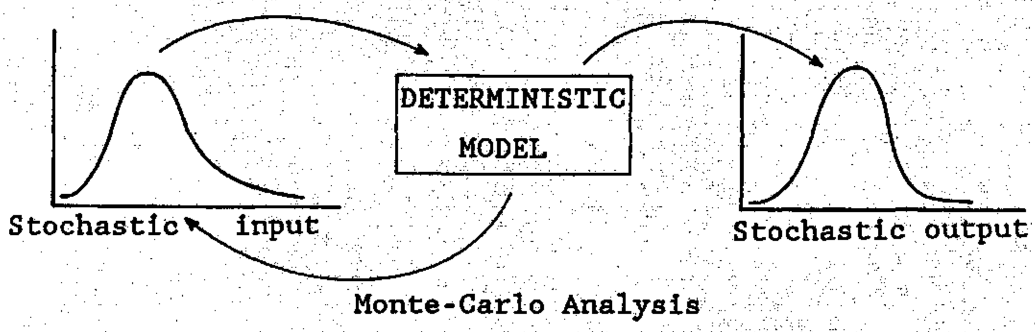
SOME MAJOR MODIFICATIONS OF THE SIMULATION MODEL "SWATRE"



PUBLICATION 79

HYDRAULICA EN
AFVOERHYDROLOGIE
Landbouwuniversiteit Wageningen

SOME MAJOR MODIFICATIONS OF THE SIMULATION MODEL SWATRE

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SOME MAJOR MODIFICATIONS OF THE SIMULATION MODEL SWATRE[1]

J.W. Hopmans

INTRODUCTION

The program SWATR was developed by Feddes et al. (1978). This original version was later extended by Belmans et al. in 1981 (SWATRE) and most recently by Belmans, Wesseling, Feddes and Kroonen (SWAPRO). The SWAPRO-version can simulate a potato crop yield and allows irrigation if soil moisture conditions are unfavourable for optimal crop growth.
As compared with the latter program, the following major extensions are added.

1. Instead of providing tables that describe the soil physical characteristics of each soil layer, analytical expressions are introduced such that only the parameters of these expressions are needed to fully describe the soil-water characteristic and hydraulic conductivity curve.

2. The definition of a new sink term that allows water extraction by roots to be influenced by the hydraulic conductivity of the soil in the rootzone.

3. From the distribution type, mean and standard deviation of a set of scale factor values, it is possible to simulate water flow with variable soil hydraulic properties. A set of scale factor values for each soil layer or compartment is calculated through generation of a standard normal distribution and the statistical properties of scale factor values.

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[1] This study was supported by the Netherlands Foundation of Earth Science Research (AWON) with funds from the Dutch Organization for the Advancement of Pure Research (ZWO).

4. Measurements of discharge at the outlet of a watershed and groundwater levels at various locations within the watershed yield a set of discharge (q) - groundwater level (h) relationships. The distribution type, mean, and standard deviation of scale factor values of the q(h)-relations are input to generate a variable q(h)-relationship as lower boundary condition of the soil-water system.

In addition, the following minor modifications are introduced:

1. The soil profile can be divided into a maximum of 100 compartments.

2. The maximum of soil layers with different soil hydraulic properties is changed to 10.

3. No surface runoff is possible.

4. Simulation of one growing season can be repeated an unlimited number of times within one run. Each simulation will use different scale factor values for the soil hydraulic properties and/or the q(h)-relationship. One run will, therefore, yield a frequency distribution for each of the output variables.

5. Output is directed to three different output files.

THEORY

1. ANALYTICAL EXPRESSIONS FOR SOIL HYDRAULIC PROPERTIES

The hydraulic properties of an unsaturated soil are characterized by a water retention curve and the hydraulic conductivity (K) as a function of volumetric water content (θ) or soil-water pressure head (Ψ). Tabulated hydraulic data do not allow for a quick comparison or the scaling of hydraulic properties of different soil layers or soils. Analytical expressions that can be used to fit experimentally determined water retention and conductivity data were introduced by van Genuchten (1980). In these expressions, both hydraulic functions are described by the same parameters α, n and m.

$$\Theta = [1+|\alpha\Psi|^{n}]^{-m} \quad , \qquad [1]$$

$$K_{rel}(\Theta)=\Theta^{1/2}[1-(1-\Theta^{1/m})^{m}]^{2} \quad , \qquad [2]$$

$$K_{rel}(\Psi) = \frac{[1-(\alpha|\Psi|)^{n-1}(1+(\alpha|\Psi|)^{n})^{-m}]^{2}}{[1+(\alpha|\Psi|)^{n}]^{m/2}} \quad , \qquad [3]$$

where

$$m = 1-(1/n) \quad ,$$

$$\Theta = \frac{\theta - \theta_r}{\theta_s - \theta_r} \quad ,$$

$$K_{rel} = K/K_{sat} \quad ,$$

and where θ_r and θ_s denote residual and saturated water content, respectively, and K_{sat} the saturated hydraulic conductivity.
Van Genuchten (1980) developed a nonlinear least-squares curve-fitting procedure to estimate the parameters α, n and m from measured $\theta(\Psi)$-data. A later version of this model (RETC) allows the expressions [1], [2], and [3] to be fitted simultaneously to observed water retention and conductivity data. Reviews of van Genuchten's work can be found in van Genuchten and Nielsen (1985) and Hopmans and Overmars (1986).

2. NEW SINK TERM

Belmans et al. (1981) defined the sink term S

$$S(\Psi) = \alpha(\Psi) \cdot S_{max} \quad , \qquad [4a]$$

where S_{max} denotes the maximum volume of water which can be taken up by the roots per unit bulk volume of soil per unit time ($cm^3\ cm^{-3}\ day^{-1}$), and $\alpha(\Psi)$ is the dimensionless sink term variable ($0 \leq \alpha \leq 1$). Assuming that the potential transpiration demand is uniformly distributed over the various layers of the rootzone, one can write (Belmans et al., 1981)

$$S_{max} = \frac{E_{pot}}{D_r} \qquad , \qquad [4b]$$

where E_{pot} is the potential transpiration rate (cm day^{-1}) and D_r the depth of the rootzone (cm). Subsequently, one can also define the sink term variable for each layer within the rootzone by

$$\alpha(\Psi) = \frac{S(\Psi)}{S_{max}} = \frac{E_{act}}{E_{pot}} \qquad , \qquad [4c]$$

where E_{act} denotes the actual transpiraton rate (cm day^{-1}) and Ψ will generally be different for each layer.

For a grass crop E_{pot} and E_{act} can be calculated from (Thom and Oliver, 1977; Rapport Verdamping en Gewasproductie, 1979)

$$E_{pot} = \frac{sR_n + \gamma f(u)\Delta e}{s + \gamma + \gamma \frac{65}{r_a}} \qquad , \qquad [5a]$$

and

$$E_{act} = \frac{sR_n + \gamma f(u)\Delta e}{s + \gamma + \gamma \frac{r_c}{r_a}} \qquad , \qquad [5b]$$

yielding

$$E_{act} = E_{pot} \left[\frac{s + \gamma + (65/r_a)\gamma}{s + \gamma + (r_c/r_a)\gamma}\right] \qquad , \qquad [5c]$$

where

s = change of saturated vapor pressure per ^oK (mbar $^oK^{-1}$),
γ = psychrometric constant (mbar $^oK^{-1}$),
r_c = crop resistance (sec m^{-1}),
r_a = aerodynamic diffusion resistance (sec m^{-1}),

f(u) = wind function,

Δe = difference between saturated vapour pressure (mbar) at surface and prevailing vapour pressure at height where f(u) is determined,

R_n = net incoming radiation

I.e., $E_{act}=E_{pot}$, if r_c has its minimum value of 65 for a grass crop. The value of r_c is, however, dependent on the leaf water potential Ψ_1,

$$r_c=r_b \qquad \Psi_1 \geq P_1 \quad ,$$

$$r_c=r_b-(r_b-r_m)\,\frac{P_1-\Psi_1}{P_1-P_2} \qquad P_1>\Psi_1>P_2 \quad , \qquad [6]$$

$$r_c=r_m \qquad \Psi_1 \leq P_2 \quad ,$$

where

r_b = basic crop resistance (sec m^{-1}),
r_m = maximum crop resistance (sec m^{-1}),
P_1, P_2 = threshold values for Ψ_1 (cm).

According to Report groep Verdamping (1984, pag. 56), Ψ_1 can be calculated from

$$\Psi_1= \Psi_s-3E_{act}\left[R_{pl}+\frac{B\,R_{pl}}{D_r K(\Psi)}\right] \quad , \qquad [7]$$

where

R_{pl} = plant resistance (day),
B = empirical constant (cm^2 day^{-1}),
$K(\Psi)$= hydraulic conductivity (cm day^{-1}),
Ψ_s = soil water pressure head (cm).

The following values of parameters and constants are adopted from Report groep Verdamping (1984):

s = 1.17 mbar $^oK^{-1}$ (for average daily temperature),

γ = 0.67 mbar $^oK^{-1}$,
r_a = 55 sec m^{-1} (grass),
r_b = 65 sec m^{-1} (grass),
r_m = 500 sec m^{-1} (grass),
P_1 = -15000 mbar (grass),
P_2 = -25000 mbar (grass),
B = 0.04 cm^2 day^{-1},
R_{p1} = 10000 day.

When substituting Eq. [6] in Eq. [5c] and subsequently Eq. [5c] into Eq. [7] yields a quadratic expression for Ψ_1. Solving for Ψ_1 and substituting this value into Eq. [6] gives a value for r_c. If Ψ_1 is larger than P_1, or smaller than P_2, then r_c is r_b and r_m, respectively. Finally, E_{act} and therefore $\alpha(\Psi)$ can be calculated from Eq. [5c] and [4c].

As compared with the already existing sink terms (Belmans et al., 1981), the new sink term allows the leaf water potential and thus the root water extraction rate to be influenced not only by the soil water pressure head Ψ_s, but also by the unsaturated hydraulic conductivity of the soil in the root zone.

3. SCALING SOIL HYDRAULIC PROPERTIES

The purpose of scaling is to simplify the description of statistical variation of soil hydraulic properties. By this simplification, the pattern of spatial variability is described by a set of scale factors a_r, relating the soil hydraulic properties at each location r to a representative mean, or referene soil. Using the similar media concept (Miller and Miller, 1956), variations in the soil-water retention curve and the hydraulic conductivity function are connected by the scaling factor a. Similar media differ only in the scale of their internal microscopic geometries and have, therefore, equal porosities. Methods to determine scale factors for soil hydraulic properties are reported by Warrick et al. (1977) and Russo and Bresler (1980).

A scaling parameter a_r is defined as the ratio of the microscopic characteristic length λ_r of a soil at location r to the characteristic length λ_m of a reference soil, or

$$a_r = \lambda_r/\lambda_m \quad , \qquad [8]$$

when r=1, .., R denotes locations. As a result of scaling one can relate the soil water characteristic and hydraulic conductivity function for similar media at any location r (Ψ_r and K_r, respectively) to a mean Ψ_m and K_m, such that

$$\Psi_r = \Psi_m/a_r \quad , \qquad [9]$$

$$K_r = a_r^2\, K_m \quad . \qquad [10]$$

Since porosities of samples from the same soil type are likely to be different in most cases, any combination of values of Ψ_r and Ψ_m or K_r and K_m correspond to the same degree of saturation S (or Θ, if θ_r=0 in Eq. [1]).

Using techniques, as described in Hopmans (1987a), one can determine a scaled mean soil-water retention and hydraulic conductivity function with a corresponding set of scale factor values for each function. Knowing the distribution of the set of scale factors (normal or lognormal) and its mean and standard deviation allows a set of new scale factors to be generated. Each such a new set can be used in Monte-Carlo analysis to investigate the influence of spatial variable hydraulic properties on soil-water flow and plant transpiration. Using soil physical data, collected in the Hupselse Beek watershed (Hopmans and Stricker, 1987b), it was found that scale factor values as determined from water retention data (Eq. [9]) correspond fairly well with scale factor values calculated from conductivity data (Eq. [10]) alone. Distribution type and statistics for scale factor values from water retention data are, therefore, assumed to be sufficient to describe the variation of soil hydraulic properties. The scaled mean functions $\Theta(\Psi)$ and $K(\Theta)$ or $K(\Psi)$ are described by the van Genuchten model (Eq. [1], [2] and [3]). Since θ_s will vary between locations, also its distribution must be investigated.

4. STOCHASTIC DESCRIPTION OF q(h)-RELATIONSHIP

The same normalizing technique as used to scale soil hydraulic properties can be applied to the discharge-groundwater level relationship. A plot of watershed discharge versus groundwater levels at various locations will generally result in a large scatter of data points. An expression that is commonly used to describe the relation between discharge (q) and groundwater level (h) is of the form

$$q = a\, e^{b|h|} \qquad , \qquad [11]$$

where a and b are parameters to be determined from measurements of q and h. Details to scale Eq. [11] can be found in Hopmans (1987c). After scaling, q(h) is described by

$$q = \frac{a_{ref}}{\gamma_i^2}\, e^{\bar{b}|h|} \qquad , \qquad [12]$$

where $\bar{b}$ and a_{ref} denote average coefficients for the reference curve, and where the scaling factor γ_i is different for each location i. Again, q(h)-relations can be generated from the mean and standard deviation of the distribution that fits the calculated γ_i-values best. When using the described procedures the initial groundwater level will depend on the q(h)-relation generated. As input serves the initial groundwater level ($h = h_{init}$) at a location where the q(h)-relation approximates the reference q(h)-relation ($\gamma = 1$) the best. The initial groundwater level at location i is then determined from Eq. [12], where q is known for γ=1 and $h = h_{init}$, and γ_i.

INSTRUCTIONS FOR INPUT

The same format description is used as in Belmans et al. (1981, pag 27). Only the modifications and extensions to the SWAPRO-model are listed.

Columns	Format	Symbol	Description
			Group B
45-50	I5	KOD(10)	= 0: SWATRE or SWAPRO version or if each layer has a predefined scale factor = 1: random distribution of scale factor values for each layer = 2: random distribution of scale factor values for each compartment
			Group D
1-10	F10.4	TAL(1)	Value of parameter α in van Genuchten model for first soil layer
11-20	F10.4	TAL(2)	
-	-	-	as above, but for 2nd, ..., 10nd
91-100	F10.4	TAL(10)	soil layer
1-10	F10.4	TEN(1)	Value of parameter n in van Genuchten model for first soil layer
11-20	F10.4	TEN(2)	
-	-	-	as above, but for 2nd, ..., 10nd
91-100	F10.4	TEN(10)	soil layer
1-10	F10.4	TTR(1)	Value of residual watercontent in van Genuchten model for first soil layer
11-20	F10.4	TTR(2)	
-	-	-	as above, but for 2nd, ..., 10nd
91-100	F10.4	TTR(10)	soil layer

Columns	Format	Symbol	Description
1-10	F10.4	SWC(1)	Value of saturated water content in van Genuchten model for first soil layer
11-20	F10.4	SWC(2)	
-	-	-	as above, but for 2nd, ..., 10nd
91-100	F10.4	SWC(10)	soil layer
1-10	F10.4	TKS(1)	Value of saturated hydraulic conductivity in van Genuchten model for first soil layer
11-20	F10.4	TKS(2)	
-	-	-	as above, but for 2nd, ..., 10nd
91-100	F10.4	TKS(10)	soil layer
1-10	F10.4	MSCA(1)	= 1.0: if parameters of above describe soil properties of first soil layer (SWATRE or SWAPRO version) = ...: appropriate scale factor value (KOD(10)=0) or mean of distribution scale factor values (KOD(10) = 1 or 2), if physical properties of first layer are scaled
11-20	F10.4	MSCA(2)	
-	-	-	as above, but for 2nd, ..., 10nd
91-100	F10.4	MSCA(10)	soil layer
1-10	F10.4	SSCA(1)	Only if KOD(10)= 1 or 2. Standard deviation of distribution scale factor values of first soil layer
11-20	F10.4	SSCA(2)	
-	-	-	as above, but for 2nd, ..., 10nd
91-100	F10.4	SSCA(10)	soil layer
1-10	F10.4	STSAT(1)	Only if KOD(10)= 1 or 2. Standard deviation of distribution sat. water content of first soil layer

Columns	Format	Symbol	Description
11-20	F10.4	STSAT(2)	
-	-	-	as above, but for 2nd, ..., 10nd
91-100	F10.4	STSAT(10)	soil layer
		Group E	
1-5	I5	IRER	= 0: sink term according to Feddes et al. (1978)
			= 1: sink term according to Hoogland et al. (1981)
			= 2: new sink term according to Report (1984)
		Group D	
		Consists now only of	
1-10	F10.3	CS1	saturated hydraulic conductivity of 1st soil layer
11-20	F10.3	FAC	factor to convert CS1 to cm day^{-1}
		Group Q	
1-10	F10.1	GWLA	If ICOD=0: initial groundwater level (cm, <0). SWATRE or SWAPRO version.
			If ICOD=1: initial groundwater level of location where q(h) coincides with reference q(h)-relationship.
11-15	I5	ICOD	= 0: one unique q(h)-relation (SWATRE or SWAPRO)
			= 1: q(h) is considered to be a random function.
		If ICOD=0 then:	
1-10	F10.4	AREL	value of a in q(h)-relation
11-20	F10.4	BREL	value of b in q(h)-relation
		If ICOD=1 then:	
1-10	F10.4	AREL	value of a_{ref} in reference q(h)-relation
11-20	F10.4	BREL	value of $\bar{b}$ in reference q(h)-relation

Columns	Format	Symbol	Description
21-30	F10.4	SCALM	mean of scale factor distribution q(h)-relation
31-40	F10.4	SCALS	standard deviation of scale factor distribution q(h)-relation
41-50	F10.4	IDICOD	= 0: if set of scale factor values q(h)-relation fit normal distribution = 1: if set of scale factor values q(h)-relation fit lognormal distribution

Group V, W, X, Y and Z can be omitted

EXAMPLE OF INPUT

The parameters used in this example are determined from data of the Hupselse Beek watershed (Hopmans and Stricker, 1987b). Calculations are performed over the period April 1 to September 30 of the fairly dry year 1982. The soil profile consists of 2 layers, an A-horizon of 30 cm thickness and a BC-horizon extending to a depth of 3 m.

