the grid 1--input directed toward the left or top of the grid
		I5	When used ITYP = 8 , INDX = 1
		I6	Used for tidal input only when you want to interpolate the values for the tidal input boundary between two tidal signals. I5 and I6 correspond to the two tidal signal numbers; i.e., the elements numbers (of your 2 signals) in the tidal signal arrays IGX and IGY
17b (F8.0) Include if ISAL ≠ 0	Optional	XDL	Dispersion coefficient reduction factor for flow restriction (dimensionless)
18 (4I5) Omit unless ITYP.EQ.99.AND.I1.NE.0	Optional		Correction codes to ICU, ICV flag arrays. This read statement is in a loop which will execute I1 number of times
		N	Horizontal index of cell
		M	Vertical index of cell
See description at ITYP and INDX codes above			$ICU_{N,M}$--a 2 digit code, n_1n_2 , where n_1 is ITYP and n_2 is INDX of the specific u face of cell (N,M) $ICV_{N,M}$--same except v face condition is described by n_1n_2
19 (4I5,F5.0)	Required		This card group is a special application: NBG--set equal to 0 KSHFT--set equal to 1
		NBG	0--normal -1--no tidal input or discharge, used for storm surge
		KSHFT	Time index unit, where the simulation begins in the boundary input tables; i.e., time step index for beginning of input used with HOTSTART CONDITIONS
20 (4Ab,3F10.0) Omit if NT10 = 0 or NCON = 0 or NBG = -1	Optional (Tidal inputs)	TITLE	Gage title
		TLON	Longitude in degrees of gage
		TM	Time meridian in degrees
		HO	Mean value referenced to model datum

Card Group (Format)		Variable	Description
20a (8F10.0) Use only with 20	Optional	$HM_{j,i}$	Tidal amplitude for each of the tidal constituents j = 1,NCONT (NCONT is the element of the array NCONST which holds the values of the tidal constituents) i = 1,NTID (number of tidal inputs) that is, HM is the specific tidal amplitude in feet of each constituent identified by its element number in the array NCONST for each of the distinct tidal inputs
		$KAPPA_{j,i}$	Tidal phases of the constituents as above (in degrees)
20b (15F5.2) These card groups are tidal boundary INPUT, thus omitted if NTID = 0	Optional	SSV_j	Tidal elevation for each time step j = 1,IT (IT = ITID (card group 3) the number of entries in the tidal input table)
		XKQ	Shift in time step units
		ALP	Amplitude multiplication factor

Repeat card group 20b (NTID-NCON) times. Omit if NTID = NCON

NOTE: If you are simulating salinity ISAL.NE.0, you will need the following additional groups repeated (NTID-NCON) times.

20c (15F5.2)		SSV_j	j = 1,IT--specific salinity value for each tidal signal
21a (15F5.2) omit if NFLO = 0 These groups are flow inputs	Optional	SSV_j	Discharge (in cfs) for each time step j = 1,IT where IT = ITID , number of entries in flow input table
		XKQ	Shift in time step units
		ALP	Multiplication factor

Repeat this card group for each flow input

If ISAL.NE.0 you will need group 21a repeated for each flow input as well

21b (15F5.2)	Optional	SSV_j	j = 1,IT , specific salinity value for each flow input (NFLO)
22 (F5.0,I5)	Optional		Specify if IFETR ≠ 0
		XLEVEL	Feather level for tidal elevation
		NTD	Number of time steps for flow input feathering

Card Groups 23 and 24 are presently not being utilized. Subroutines have been removed which accomplish range output. Supplied upon request.

Card Group (Format)	Variable	Description
23 (16I5)	JNS	Number of ranges for computing volumetric discharge (if equal to 0 put in a blank card for this group) integrated value
This card group controls range output	JT1	Time index marking beginning of discharge computation (time step)
Omit if INITL = 1	JPER	Period of discharge cycle in time index units (total length of cycles in time steps)
Use a blank if JNS = 0	JDT	Sampling time step in time index units
	JMUL	Number of seconds in sampling period (τ JDT)
	JDELAY	Delay print of special gage data until ITIME = JDELAYS (avoid spinup time computation)
24 Optional (16I5) Omit if JNS = 0	JDIR$_i$	Direction of flow in discharge range. Coded: 1--vertical direction 2--horizontal direction where i = i,JNS
	JMN$_i$	Coordinate index of the range line i = 1,JNS
	JMN1$_i$ JMN2$_i$	Range line extends from JNS1$_i$ to JNS2$_i$ where i = 1,JNS
25 Required (16I5)	MNPOT	Number of special gage points to be punched and/or plotted for surface elevation data
	MSKP	Frequency to punch surface elevation data (i.e., every MSKP τ's)
	MDLY	Delay punch of surface elevation data (at special gage points) until ITIME = MDLY
	NVELPN	Number of special gage points for punching and/or plotting velocity magnitude
	MVELP	Frequency to punch velocity magnitude data (every MVELP τ's) (τ is time step)
	MVDLY	Delay punch of velocity data until ITIME = MUDLY

These control variables are for tape (punch) or plot output and are output to tape 3. The plotting is automatic. Plot file name must be specified in JCL.

Card Group (Format)		Variable	Description
26 (16I5) *Omit if NNPO7.EQ.0*	Optional	INPOT_i	N indices of special gage points for surface elevations data (ref. card group 25) i = 1,NNPOT up to a maximum of 30 pts
		JMPOT_i	M indices of same (start a new card) i = 1,NNPOT
27 (16I5) Omit if NVELPN EQ.0	Optional	NVCORD_i	N indices of special gage points for velocity magnitude data i = 1, NVELPN
		MVCORD_i	M indices of same (start new card) i = 1,NVELPN
28 (16I5) Omit if ISURG = 0 (see card group 2)	Optional	COAST_i	Indices of open coast cells where i = 1,NMAX for horizontal coastline and i = 1,MMAX for vertical coastline. This information is obtained from program SHORE
29 (16I5) Omit if IGLOB = 0 (see card group 5)	Optional	IU1_i	N indices of cells where boundary conditions are to be saved in global grid, i = 1,IGLOB
		IU2_i	M indices of same i = 1,IGLOB (start a new card)

APPENDIX C: REFINED GRID INPUT DATA

```
        PAGE 1                    ON=ELMPQRSV                    07/13/82-00:33:03   CFT 1.09(12/01/81)  PAGE 17
  5234      1. COIRS NOLIST                                                                      CAL.699
     5
 PASCAGOULA CHANNEL, REFINED GRID
    49    28     0     1     1     3
     1     1  1440        150.         100.
     6  1440     0     2    14    43     1    -2    -2    10
     0    40     0
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280  270       270  270  270  270  270  270  270  270  270  280  280  280  280
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290  290  290  290  290  250  250  290  290  290  290  250  280  280  260  280
280
280  280  270  270  270  270  [illegible]  270  270  270  270  280  280  280  280
260  280  280  280  290  290  290  290  290  290  290  290  290  290  250  29
290  290  290  290  290  250  290  290  290  290  290  270  290  290  290  280
290
```

```
 280  280  280  280  290  290  290  290  290  290  290  300  300  300  300  300
 300  300  300  300  300                                300  300  300  290  290  290
 290
 280  280  280  280  280  280  280  280  280  280  280  280  280  280  280  280
 280  280  280  280  290  290  290  290  290  290  290  300  300  300  300  300
 300  300  300  300  300  300  300  300  300  300  300  300  300  290  290  290
 290
 280  280  280  280  280  280  280  280  280  280  280  280  280  280  280  280
 280  280  280  280  290  290  290  290  290  290  290  300  300  300  300  300
 300  300  300  300  300  300  300  300  300  300  300  300  300  290  290  290
 290
   1
   1   49    1   28        10.
   1
   1   49    1   28         0.
   1
   1   49    1   28        10.
   1
   1   49    1   28         0.
14
   -5000.     -1000.      -500.     -200.     -100.      -50.     -40.      -35.
      -30.       -25       -20.      -10.       -5.        0.
    8    1   99
   16    1   99
    1   28   99
   49   25   99
 1 1 2    7    2    3
 1 1 2    8    3    3
 1 1 2   13    8    8
 1 1 2    9   10   10
 1 1 1   10   10   10
 1 1 1   24    4    6
 1 1 1   25    9   16
 1 1 1   25   30   31
 1 1 1   26   43   47
 8 1 2    1    6    8    0    1    2
 8 1 2    1    9    9    0    3    3
 8 1 2    1   10   14    0    4    5
 8 1 2    1   15   18    0    5    6
 8 1 2    1   19   20    0    6    7
 8 1 2    1   21   22    0    7    8
 8 1 2    1   24   24    0    9    9
 8 1 2    1   25   25    0   10   10
 8 1 2    1   26   26    0   11   11
 8 1 2    1   27   27    0   12   12
 8 1 2    1   28   28    0   13   13
 8 1 2   49    6    8    1   14   14
 8 1 2   49    9    9    1   15   15
 8 1 2   49   10   14    1   16   17
 8 1 2   49   15   18    1   17   19
 8 1 2   49   19   20    1   18   19
 8 1 2   49   21   22    1   19   20
 8 1 2   49   23   24    1   20   21
 8 1 2   49   25   25    1   22   22
 8 1 2   49   26   26    1   23   23
 8 1 2   49   27   27    1   24   24
 8 1 2   49   28   28    1   25   25
 8 1 1   28    1    1    1   26   26
 8 1 1   28    2    4    1   27   29
 8 1 1   28    5    6    1   29   30
 8 1 1   28    9   11    1   30   31
 8 1 1   28   12   17    1   31   32
 8 1 1   28   18   23    1   32   33
 8 1 1   28   24   26    1   33   34
 8 1 1   28   27   31    1   34   35
 8 1 1   28   32   42    1   35   36
 8 1 1   28   43   45    1   36   37
 8 1 1   28   46   47    1   37   38
 8 1 1   28   48   48    1   39   39
 8 1 1   28   49   49    1   40   40
```

```
. 1 1  26  45  45   1  36  37
c 1 1  28  46  47   1  37  38
8 1 1  28  48  48   1  38  39
0 1 1  29  49  49   1  40  40
9 1 1   1   6   8
9 2 1   1  16  16
69          3
  .0300
   1   49   12   17
  19   20    1   28
  29   42    1   28
   0    1
    1153.     1107.     1084.     1032.     963.     934.

    1730.     1660.     1626.     1540.     1444.     1401.

   4   60    0    7   60    0
   4   25   49   49
  24    6   27    8
   3   35   24   33   30   48   48
  20   20   25   26   27   23   22
```

