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Numerical Solution of The One-dimensional Water Flow Equation With and Without Temperature Dependent Hydraulic Properties

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SUMMARY

The pressure head form of the general flow equation for water in a porous medium was numerically solved using the predictor-corrector method. The mass-balance equation was used to check the accuracy of the simulation. If a predefined error criterion was not met, the time step increment was decreased. Several flow problems were solved, of which the resulting water content distributions were compared with other models. The execution time was generally less for the described model than for WAFLOW (2). However, space increments could not be changed during the simulation. The computer model also accounts for temperature effects on the hydraulic properties. For temperature varying with both time and depth, the effect seemed to be minimal if the hydraulic properties were determined at the mean temperature of the profile.

NUMERICAL SOLUTION OF THE ONE-DIMENSIONAL WATER FLOW EQUATION WITH AND WITHOUT TEMPERATURE DEPENDENT HYDRAULIC PROPERTIES

J.W. Hopmans and J.H. Dane[1]

INTRODUCTION

Solution of the one-dimensional soil water flow equation is usually complicated. Boundary conditions may vary with time, while the soil hydraulic properties often change with time and position. In view of this, most efforts have been concentrated on seeking numerical rather than analytical solutions. The Douglas-Jones predictor-corrector method is a finite difference method which can be used to solve nonlinear parabolic partial differential equations. The model was adapted to account for temperature dependency of soil hydraulic properties. The dependence of surface tension of water on temperature was assumed to be responsible for the temperature effect on soil water pressure head, while the hydraulic conductivity variation with temperature was attributed entirely to changes in the water viscosity. The source text, a description of the model, and three numerical examples are presented.

THEORY

The general transport equation for water movement in the soil, which was used in the simulation described in this report, can be formulated by combining the Darcy equation and the mass balance equation of soil water. In one-dimensional form the Darcy equation may be written as:

$$v = -K(h)\frac{\partial H}{\partial z} \quad , \qquad [1]$$

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where K(h) is the hydraulic conductivity function, h is soil water pressure head, H is hydraulic head, z is distance (z=0 at reference level and z > 0 above reference level), and $\frac{\partial H}{\partial z}$ is the hydraulic gradient. The algebraic sign of the flux v indicates the direction of the flow, i.e., v is upward if positive and downward if negative. Since the hydraulic head is the sum of the pressure and gravitational head, Eq. [1] may be written as:

$$v = -K(h)\left[\frac{\partial h}{\partial z} + 1\right] \quad , \qquad [2]$$

where $\frac{\delta h}{\delta z}$ is the pressure head gradient.

For a certain set of assumptions the mass balance equation can be written as a volume balance equation:

$$\frac{\partial \theta}{\partial t} = -\frac{\partial v}{\partial z} \quad . \qquad [3]$$

This equation relates the time rate of change of water content, $\frac{\delta \theta}{\delta t}$, of a differential volume element of soil to the difference of inflow and outflow across that element, $\frac{\delta v}{\delta z}$, which is called the divergence of the flux. Combining Eq. [2] with Eq. [3] yields the general equation for vertical flow of water in soil:

$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial z}\left[K(h)\left(\frac{\partial h}{\partial z} + 1\right)\right] \quad . \qquad [4]$$

To obtain an equation for water flow in one dependent variable, another relation between θ and h is required. Introducing the water capacity of the soil as $C(h) = \frac{\delta \theta}{\delta h}$ (slope of the water retention curve), the time derivative term in Eq. [4] can be transformed to:

$$\frac{\partial\theta}{\partial t} = \frac{d\theta}{dh} \cdot \frac{\partial h}{\partial t} = C(h) \cdot \frac{\partial h}{\partial t} \quad . \qquad [5]$$

Substituting Eq. [5] into Eq. [4] yields:

$$C(h,T) \ \frac{\partial h}{\partial t} = \frac{\partial}{\partial z} \ \{ \ K(h,T) \ \left(\ \frac{\partial h}{\partial z} + 1 \ \right) \} \quad , \qquad [6]$$

which is called the pressure head form of the one-dimensional general flow equation. An elaborate review of the movement of water in unsaturated soils has been given by Klute (5).

Eq. [6] was derived for isothermal conditions. Because of the temperature dependency of a soil's hydraulic properties on temperature, additional complications in the numerical solution arise when the temperature varies with time and/or depth. The computer model presented in this report was adapted to account for temperature dependency of the hydraulic properties. According to Wilkinson and Klute (6), the change of pressure head (h) with temperature (T) can be described by

$$\frac{dh}{dT} = \frac{h}{\sigma} \frac{d\sigma}{dT} = h\gamma(T) \quad , \qquad [7]$$

where dh/dT is the temperature coefficient of soil-water pressure head (kPa/°C), σ is the surface tension at the air-water interface (N/m), and $\gamma(T)$ is the temperature coefficient of surface tension of water. Application of Eq. [7] and knowledge of a reference soil water pressure head value (h_{ref}) at a reference temperature (T_{ref}) allows the soil water pressure head value (h_T) at any other temperature to be approximated by

$$h_T = h_{ref} + (T-T_{ref}) \cdot \frac{dh}{dT} = h_{ref} + (T-T_{ref})\ h_{ref} \cdot \gamma(T)$$

or

$$h_T = \left[1 + (T-T_{ref}) \cdot \gamma(T)\right] \cdot h_{ref} \qquad , \qquad [8]$$

provided $|T-T_{ref}|$ is small. The reference temperature is defined as that temperature at which the hydraulic properties were determined. As γ is temperature dependent and $|T-T_{ref}|$ is not always small, $(T-T_{ref}) \cdot \gamma(T)$ was approximated by summation over a finite number of temperature steps of 0.01 °C, i.e.

$$(T-T_{ref})\gamma(T) \simeq \sum_{i=1}^{k} (T_{i+1} - T_i)\gamma(T_i) \qquad , \qquad [9]$$

where $T_1 = T_{ref}$ and $T_{k+1} = T$, so that

$$h_T = \{1 + \sum_{i=1}^{k}(T_{i+1}-T_i)\gamma(T_i)\}h_{ref} = \alpha(T)h_{ref} \ . \qquad [10]$$

The coefficient $\alpha(T)$ is a function of both depth and time if T changes with depth and time.

The water capacity, C(h), can also be determined as a function of temperature, figure 1:

$$C(h_T) = \frac{d\theta}{dh_T} = \frac{1}{\alpha(T)} \cdot \frac{d\ \theta}{dh_{ref}} = \frac{1}{\alpha(T)} \cdot C(h_{ref}) \qquad . \qquad [11]$$

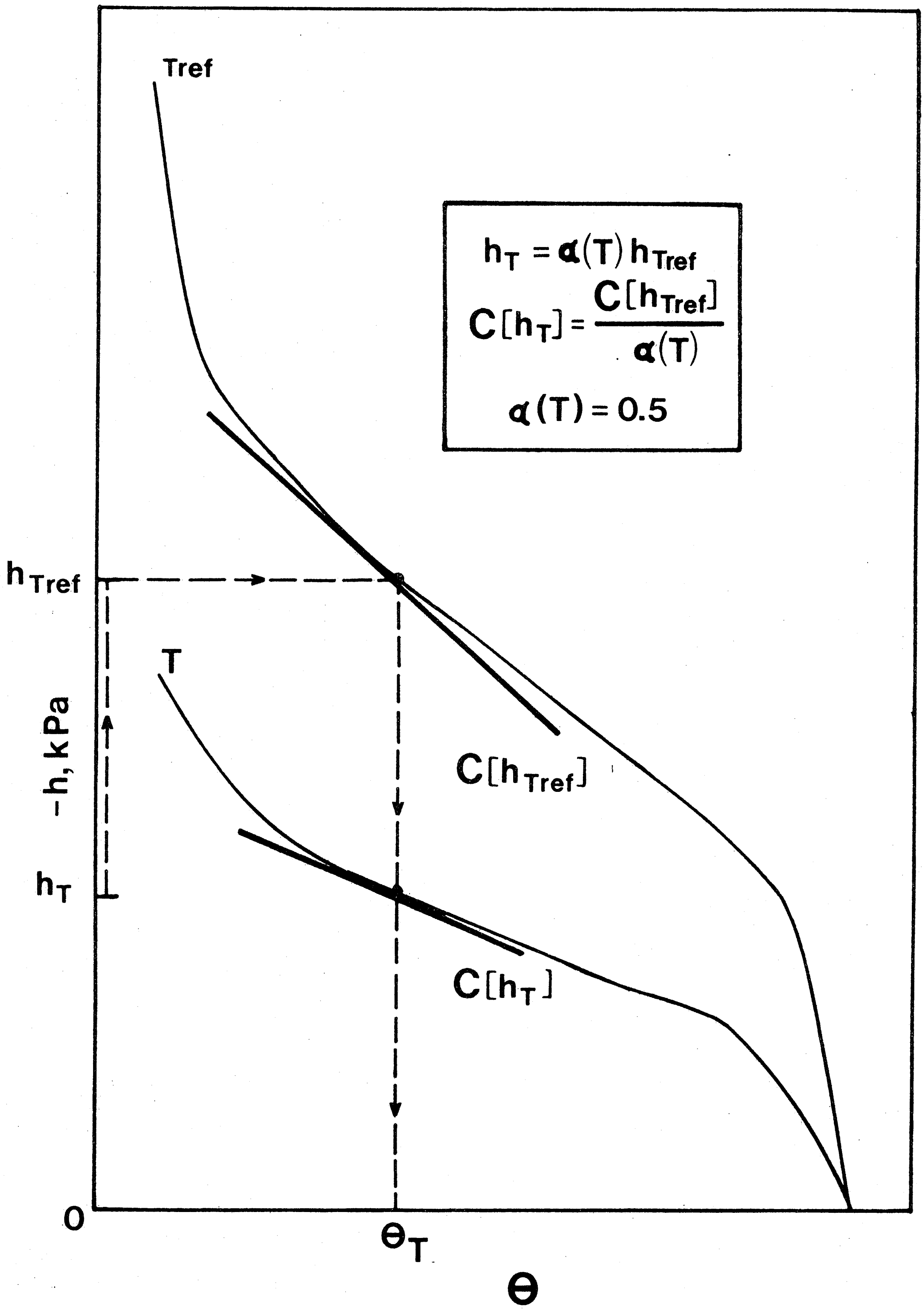

FIG. 1. Relation between soil water pressure head (h) and water content (θ) at reference temperature, T_{ref}, and at temperature T.

The hydraulic conductivity, $K(\theta)$, at any temperature, T, can be calculated from

$$K_T = \{ \frac{\eta_{ref}}{\eta_T} \} K_{ref} \quad , \qquad [12]$$

where η_{ref} and η_T denote the viscosity of water (Ns/m) at the reference temperature and the soil temperature in question, respectively, and K_{ref} is the hydraulic conductivity value at the reference temperature. It is assumed that the changes in water density with temperature are negligible.

NUMERICAL IMPLEMENTATION

To solve the flow equation, Eq. (6) is written in the quasi-linear form:

$$\frac{\partial^2 h}{\partial z^2} = \frac{C(h,T)}{K(h,T)} \cdot \frac{\partial h}{\partial t} - \frac{1}{K(h,T)} \frac{\partial K(h,T)}{\partial z} \cdot \frac{\partial h}{\partial z} - \frac{1}{K(h,T)} \cdot \frac{\partial K(h,T)}{\partial z} \quad , \qquad [13]$$

which can be written as a combination of two functions

$$\frac{\partial^2 h}{\partial z^2} = f_1(h,t,z)\frac{\partial h}{\partial t} + f_2(h,t,z,\frac{\partial h}{\partial z}) \quad . \qquad [14]$$

A quasi-linear equation is one in which the highest order derivative appears linearly. The method that will be described to solve Eq. [14] was introduced by Douglas and Jones (3). The solution by a finite difference technique requires that a grid be superimposed upon the time-depth region of the flow system. The independent variables t and z will be subscripted by j and i, respectively.

Let L be the depth of the profile under consideration and T the total simulation time required, then for $-L \leq z \leq 0$ and $0 \leq t \leq T$, the gridpoints (z_i, t_j) are defined for i=0, 1,....., N, and j=0, 1, ..., M such that $z_0=0$, $z_N=-L$, $t_0=0$ and $t_M=T$, figure 2. The Douglas-Jones approximation uses two equations, the predictor and the corrector. Each equation advances the solution one-half time increment. The predictor is a modification of the implicit method, and calculates the unknowns (h_i) at the $(j+\frac{1}{2})$- time level. The corrector is a modification of the Crank-Nicolson scheme and uses the values of C(h) and K(h) calculated at the $(j+\frac{1}{2})$- time level to solve for h_i at time (j+1). The grid spacing in the z-direction is fixed and is denoted by Δz. The time increment is variable: $\Delta t_j = t_{j+1} - t_j$.

If $\delta^2 h/\delta z^2$ can be represented by two functions f_1 and f_2 as in Eq. [14], the predictor-corrector analog leads to linear algebraic equations. The predictor is

$$\Delta_z^2 (h_{i,j+\frac{1}{2}}) = f_1(z_i, t_{j+\frac{1}{2}}, h_{i,j}) \frac{h_{i,j+\frac{1}{2}} - h_{i,j}}{\Delta t/2} + f_2(z_i, t_{j+\frac{1}{2}}, h_{i,j}, \delta_z h_{i,j}) \quad ,[15a]$$

for i=1,.....,N-1 , followed by the corrector

$$\tfrac{1}{2}\Delta_z^2 (h_{i,j+1} + h_{i,j}) = f_1(z_i, t_{j+\frac{1}{2}}, h_{i,j+\frac{1}{2}}) \frac{h_{i,j+1} - h_{i,j}}{\Delta t} + f_2(z_i, t_{j+\frac{1}{2}}, h_{i,j+\frac{1}{2}}, \delta_z h_{i,j+\frac{1}{2}}) \quad ,[15b]$$

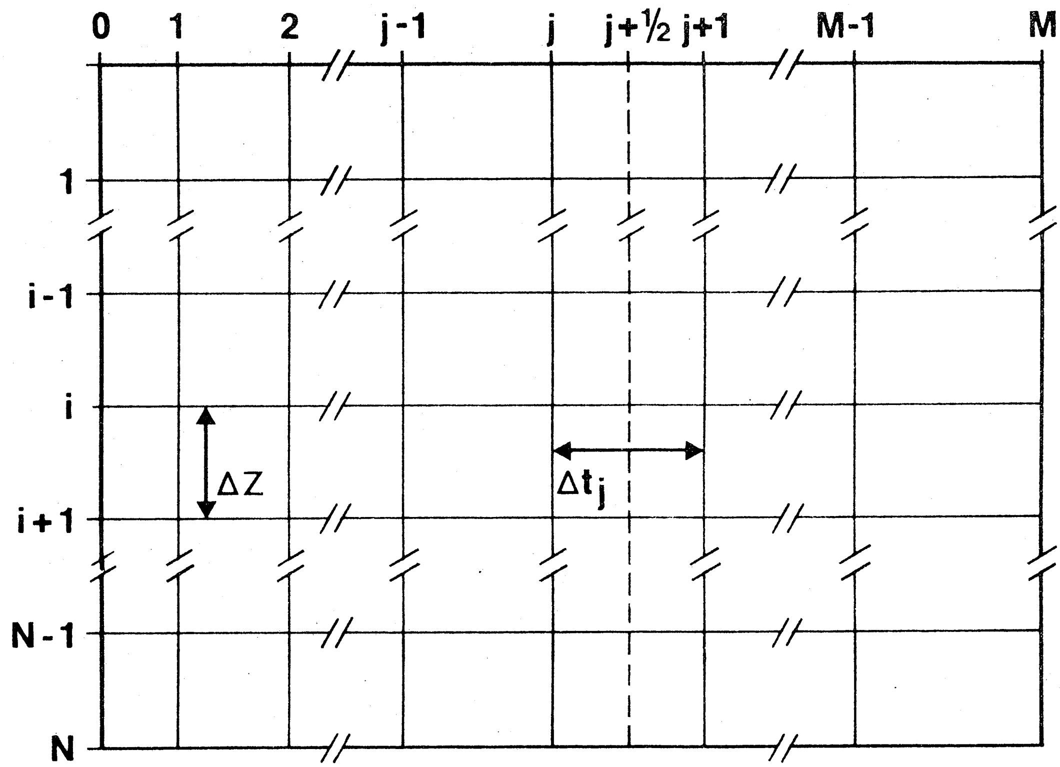

FIG. 2. Diagram of the finite difference grid superimposed on the depth-time region of a soil profile.

where $$\delta_z h_{i,j} = \frac{h_{i+1,j}-h_{i-1,j}}{2\Delta z}$$

and $$\Delta_z^2 h_{i,j} = \frac{h_{i+1,j}-2h_{i,j}+h_{i-1,j}}{(\Delta z)^2}$$

An advantage of the predictor-corrector method is that it gives rise to sets of linear equations with tri-diagonal coefficient matrices. The predictor-corrector method is unconditionally stable and the truncation error is of the order $(\Delta z)^2 + (\Delta t)^{3/2}$.

Specific details of the procedure will be shown by means of an example. Consider a system with only 5 gridpoints in the z-direction (N=4), the boundary points included, figure 3. Assuming a pressure head bottom boundary condition, a derivation is given for the equations of the predictor and corrector for two different boundary conditions: (1) a constant pressure head top and bottom boundary condition, and (2) a flux boundary at the surface and a pressure head boundary at the bottom which may both vary with time.