Parameters, describing the soil hydraulic properties of these 2 horizons are listed in part A of Table 1. The parameters also refer to the scaled mean hydraulic functions, shown in Fig. 1a and 1b. Part B of Table 1 lists the mean and standard deviation of the lognormal distribution of scale factor values, as well as the standard deviation of the saturated water content for both layers. Since θ_s is normally distributed, the means corresponds to the θ_s-values in part A. Unscaled and scaled hydraulic data for both horizons are shown in Fig. 2a and 2b.

The parameters a_{ref} and b for the reference q(h)-relationship, as well as the mean and standard deviation of the normal distribution of scale factor values of the q(h)-function are shown in part C of Table 1. Fig. 3a and 3b show how scaling coalesces q(h)-data to a narrow band around the reference curve. The effect of $K(\Psi)$ or the new sink term $\alpha(\Psi)$ is shown in Fig. 4 as a

function of Ψ and E_{pot}.
An example of a list of input data is presented, as well as an example of a listing of output to which the given input data apply. The last section gives a listing of the modified version of SWAPRO, as used to obtain the output preceding the program listing.

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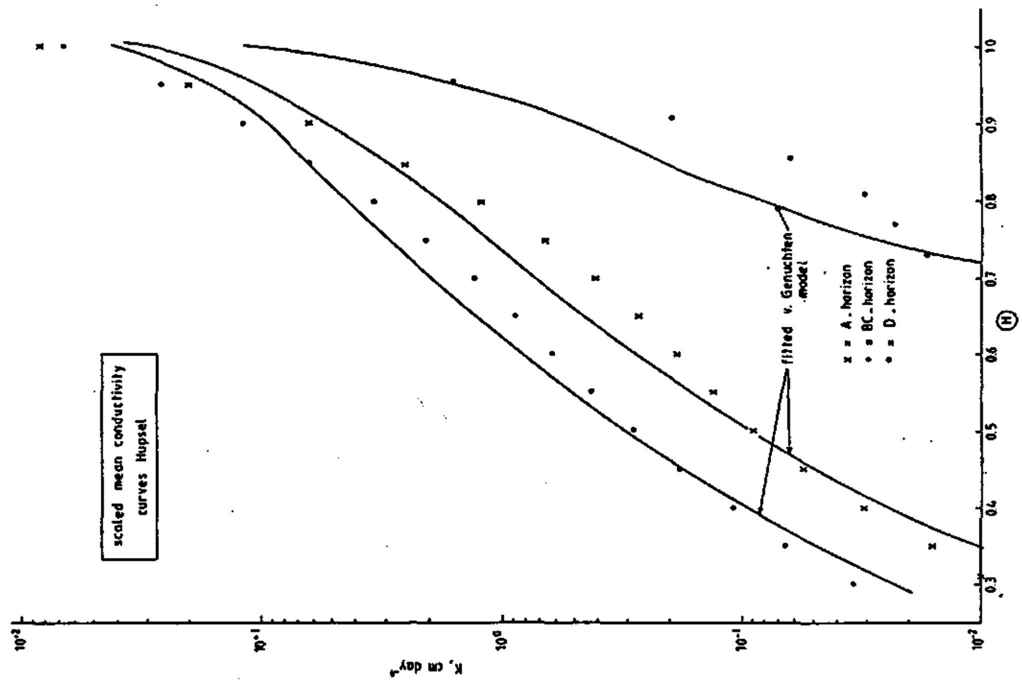
Table 1 Parameter values for modified SWAPRO-model

	Horizon	
	A	BC
Part A (parameters van Genuchten model)		
α	0.01924	0.02043
n	1.5931	1.8187
θ_s	0.4024	0.3195
θ_r	0.00	0.00
K_s(cm day^{-1})	33.7	40.55
Part B (statistics hydraulic functions)		
scale factors (lognormal distribution)		
μ	-0.1155	-0.0706
σ	0.3430	0.2567
θ_s (normal distribution)		
μ	0.4024	0.3195
σ	0.0354	0.0393
Part C (parameters + statistics q(h)-relation		
$\bar{b}$ (cm^{-1})	-0.03592	
a_{ref} (cm day^{-1})	-0.85230	
μ_γ	1.0 (ICOD=0)	
σ_γ	0.6764	
h_{init} (cm)	78	



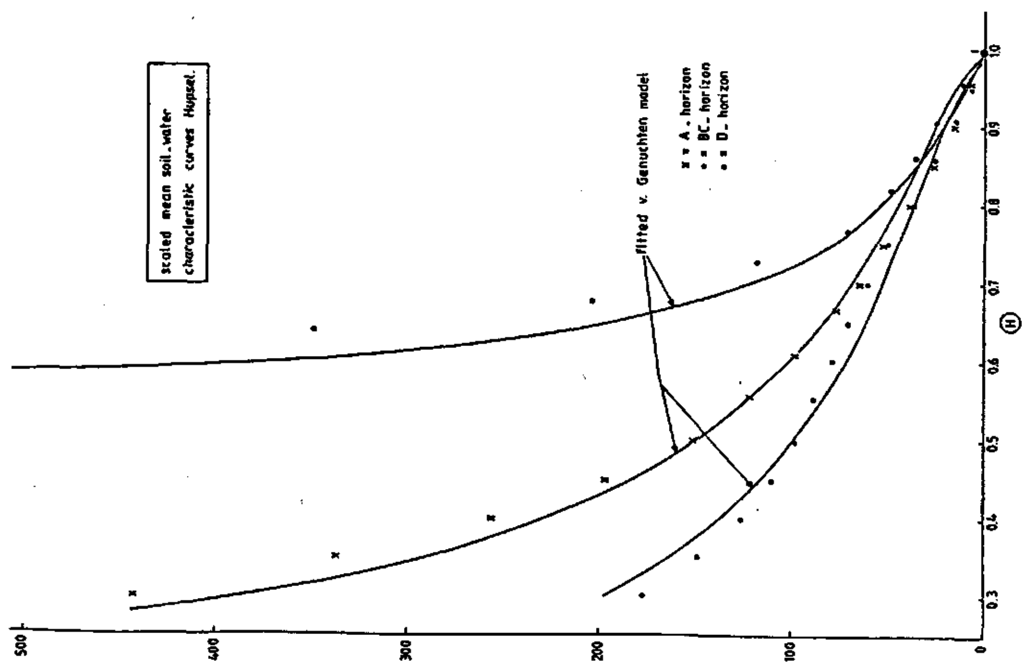


Figure 1 Scaled mean hydraulic functions Hupsel.

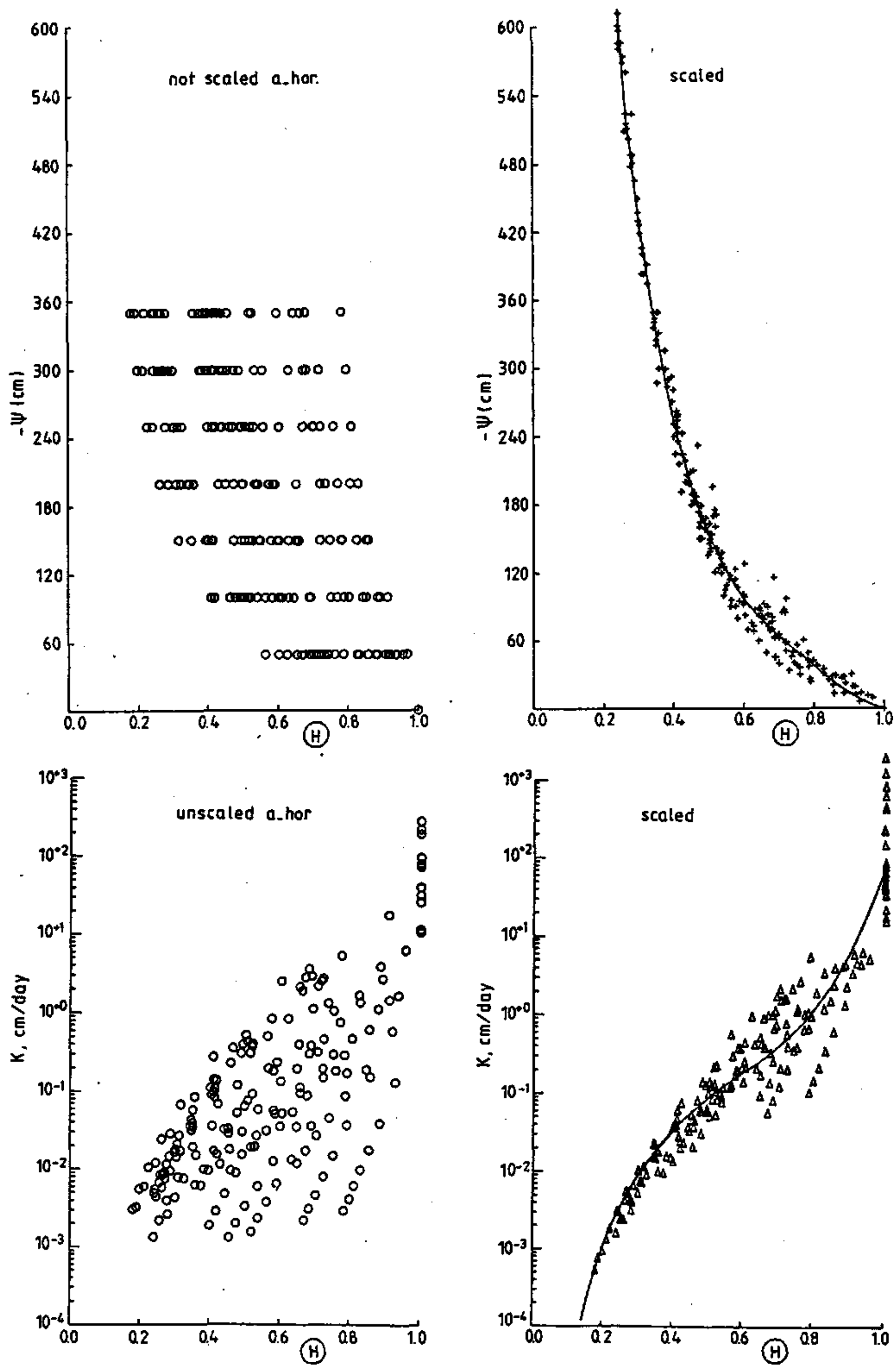


Figure 2a Unscaled and scaled hydraulic data A-horizon.

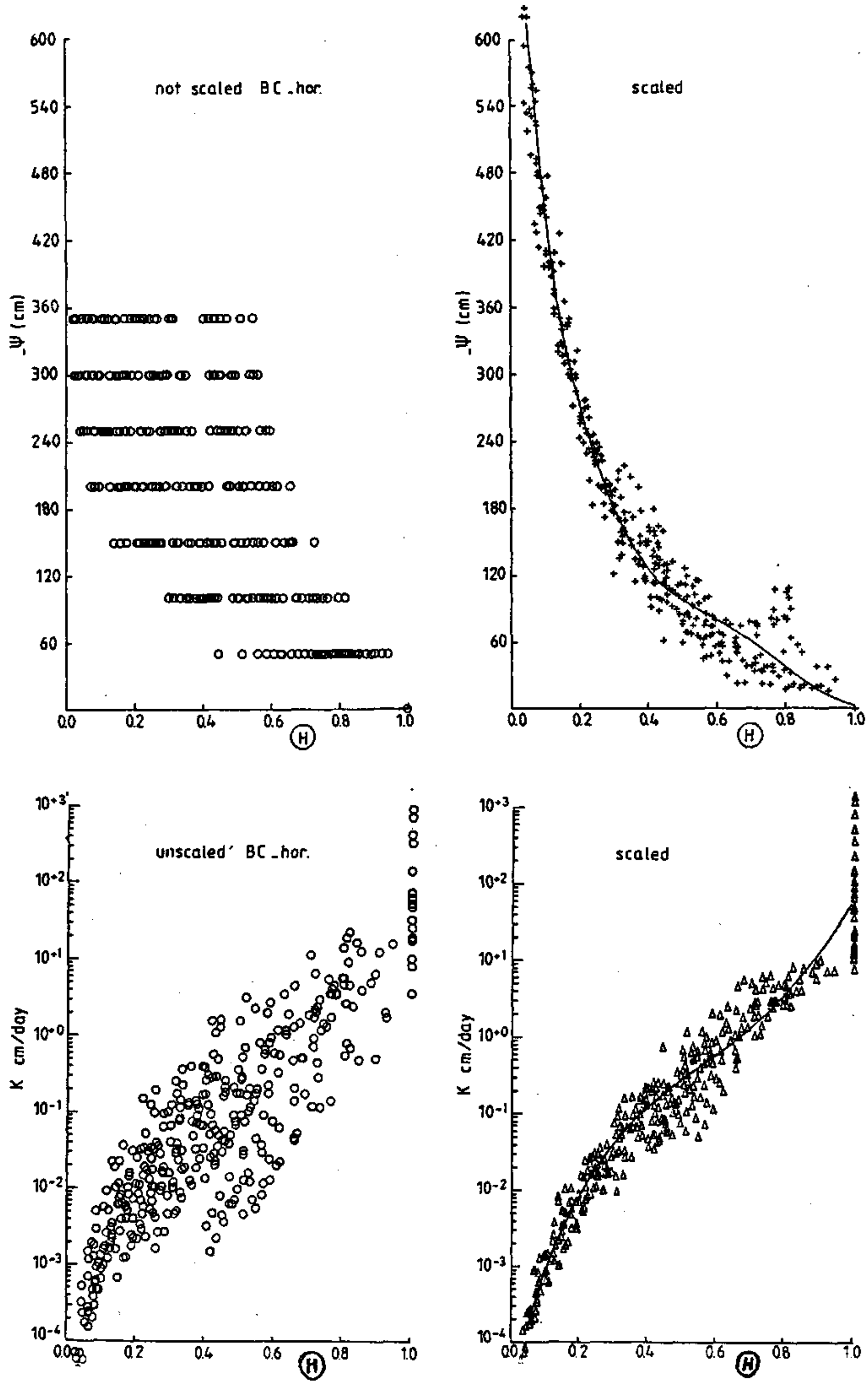
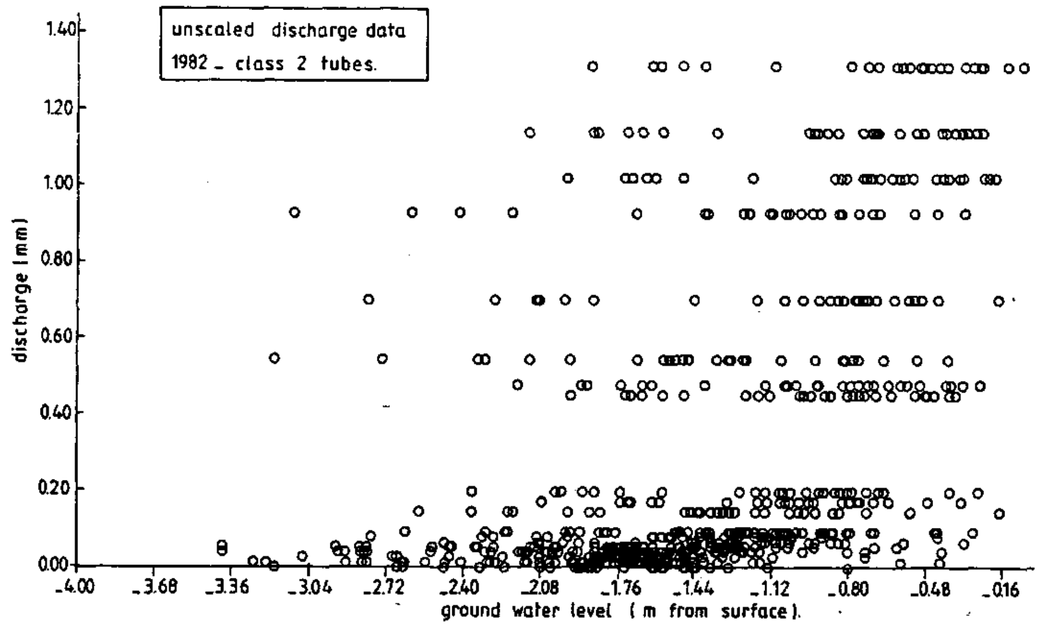


Figure 2b Unscaled and scaled hydraulic data BC-horizon.