APPENDIX D: REFINED GRID OUTPUT DATA

```
INPUT DATA--CARD 1     PASCAGOULA CHANNEL, REFINED GRID

INPUT DATA--CARD   2
    NMAX,MMAX,INITL,IOVER,IFLVL,LEVEL,ISURG,IHOT,IPOND,NCHAN        49   28    0    1    1    3    0    0    0
    ISAL,ISALC,CMAX,XMS           1 1440  150.00  100.00

INPUT DATA--CARD   3
    ITID,JTID,NTID,NFLO,NP1,NP2,NP3,NPR,MPR,MSURF,KS1,KS2,KS3,KS4,KS5,KS6
       6 1440    0    2   14   43    1   -2   -2   60    0    0    0    0    0    0
    NCON    0

INPUT DATA--CARD   4
    TAU,DX,DY,G,ALAT,XI,WA,THETA,EPSD,APSD,CON1,DMPX,ROTA,TPRO,ADV,VIS,XLAND,XSCOUR,SMAX,SINIT,DMAXG,DCON2,DLIMIT
      60.000        3333.3        3333.3        32.200        30.250       0.00000      -1.0000        6.0000
      1.0000        1.0000       -1.0000        50.000       0.00000       0.00000       1.0000        1.0000
      8.0000        1.0000        10.100       0.00000        200.00       0.00000      -100.00

INPUT DATA--CARD   5
    MAXTIM,INTAP,IDELAY,IPLOT,IVPLOT,ICPLOT,IXPAN,NGAGE     ,NFREQ,KREST,NZP,NZO,NDTAP,NTABLE,IGLOB
     7200    -1 9999    0    0    0    1   11   10    0    0    4    5   21    0

INPUT DATA--CARD   6
    EXPANSION WEIGHTS IN X-DIRECTION
      1.4545       1.3907       1.2924       1.1995       1.1118       1.0290       0.95095      0.87749
      0.80641      0.82459      0.84143      0.85898      0.87728      0.89639      0.91636      0.93725
      0.95513      0.98206      1.0061       0.86442      0.73975      0.63044      0.53493      0.34568
      0.22057      0.13867      0.86192E-01  0.92487E-01  0.99471E-01  0.10725      0.11594      0.16166
      0.22627      0.32671      0.47451      0.52896      0.59252      0.66723      0.75573      0.77813
      0.60245      0.62900      0.85812      0.89024      0.92590      0.96581      1.0108       1.0622
      1.1214       1.1908       1.2734       1.3740       1.5000       1.5000       1.5000       1.5000
    EXPANSION WEIGHTS IN Y-DIRECTION
      1.9495       1.6493       1.7751       1.7168       1.6689       1.6285       1.5937       1.5632
      1.3606       1.2325       1.1104       1.0081       0.93404      0.86967      0.81325      0.76342
      0.70527      0.65420      0.60706      0.56893      0.53305      0.50082      0.50040      0.49999
      0.45560      0.45922      0.33263      0.22470      0.15375      0.10648      0.10308      0.99874E-01
      0.96660E-01  0.94016E-01  0.12442      0.16343      0.21315      0.27614      0.35546      0.45479
      0.45999      0.46514      0.47023      0.47525      0.48023      0.48514      0.49001      0.49482
      0.49955      0.50431      0.44932      0.40119      0.35897      0.32183      0.28909      0.26017
      0.22660      0.18758      0.15992      0.13670      0.11714      0.10063      0.10055      0.10048
      0.10040      0.10033      0.10026      0.10019      0.10012      0.10005      0.99987E-01  0.99921E-01
      0.99656E-01  0.99792E-01  0.99729E-01  0.99667E-01  0.99605E-01  0.99545E-01  0.99485E-01  0.99426E-01
      0.12671      0.16611      0.21373      0.27418      0.35073      0.44739      0.49528      0.54768
      0.60496      0.66749      0.73571      0.81005      0.89100      0.97906      1.0748       1.1787
      1.2515       1.4138

INPUT DATA--CARD   7
    NPRINT 1440 2880 4320 5760 7200    0    0    0    0    0    0    0    0    0    0    0
    NPRINT    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

INPUT DATA--CARD   8
    SPECIAL GAGE LOCATIONS
    NPOT      3   35   24   33   30   49   49    4   25   49   49
    NPOT2    20   20   25   26   27   23   22   24    6   27    8
```

```
DEFINE FLOW CALCULATION FOR ALL GAGES
 IGAGE    0    0    0    0    0    0    0    0    0    0    0
```

```
INPUT DATA--CARD  11
    VARIABLE WIND DATA
    VELOCITY      9.60   7.30   5.20   7.60   5.80   8.70   4.90   6.50   7.20   8.00   5.50   5.90   7.60   4.60   3.40   6.60
                  6.70   7.40   4.20   5.10   6.70
    DIRECTION     2.76   1.97   2.68   2.25   2.06   2.13   1.73   2.23   1.95   1.90   1.80   2.23   1.82   1.71   4.24   2.83
                  1.92   1.75   2.32   1.20   2.04

INPUT DATA--CARD  12
    FRICTION CODES      0.010   0.011   0.012   0.013   0.014   0.015   0.016   0.017   0.018   0.019
    FRICTION CODES      0.020   0.021   0.022   0.023   0.024   0.025   0.026   0.027   0.028   0.029
    BARRIER HEIGHTS    10.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
    BARRIER HEIGHTS     0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
    BARRIER CHEZYS    4.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
    BARRIER CHEZYS    0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
    OT/BAR-AD COEFF     4.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
    OT/BAR-AD COEFF     0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
    RECESSION COEFF     4.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
    RECESSION COEFF     0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
    FLOOD-AD COEFF      0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500
    FLOOD-AD COEFF      0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500
    CANOPY COEFF 1      0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500
    CANOPY COEFF 1      0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500
    CANOPY COEFF 2      0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500
    CANOPY COEFF 2      0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500

INPUT DATA--CARD  25

    NNPOT,MSKP,MDLY,NVELPN,MVELP,MVDLY          4   60    0    7   60    0

INPUT DATA--CARD  26

    INPOT AND JMPOT

       4   25   49   49
      24    6   27    8

INPUT DATA--CARD  27

    NVCORD      3   35   24   33   30   48   48

    MVCORD     20   20   25   26   27   23   22


PROGRAM TIDAL HAS CONSTRUCTED THE FOLLOWING ARRAYS

    DEPTH
    MANNING,S N
    ICF FLAG ARRAY
    VECTORS-IFLOOD,IBARR,ITIDE
```

```
ICF FLAG ARRAY
 M  N    1     2     3     4     5     6     7     8     9.   10    11    12    13    14    15    16    17    18    19    20

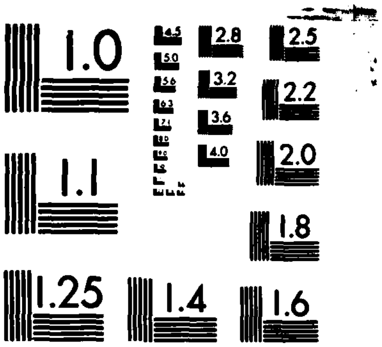
 1      1010  1010  1010  1010  1010  1010  1010  9170  1010  1010  1010  1010  1010  1010  1010  9270  1010  1010  1010  1010
 2      1010  1010  1010  1010  1010  1010  6011  6150  1010  6060  6050  1010  1010  1010  6060  6060  6050  1010  1010  1010
 3      1010  1010  1010  1010  1010  6060  6111  6111  6060  6361  6150  1010  1010  1010  6060  6060  6050  1010  1010  1010
 4      1010  1010  6060  6262  6262  6363  6362  6362  6363  6361  6150  1010  1010  1010  6060  6060  6050  1010  1010  1010
 5      1010  6060  6363  6363  6363  6363  6363  6363  6363  6363  6162  5062  5062  6060  6060  6060  6050  1010  1010  1010
 6      7081  6163  6363  6363  6363  6363  6363  6363  6363  6361  6150  1010  1010  6060  6060  6060  6060  6060  6060  6060
 7      7081  6163  6363  6363  6363  6363  6363  6363  6363  6361  6150  1010  1010  6060  6060  6060  6060  6060  6060  6060
 8      7081  6163  6363  6363  6363  6363  6363  6363  6363  6363  6362  6260  6011  6060  6060  6060  6060  6060  6060  6060
 9      7081  6163  6363  6363  6363  6363  6363  6363  6162  6063  6263  6363  6362  6060  6060  6060  6060  6060  6060  6060
10      7081  6163  6363  6363  6363  6363  6363  6361  6111  1160  5062  6163  6363  6060  6060  6060  6060  6060  6060  6060
11      7081  6163  6363  6363  6363  6363  6363  6363  6360  6050  1010  6161  6363  6060  6060  6060  6060  6060  6060  6060
12      7081  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060
13      7081  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060
14      7061  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060
15      7081  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060
16      7081  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060
17      7081  6060  6060  6060  6060  6060  6060  6060  6060  6060  6060  6068  6060  6060  6060  6060  6060  6060  6060  6060
18      7081  6163  6363  6363  6363  6363  6363  6363  6363  6363  6363  6363  6363  6060  6060  6060  6060  6060  6060  6060
19      7081  6163  6363  6363  6363  6363  6363  6363  6363  6363  6363  6363  6363  6060  6060  6060  6060  6060  6060  6060
20      7081  6163  6363  6363  6363  6363  6363  6363  6363  6363  6363  6363  6363  6060  6060  6060  6060  6060  6060  6050
21      7081  6063  6363  6363  6363  6363  6363  6363  6363  6363  6363  6363  6363  6060  6060  6060  6060  6060  6060  6060
22      7081  5062  6063  6363  6363  6363  6363  6363  6363  6363  6363  6363  6363  6060  6060  6060  6060  6060  6060  6060
23      1010  1010  5060  6063  6263  6263  6263  6263  6363  6363  6363  6363  6363  6060  6060  6060  6060  6060  6060  6060
24      7081  6050  1010  1160  1162  1162  5062  5062  6063  6263  6263  6263  6263  6060  6060  6060  6060  6060  6060  6060
25      7061  6162  6262  6262  6260  6050  1010  1010  1160  1162  1162  1162  1162  1160  1160  1160  6060  6060  6060  6060
26      7061  6163  6363  6363  6363  6362  6262  6262  6262  6262  6262  6262  6262  6060  6060  6060  6060  6060  6060  6060
27      7081  6062  6262  6262  6262  6262  6262  6262  6262  6262  6262  6262  6262  6060  6060  6060  6060  6060  6060  6060
28      8171  8171  8171  8171  8171  8171  8171  8171  8171  8171  8171  8171  8171  8171  8171  8171  8171  8171  8171  8171
```