1.a. Predictor-- constant pressure head top boundary condition. Using finite differences, Eq. [14] can be written as:

$$\frac{h_{i+1,j+\frac{1}{2}}-2h_{i,j+\frac{1}{2}}+h_{i-1,j+\frac{1}{2}}}{(\Delta z)^2} = \frac{C_{i,j}}{K_{i,j}} \cdot \frac{h_{i,j+\frac{1}{2}}-h_{i,j}}{\Delta t/2} - \frac{1}{K_{i,j}} \cdot \frac{K_{i+1,j}-K_{i-1,j}}{2\Delta z}\left[\frac{h_{i+1,j}-h_{i-1,j}}{2\Delta z} + 1\right] \quad , \quad [16]$$

which, on solving for the pressure heads at the unknown time level (j + ½), yields:

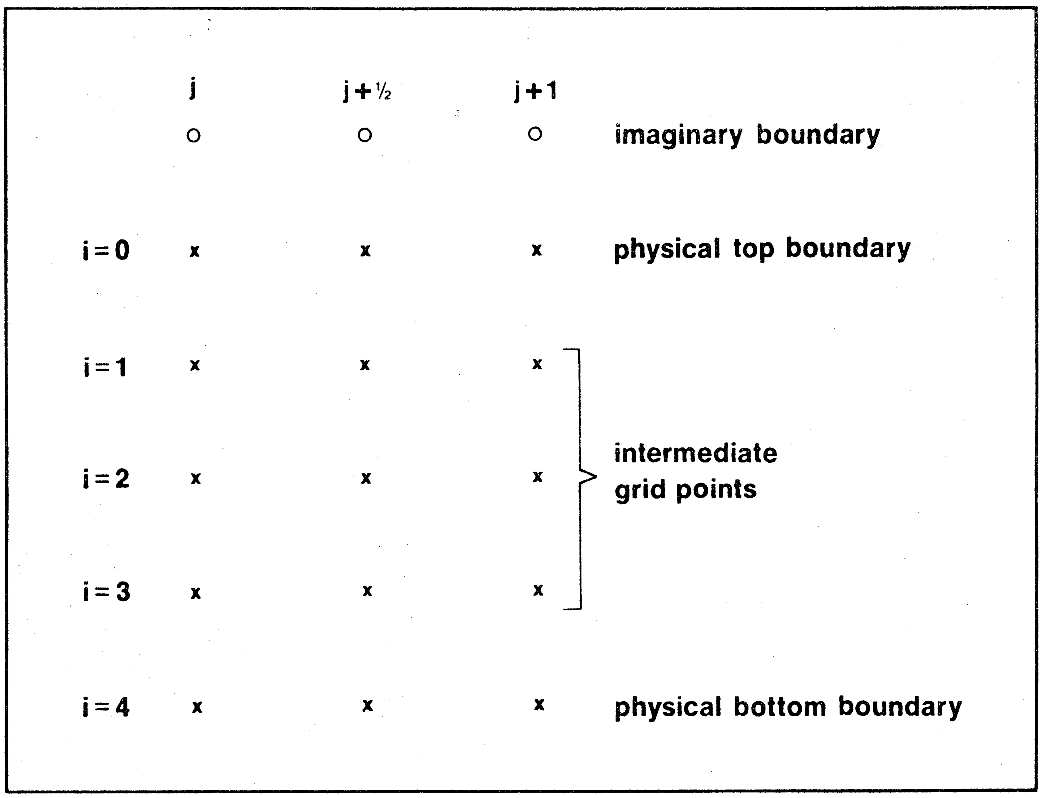

FIG. 3. Diagram of the grid point distribution for a flux boundary condition at the soil surface.

$$h_{i-1,j+\frac{1}{2}} - \left(2 + \frac{2(\Delta z)^2 C_{i,j}}{\Delta t_j K_{i,j}}\right) h_{i,j+\frac{1}{2}} + h_{i+1,j+\frac{1}{2}} = \frac{K_{i+1,j}-K_{i-1,j}}{4K_{i,j}} h_{i-1,j}$$

$$- \left(\frac{2(\Delta z)^2 C_{i,j}}{\Delta t_j K_{i,j}}\right) h_{i,j} - \left(\frac{K_{i+1,j}-K_{i-1,j}}{4K_{i,j}}\right) h_{i+1,j} - \frac{\Delta z}{2K_{i,j}} (K_{i+1,j}-K_{i-1,j}) \quad , \quad [17]$$

or

$$h_{i-1,j+\frac{1}{2}}-(2+a_j)h_{i,j+\frac{1}{2}}+h_{i+1,j+\frac{1}{2}} = b_j h_{i-1,j}-a_j h_{i,j}-b_j h_{i+1,j}-c_j \quad , \quad [18]$$

for i=1,2,3

and

$$a_j = \frac{2(\Delta z)^2 C_{i,j}}{\Delta t_j K_{i,j}}$$

$$b_j = \frac{K_{i+1,j} - K_{i-1,j}}{4K_{i,j}} \qquad c_j = 2\Delta z b_j \quad . \quad [19]$$

It is obvious that a_j, b_j, and c_j vary with depth and time. Writing Eq. [18] in matrix form yields:

$$\begin{bmatrix} -(2+a_j) & 1 & 0 \\ 1 & -(2+a_j) & 1 \\ 0 & 1 & -(2+a_j) \end{bmatrix} \begin{bmatrix} h_1 \\ h_2 \\ h_3 \end{bmatrix}_{j+\frac{1}{2}} = \begin{bmatrix} -a_j & -b_j & 0 \\ b_j & -a_j & -b_j \\ 0 & b_j & -a_j \end{bmatrix} \begin{bmatrix} h_1 \\ h_2 \\ h_3 \end{bmatrix}_j - \begin{bmatrix} c_j+h_{0,j+\frac{1}{2}}-b_j h_{0,j} \\ c_j \\ c_j+h_{4,j+\frac{1}{2}}+b_j h_{4,j} \end{bmatrix}$$

where h_0 and h_4 are the values for h at the top and bottom boundary, respectively.

1. b. Corrector-- constant pressure head top boundary condition. Again, as for the predictor, finite differences are used to rewrite Eq. [14]:

$$\frac{1}{2}\left(\frac{h_{i+1,j+1}-2h_{i,j+1}+h_{i-1,j+1}+h_{i+1,j}-2h_{i,j}+h_{i-1,j}}{(\Delta z)^2}\right)=\frac{C_{i,j+\frac{1}{2}}}{K_{i,j+\frac{1}{2}}}\cdot\frac{h_{i,j+1}-h_{i,j}}{\Delta t_j}$$

$$-\frac{1}{K_{i,j+\frac{1}{2}}}\cdot\frac{K_{i+1,j+\frac{1}{2}}-K_{i-1,j+\frac{1}{2}}}{2\Delta z}\cdot\left[\frac{h_{i+1,j+\frac{1}{2}}-h_{i-1,j+\frac{1}{2}}}{2\Delta z}+1\right] \quad . \qquad [20]$$

Solving Eq. [20] for the pressure heads at the unknown time level (j+1) yields:

$$h_{i-1,j+1}-(2+a_{j+\frac{1}{2}})h_{i,j+1}+h_{i+1,j+1} = -h_{i-1,j}+(2-a_{j+\frac{1}{2}})h_{i,j}-h_{i+1,j}$$

$$+ 2b_{j+\frac{1}{2}}h_{i-1,j+\frac{1}{2}}-2b_{j+\frac{1}{2}}h_{i+1,j+\frac{1}{2}}-2c_{j+\frac{1}{2}} \qquad (i=1,\ 2\ ,3) \qquad , \qquad [21]$$

where $a_{j+\frac{1}{2}}$, $b_{j+\frac{1}{2}}$, and $c_{j+\frac{1}{2}}$ are defined as in Eq. [19] with all time steps incremented by $\frac{1}{2}$.

Writing Eq. [21] in matrix form results in :

$$\begin{bmatrix} -(2+a_{j+\frac{1}{2}}) & 1 & 0 \\ 1 & -(2+a_{j+\frac{1}{2}}) & 1 \\ 0 & 1 & -(2+a_{j+\frac{1}{2}}) \end{bmatrix} \begin{bmatrix} h_1 \\ h_2 \\ h_3 \end{bmatrix}_{j+1} = \begin{bmatrix} (2-a_{j+\frac{1}{2}}) & -1 & 0 \\ -1 & (2-a_{j+\frac{1}{2}}) & -1 \\ 0 & -1 & (2-a_{j+\frac{1}{2}}) \end{bmatrix} \begin{bmatrix} h_1 \\ h_2 \\ h_3 \end{bmatrix}_j +$$

$$\begin{bmatrix} 0 & -2b_{j+\frac{1}{2}} & 0 \\ 2b_{j+\frac{1}{2}} & 0 & -2b_{j+\frac{1}{2}} \\ 0 & 2b_{j+\frac{1}{2}} & 0 \end{bmatrix} \begin{bmatrix} h_1 \\ h_2 \\ h_3 \end{bmatrix}_{j+\frac{1}{2}} + \begin{bmatrix} 2b_{j+\frac{1}{2}}h_{0,j+\frac{1}{2}} - 2c_{j+\frac{1}{2}} - h_{0,j+1} - h_{0,j} \\ -2c_{j+\frac{1}{2}} \\ -2b_{j+\frac{1}{2}}h_{4,j+\frac{1}{2}} - 2c_{j+\frac{1}{2}} - h_{4,j+1} - h_{4,j} \end{bmatrix}$$

2. a. Predictor-- flux top boundary condition.

Introducing an imaginary boundary at distance z above the soil surface, figure 3, it is possible to determine the pressure head value at this imaginary point needed to sustain the flux at the soil surface. Writing Darcy's law in finite difference form:

$$v_{0,j+\frac{1}{2}} = -K_{0,j}\left(\frac{h_{1,j+\frac{1}{2}} - h_{-1,j+\frac{1}{2}}}{2\Delta z}\right) - K_{0,j} \quad , \qquad [22]$$

and solving for $h_{-1,j+\frac{1}{2}}$ (the imaginary boundary) yields:

$$h_{-1,j+\frac{1}{2}} = h_{1,j+\frac{1}{2}} + \frac{2\Delta z(v_{0,j+\frac{1}{2}} + K_{0,j})}{K_{0,j}} \quad , \qquad [23]$$

or

$$h_{-1,j+\frac{1}{2}} = h_{1,j+\frac{1}{2}} + d_{j+\frac{1}{2}} \quad , \qquad [24]$$

where

$$d_{j+\frac{1}{2}} = \frac{2\Delta z(v_{0,j+\frac{1}{2}} + K_{0,j})}{K_{0,j}} \quad .$$

Similarly:

$$h_{-1,j} = h_{1,j} + d_j$$

where

$$d_j = \frac{2\Delta z(v_{0,j} + K_{0,j})}{K_{0,j}}$$

For i=0,...,3, and substituting the expressions for $h_{-1,j+\frac{1}{2}}$ and $h_{-1,j}$ into Eq. [18] yields the following set of linear equations:

$$\begin{bmatrix} -(2+a_j) & 2 & 0 & 0 \\ 1 & -(2+a_j) & 1 & 0 \\ 0 & 1 & -(2+a_j) & 1 \\ 0 & 0 & 1 & -(2+a_j) \end{bmatrix} \begin{bmatrix} h_0 \\ h_1 \\ h_2 \\ h_3 \end{bmatrix}_{j+\frac{1}{2}} = \begin{bmatrix} -a_j & 0 & 0 & 0 \\ b_j & -a_j & -b_j & 0 \\ 0 & b_j & -a_j & -b_j \\ 0 & 0 & b_j & -a_j \end{bmatrix} \begin{bmatrix} h_0 \\ h_1 \\ h_2 \\ h_3 \end{bmatrix}_j - \begin{bmatrix} c_j - b_j d_j + d_{j+\frac{1}{2}} \\ c_j \\ c_j \\ c_j + h_{4,j+\frac{1}{2}} + b_j h_{4,j} \end{bmatrix}$$

2. b. Corrector-- flux top boundary condition.

Defining

$$d_{j+1} = \frac{2\Delta z(v_{0,j+1} + K_{0,j+\frac{1}{2}})}{K_{0,j+\frac{1}{2}}}$$

and d_j and $d_{j+\frac{1}{2}}$ as before, substituting expressions for $h_{-1,j}$, $h_{-1,j+\frac{1}{2}}$ and $h_{-1,j+1}$ into Eq.[21] results in:

$$\begin{bmatrix} -(2+a_{j+\frac{1}{2}}) & 2 & 0 & 0 \\ 1 & -(2+a_{j+\frac{1}{2}}) & 1 & 0 \\ 0 & 1 & -(2+a_{j+\frac{1}{2}}) & 1 \\ 0 & 0 & 1 & -(2+a_{j+\frac{1}{2}}) \end{bmatrix} \begin{bmatrix} h_0 \\ h_1 \\ h_2 \\ h_3 \end{bmatrix}_{j+1} = \begin{bmatrix} (2-a_{j+\frac{1}{2}}) & -2 & 0 & 0 \\ -1 & (2-a_{j+\frac{1}{2}}) & -1 & 0 \\ 0 & -1 & (2-a_{j+\frac{1}{2}}) & -1 \\ 0 & 0 & -1 & (2-a_{j+\frac{1}{2}}) \end{bmatrix} \begin{bmatrix} h_0 \\ h_1 \\ h_2 \\ h_3 \end{bmatrix}_{j}$$

$$\begin{bmatrix} 0 & 0 & 0 & 0 \\ 2b_{j+\frac{1}{2}} & 0 & -2b_{j+\frac{1}{2}} & 0 \\ 0 & 2b_{j+\frac{1}{2}} & 0 & -2b_{j+\frac{1}{2}} \\ 0 & 0 & 2b_{j+\frac{1}{2}} & 0 \end{bmatrix} \begin{bmatrix} h_0 \\ h_1 \\ h_2 \\ h_3 \end{bmatrix}_{j+\frac{1}{2}} + \begin{bmatrix} 2b_{j+\frac{1}{2}}d_{j+\frac{1}{2}}-d_j-d_{j+1}-2c_{j+\frac{1}{2}} \\ -2c_{j+\frac{1}{2}} \\ -2c_{j+\frac{1}{2}} \\ -2b_{j+\frac{1}{2}}h_{4,j+\frac{1}{2}}-2c_{j+\frac{1}{2}}-h_{4,j+1}-h_{4,j} \end{bmatrix}.$$

Once the matrices are defined it is relatively simple to calculate the h-values at all grid points at times $j+\frac{1}{2}$ (predictor values) and $j+1$ (corrector values). It should be noted that all matrices are of the tridiagonal form (elements occur only on the main diagonal and on one subdiagonal above and below). Such a matrix can be solved explicitly for the unknowns, and eliminates any matrix operations. Through transformation of a tridiagonal matrix into a simpler, bidiagonal form the unknowns can be solved by backward substitution. This method has been called the Thomas algorithm (1).

In summary, at each time step two systems of linear equations (predictor and corrector) are solved. The pressure heads calculated by the predictor are used to define the hydraulic properties of the corrector.

The solution process uses the initial condition to determine the pressure head values at the end of the first time step. These values are then used to determine the h-values at the next time step. The solution process thus marches forward in time by increments Δt_j.

CALCULATION OF THE TIME STEP

The mass balance equation was used to control the time step size. A too large time step will result in an inaccurate approximation of $h_{i,j+1}$ and $v_{i,j+1}$, which in turn will influence the outcome of the mass balance equation. At time t_{j+1}, the mass balance MB_{j+1} is defined as:

$$MB_{j+1} = \left| \int_{-L}^{0} [\theta(z,t_{j+1}) - \theta(z,t_j)] \, dz - \int_{t_j}^{t_{j+1}} [v(0,t) - v(-L,t)] \, dt \right| , \qquad [25]$$

where $\theta(z,t)$ is a function of pressure head and can thus be calculated. The increase in water in a profile (first integral form in Eq. [25]) was estimated by applying the trapezoidal rule. The second integral is simply a subtraction of the fluxes at the top and bottom of the profile under consideration and integrated over Δt_j.

The flux at the bottom was approximated by:

$$v_{N,j+1} = -K\left(\frac{h_{N,j+1}+h_{N-1,j+1}}{2}\right) \cdot \left[\frac{h_{N,j+1}-h_{N-1,j+1}}{\Delta z} + 1 \right]$$

In case of a pressure head top boundary condition, the flux at the surface was assumed to be equal to the average flux between the first two grid points. If MB_{j+1} was larger than a specific value ε, the values of $h_{i,j+1}$ were rejected, the time step decreased, and new values for $h_{i,j+1}$ were calculated. Very small values for MB_{j+1}, e.g. 0.1ε, resulted in an increase of the time step.

A relative mass balance was also calculated after each time step. The relative mass balance (percentage) is defined as MB_{j+1} *100 divided by the total amount of water that enters (or leaves) the profile across the bottom and top boundary over a given time step. The relative mass balance may be a better tool to check accuracy, especially if the second term of the right hand side in Eq. [25] is small relative to MB_{j+1}.

RESULTS

The results of three simulations will be presented in this section. The first two simulations describe the infiltration of water into a sandy and into a light clay soil, as reported by Haverkamp et al. (4). During the third simulation, both the boundary conditions and temperature distribution vary with time.

1. Infiltration into a sandy soil

In this simulation (4), water was allowed to infiltrate into a 80-cm deep homogeneous soil profile, having the following hydraulic properties:

$$K = K_s \cdot \frac{A}{A + |h|^b} \quad , \quad K_s = 34 \text{ cm/hr}, \quad A = 1.175 \cdot 10^6, \quad b = 4.74$$

and

$$\theta = \frac{a(\theta_s - \theta_r)}{a + |h|^b} + \theta_r \quad , \quad \theta_s = 0.287$$

$\theta_r = 0.075$

$a = 1.611*10^6$

$b = 3.96$

The initial and boundary conditions were:

h=-61.5 cm	$0 \leq L \leq 80$ cm	, t = 0
h=-20.73 cm,	or	
v=-13.69 cm/hr	z=0 ,	t > 0
h=-61.5 cm	z = -80 cm	, t > 0

where v denotes a constant downward flux and h a constant pressure head. Water content profiles after 0.2 and 0.8 hour of simulation time are shown in figure 4 for the pressure head top boundary condition and in figure 5 for the flux top boundary condition, respectively. The water content distributions in figure 4 are compared with those computed by the h-implicit method of Haverkamp et al. (4) and by the model WAFLOW of Dane et al. (2). The results of the simulation with the flux boundary condition, figure 5, are compared with the water content profiles computed with WAFLOW.