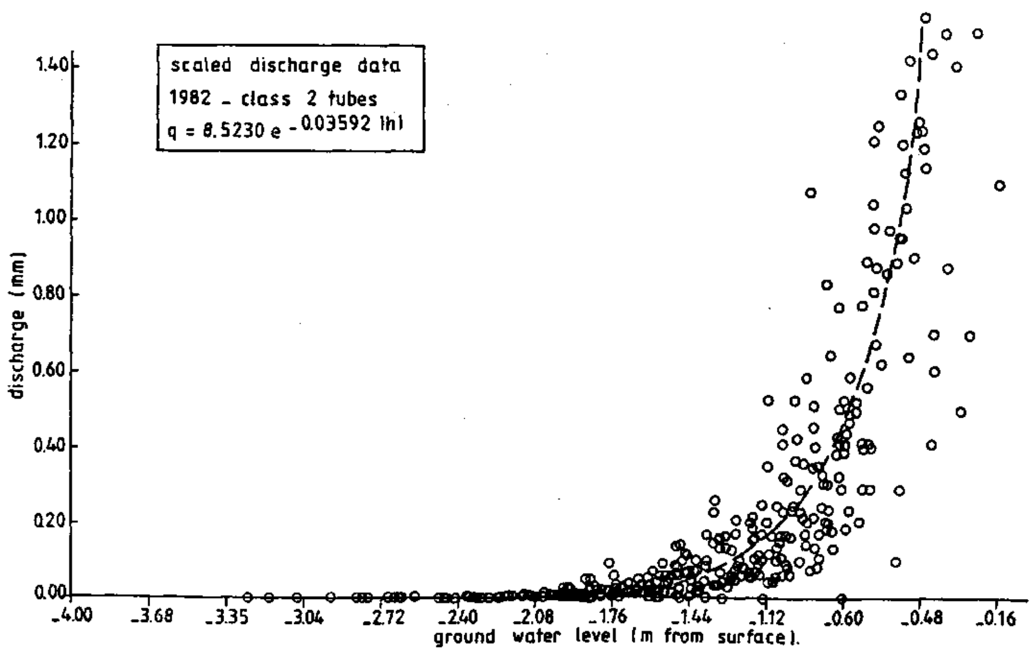


Figure 3 Unscaled and scaled discharge data 1982.

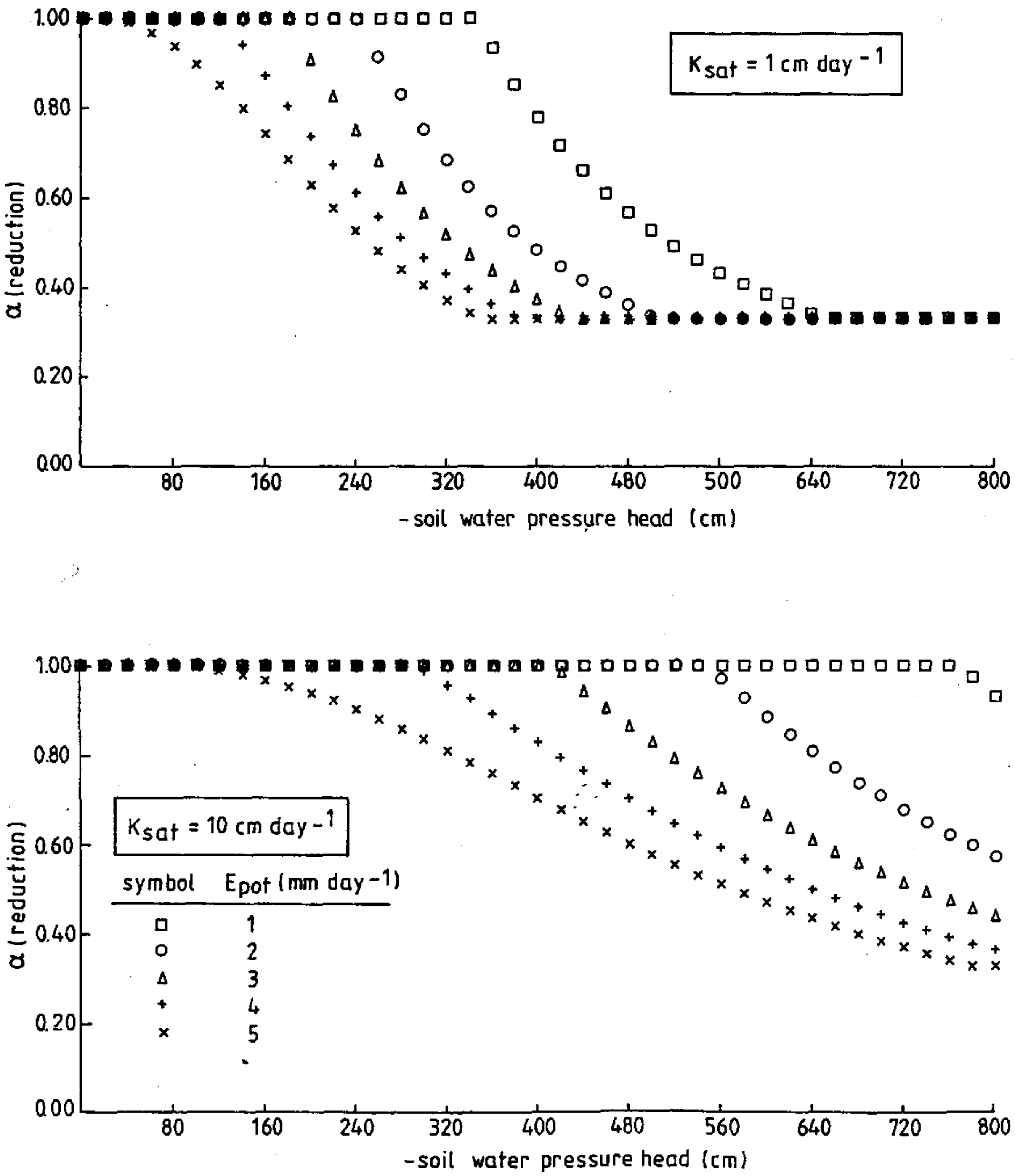


Figure 4 Effect of K(Ψ) on sinkterm (α) as a function of Ψ and E_{pot}

INPUT FILE: SR.IN

```
 PROFILE 1982 1 APRIL - 30 SEPTEMBER, BROM FIELD
 3 0 0 0 2 1 0 0 0 1
300.0 30 2 4 30 0 0 0 0 0 0 0 0 3
   0.01924  0.02043
  1.5931  1.8187
  0.0    0.0
   0.400    0.3195
   33.70    40.55
  -0.1155    -0.0706
   0.3430   0.2567
    0.0283   0.0393
  33.70     1.0
2 0 .2E-01 .0E0
.000 365.000 366.000
-10. -25. -25. -200. -800. -575. -8000.
91 273 28 1 4 9 1 1
90.  273. 0.5 .5E-2 .1
4
  3.0  60.0  60.0  60.0   183.0  178.0
0.00  0.0  0.160  .1E+06
0.07  0.0   0.180  .1E+06
0.02  0.0   0.130  .1E+06
0.00  0.0   0.2    .1E+06
0.00  0.0   0.28   .1E+06
0.07  0.0   0.18   .1E+06
0.29  0.0   0.08   .1E+06
0.44  0.0   0.14   .1E+06
0.20  0.0   0.11   .1E+06
0.29  0.0   0.11   .1E+06
0.32  0.0   0.11   .1E+06
0.49  0.0   0.11   .1E+06
0.01  0.0   0.16   .1E+06
0.00  0.0   0.17   .1E+06
0.00  0.0   0.22   .1E+06
0.00  0.0   0.21   .1E+06
0.00  0.0   0.23   .1E+06
0.00  0.0   0.23   .1E+06
0.00  0.0   0.24   .1E+06
0.00  0.0   0.18   .1E+06
0.00  0.0   0.15   .1E+06
0.00  0.0   0.19   .1E+06
0.01  0.0   0.15   .1E+06
0.01  0.0   0.22   .1E+06
0.00  0.0   0.23   .1E+06
0.02  0.0   0.20   .1E+06
0.00  0.0   0.17   .1E+06
0.02  0.0   0.14   .1E+06
0.26  0.0   0.13   .1E+06
0.24  0.0   0.11   .1E+06
0.61  0.0   0.08   .1E+06
0.00  0.0   0.21   .1E+06
0.19  0.0   0.14   .1E+06
0.17  0.0   0.21   .1E+06
0.78  0.0   0.07   .1E+06
1.18  0.0   0.1    .1E+06
0.68  0.0   0.1    .1E+06
0.0   0.0   0.16   .1E+06
0.00  0.0   0.26   .1E+06
0.00  0.0   0.26   .1E+06
0.00  0.0   0.25   .1E+06
0.00  0.0   0.31   .1E+06
0.00  0.0   0.35   .1E+06
0.00  0.0   0.41   .1E+06
0.00  0.0   0.39   .1E+06
```

0.00	0.0	0.40	.1E+06
0.19	0.0	0.17	.1E+06
0.26	0.0	0.25	.1E+06
0.01	0.0	0.29	.1E+06
0.20	0.0	0.15	.1E+06
0.00	0.0	0.16	.1E+06
0.25	0.0	0.12	.1E+06
0.20	0.0	0.22	.1E+06
0.07	0.0	0.19	.1E+06
0.00	0.0	0.27	.1E+06
0.00	0.0	0.44	.1E+06
0.29	0.0	0.39	.1E+06
0.01	0.0	0.23	.1E+06
0.00	0.0	0.31	.1E+06
0.00	0.0	0.42	.1E+06
0.00	0.0	0.43	.1E+06
0.00	0.0	0.40	.1E+06
0.00	0.0	0.46	.1E+06
0.00	0.0	0.42	.1E+06
0.00	0.0	0.28	.1E+06
0.00	0.0	0.44	.1E+06
1.07	0.0	0.29	.1E+06
0.01	0.0	0.36	.1E+06
0.00	0.0	0.36	.1E+06
0.00	0.0	0.30	.1E+06
0.00	0.0	0.34	.1E+06
0.22	0.0	0.18	.1E+06
0.50	0.0	0.26	.1E+06
0.46	0.0	0.12	.1E+06
0.01	0.0	0.25	.1E+06
0.00	0.0	0.20	.1E+06
0.80	0.0	0.08	.1E+06
0.00	0.0	0.23	.1E+06
0.19	0.0	0.15	.1E+06
0.78	0.0	0.1	.1E+06
0.01	0.0	0.26	.1E+06
0.00	0.0	0.20	.1E+06
1.56	0.0	0.20	.1E+06
0.18	0.0	0.31	.1E+06
0.23	0.0	0.160	.1E+06
0.02	0.0	0.30	.1E+06
0.65	0.0	0.37	.1E+06
0.12	0.0	0.21	.1E+06
0.82	0.0	0.20	.1E+06
0.62	0.0	0.17	.1E+06
0.01	0.0	0.29	.1E+06
0.04	0.0	0.24	.1E+06
0.01	0.0	0.37	.1E+06
0.44	0.0	0.11	.1E+06
0.02	0.0	0.26	.1E+06
0.05	0.0	0.32	.1E+06
0.01	0.0	0.21	.1E+06
0.00	0.0	0.34	.1E+06
0.00	0.0	0.41	.1E+06
0.00	0.0	0.51	.1E+06
0.00	0.0	0.30	.1E+06
0.00	0.0	0.37	.1E+06
0.01	0.0	0.46	.1E+06
0.00	0.0	0.47	.1E+06
0.00	0.0	0.48	.1E+06
0.24	0.0	0.36	.1E+06
0.01	0.0	0.32	.1E+06
0.00	0.0	0.38	.1E+06
0.00	0.0	0.43	.1E+06

0.00	0.0	0.30	.1E+06
0.00	0.0	0.35	.1E+06
0.00	0.0	0.34	.1E+06
0.00	0.0	0.26	.1E+06
0.00	0.0	0.29	.1E+06
0.00	0.0	0.24	.1E+06
0.00	0.0	0.25	.1E+06
0.01	0.0	0.21	.1E+06
0.07	0.0	0.24	.1E+06
0.05	0.0	0.33	.1E+06
0.00	0.0	0.48	.1E+06
0.00	0.0	0.56	.1E+06
0.00	0.0	0.65	.1E+06
0.00	0.0	0.22	.1E+06
0.00	0.0	0.58	.1E+06
0.00	0.0	0.59	.1E+06
0.01	0.0	0.38	.1E+06
0.52	0.0	0.05	.1E+06
0.00	0.0	0.32	.1E+06
0.06	0.0	0.16	.1E+06
0.00	0.0	0.21	.1E+06
0.20	0.0	0.09	.1E+06
0.10	0.0	0.32	.1E+06
0.00	0.0	0.32	.1E+06
0.00	0.0	0.36	.1E+06
0.02	0.0	0.26	.1E+06
0.31	0.0	0.27	.1E+06
0.95	0.0	0.11	.1E+06
0.00	0.0	0.27	.1E+06
0.97	0.0	0.22	.1E+06
0.78	0.0	0.24	.1E+06
0.00	0.0	0.30	.1E+06
0.26	0.0	0.33	.1E+06
0.08	0.0	0.20	.1E+06
0.06	0.0	0.15	.1E+06
0.08	0.0	0.14	.1E+06
0.19	0.0	0.21	.1E+06
0.07	0.0	0.20	.1E+06
0.53	0.0	0.06	.1E+06
0.20	0.0	0.18	.1E+06
0.08	0.0	0.13	.1E+06
0.00	0.0	0.23	.1E+06
0.00	0.0	0.30	.1E+06
0.05	0.0	0.13	.1E+06
0.11	0.0	0.15	.1E+06
0.16	0.0	0.23	.1E+06
0.00	0.0	0.25	.1E+06
0.00	0.0	0.31	.1E+06
0.02	0.0	0.18	.1E+06
0.04	0.0	0.08	.1E+06
0.00	0.0	0.12	.1E+06
0.00	0.0	0.20	.1E+06
0.00	0.0	0.20	.1E+06
0.00	0.0	0.22	.1E+06
0.00	0.0	0.18	.1E+06
0.00	0.0	0.14	.1E+06
0.00	0.0	0.13	.1E+06
0.00	0.0	0.14	.1E+06
0.00	0.0	0.20	.1E+06
0.00	0.0	0.14	.1E+06
0.00	0.0	0.19	.1E+06
0.00	0.0	0.14	.1E+06
0.00	0.0	0.20	.1E+06
0.35	0.0	0.23	.1E+06

```
0.52  0.0   0.16   .1E+06
0.00  0.0   0.21   .1E+06
0.00  0.0   0.19   .1E+06
0.00  0.0   0.18   .1E+06
0.00  0.0   0.18   .1E+06
0.53  0.0   0.09   .1E+06
0.07  0.0   0.23   .1E+06
0.00  0.0   0.17   .1E+06
0.00  0.0   0.22   .1E+06
1.04  0.0   0.00   .1E+06
 78.0    1
  -0.8523    -0.035922 1.0  0.67641  0
-30.
```