M N	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010
2	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010
3	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010
4	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	6060	6050	1010	1010	1010	1010
5	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	6060	6050	1010	1010	1010	1010
6	6262	6262	6262	6262	6262	6260	6050	1010	1010	1010	1010	1010	1010	6060	6060	6060	6050	1010	1010	1010
7	6363	6363	6363	6363	6363	6363	6362	6262	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6050	1010
8	6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6050	1010
9	6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
10	6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
11	6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
12	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	5050
13	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
14	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
15	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
16	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
17	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
18	6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
19	6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
20	6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
21	6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
22	6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	5050
23	6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
24	6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
25	6363	6363	6363	6363	6363	6363	6363	6363	6060	1160	1160	6060	6060	6060	6060	6060	6060	5060	5060	5060
26	6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6050	1010	1010	1010
27	6262	6262	6262	6262	6262	6262	6262	6262	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
28	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171

M	N	41	42	43	44	45	46	47	48	49
1		1010	1010	1010	1010	1010	1010	1010	1010	1010
2		1010	1010	1010	1010	1010	1010	1010	1010	1010
3		1010	1010	1010	1010	1010	1010	1010	1010	1010
4		1010	1010	1010	1010	1010	1010	1010	1010	1010
5		1010	1010	1010	1010	1010	1010	1010	1010	1010
6		1010	1010	1010	1010	1010	1010	1010	1010	1010
7		1010	1010	1010	1010	1010	1010	1010	1010	1010
8		1010	1010	1010	1010	1010	1010	1010	6060	7181
9		6060	6060	6262	6262	6262	6262	6262	6161	7181
10		6060	6060	6363	6363	6363	6363	6363	6161	7181
11		6060	6060	6363	6363	6363	6363	6363	6161	7181
12		6060	6060	6060	6060	6060	6060	6060	6060	7181
13		6060	6060	6060	6060	6060	6060	6060	6060	7181
14		6060	6060	6060	6060	6060	6060	6060	6060	7181
15		6060	6060	6060	6060	6060	6060	6060	6060	7181
16		6060	6060	6060	6060	6060	6060	6060	6060	7181
17		6060	6060	6060	6060	6060	6060	6060	6060	7181
18		6060	6060	6363	6363	6363	6363	6363	6161	7181
19		6060	6060	6363	6363	6363	6363	6363	6161	7181
20		6060	6060	6363	6363	6363	6363	6363	6161	7181
21		6060	6060	6363	6363	6363	6363	6363	6161	7181
22		6060	6060	6363	6363	6363	6363	6363	6161	7181
23		6060	6060	6363	6363	6363	6363	6363	6161	7181
24		6060	6060	6363	6363	6363	6363	6363	6161	7181
25		5060	5060	6063	6263	6263	6263	6263	6061	7181
26		1010	1010	1160	1162	1162	1162	1162	1160	7181
27		6060	6060	6262	6262	6262	6262	6262	6060	7181
28		8171	8171	8171	8171	8171	8171	8171	8171	8171

AD-A157 446 USER GUIDE FOR WIFM-SAL (WES IMPLICIT FLOODING 2/2
MODEL-SAL): A TWO-DIMENSIO..(U) ARMY ENGINEER WATERWAYS
EXPERIMENT STATION VICKSBURG MS ENVIR.. R A SCHMALZ
UNCLASSIFIED MAR 85 WES/IR/EL-85-1 F/G 8/8 NL

END
FILMED
DTIC


1.0
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5.0
5.6
6.3
2.8
3.2
3.6
4.0
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

DEPTH--CARD GROUP 13

M	N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1		10.	10.	10.	10.	10.	10.	10.	-19.	10.	10.	10.	10.	10.	10.	10.	-39.	10.	10.	10.	10.
2		10.	10.	10.	10.	10.	10.	-16.	-16.	10.	-3.	-3.	10.	10.	10.	-17.	-39.	-16.	10.	10.	10.
3		10.	10.	10.	10	10.	-4.	-2.	-11.	-2.	-3.	-3.	10.	10.	10.	-17.	-39.	-16.	10	10.	10.
4		10.	10.	-6.	-6.	-3.	-3.	-2	-7.	-2.	-3.	-3.	10.	10.	10.	-31.	-39.	-16.	10.	10.	10.
5		10.	-4.	-6.	-7.	-6.	-5.	-3.	-3.	-3.	-4.	-4.	-4.	-4.	-4.	-20.	-39.	-7.	10	10.	10
6		-4.	-7.	-8.	-7.	-6.	-5.	-3.	-3.	-4.	-4.	-4.	10.	10.	-4.	-9.	-39.	-7.	-7.	-8.	-5.
7		-5.	-8.	-9.	-8.	-7.	-6.	-6.	-6.	-7.	-7.	-6.	10.	10.	-4.	-9.	-39.	-7.	-7	-7.	-6.
8		-8.	-9.	-9.	-10.	-8.	-7.	-8	-8.	-9.	-9.	-8.	-8.	-8.	-8.	-8.	-39.	-7.	-7.	-7.	-7.
9		-9.	-11.	-12.	-12.	-11.	-9.	-8.	-5.	-7.	-9.	-10.	-10.	-9.	-9.	-8.	-39.	-8.	-7.	-7.	-7.
10		-10.	-12.	-14.	-13.	-13.	-11.	-9.	-7.	-4.	-4.	-6.	-9.	-9.	-9.	-8.	-39.	-9.	-9.	-7.	-7.
11		-11.	-14.	-14.	-14.	-14.	-13.	-12.	-10.	-9.	-4.	10.	-5.	-6.	-7	-10.	-39.	-13.	-9	-7.	-7.
12		-15.	-15.	-15.	-14.	-14.	-13.	-12.	-10.	-9.	-4.	-2.	-3.	-6.	-9.	-11.	-39.	-13.	-9.	-7.	-7.
13		-16.	-16.	-15.	-14.	-14.	-14.	-12.	-10.	-9.	-8.	-3.	-6.	-8.	-10.	-13.	-39.	-13.	-11.	-10.	-10.
14		-17.	-16.	-14.	-14.	-14.	-14.	-13.	-10.	-9.	-8.	-3.	-6.	-8.	-10.	-11.	-39.	-39.	-39.	-39.	-39.
15		-17.	-16.	-14.	-14.	-14.	-14.	-13.	-10.	-9.	-8.	-3.	-6.	-8.	-10	-11.	-11.	-11.	-11.	-11.	-11.
16		-16.	-16.	-15.	-14.	-14.	-14.	-13.	-11.	-9.	-8.	-3.	-8.	-9.	-10.	-11.	-11.	-11.	-11.	-11.	-12.
17		-16.	-16.	-15.	-14.	-14.	-14.	-12	-10.	-9.	-7.	-3.	-8.	-10.	-10.	-11.	-11.	-11.	-11.	-11.	-11.
18		-16.	-16.	-15.	-14.	-14.	-14.	-12.	-10.	-8.	-7.	-5.	-8.	-10.	-10.	-11.	-11.	-11.	-11.	-11.	-11.
19		-15.	-16	-15.	-14.	-11.	-13.	-11.	-10.	-8.	-6.	-8.	-9.	-10.	-11.	-11.	-11.	-11.	-11.	-11.	-12.
20		-15.	-13.	-15.	-13.	-11.	-12.	-12.	-9.	-9.	-9.	-11.	-12.	-13.	-13.	-13.	-13.	-13.	-13.	-14.	-15.
21		-11.	-11.	-14.	-14.	-12.	-10.	-13.	-10.	-11.	-12.	-12.	-12.	-13.	-14.	-14.	-14.	-14.	-14.	-14.	-15.
22		-3.	-7.	-13.	-9.	-10.	-11.	-14.	-15.	-14.	-14.	-14.	-15.	-15.	-16.	-17.	-17.	-17.	-17.	-17.	-18.
23		10.	10.	-13.	-7.	-14.	-10.	-13.	-14.	-14.	-15.	-16.	-17.	-17.	-17.	-17.	-17.	-17.	-17.	-17.	-17.
24		-21.	-23.	10.	-11.	-11.	-11.	-13.	-15.	-15.	-17.	-18.	-18.	-17.	-16.	-15.	-15.	-15.	-15.	-14.	-14.
25		-28.	-30.	-26.	-25.	-23.	-25.	10.	10.	-4.	-4.	-6.	-10.	-6.	-11.	-9.	-7.	-7.	-7.	-9.	-9.
26		-36.	-35.	-33.	-33.	-33.	-33.	-29.	-29.	-28.	-29.	-16.	-21.	-21.	-22.	-21.	-21.	-21.	-21.	-21.	-23.
27		-37.	-37.	-39.	-39.	-39.	-39.	-37.	-39.	-36.	-37.	-38.	-36.	-36.	-38.	-34.	-33.	-33.	-33.	-33.	-33.
28		-41.	-41.	-41.	-41.	-41.	-41.	-41	-41.	-41.	-41.	-42.	-43.	-42.	-42.	-41.	-41.	-41.	-41.	-41.	-41.