Table 1 displays the absolute mass balance, the relative mass balance, and the computing times required to simulate both situations for 0.8 hour by the predictor-corrector method and the WAFLOW model, respectively. The results indicate shorter execution times for the predictor-corrector method than for WAFLOW. It should be noted, however, that WAFLOW evaluated the coefficients C and K at the future time step, which consequently resulted in sets of nonlinear equations to be solved by iteration. Table 2 shows the effect of a decrease in the number of space steps on computing time and accuracy. It appears

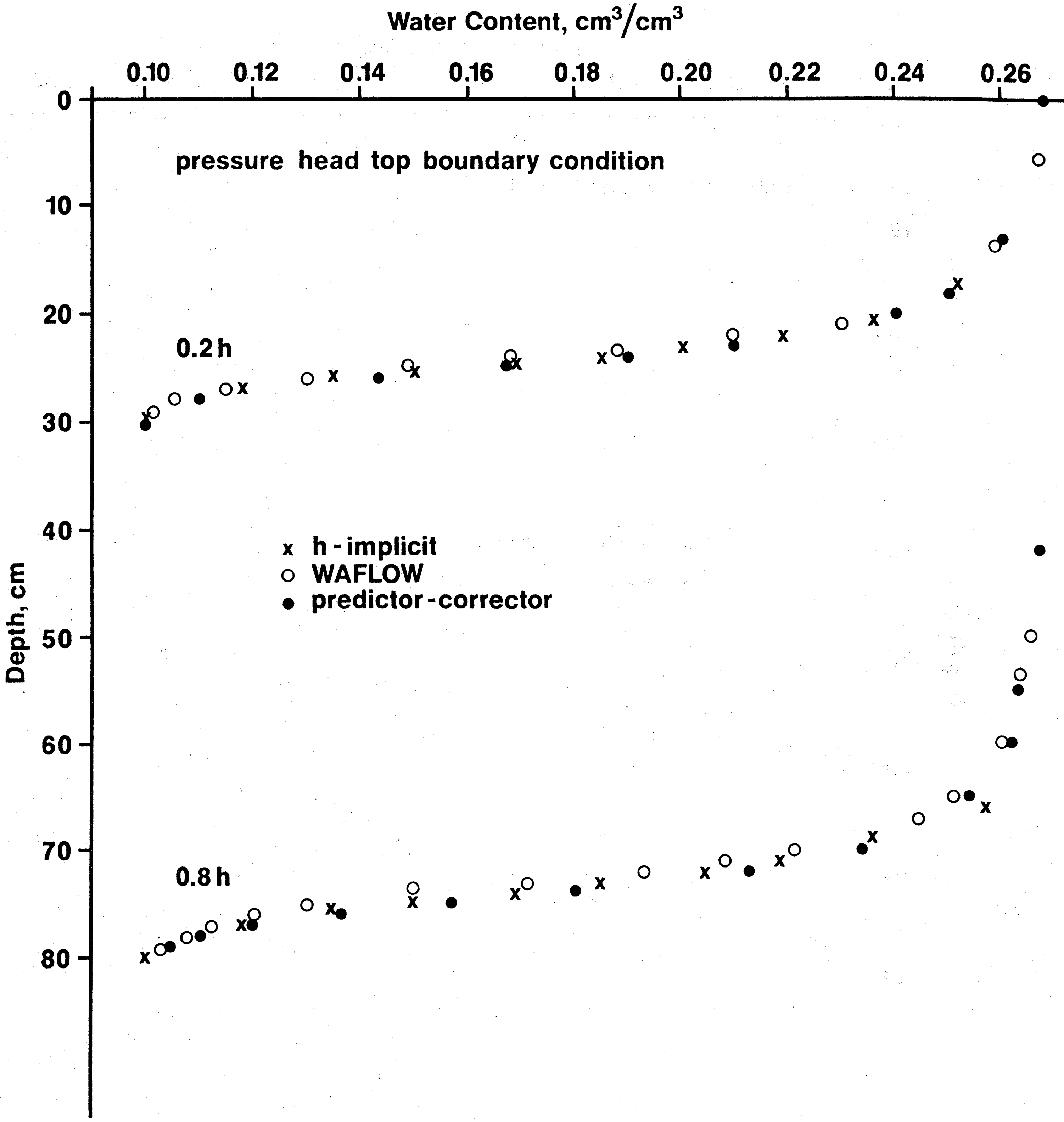

FIG. 4. Water content profiles during infiltration into a sandy soil after 0.2 and 0.8 hour as calculated with the h-implicit, WAFLOW and the predictor-corrector model.

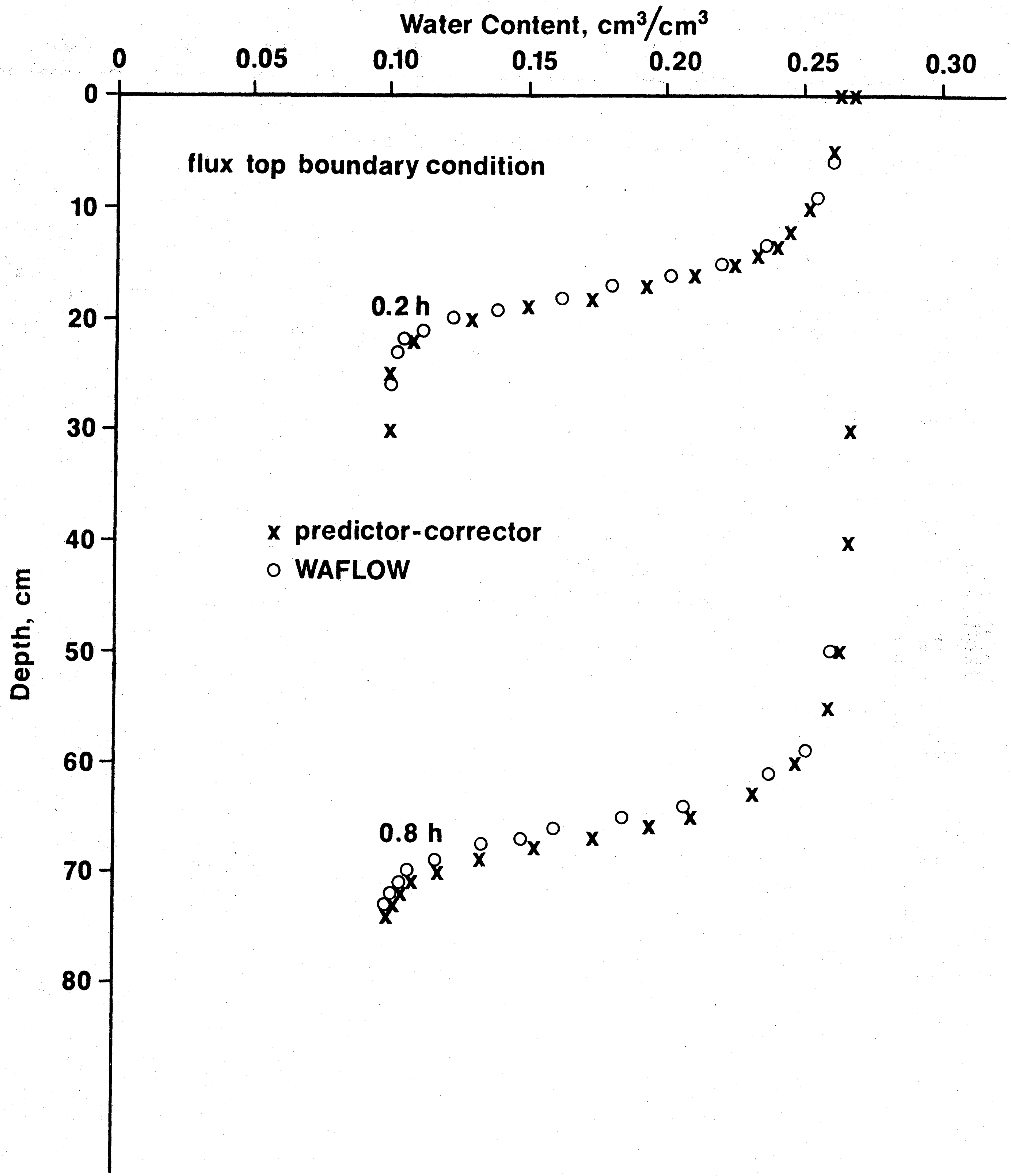

FIG. 5. Water content profiles during infiltration into a sandy soil after 0.2 and 0.8 hour as calculated with WAFLOW and the predictor-corrector model.

Table 1. Comparison of the absolute mass balance, the relative mass balance, and computing time after 0.8 hour of infiltration into a sandy soil for a pressure head and a flux top boundary condition, respectively, as calculated by WAFLOW and the predictor-corrector method (number of grid points:81, mass balance criterion: 0.001)

	Top boundary condition			
	Pressure head		Flux	
	MODEL	WAFLOW	MODEL	WAFLOW
Computing time (minutes)	1.12	2.50	0.21	0.30
Absolute mass balance (cm) at 0.8 hour	$.17*10^{-3}$	$.12*10^{-3}$	$.73*10^{-4}$	$.78*10^{-3}$
Relative mass balance (%) at 0.8 hour	.47	.35	.32	1.46

Table 2. Effect of number of space steps on computer time and mass balance during 0.8 hour of infiltration in an 80-cm deep sandy soil profile with a flux top boundary condition

Number of space steps	Computer time(sec)	Relative mass balance(%) time (h)			Overall relative mass balance (%) at t=0.8 h
		0.1	0.5	0.8	
80	27	0.38	0.44	0.32	0.79
60	27	0.75	0.84	0.57	0.94
40	30	0.51	1.0	1.0	1.36
20	33	2.5	0.8	1.1	1.38
15	35	6.5	0.55	0.5	0.74
WAFLOW 80	30	0.5	1.53	1.46	1.33

that computer time increases slightly with a decrease in grid points. Also note that the accuracy with only 15 grid points is at least as good as with 80 grid points.

2. Infiltration into Yolo light clay

The hydraulic properties as presented by Haverkamp et al. (4) are:

$$K = K_s \frac{A}{A + |h|^b}, \qquad K_s = 4.428*10^{-2} \text{ cm/hr}, \quad A = 124.6, \quad b = 1.77$$

and

$$\theta = \frac{a(\theta_s - \theta_r)}{a + (\ln|h|)^b} + \theta_r, \qquad \theta_s = 0.495, \quad \theta_r = 0.124, \quad a = 739, \quad b = 4.0$$

The infiltration profiles obtained by the h-implicit and the predictor-corrector model are presented in figure 6. The flow regime was subjected to the following initial and boundary conditions:

$$h = -600 \text{ cm}, \quad t = 0, \quad z \leq 0$$

$$h = -0.5 \text{ cm}, \quad t > 0, \quad z = 0$$

$$h = -600 \text{ cm}, \quad t > 0, \quad z = -200 \text{ cm}$$

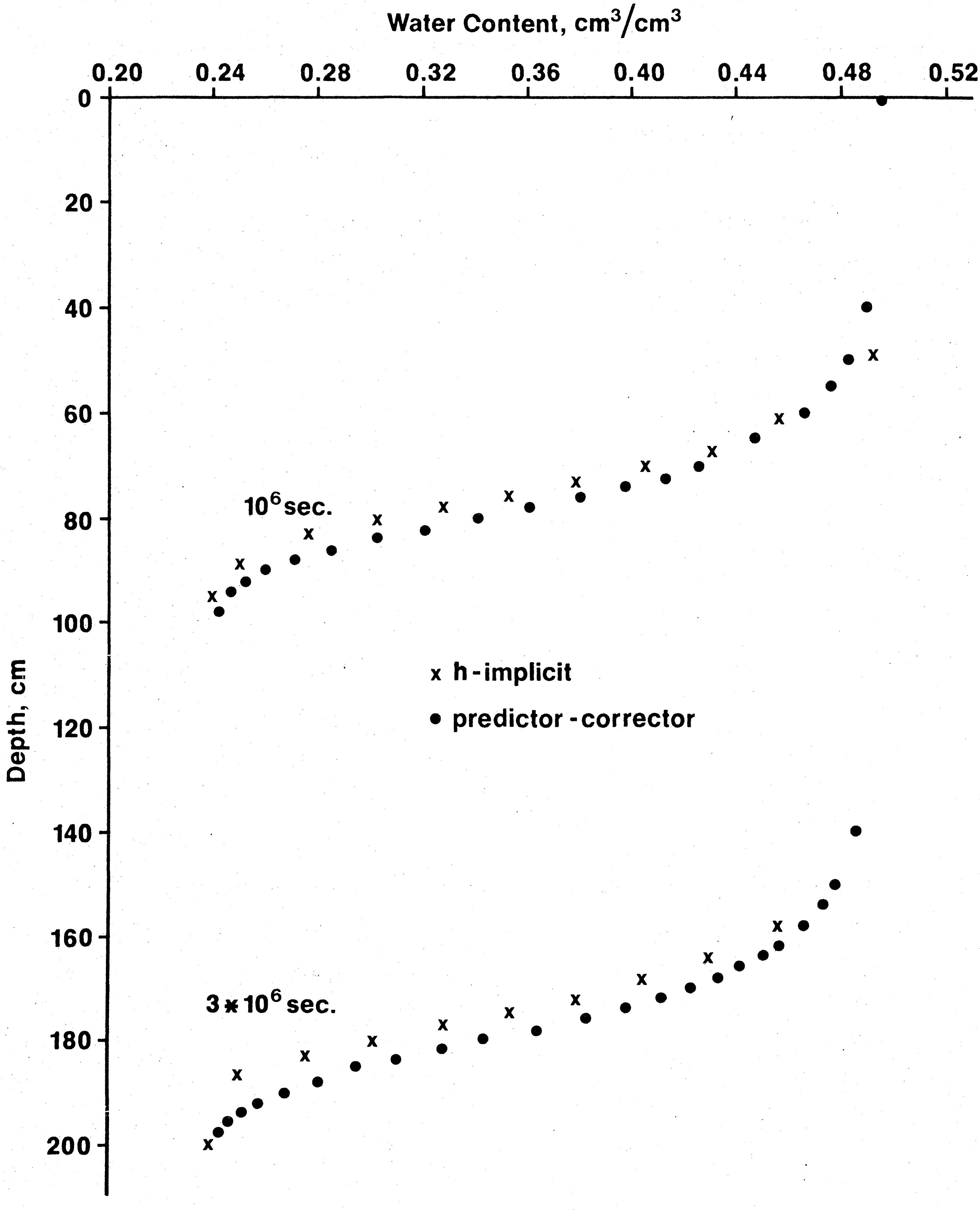

FIG. 6. Water content profiles during infiltration into Yolo light clay after 10^6 and $3*10^6$ seconds as computed by the h-implicit and the predictor-corrector model.

The numerical computations were made with a depth interval of 2 cm, while the time step varied from a few seconds (initial stage) to a few thousand seconds (for $t > 30$ hours). The lower wetting front corresponds to a simulation time of about 35 days.

3. Water movement with temperature affected hydraulic properties

This experiment involved a long-term simulation, during which infiltration and evaporation were alternated and varied in magnitude, figure 7. The bottom boundary condition was one of changing pressure head, figure 8. The hydraulic properties and initial condition were the same as those in the first example. In addition to these changing boundary conditions, a varying temperature was applied with regard to both time and position, viz.,

$$T(z,t)=20 + 10 \exp(+z/0.226)\sin(.2618t+z/0.266). \qquad [26]$$

Eq. [26] indicates an average daily temperature (T_{av}) of 20°C at any depth and a temperature amplitude at the soil surface of 10°C. Although the damping depth is a function of water content, it was chosen to be constant (0.266 m) since the only purpose of Eq. [26] was to obtain a reasonable change of temperature with time (t in hours) and depth. The constant 0.2168 is the angular frequency. The results of this flow problem and those of a similar flow problem but with a T_{av} of 25°C were compared with the results of the same flow problem subjected to a constant temperature of 20°C with respect to both time and depth. The water content distributions at specific times for the three temperature regimes are shown in figure 9. During the simulation, 2 hours of

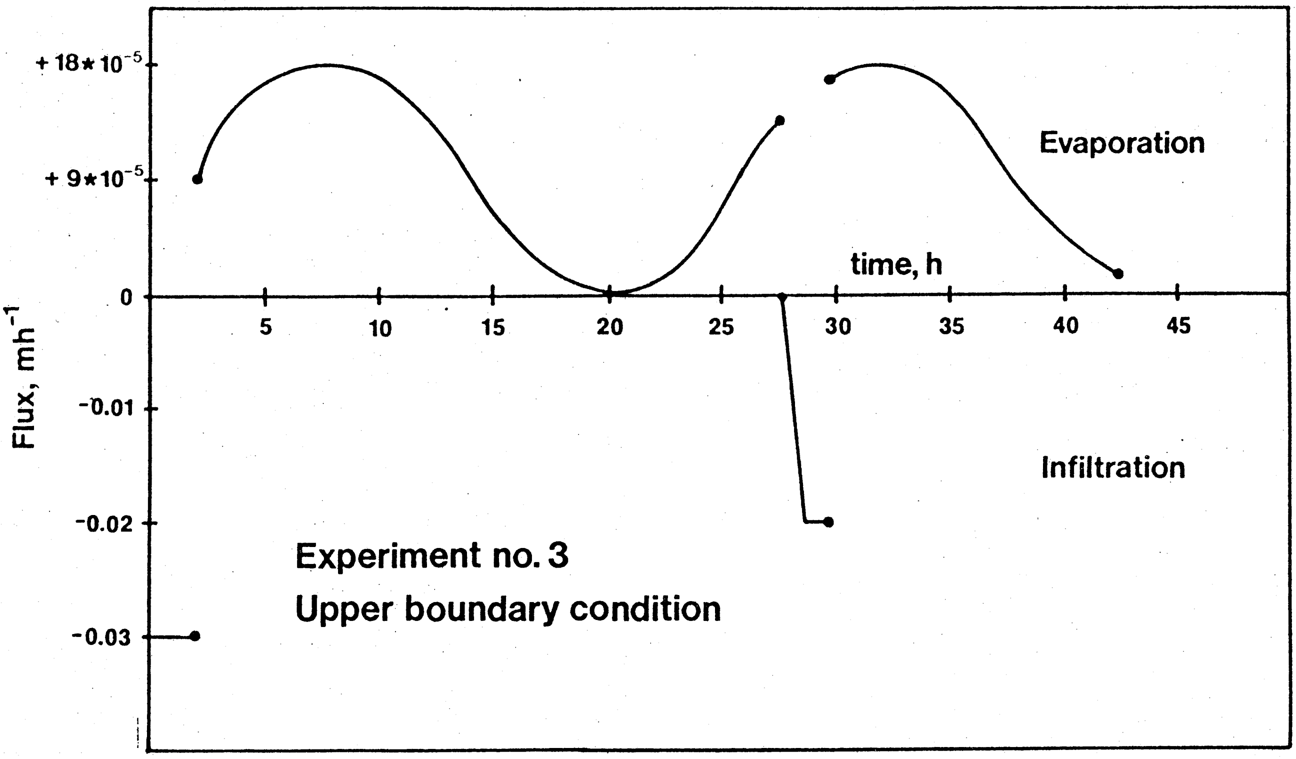

FIG. 7. Top boundary condition for long-term simulation.