OUTPUT FILE: INIT.OUT

```
profile 1982 1 APRIL - 30 SEPT brom field

..............................................................................................................
I N P U T     V A R I A B L E S :
- - - - -     - - - - - - - - - -

KOD(1)=3  KOD(2)=0  KOD(3)=0   KOD(4)=0  KOD(5)=2  KOD(6)=1  KOD(7)=0   KOD(8)=0  KOD(9)=0  KOD(10)=1


DEPTH OF SOIL PROFILE  :   300.0 CM
NUMBER OF COMPARTMENTS : 30
NUMBER OF SOIL LAYERS  :  2
NC - ARRAY :    3   30    0    0    0    0    0    0    0    0
DARCIAN FLUX INTEGRATED AT BOTTOM OF COMPARTMENT NR :  3


                    alpha - ARRAY  :  0.0192  0.0204
                       en - ARRAY  :  1.5931  1.8187
residual MOISTURE CONTENT - array   :  0.0000  0.0000
                      SWC - ARRAY :    0.40    0.32
                     KSAT - ARRAY  : 33.7000 40.5500
       scale factor mean - array : -0.1155 -0.0706
   scale factor st. dev. - array :  0.3430  0.2567
   sat wat ct st. dev. -array:  0.0283  0.0393
              scale factor - ARRAY :  1.2486  1.2486  1.2486  0.8945  0.8945  0.8945  0.8945  0.8945  0.8945  0.8945
                                    0.8945  0.8945  0.8945  0.8945  0.8945  0.8945  0.8945  0.8945  0.8945  0.8945
                                    0.8945  0.8945  0.8945  0.8945  0.8945  0.8945  0.8945  0.8945  0.8945  0.8945

     sat. water content - array:  0.3415  0.3415  0.3415  0.3156  0.3156  0.3156  0.3156  0.3156  0.3156  0.3156
                                    0.3156  0.3156  0.3156  0.3156  0.3156  0.3156  0.3156  0.3156  0.3156  0.3156
                                    0.3156  0.3156  0.3156  0.3156  0.3156  0.3156  0.3156  0.3156  0.3156  0.3156

SATURATED HYDRAULIC CONDUCTIVITY OF FIRST SOIL LAYER  : 0.337E+02
FAC    : 0.100E+01


S I N K  T E R M  V A R I A B L E S

    IRER  INL       ARER       BRER
     2     0     0.200E-01 0.000E+00

    RNAM       TB        TE
     0.0      365.      366.

      P0        PU1       PL1       P2        P3
     -10.      -25.      -25.      -575.     -8000.



L - ARRAY :   91   273   28    1    4    9    1    1


START OF CALCULATIONS :  90. DAYS
END OF  CALCULATIONS   : 273. DAYS
MAXIMUM TIME STEP      : 0.500E+00 DAYS
MAXIMUM CHANGE OF MOISTURE CONTENT    : 0.500E-02 CM**3/CM**3
MAXIMUM CHANGE OF GROUNDWATER LEVEL  : 0.100E+00 CM


NUMBER OF PRINTPLOTS :    4
PRINTING INTERVALS (DAYS) :   3.  60.  60.  60.
..............................................................................................................
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BOUNDARY CONDITIONS AT THE TOP :

DAY	PREC	ESOIL	EPLANT	PHS	DAY	PREC	ESOIL	EPLANT	PHS	DAY	PREC	ESOIL	EPLANT	PHS
91	0.000	0.000	0.160	-0.100E+06	92	0.070	0.000	0.180	-0.100E+06	93	0.020	0.000	0.130	-0.100E+06
94	0.000	0.000	0.200	-0.100E+06	95	0.000	0.000	0.280	-0.100E+06	96	0.070	0.000	0.180	-0.100E+06
97	0.290	0.000	0.080	-0.100E+06	98	0.440	0.000	0.140	-0.100E+06	99	0.200	0.000	0.110	-0.100E+06
100	0.290	0.000	0.110	-0.100E+06	101	0.320	0.000	0.110	-0.100E+06	102	0.490	0.000	0.110	-0.100E+06
103	0.010	0.000	0.160	-0.100E+06	104	0.000	0.000	0.170	-0.100E+06	105	0.000	0.000	0.220	-0.100E+06
106	0.000	0.000	0.210	-0.100E+06	107	0.000	0.000	0.230	-0.100E+06	108	0.000	0.000	0.230	-0.100E+06
109	0.000	0.000	0.240	-0.100E+06	110	0.000	0.000	0.180	-0.100E+06	111	0.000	0.000	0.150	-0.100E+06
112	0.000	0.000	0.190	-0.100E+06	113	0.010	0.000	0.150	-0.100E+06	114	0.010	0.000	0.220	-0.100E+06
115	0.000	0.000	0.230	-0.100E+06	116	0.020	0.000	0.200	-0.100E+06	117	0.000	0.000	0.170	-0.100E+06
118	0.020	0.000	0.140	-0.100E+06	119	0.260	0.000	0.130	-0.100E+06	120	0.240	0.000	0.110	-0.100E+06
121	0.610	0.000	0.080	-0.100E+06	122	0.000	0.000	0.210	-0.100E+06	123	0.190	0.000	0.140	-0.100E+06
124	0.170	0.000	0.210	-0.100E+06	125	0.780	0.000	0.070	-0.100E+06	126	1.180	0.000	0.100	-0.100E+06
127	0.680	0.000	0.100	-0.100E+06	128	0.000	0.000	0.160	-0.100E+06	129	0.000	0.000	0.260	-0.100E+06
130	0.000	0.000	0.260	-0.100E+06	131	0.000	0.000	0.250	-0.100E+06	132	0.000	0.000	0.310	-0.100E+06
133	0.000	0.000	0.350	-0.100E+06	134	0.000	0.000	0.410	-0.100E+06	135	0.000	0.000	0.390	-0.100E+06
136	0.000	0.000	0.400	-0.100E+06	137	0.190	0.000	0.170	-0.100E+06	138	0.260	0.000	0.250	-0.100E+06
139	0.010	0.000	0.290	-0.100E+06	140	0.200	0.000	0.150	-0.100E+06	141	0.000	0.000	0.160	-0.100E+06
142	0.250	0.000	0.120	-0.100E+06	143	0.200	0.000	0.220	-0.100E+06	144	0.070	0.000	0.190	-0.100E+06
145	0.000	0.000	0.270	-0.100E+06	146	0.000	0.000	0.440	-0.100E+06	147	0.290	0.000	0.390	-0.100E+06
148	0.010	0.000	0.230	-0.100E+06	149	0.000	0.000	0.310	-0.100E+06	150	0.000	0.000	0.420	-0.100E+06
151	0.000	0.000	0.430	-0.100E+06	152	0.000	0.000	0.400	-0.100E+06	153	0.000	0.000	0.460	-0.100E+06
154	0.000	0.000	0.420	-0.100E+06	155	0.000	0.000	0.280	-0.100E+06	156	0.000	0.000	0.440	-0.100E+06
157	1.070	0.000	0.290	-0.100E+06	158	0.010	0.000	0.360	-0.100E+06	159	0.000	0.000	0.360	-0.100E+06
160	0.000	0.000	0.300	-0.100E+06	161	0.000	0.000	0.340	-0.100E+06	162	0.220	0.000	0.180	-0.100E+06
163	0.500	0.000	0.260	-0.100E+06	164	0.460	0.000	0.120	-0.100E+06	165	0.010	0.000	0.250	-0.100E+06
166	0.000	0.000	0.200	-0.100E+06	167	0.800	0.000	0.080	-0.100E+06	168	0.000	0.000	0.230	-0.100E+06
169	0.190	0.000	0.150	-0.100E+06	170	0.780	0.000	0.100	-0.100E+06	171	0.010	0.000	0.260	-0.100E+06
172	0.000	0.000	0.200	-0.100E+06	173	1.560	0.000	0.200	-0.100E+06	174	0.180	0.000	0.310	-0.100E+06
175	0.230	0.000	0.160	-0.100E+06	176	0.020	0.000	0.300	-0.100E+06	177	0.650	0.000	0.370	-0.100E+06
178	0.120	0.000	0.210	-0.100E+06	179	0.820	0.000	0.200	-0.100E+06	180	0.620	0.000	0.170	-0.100E+06
181	0.010	0.000	0.290	-0.100E+06	182	0.040	0.000	0.240	-0.100E+06	183	0.010	0.000	0.370	-0.100E+06
184	0.440	0.000	0.110	-0.100E+06	185	0.020	0.000	0.260	-0.100E+06	186	0.050	0.000	0.320	-0.100E+06
187	0.010	0.000	0.210	-0.100E+06	188	0.000	0.000	0.340	-0.100E+06	189	0.000	0.000	0.410	-0.100E+06
190	0.000	0.000	0.510	-0.100E+06	191	0.000	0.000	0.300	-0.100E+06	192	0.000	0.000	0.370	-0.100E+06
193	0.010	0.000	0.460	-0.100E+06	194	0.000	0.000	0.470	-0.100E+06	195	0.000	0.000	0.480	-0.100E+06
196	0.240	0.000	0.360	-0.100E+06	197	0.010	0.000	0.320	-0.100E+06	198	0.000	0.000	0.380	-0.100E+06
199	0.000	0.000	0.430	-0.100E+06	200	0.000	0.000	0.300	-0.100E+06	201	0.000	0.000	0.350	-0.100E+06
202	0.000	0.000	0.340	-0.100E+06	203	0.000	0.000	0.260	-0.100E+06	204	0.000	0.000	0.290	-0.100E+06
205	0.000	0.000	0.240	-0.100E+06	206	0.000	0.000	0.250	-0.100E+06	207	0.010	0.000	0.210	-0.100E+06
208	0.070	0.000	0.240	-0.100E+06	209	0.050	0.000	0.330	-0.100E+06	210	0.000	0.000	0.480	-0.100E+06
211	0.000	0.000	0.560	-0.100E+06	212	0.000	0.000	0.650	-0.100E+06	213	0.000	0.000	0.220	-0.100E+06
214	0.000	0.000	0.580	-0.100E+06	215	0.000	0.000	0.590	-0.100E+06	216	0.010	0.000	0.380	-0.100E+06
217	0.520	0.000	0.050	-0.100E+06	218	0.000	0.000	0.320	-0.100E+06	219	0.060	0.000	0.160	-0.100E+06
220	0.000	0.000	0.210	-0.100E+06	221	0.200	0.000	0.090	-0.100E+06	222	0.100	0.000	0.320	-0.100E+06
223	0.000	0.000	0.320	-0.100E+06	224	0.000	0.000	0.360	-0.100E+06	225	0.020	0.000	0.260	-0.100E+06
226	0.310	0.000	0.270	-0.100E+06	227	0.950	0.000	0.110	-0.100E+06	228	0.000	0.000	0.270	-0.100E+06
229	0.970	0.000	0.220	-0.100E+06	230	0.780	0.000	0.240	-0.100E+06	231	0.000	0.000	0.300	-0.100E+06
232	0.260	0.000	0.330	-0.100E+06	233	0.080	0.000	0.200	-0.100E+06	234	0.060	0.000	0.150	-0.100E+06
235	0.080	0.000	0.140	-0.100E+06	236	0.190	0.000	0.210	-0.100E+06	237	0.070	0.000	0.200	-0.100E+06
238	0.530	0.000	0.060	-0.100E+06	239	0.200	0.000	0.180	-0.100E+06	240	0.080	0.000	0.130	-0.100E+06
241	0.000	0.000	0.230	-0.100E+06	242	0.000	0.000	0.300	-0.100E+06	243	0.050	0.000	0.130	-0.100E+06
244	0.110	0.000	0.150	-0.100E+06	245	0.160	0.000	0.230	-0.100E+06	246	0.000	0.000	0.250	-0.100E+06
247	0.000	0.000	0.310	-0.100E+06	248	0.020	0.000	0.180	-0.100E+06	249	0.040	0.000	0.080	-0.100E+06
250	0.000	0.000	0.120	-0.100E+06	251	0.000	0.000	0.200	-0.100E+06	252	0.000	0.000	0.200	-0.100E+06
253	0.000	0.000	0.220	-0.100E+06	254	0.000	0.000	0.180	-0.100E+06	255	0.000	0.000	0.140	-0.100E+06
256	0.000	0.000	0.130	-0.100E+06	257	0.000	0.000	0.140	-0.100E+06	258	0.000	0.000	0.200	-0.100E+06
259	0.000	0.000	0.140	-0.100E+06	260	0.000	0.000	0.190	-0.100E+06	261	0.000	0.000	0.140	-0.100E+06
262	0.000	0.000	0.200	-0.100E+06	263	0.350	0.000	0.230	-0.100E+06	264	0.520	0.000	0.160	-0.100E+06
265	0.000	0.000	0.210	-0.100E+06	266	0.000	0.000	0.190	-0.100E+06	267	0.000	0.000	0.180	-0.100E+06
268	0.000	0.000	0.180	-0.100E+06	269	0.530	0.000	0.090	-0.100E+06	270	0.070	0.000	0.230	-0.100E+06
271	0.000	0.000	0.170	-0.100E+06	272	0.000	0.000	0.220	-0.100E+06	273	1.040	0.000	0.000	-0.100E+06

```
BOUNDARY CONDITION AT BOTTOM OF SOIL PROFILE :
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FLUX-GROUNDWATER LEVEL RELATIONSHIP

 random distribution q(h)-relation

flux=(1/ 0.999)**2[-0.852E+00 *EXP(-0.359E-01*ABS(groundwater level))] (cm/day)
distribution code =    0 (0=normal,1=lognormal distribution)
mean and standard deviation scale factor,resp.    1.0000    0.6764
Groundwater level at start of simulation=   -78.0814 cm
..........................................................................................................................

THE ROOTING DEPTH IS CONSTANT = -30.0 CM
--- ------- ----- -- --------
..........................................................................................................................

INITIAL CONDITION :
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+++++ PRESSURE HEAD PROFILE IS CALCULATED(EQUILIBRIUM  WITH GROUNDWATER LEVEL) +++++

  -0.7308E+02  -0.6308E+02  -0.5308E+02  -0.4308E+02  -0.3308E+02
  -0.2308E+02  -0.1308E+02  -0.4041E+01   0.0000E+00   0.0000E+00
   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
..........................................................................................................................
```

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mean soil hydraulic properties OF SOIL LAYER NR : 1

THETA	PR.HEAD CM	CONDUC CM/DAY
0.01	-0.263E+05	0.178E-08
0.02	-0.818E+04	0.104E-06
0.03	-0.413E+04	0.113E-05
0.04	-0.254E+04	0.610E-05
0.05	-0.174E+04	0.226E-04
0.06	-0.128E+04	0.661E-04
0.07	-0.985E+03	0.164E-03
0.08	-0.784E+03	0.360E-03
0.09	-0.641E+03	0.720E-03
0.10	-0.535E+03	0.134E-02
0.11	-0.453E+03	0.236E-02
0.12	-0.389E+03	0.395E-02
0.13	-0.338E+03	0.636E-02
0.14	-0.296E+03	0.990E-02
0.15	-0.262E+03	0.150E-01
0.16	-0.232E+03	0.221E-01
0.17	-0.208E+03	0.318E-01
0.18	-0.187E+03	0.450E-01
0.19	-0.168E+03	0.626E-01
0.20	-0.152E+03	0.858E-01
0.21	-0.138E+03	0.116E+00
0.22	-0.125E+03	0.155E+00
0.23	-0.114E+03	0.205E+00
0.24	-0.104E+03	0.269E+00
0.25	-0.943E+02	0.350E+00
0.26	-0.858E+02	0.452E+00
0.27	-0.781E+02	0.580E+00
0.28	-0.709E+02	0.741E+00
0.29	-0.643E+02	0.942E+00
0.30	-0.581E+02	0.119E+01
0.31	-0.523E+02	0.151E+01
0.32	-0.468E+02	0.191E+01
0.33	-0.415E+02	0.242E+01
0.34	-0.364E+02	0.307E+01
0.35	-0.315E+02	0.392E+01
0.36	-0.266E+02	0.504E+01
0.37	-0.217E+02	0.658E+01
0.38	-0.167E+02	0.881E+01
0.39	-0.110E+02	0.125E+02
0.40	-0.348E+01	0.215E+02

mean soil hydraulic properties OF SOIL LAYER NR : 2

THETA	PR.HEAD CM	CONDUC CM/DAY
0.01	-0.337E+04	0.299E-06
0.02	-0.145E+04	0.919E-05
0.03	-0.879E+03	0.683E-04
0.04	-0.617E+03	0.284E-03
0.05	-0.468E+03	0.859E-03
0.06	-0.373E+03	0.212E-02
0.07	-0.307E+03	0.458E-02
0.08	-0.259E+03	0.891E-02
0.09	-0.223E+03	0.161E-01
0.10	-0.194E+03	0.273E-01
0.11	-0.171E+03	0.442E-01
0.12	-0.152E+03	0.688E-01
0.13	-0.136E+03	0.104E+00
0.14	-0.122E+03	0.152E+00
0.15	-0.110E+03	0.217E+00
0.16	-0.100E+03	0.304E+00
0.17	-0.908E+02	0.419E+00
0.18	-0.826E+02	0.568E+00
0.19	-0.752E+02	0.761E+00
0.20	-0.685E+02	0.101E+01
0.21	-0.623E+02	0.133E+01
0.22	-0.565E+02	0.173E+01
0.23	-0.511E+02	0.224E+01
0.24	-0.460E+02	0.289E+01
0.25	-0.412E+02	0.371E+01
0.26	-0.365E+02	0.477E+01
0.27	-0.319E+02	0.614E+01
0.28	-0.273E+02	0.795E+01
0.29	-0.226E+02	0.104E+02
0.30	-0.175E+02	0.139E+02
0.31	-0.116E+02	0.196E+02

OUTPUT FILE: PROF.OUT

```
TIME :    90. DAYS                                         TIME STEP= 0.100E-09 DAY     NUMBER OF TIME STEP=    1

CPREC    =  0.000 CM      CINTCEP =  0.000 CM      CPINFILT=  0.000 CM      CINFILT =      0.000 CM
CPETR    =  0.000 CM      CPTRANSP=  0.000 CM      CPSEVAP =  0.000 CM      CRUNOFF =      0.000 CM
CETR     =  0.000 CM     *CTRANSP =  0.000 CM*    *CSEVAP  =  0.000 CM*     FLUX1   =  0.000000 CM/DAY
CFLXSD   =  0.000 CM      CFLXSDP =  0.000 CM      CFLXSDN =  0.000 CM      FLXSD   =  0.000001 CM/DAY        ISD=  3
CFLXBU   =  0.000 CM                                                        FLXBU   =  0.000000 CM/DAY
CQDEEP   =  0.000 CM      CQDEEPP =  0.000 CM      CQDEEPN =  0.000 CM      QDEEPA  = -0.051729 CM/DAY
CDELTA   =  0.000 CM      CDELTAP =  0.000 CM      CDELTAN =  0.000 CM      DELTA   = 0.160E-10 CM
VOLINIT  = 90.637 CM      VOL     = 90.637 CM      GWLA    =  -78.1 CM      DRZA    =     -30.0 CM            N  =  8
QPOT     =      0. KG/HA  QTOT    =      0. KG/HA  QTUBER  =      0. KG/HA
```

COMP. NR	LEVEL (CM)	THETA (VOL)	PR.HEAD (CM)	CONDUC (CM/DAY)	ROOT EXT (1/DAY)	C.ROOT EXT (CM)	CUM.WATER (CM)	FLUXES (CM/DAY)	SCALE FACT
1	-5.0	0.215	-73.08	0.5967	0.5333E-02	0.5333E-11	2.153	-.27738E-06	1.24862
2	-15.0	0.229	-63.08	0.8844	0.5333E-02	0.5333E-11	4.440	0.00000E+00	1.24862
3	-25.0	0.244	-53.08	1.366	0.5333E-02	0.5333E-11	6.878	0.82401E-06	1.24862
4	-35.0	0.252	-43.08	3.417	0.0000E+00	0.0000E+00	9.398	0.16658E-05	0.89450
5	-45.0	0.271	-33.08	5.583	0.0000E+00	0.0000E+00	12.110	0.27486E-05	0.89450
6	-55.0	0.290	-23.08	9.303	0.0000E+00	0.0000E+00	15.008	-.11515E-05	0.89450
7	-65.0	0.306	-13.08	15.64	0.0000E+00	0.0000E+00	18.064	0.19893E-04	0.89450
8	-75.0	0.314	-4.041	25.19	0.0000E+00	0.0000E+00	21.208	0.19893E-04	0.89450
9	-85.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	24.363	-.51729E-01	0.89450
10	-95.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	27.519	-.51729E-01	0.89450
11	-105.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	30.675	-.51729E-01	0.89450
12	-115.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	33.831	-.51729E-01	0.89450
13	-125.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	36.986	-.51729E-01	0.89450
14	-135.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	40.142	-.51729E-01	0.89450
15	-145.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	43.298	-.51729E-01	0.89450
16	-155.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	46.454	-.51729E-01	0.89450
17	-165.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	49.609	-.51729E-01	0.89450
18	-175.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	52.765	-.51729E-01	0.89450
19	-185.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	55.921	-.51729E-01	0.89450
20	-195.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	59.077	-.51729E-01	0.89450
21	-205.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	62.232	-.51729E-01	0.89450
22	-215.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	65.388	-.51729E-01	0.89450
23	-225.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	68.544	-.51729E-01	0.89450
24	-235.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	71.700	-.51729E-01	0.89450
25	-245.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	74.855	-.51729E-01	0.89450
26	-255.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	78.011	-.51729E-01	0.89450
27	-265.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	81.167	-.51729E-01	0.89450
28	-275.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	84.323	-.51729E-01	0.89450
29	-285.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	87.478	-.51729E-01	0.89450
30	-295.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	90.634	-.51729E-01	0.89450

TIME : 93. DAYS TIME STEP= 0.500E+00 DAY NUMBER OF TIME STEP= 9