M	N	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1		10	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.
2		10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.
3		10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.
4		10.	10.	10.	10.	10.	10.	10	10.	10.	10.	10.	10.	10.	10.	-16.	-39.	10.	10.	10.	10.
5		10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	-16.	-39.	10.	10.	10.	10
6		-6.	-7.	-7.	-6.	-6.	-6.	-6.	10.	10.	10.	10.	10.	10.	-11.	-16.	-39.	-27.	10.	10.	10.
7		-6.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-39.	-7.	-4.	-3.	10.
8		-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-9.	-8.	-8.	-8.	-8.	-39.	-7.	-5.	-3.	10.
9		-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-8.	-8.	-8.	-8.	-8.	-39.	-7.	-7.	-7.	-7.
10		-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-8.	-8.	-8.	-9.	-9.	-9.	-9.	-39.	-8.	-8.	-8.	-8.
11		-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-8.	-9.	-9.	-10.	-10.	-10.	-10.	-39	-10.	-10.	-10.	-10.
12		-7.	-7.	-8.	-8.	-8.	-8.	-8.	-8.	-8.	-9.	-10.	-11.	-11.	-11.	-11.	-39.	-11.	-11.	-11.	-11.
13		-11.	-11.	-11.	-11.	-11.	-11.	-11.	-11.	-12.	-12.	-13.	-13.	-13.	-13.	-13.	-39.	-14.	-14.	-14.	-14.
14		-39.	-39.	-39.	-39.	-39.	-39.	-39.	-39.	-39.	-39.	-39.	-39.	-39.	-39.	-39.	-39.	-14.	-14.	-14.	-14.
15		-11.	-11.	-11.	-11.	-12.	-11.	-12.	-13.	-13.	-13.	-13.	-13.	-13.	-13.	-13.	-39.	-15.	-15	-15.	-15.
16		-12.	-13.	-14.	-16.	-15.	-15.	-13.	-13.	-13.	-13.	-13.	-13.	-13.	-13.	-13.	-39.	-16.	-16.	-16.	-16.
17		-12.	-13.	-14.	-16.	-15.	-15.	-13.	-13.	-13.	-14.	-14.	-14.	-14.	-15.	-15.	-39.	-16.	-16.	-16.	-16.
18		-12.	-13.	-14.	-16.	-17.	-16.	-16	-15.	-11.	-16.	-16.	-16.	-16.	-17.	-17.	-39.	-17.	-17.	-17.	-17.
19		-13.	-13.	-15.	-15.	-17.	-17.	-17.	-16.	-12.	-17.	-17.	-17.	-17.	-17.	-17.	-39.	-17.	-17.	-17.	-17.
20		-14.	-15.	-15.	-16.	-16.	-17.	-17.	-17.	-17.	-16.	-15.	-16.	-17.	-18.	-19.	-39.	-18.	-18.	-19.	-18.
21		-16.	-17.	-16.	-16.	-17.	-17.	-17.	-17.	-18.	-18.	-15.	-15.	-17.	-19.	-19.	-39.	-19.	-19.	-19.	-19.
22		-17.	-16.	-15.	-16.	-16.	-15.	-17	-16.	-16.	-17.	-17.	-18.	-16.	-18.	-19.	-39.	-19.	-19.	-19.	-21.
23		-17.	-16.	-16.	-14.	-15.	-15.	-16.	-16.	-15.	-15.	-15.	-15.	-16.	-16.	-17.	-39.	-19.	-18.	-18.	-19.
24		-15.	-14.	-13.	-14.	-16.	-19.	-19.	-17.	-16.	-15.	-14.	-16.	-11.	-16	-16.	-39	-17.	-15.	-16.	-16.
25		-8.	-8.	-10.	-13.	-11.	-11.	-12.	-11.	-16.	-16.	-16.	-16.	-19.	-17.	-13.	-39.	-22.	-20.	-20.	-20.
26		-23.	-20.	-20.	-16.	-16.	-14.	-11.	-13.	-15.	-21.	-23.	-26.	-41.	-36.	-50.	-39.	-16.	10.	10.	10.
27		-34.	-34.	-32.	-30.	-28.	-31.	-29.	-19.	-19.	-21.	-21.	-26.	-26.	-26.	-26.	-39.	-21.	-21.	-21.	-21.
28		-36.	-36	-38.	-36.	-38.	-38.	-38.	-34.	-36.	-37.	-37.	-37.	-37.	-37.	-37.	-39.	-37.	-37.	-37.	-37.

M	N	41	42	43	44	45	46	47	48	49
1	1	10.	10.	10.	10.	10.	10.	10.	10.	10.
2		10.	10.	10.	10.	10.	10.	10.	10.	10.
3		10.	10.	10.	10.	10.	10.	10.	10.	10.
4		10.	10.	10.	10.	10.	10.	10.	10	10.
5		10	10	10.	10.	10.	10.	10.	10.	10.
6		10.	10.	10.	10.	10.	10.	10.	10.	10.
7		10.	10.	10.	10.	10.	10.	10.	10.	10.
8		10	10.	10.	10.	10.	10.	10.	-7.	-9.
9		-7.	-6.	-6.	-4.	-4.	-4.	-7.	-9.	-6.
10		-9.	-9	-9.	-9.	-10.	-10.	-11.	-10.	-6.
11		-10.	-12.	-12.	-12.	-13.	-12.	-12.	-10.	-8.
12		-11.	-12.	-14.	-13.	-13.	-14.	-13.	-11.	-8.
13		-14.	-14.	-15.	-14.	-15.	-14.	-13.	-12.	-9.
14		-14.	-14.	-15.	-15.	-15.	-14.	-13.	-12.	-9.
15		-15.	-15.	-15.	-15.	-15.	-14.	-13.	-12.	-9.
16		-16.	-16.	-16.	-16.	-15.	-16.	-14	-13.	-9.
17		-16.	-16.	-16.	-16.	-17.	-16.	-15	-13.	-9.
18		-17.	-17.	-17.	-17.	-17.	-17.	-16	-14.	-10.
19		-18.	-18	-18.	-18.	-18.	-17.	-16.	-15.	-13.
20		-18.	-19.	-19.	-18.	-18.	-18.	-17.	-16.	-15.
21		-19.	-19.	-19.	-18.	-18.	-18.	-17.	-17.	-15.
22		-20.	-20.	-20.	-20.	-20.	-19.	-19.	-18.	-17.
23		-18.	-17	-18.	-17.	-19.	-20.	-19.	-20.	-18.
24		-16.	-16	-15.	-15.	-16.	-17.	-19.	-17.	-20.
25		-20.	-18.	-16.	-12.	-13.	-15.	-11.	-15.	-15.
26		10.	10.	-9.	-9.	-9.	-7.	-11.	-11.	-16.
27		-21.	-21.	-24.	-16.	-16.	-13.	-12.	-13.	-11.
28		-37	-36	-38.	-38.	-39.	-36.	-36.	-35.	-31.

```
CHEZY COEFFICIENT

 M  N     1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18    19    20

  1        0.    0.    0.    0.    0.    0.    0.  243.    0.    0.    0.    0.    0.    0.    0.  274.    0.    0.    0.    0.
  2        0.    0.    0.    0.    0.    0.  118.  118.    0.   81.   81.    0.    0.    0.  119.  171.  118.    0.    0.    0.
  3        0.    0.    0.    0.    0.   85.   76   111.   76.   81.   81.    0.    0.    0.  119.  171.  118.    0.    0.    0
  4        0.    0.   96.   96.   81.   81.   76.   98.   76.   81.   81.    0.    0.    0.  155.  171.  118.    0.    0.    0.
  5        0.   85.  100.   98.   96.   93.   81.   81.   81.   85.   85.   85.   85    85.  129.  171.   98.    0.    0.    0.
  6       85.   98   100.   98.   96.   93.   81.   81.   85.   85.   85.    0.    0.   85.  102.  171.   98.   98.  100.   93.
  7       93.  100.  102.  100.   98.   96.   96.   96.   98.   98.   96.    0.    0.   85.  102.  171.   98.   99.   98.   96
  8      100.  102.  102.  109.  100.   99.  100.  100.  102   102.  100.  100.  100.  100.  100.  171.   98.   98.   98.   98.
  9      102   111.  113.  113.  111.  102.  100.   93.   98.  102.  109.  109   102.  102.  100.  171.  100.   98.   98.   98.
 10      109.  113.  116.  114.  114.  111.  102.   96.   85.   85.   96.  102.  102.  102.  100.  171.  102.  102.   98.   98.
 11      111.  116.  116.  116.  116.  114.  113.  109.  102.   85.    0.   93.   96.   98.  109   171   114.  102.   98.   98.
 12      117.  117.  117.  116.  116.  114.  113   109.  102.   85.   76.   81.   96.  102.  111.  171.  114.  102.   98.   99.
 13      118   118.  117.  116.  116.  116.  113.  109.  102.  100.   81.   96.  100.  109.  114.  171.  114.  111.  109.  109.
 14      119.  118.  116.  116.  116.  116.  114.  109.  102.  100.   81.   96.  100.  109   111.  171.  171.  171.  171.  171.
 15      119.  116.  116.  116.  116.  116.  114.  109.  102.  100.   81.   96.  100.  109.  111.  111.  111.  111.  111.  111.
 16      118.  118.  117.  116.  116.  116.  114.  111.  102.  100.   81.  100.  102.  109.  111.  111.  111.  111.  111.  113.
 17      118.  116.  117.  116.  116.  116.  113.  109.  102.   98.   81.  100.  109.  109   111.  111   111.  111.  111.  111.
 18      118   118   117.  116.  116.  116.  113.  109.  100.   98.   93.  100.  109.  109   111.  111.  111.  111.  111.  111.
 19      117.  119.  117.  116.  111.  114.  111.  109.  100.   96.  100.  102.  109.  111.  111.  111.  111.  111.  111.  113.
 20      117.  114.  117.  114.  111.  113.  113.  102.  102.  102.  111.  113.  114.  114.  114.  114.  114.  114.  116.  117.
 21      111   111   116.  116.  113.  109.  114   109.  111.  113.  113.  113.  114.  116.  116.  116.  116.  116.  116.  118.
 22       81.   98.  114.  102.  109.  111.  116.  117.  116.  116.  116.  117.  117.  118.  119.  119.  119.  119.  119.  121.
 23        0.    0.  114.   98.  116.  109.  114.  116.  116.  117.  118.  119.  119.  119.  119.  119.  119.  119.  119.  119.
 24      130.  132.    0.  111.  111.  111.  114.  117.  117.  119.  121.  121.  119.  118.  117.  117.  117.  117.  116.  116.
 25      144.  154.  142.  142.  132.  142.    0.    0.   85.   85.   96.  109.   96.  111.  102.   98.   98.   98.  102.  102.
 26      165.  168.  157.  157.  157.  157.  145.  145.  144.  145.  118.  130.  130.  131.  130.  130.  130.  130.  130.  132.
 27      170.  170.  171.  171.  171.  171.  170   171.  171.  170.  171.  169.  169.  171.  158.  157.  157.  157.  157.  157.
 28      277.  184.  184.  184.  184.  184.  184.  184.  184.  184.  185.  186   185.  185.  184.  184.  184.  184.  184.  184.
```