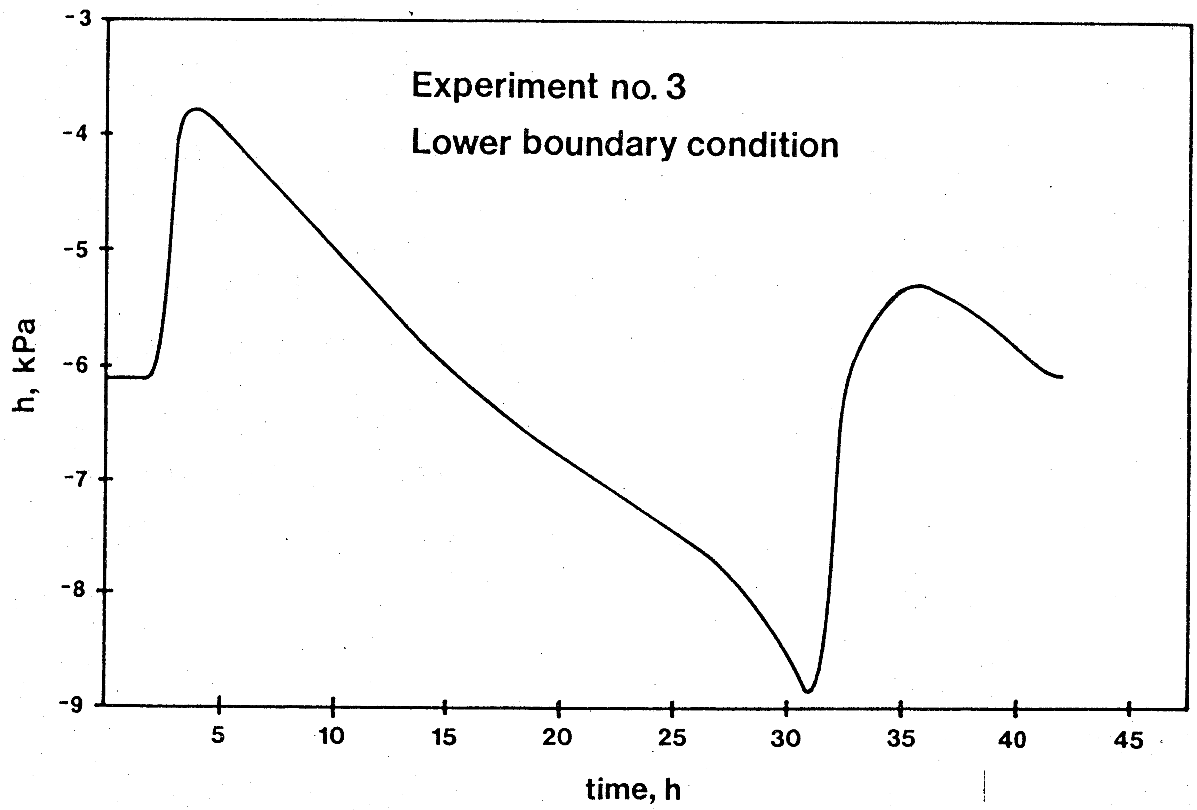

FIG. 8. Bottom boundary condition for long-term simulation.

infiltration were followed with evaporation at an average rate of 0.00216 m day^{-1}. After 27.8 hours of simulation, a second application of water infiltrated during a 2-hour period. For the remaining period of time, the top boundary condition was again changed to evaporation. figure 9 shows that a varying temperature with T_{av}= 20°C did not significantly affect the soil water content profiles. However, it should be noted that the average soil temperature at any depth was 20°C, which is the same as the reference temperature. More distinct differences did occur when the mean soil temperature differed from the temperature at which the hydraulic properties were measured (T_{av}= 25°C, figure 9).

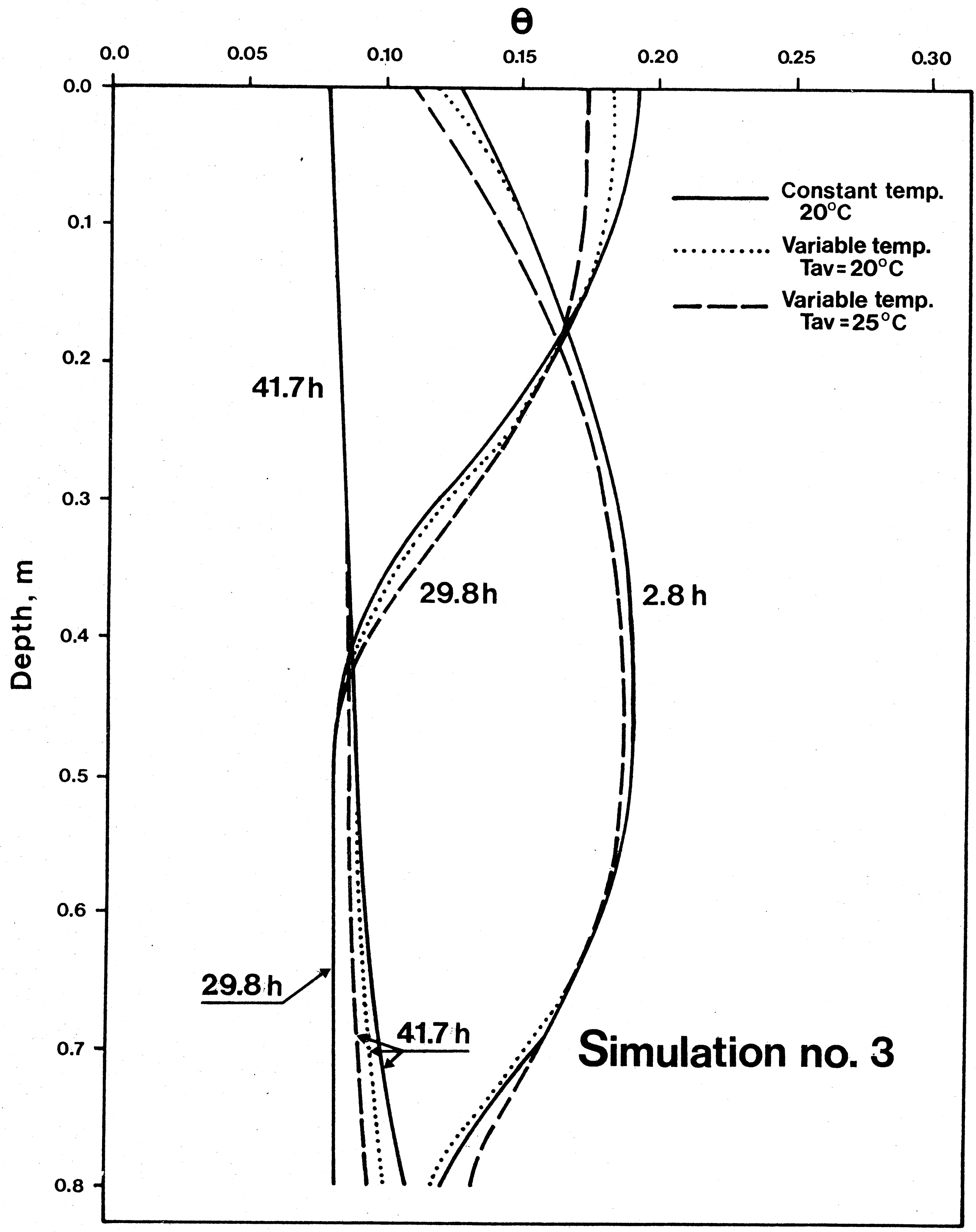

FIG. 9. Water content profiles after 2.8, 29.8, and 41.7 hours of simulation at a constant temperature of 20°C (reference temperature), a variable temperature with a mean temperature of 20°C, and a variable temperature with a mean temperature of 25°C.

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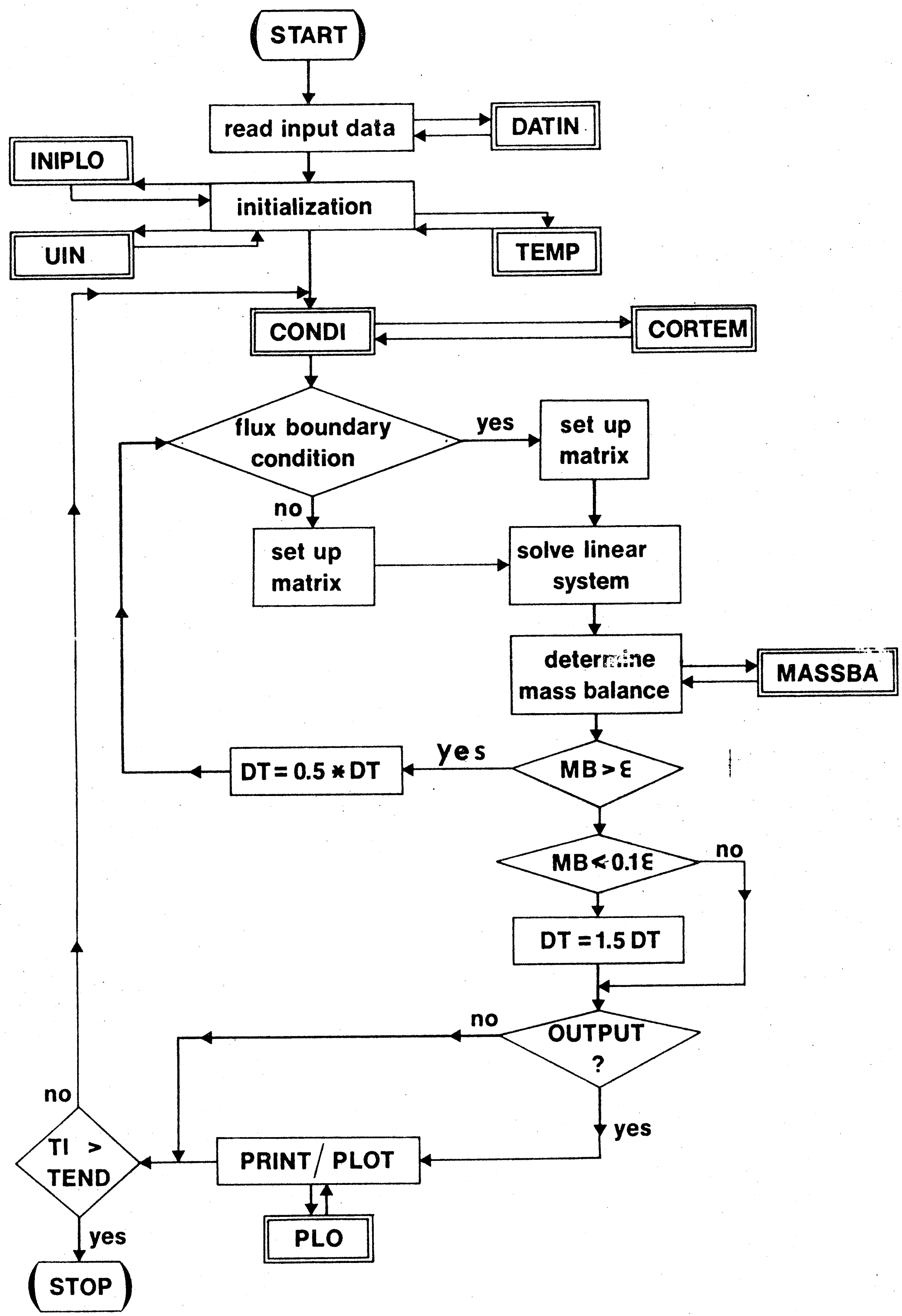
APPENDIX

Execution of the Program

Appendix figure 1 shows a flow chart of the simulation model. The program consists of a main program, 6 subroutines (INIPLO, TEMP, CORTEM, PLO, MASSBA, CONDI) and 4 functions (FK, FC, FTH AND UIN). The input data are read from the data file DATIN. The functions FK, FC, and FTH define the hydraulic functions K(h), C(h) and (h) during initialization. The function UIN provides the initial conditions, expressed in pressure head as a function of depth. Upon execution of the program, a listing is printed of the soil's hydraulic properties and the initial conditions. INIPLO generates a plot of the initial pressure head and water content distribution, while TEMP sets the initial temperature distribution. CORTEM determines the temperature coefficients of pressure head and hydraulic conductivity as a function of water content and temperature.

If the solution does not satisfy the criterion of the mass balance equation (calculations done in MASSBA), the time step is decreased and the solution process is repeated. The simulation, on the other hand, proceeds in time if the mass balance criterion is met. The time step size will increase for subsequent calculations if the mass balance is less than 1/10 of the imposed criterion. The simulation proceeds in time until the maximum simulation time is reached. The subroutine PLO generates a plot of the water content distribution at pre-defined times after the start of the simulation. CONDI allows for transient top and bottom boundary conditions and for a variable temperature distribution in both time and space.

Appendix table 1 gives a list of the most significant variables



APP. FIG. 1. Flow chart of predictor-corrector model with provision of temperature dependent hydraulic properties.

used in the program. Instructions for preparing the input data, together with a listing of the actual input data, are given in appendix table 2. A description and listing of the output are given in appendix table 3, while the listing of the program itself is given in appendix table 4.

Appendix Table 1. Definition of the Main Program Variables; if the Variable Represents an Array, the Maximum Dimension of that Array is Specified

Variable	Definition
ALP	Specifies whether the top boundary condition is a pressure head or flux: ALP=0.0 : pressure head ALP=1.0 : flux
CON	hydraulic conductivity determined from FK(H, V,F)
DT(2)	time step (sec)
DELMO	change in stored water over current time step (cm), calculated from 2 consecutive water content profiles.
DELFLU	change in stored water over current time step (cm), calculated from fluxes at boundaries.
DZ	space step (cm)
EMB	absolute mass balance at current time step (cm)
EPS	criterion for mass balance (cm)
F(220)	factor by which pressure head must be multiplied in order to correct for temperature, if different from reference temperature
FU1	pressure head at imaginary grid point
FC	function, to compute water capacity from pressure head and F

Appendix Table 1 (continued)

FK	function to compute hydraulic conductivity from pressure head, F and V
FTH	function to compute water content from pressure head and F
H0(220)	pressure head at time level (j)
H1(220)	pressure head at time level (j+½)
H2(220)	pressure head at time level (j+1)
NO	number of times output is desired
NZ	number of space steps
NZ1	number of gridpoints (NZ + 1)
O(10)	array, containing the times at which output is desired
OVERAL	relative mass balance since start of simulation (%)
REMB	relative mass balance at current time step (%)
TE(220)	array, containing temperatures at all grid points
TEND	end of simulation (sec)
TI	time since start of simulation (time level j)
TII	time since start of simulation (time level (j+1)
TIII	time since start of simulation (time level j+½)
TH(220)	array, containing water contents at all grid points
UBOT	bottom boundary condition of profile (cm)
UIN	function, containing the initial conditions
UTOP	top boundary condition (flux or pressure head)

Appendix Table 1 (continued)

V(220)	factor by which conductivity must be multiplied to correct for temperature if different from reference temperature
VO(220)	array, containing fluxes at time level (j)
V2(220)	array, containing fluxes at time level (j+1)
WAT(1)	value representing amount of water stored in profile, as determined by trapezoidal rule
Z(220)	array, containing the depths of the gridpoints (negative, cm)
ZBOT	depth of profile L (cm)

Appendix Table 2. Required Input Data and a Listing of Actual Input Data

---

1. Input data file DATIN

column	format	variable	description
1-5	I5	NZ	number of space steps
11-20	F10.4	ZBOT	profile depth (cm)
21-30	F10.4	UTOP	top boundary condition, pressure head (cm) or flux (negative if downward, cm/hr)
31-40	F10.4	UBOT	bottom boundary condition (cm)
41-50	F10.4	DT (1)	initial time step (sec)
51-60	F10.4	TEND	simulation time (sec)
61-70	F10.4	EPS	error criterion mass balance
1-5	F5.1	ALP	see appendix table 1
6-10	I5	NO	number of times that output must be printed
1-80	8F10.1	O(8)	array containing times (sec) that output must be printed (TEND included)

2. Initial conditions:

The initial conditions are listed in the function UIN (Z), where

Appendix Table 2 (continued)

only pressure head values can be assigned, and in the subroutine TEMP (Z,TE) for the initial temperature distribution.

3. Soil Properties:

Analytical expressions for $\theta(h)$, K(h) and C(h) are defined in the functions FTH (H,F),FK(H,V,F) and FC (H,F).

4. Transient boundary conditions and temperature distributions can be defined in the subroutine CONDI.

```
INITIALIZATIONS AND BOUNDARY CONDITIONS
   NR. OF SPACE STEPS ........   80
   DEPTH OF PROFILE (CM) .....  80.00000
   TOP BOUNDARY CONDITION .... -0.003803   ALPHA =    1.0
   BOTTOM BOUNDARY CONDITION . -61.50000
   INITIAL TIME STEP (SECON)   0.01000
   MODEL STOPS AT ............   1000.00 SECON
   ERROR CRITERION MASS BALANCE   0.00100


   OUTPUT IS PRINTED AT

     360.0    1000.0
```

THE FOLLOWING TABLE GIVES THE HYDRAULIC PROPERTIES OF THE SOIL CONSIDEREL
SOIL TEMPERATURE IS REFERENCE TEMP

PRESSURE	WATER CONTENT	CONDUCTIVITY	WATER CAPACITY
-10.0	0.286	0.90225E-02	0.46993E-03
-15.0	0.281	0.71569E-02	0.14928E-02
-20.0	0.270	0.41979E-02	0.31235E-02
-25.0	0.250	0.20535E-02	0.48639E-02
-30.0	0.222	0.98987E-03	0.59319E-02
-35.0	0.192	0.50410E-03	0.59289E-02
-40.0	0.164	0.27456E-03	0.51185E-02
-45.0	0.142	0.15908E-03	0.40178E-02
-50.0	0.124	0.97187E-04	0.29881E-02
-55.0	0.111	0.62092E-04	0.21665E-02
-60.0	0.102	0.41199E-04	0.15589E-02
-65.0	0.095	0.28230E-04	0.11248E-02
-70.0	0.091	0.19885E-04	0.81842E-03
-75.0	0.087	0.14347E-04	0.60228E-03
-80.0	0.084	0.10570E-04	0.44877E-03
-85.0	0.083	0.79325E-05	0.33866E-03
-90.0	0.081	0.60511E-05	0.25877E-03
-95.0	0.080	0.46837E-05	0.20010E-03
-100.0	0.079	0.36733E-05	0.15648E-03
-100.0	0.079	0.36733E-05	0.15648E-03
-200.0	0.075	0.13751E-06	0.52113E-05
-300.0	0.075	0.20122E-07	0.0
-400.0	0.075	0.51458E-08	0.0
-500.0	0.075	0.17869E-08	0.0
-600.0	0.075	0.75297E-09	0.0
-700.0	0.075	0.36262E-09	0.0
-800.0	0.075	0.19256E-09	0.0
-900.0	0.075	0.11018E-09	0.0
-1000.0	0.075	0.66868E-10	0.0
-1100.0	0.075	0.42562E-10	0.0
-1200.0	0.075	0.28177E-10	0.0
-1300.0	0.075	0.19281E-10	0.0
-1400.0	0.075	0.13570E-10	0.0
-1500.0	0.075	0.97846E-11	0.0
-2500.0	0.075	0.86893E-12	0.0
-3500.0	0.075	0.17633E-12	0.0
-4500.0	0.075	0.53578E-13	0.0
-5500.0	0.075	0.20697E-13	0.0
-6500.0	0.075	0.93758E-14	0.0
-7500.0	0.075	0.47580E-14	0.0
-8500.0	0.075	0.26289E-14	0.0
-9500.0	0.075	0.15517E-14	0.0
-10500.0	0.075	0.96556E-15	0.0
-11500.0	0.075	0.62735E-15	0.0
-12500.0	0.075	0.42254E-15	0.0
-13500.0	0.075	0.29338E-15	0.0
-14500.0	0.075	0.20909E-15	0.0
-15500.0	0.075	0.15242E-15	0.0