```
CPREC    =  0.090 CM    CINTCEP =  0.000 CM    CPINFILT=  0.090 CM    CINFILT =     0.090 CM
CPETR    =  0.470 CM    CPTRANSP=  0.470 CM    CPSEVAP =  0.000 CM    CRUNOFF =     0.000 CM
CETR     =  0.470 CM   *CTRANSP =  0.470 CM*  *CSEVAP  =  0.000 CM*   FLUX1   =  0.000000 CM/DAY
CFLXSD   =  0.216 CM    CFLXSDP =  0.216 CM    CFLXSDN =  0.000 CM    FLXSD   =  0.086984 CM/DAY       ISD=  3
CFLXBU   =  0.000 CM                                                  FLXBU   =  0.000000 CM/DAY
CQDEEP   = -0.146 CM    CQDEEPP =  0.000 CM    CQDEEPN = -0.146 CM    QDEEPA  = -0.047117 CM/DAY
CDELTA   =  0.136 CM    CDELTAP =  0.164 CM    CDELTAN = -0.028 CM    DELTA   = 0.406E-01 CM
VOLINIT  = 90.637 CM    VOL     = 90.110 CM    GWLA    =  -83.5 CM    DRZA    =     -30.0 CM           N  =  8
QPOT     =     0. KG/HA QTOT    =     0. KG/HA QTUBER  =     0. KG/HA
```

COMP. NR	LEVEL (CM)	THETA (VOL)	PR.HEAD (CM)	CONDUC (CM/DAY)	ROOT EXT (1/DAY)	C.ROOT EXT (CM)	CUM.WATER (CM)	FLUXES (CM/DAY)	SCALE FACT
1	-5.0	0.210	-77.36	0.5098	0.6667E-02	0.1567	2.102	0.13072E-01	1.24862
2	-15.0	0.223	-67.15	0.7501	0.6667E-02	0.1567	4.332	0.48502E-01	1.24862
3	-25.0	0.238	-56.63	1.165	0.6667E-02	0.1567	6.714	0.86984E-01	1.24862
4	-35.0	0.246	-46.16	2.952	0.0000E+00	0.0000E+00	9.177	-.75032	0.89450
5	-45.0	0.261	-38.26	4.316	0.0000E+00	0.0000E+00	11.789	-.36582E-01	0.89450
6	-55.0	0.280	-28.33	7.105	0.0000E+00	0.0000E+00	14.592	-.72053E-01	0.89450
7	-65.0	0.298	-18.41	11.86	0.0000E+00	0.0000E+00	17.569	-.10295	0.89450
8	-75.0	0.312	-6.741	21.80	0.0000E+00	0.0000E+00	20.694	-.10295	0.89450
9	-85.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	23.850	-.47117E-01	0.89450
10	-95.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	27.005	-.47117E-01	0.89450
11	-105.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	30.161	-.47117E-01	0.89450
12	-115.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	33.317	-.47117E-01	0.89450
13	-125.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	36.473	-.47117E-01	0.89450
14	-135.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	39.628	-.47117E-01	0.89450
15	-145.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	42.784	-.47117E-01	0.89450
16	-155.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	45.940	-.47117E-01	0.89450
17	-165.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	49.096	-.47117E-01	0.89450
18	-175.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	52.252	-.47117E-01	0.89450
19	-185.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	55.407	-.47117E-01	0.89450
20	-195.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	58.563	-.47117E-01	0.89450
21	-205.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	61.719	-.47117E-01	0.89450
22	-215.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	64.875	-.47117E-01	0.89450
23	-225.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	68.030	-.47117E-01	0.89450
24	-235.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	71.186	-.47117E-01	0.89450
25	-245.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	74.342	-.47117E-01	0.89450
26	-255.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	77.497	-.47117E-01	0.89450
27	-265.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	80.653	-.47117E-01	0.89450
28	-275.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	83.809	-.47117E-01	0.89450
29	-285.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	86.965	-.47117E-01	0.89450
30	-295.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	90.120	-.47117E-01	0.89450

TIME : 153. DAYS   TIME STEP= 0.191E+00 DAY   NUMBER OF TIME STEP= 283

```
CPREC   =  7.850 CM     CINTCEP =  0.000 CM      CPINFILT=  7.850 CM     CINFILT =      7.850 CM
CPETR   = 13.720 CM     CPTRANSP= 13.720 CM      CPSEVAP =  0.000 CM     CRUNOFF =      0.000 CM
CETR    = 13.720 CM    *CTRANSP = 13.720 CM*    *CSEVAP  =  0.000 CM*    FLUX1   =  0.000000 CM/DAY
CFLXSD  =  3.561 CM     CFLXSDP =  6.599 CM      CFLXSDN = -3.038 CM     FLXSD   =  0.290060 CM/DAY      ISD=  3
CFLXBU  =  0.000 CM                                                      FLXBU   =  0.000000 CM/DAY
CQDEEP  = -1.734 CM     CQDEEPP =  0.000 CM      CQDEEPN = -1.734 CM     QDEEPA  = -0.010273 CM/DAY
CDELTA  =  0.557 CM     CDELTAP =  3.265 CM      CDELTAN = -2.707 CM     DELTA   = 0.491E-02 CM
VOLINIT = 90.637 CM     VOL     = 83.107 CM      GWLA    = -123.1 CM     DRZA    =      -30.0 CM           N  = 12
QPOT    =       0. KG/HA QTOT   =       0. KG/HA QTUBER  =       0. KG/HA
```

COMP. NR	LEVEL (CM)	THETA (VOL)	PR.HEAD (CM)	CONDUC (CM/DAY)	ROOT EXT (1/DAY)	C.ROOT EXT (CM)	CUM.WATER (CM)	FLUXES (CM/DAY)	SCALE FACT
1	-5.0	0.138	-181.4	0.3748E-01	0.1400E-01	4.573	1.379	0.85397E-01	1.24862
2	-15.0	0.151	-153.9	0.6376E-01	0.1400E-01	4.573	2.884	0.18071	1.24862
3	-25.0	0.168	-123.8	0.1268	0.1400E-01	4.573	4.568	0.29006	1.24862
4	-35.0	0.169	-100.1	0.3511	0.0000E+00	0.0000E+00	6.260	0.25348	0.89450
5	-45.0	0.187	-84.53	0.5992	0.0000E+00	0.0000E+00	8.128	0.22267	0.89450
6	-55.0	0.204	-71.62	0.9783	0.0000E+00	0.0000E+00	10.169	0.19755	0.89450
7	-65.0	0.222	-60.03	1.580	0.0000E+00	0.0000E+00	12.390	0.17855	0.89450
8	-75.0	0.241	-49.15	2.569	0.0000E+00	0.0000E+00	14.798	0.16554	0.89450
9	-85.0	0.261	-38.64	4.236	0.0000E+00	0.0000E+00	17.403	0.15771	0.89450
10	-95.0	0.280	-28.36	7.094	0.0000E+00	0.0000E+00	20.205	0.15387	0.89450
11	-105.0	0.298	-18.19	11.99	0.0000E+00	0.0000E+00	23.186	0.15257	0.89450
12	-115.0	0.313	-6.540	22.03	0.0000E+00	0.0000E+00	26.312	0.15257	0.89450
13	-125.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	29.468	-.10273E-01	0.89450
14	-135.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	32.624	-.10273E-01	0.89450
15	-145.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	35.780	-.10273E-01	0.89450
16	-155.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	38.935	-.10273E-01	0.89450
17	-165.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	42.091	-.10273E-01	0.89450
18	-175.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	45.247	-.10273E-01	0.89450
19	-185.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	48.403	-.10273E-01	0.89450
20	-195.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	51.558	-.10273E-01	0.89450
21	-205.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	54.714	-.10273E-01	0.89450
22	-215.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	57.870	-.10273E-01	0.89450
23	-225.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	61.026	-.10273E-01	0.89450
24	-235.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	64.181	-.10273E-01	0.89450
25	-245.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	67.337	-.10273E-01	0.89450
26	-255.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	70.493	-.10273E-01	0.89450
27	-265.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	73.649	-.10273E-01	0.89450
28	-275.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	76.804	-.10273E-01	0.89450
29	-285.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	79.960	-.10273E-01	0.89450
30	-295.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	83.116	-.10273E-01	0.89450

TIME : 213. DAYS TIME STEP= 0.290E+00 DAY NUMBER OF TIME STEP= 645

```
CPREC    = 17.070 CM     CINTCEP =  0.000 CM    CPINFILT= 17.070 CM      CINFILT =     17.070 CM
CPETR    = 31.810 CM     CPTRANSP= 31.810 CM    CPSEVAP =  0.000 CM      CRUNOFF =      0.000 CM
CETR     = 30.999 CM    *CTRANSP = 30.999 CM*  *CSEVAP  =  0.000 CM*     FLUX1   =  0.000000 CM/DAY
CFLXSD   =  9.535 CM     CFLXSDP = 14.759 CM    CFLXSDN = -5.224 CM      FLXSD   =  0.180434 CM/DAY      ISD=  3
CFLXBU   =  0.000 CM                                                     FLXBU   =  0.000000 CM/DAY
CQDEEP   = -2.112 CM     CQDEEPP =  0.000 CM    CQDEEPN = -2.112 CM      QDEEPA  = -0.002605 CM/DAY
CDELTA   =  1.805 CM     CDELTAP =  6.285 CM    CDELTAN = -4.480 CM      DELTA   = 0.278E-02 CM
VOLINIT  = 90.637 CM     VOL     = 74.564 CM    GWLA    = -161.3 CM      DRZA    =     -30.0 CM            N  = 16
QPOT     =      0. KG/HA QTOT    =      0. KG/HA QTUBER =      0. KG/HA
```

COMP. NR	LEVEL (CM)	THETA (VOL)	PR.HEAD (CM)	CONDUC (CM/DAY)	ROOT EXT (1/DAY)	C.ROOT EXT (CM)	CUM.WATER (CM)	FLUXES (CM/DAY)	SCALE FACT
1	-5.0	0.058	-816.4	0.2263E-03	0.6416E-02	10.08	0.583	0.15768E-01	1.24862
2	-15.0	0.077	-503.7	0.1198E-02	0.1017E-01	10.40	1.356	0.85396E-01	1.24862
3	-25.0	0.113	-260.9	0.1123E-01	0.1596E-01	10.52	2.483	0.18043	1.24862
4	-35.0	0.116	-174.5	0.4965E-01	0.0000E+00	0.0000E+00	3.643	0.17287	0.89450
5	-45.0	0.135	-140.9	0.1083	0.0000E+00	0.0000E+00	4.994	0.16292	0.89450
6	-55.0	0.151	-119.7	0.1925	0.0000E+00	0.0000E+00	6.503	0.15086	0.89450
7	-65.0	0.166	-103.5	0.3139	0.0000E+00	0.0000E+00	8.159	0.13599	0.89450
8	-75.0	0.180	-90.06	0.4921	0.0000E+00	0.0000E+00	9.960	0.11736	0.89450
9	-85.0	0.195	-78.14	0.7595	0.0000E+00	0.0000E+00	11.911	0.95102E-01	0.89450
10	-95.0	0.211	-67.13	1.173	0.0000E+00	0.0000E+00	14.019	0.71305E-01	0.89450
11	-105.0	0.228	-56.64	1.831	0.0000E+00	0.0000E+00	16.296	0.49402E-01	0.89450
12	-115.0	0.246	-46.43	2.915	0.0000E+00	0.0000E+00	18.754	0.32487E-01	0.89450
13	-125.0	0.265	-36.34	4.745	0.0000E+00	0.0000E+00	21.403	0.21799E-01	0.89450
14	-135.0	0.284	-26.31	7.878	0.0000E+00	0.0000E+00	24.243	0.16477E-01	0.89450
15	-145.0	0.301	-16.29	13.23	0.0000E+00	0.0000E+00	27.254	0.14785E-01	0.89450
16	-155.0	0.313	-5.641	23.11	0.0000E+00	0.0000E+00	30.387	0.14785E-01	0.89450
17	-165.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	33.543	-.26046E-02	0.89450
18	-175.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	36.698	-.26046E-02	0.89450
19	-185.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	39.854	-.26046E-02	0.89450
20	-195.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	43.010	-.26046E-02	0.89450
21	-205.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	46.166	-.26046E-02	0.89450
22	-215.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	49.321	-.26046E-02	0.89450
23	-225.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	52.477	-.26046E-02	0.89450
24	-235.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	55.633	-.26046E-02	0.89450
25	-245.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	58.789	-.26046E-02	0.89450
26	-255.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	61.944	-.26046E-02	0.89450
27	-265.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	65.100	-.26046E-02	0.89450
28	-275.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	68.256	-.26046E-02	0.89450
29	-285.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	71.412	-.26046E-02	0.89450
30	-295.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	74.567	-.26046E-02	0.89450

```
TIME :  273. DAYS                                              TIME STEP= 0.841E-01 DAY     NUMBER OF TIME STEP= 955

CPREC    = 25.430 CM      CINTCEP =  0.000 CM      CPINFILT= 25.430 CM      CINFILT =     25.430 CM
CPETR    = 44.380 CM      CPTRANSP= 44.380 CM      CPSEVAP =  0.000 CM      CRUNOFF =      0.000 CM
CETR     = 42.724 CM     *CTRANSP = 42.724 CM*    *CSEVAP  =  0.000 CM*     FLUX1   = -1.040000 CM/DAY
CFLXSD   = 14.734 CM      CFLXSDP = 20.118 CM      CFLXSDN = -5.385 CM      FLXSD   =  0.041195 CM/DAY          ISD=  3
CFLXBU   =  0.000 CM                                                        FLXBU   =  0.000000 CM/DAY
CQDEEP   = -2.201 CM      CQDEEPP =  0.000 CM      CQDEEPN = -2.201 CM      QDEEPA  = -0.000919 CM/DAY
CDELTA   =  3.041 CM      CDELTAP =  8.462 CM      CDELTAN = -5.421 CM      DELTA   = 0.234E-03 CM
VOLINIT  = 90.637 CM      VOL     = 71.074 CM      GWLA    = -190.3 CM      DRZA    =      -30.0 CM            N  = 19
QPOT     =      0. KG/HA  QTOT    =      0. KG/HA  QTUBER  =      0. KG/HA
```

COMP. NR	LEVEL (CM)	THETA (VOL)	PR.HEAD (CM)	CONDUC (CM/DAY)	ROOT EXT (1/DAY)	C.ROOT EXT (CM)	CUM.WATER (CM)	FLUXES (CM/DAY)	SCALE FACT
1	-5.0	0.179	-109.5	0.1850	0.0000E+00	13.85	1.790	-.70535	1.24862
2	-15.0	0.133	-194.3	0.2992E-01	0.0000E+00	14.25	3.119	-.10936	1.24862
3	-25.0	0.120	-234.0	0.1617E-01	0.0000E+00	14.63	4.317	0.41195E-01	1.24862
4	-35.0	0.103	-204.4	0.2741E-01	0.0000E+00	0.0000E+00	5.349	0.67140E-01	0.89450
5	-45.0	0.115	-176.0	0.4815E-01	0.0000E+00	0.0000E+00	6.501	0.71254E-01	0.89450
6	-55.0	0.127	-154.3	0.7803E-01	0.0000E+00	0.0000E+00	7.768	0.70404E-01	0.89450
7	-65.0	0.138	-137.0	0.1197	0.0000E+00	0.0000E+00	9.145	0.67485E-01	0.89450
8	-75.0	0.149	-122.4	0.1779	0.0000E+00	0.0000E+00	10.632	0.62895E-01	0.89450
9	-85.0	0.160	-109.5	0.2603	0.0000E+00	0.0000E+00	12.230	0.56721E-01	0.89450
10	-95.0	0.172	-97.70	0.3794	0.0000E+00	0.0000E+00	13.947	0.49359E-01	0.89450
11	-105.0	0.184	-86.62	0.5557	0.0000E+00	0.0000E+00	15.789	0.41572E-01	0.89450
12	-115.0	0.198	-76.01	0.8241	0.0000E+00	0.0000E+00	17.768	0.34236E-01	0.89450
13	-125.0	0.213	-65.67	1.245	0.0000E+00	0.0000E+00	19.899	0.28059E-01	0.89450
14	-135.0	0.230	-55.49	1.927	0.0000E+00	0.0000E+00	22.196	0.23399E-01	0.89450
15	-145.0	0.248	-45.39	3.061	0.0000E+00	0.0000E+00	24.673	0.20238E-01	0.89450
16	-155.0	0.267	-35.34	4.987	0.0000E+00	0.0000E+00	27.342	0.18399E-01	0.89450
17	-165.0	0.286	-25.31	8.292	0.0000E+00	0.0000E+00	30.200	0.17528E-01	0.89450
18	-175.0	0.303	-15.29	13.94	0.0000E+00	0.0000E+00	33.225	0.17257E-01	0.89450
19	-185.0	0.314	-5.142	23.74	0.0000E+00	0.0000E+00	36.362	0.17257E-01	0.89450
20	-195.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	39.517	-.91894E-03	0.89450
21	-205.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	42.673	-.91894E-03	0.89450
22	-215.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	45.829	-.91894E-03	0.89450
23	-225.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	48.985	-.91894E-03	0.89450
24	-235.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	52.140	-.91894E-03	0.89450
25	-245.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	55.296	-.91894E-03	0.89450
26	-255.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	58.452	-.91894E-03	0.89450
27	-265.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	61.608	-.91894E-03	0.89450
28	-275.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	64.763	-.91894E-03	0.89450
29	-285.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	67.919	-.91894E-03	0.89450
30	-295.0	0.316	0.0000E+00	32.45	0.0000E+00	0.0000E+00	71.075	-.91894E-03	0.89450

end of simulation nr   1

$

OUTPUT FILE: BALANC.OUT

******** TERMS OF THE WATER BALANCE AND CUMULATIVE REDUCTION OF TRANSPIRATION RATE ********

TIME	E CM	I CM	QROOTZ CM	QBOTTOM CM	DELTAWR CM	DELTAW CM	REDUCT PERCT	PHROOTZ CM	GWL cm	CUM REDUCTION cm
91	0.16	0.00	0.09	-0.05	-0.07	-0.21	0.0	-0.647E+02	-80.7	0.000
105	2.34	2.20	-0.17	-0.64	-0.31	-0.75	0.0	-0.707E+02	-83.7	0.000
112	3.77	2.20	0.76	-0.88	-0.81	-2.43	0.0	-0.849E+02	-96.0	0.000
119	5.01	2.52	1.59	-1.04	-0.90	-3.44	0.0	-0.876E+02	-104.5	0.000
126	5.93	5.69	0.36	-1.18	0.12	-1.45	0.0	-0.599E+02	-98.0	0.000
133	7.62	6.37	0.32	-1.41	-0.93	-2.69	0.0	-0.891E+02	-97.4	0.000
140	9.68	7.03	1.56	-1.55	-1.09	-4.20	0.0	-0.940E+02	-110.3	0.000
147	11.47	7.84	2.18	-1.66	-1.45	-5.32	0.0	-0.108E+03	-115.1	0.000
154	14.14	7.85	3.86	-1.74	-2.43	-8.01	0.0	-0.162E+03	-125.6	0.000
161	16.51	8.93	5.18	-1.80	-2.40	-9.42	0.0	-0.158E+03	-136.1	0.000
168	17.83	10.92	5.32	-1.84	-1.59	-8.68	0.0	-0.113E+03	-138.8	0.000
175	19.21	13.87	4.16	-1.88	-1.18	-7.22	0.0	-0.970E+02	-132.4	0.000
182	20.99	16.15	3.35	-1.94	-1.49	-6.80	0.0	-0.109E+03	-127.0	0.000
189	23.01	16.68	4.09	-2.00	-2.24	-8.33	0.0	-0.148E+03	-129.7	0.000
196	25.93	16.93	5.91	-2.05	-3.08	-11.07	0.1	-0.216E+03	-140.5	0.034
203	28.27	16.94	7.55	-2.08	-3.78	-13.43	0.2	-0.340E+03	-151.0	0.067
210	30.11	17.07	8.94	-2.10	-4.10	-15.20	0.9	-0.407E+03	-158.7	0.275
217	31.92	17.60	10.26	-2.12	-4.05	-16.36	4.5	-0.381E+03	-163.8	1.495
224	33.59	17.96	11.30	-2.14	-4.33	-17.80	4.5	-0.456E+03	-171.0	1.598
231	35.20	20.99	11.89	-2.15	-2.33	-16.43	4.5	-0.152E+03	-176.1	1.655
238	36.49	22.26	12.02	-2.16	-2.21	-16.48	4.3	-0.146E+03	-178.9	1.655
245	37.84	22.86	12.20	-2.17	-2.78	-17.13	4.2	-0.185E+03	-178.9	1.655
252	39.18	22.92	12.81	-2.18	-3.46	-18.49	4.1	-0.259E+03	-181.3	1.655
259	40.33	22.92	13.50	-2.19	-3.91	-19.60	3.9	-0.341E+03	-183.5	1.655
266	41.65	23.79	14.19	-2.19	-3.67	-20.11	3.8	-0.287E+03	-187.9	1.656
273	42.72	25.43	14.73	-2.20	-2.56	-19.56	3.7	-0.179E+03	-190.3	1.656

PROGRAM LISTING