M N	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.	0.
4	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	118.	171.	0.	0.	0.	0.
5	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	118.	171.	0.	0	0.	0.
6	96.	98.	98.	96.	96.	96.	96.	0.	0.	0.	0.	0.	0.	111.	118.	171.	143.	0.	0.	0.
7	96	98.	98.	98.	98.	98.	98.	98.	98.	98.	98.	98.	98.	98.	98.	171.	98.	85.	81.	0.
8	98.	98.	98.	98.	98.	98.	98.	98.	98.	98.	100.	100.	100.	100	100.	171.	98.	93.	81.	0.
9	98	98.	98.	98.	98.	98.	98.	98.	98.	98.	100.	100.	100.	100.	100.	171.	98.	99.	98.	98.
10	98.	98.	98.	98.	98.	98.	98.	98.	100.	100.	100.	102.	102.	102.	102.	171.	100.	100	100.	100.
11	98	96	98.	98.	98.	98.	98.	96.	100.	102.	102.	109.	109.	109.	109.	171.	109.	109.	109.	109.
12	96.	96.	100.	100.	100.	100.	100.	100.	100.	102.	109.	111	111.	111.	111.	171.	111.	111.	111.	111.
13	111.	111.	111.	111.	111.	111.	111.	111.	113.	113.	114.	114.	114.	114.	114.	171.	116.	116.	116.	116.
14	171.	171.	171.	171.	171.	171.	171.	171.	171.	171.	171.	171.	171.	171.	171.	171.	116.	116.	116.	116.
15	111.	111.	111.	111.	113.	111.	113.	114.	114.	114.	114.	114.	114.	114.	114.	171.	117.	117.	117.	117.
16	113	114.	116.	119.	117.	117.	114.	114.	114.	114.	114.	114.	114.	114.	114.	171.	118.	119.	118.	119.
17	113.	114.	116.	116.	117.	117.	114.	114.	114.	116.	116.	116.	116.	117.	117.	171.	118.	119.	118.	118.
18	113.	114.	116.	118.	119.	118.	118.	117.	111.	118.	118.	118.	118.	119.	119.	171.	119.	119.	119.	119.
19	114.	114.	117.	117.	119.	119.	119.	118.	113.	119.	119.	119.	119.	119.	119.	171.	119.	119.	119.	119.
20	116.	117.	117.	118.	118.	119.	119.	119.	119.	118.	117.	118.	119.	121.	122.	171.	121.	121.	121.	121.
21	118.	119.	118.	118.	119.	119.	119.	119.	121.	121.	117.	119.	119.	122.	122.	171.	122.	122.	122.	122.
22	119	118	117.	118.	118.	117.	119.	116.	118.	119.	119.	121.	118.	121.	122.	171.	122.	122.	122.	130.
23	119.	118.	119.	116.	117.	117.	118.	116.	117.	117.	117.	117.	118.	118.	119.	171.	122.	121.	121.	121.
24	117.	116.	114.	116.	118.	122.	122.	119.	118.	117.	116.	118	111.	118.	118.	171.	119.	117.	118.	118.
25	100.	100.	109.	114.	111.	111.	113.	111.	118.	118.	119.	119.	122.	119.	114.	171.	131.	129.	129.	129.
26	132.	129.	129.	121.	116.	116.	111.	114.	117.	130.	132.	142.	184.	169.	204.	171.	118.	0.	0.	0
27	158.	156.	156.	154.	144.	155.	145.	122.	122.	130.	130.	142.	142.	142.	142.	171.	130.	130.	130.	130.
28	169.	169.	171.	171.	171.	171.	171.	158.	169.	170.	170.	170.	170.	170.	170.	171.	170.	170.	170.	170.

```
INITIAL SALINITY DISTRIBUTION
 M  N     1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18    19    20

    1    0.    0.    0.    0.    0.    0.    0.   24.    0.    0.    0.    0.    0.    0.    0.   24.    0.    0.    0.    0.
    2    0.    0.    0.    0.    0.    0.   24.   24.    0.   24.   24.    0.    0.    0.   25.   25.   25.    0.    0.    0.
    3    0.    0.    0.    0.    0.   24.   24.   24.   24.   24.   24.    0.    0.    0.   25.   25.   25.    0.    0.    0.
    4    0.    0.   24.   24.   24.   24.   24.   24.   24.   24.   24.    0.    0.    0.   26.   26    25.    0.    0.    0.
    5    0.   24.   24.   24.   24.   24.   24.   24.   24.   24.   24.   25.   25.   26.   26.   27.   26.    0.    0.    0.
    6   24    25.   25.   25.   25.   25.   25.   25.   25.   25.   25.    0.    0.   28.   28.   28.   28.   28.   28.   28.
    7   24    25.   25.   25.   25.   25.   26.   26.   26.   27.   27.    0.    0.   27.   27.   28.   28.   28.   28.   28.
    8   25.   25.   25.   25.   25.   25.   26.   26.   26.   27.   27.   27.   28.   28.   28.   28.   28.   28.   28.   29.
    9   26.   26.   26.   26.   26.   26.   26.   26.   26.   27.   27.   27.   28.   28.   28.   28.   28.   28.   28.   28.
   10   26.   26.   26.   26.   27.   27.   27.   27.   27.   28.   28.   28.   28.   28.   28.   28.   28.   28.   28.   28.
   11   26.   26.   26.   26.   27.   27.   27.   27.   27.   28.    0.   28    28.   28    28.   28.   28.   28.   28.   28.
   12   26    26.   27.   27.   27.   27.   27    27.   27.   28.   28.   28.   28.   28    28.   28.   28.   28.   28.   28.
   13   26.   26.   27.   27.   27.   27.   27.   27.   27.   28.   28.   28.   28.   28.   28.   28.   28.   28.   28.   28.
   14   26.   26.   27.   27.   27.   27.   27.   27.   27.   28.   28.   28.   28.   28.   28.   28.   28.   28.   28.   28.
   15   26.   26.   27.   27.   27.   27.   27.   27.   27.   28.   28.   28.   28.   28.   28.   28.   28.   28.   28.   28.
   16   26    26.   27.   27.   27.   27.   27.   27.   27.   28.   29.   28.   28.   28.   28.   28.   28.   28.   28.   28.
   17   26    26    27.   27.   27.   27.   27.   27.   27.   28.   28.   28.   28.   28.   28.   28.   28.   28    28.   28.
   18   26.   26.   27.   27.   27.   27.   27.   27.   27.   28.   28.   28.   29.   28.   28.   28.   28.   29.   28.   28.
   19   27.   26.   27.   27.   27.   27.   27.   27.   27.   28.   28.   28.   28.   28.   28.   28.   28.   29.   28.   28.
   20   27.   27.   27.   27.   27.   27.   27.   27.   27.   27.   27.   27.   28.   28.   28.   28.   28.   29.   28.   28.
   21   27.   27.   27.   27.   27.   27.   27.   27.   27.   27.   27.   27.   28.   28.   28.   28.   28.   28.   28.   28.
   22   27.   27.   27.   27.   27.   27.   27.   27.   27.   27.   27.   27.   28.   28.   28.   28.   28.   29.   28.   28.
   23    0.    0.   27.   27.   27.   27.   27.   27.   27.   27.   27.   27.   28.   28.   28.   28.   28.   28.   28.   29.
   24   28.   27.    0.   27.   27.   27.   27.   27.   27.   27.   27.   27.   28.   28.   28.   28.   28.   28.   28.   28.
   25   28.   28.   27.   27.   27.   27.    0     0.   27.   27.   27.   27.   28.   28    28.   28.   28.   28.   28.   28.
   26   28.   28.   27.   27.   27.   27.   28.   26.   28.   28.   28.   28.   28.   28.   28.   28.   28.   28.   28.   29.
   27   26.   28.   28.   28.   28.   28.   28.   28.   28.   28.   28.   28.   28.   28.   28.   28.   28.   28.   28.   29.
   28   30.   30.   30.   30.   30.   30.   30.   30.   30.   30.   30.   30.   30.   30    30.   30.   30.   30.   30.   30.
```