DEPTH,TEMPERATURE AND TEMPERATURE CORRECTION FACTORS FOR
PRESSURE HEAD AND HYDRAULIC CONDUCITIVITY RESP

0.0	20.0000	1.0000	1.0000
-1.0000	20.0000	1.0000	1.0000
-2.0000	20.0000	1.0000	1.0000
-3.0000	20.0000	1.0000	1.0000
-4.0000	20.0000	1.0000	1.0000
-5.0000	20.0000	1.0000	1.0000
-6.0000	20.0000	1.0000	1.0000
-7.0000	20.0000	1.0000	1.0000
-8.0000	20.0000	1.0000	1.0000
-9.0000	20.0000	1.0000	1.0000
-10.0000	20.0000	1.0000	1.0000
-11.0000	20.0000	1.0000	1.0000
-12.0000	20.0000	1.0000	1.0000
-13.0000	20.0000	1.0000	1.0000
-14.0000	20.0000	1.0000	1.0000
-15.0000	20.0000	1.0000	1.0000
-16.0000	20.0000	1.0000	1.0000
-17.0000	20.0000	1.0000	1.0000
-18.0000	20.0000	1.0000	1.0000
-19.0000	20.0000	1.0000	1.0000
-20.0000	20.0000	1.0000	1.0000
-21.0000	20.0000	1.0000	1.0000
-22.0000	20.0000	1.0000	1.0000
-23.0000	20.0000	1.0000	1.0000
-24.0000	20.0000	1.0000	1.0000
-25.0000	20.0000	1.0000	1.0000
-26.0000	20.0000	1.0000	1.0000
-27.0000	20.0000	1.0000	1.0000
-28.0000	20.0000	1.0000	1.0000
-29.0000	20.0000	1.0000	1.0000
-30.0000	20.0000	1.0000	1.0000
-31.0000	20.0000	1.0000	1.0000
-32.0000	20.0000	1.0000	1.0000
-33.0000	20.0000	1.0000	1.0000
-34.0000	20.0000	1.0000	1.0000
-35.0000	20.0000	1.0000	1.0000
-36.0000	20.0000	1.0000	1.0000
-37.0000	20.0000	1.0000	1.0000
-38.0000	20.0000	1.0000	1.0000
-39.0000	20.0000	1.0000	1.0000
-40.0000	20.0000	1.0000	1.0000
-41.0000	20.0000	1.0000	1.0000
-42.0000	20.0000	1.0000	1.0000
-43.0000	20.0000	1.0000	1.0000
-44.0000	20.0000	1.0000	1.0000
-45.0000	20.0000	1.0000	1.0000
-46.0000	20.0000	1.0000	1.0000
-47.0000	20.0000	1.0000	1.0000
-48.0000	20.0000	1.0000	1.0000
-49.0000	20.0000	1.0000	1.0000
-50.0000	20.0000	1.0000	1.0000
-51.0000	20.0000	1.0000	1.0000
-52.0000	20.0000	1.0000	1.0000
-53.0000	20.0000	1.0000	1.0000
-54.0000	20.0000	1.0000	1.0000
-55.0000	20.0000	1.0000	1.0000
-56.0000	20.0000	1.0000	1.0000
-57.0000	20.0000	1.0000	1.0000

-58.0000	20.0000	1.0000	1.0000
-59.0000	20.0000	1.0000	1.0000
-60.0000	20.0000	1.0000	1.0000
-61.0000	20.0000	1.0000	1.0000
-62.0000	20.0000	1.0000	1.0000
-63.0000	20.0000	1.0000	1.0000
-64.0000	20.0000	1.0000	1.0000
-65.0000	20.0000	1.0000	1.0000
-66.0000	20.0000	1.0000	1.0000
-67.0000	20.0000	1.0000	1.0000
-68.0000	20.0000	1.0000	1.0000
-69.0000	20.0000	1.0000	1.0000
-70.0000	20.0000	1.0000	1.0000
-71.0000	20.0000	1.0000	1.0000
-72.0000	20.0000	1.0000	1.0000
-73.0000	20.0000	1.0000	1.0000
-74.0000	20.0000	1.0000	1.0000
-75.0000	20.0000	1.0000	1.0000
-76.0000	20.0000	1.0000	1.0000
-77.0000	20.0000	1.0000	1.0000
-78.0000	20.0000	1.0000	1.0000
-79.0000	20.0000	1.0000	1.0000
-80.0000	20.0000	1.0000	1.0000

INITIAL CONDITIONS ARE:

NODE	DEPTH	THETA	PRESSURE HEAD	FLUX	TEMPERATURE	WATER CAPACITY
1	0.0	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
2	-0.10000E+01	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
3	-0.20000E+01	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
4	-0.30000E+01	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
5	-0.40000E+01	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
6	-0.50000E+01	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
7	-0.60000E+01	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
8	-0.70000E+01	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
9	-0.80000E+01	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
10	-0.90000E+01	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
11	-0.10000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
12	-0.11000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
13	-0.12000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
14	-0.13000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
15	-0.14000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
16	-0.15000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
17	-0.16000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
18	-0.17000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
19	-0.18000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
20	-0.19000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
21	-0.20000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
22	-0.21000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
23	-0.22000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
24	-0.23000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
25	-0.24000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
26	-0.25000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
27	-0.26000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
28	-0.27000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
29	-0.28000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
30	-0.29000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
31	-0.30000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
32	-0.31000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
33	-0.32000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
34	-0.33000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
35	-0.34000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
36	-0.35000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
37	-0.36000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
38	-0.37000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
39	-0.38000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
40	-0.39000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
41	-0.40000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
42	-0.41000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
43	-0.42000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
44	-0.43000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
45	-0.44000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
46	-0.45000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
47	-0.46000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
48	-0.47000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
49	-0.48000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
50	-0.49000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
51	-0.50000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
52	-0.51000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
53	-0.52000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
54	-0.53000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02

55	-0.54000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
56	-0.55000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
57	-0.56000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
58	-0.57000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
59	-0.58000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
60	-0.59000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
61	-0.60000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
62	-0.61000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
63	-0.62000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
64	-0.63000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
65	-0.64000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
66	-0.65000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
67	-0.66000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
68	-0.67000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
69	-0.68000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
70	-0.69000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
71	-0.70000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
72	-0.71000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
73	-0.72000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
74	-0.73000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
75	-0.74000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
76	-0.75000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
77	-0.76000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
78	-0.77000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
79	-0.78000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
80	-0.79000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02
81	-0.80000E+02	0.99851E-01	-0.61500E+02	-0.36666E-04	20.00	0.14126E-02

Appendix Table 3. Description and listing of output.

The following variables are printed during the simulation and at the selected times for output:

TII-	time since start of simulation
WAT(1)-	water storage in profile at time TII
EMB-	absolute mass balance over current time step
REMB-	relative mass balance over current time step
OVERAL-	relative mass balance since start of simulation
UTOP-	bottom boundary condition (pressure head)
UBOT-	top boundary condition (pressure head or flux)

At the pre-selected times (defined in DATIN) a listing is given of pressure head, water content, flux,and temperature at all grid points.

AT TIME 0.0 WATER IN PROFILE IS 0.79881E+01 CM

TI WAT EMB RE OVER TOP BOT	0.0	0.799E+01	0.208E-02	0.552E+04	0.552E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.0	0.799E+01	0.936E-03	0.497E+04	0.534E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.0	0.799E+01	0.862E-03	0.458E+04	0.515E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.0	0.799E+01	0.803E-03	0.426E+04	0.497E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.0	0.799E+01	0.752E-03	0.399E+04	0.481E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.0	0.799E+01	0.708E-03	0.376E+04	0.466E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.0	0.800E+01	0.671E-03	0.356E+04	0.452E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.0	0.800E+01	0.661E-03	0.351E+04	0.441E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.0	0.800E+01	0.608E-03	0.323E+04	0.429E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.0	0.800E+01	0.583E-03	0.309E+04	0.418E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.800E+01	0.559E-03	0.297E+04	0.408E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.800E+01	0.537E-03	0.285E+04	0.399E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.800E+01	0.518E-03	0.275E+04	0.390E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.800E+01	0.500E-03	0.266E+04	0.382E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.800E+01	0.483E-03	0.257E+04	0.374E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.800E+01	0.497E-03	0.264E+04	0.367E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.800E+01	0.454E-03	0.241E+04	0.360E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.800E+01	0.441E-03	0.234E+04	0.354E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.800E+01	0.429E-03	0.228E+04	0.347E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.800E+01	0.417E-03	0.221E+04	0.341E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.800E+01	0.406E-03	0.216E+04	0.336E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.800E+01	0.396E-03	0.211E+04	0.330E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.800E+01	0.414E-03	0.220E+04	0.326E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.800E+01	0.377E-03	0.200E+04	0.321E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.800E+01	0.369E-03	0.196E+04	0.316E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.800E+01	0.361E-03	0.192E+04	0.311E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.800E+01	0.353E-03	0.187E+04	0.307E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.801E+01	0.345E-03	0.183E+04	0.303E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.801E+01	0.338E-03	0.179E+04	0.298E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.1	0.801E+01	0.330E-03	0.175E+04	0.294E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.345E-03	0.183E+04	0.291E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.313E-03	0.166E+04	0.287E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.303E-03	0.161E+04	0.283E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.294E-03	0.156E+04	0.280E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.282E-03	0.150E+04	0.276E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.270E-03	0.144E+04	0.273E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.258E-03	0.137E+04	0.269E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.245E-03	0.130E+04	0.266E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.233E-03	0.124E+04	0.262E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.220E-03	0.117E+04	0.258E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.235E-03	0.125E+04	0.255E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.198E-03	0.105E+04	0.252E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.186E-03	0.989E+03	0.248E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.176E-03	0.935E+03	0.245E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.166E-03	0.884E+03	0.241E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.158E-03	0.838E+03	0.238E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.150E-03	0.794E+03	0.235E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.164E-03	0.873E+03	0.232E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.135E-03	0.716E+03	0.229E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.2	0.801E+01	0.128E-03	0.681E+03	0.225E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.3	0.801E+01	0.122E-03	0.651E+03	0.222E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.3	0.801E+01	0.116E-03	0.618E+03	0.219E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.3	0.801E+01	0.111E-03	0.591E+03	0.216E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.3	0.801E+01	0.107E-03	0.566E+03	0.213E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.3	0.801E+01	0.102E-03	0.544E+03	0.211E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.3	0.801E+01	0.125E-03	0.663E+03	0.208E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.3	0.801E+01	0.941E-04	0.500E+03	0.205E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.3	0.801E+01	0.134E-03	0.475E+03	0.201E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.3	0.801E+01	0.127E-03	0.451E+03	0.198E+04	-0.380E-02	-0.615E+02

TI WAT EMB RE OVER TOP BOT	0.3	0.801E+01	0.120E-03	0.425E+03	0.194E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.3	0.801E+01	0.114E-03	0.404E+03	0.190E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.3	0.801E+01	0.108E-03	0.384E+03	0.187E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.3	0.801E+01	0.103E-03	0.365E+03	0.183E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.3	0.801E+01	0.126E-03	0.445E+03	0.180E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.3	0.801E+01	0.946E-04	0.335E+03	0.177E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.4	0.801E+01	0.133E-03	0.315E+03	0.173E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.4	0.801E+01	0.126E-03	0.297E+03	0.168E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.4	0.801E+01	0.119E-03	0.280E+03	0.164E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.4	0.801E+01	0.134E-03	0.317E+03	0.160E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.4	0.801E+01	0.105E-03	0.249E+03	0.157E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.4	0.801E+01	0.100E-03	0.237E+03	0.153E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.4	0.801E+01	0.953E-04	0.225E+03	0.150E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.4	0.801E+01	0.134E-03	0.211E+03	0.145E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.5	0.801E+01	0.152E-03	0.240E+03	0.140E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.5	0.801E+01	0.117E-03	0.183E+03	0.136E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.5	0.801E+01	0.110E-03	0.173E+03	0.132E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.5	0.801E+01	0.103E-03	0.162E+03	0.128E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.5	0.801E+01	0.123E-03	0.194E+03	0.125E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.5	0.802E+01	0.915E-04	0.144E+03	0.121E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.6	0.802E+01	0.128E-03	0.134E+03	0.117E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.6	0.802E+01	0.140E-03	0.147E+03	0.112E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.6	0.802E+01	0.109E-03	0.114E+03	0.108E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.6	0.802E+01	0.101E-03	0.106E+03	0.104E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.7	0.802E+01	0.934E-04	0.980E+02	0.101E+04	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.7	0.802E+01	0.155E-03	0.108E+03	0.960E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.7	0.802E+01	0.115E-03	0.808E+02	0.916E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.8	0.802E+01	0.127E-03	0.886E+02	0.876E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.8	0.802E+01	0.948E-04	0.663E+02	0.839E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.9	0.802E+01	0.153E-03	0.711E+02	0.789E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	0.9	0.802E+01	0.109E-03	0.509E+02	0.744E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	1.0	0.802E+01	0.122E-03	0.568E+02	0.705E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	1.0	0.802E+01	0.104E-03	0.485E+02	0.669E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	1.1	0.802E+01	0.716E-04	0.334E+02	0.637E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	1.2	0.802E+01	0.885E-04	0.275E+02	0.593E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	1.3	0.802E+01	0.994E-04	0.206E+02	0.538E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	1.5	0.802E+01	0.915E-04	0.126E+02	0.471E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	1.8	0.802E+01	0.462E-04	0.426E+01	0.397E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	2.2	0.802E+01	0.331E-04	0.203E+01	0.320E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	2.9	0.803E+01	0.240E-03	0.984E+01	0.245E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	3.5	0.803E+01	0.285E-03	0.117E+02	0.198E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	4.2	0.803E+01	0.334E-03	0.137E+02	0.165E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	4.8	0.803E+01	0.331E-03	0.135E+02	0.141E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	5.5	0.803E+01	0.296E-03	0.121E+02	0.123E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	6.1	0.804E+01	0.297E-03	0.122E+02	0.109E+03	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	6.8	0.804E+01	0.249E-03	0.102E+02	0.975E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	7.4	0.804E+01	0.253E-03	0.104E+02	0.881E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	8.1	0.804E+01	0.231E-03	0.944E+01	0.802E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	8.7	0.805E+01	0.191E-03	0.781E+01	0.737E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	9.4	0.805E+01	0.192E-03	0.786E+01	0.680E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	10.0	0.805E+01	0.173E-03	0.710E+01	0.632E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	10.7	0.805E+01	0.134E-03	0.547E+01	0.590E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	11.3	0.805E+01	0.142E-03	0.581E+01	0.553E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	12.0	0.806E+01	0.129E-03	0.526E+01	0.520E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	12.6	0.806E+01	0.930E-04	0.380E+01	0.491E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	13.6	0.806E+01	0.152E-03	0.415E+01	0.453E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	14.6	0.807E+01	0.112E-03	0.305E+01	0.421E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	15.5	0.807E+01	0.112E-03	0.305E+01	0.393E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	16.5	0.807E+01	0.977E-04	0.267E+01	0.368E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	18.0	0.808E+01	0.101E-03	0.184E+01	0.336E+02	-0.380E-02	-0.615E+02

TI WAT EMB RE OVER TOP BOT	19.4	0.808E+01	0.990E-04	0.180E+01	0.310E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	21.6	0.809E+01	0.114E-03	0.139E+01	0.277E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	23.8	0.810E+01	0.771E-04	0.935E+00	0.251E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	27.1	0.811E+01	0.675E-04	0.546E+00	0.220E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	32.0	0.813E+01	0.627E-04	0.338E+00	0.186E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	39.4	0.816E+01	0.703E-03	0.253E+01	0.156E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	46.8	0.819E+01	0.898E-03	0.323E+01	0.137E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	54.2	0.822E+01	0.661E-03	0.238E+01	0.121E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	61.6	0.825E+01	0.607E-03	0.218E+01	0.109E+02	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	69.0	0.827E+01	0.531E-03	0.191E+01	0.996E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	76.3	0.830E+01	0.494E-03	0.177E+01	0.917E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	83.7	0.833E+01	0.460E-03	0.165E+01	0.851E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	91.1	0.836E+01	0.453E-03	0.163E+01	0.795E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	98.5	0.839E+01	0.412E-03	0.148E+01	0.746E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	105.9	0.841E+01	0.393E-03	0.141E+01	0.704E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	113.3	0.844E+01	0.379E-03	0.136E+01	0.667E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	120.7	0.847E+01	0.379E-03	0.136E+01	0.635E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	128.1	0.850E+01	0.349E-03	0.126E+01	0.605E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	135.5	0.853E+01	0.338E-03	0.121E+01	0.579E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	142.9	0.856E+01	0.327E-03	0.118E+01	0.555E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	150.2	0.858E+01	0.332E-03	0.119E+01	0.534E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	157.6	0.861E+01	0.308E-03	0.111E+01	0.514E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	165.0	0.864E+01	0.299E-03	0.108E+01	0.496E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	172.4	0.867E+01	0.295E-03	0.106E+01	0.479E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	179.8	0.870E+01	0.299E-03	0.108E+01	0.464E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	187.2	0.872E+01	0.277E-03	0.996E+00	0.449E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	194.6	0.875E+01	0.273E-03	0.981E+00	0.436E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	202.0	0.878E+01	0.268E-03	0.964E+00	0.423E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	209.4	0.881E+01	0.273E-03	0.982E+00	0.412E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	216.7	0.884E+01	0.255E-03	0.917E+00	0.401E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	224.1	0.887E+01	0.251E-03	0.902E+00	0.391E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	231.5	0.889E+01	0.247E-03	0.887E+00	0.381E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	238.9	0.892E+01	0.251E-03	0.902E+00	0.372E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	246.3	0.895E+01	0.238E-03	0.855E+00	0.364E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	253.7	0.898E+01	0.233E-03	0.837E+00	0.355E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	261.1	0.901E+01	0.231E-03	0.830E+00	0.348E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	268.5	0.903E+01	0.237E-03	0.852E+00	0.340E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	275.9	0.906E+01	0.222E-03	0.797E+00	0.334E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	283.3	0.909E+01	0.220E-03	0.790E+00	0.327E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	290.6	0.912E+01	0.226E-03	0.813E+00	0.321E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	298.0	0.915E+01	0.211E-03	0.758E+00	0.315E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	305.4	0.917E+01	0.210E-03	0.754E+00	0.309E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	312.8	0.920E+01	0.211E-03	0.757E+00	0.303E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	320.2	0.923E+01	0.214E-03	0.769E+00	0.298E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	327.6	0.926E+01	0.201E-03	0.721E+00	0.293E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	335.0	0.929E+01	0.198E-03	0.712E+00	0.288E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	342.4	0.931E+01	0.199E-03	0.714E+00	0.283E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	349.8	0.934E+01	0.204E-03	0.733E+00	0.279E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	357.1	0.937E+01	0.191E-03	0.686E+00	0.275E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	360.0	0.938E+01	0.426E-04	0.397E+00	0.273E+01	-0.380E-02	-0.615E+02