```
       program swatre
c
c
      common/cum/cprec,cintc,cinf,cptra,cpsev,ctra,ctral,ctra2,csev,
     !  csev2,cflsd,cflsdp,cflbu,cqd,cqdp,cqdn,cdel,cdelp,del,dvol,
     !  crtex(100)
      open(unit=20,file='init.out',status='new')
      open(unit=21,file='prof.out',status='new')
      open(unit=22,file='balanc.out',status='new')
        do 1000 nreal=1,2
c       if(nreal.gt.1) open(unit=20,file='out.dat',status='new',
c      *                     dispose='delete')
       iflagl=0
         iflag2=0
        iwt=0
        its=0
        nts=0
        npra=0
        cprec=0.0
        cintc=0.0
        cinf=0.0
        cptra=0.0
        cpsev=0.0
        ctra=0.0
        ctral=0.0
        ctra2=0.0
        csev=0.0
        csev2=0.0
        cflsd=0.0
        cflsdp=0.0
        cflbu=0.0
        cqd=0.0
        cqdp=0.0
        cdel=0.0
        cdelp=0.0
        del=0.0
        dvol=0.0
        do 50 i=1,100
          crtex(i)=0.0
50       continue
        call main(iflagl,iflag2)
        if(iflagl.eq.999) write(21,11)
11        format(' groundwater outside domain or close to surface')
          if(iflag2.eq.999) write(21,12) nreal
12       format(' end of simulation nr',i5)
1000       continue
      stop
         end
       subroutine main(iflagl,iflag2)
C
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C     *                                                           *
C     *  SIMULATION MODEL OF THE WATER BALANCE OF A CROPPED SOIL  *
C     *     PROVIDING DIFFERENT TYPES OF BOUNDARY CONDITIONS      *
C     *     INCLUDING THE POSSIBILITY TO SIMULATE CROP YIELD      *
C     *                    AND IRRIGATION                         *
C     *               ( S   W   A   T   R   E )                   *
C     *                                                           *
C     *                                                           *
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C   * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C   *                                                               *
C   *  T H I S   P R O G R A M   I S   D E V E L O P E D   A T   T H E : *
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C   *     ..................................................           *
C   *     . INSTITUTE FOR LAND AND WATER MANAGEMENT RESEARCH .        *
C   *     ..................................................           *
C   *                                                                  *
C   *  BY :  C. BELMANS(1), J.G. WESSELING(2), R.A. FEDDES(2) AND     *
C   *        W.A.J.M. KROONEN(2)                                      *
C   *                                                                  *
C   *   (1) SOIL SURVEY INSTITUTE; P.O.BOX 98; 6700 AA WAGENINGEN;    *
C   *   (2) INSTITUTE FOR LAND AND WATER MANAGEMENT RESEARCH;         *
C   *       I.C.W.; P.O. BOX 35; 6700 AA WAGENINGEN; THE NETHERLANDS*
C   *                                                                  *
C   * S W A P R O IS A MODIFIED AND EXTENDED VERSION OF SWATRE        *
C   * WHICH IS A MODIFIED AND EXTENDED VERSION OF SWATR AS            *
C   * DEVELOPED BY : R.A. FEDDES, P.J. KOWALIK AND H. ZARADNY :       *
C   *     'SIMULATION OF FIELD WATER USE AND CROP YIELD'               *
C   * SIMULATION MONOGRAPH 1978 PUDOC WAGENINGEN,ISBN 90-220-0676-X *
C   *                                                                  *
C   * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C     *       V E R S I O N   A P R I L   1 9 8 5               *
C     *              UPDATED TILL APRIL 1985                     *

C     *     SOME MINOR CHANGES IN OUTPUT ADDED BY P.I.ADRIAANSE   *

C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C
c  !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
c
c    M O D I F I E D   A U G US T  1 9 8 6 -----------
C
C   THE  FOLLOWING  CHANGES  WERE  IMPLEMENTED
C
C
C     1. instead of providing tables to calculate hydraulic
c        properties, the van Genuchten model is used
c
c     2. the maximum number of compartments is expanded to 100
c
c     3. the maximum number of different soil layers is expanded
c        to 10
c
C     4. NEW ROOT EXTRACTION FUNCTION IS ADDED.
C         (MUST MODEL, ROOT EXTRACTION RATE IS INFLUENCED BY HYDRAULIC
C          CONDUCTIVITY).
C          CHOOSE IRER=2.
C
C       5. POSSIBILITY TO SCALE HYDRAULIC PROPERTIES,
C          KOD(10)=0 : OLD VERSION, OR SCALED HYDRAULIC PROPERTIES,
C          WHERE EACH LAYER HAS A KNOWN SCALE FACTOR VALUE.
C          KOD(10)=1 : RANDOM DISTRIBUTION OF SCALE FACTOR VALUES FOR
C                      EACH LAYER.
C          KOD(10)=2 : RANDOM DISTRIBUTION OF SCALE FACTOR VALUES FOR
C                      EACH COMPARTMENT.
C
C        6. WHEN KOD(10) = 1 OR 2, AND KOD(1)=3:
C             POSSIBILITY OF RANDOM DISTRIBUTION OF FLUX-GROUNDWATER
C             LEVEL RELATIONSHIP.
C             CHOOSE ICOD=1, ELSE ICOD=0.
C
c                                  Jan. W. Hopmans
c
```

```
c    !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
c
C*********************************************************************
C
C
C            *** THE FOLLOWING VALUES MUST BE PRESCRIBED : ***
C
C    -INITIAL CONDITIONS :
C     ------- ----------
C                  -A) VALUES OF MOISTURE CONTENT            [KOD(5)=0]
C              OR  -B) VALUES OF PRESSURE HEAD               [KOD(5)=1]
C
C
C    -BOUNDARY CONDITIONS (DAILY VALUES):
C     -------- ---------- -------------
C  -AT THE BOTTOM  -A) GROUNDWATER LEVEL                     [KOD(1)=0]
C                  -B) FLUX FROM  SATURATED ZONE             [KOD(1)=1]
C                  -C) FLUX TOWARDS DITCHES AND DEEP PERCOLATION
C                                                            [KOD(1)=2]
C                  -D) FLUX-GROUNDWATER LEVEL RELATIONSHIP   [KOD(1)=3]
C                  -E) PRESSURE HEAD OF BOTTOM COMPARTMENT   [KOD(1)=4]
C                  -F) ZERO FLUX (UNSATURATED SOIL PROFILE)  [KOD(1)=5]
C                  -G) FREE DRAINAGE                         [KOD(1)=6]
C
C  -AT THE SURFACE -A) KOD(3)=0 : PRESCRIBED VALUES OF :
C                      PREC : PRECIPITATION (CM/DAY)
C                      ES   : POTENTIAL SOIL EVAPORATION (CM/DAY)
C                      EP   : POTENTIAL TRANSPIRATION (CM/DAY)
C                      PHS  : MINIMUM ALLOWED  PRESSURE HEAD AT
C                             THE SOIL SURFACE (CM)
C
C                  -B) KOD(3)=1 :  PRIESTLEY AND TAYLOR FORMULA
C                      INPUT : PREC,HSH,TEM,RH,SC (SEE UNDER -D)
C
C                  -C) KOD(3)=2 : PENMAN(OPEN WATER)*CROP COEFFICIENT
C                      INPUT : HSH : SHORT WAVE RADIATION (W/M**2)
C                              DCL : DEGREE OF CLOUDINESS (FRACTION)
C                              PREC,TEM,RH,SC ( SEE UNDER -D) )
C
C                  -D) KOD(3)=3 : MONTEITH-RYTEMA FORMULA
C                      PREC  : PRECIPITATION(CM/DAY)
C                      RH    : RELATIVE HUMIDITY OF AIR(FRACTION)
C                      U     : WIND VELOCITY AT 2 M HEIGHT(M/S)
C                      HNT   : NET RADIATION FLUX (W/M**2)
C                      CH    : CROP HEIGHT(CM)
C                      SC    : SOIL COVER(FRACTION)
C                      TEM   : TEMPERATURE OF AIR(DEGREES CELSIUS)
C
C    -DEPTH OF ROOT ZONE(CM)
C     ----- -- ---- -------
C
C*********************************************************************
C     MAXIMALLY CAN BE USED:
C     366 VALUES OF THE BOUNDARY CONDITION
C     80  VALUES OF PRESSURE HEAD AND CONDUCTIVITY(FOR EVERY LAYER)
C     100  NODAL POINTS OF THE SOIL PROFILE
C     52  OUTPUTS
c     10 different soil layers
C*********************************************************************
C
      DIMENSION PH(100),PH1(100),WC(100)
C
      LOGICAL TGIFT
      INTEGER TRAIN,TDIF
```

```
      REAL LAI
C
      COMMON/INTRS/ IAD,N,NPL,NCS,IRZ,IRER,INL,IPRT,ISD,NPR,
     $LV(10),MV(10),NC(10),KOD(10),L(8),LC1(5),ICOD,IDICOD
      COMMON/REALS/ VISD,VISD1,TEM(366),GPRH(366),SC(366),QDEEP(366),
     $PO,PU1,PL1,P2H,P2L,P2,P3,RNAM,CGWLAM,DSP,DX,DXG,DXH,DXN,CS1,ESRA,
     $FAC,DT,DT1,DTI,DTM,DTHM,TINIT,TEND,TPRINT,TOUTP,TMD,T2,TB,TE,
     $VOL1,VOLI,VOL,FINA,GWLA,DRZA,GPRHA,QDEEPA,ESA,EPA,PHSA,PRECA,FLXA,
     $ARER,BRER,AREL,BREL,FLX1,CHNL,CHND,CHNR,DKD,ALPHAR,DGRWL,SIMPR,
     $TPR(52),PREC(366),FIN(366),PHS(366),EP(366),ES(366),DRZ(366),
     $HNT(366),HSH(366),X(100),PRH(10,81),CON(10,81),CONDUC(101),
     $conin(101),SCALM,SCALS,SND(100,3),
     $DMCAP(100),RTEX(100),FLXS(101),THETA(4),SWC(10),SWCA(100),
     $ttr(10),tal(10),ten(10),tks(10),tla(100),
     $DOUTP(366,13),ESR(366),GWL(366),VPD(366),VOLIR
      COMMON/CUM/ CPREC,CINTC,CINF,CPTRA,CPSEV,CTRA,CTRA1,CTRA2,CSEV,
     $CSEV2,CFLSD,CFLSDP,CFLBU,CQD,CQDP,CQDN,CDEL,CDELP,DEL,DVOL,
     $CRTEX(100)
      COMMON/IRRI/ SIZE,TDIF,PHCRIT,TRAIN,NCRIT,TGIFT(366)
      COMMON/CROP/FSX(6),FSY(6),FTX(6),FTY(6),TWOPI,HALFPI,DVS,LAI,
     *FACLAI,EPSFAC,CVF,AMAX,QINIT,QPOT,QTOT,QLEAVE,QTUBER,TCROP,
     *FLA,FLB,FLC
C
      DATA IWT,ITS,NTS,NPRA/4*0/,PH/100*0./,WC/100*0./
C
C***********************************************************************
C**********   M A I N     P R O G R A M   *****************
C***********************************************************************
C
c       write(6,1111)
1111        format(' main')
C     READING OF INPUT AND INITIAL CALCULATIONS#
         iwt=0
           its=0
           nts=0
           npra=0
        do 5 i=1,100
            ph(i)=0.0
            wc(i)=0.0
5          continue
      HALFPI=2.0*ATAN(1.0)
      TWOPI=4.0*HALFPI
C
      OPEN(UNIT=11,FILE='SR.IN',STATUS='OLD')

C
C
      CALL RDATA(PH,WC)
      IF(KOD(1).GT.0.AND.KOD(1).LT.4) IWT=1
      IPRT=1
      T=TINIT
C
C
C
C################ 'S T A R T   O F   T I M E   S T E P' ###############
C
9999  T=T+DT
c          write(6,9998) t
9998       format(' time= ',f10.5)
      NTS=NTS+1
C
C#UPDATING OF PRESSURE HEADS#
      DO 10 I=1,N
       PH1(I)=PH(I)
```

```
10    CONTINUE
      CALL PRHEAD(PH)
C
C --- IRRIGATION NECESSARY ?
      IF (KOD(9).EQ.1) THEN
         IF (PH(NCRIT).LT.PHCRIT) THEN
            M-INT(T)+2
            IF (TRAIN.LT.(M-TDIF)) THEN
               TGIFT(M)-.TRUE.
               TRAIN-M
               PREC(M)-PREC(M)+SIZE
            END IF
         END IF
      END IF
C
      NO-N
      IF(KOD(1).LT.4) NO-N-1
      DO 20 I-1,NO
       WC(I)-WC(I)+(PH(I)-PH1(I))*DMCAP(I)
20    CONTINUE
      CALL HEPR(PH,WC)
C
C#CALCULATION OF CUMULATIVE VALUES#
      CALL INTGRL(PH)
C
C#READING OF BOUNDARY CONDITIONS#
      CALL BOCO(T,PH,WC)
C
C#CALCULATION OF WATER BALANCE#
      VOL1=VOL
      VOL=0.0
      DO 30 I-1,NCS
       VOL-VOL+WC(I)*DX
30    CONTINUE
      IF(KOD(1).LT.4) VOL-VOL+(N*DX+GWLA)*(SWCA(N+1)-WC(N))
      DEL-VOL-VOL1+CTRA-CTRA1+FLXS(1)*DT
      IF(DEL.GT.0.) CDELP-CDELP+DEL
      CDEL-CDEL+DEL
      VISD1-VISD
      VISD-0.
      DO 31 I-1,ISD
       VISD-VISD+WC(I)*DX
31    CONTINUE
      DELISD-VISD-VISD1+CTRA-CTRA1+FLXS(1)*DT
      IF(DELISD.GT.0.) CFLSDP-CFLSDP+DELISD
      CFLSD-CFLSD+DELISD
C
C#CALCULATION OF GROUNDWATER LEVEL#
C   #ONLY IF KOD(1)-1,KOD(1)-2 OR KOD(1)-3#
      IF(IWT.EQ.1) CALL CALGWL(PH,wc,iflag1)
        if(iflag1.eq.999) go to 10000
C
C#CALCULATION OF DIF. MOIST. CAPACITIES AND HYDR. CONDUCTIVITIES#
      CALL DMCCON(WC,ph)
C
C#CALCULATION OF FLUXES IN BETWEEN THE NODAL POINTS#
      CALL FLUXES(PH)
C
C#CALCULATION OF ROOT EXTRACTION RATES#
      CALL RER(T,PH      )
C
C#OUTPUT#
      IF(IPRT.EQ.1.OR.ITS.EQ.1) CALL PRTPLT(T,WC,PH,ITS,NTS,NPRA)
C
```