X DISPERSION COEFFICIENT FACTOR

M N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0.	0	0.	0.	0.	0.	0.	57.	0.	0.	0.	0.	0.	0.	0.	57.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	2.	57.	0	2.	2.	0.	0.	0.	2.	57.	2.	0.	0.	0.
3	0.	0.	0.	0.	0.	2.	57.	57.	2.	57.	57.	0	0.	0.	57.	57.	57.	0.	0.	0.
4	0.	0.	2.	2.	2.	57.	57.	57.	57.	57.	57.	0.	0.	0.	57.	57	57.	0.	0.	0.
5	0.	2.	57.	57	57.	57.	57.	57.	57.	57.	57.	0.	0.	2.	57.	57.	57.	0.	0.	0.
6	0.	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	0.	0.	57.	57.	57.	57.	2.	2.	2.
7	0.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	0.	0.	57.	57.	57.	57.	57.	57.	57.
8	0.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	2.	2.	57	57.	57.	57.	57.	57.	57.
9	0.	57.	57.	57.	57.	57.	57	57.	57.	2.	2.	57.	57.	57	57	57.	57.	57.	57.	57.
10	0.	57	57.	57.	57.	57.	57.	57.	57.	0.	0.	57.	57.	57.	57.	57.	57.	57.	57.	57.
11	0.	57.	57.	57.	57.	57.	57.	57.	57.	2	0.	57	57.	57	57.	57.	57.	57.	57.	57.
12	0.	57.	57.	57.	57.	57.	57.	57.	57.	57.	2.	57.	57.	57	57.	57.	57.	57.	57.	57.
13	0.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
14	0.	57.	57.	57.	57.	57.	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
15	0.	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
16	0.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57	57.	57.	57.	57.	57.	57.
17	0.	57.	57	57.	57.	57.	57.	57.	57.	57.	57.	57	57.	57	57.	57.	57.	57.	57.	57.
18	0.	57.	57.	57.	57.	57	57.	57.	57.	57.	57.	57.	57.	57.	57	57	57.	57.	57.	57.
19	0.	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
20	0.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
21	0.	2.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
22	0.	0.	2.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57
23	0.	0.	0.	2.	2.	2.	2.	2.	57.	57	57.	57.	57.	57	57.	57.	57.	57.	57.	57.
24	0.	2.	0.	0.	0.	0.	0	0.	2.	2.	2.	2.	2.	2.	2.	2.	57.	57.	57.	57.
25	0.	57.	2.	2.	2.	2.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	57.	57.	57.	57.
26	0.	57.	57.	57.	57.	57.	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.	57.	57.	57.	57.
27	0.	57.	57.	57.	57.	57.	57.	57.	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
28	57.	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57	57.	57.	57.	57.	57.	57.	57.	57.

```
A DISPERSION COEFFICIENT OFFSET
  M  N     1    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16   17   18   19   20

     1    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
     2    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
     3    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
     4    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
     5    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
     6    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
     7    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
     8    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
     9    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
    10    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
    11    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
    12    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
    13    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
    14    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
    15    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
    16    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
    17    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
    18    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
    19    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
    20    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
    21    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
    22    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
    23    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
    24    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
    25    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
    26    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
    27    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
    28    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
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Y DISPERSICN COEFFICIENT FACTOR

M N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	0.	0.	0.	0.	2.	2.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	2.	0.	0.	2.	2.	0.	0.	0.	0.	2.	2.	0.	0.	0.	0.
4	0.	0.	2.	57.	57.	57.	57.	57.	57.	2.	0.	0.	0.	0.	2.	2.	0.	0.	0.	0.
5	0	2.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57	57.	2	0.	0	0.	0.
6	57.	57.	57.	57.	57.	57.	57	57.	57.	2.	0.	0.	0.	2.	57.	57.	57.	57.	57.	57.
7	57.	57.	57.	57.	57.	57.	57.	57.	57.	2.	0.	0.	0.	2.	57.	57.	57.	57.	57.	57.
8	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	2.	0.	2	57.	57.	57.	57.	57.	57.
9	57.	57.	57.	57.	57.	57.	57	57.	57.	57.	57.	57.	57.	57.	57	57.	57.	57.	57.	57.
10	57.	57	57.	57.	57.	57.	57	2.	0.	2.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
11	57.	57.	57.	57.	57.	57.	57.	57.	2.	0.	0.	2.	57.	57	57.	57.	57.	57.	57.	57.
12	57	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57	57.	57.	57.	57.	57.	57.
13	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
14	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57
15	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57	57.	57.	57.	57.	57.	57.
16	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
17	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57	57.	57.	57.	57	57.	57.	57.	57.
18	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57	57.	57	57.	57	57.	57.	57.	57.
19	57.	57.	57.	57.	57.	57.	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
20	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57	57.	57	57.	57	57.	57.	57.	57.
21	57.	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57	57.	57.	57.	57.	57.	57.
22	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
23	0.	0.	2.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
24	57.	0.	0.	2.	57.	57.	57.	57.	57.	57.	57.	57	57.	57	57.	57	57.	57.	57.	57.
25	57.	57.	57.	57.	2.	0.	0.	0.	2.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
26	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
27	57.	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
28	0.	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.	0.

```
Y DISPERSION COEFFICIENT FACTOR OFFSET
 M  N     1    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16   17   18   19   20
  1       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
  2       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
  3       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
  4       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
  5       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
  6       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
  7       0    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
  8       0.   0    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
  9       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
 10       0.   0.   0.   0.   0.   0.   0    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
 11       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0    0.   0.   0.   0.   0.   0.   0.   0.
 12       0    0.   0.   0.   0.   0.   0    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0    0.
 13       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
 14       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
 15       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
 16       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0    0.   0.   0.   0.   0.   0.
 17       0.   0.   0.   0.   0.   0.   0    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
 18       0.   0.   0.   0.   0.   0    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
 19       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
 20       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0    0.   0.   0.   0.   0.   0.   0.   0.
 21       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
 22       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
 23       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
 24       0 .  0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
 25       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
 26       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
 27       0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
 29       0.   0.   0.   0.   0.   0.   0.   0.   0.   0    0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
```

```
BARRIER ARRAY.
      1           2       1       1       7       2
      2           2       1       1       7       3
      3           2       1       1       8       3
      4           2       1       1      13       6
      5           2       1       1       9      10
      6           1       1       1      10      10
      7           1       1       1       4      24
      8           1       1       1       5      24
      9           1       1       1       6      24
     10           1       1       1       9      25
     11           1       1       1      10      25
     12           1       1       1      11      25
     13           1       1       1      12      25
     14           1       1       1      13      25
     15           1       1       1      14      25
     16           1       1       1      15      25
     17           1       1       1      16      25
     18           1       1       1      30      25
     19           1       1       1      31      25
     20           1       1       1      43      26
     21           1       1       1      44      26
     22           1       1       1      45      26
     23           1       1       1      46      26
     24           1       1       1      47      26
     25           1       1       1      48      26
```

```
TIDAL AND DISCHARGE BOUNDARY VECTORS---TRANSMISSION BOUNDARY VECTOR
          1    21001006    11008001          0
          2    21001007    12016001          0
          3    21001008
          4    21001009
          5    21001010
          6    21001011
          7    21001012
          8    21001013
          9    21001014
         10    21001015
         11    21001016
         12    21001017
         13    21001018
         14    21001019
         15    21001020
         16    21001021
         17    21001022
         18    21001024
         19    21001025
         20    21001026
         21    21001027
         22    21001028
         23   121049008
         24   121049009
         25   121049010
         26   121049011
         27   121045012
         28   121049013
         29   121049014
         30   121049015
         31   121049016
         32   121049017
         33   121049018
         34   121049019
         35   121049020
         36   121049021
         37   121049022
         38   121049023
         39   121049024
         40   121049025
         41   121049026
         42   121049027
         43   121049028
         44   111001029
         45   111002028
         46   111003028
         47   111004028
         48   111005028
         49   111006028
         50   111007028
         51   111008028
         52   111009028
         53   111010028
         54   111011028
         55   111012028
         56   111013028
         57   111014028
         58   111015028
         59   111016028
```

```
60   111017028
61   111018028
62   111019028
63   111020028
64   111021028
65   111022028
66   111023028
67   111024028
68   111025028
69   111026028
70   111027028
71   111028028
72   111029028
73   111030028
74   111031028
75   111032028
76   111033028
77   111034028
78   111035028
79   111036028
80   111037028
81   111038028
82   111039028
83   111040028
84   111041028
85   111042028
86   111043028
87   111044028
88   111045028
89   111046028
90   111047028
91   111048028
92   111049028
```

```
DISCHARGE FLOWS
     1        1152.968  1729.951
    61        1151.051  1727.035
   121        1149.135  1724.118
   181        1147.218  1721.201
   241        1145.301  1718.285
   301        1143.385  1715.368
   361        1141.468  1712.451
   421        1139.551  1709.535
   481        1137.635  1706.618
   541        1135.718  1703.701
   601        1133.801  1700.785
   661        1131.885  1697.868
   721        1129.966  1694.951
   781        1128.051  1692.035
   841        1126.135  1689.118
   901        1124.218  1686.201
   961        1122.361  1683.285
  1021        1120.385  1680.368
  1081        1118.468  1677.451
  1141        1116.551  1674.535
  1201        1114.635  1671.618
  1261        1112.718  1668.701
  1321        1110.801  1665.785
  1381        1108.885  1662.868
  1441        1106.968  1659.976
  1501        1106.026  1658.560
  1561        1105.067  1657.143
  1621        1104.109  1655.726
  1681        1103.151  1654.310
  1741        1102.192  1652.893
  1801        1101.234  1651.476
  1861        1100.276  1650.060
  1921        1099.317  1648.643
  1981        1098.359  1647.226
  2041        1097.401  1645.810
  2101        1096.442  1644.393
  2161        1095.484  1642.976
  2221        1094.526  1641.560
  2281        1093.567  1640.143
  2341        1092.609  1638.726
  2401        1091.651  1637.310
  2461        1090.692  1635.893
  2521        1089.734  1634.476
  2581        1088.776  1633.060
  2641        1087.817  1631.643
  2701        1086.859  1630.226
  2761        1085.901  1628.810
  2821        1084.942  1627.393
  2881        1083.964  1625.946
  2941        1081.797  1622.696
  3001        1079.631  1619.446
  3061        1077.464  1616.196
  3121        1075.297  1612.946
  3181        1073.131  1609.696
  3241        1070.964  1606.446
  3301        1068.797  1603.196
  3361        1066.631  1599.946
  3421        1064.464  1596.696
  3481        1062.297  1593.446
  3541        1060.131  1590.196
  3601        1057.964  1586.946
  3661        1055.797  1583.696
```