DEPTH, PRESSURE HEAD, THETA, FLUX AND TEMPERATURE
AT TIME: 0.100 HOURS

Z H TH V TEMP	0.0	-0.2331E+02	0.2575E+00	-0.3803E-02	0.2000E+02
Z H TH V TEMP	-0.1000E+01	-0.2380E+02	0.2554E+00	-0.3773E-02	0.2000E+02
Z H TH V TEMP	-0.2000E+01	-0.2438E+02	0.2527E+00	-0.3724E-02	0.2000E+02
Z H TH V TEMP	-0.3000E+01	-0.2510E+02	0.2493E+00	-0.3659E-02	0.2000E+02
Z H TH V TEMP	-0.4000E+01	-0.2598E+02	0.2448E+00	-0.3572E-02	0.2000E+02
Z H TH V TEMP	-0.5000E+01	-0.2709E+02	0.2390E+00	-0.3454E-02	0.2000E+02
Z H TH V TEMP	-0.6000E+01	-0.2852E+02	0.2310E+00	-0.3293E-02	0.2000E+02
Z H TH V TEMP	-0.7000E+01	-0.3039E+02	0.2200E+00	-0.3069E-02	0.2000E+02
Z H TH V TEMP	-0.8000E+01	-0.3288E+02	0.2050E+00	-0.2758E-02	0.2000E+02
Z H TH V TEMP	-0.9000E+01	-0.3627E+02	0.1848E+00	-0.2334E-02	0.2000E+02
Z H TH V TEMP	-0.1000E+02	-0.4078E+02	0.1605E+00	-0.1798E-02	0.2000E+02
Z H TH V TEMP	-0.1100E+02	-0.4632E+02	0.1364E+00	-0.1213E-02	0.2000E+02
Z H TH V TEMP	-0.1200E+02	-0.5204E+02	0.1184E+00	-0.7049E-03	0.2000E+02
Z H TH V TEMP	-0.1300E+02	-0.5653E+02	0.1082E+00	-0.3629E-03	0.2000E+02
Z H TH V TEMP	-0.1400E+02	-0.5922E+02	0.1033E+00	-0.1800E-03	0.2000E+02
Z H TH V TEMP	-0.1500E+02	-0.6053E+02	0.1013E+00	-0.9635E-04	0.2000E+02
Z H TH V TEMP	-0.1600E+02	-0.6111E+02	0.1004E+00	-0.6084E-04	0.2000E+02
Z H TH V TEMP	-0.1700E+02	-0.6134E+02	0.1001E+00	-0.4625E-04	0.2000E+02
Z H TH V TEMP	-0.1800E+02	-0.6143E+02	0.9994E-01	-0.4040E-04	0.2000E+02
Z H TH V TEMP	-0.1900E+02	-0.6147E+02	0.9989E-01	-0.3810E-04	0.2000E+02
Z H TH V TEMP	-0.2000E+02	-0.6148E+02	0.9988E-01	-0.3722E-04	0.2000E+02
Z H TH V TEMP	-0.2100E+02	-0.6149E+02	0.9987E-01	-0.3688E-04	0.2000E+02
Z H TH V TEMP	-0.2200E+02	-0.6149E+02	0.9987E-01	-0.3676E-04	0.2000E+02
Z H TH V TEMP	-0.2300E+02	-0.6149E+02	0.9986E-01	-0.3672E-04	0.2000E+02
Z H TH V TEMP	-0.2400E+02	-0.6149E+02	0.9986E-01	-0.3670E-04	0.2000E+02
Z H TH V TEMP	-0.2500E+02	-0.6149E+02	0.9986E-01	-0.3670E-04	0.2000E+02
Z H TH V TEMP	-0.2600E+02	-0.6149E+02	0.9986E-01	-0.3670E-04	0.2000E+02
Z H TH V TEMP	-0.2700E+02	-0.6149E+02	0.9986E-01	-0.3670E-04	0.2000E+02
Z H TH V TEMP	-0.2800E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.2900E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.3000E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.3100E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.3200E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.3300E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.3400E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.3500E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.3600E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.3700E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.3800E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.3900E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.4000E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.4100E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.4200E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.4300E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.4400E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.4500E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.4600E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.4700E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.4800E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.4900E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.5000E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.5100E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.5200E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.5300E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.5400E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.5500E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.5600E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02

Z H TH V TEMP	-0.5700E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.5800E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.5900E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.6000E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.6100E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.6200E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.6300E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.6400E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.6500E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.6600E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.6700E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.6800E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.6900E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.7000E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.7100E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.7200E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.7300E+02	-0.6149E+02	0.9986E-01	-0.3669E-04	0.2000E+02
Z H TH V TEMP	-0.7400E+02	-0.6149E+02	0.9986E-01	-0.3670E-04	0.2000E+02
Z H TH V TEMP	-0.7500E+02	-0.6149E+02	0.9986E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.7600E+02	-0.6149E+02	0.9986E-01	-0.3672E-04	0.2000E+02
Z H TH V TEMP	-0.7700E+02	-0.6149E+02	0.9986E-01	-0.3673E-04	0.2000E+02
Z H TH V TEMP	-0.7800E+02	-0.6150E+02	0.9986E-01	-0.3674E-04	0.2000E+02
Z H TH V TEMP	-0.7900E+02	-0.6150E+02	0.9985E-01	-0.3676E-04	0.2000E+02
Z H TH V TEMP	-0.8000E+02	-0.6150E+02	0.9985E-01	-0.3677E-04	0.2000E+02

WATER IN PROFILE AT TIME 360.00SEC: 0.93807E+01CM

TI WAT EMB RE OVER TOP BOT	371.1	0.942E+01	0.434E-03	0.104E+01	0.268E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	382.2	0.947E+01	0.423E-03	0.101E+01	0.263E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	393.3	0.951E+01	0.408E-03	0.977E+00	0.258E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	404.3	0.955E+01	0.410E-03	0.982E+00	0.254E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	415.4	0.959E+01	0.389E-03	0.931E+00	0.250E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	426.5	0.963E+01	0.380E-03	0.909E+00	0.245E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	437.6	0.968E+01	0.382E-03	0.914E+00	0.242E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	448.7	0.972E+01	0.365E-03	0.876E+00	0.238E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	459.8	0.976E+01	0.359E-03	0.861E+00	0.234E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	470.8	0.980E+01	0.362E-03	0.867E+00	0.231E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	481.9	0.984E+01	0.345E-03	0.827E+00	0.227E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	493.0	0.989E+01	0.341E-03	0.817E+00	0.224E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	504.1	0.993E+01	0.344E-03	0.824E+00	0.221E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	515.2	0.997E+01	0.328E-03	0.786E+00	0.218E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	526.3	0.100E+02	0.328E-03	0.787E+00	0.215E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	537.3	0.101E+02	0.323E-03	0.774E+00	0.212E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	548.4	0.101E+02	0.314E-03	0.753E+00	0.209E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	559.5	0.101E+02	0.314E-03	0.753E+00	0.207E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	570.6	0.102E+02	0.308E-03	0.737E+00	0.204E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	581.7	0.102E+02	0.301E-03	0.722E+00	0.202E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	592.8	0.103E+02	0.305E-03	0.730E+00	0.199E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	603.8	0.103E+02	0.296E-03	0.710E+00	0.197E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	614.9	0.103E+02	0.292E-03	0.699E+00	0.194E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	626.0	0.104E+02	0.293E-03	0.701E+00	0.192E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	637.1	0.104E+02	0.286E-03	0.684E+00	0.190E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	648.2	0.105E+02	0.281E-03	0.674E+00	0.188E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	659.3	0.105E+02	0.285E-03	0.683E+00	0.186E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	670.4	0.106E+02	0.276E-03	0.661E+00	0.184E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	681.4	0.106E+02	0.272E-03	0.653E+00	0.182E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	692.5	0.106E+02	0.276E-03	0.661E+00	0.180E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	703.6	0.107E+02	0.268E-03	0.643E+00	0.178E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	714.7	0.107E+02	0.270E-03	0.647E+00	0.177E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	725.8	0.108E+02	0.264E-03	0.633E+00	0.175E+01	-0.380E-02	-0.615E+02
TI WAT EMB RE OVER TOP BOT	736.9	0.108E+02	0.261E-03	0.625E+00	0.173E+01	-0.380E-02	-0.615E+02

TI	WAT	EMB	RE	OVER	TOP	BOT	747.9	0.109E+02	0.262E-03	0.627E+00	0.172E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	759.0	0.109E+02	0.259E-03	0.620E+00	0.170E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	770.1	0.109E+02	0.255E-03	0.611E+00	0.168E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	781.2	0.110E+02	0.255E-03	0.611E+00	0.167E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	792.3	0.110E+02	0.254E-03	0.609E+00	0.165E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	803.4	0.111E+02	0.249E-03	0.597E+00	0.164E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	814.4	0.111E+02	0.252E-03	0.604E+00	0.163E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	825.5	0.111E+02	0.248E-03	0.593E+00	0.161E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	836.6	0.112E+02	0.245E-03	0.586E+00	0.160E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	847.7	0.112E+02	0.244E-03	0.585E+00	0.158E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	858.8	0.113E+02	0.246E-03	0.590E+00	0.157E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	869.9	0.113E+02	0.241E-03	0.577E+00	0.156E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	880.9	0.114E+02	0.239E-03	0.573E+00	0.155E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	892.0	0.114E+02	0.240E-03	0.575E+00	0.153E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	903.1	0.114E+02	0.236E-03	0.566E+00	0.152E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	914.2	0.115E+02	0.234E-03	0.560E+00	0.151E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	925.3	0.115E+02	0.237E-03	0.568E+00	0.150E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	936.4	0.116E+02	0.232E-03	0.557E+00	0.149E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	947.5	0.116E+02	0.236E-03	0.565E+00	0.148E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	958.5	0.117E+02	0.229E-03	0.550E+00	0.147E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	969.6	0.117E+02	0.229E-03	0.549E+00	0.146E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	980.7	0.117E+02	0.230E-03	0.551E+00	0.145E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	991.8	0.118E+02	0.227E-03	0.543E+00	0.144E+01	-0.380E-02	-0.615E+02
TI	WAT	EMB	RE	OVER	TOP	BOT	1000.0	0.118E+02	0.144E-03	0.466E+00	0.143E+01	-0.380E-02	-0.615E+02

DEPTH, PRESSURE HEAD, THETA, FLUX, AND TEMPERATURE
AT TIME: 0.278 HOURS

Z H TH V TEMP	0.0	-0.2113E+02	0.2661E+00	-0.3803E-02	0.2000E+02
Z H TH V TEMP	-0.1000E+01	-0.2118E+02	0.2659E+00	-0.3801E-02	0.2000E+02
Z H TH V TEMP	-0.2000E+01	-0.2125E+02	0.2656E+00	-0.3796E-02	0.2000E+02
Z H TH V TEMP	-0.3000E+01	-0.2133E+02	0.2654E+00	-0.3791E-02	0.2000E+02
Z H TH V TEMP	-0.4000E+01	-0.2141E+02	0.2651E+00	-0.3785E-02	0.2000E+02
Z H TH V TEMP	-0.5000E+01	-0.2151E+02	0.2647E+00	-0.3778E-02	0.2000E+02
Z H TH V TEMP	-0.6000E+01	-0.2162E+02	0.2643E+00	-0.3770E-02	0.2000E+02
Z H TH V TEMP	-0.7000E+01	-0.2175E+02	0.2638E+00	-0.3760E-02	0.2000E+02
Z H TH V TEMP	-0.8000E+01	-0.2190E+02	0.2632E+00	-0.3749E-02	0.2000E+02
Z H TH V TEMP	-0.9000E+01	-0.2207E+02	0.2626E+00	-0.3735E-02	0.2000E+02
Z H TH V TEMP	-0.1000E+02	-0.2227E+02	0.2618E+00	-0.3720E-02	0.2000E+02
Z H TH V TEMP	-0.1100E+02	-0.2249E+02	0.2609E+00	-0.3701E-02	0.2000E+02
Z H TH V TEMP	-0.1200E+02	-0.2276E+02	0.2598E+00	-0.3679E-02	0.2000E+02
Z H TH V TEMP	-0.1300E+02	-0.2306E+02	0.2586E+00	-0.3652E-02	0.2000E+02
Z H TH V TEMP	-0.1400E+02	-0.2342E+02	0.2570E+00	-0.3620E-02	0.2000E+02
Z H TH V TEMP	-0.1500E+02	-0.2385E+02	0.2551E+00	-0.3581E-02	0.2000E+02
Z H TH V TEMP	-0.1600E+02	-0.2435E+02	0.2528E+00	-0.3532E-02	0.2000E+02
Z H TH V TEMP	-0.1700E+02	-0.2496E+02	0.2499E+00	-0.3472E-02	0.2000E+02
Z H TH V TEMP	-0.1800E+02	-0.2569E+02	0.2463E+00	-0.3396E-02	0.2000E+02
Z H TH V TEMP	-0.1900E+02	-0.2660E+02	0.2416E+00	-0.3299E-02	0.2000E+02
Z H TH V TEMP	-0.2000E+02	-0.2773E+02	0.2355E+00	-0.3172E-02	0.2000E+02
Z H TH V TEMP	-0.2100E+02	-0.2915E+02	0.2273E+00	-0.3006E-02	0.2000E+02
Z H TH V TEMP	-0.2200E+02	-0.3100E+02	0.2164E+00	-0.2784E-02	0.2000E+02
Z H TH V TEMP	-0.2300E+02	-0.3341E+02	0.2018E+00	-0.2489E-02	0.2000E+02
Z H TH V TEMP	-0.2400E+02	-0.3659E+02	0.1830E+00	-0.2106E-02	0.2000E+02
Z H TH V TEMP	-0.2500E+02	-0.4069E+02	0.1609E+00	-0.1641E-02	0.2000E+02
Z H TH V TEMP	-0.2600E+02	-0.4561E+02	0.1391E+00	-0.1146E-02	0.2000E+02
Z H TH V TEMP	-0.2700E+02	-0.5075E+02	0.1219E+00	-0.7098E-03	0.2000E+02
Z H TH V TEMP	-0.2800E+02	-0.5512E+02	0.1111E+00	-0.3988E-03	0.2000E+02
Z H TH V TEMP	-0.2900E+02	-0.5809E+02	0.1052E+00	-0.2155E-03	0.2000E+02
Z H TH V TEMP	-0.3000E+02	-0.5980E+02	0.1024E+00	-0.1213E-03	0.2000E+02
Z H TH V TEMP	-0.3100E+02	-0.6068E+02	0.1010E+00	-0.7602E-04	0.2000E+02
Z H TH V TEMP	-0.3200E+02	-0.6111E+02	0.1004E+00	-0.5486E-04	0.2000E+02
Z H TH V TEMP	-0.3300E+02	-0.6131E+02	0.1001E+00	-0.4505E-04	0.2000E+02
Z H TH V TEMP	-0.3400E+02	-0.6141E+02	0.9999E-01	-0.4053E-04	0.2000E+02
Z H TH V TEMP	-0.3500E+02	-0.6145E+02	0.9992E-01	-0.3845E-04	0.2000E+02
Z H TH V TEMP	-0.3600E+02	-0.6147E+02	0.9990E-01	-0.3751E-04	0.2000E+02
Z H TH V TEMP	-0.3700E+02	-0.6148E+02	0.9988E-01	-0.3707E-04	0.2000E+02
Z H TH V TEMP	-0.3800E+02	-0.6148E+02	0.9988E-01	-0.3687E-04	0.2000E+02
Z H TH V TEMP	-0.3900E+02	-0.6148E+02	0.9988E-01	-0.3679E-04	0.2000E+02
Z H TH V TEMP	-0.4000E+02	-0.6148E+02	0.9987E-01	-0.3674E-04	0.2000E+02
Z H TH V TEMP	-0.4100E+02	-0.6148E+02	0.9987E-01	-0.3673E-04	0.2000E+02
Z H TH V TEMP	-0.4200E+02	-0.6148E+02	0.9987E-01	-0.3672E-04	0.2000E+02
Z H TH V TEMP	-0.4300E+02	-0.6148E+02	0.9987E-01	-0.3672E-04	0.2000E+02
Z H TH V TEMP	-0.4400E+02	-0.6148E+02	0.9987E-01	-0.3672E-04	0.2000E+02
Z H TH V TEMP	-0.4500E+02	-0.6148E+02	0.9987E-01	-0.3672E-04	0.2000E+02
Z H TH V TEMP	-0.4600E+02	-0.6148E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.4700E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.4800E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.4900E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.5000E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.5100E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.5200E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.5300E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.5400E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.5500E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.5600E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02

Z H TH V TEMP	-0.5700E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.5800E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.5900E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.6000E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.6100E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.6200E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.6300E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.6400E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.6500E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.6600E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.6700E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.6800E+02	-0.6149E+02	0.9987E-01	-0.3670E-04	0.2000E+02
Z H TH V TEMP	-0.6900E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.7000E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.7100E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.7200E+02	-0.6149E+02	0.9987E-01	-0.3671E-04	0.2000E+02
Z H TH V TEMP	-0.7300E+02	-0.6149E+02	0.9987E-01	-0.3672E-04	0.2000E+02
Z H TH V TEMP	-0.7400E+02	-0.6149E+02	0.9987E-01	-0.3673E-04	0.2000E+02
Z H TH V TEMP	-0.7500E+02	-0.6149E+02	0.9987E-01	-0.3674E-04	0.2000E+02
Z H TH V TEMP	-0.7600E+02	-0.6149E+02	0.9987E-01	-0.3674E-04	0.2000E+02
Z H TH V TEMP	-0.7700E+02	-0.6149E+02	0.9986E-01	-0.3675E-04	0.2000E+02
Z H TH V TEMP	-0.7800E+02	-0.6149E+02	0.9986E-01	-0.3677E-04	0.2000E+02
Z H TH V TEMP	-0.7900E+02	-0.6150E+02	0.9986E-01	-0.3678E-04	0.2000E+02
Z H TH V TEMP	-0.8000E+02	-0.6150E+02	0.9985E-01	-0.3679E-04	0.2000E+02