```
C#CALCULATION OF NEXT TIME STEP (DT)#
      CALL CALCDT(T,its,iflag2)
       if(iflag2.eq.999) go to 10000
C
C################## GOTO     'S T A R T  O F  T I M E  S T E P' ###
      GOTO 9999
C
10000  return
      END
C
C*********************************************************************
C************* S U B R O U T I N E S ****************
C*********************************************************************
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
      SUBROUTINE RDATA(PH,WC)
C     SUBROUTINE RDATA : READING AND PRINTING OF INITIAL CONDITIONS,BOUN
C                        DARY CONDITIONS, DEPTH OF ROOT ZONE AND  HYDRAU
C                        LIC PARAMETERS OF THE DIFFERENT SOIL LAYERS
      REAL LAI
      real MSCA(10),SSCA(10),STSAT(10)
      LOGICAL TGIFT
      INTEGER TRAIN,TDIF
      DIMENSION KM(12),RH(366),U(366),CH(366),DCL(366),
     *PH(100),WC(100),IB(69),HED(20)
      COMMON/INTRS/ IAD,N,NPL,NCS,IRZ,IRER,INL,IPRT,ISD,NPR,
     $LV(10),MV(10),NC(10),KOD(10),L(8),LC1(5),ICOD,IDICOD
      COMMON/REALS/ VISD,VISD1,TEM(366),GPRH(366),SC(366),QDEEP(366),
     $PO,PU1,PL1,P2H,P2L,P2,P3,RNAM,CGWLAM,DSP,DX,DXG,DXH,DXN,CS1,ESRA,
     $FAC,DT,DT1,DTI,DTM,DTHM,TINIT,TEND,TPRINT,TOUTP,TMD,T2,TB,TE,
     $VOL1,VOLI,VOL,FINA,GWLA,DRZA,GPRHA,QDEEPA,ESA,EPA,PHSA,PRECA,FLXA,
     $ARER,BRER,AREL,BREL,FLX1,CHNL,CHND,CHNR,DKD,ALPHAR,DGRWL,SIMPR,
     $TPR(52),PREC(366),FIN(366),PHS(366),EP(366),ES(366),DRZ(366),
     $HNT(366),HSH(366),X(100),PRH(10,81),CON(10,81),CONDUC(101),
     $conin(101),SCALM,SCALS,SND(100,3),
     $DMCAP(100),RTEX(100),FLXS(101),THETA(4),SWC(10),SWCA(100),
     $ttr(10),tal(10),ten(10),tks(10),TLA(100),
     $DOUTP(366,13),ESR(366),GWL(366),VPD(366),VOLIR
      COMMON/CUM/ CPREC,CINTC,CINF,CPTRA,CPSEV,CTRA,CTRA1,CTRA2,CSEV,
     $CSEV2,CFLSD,CFLSDP,CFLBU,CQD,CQDP,CQDN,CDEL,CDELP,DEL,DVOL,
     $CRTEX(100)
      COMMON/IRRI/ SIZE,TDIF,PHCRIT,TRAIN,NCRIT,TGIFT(366)
      COMMON/CROP/FSX(6),FSY(6),FTX(6),FTY(6),TWOPI,HALFPI,DVS,LAI,
     *FACLAI,EPSFAC,CVF,AMAX,QINIT,QPOT,QTOT,QLEAVE,QTUBER,TCROP,
     *FLA,FLB,FLC
C
      DATA KM(1),KM(3),KM(5),KM(7),KM(8),KM(10),KM(12)/7*31/,KM(4),KM(6)
     $,KM(9),KM(11)/4*30/,GAMMA/1*0.66713/,SEP,SES/2*0.0/,IPL/'+'/,
     $IMN/'-'/,IBL/' '/,ISL/'/'/,FGA,FGB,FGC,FGD,FGM,FMCH,FIA,FIB,FIC,
     $FID,FMP,FMI/.37E-7,.283,.164E-7,.59,1.3E-7,20.,0.169,0.516,0.1787,
     $0.0593,2.0,0.19/
      DATA AVALUE/0.35/,TRAIN/-999.0/
C
C
c        write(6,1111)
1111     format(' rdata')
      DO 5000 I=1,366
         TGIFT(I)=.FALSE.
         TEM(I)=0.0
         RH(I)=0.0
         U(I)=0.0
         HNT(I)=0.0
         CH(I)=0.0
         SC(I)=0.0
```

```
        DCL(I)=0.0
5000  CONTINUE
C
C
C** READING AND PRINTING OF INPUT DATA  AND  INITIAL CALCULATIONS ******
C   ------- --- -------- -- ----- ----  ---  ------- -----------
      READ(11,1000) HED
 1000 FORMAT(20A4)
      WRITE(20,1001) HED
1001  FORMAT(1H1,20A4,/)
      WRITE(20,6666)
      WRITE(20,1002)
1002  FORMAT(1X,'I  N  P  U  T     V  A  R  I  A  B  L  E  S :',/,
     $          ' -  -  -  -  -     -  -  -  -  -  -  -  -  -',/)
      READ(11,*) (KOD(I),I-1,10)
      WRITE(20,1021) (KOD(I),I-1,10)
1021  FORMAT(1X,'KOD(1)-',I1,'  KOD(2)-',I1,'  KOD(3)-',I1,
     $'   KOD(4)-',I1,'  KOD(5)-',I1,'  KOD(6)-',I1,'  KOD(7)-',I1,
     $'   KOD(8)-',I1,'  KOD(9)-',I1,'  KOD(10)=',i1,//)
      READ(11,*)  DSP,NCS,NPL,(NC(I),I-1,10),ISD
      WRITE(20,1031) DSP,NCS,NPL,(NC(I),I-1,10),ISD
1031  FORMAT(1X,'DEPTH OF SOIL PROFILE  :',F8.1,' CM',/,
     $' NUMBER OF COMPARTMENTS :',I3,/,' NUMBER OF SOIL LAYERS  :',
     $I3,/,' NC - ARRAY :',10I5,/,
     $' DARCIAN FLUX INTEGRATED AT BOTTOM OF COMPARTMENT NR :',I3,//)
      READ(11,*) (tal(I),I-1,NPL)
      WRITE(20,1041) (tal(I),I-1,NPL)
1041  FORMAT(1X,'                         alpha - ARRAY  :',10F8.4)
C
      READ(11,*) (ten(I),I-1,NPL)
      WRITE(20,1042) (ten(I),I-1,NPL)
1042  FORMAT(1X,'                            en - ARRAY  :',10F8.4)
C
      read(11,*) (ttr(i),i-1,npl)
      write(20,1060) (ttr(i),i-1,npl)
1060  format(1x,'residual MOISTURE CONTENT - array   :',10f8.4)
c
      READ(11,*) (SWC(I),I-1,NPL)
      WRITE(20,1043) (SWC(I),I-1,NPL)
1043  FORMAT(1X,'                           SWC - ARRAY :',10F8.2)
C
      read(11,*) (tks(i),i-1,npl)
      write(20,1070) (tks(i),i-1,npl)
1070  format(1x,'                         KSAT - ARRAY  :',10f8.4,//)
c
c
      read(11,*)(msca(i),i-1,npl)
      write(20,1049)(msca(i),i-1,npl)
1049  format(1x,'       scale factor mean - array :',10f8.4,//)
c
c     next segment computes 3 arrays of standard normal deviates
c     using the system time (secnds) and a random number
c     generator (function ran)..........
c
         tsec-secnds(0.0)
         iseed-ifix(10000*tsec)
         do 1700 ii-1,3
             do 1600 i-1,ncs
1499             sum-0.0
               do 1500 j-1,200
               sum-sum+(ran(iseed)-0.5)
1500           continue
             snd(i,ii)-((12./200.)**0.5)*sum
       if(i.gt.nc(1).and.snd(i,1).lt.-0.2) go to 1499
```

```
       if(i.gt.nc(1).and.snd(i,1).gt.0.85) go to 1499
1600         continue
1700     continue
         type *,(snd(i,1),i=1,ncs)
c
       if(kod(10).eq.0) go to 1004
      read(11,*)(ssca(i),i=1,npl)
      write(20,1046)(ssca(i),i=1,npl)
1046  format(1x,'   scale factor st. dev. - array :',10f8.4,//)
       read(11,*) (stsat(i),i=1,npl)
        write(20,1050) (stsat(i),i=1,npl)
1050    format(1x,'   sat wat ct st. dev. -array:',10f8.4,//)
c
c
1004       nla=1
      nnl=nc(1)
      do 1047  i=1,ncs
      if (i.le.nnl) goto 1048
      nla=nla+1
      nnl=nc(nla)
1048  if(kod(10).eq.2) tla(i)=10.**(snd(i,1)*ssca(nla)+msca(nla))
       if(kod(10).eq.1) tla(i)=10.**(snd(nnl,1)*ssca(nla)+msca(nla))
       if(kod(10).eq.0) tla(i)=msca(nla)
       if(tla(i).gt.2.5) tla(i)=2.49
         if(tla(i).le.0.25) tla(i)=0.26
          if(kod(10).eq.2) swca(i)=swc(nla)+snd(i,2)*stsat(nla)
        if(kod(10).eq.1)  swca(i)=swc(nla)+snd(nla,2)*stsat(nla)
        if(kod(10).eq.0) swca(i)=swc(nla)
1047  continue
C
      WRITE(20,1045)(TLA(I),I=1,ncs)
1045  FORMAT(1X,'                    scale factor - ARRAY :',10f8.4,/,
     * 9(35x,10f8.4,/),//)
       type *,(tla(i),i=1,5)
       write(20,1005) (swca(i),i=1,ncs)
1005     format(1x,'     sat. water content - array:',10f8.4,/,
     * 9(35x,10f8.4,/),//)
         type *,(swca(i),i=1,5)
      READ(11,*)  CS1,FAC
      WRITE(20,1044) CS1,FAC
1044  FORMAT(1X,'SATURATED HYDRAULIC CONDUCTIVITY OF FIRST SOIL LAYER  :
     $',E10.3,/,' FAC     :',E10.3,///)
      READ(11,*)  IRER,INL,ARER,BRER
      WRITE(20,1051) IRER,INL,ARER,BRER
1051  FORMAT(1X,'S I N K  T E R M  V A R I A B L E S',//,'     IRER',
     $2X,'INL',6X,'ARER',6X,'BRER',/,7X,I1,4X,I1,3X,2(1X,E9.3),/)
      READ(11,*)  RNAM,TB,TE
      WRITE(20,1052) RNAM,TB,TE
1052  FORMAT(1X,'    RNAM',7X,'TB',8X,'TE',/,F9.1,(2(6X,F4.0)),/)
      READ(11,*) P0,PU1,PL1,P2H,P2L,P2,P3
      READ(11,*) (L(I),I=1,8)
      CS1=CS1*FAC
      P0=-ABS(P0)
      PU1=-ABS(PU1)
      PL1=-ABS(PL1)
      P2H=-ABS(P2H)
      P2L=-ABS(P2L)
      P2=-ABS(P2)
      P3=-ABS(P3)
      IF (IRER.EQ.0) THEN
C
C ---    FEDDES
         WRITE(20,1053) P0,PU1,PL1,P2H,P2L,P3
1053     FORMAT(1X,'       P0          PU1         PL1         P2H         P2L',
```

```
     $   '         P3',/,6(1X,F9.0))
      ELSE
C
C ---    HOOGLAND
           WRITE(20,1055) P0,PU1,PL1,P2,P3
1055       FORMAT(1X,'       P0        PU1       PL1       P2          P3',
     $     /,5(1X,F9.0))
      END IF
      READ(11,*) TINIT,TEND,DTM,DTHM,CGWLAM
      IF (KOD(6).EQ.2.OR.KOD(8).EQ.1) READ(11,*)TCROP
      DTM=AMAX1(DTM,0.2)
      DTM=AMIN1(DTM,1.0)
      DTHM=AMAX1(DTHM,0.005)
      DTHM=AMIN1(DTHM,0.03)
      CGWLAM=AMIN1(3.,CGWLAM)
      CGWLAM=AMAX1(CGWLAM,0.1)
      IF(KOD(8).EQ.1) THEN
         READ(11,*)QINIT
         WRITE(20,1054)QINIT
1054     FORMAT(//,' INITIAL CROP DRY MATTER : ',F7.2,' KG/HA')
         QLEAVE=QINIT/3.0
         QTUBER=QINIT/3.0
         QTOT=QLEAVE+QTUBER
         QPOT=QTOT
C
         READ(11,*)(FSX(I),I=1,6)
         READ(11,*)(FSY(I),I=1,6)
         READ(11,*)(FTX(I),I=1,6)
         READ(11,*)(FTY(I),I=1,6)
         READ(11,*)AMAX,CVF,EPSFAC
         WRITE(20,1056)(FSX(I),I=1,6),(FSY(I),I=1,6),(FTX(I),I=1,6),
     *   (FTY(I),I=1,6),AMAX,CVF,EPSFAC
1056     FORMAT(///,' PRESCRIBED SOIL COVER DEPENDING ON DVS',/,
     *              ' -------------------------------------',/,
     *   ' DVS: ',6F7.2,/,' SC:  ',6F7.2,///,
     *   ' PART OF YIELD GOING TO TUBER:',/,
     *   ' ----------------------------',/,
     *   ' DVS: ',6F7.2,/,' FTY: ',6F7.2,///,
     *   ' CONSTANTS FOR CROP PRODUCTION:',/,
     *   ' ------------------------------',/,
     *   ' AMAX  =',F7.2,/,' CVF   =',F7.2,/,' EPSFAC=',F7.2,///)
      END IF
C
      READ(11,*) NPR
      IF(KOD(7).EQ.0) READ(11,*) (TPR(I),I=1,NPR)
      IF(KOD(7).NE.0) READ(11,*) TPRINT
C
      DX=ABS(DSP/NCS)
      DXH=0.5*DX
      IF(ISD.GT.NCS) ISD=NCS/2
C
C
      WRITE(20,1061) (L(I),I=1,8)
1061  FORMAT(1X,////,' L - ARRAY :',8I5,//)
      WRITE(20,1071) TINIT,TEND,DTM,DTHM,CGWLAM
1071  FORMAT(1X,'START OF CALCULATIONS :',F5.0,' DAYS',/,' END OF  CALCU
     $LATIONS   :',F5.0,' DAYS',/,' MAXIMUM TIME STEP      :',E10.3,
     $' DAYS',/,' MAXIMUM CHANGE OF MOISTURE CONTENT   :',E10.3,' CM**3/
     $CM**3',/,' MAXIMUM CHANGE OF GROUNDWATER LEVEL  :',E10.3,' CM',//)
C
      IF (KOD(6).EQ.2.OR.KOD(8).EQ.1) WRITE(20,1075)TCROP
1075  FORMAT(' CROP STARTS GROWING AT DAY: ',F6.1)
      RNAM=-ABS(RNAM)
      WRITE(20,1081) NPR
```

```
1081  FORMAT(1X,'NUMBER OF PRINTPLOTS :',I5)
      IF (KOD(7).NE.0) GOTO 1083
      WRITE(20,1082) (TPR(I),I=1,NPR)
1082  FORMAT(1X,'PRINTING INTERVALS (DAYS) :',10F5.0)
      GOTO 1085
1083  WRITE(20,1084) TPRINT
1084  FORMAT(1X,'PRINTING INTERVAL     :',F5.0,' DAYS')
1085  WRITE(20,6666)
      RNAM=-ABS(RNAM)
      KM(2)=L(3)
      L1=L(1)
      L2=L(2)
      DT=1.E-10
      DT1=DT
      T2=L(2)-1.
      TOUTP=TINIT+DT
      TMD=TINIT+1.
      IAD=TINIT+1
C
C --- IRRIGATION DATA
      IF (KOD(9).EQ.1) THEN
         READ(11,*) SIZE,TDIF,PHCRIT,NCRIT
         PHCRIT=-1.0*ABS(PHCRIT)
         WRITE(20,1087) NCRIT,PHCRIT,SIZE,TDIF
1087     FORMAT (//' IF PRESSURE HEAD IN NODAL POINT ',I2,' < ',F7.0,
     $   ' CM, IRRIGATION OF ',F4.1,' CM IS APPLIED.'/' MINIMAL TIMELAG',
     $   ' BETWEEN TWO SUCCESSIVE APPLICATIONS IS ',I2,' DAYS.')
      END IF
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C********* BOUNDARY CONDITIONS AT THE TOP OF THE SYSTEM ****************
C          -------- ---------- -- --- --- -- --- ------
      WRITE(20,10)
10    FORMAT(1H1,130('.'),/,' BOUNDARY CONDITIONS AT THE TOP :',/,
     $                      ' -------- --------- -- --- ---',/)
C
C # KOD(3)=0 #
      IF(KOD(3).NE.0) GOTO 100
      IF(KOD(4).EQ.0) GOTO 20
      READ(11,*) PREC(L1),ES(L1),EP(L1),PHS(L1)
      DO 30 I=L1,L2
         PREC(I)=ABS(PREC(L1))
         ES(I)=ABS(ES(L1))
         EP(I)=ABS(EP(L1))
         PHS(I)=-ABS(PHS(L1))
30    CONTINUE
      GOTO 40
C
20    READ(11,*) (PREC(I),ES(I),EP(I),PHS(I),I=L1,L2)
      DO 50 I=L1,L2
         PREC(I)=ABS(PREC(I))
         ES(I)=ABS(ES(I))
         EP(I)=ABS(EP(I))
50       PHS(I)=-ABS(PHS(I))
40    WRITE(20,60)
60    FORMAT(3(1X,' DAY',4X,'PREC',3X,'ESOIL',2X,'EPLANT',8X,'PHS',4X))
      LL=L2
      IF(KOD(4).EQ.1) LL=L1
      DO 70 I=L1,LL,3
       KM(1)=I
       KM(2)=I+1
       km(3)=i+2
       WRITE(20,80) (KM(J),PREC(I+J-1),ES(I+J-1),EP(I+J-1),PHS(I+J-1),
     $ J=1,3)
```