```
DISCHARGE SALINITIES
      1        0.000      0.000
     61        0.000      0.000
    121        0.000      0.000
    181        0.000      0.000
    241        0.000      0.000
    301        0.000      0.000
    361        0.000      0.000
    421        0.000      0.000
    481        0.000      0.000
    541        0.000      0.000
    601        0.000      0.000
    661        0.000      0.000
    721        0.000      0.000
    781        0.000      0.000
    841        0.000      0.000
    901        0.000      0.000
    961        0.000      0.000
   1021        0.000      0.000
   1081        0.000      0.000
   1141        0.000      0.000
   1201        0.000      0.000
   1261        0.000      0.000
   1321        0.000      0.000
   1381        0.000      0.000
   1441        0.000      0.000
   1501        0.000      0.000
   1561        0.000      0.000
   1621        0.000      0.000
   1681        0.000      0.000
   1741        0.000      0.000
   1801        0.000      0.000
   1861        0.000      0.000
   1921        0.000      0.000
   1981        0.000      0.000
   2041        0.000      0.000
   2101        0.000      0.000
   2161        0.000      0.000
   2221        0.000      0.000
   2281        0.000      0.000
   2341        0.000      0.000
   2401        0.000      0.000
   2461        0.000      0.000
   2521        0.000      0.000
   2581        0.000      0.000
   2641        0.000      0.000
   2701        0.000      0.000
   2761        0.000      0.000
   2821        0.000      0.000
   2881        0.000      0.000
   2941        0.000      0.000
   3001        0.000      0.000
   3061        0.000      0.000
   3121        0.000      0.000
   3181        0.000      0.000
   3241        0.000      0.000
   3301        0.000      0.000
   3361        0.000      0.000
   3421        0.000      0.000
   3481        0.000      0.000
   3541        0.000      0.000
   3601        0.000      0.000
   3661        0.000      0.000
```

```
1 SALINITY AT T      120 0000 HRS      ITIME = 7200

 M  N     1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18    19    20
     1    0.    0.    0.    0.    0.    0.    0.    0.    0.    0.    0.    0.    0.    0.    0.    0.    0.    0.    0.    0.
     2    0.    0.    0.    0.    0     0. 2377    10    0. 2909. 2903.    0.    0     0. 2879. 1861. 2687.    0.    0.    0.
     3    0.    0.    0.    0.    0. 2155. 1040.  276. 2571. 2480. 2405.    0.    0.    0.  827.  853. 1403.    0.    0.    0.
     4    0.    0. 2330. 2214. 1914  1253. 1708. 1081. 2480  2474. 2569.    0.    0.    0. 2461.  741. 2183.    0.    0.    0.
     5    0. 2409. 2402. 2631. 2475  2417  2671. 1467. 2530  2660. 2663. 2687. 2711. 2518. 2547.  779. 1665.    0.    0.    0.
     6 2443. 2440. 2516. 2795. 2794. 2814. 2814. 2778. 2750. 2720. 2565.    0.    0. 2090. 2431. 1994. 2626. 2783. 2800. 2800.
     7 2433. 2445. 2577. 2743. 2739. 2758. 2775. 2728. 2693. 2589. 2448.    0.    0. 2102. 2369. 2124. 2479. 2584. 2737. 2735.
     8 2422. 2450. 2590. 2740. 2758. 2767. 2769. 2730. 2624. 2432. 2319. 2296. 2279. 2193. 2367. 1956. 1833. 1892. 2383. 2556.
     9 2465. 2455. 2629. 2746. 2719  2754. 2777. 2814. 2813. 2714. 2379. 2270. 2265. 2266. 2459. 1897. 1860. 2097. 2172. 2319.
    10 2459. 2464. 2700. 2731. 2700  2705. 2746  2807. 2820. 2796. 2791. 2719. 2520. 2394. 2459. 1957. 2044. 2205. 2342. 2468.
    11 2545. 2546. 2724. 2712. 2701  2713  2742  2794. 2792. 2740.    0. 2605. 2601  2513. 2405. 2077. 2190. 2298. 2430. 2379.
    12 2570. 2554. 2724. 2702. 2702. 2715. 2772. 2826. 2801. 2747. 2726. 2750. 2648. 2516. 2479. 2212. 2249. 2249. 2354. 2377.
    13 2558. 2607. 2724. 2659. 2707. 2727. 2751. 2826. 2823. 2783. 2792. 2739. 2739. 2712. 2499. 2259. 2262. 2255. 2296. 2303.
    14 2606. 2610. 2724. 2699. 2706. 2725. 2772. 2827. 2805. 2788. 2810. 2740. 2719. 2576. 2379. 2274. 2276. 2267. 2277. 2277.
    15 2616. 2614. 2724. 2699. 2706  2727. 2791  2827. 2809. 2802. 2812. 2727. 2707. 2711. 2420. 2264. 2275. 2262. 2310. 2420.
    16 2627. 2614. 2724. 2699. 2706. 2725. 2775. 2827. 2810. 2797. 2816. 2751. 2707. 2556. 2364. 2400. 2274. 2306. 2397. 2366.
    17 2641. 2623. 2724. 2659. 2709. 2730. 2792. 2826. 2813. 2802. 2819. 2759. 2737. 2703. 2313. 2457. 2407. 2405. 2439. 2499.
    18 2684. 2623. 2721. 2699. 2711. 2737. 2789. 2831. 2810. 2815. 2819. 2836. 2838. 2842. 2689. 2650. 2742. 2677. 2797. 2793.
    19 2702. 2664. 2718. 2699. 2715. 2751. 2803. 2843. 2811. 2824. 2836. 2859. 2878. 2855. 2827. 2843. 2845. 2839. 2836. 2816.
    20 2725. 2706. 2788. 2705. 2721. 2782. 2825. 2851. 2814. 2829. 2838. 2868. 2885. 2879. 2863. 2866. 2856. 2853. 2838. 2828.
    21 2658. 2697. 2702. 2705. 2731. 2811. 2836. 2867. 2845. 2894. 2898. 2885. 2892. 2889. 2870. 2867. 2854. 2851. 2840. 2836.
    22 2665. 2655. 2702. 2710. 2752  2847. 2864  2860  2878. 2915. 2906. 2896. 2918  2891. 2876. 2876. 2870. 2873. 2973. 2999.
    23    0.    0. 2702. 2716. 2771. 2876. 2876. 2914. 2923. 2931. 2906. 2910. 2937. 2929. 2918. 2923. 2915. 2919. 2909. 2911.
    24 2693. 2781.    0. 2750. 2792. 2874. 2856. 2913. 2943. 2948. 2944. 2931. 2947. 2946. 2950. 2941. 2947. 2939. 2943. 2934.
    25 2746. 2792. 2861. 2907. 2835. 2873.    0.    0. 2923. 2945. 2953. 2954. 2957. 2956. 2953. 2953. 2956. 2952. 2948. 2937.
    26 2772. 2949. 3011. 2930. 2916. 2986. 2986. 2963. 2974. 2977. 2970. 2970. 2971. 2964. 2966. 2967. 2968. 2969. 2968. 2970.
    27 2831. 2973. 3015. 3019. 2987. 2986. 2981  2986. 2985. 2978. 2976. 2975. 2982. 2994. 2996. 2996. 2997. 2997. 2997. 3000.
    28 3040. 2970. 2998. 3024. 2990. 2992. 2993. 2994. 2991. 2989. 2987. 2980. 2973. 2967. 2964. 2962. 2960. 2960. 2960. 2960.
```

M N	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0	0.	0	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0	0.	0	0	0	0	0	0.	0.	0.	0.	0.	2788.	2800.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2791.	2814.	0.	0.	0.	0.
6	2818.	2804.	2811.	2818.	2806.	2806.	2803.	0.	0.	0.	0.	0.	0.	2772.	2784.	2667.	2860.	0.	0.	0.
7	2819.	2789.	2806.	2809.	2806.	2809.	2801.	2795.	2791.	2766.	2786.	2783.	2784.	2775.	2789.	2749.	2523.	2556.	2556.	0.
8	2757.	2750.	2771.	2763.	2786.	2774.	2763	2757.	2751	2755.	2733.	2764.	2707.	2775.	2659.	2721.	2596.	2606.	2569.	0.
9	2577.	2693.	2746.	2772.	2763.	2785.	2771.	2763.	2763.	2755.	2736.	2697.	2650.	2625.	2605.	2687.	2603.	2633.	2607.	2625.
10	2919.	2515.	2658.	2721.	2755	2769.	2750	2752.	2742.	2734.	2716.	2713.	2673.	2673.	2619.	2665.	2700.	2684.	2670.	2702.
11	2342.	2358.	2475.	2576.	2667.	2698.	2708.	2697.	2659.	2637.	2630.	2626.	2626.	2643.	2634.	2674.	2740.	2749.	2777.	2741.
12	2352.	2349.	2393.	2426.	2530	2634.	2684.	2672.	2645.	2633.	2659.	2672.	2674.	2667.	2659.	2670.	2752.	2751.	2770.	2761.
13	2342.	2421.	2419.	2399.	2463.	2622.	2669.	2669.	2663.	2665.	2669.	2662.	2662.	2671.	2696.	2682.	2787.	2793.	2790.	2786.
14	2254.	2362.	2348.	2323.	2345.	2459.	2577.	2645.	2673.	[illegible]	2702.	2703.	2698.	2675.	2676.	2665.	2697.	2724.	2750.	2774.
15	2346.	2313.	2378.	2404.	2562.	2634.	2689.	2672.	2666.	2726.	2717.	2704.	2692.	2691.	2689.	2690.	2708.	2707.	2744.	2776.
16	2315.	2367.	2549.	2517.	2621.	2697.	2686.	2655.	2652.	2705.	2731.	2731.	2704.	2687.	2654.	2685.	2694.	2710.	2766.	2762.
17	2476.	2650.	2708.	2682.	2697.	2661.	2672.	2656.	2657.	2660.	2727.	2710.	2702.	2680.	2683.	2700.	2694.	2746.	2777.	2780.
18	2772.	2769.	2748.	2751.	2743.	2718.	2669.	2650.	2671.	2671.	2727.	2713.	2681.	2676.	2680.	2686.	2779.	2795.	2808.	2810.
19	2808.	2760.	2756.	2754.	2736.	2699.	2669.	2673.	2719.	2731.	2707.	2716.	2709.	2687.	2686.	2697.	2793.	2815.	2821.	2822.
20	2811.	2773.	2776.	2757.	2764.	2726.	2706.	2676.	2722.	2747.	2747.	2739.	2729.	2712.	2704.	2703.	2799.	2790.	2816.	2809.
21	2844.	2805.	2822.	2763.	2740.	2726.	2760.	2710.	2711.	2771.	2757.	2773.	2759.	2754.	2745.	2725.	2805.	2774.	2800.	2795.
22	2858.	2816.	2871.	2760.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2745.	2776.	2759.	2757.	2751.	2735.	2812.	2774.	2798.	2743.
23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2789	[illegible]	2772	2795	[illegible]	2804.	2788.	2791	2703.	2776.	2772.	[illegible]	2794.	2472.	2805.
24	2946.	2946.	2939.	2925.	2981	2694.	2657.	2649.	2766.	2774.	2776.	2769.	2811.	2798.	2807.	2772.	2858.	2842.	2860.	2851.
25	2834.	2931.	2911.	2672.	2830	2492.	2805	2736	2714	2885.	2803.	2684.	2862.	2882.	2882.	2794.	2867.	2800.	2871.	2869.
26	2561.	3063.	2964.	2961.	2664.	2516.	2527.	2654.	2611.	2775.	2789.	2610.	2828.	2801.	2619.	2823.	2971.	0.	0.	0.
27	2559.	3005.	3086.	3026.	3026.	3042.	3014.	2573.	2513.	2644.	2654.	2666.	2862.	2276.	2896.	2959.	3034.	3034.	3037.	3010.
28	2961.	2961.	[illegible]	2975.	3026.	3057.	3047.	3039.	3033.	3029.	3025.	3030.	3034.	3039.	3043.	3047.	3051.	3055.	3059.	3064.

M\N	41	42	43	44	45	46	47	48	49
1	0.	0.	0.	0.	0	0	0	0	0
2	0.	0.	0.	0.	0	0.	0	0.	0
3	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0	0.	0.	0.	0.
7	0	0.	0.	0.	0	0.	0	0	0
8	0.	0.	0.	0.	0.	0.	0.	2544.	2654.
9	2612.	2615.	2609.	2616.	2552.	2592.	2566.	2665.	2611.
10	2639.	2669.	2626.	2704.	2642.	2712.	2681.	2712.	2698.
11	2761.	2715.	2746.	2759.	2734.	2762.	2737.	2757.	2746.
12	2739.	2750.	2762.	2775.	2746	2763.	2753.	2792.	2786.
13	2777.	2783.	2752.	2779.	2752.	2764.	2771.	2812.	2810.
14	2765.	2786.	2799.	2761.	2753	2767.	2765	2812.	2820.
15	[illegible]	2793.	2767.	2775.	2753.	2761.	[illegible]	2817.	2820.
16	2795.	2757.	2800.	2767.	2758	2771.	2797.	2816.	2819.
17	2793.	2797.	2800.	2763.	2756.	2778.	2800.	2816.	2810.
18	2819.	2810.	2810.	2757.	2782.	2794.	2807.	2819.	2815.
19	2822.	2824.	2821.	2812.	2795.	2797.	2800	2802.	2804.
20	2821.	2805.	2817.	2813.	2805	2757	2799	2793	2791
21	2806.	2753.	2804.	2802.	2806.	[illegible]	2801.	2805.	2805.
22	2795.	2793.	2815.	2796.	2800.	2800.	2802.	2811.	2820.
23	2813.	2810.	2831.	2796.	2820.	2797.	2801.	2810.	2820.
24	2859.	2803.	2852.	2823.	2819.	2773.	2801.	2821.	2821.
25	2976.	2666.	2856.	2825.	2794	2767.	2795	2814	2810
26	0.	0.	2892.	2830.	2763	2761	2762	2766	2757
27	3013.	2951.	2967.	2534.	2716.	2720.	2723.	2794.	2793.
28	3068.	3076.	3052.	3017.	2971.	3006.	3046.	3012.	3028.

APPENDIX E: CRAY I-S JOB CONTROL LANGUAGE

Global Grid Hydrodynamics and Salinity