WATER IN PROFILE AT TIME 1000.00SEC: 0.11808E+02CM

```
C
C ******************************************************************
C * M O D E L                                                      *
C *                A ONE DIMENSIONAL SIMULATION MODEL              *
C *                USING THE PREDICTOR-CORRECTOR METHOD            *
C *                TIME STEP : VARIABLE                            *
C *                SPACE STEP: FIXED                               *
C *                POSSIBLE BOUNDARY CONDITIONS:                   *
C *                1.CONSTANT PRESSURE HEAD FOR TOP AND BOTTOM     *
C *                  BOUNDARY CONDITION                            *
C *                2.VARIABLE FLUX TOP BOUNDARY AND VARIABLE       *
C *                  PRESSURE HEAD BOTTOM BOUNDARY CONDITION.      *
C *                ACCOUNTS FOR TEMPERATURE EFFECTS ON HYDRAULIC   *
C *                PROPERTIES.                                     *
C *                                                                *
C *                                                                *
C *  JAN HOPMANS                       VERSION DECEMBER  1983      *
C ******************************************************************
C
C
C
C
C  ***** THE DATA ARE READ FROM DISK ******************************
      INTEGER TT
      REAL HO(220),H1(220),H2(220),TH(220),VO(220),V2(220),DT(2)
      REAL Z(220),A(220),B(220),C(220),CC(220),D(220),WAT(2),O(10)
      REAL TE(220),F(220),V(220),CO(220),GR(220)
      COMMON AAA,JJJ,NZ1,ZBOT,ALP,UTOP,EMB,REMB,DELMO,TT,DELFLU,TEND
      READ(3,25) NZ,ZBOT,UTOP,UBOT,DT(1),TEND,EPS,ALP,NO
      READ(3,26) (O(I),I=1,NO)
26    FORMAT(8F10.1)
C
25    FORMAT(I5,5X,4F10.4,F10.2,F10.4,/,F5.1,I5)
C
C CONVERT FLUX TOP BOUNDARY TO CM/SEC
      IF(ALP.EQ.1.0) UTOP = UTOP/3600
C
C ****** THESE DATA ARE WRITTEN TO UNIT 6 ************************
      WRITE(6,45) NZ,ZBOT,UTOP,ALP,UBOT,DT(1),TEND,EPS,(O(I),I=1,NO)
45    FORMAT(' INITIALIZATIONS AND BOUNDARY CONDITICNS ',2X,/,
     1'     NR. OF SPACE STEPS ........',I5,/,
     2'     DEPTH OF PROFILE (CM) .....',F10.5,/,
     3'     TOP BOUNDARY CONDITION ....',F10.6,'   ALPHA = ',F5.1,/,
     4'     BOTTOM BOUNDARY CONDITION .',F10.5,/,
     5'     INITIAL TIME STEP (SECON)',F10.5,/,
     6'     MODEL STOPS AT ............',F10.2,' SECON',/,
     7'     ERROR CRITERION MASS BALANCE',F10.5,3(/),
     8'     OUTPUT IS PRINTED AT ',2(/),
```

```
     92X,8F10.1)
C
C ***********************************************************************
C                                                                       C
C TOP BOUNDARY CONDITION:                                               C
C                            FLUX: ALP = 1.0                            C
C                   PRESSURE HEAD: ALP = 0.0                            C
C BOTTOM BOUNDARY CONDITION:                                            C
C                   PRESSURE HEAD ONLY                                  C
C                                                                       C
C                                                                       C
C                                                                       C
C  R E M E M B E R   T H E   D A R C Y   C O N V E N T I O N            C
C                                                                       C
C          POSITIVE FLUX ----> UPWARD FLOW                              C
C          NEGATIVE FLUX ----> DOWNWARD FLOW                            C
C                                                                       C
C ***********************************************************************
C
C
C
C
C     LISTING OF THE SOIL'S PHYSICAL PROPERTIES .....
      WRITE(6,10)
10    FORMAT(1H1,' THE FOLLOWING TABLE GIVES THE HYDRAULIC PROPERTIES',
     1' OF THE SOIL CONSIDERED'/' SOIL TEMPERATURE IS REFERENCE TEMP',
     22(/),'     PRESSURE    WATER CONTENT     ',
     3'CONDUCTIVITY      WATER CAPACITY',/)
      FF= 1.
      VV= 1.
      TE(1)=20.0
      DO 20 I=10,100,5
      U=-1.0*I
      THET = FTH(U,FF)
      COND = FK(U,VV,FF)
      CAP  = FC(U,FF)
      WRITE(6,50) U,THET,COND,CAP
C     WRITE(1,50) U,THET,COND,CAP
20    CONTINUE
      DO 30 I=100,1400,100
      U=-1.0*I
      THET = FTH(U,FF)
      COND = FK(U,VV,FF)
      CAP  = FC(U,FF)
      WRITE(6,50) U,THET,COND,CAP
C     WRITE(1,50) U,THET,COND,CAP
30    CONTINUE
      DO 40 I=1500,15500,1000
```

```
      U=-1.0*I
      THET = FTH(U,FF)
      COND = FK(U,VV,FF)
      CAP  = FC(U,FF)
      WRITE(6,50) U,THET,COND,CAP
C     WRITE(1,50) U,THET,COND,CAP
50    FORMAT(2X,F8.1,7X,F5.3,8X,E12.5,7X,E12.5)
40    CONTINUE
C
C     SOME INTIALIZATIONS
C
55    DELM = 0.0
      DELF = 0.0
      EPS = .001
      NO = 1
      TT = 1
      DZ = -ZBOT/NZ
      NZ1=NZ+1
      N1Z=NZ-1
      N2Z=NZ-2
      TI=0.0
      AAA = -0.30
      JJJ = 0
      KKK = 1
      CALL PLOTS(0,0,0)
C
C     INITIAL VALUES OF Z,U,V AND TH AT TIME ZERO
      PMAX=0.
      DO 60 I=1,NZ1
        Z(I) = FLOAT(I-1)*DZ
        HO(I)=UIN(Z(I))
        PMAX = AMIN1(PMAX,HO(I))
60    CONTINUE
C
C THIS SUBROUTINE GIVES AND PLOTS THE TEMP. DISTRIBUTION IN PROFILE.
C AT TIME ZERO (ONLY TO BE USED IF TEMPERATURE IS CONTSTANT WITH TIME):
C
      CALL TEMP(Z,TE)
C
C DETERMINATION OF TEMPERATURE COEFFICIENTS OF PRESSURE HEAD AND
C HYDRAULIC CONDUCTIVITY:
C
      CALL CORTEM(TE,Z,F,V)
         WRITE(6,8)
8        FORMAT(1H1,' DEPTH,TEMPERATURE AND TEMPERATURE CORRECTION ',
     1 'FACTORS FOR'/'  PRESSURE HEAD AND HYDRAULIC CONDUCITIVITY RESP')
         DO 61 I=1,NZ1
         WRITE(6,9) Z(I),TE(I),F(I),V(I)
```

```
61        CONTINUE
9         FORMAT(2X,4(2X,F9.4))
C
C FOR TEMP. DISTRIBUTION AND/OR BOUNDARY CONDITIONS,IF TRANSIENT:
      IF(ALP.EQ.1.0) CALL CONDI(Z,TE,UTOP,UBOT,TI,F,V,HO(NZ))
C
      DO 62 I=1,NZ1
         TH(I)=FTH(HO(I),F(I))
          C(I)=FC(HO(I),F(I))
62    CONTINUE
C
C A PLOT OF INITIAL CONDITIONS:
C
      CALL INIPLO(Z,HO,TH,PMAX)
      DO 65 I=2,NZ1
          CON = -FK(.5*(HO(I)+HO(I-1)),.5*(V(I)+V(I-1)),.5*(F(I)+F(I-1
     1 )))
          VO(I) = CON*((HO(I)-HO(I-1))/DZ) + CON
65    CONTINUE
      VO(1) =-FK(HO(1),V(1),F(1))
C
C **LIST THE INITIAL VALUES OF DEPTH,THETA,PRESSURE HEAD AND FLUX RESP.
C                                                      + TEMPERATURE.
      WRITE(6,66)
66    FORMAT(1H1,/,' INITIAL CONDITIONS ARE: ',2(/),
     1'      NODE            DEPTH          THETA          PRESSURE HEAD ',
     2'       FLUX','      TEMPERATURE',' WATER CAPACITY',2(/))
      DO 70 I=1,NZ1
      WRITE(6,75) I,Z(I),TH(I),HO(I),VO(I),TE(I),C(I)
70    CONTINUE
75    FORMAT(2X,I5,4X,4(3X,E12.5),6X,F6.2,3X,E12.5)
C
      DELMO = 0.0
      DO 80 I=1,NZ
          DELMO=DELMO-(TH(I)+TH(I+1))
80    CONTINUE
      WAT(1)       = DZ*DELMO/2.
      WRITE(6,81) TI,WAT(1)
81    FORMAT(1H1,' AT TIME ',F10.5,' WATER IN PROFILE IS ',E12.5,' CM')
C
C
C IF CONTSTANT FLUX AT TOP THEN:
      IF(ALP.EQ.1.0) VO(1)=UTOP
      IF(ALP.EQ.1.0) GO TO 300
C
C FOR CONSTANT PRESSURE HEAD TOP  AND BOTTOM BOUNDARY CONDITION
      TII = TI + DT(TT)
C
```

```
CCCCCCCCCCCCCCCC   P R E D I C T O R   CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
85     DO 90 I=2,NZ
          A(I)=((2*DZ**2)/DT(TT))*FC(HO(I),F(I))/FK(HO(I),V(I),F(I))
          B(I)=(FK(HO(I+1),V(I+1),F(I+1)) - FK(HO(I-1),V(I-1),F(I-1)))
      1 /(4*FK(HO(I),V(I),F(I)))
          CC(I)=2*DZ*B(I)
90     CONTINUE
C      WRITE(6,91) TII
91     FORMAT(2(/),' PREDICTOR AT TIME ',F10.5,' SEC ')
       H1(1)=UTOP
       H1(NZ1)=UBOT
       D(2)=-A(2)*HO(2) - B(2)*HO(3) - CC(2) - H1(1) + B(2)*HO(1)
       D(NZ)= B(NZ)*HO(N1Z)-A(NZ)*HO(NZ)- CC(NZ)- H1(NZ1)-B(NZ)*HO(NZ1)
       DO 100 I=3,N1Z
          D(I) = B(I)*HO(I-1) - A(I)*HO(I) - B(I)*HO(I+1) - CC(I)
100    CONTINUE
       DO 105 I=2,NZ
C      WRITE(6,104) Z(I),A(I),B(I),CC(I),D(I)
104    FORMAT(' Z A B CC D',2X,5E15.5)
105    CONTINUE
C
C   SOLVE FOR PRESSURE HEAD BY THOMAS ALGORITHM.
C
       C(2)= -1.0/(2.0 + A(2))
       D(2)= -D(2)/(2.0 + A(2))
       DO 120 I=3,NZ
          Y = -2.0 - A(I) - C(I-1)
          C(I) = 1.0/Y
          D(I) = (D(I) - D(I-1))/Y
120    CONTINUE
C
       DO 130 I=2,NZ
C      WRITE(6,125) I,C(I),D(I)
125    FORMAT(2X,'C D ',I3,2E15.5)
130    CONTINUE
       C(NZ)=0.0
       H1(NZ) = D(NZ)
       N2Z = N1Z - 1
       DO 140 I=1,N2Z
          J = NZ - I
          H1(J) = D(J) - C(J)*H1(J+1)
140    CONTINUE
       DO 160 I=1,NZ1
C      WRITE(6,150) Z(I),HO(I),H1(I)
150    FORMAT(' Z U0 U1',2X,3E15.5,/)
160    CONTINUE
C
```

```
CCCCCCCCCCCCCCCCCCC  C O R R E C T O R   CCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C     WRITE(6,161) TII
161   FORMAT(2(/),' CORRECTOR AT TIME ',F10.5,' SEC ')
      DO 180 I=2,NZ
         A(I)=((2.0*DZ**2)/DT(TT))*FC(H1(I),F(I))/FK(H1(I),V(I),F(I))
         B(I)=(FK(H1(I+1),V(I+1),F(I+1)) - FK(H1(I-1),V(I-1),F(I-1)))
     1 /(4*FK(H1(I),V(I),F(I)))
         CC(I)=2.0*DZ*B(I)
180   CONTINUE
      H2(1)=UTOP
      H2(NZ1)=UBOT
      D(2)=(2.0-A(2))*H0(2)-H0(3)-2.0*B(2)*H1(3)+2.0*B(2)*H1(1)-
     1 2.0*CC(2) -H2(1) - H0(1)
      D(NZ)=-H0(N1Z)+(2.0-A(NZ))*H0(NZ)+2.0*B(NZ)*H1(N1Z)
     1 -2.0*B(NZ)*H2(NZ1) - 2.0*CC(NZ) - H2(NZ1) - H0(NZ1)
      DO 200 I=3,N1Z
         D(I) = -H0(I-1) + (2.0-A(I))*H0(I) - H0(I+1) + 2.*B(I)*H1(I-1)
     1 - 2.0*B(I)*H1(I+1) - 2.0*CC(I)
200   CONTINUE
      DO 205 I=2,NZ
C     WRITE(6,104) Z(I),A(I),B(I),CC(I),D(I)
205   CONTINUE
C
C  SOLVE FOR PRESSURE HEAD BY THOMAS ALGORITHM.
C
      C(2)= -1.0/(2.0 + A(2))
      D(2)= -D(2)/(2.0 + A(2))
      DO 220 I=3,NZ
         Y = -2.0 - A(I) - C(I-1)
         C(I) = 1.0/Y
         D(I) = (D(I) - D(I-1))/Y
220   CONTINUE
C
      DO 230 I=2,NZ
C     WRITE(6,125) I,C(I),D(I)
230   CONTINUE
      C(NZ)=0.0
      H2(NZ) = D(NZ)
      DO 240 I=1,N2Z
         J = NZ - I
         H2(J) = D(J) - C(J)*H2(J+1)
240   CONTINUE
      DO 260 I=1,21
C     WRITE(6,250) Z(I),H0(I),H1(I),H2(I)
250   FORMAT(' Z H TH V TEMP',3X,5E13.4)
260   CONTINUE
C
```

```
C   SET-UP MASS BALANCE:
      GO TO 335
C
C   FOR VARIABLE FLUX TOP BOUNDARY CONDITICN ::
C
300   TII = TI + DT(TT)
C
CCCCCCCCCCCCCCCCCCCCCCC   PREDICTOR   CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
301   CONTINUE
      UUU=HO(NZ)
      TIII=TI + .5*DT(TT)
      CALL CONDI(Z,TE,UTOP2,UBOT2,TIII,F,V,UUU)
      CALL CONDI(Z,TE,UTOP1,UBOT1,TI,F,V,UUU)
      D1 = 2*DZ*(UTOP1 + FK(HO(1),V(1),F(1)))/FK(HO(1),V(1),F(1))
      D2 = 2*DZ*(UTOP2 + FK(HO(1),V(1),F(1)))/FK(HO(1),V(1),F(1))
      FU1 = HO(2) + D1
      DO 303 I=1,NZ
         A(I)=((2*DZ**2)/DT(TT))*FC(HO(I),F(I))/FK(HO(I),V(I),F(I))
          IF(I.EQ.1) GO TO 302
         B(I)=(FK(HO(I+1),V(I+1),F(I+1)) - FK(HO(I-1),V(I-1),F(I-1)))
     1   /(4*FK(HO(I),V(I),F(I)))
302      IF(I.EQ.1) B(I) = (FK(HO(I+1),V(I+1),F(I+1))-FK(FU1,V(I),F(I)))
     1   /(4*FK(HO(I),V(I),F(I)))
         CC(I)=2*DZ*B(I)
303   CONTINUE
C     WRITE(6,91) TII
      H1(NZ1) = UBOT2
      D(1)=-A(1)*HO(1) - CC(1) + B(1)*D1 - D2
      D(NZ)= B(NZ)*HO(N1Z)-A(NZ)*HO(NZ)- CC(NZ)- H1(NZ1)-B(NZ)*HO(NZ1)
      DO 304 I=2,N1Z
         D(I) = B(I)*HO(I-1) - A(I)*HO(I) - B(I)*HO(I+1) - CC(I)
304   CONTINUE
      DO 305 I=1,NZ
C     WRITE(6,104) Z(I),A(I),B(I),CC(I),D(I)
305   CONTINUE
C
C  SOLVE FOR PRESSURE HEAD BY THOMAS ALGORITHM:
      C(1)= -2.0/(2.0 + A(1))
      D(1)= -D(1)/(2.0 + A(1))
      DO 306 I=2,NZ
         Y = -2.0 - A(I) - C(I-1)
         C(I) = 1.0/Y
         D(I) = (D(I) - D(I-1))/Y
306   CONTINUE
C
      DO 307 I=1,NZ
C     WRITE(6,125) I,C(I),D(I)
```

```
307   CONTINUE
      C(NZ)=0.0
      H1(NZ) = D(NZ)
      DO 310 I=1,N1Z
         J = NZ - I
         H1(J) = D(J) - C(J)*H1(J+1)
310   CONTINUE
      DO 311 I=1,NZ1
C     WRITE(6,150) Z(I),H0(I),H1(I)
311   CONTINUE
C
CCCCCCCCCCCCCCCCCCCCCCCCC   CORRECTOR   CCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C     WRITE(6,161) TII
      CALL CONDI(Z,TE,UTOP,UBOT,TII,F,V,UUU)
      CALL CONDI(Z,TE,UTOP2,UBOT2,TIII,F,V,UUU)
      D2 = 2*DZ*(UTOP2 + FK(H1(1),V(1),F(1)))/FK(H1(1),V(1),F(1))
      D3 = 2*DZ*(UTOP + FK(H1(1),V(1),F(1)))/FK(H1(1),V(1),F(1))
      FU1 = H1(2) + D2
C     WRITE(6,312) D2,FU1
312   FORMAT(' D2,FU1',2E12.5)
      DO 315 I=1,NZ
         A(I)=((2.0*DZ**2)/DT(TT))*FC(H1(I),F(I))/FK(H1(I),V(I),F(I))
         IF(I.EQ.1) GO TO 313
         B(I)=(FK(H1(I+1),V(I+1),F(I+1)) - FK(H1(I-1),V(I-1),F(I-1)))
     1   /(4*FK(H1(I),V(I),F(I)))
313      IF(I.EQ.1) B(I) = (FK(H1(I+1),V(I+1),F(I+1))-FK(FU1,V(I),F(I)))
     1   /(4*FK(H1(I),V(I),F(I)))
C     WRITE(6,314) I,B(I)
314   FORMAT(' I B(I)',I3,E12.5)
         CC(I)=2.0*DZ*B(I)
315   CONTINUE
      H2(NZ1)=UBOT
      D(1)=(2.0-A(1))*H0(1)-2*H0(2)+2.0*B(1)*D2-D1-D3-2*CC(1)
      D(NZ)=-H0(N1Z)+(2.0-A(NZ))*H0(NZ)+2.0*B(NZ)*H1(N1Z)
     1 -2.0*B(NZ)*H2(NZ1) - 2.0*CC(NZ) - H2(NZ1) - H0(NZ1)
      DO 320 I=2,N1Z
         D(I) = -H0(I-1) + (2.0-A(I))*H0(I) - H0(I+1) + 2.*B(I)*H1(I-1)
     1 - 2.0*B(I)*H1(I+1) - 2.0*CC(I)
320   CONTINUE
      DO 321 I=1,NZ
C     WRITE(6,104) Z(I),A(I),B(I),CC(I),D(I)
321   CONTINUE
C
C SOLVE FOR PRESSURE HEAD BY THOMAS ALGORITHM:
      C(1)= -2.0/(2.0 + A(1))
      D(1)= -D(1)/(2.0 + A(1))
      DO 325 I=2,NZ
```

```
            Y = -2.0 - A(I) - C(I-1)
            C(I) = 1.0/Y
            D(I) = (D(I) - D(I-1))/Y
325     CONTINUE
C
        DO 326 I=1,NZ
C       WRITE(6,125) I,C(I),D(I)
326     CONTINUE
        C(NZ)=0.0
        H2(NZ) = D(NZ)
        DO 330 I=1,N1Z
            J = NZ - I
            H2(J) = D(J) - C(J)*H2(J+1)
330     CONTINUE
        DO 331 I=1,21
C       WRITE(6,250) Z(I),H0(I),H1(I),H2(I)
331     CONTINUE
C
335     CALL MASSBA(TH,H2,Z,V0,V2,DT,DZ,V,F,C0,GR)
C
C       IF(TII.GT.1.00) EPS = 0.001
C       WRITE(6,501) DELMO,DELFLU,EMB,REMB
501     FORMAT(' DELMO DELFLU EMD REMB ',4E15.5)
        TT = 1
        IF(EMB.GT.EPS) GO TO 510
        IF(EMB.LT.0.1*EPS) DT(TT) = 1.5*DT(TT)
C
C TIME STEP IS DECREASED IF THE REL. MASS BALANCE IS TOO LARGE:
C
C       IF(TII.GT.50.0.AND.REMB.GT.0.5) GO TO 510
        GO TO 520
510     DT(TT) = 0.5* DT(TT)
        TII = TI + DT(TT)
        IF(TII.GT.O(NO)) GO TO 900
        IF(TI.EQ.0.0) GO TO 520
        DO 515 I=1,NZ1
        TH(I)=FTH(H0(I),F(I))
515     CONTINUE
        IF(ALP.EQ.1.0) GO TO 301
        GO TO 85
520     TI = TII
        WAT(1) = WAT(1) + DELMO
        DELF = DELF + DELFLU
        DELM = DELM + DELMO
        OVERAL = ((ABS(DELM-DELF))/DELF)*100
        WRITE(6,502) TII,WAT(1),EMB,REMB,OVERAL,UTOP,UBOT
502     FORMAT(' TI WAT EMB RE OVER TOP BOT',F8.1,6(E11.3))
C       WRITE(6,451) TII, WAT(1)
```

```
451   FORMAT(/,' WATER IN PROFILE AT TIME ',F10.2,'SEC:',E12.5,'CM')
      IF(TI.EQ.TEND) GO TO 1000
      TII = TI + DT(TT)
      IF(TI.EQ.O(NO)) GO TO 530
      IF(TII.GT.O(NO)) GO TO 900
530   TIHR=TI/3600
      IF(TI.EQ.O(NO)) WRITE(6,531) TIHR
531   FORMAT(1H1,' DEPTH, PRESSURE HEAD, THETA, FLUX AND TEMPERATURE ',
     1/,' AT TIME:    ',F10.3,'  HOURS',1(/))
      DO 700 I=1,NZ1
         TH(I) = FTH(H2(I),F(I))
         IF(TI.EQ.O(NO)) WRITE(6,250) Z(I),H2(I),TH(I),V2(I),TE(I)
         HO(I)=H2(I)
         VO(I) =V2(I)
700   CONTINUE
      IF(TI.EQ.O(NO)) GO TO 800
      GO TO 750
800   AAA = AAA - 0.3
      JJJ = JJJ + 1
      WRITE(6,451) TI, WAT(1)
      CALL PLO(Z,TH,TI,O,PMAX,HO)
      NO = NO + 1
      IF(TII.GT.O(NO)) GO TO 900
750   IF(ALP.EQ.1.0) GO TO 301
      GO TO 85
900   TT=2
      DT(TT) = O(NO) - TI
      TII= TI + DT(TT)
      DO 940 I=1,NZ1
         HO(I)=H2(I)
         TH(I) = FTH(HO(I),F(I))
         VO(I) =V2(I)
940   CONTINUE
      IF(ALP.EQ.1.0) GO TO 301
      GO TO 85
1000  TIHR=TI/3600
      WRITE(6,531) TIHR
      DO 950 I=1,NZ1
          TH(I) = FTH(H2(I),F(I))
          WRITE(6,250) Z(I),H2(I),TH(I),V2(I),TE(I)
950   CONTINUE
      AAA = AAA - 0.3
      JJJ = JJJ + 1
      WRITE(6,451) TI, WAT(1)
      CALL PLO(Z,TH,TI,O,PMAX,H2)
      NO = NO + 1
      CALL PLOT(0.0,0.0,-999)
      CALL PLOCO(CO,GR,Z)
```

```
      CALL PLOT(0.0,0.0,+999)
      STOP
      END
```

```
      FUNCTION FTH(H,F)
C ** COMPUTES WATER CONTENT FROM WATER RETENTION CURVES.
      REAL H,F,HH
      REAL M,N
      HH= (1./F)*H
C     IF(HH.GE.-1.0) GO TO 10
C     GO TO 30
      FTH=1.611E+06*.212/(1.611E+06+ABS(HH)**3.96)+.075
C     FTH=739*.371/(739+ALOG(ABS(HH))**4.00)+.124
      GO TO 20
10    FTH=.495
30    N=4.16259
      A = 0.030627
      M=1.-(1./N)
      TE=(1.0/(1.0+(A*ABS(H))**N))**M
      FTH=.21950*TE+0.0675
20    RETURN
      END
```

```
      FUNCTION FK(H,V,F)
C ** HYDRAULIC CONDUCTIVITY VALUES FROM PRESSURE HEAD DATA.
      REAL H,V,F,HH
      HH= (1.0/F)*H
      IF(HH.GT.0.0) HH=0.0
C     GOTO 10
      FK=34.*1.175E+06/(3600*(1.175E+06+ABS(HH)**4.74))
C     FK=4.428E-02*124.6/(3600*(124.6+ABS(HH)**1.77))
      FK = V*FK
      GO TO 30
10    HH=ABS(H)
      F=-0.58420234 - 0.09268778*HH + 0.00051873*HH**2
      FK=10**F
30    RETURN
      END
```

```
      FUNCTION FC(H,F)
C ** WATER CAPACITY VALUES FROM PRESSURE HEAD DATA.
      REAL H,F,HH
      REAL N,M
C
      HH=H/F
      IF(HH.LT.-240.0) GO TO 10
C     GO TO 30
      FC=1.611E+06*.212*3.96*ABS(HH)**2.96
      FC = FC/(1.611E+06+ABS(HH)**3.96)**2
C     IF(HH.GT.-1.0) GO TO 10
C     FC=739*.371*4.00*ALOG(ABS(HH))**3.00
C     FC = FC/(739+ALOG(ABS(HH))**4.00)**2
C     FC = FC /ABS(HH)
      FC = FC/F
      GO TO 20
10    FC = 0.0
      GO TO 20
30    A = 0.030627
      N = 4.16259
      M = 1 -(1./N)
      R = -M-1
      T = N - 1
      HH = (1+(A*ABS(H))**N)**R
      FC=0.2195*M*HH*N*(A**N)*(ABS(H)**T)
20    RETURN
      END


      FUNCTION UIN(Z)
C ** THE INITIAL CONDITIONS, EXPRESSED IN PRESSURE HEAD VALUES AS A
C ** FUNCTION OF DEPTH.
      UIN = -61.5
      RETURN
      END


      SUBROUTINE INIPLO(Z,HO,TH,PMAX)
      COMMON AAA,JJJ,NZ1,ZBOT
      REAL Z(220),TH(220),HO(220)
      CALL PLOT(1.0,9.0,-3)
      K=NZ1+1
      L = K + 1
      Z(K) = 0.0
      Z(L) =ZBOT/8.0
      HO(K)= 0.
      HO(L)=PMAX/4.
      TH(K)=0.
      TH(L)=0.05
     CALL AXIS(0.0,0.0,'PRESSURE HEAD THETA',+19,8.0,0.0,0.0,HO(L))
     CALL AXIS(0.0,0.0,'DEPTH CM',-8,8.0,270.0,0.0,Z(L))
     CALL LINE(HO,Z,NZ1,1,+1,1)
     CALL AXIS(0.0,0.3,' ',+1,8.0,0.0,0.0,0.05)
     CALL LINE(TH,Z,NZ1,1,+1,2)
     CALL SYMBOL(2.0,-8.2,0.10,'THETA AND PRESSURE HEAD',0.0,+23)
     CALL PLCT(0.0,0.0,-999)
     RETURN
     END
```

```
      SUBROUTINE CORTEM(TE,Z,FACT,VIS)
C
C DETERMINES THE TEMP. COEFFICIENT OF PRESSURE HEAD AND HYDRAULIC
C CCNDUCTIVITY:
C
      COMMON AAA,JJJ,NZ1
      REAL TE(220),Z(220),FACT(220),VIS(220),T(220)
      DO 200 I=1,NZ1
         SUM=0.0
         T(I)=10.0*TE(I)
         IT=INT(T(I))
         IF(IT.LE.200) GO TC 150
            DO 100 J=210,IT
            E = J/10.
            SIG = 75.594 -0.1328*E-0.000537*E**2+2.2719E-06*E**3
            DSIG= -.1328 - 0.001074*E + 6.8157E-06*E**2
            GAM = (3.0/SIG)*DSIG*.1
            SUM = SUM + GAM
100         CONTINUE
         FACT(I)= 1.0 + SUM
         GO TO 200
150      IF(IT.EQ.200) GO TO 195
            DO 190 J=IT,200
            E = J/10.
            SIG = 75.594 -0.1328*E-0.000537*E**2+2.2719E-06*E**3
            DSIG= -.1328 - 0.001074*E + 6.8157E-06*E**2
            GAM = (3.0/SIG)*DSIG*.1
            SUM = SUM + GAM
190         CONTINUE
195      FACT(I)= 1.0 - SUM
200      CONTINUE
         DO 400 I=1,NZ1
         IF(TE(I).LT.20.) GO TO 300
         A = 1.3272*(20.-TE(I)) -0.001053*(TE(I)-20.)**2
         B = TE(I) + 105.
         C = 10**(A/B)
         VI = 0.01002*C
         IF(TE(I).EQ.20.0) VI=.01002
         GO TO 350
300      A = 998.333+8.1855*(TE(I)-20.)+0.00585*(TE(I)-20.)**2
         B = (1301./A) - 3.30233
         VI = 10**B
350      VIS(I) = 0.01002/VI
400      CONTINUE
         RETURN
         END
```

```
      SUBROUTINE MASSBA(TH,H2,Z,V0,V2,DT,DZ,V,F,CO,GR)
C
C CALCULATES MASS BALANCE OVER EACH TIME PERIOD.
C
      REAL TH(220),H2(220),Z(220),V0(220),V2(220),DT(2),V(220),F(220)
      REAL CO(220),GR(220)
      INTEGER TT,JJJ
      COMMON AAA,JJJ,NZ1,ZBOT,ALP,UTOP,EMB,REMB,DELMO,TT,DELFLU,TEND
      NZ = NZ1 -1
      DO 10 I=1,NZ1
      TH(I) = FTH(H2(I),F(I)) - TH(I)
C     WRITE(6,349) I,H2(I),TH(I)
349   FORMAT(' I H DELTH',I4,2E15.5)
10    CONTINUE
      DELMO=0.0
      DO 20 I=1,NZ
         DELMO = DELMO - (TH(I) + TH(I+1))
399      FORMAT(' DELTH ',E12.5)
20    CONTINUE
C        WRITE(6,399) DELMO
      DELMO = DELMO *DZ / 2.0
C
      IF(ALP.EQ.1.0) V0(1)=UTOP
      DO 50 I=2,NZ1
      GR(I-1)=(H2(I)-H2(I-1))/DZ
      CON = -FK(.5*(H2(I)+H2(I-1)),.5*(V(I)+V(I-1)),.5*(F(I)+F(I-1)))
         V2(I) = CON * ((H2(I) - H2(I-1))/DZ) +CON
         CO(I-1) =-CON
50    CONTINUE
      V2(1)=V2(2)
      IF(ALP.EQ.1.0) V2(1)=UTOP
      DELFLU = (-V2(1) - V0(1) + V2(NZ1) + V0(NZ1)) * DT(TT) / 2.0
      EMB = ABS(DELMO - DELFLU)
      REMB = ( EMB/ABS(DELFLU))*100
      RETURN
      END

       SUBROUTINE TEMP(Z,TE)
C  SETS AND PLOTS INITIAL TEMPERATUE DISTRIBUTION IN PROFILE
C
       COMMON AAA,JJJ,NZ1,ZBOT
       REAL Z(220),TE(220)
       DO 100 I=1,NZ1
C        TE(I) = ((+25.*Z(I))/ZBOT) + 40.
          TE(I) = 20.0
100    CONTINUE
       K= NZ1 + 1
       L = K+1
       Z(K) = 0.0
       Z(L) = ZBOT/8.0
       TE(K) = 10.0
       TE(L) = 5.0
      CALL PLOT(1.0,9.0,-3)
      CALL AXIS(0.0,0.0,'TEMPERATURE',+11,8.0,0.0,10.0,5.0)
      CALL AXIS(0.0,0.0,'DEPTH CM',-8,8.0,270.0,0.0,Z(L))
      CALL LINE(TE,Z,NZ1,1,+1,1)
      CALL SYMBOL(2.0,-8.2,0.10,'TEMPERATURE PROFILE',0.0,+19)
      CALL PLOT(0.0,0.0,-999)
      RETURN
      END
```

```
      SUBROUTINE CONDI(Z,T,UT,UB,TIM,F,V,U)
C
C TEMPERATURE DISTRIBUTION AND TRANSIENT BOUNDARY CONDITIONS
C AS A FUNCTION OF TIME:
C
      REAL Z(220),T(220),UT,UB,TIM,F(220),V(220),XX
      COMMON AAA,JJJ,NZ1,ZBOT
      GO TO 600
      XX=100000.
$
01)  IGI002I LABEL
      IF(TIM.GT.(7200.+XX)) GO TO 100
      IF(TIM.LT.7200.) GO TO 200
      IF(TIM.GT.XX) GO TO 300
100   A1 =(2*3.141*(TIM-7200))/86400
      UT=0.0000025+0.0000025*SIN(A1)
      GO TO 400
200   UT= -3./3600
      GO TO 400
300   UT =(-2./3600)*(TIM-XX)/3600.
      IF(TIM.GT.(XX+3600)) UT=-2./3600
400   IF(TIM.GT.7200.) UB = U-0.05
      IF(TIM.LT.7200.) UB = -61.5
      WW = 7.272E-05
      TA = 25.0
      AO = 15.0
      DD = 22.6
      DO 500 I=1,NZ1
         A2 = Z(I)/DD
         A3 = (EXP(A2))*SIN(WW*TIM + A2)
         T(I) = TA + AO*A3
C        T(I) = 20.0
500   CONTINUE
      GO TO 700
600   UT = -13.69/3600.
      UB = -61.5
      DO 650 I=1,NZ1
      T(I)=20.0
650   CONTINUE
700   CALL CORTEM(T,Z,F,V)
      RETURN
      END
```

```
      SUBROUTINE PLUCO(C,G,Z)
      REAL Z(100),C(100),G(100)
      COMMON AAA,JJJ,NZ1,ZBOT,ALP,UTOP,EMB,REMB,DFLMO,TT,DELFLU,TEND
      NZ=NZ1 -1
      K=NZ1
      L = K + 1
      DO 10 J=1,NZ
      Z(J)=Z(J+1)
10    CONTINUE
      DO 20 I=1,NZ
      WRITE(6,25) Z(I),C(I),G(I)
20    CONTINUE
25    FORMAT( ' Z C G',2X,3E12.5)
      C(K)=0.0
      C(L)=0.0005
      G(K)=0.0
      G(L)=1.0
      Z(K)=0.0
      Z(L)=ZBOT/8.0
      CALL PLOT(2.0,9.0,-3)
      CALL AXIS(0.0,0.0,'DEPTH CM',-8,8.0,270.0,0.0,Z(L))
      CALL AXIS(0.0,0.0,'PRESSURE GRADIENT',17,8.0,0.0,0.0,1.00)
      CALL AXIS(0.0,.43,'CONDUCITIVITY',12,10.0,0.0,0.0,0.0005)
      CALL LINE(G,Z,NZ,1,+1,1)
      CALL LINE(C,Z,NZ,1,+1,2)
      CALL PLOT(0.0,0.0,-999)
      RETURN
      END

       SUBROUTINE PLO(Z,TH,TIME,O,PMAX,H)
C ** THETA WILL BE PLOTTED VERSUS DEPTH FOR THE TIMES SPECIFIED
C ** IN THE INPUT DATA FILE.
      REAL Z(220),TH(220),TIME,O(10),H(220),PMAX,P
      COMMON AAA,JJJ,NZ1,ZBOT
      K = NZ1 + 1
      L = K + 1
      Z(K) = 0.0
      Z(L) = ZBOT/8.0
      H(K)=0.0
      H(L)=-PMAX/4.
      P = PMAX/4.
      TH(K) = 0.0
      TH(L) = 0.05
      IF(TIME.GT.O(1)) GO TO 20
      CALL PLOT(10.0,9.0,-3)
      CALL AXIS(0.0,0.0,'VOLUMETRIC WATERCONTENT',+23,8.0,0.0,0.0,0.05)
      CALL AXIS(0.0,0.0,'DEPTH CM',-8,8.0,270.0,0.0,Z(L))
      CALL AXIS(0.0,-8.0,'PRESSURE HEAD',+13,8.0,180.0,0.0,P)
      CALL SYMBOL(1.0,-0.3,0.10,'SEC',0.0,+3)
C     CALL SYMBOL(6.0,-6.0,0.10,'JAN HOPMANS',0.0,+11)
20    CALL LINE(TH,Z,NZ1,1,+1,JJJ)
      CALL LINE(H,Z,NZ1,1,+1,JJJ)
      CALL SYMBOL(0.3,AAA,0.10,JJJ,0.0,-1)
      CALL SYMBOL(0.5,AAA,0.10,'TIME',0.0,+4)
      CALL NUMBER(1.0,AAA,0.10,TIME,0.0,-1)
      CALL PLOT(0.0,0.0,+3)
      RETURN
      END
```