```
COESR,T17,I060,STCRA.
ACCOUNT(H48511KV00,921C0933-ACO,ACOCOE,6343809)
JOB,JN=COESR,T=120.
SWITCH,CARET=+.
ACQUIRE,DN=$PL,PDN=SFMSHYDDU,RT=0,MF=I1,UQ,ID=COFHO933.
UPDATE,C=DATA,E,DW=80,IN.
DELETE,DN=$PL,NA.
RELEASE,DN=$PL.
ACQUIRE,DN=$PL,PDN=CLMSHYDPU,RT=0,MF=I1,UQ,ID=COEHO933.
UPDATE,C,F,IN.
DELETE,DN=$PL,NA.
RELEASE,DN=$PL.
AUDIT,PDN=-,ID=COEHO933.
CFT,I=$CPL.
REWIND,DN=DATA.
COPYSBF,I=DATA,O=$OUT.
REWIND,DN=DATA.
ASSIGN,DN=DATA,A=FT05.
LDR,MAP,LIB=DISSPLA.
REWIND,DN=FT07:FT08:FT09:FT10:FT11:FT12.
COPYD,I=FT07.
COPYD,I=FT08.
COPYD,I=FT09.
COPYD,I=FT10.
COPYD,I=FT11.
COPYD,I=FT12.
DISPOSE,DN=FT99,SDN=COETGS1PLOT,ID=COEHO933,DF=SB,DC=ST,WAIT.
DISPOSE,DN=FT25,ID=COEHO933,DC=ST,DF=TR,WAIT,+
TEXT='USERNO,868,XUMPOM.MASS.STORE FT25:TINSH1.'.
DISPOSE,DN=FT35,ID=COEHO933,DC=SI,DF=TR,WAIT,+
TEXT='USERNO,868,XUMPOM.MASS STORE FT35:TINTS1.'.
EXIT.
REWIND,DN=FT07:FT08:FT09:FT10:FT11:FT12.
COPYD,I=FT07.
COPYD,I=FT08.
COPYD,I=FT09.
COPYD,I=FT10.
COPYD,I=FT11.
COPYD,I=FT12.
DISPOSE,DN=FT89,SDN=COETGS1PLOT,ID=COEHO933,DF=SB,DC=ST,WAIT.
DISPOSE,DN=FT25,ID=COEHO933,DC=ST,DF=TR,WAIT,+
TEXT='USERNO,868,XUMPOM.MASS STORE FT25:TINSH1.
DISPOSE,DN=FT35,ID=COEHO933,DC=ST,DF=TR,WAIT,+
TEXT='USERNO,868,XUMPOM.MASS STORE FT35:TINTS1.
```

Refined Grid Hydrodynamics and Salinity

```
COESR,T17,I060,STCRA.
ACCOUNT(H48511KV00,921C0933-ACO,ACOCOE,6343809)
JOB,JN=COESR,T=820,CL=C.
SWITCH,CARET=+.
ACCESS,DN=FT24,UQ,NA.
ACCESS,DN=FT34,UQ,NA.
DELETE,DN=FT24,NA.
DELETE,DN=FT34,NA.
RELEASE,DN=FT24.
RELEASE,DN=FT34.
ACQUIRE,DN=FT24,ID=COEH0933,RT=0,DF=TR,UQ,+
TEXT='USERNO,868,XUMPOM.MASS.GET FT24:TINSH.'.
ACQUIRE,DN=FT34,ID=COEH0933,RT=0,DF=TR,UQ,+
TEXT ='USERNO,868,XUMPOM.MASS.GET FT34:TINTS.'.
REWIND,DN=FT24:FT34.
ACCESS,DN=DATA,ID=COEH0933,UQ,NA.
DELETE,DN=DATA,NA.
RELEASE,DN=DATA.
ACQUIRE,DN=DATA,ID=COEH0933,RT=0,UQ,+
TEXT='USERNO,868,XUMPOM.MASS.GET DATA:H485TRSD.'.
ACQUIRE,DN=$PL,PDN=CLMSHYDPU,RT=0,MF=I1,UQ,ID=COEH0933.
UPDATE,C,F,IN.
DELETE,DN=$PL,NA.
RELEASE,DN=$PL.
AUDIT,PDN=-,ID=COEH0933.
CFT,I=$CPL,L=0.
REWIND,DN=DATA.
COPYSBF,I=DATA,O=$OUT.
REWIND,DN=DATA.
ASSIGN,DN=DATA,A=FT05.
LDR,MAP,LIB=DISSPLA.
REWIND,DN=FT07:FT08:FT09:FT10:FT11:FT12.
COPYD,I=FT07.
COPYD,I=FT08.
COPYD,I=FT09.
COPYD,I=FT10.
COPYD,I=FT11.
COPYD,I=FT12.
DISPOSE,DN=FT99,SDN=COERTSPLOT,ID=COEH0933,DF=SB,DC=ST,WAIT.
EXIT.
REWIND,DN=FT07:FT08:FT09:FT10:FT11:FT12.
COPYD,I=FT07.
COPYD,I=FT08.
COPYD,I=FT09.
COPYD,I=FT10.
COPYD,I=FT11.
COPYD,I=FT12.
DISPOSE,DN=FT99,SDN=COERTSPLOT,ID=COEH0933,DF=SB,DC=ST,WAIT.
```