```
70    CONTINUE
80    FORMAT(3(1X,I4,3F8.3,E11.3,4X))
      GOTO 400
C
C # KOD(3)=1,2, OR 3 #
100   LL=L2
      IF(KOD(4).EQ.1) LL=L1
      IF(KOD(3).EQ.2) GOTO 102
      IF(KOD(3).EQ.3) GOTO 103
      READ(11,*) ALPHA
      IF (KOD(8).EQ.0) THEN
C ---    KOD(8)=0, KOD(3)=1
         READ(11,*) (PREC(I),HSH(I),TEM(I),RH(I),SC(I),I=L1,LL)
      ELSE
C ---    KOD(8)=1, KOD(3)=1
         DO 101 I=L1,LL
            READ(11,*) PREC(I),HSH(I),TEM(I),RH(I)
101      CONTINUE
         CALL SCCALC
      END IF
      WRITE(20,110)
110   FORMAT(//,2X,'DAY',2X,' PRECIPITATION',2X,'SH.RAD(J.CM^-2)',2X,
     $'   TEMPERATURE',2X,' REL. HUMIDITY',2X,'    SOIL COVER',/)
      GOTO 140
102   IF (KOD(8).EQ.0) THEN
C ---    KOD(8)=0, KOD(3)=2
         READ(11,*) (PREC(I),HSH(I),DCL(I),TEM(I),RH(I),U(I),CH(I),
     *   SC(I),I=L1,LL)
      ELSE
C ---    KOD(8)=1, KOD(3)=2
         DO 104 I=L1,LL
            READ(11,*) PREC(I),HSH(I),DCL(I),TEM(I),RH(I),U(I),CH(I)
104      CONTINUE
         CALL SCCALC
      END IF
      WRITE(20,120)
120   FORMAT(//,2X,'DAY',2X,' PRECIPITATION',2X,'     RADIATION',2X,
     $'    CLOUDINESS',2X,'   TEMPERATURE',2X,' REL. HUMIDITY',2X,
     $'WIND VELOCITY',2X,'    CROP COEFF',2X,'   SOIL COVER',/)
      GOTO 140
103   READ(11,*) RB,RM
      IF (KOD(8).EQ.0) THEN
C ---    KOD(8)=0, KOD(3)=3
         READ(11,*) (PREC(I),HNT(I),TEM(I),RH(I),U(I),CH(I),SC(I),
     $   I=L1,LL)
      ELSE
C ---    KOD(8)=1, KOD(3)=3
         DO 106 I=L1,LL
            READ(11,*) PREC(I),HNT(I),TEM(I),RH(I),U(I),CH(I)
106      CONTINUE
         CALL SCCALC
      END IF
      WRITE(20,130)
130   FORMAT(//,2X,'DAY',2X,' PRECIPITATION',2X,' NET RADIATION',2X,
     $'   TEMPERATURE',2X,' REL. HUMIDITY',2X,' WIND VELOCITY',2X,
     $'   CROP HEIGHT',2X,'   SOIL COVER',/)
      ISTP=0
140   DO 150 I=L1,L2
         TEM(I)=TEM(I)+273.15
         IF(KOD(4).EQ.0) GOTO 151
         PREC(I)=PREC(L1)
         HNT(I)=HNT(L1)
         TEM(I)=TEM(L1)
         RH(I)=RH(L1)
```

```
          U(I)=U(L1)
          SC(I)=SC(L1)
          CH(I)=CH(L1)
          DCL(I)=DCL(L1)
151       IF(ISTP.EQ.1) GOTO 150
          IF(KOD(3).EQ.1) WRITE(20,7) I,PREC(I),HSH(I),TEM(I),RH(I),
     *    SC(I)
          IF(KOD(3).EQ.2) WRITE(20,8) I,PREC(I),HSH(I),DCL(I),
     *    TEM(I),RH(I),U(I),CH(I),SC(I)
          IF(KOD(3).EQ.3) WRITE(20,9) I,PREC(I),HNT(I),TEM(I),RH(I),
     *    U(I),CH(I),SC(I)
          IF(KOD(4).EQ.1) ISTP=1
150    CONTINUE
C
       DO 312 I=L1,L2
          IF(KOD(3).EQ.3)THEN
C            NET TO SHORT (POTATOES)
             HSH(I)=(HNT(I)+4.0)/0.54
          ELSE
C            JOULE TO WATT
             HSH(I)=0.1157*HSH(I)
C            SHORT TO NET (POTATOES)
             HNT(I)=0.54*HSH(I)-4.0
          END IF
312    CONTINUE
C
       WRITE(20,6666)
       WRITE(20,170)
170    FORMAT(/,' THE FUNCTIONS OF G(CH), LAI(SC) AND  FIN(PREC,LAI)',/,
     $         ' --- --------- -- -----  ------- ---  -------------',/)
C
C********* READING AND PRINTING OF THE G(CH)-FUNCTION *****************
C          ------- --- -------- -- --- ----- --------
       IF(KOD(3).NE.3) GOTO 185
C      FGA,FGB,FGC,FGD,FGM,FMCH :          COEFFICIENTS OF G(CH)-FUNCTION
       IF(L(7).EQ.0) READ(11,*) FGA,FGB,FGC,FGD,FGM,FMCH
       WRITE(20,6666)
       WRITE(20,180) FGA,FGB,FMCH,FGC,FGD,FMCH,FGM
180    FORMAT(/1X,'G(CH)=',E10.3,' * (CH**',F6.3,24X,'FOR CH.GE.',F7.2,
     $' CM',/,' G(CH)=',E10.3,' * (CH**',F6.3,24X,'FOR CH.LT.',F7.2,
     $' CM',/,' MAXIMUM VALUE OF G(CH)=',E10.3,' CM',//)
C
C********* READING AND PRINTING OF THE LAI(SC)-FUNCTION ***************
C          ------- --- -------- -- --- ------- --------
C      FLA,FLB,FLC : COEFFICIENTS OF LAI-FUNCTION
185    READ(11,*) FLA,FLB,FLC
       WRITE(20,6666)
       WRITE(20,190) FLA,FLB,FLC
190    FORMAT(/1X,'LAI =',F6.3,' * SC + ',F6.3,' * SC**2 + ',F6.3,
     $' * SC**3',//)
C
C**************** READING AND PRINTING FIN(PREC,SC) FUNCTION ***********
C                 ------- --- -------- ------------ --------
C      FIA,FIB,FIC,FID,FMP,FMI : COEFFICIENTS OF INTERCEPTION FUNCTION
       IF (KOD(3).EQ.0) GOTO 195
       IF (L(8).EQ.0) READ(11,*) FIA,FIB,FIC,FID,FMP,FMI
       WRITE(20,6666)
       WRITE (20,200) FIA,FIB,FIC,FID,FMP,FMI,FMP
200    FORMAT(1X,'FIN(PREC,SC) = SC *',F6.3,' * PREC**(',F5.2,'-',F6.4,
     $' * (PREC-',F5.2,'))      FOR PREC.LT.',F5.2,' CM/DAY',/,
     $' FIN(PREC,SC) = SC *',F5.2,43X,' FOR PREC.GE.',F5.2,' CM/DAY',/)
C       WRITE(20,192)
C192    FORMAT(/1X,'INTERCEPTION FUNCTION ACC. HOYNINGEN - HUENE :'//
C      $1X,'FIN = -0.042 + 0.245*PREC + 0.02*LAI - 0.111*PREC**2 +',
```

```
C     $' 0.0271*PREC*LAI - 0.00109*LAI**2   (CM.)'//)
      WRITE(20,6666)
C
C********************* CALCULATION  OF : *****************************
C                       -----------  --
C      - EPOT - POTENTIAL EVAPOTRANSPIRATION(CM)
C      - ES   - SOIL EVAPORATION(CM/DAY)
C      - EP   - TRANSPIRATION(CM/DAY)
C      - SEP  - CUMULATIVE TRANSPIRATION(CM)
C      - SES  - CUMULATIVE SOIL EVAPORATION(CM)
C      - FIN  - FLUX OF INTERCEPTED WATER(CM/DAY)
C      - EV   - SATURATED WATER VAPOUR PRESSURE(MBAR)
C      - DEL  - SLOPE OF THE SATURATED VAPOUR PRESSURE CURVE(MBAR/K)
C      - VPD  - THE VAPOUR PRESSURE DEFICIT OF THE AIR(MBAR)
C      - PHS  - MINIMUM ALLOWED PRESSURE HEAD AT THE SOIL SURFACE(CM)
C
C
195   WRITE(20,210)
210   FORMAT(1H1,//,48X,'CALCULATION OF POTENTIAL EVAPOTRANSPIRATION',/)
C
      WRITE(20,220)
220   FORMAT(1X,//,50X,'POTENTIAL TRANSPIRATION RATE  (CM/DAY)',/)
      WRITE(20,230)
230   FORMAT(1X,'DATE  DAY  EPOT ESOIL EPLANT 0.0',7X,'0.2',7X,'0.4',7X
     $,'0.6',7X,'0.8',7X,'1.0',7X,'1.2',7X,'1.4',3X,'SEP',4X,'SES',5X
     2,'PHS',5X,'VPD')
      WRITE(20,240)
240   FORMAT(1X,30X,'+****+****+****+****+****+****+****+****+****+
     $****+****+****+****+')
      I=L(1)
      L4=L(4)
      LF=L(5)
      LE=L(6)
C
      DO 250 M=LF,LE
       I2=KM(M)
       DO 260 J=L4,I2
        WED=.0583*TEM(I)-2.1938
        EV=1.3332*EXP((1.08872*TEM(I)-276.4884)/WED)
        DEL=13.7315*EV/(WED**2)
        VPD(I)=(1.0-RH(I))*EV
        IF(PREC(I).LE.FMP) FINI=SC(I)*FIA*PREC(I)**(FIB-FIC*
     $  (PREC(I)-FID))
        IF(PREC(I).GT.FMP) FINI=SC(I)*FMI
        LAI=FLA*SC(I)+FLB*SC(I)**2+FLC*SC(I)**3
C
C ---   INTERCEPTION ACC. HOYNINGEN-HUENE
C        IF (PREC(I).GT.0.01.AND.LAI.GT.0.01) THEN
C           FINI=-0.042+0.245*PREC(I)+0.02*LAI-0.111*PREC(I)**2+
C     $     0.0271*PREC(I)*LAI-0.00109*LAI**2
C           FINI=AMAX1(FINI,0.0)
C        ELSE
C           FINI=0.0
C        END IF
C
        IF(KOD(3).NE.1) GO TO 261
        EPOT=0.00352*HNT(I)*ALPHA*DEL/(DEL+GAMMA)
        GOTO 265
261     IF(KOD(3).NE.2) GOTO 262
        HNT(I)=(1-.06)*HSH(I)-5.67E-8*TEM(I)**4*
     $  (.47-.067*SQRT(EV*RH(I)))*(1-.8*DCL(I))
        EPOT=.00352*CH(I)*(DEL*HNT(I)+GAMMA*28.368*
     $  .26*(.54*U(I)+.5)*VPD(I))/(DEL+GAMMA)
        GOTO 265
```

```
262     IF(CH(I).GE.FMCH) GCH=FGA*CH(I)**FGB
        IF(CH(I).LT.FMCH) GCH=FGC*CH(I)**FGD
        IF(GCH.GT.FGM)    GCH=FGM
        IF(GCH.LT.0.18E-7)GCH=0.18E-7
        RA=6.43E-6/(GCH*U(I)**.75)
        EWET=.00352*(DEL*HNT(I)+1210./RA*VPD(I))/(DEL+GAMMA)
C
C ---   RS DEPENDENT ON EWET
        BOT=0.7
        TOP=1.1
        IF (EWET.LT.BOT) THEN
           RS=RB
        ELSE IF (EWET.GT.TOP) THEN
           RS=RM
        ELSE
           RS=ALOG10(RB)+(EWET-BOT)/(TOP-BOT)*(ALOG10(RM)-ALOG10(RB))
           RS=10.0**RS
        END IF
        EPOT=((DEL+GAMMA)/(DEL+GAMMA*(1.+RS/RA)))*(EWET-FINI)
        IF (EPOT.LE.0.00001) EPOT=0.00001
265     FIN(I)=FINI
        PHS(I)=4708.0*TEM(I)*ALOG(RH(I))
        ES(I)=0.9*EXP(-0.6*LAI)*EPOT
        EP(I)=EPOT-ES(I)
        SEP=SEP+EP(I)
        SES=SES+ES(I)
        II=(EP(I)*50.+.5)
         DO 270 I3=1,69
          IF(II.GT.I3) IB(I3)=IMN
          IF(II.EQ.I3) IB(I3)=IPL
          IF(II.LT.I3) IB(I3)=IBL
270      CONTINUE
        WRITE(20,280) J,M,I,EPOT,ES(I),EP(I),IB,SEP,SES,PHS(I),VPD(I)
280     FORMAT(1X,I2,1X,I2,1X,I3,1X,F5.2,1X,F5.2,1X,F5.2,3X,1H+,
     $  69A1,1H+,1X,F6.2,1X,F6.2,1X,E9.3,1X,F5.1)
        IF(I.GE.L(2)) GOTO 300
        I=I+1
260    CONTINUE
       L4=1
250   CONTINUE
C
300   WRITE(20,240)
      WRITE(20,230)
      GOTO 400
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C**** READING AND PRINTING THE BOUNDARY CONDITION AT THE BOTTOM ********
C     ------- --- -------- --- -------- --------- -- --- ------
C
400   WRITE(20,6666)
      WRITE(20,401)
401   FORMAT(/,' BOUNDARY CONDITION AT BOTTOM OF SOIL PROFILE :',/,
     $          ' -------- --------- -- ------ -- ---- -------',//)
C***************** THE GROUNDWATER LEVEL IS GIVEN ******************
C                  --- ----------- ----- -- -----
      IF(KOD(1).NE.0) GOTO 410
      IF(KOD(2).EQ.0) GOTO 430
      READ(11,*) GWLA
      GWLA=-ABS(GWLA)
      WRITE(20,440) GWLA
440   FORMAT(1X,' THE GROUNDWATER LEVEL IS CONSTANT AT',F7.1,' CM')
      GOTO 700
430   READ(11,*) (GWL(I),I=L1,L2)
      DO 435 I=1,366
```

```
435   GWL(I)=-ABS(GWL(I))
      IT=TINIT+1
      GWLA=GWL(IT)
      WRITE(20,450)
450   FORMAT(1X,' THE GROUNDWATER LEVEL IS GIVEN',///,
     $5(11X,'DAY',5X,'LEVEL'),/)
      GOTO 500
C
C
C**** THE FLUX OF WATER THROUGH THE BOTTOM OF THE SOIL PROFILE IS GIVEN
C     --- ---- -- ----- ------- --- ------ -- --- ---- ------- -- -----
410   IF(KOD(1).NE.1) GOTO 460
      READ(11,*) GWLA
      GWLA=-ABS(GWLA)
      IF(KOD(2).EQ.0) GOTO 470
      READ(11,*) QDEEPA
      WRITE(20,480) QDEEPA
480   FORMAT(1X,' THE FLUX OF WATER THROUGH THE BOTTOM IS CONSTANT :',
     $F8.1,' CM/DAY',//)
      GOTO 700
470   READ(11,*) (QDEEP(I),I=L1,L2)
      QDEEPA=QDEEP(L1)
      WRITE(20,490)
490   FORMAT(1X,' THE FLUX OF WATER THROUGH THE BOTTOM IS GIVEN :',
     $///,5(11X,3HDAY,5X,5HDEPTH),/)
500   DO 510 I=L1,L2,5
         DO 520 J=1,5
            LC1(J)=I-1+J
            IF(LC1(J).EQ.L(2)) GOTO 530
520      CONTINUE
530   WRITE(20,5) (LC1(IL),GWL(I+IL-1),IL=1,5)
510   CONTINUE
      GOTO 700
C
C************ FLUX TOWARDS DITCHES AND DEEP PERCOLATION ****************
C             ---- ------- ------- --- ---- -----------
460   IF(KOD(1).NE.2) GOTO 540
      WRITE(20,550)
550   FORMAT(1X,'FLUX TOWARDS DITCHES AND DEEP PERCOLATION',///)
      READ(11,*) GWLA
      GWLA=-ABS(GWLA)
      READ(11,*)CHND,CHNR,DKD,ALPHAR,DGRWL,SIMPR
C
      DGRWL=-ABS(DGRWL)
      WRITE(20,560) CHND,CHNR,DKD,ALPHAR,DGRWL,SIMPR
560   FORMAT(1X,
     $'DISTANCE BETWEEN THE CHANNELS          :',F12.0,'  M',/
     $,' RADIAL RESISTANCE OF THE CHANNEL      :',E12.3,'  DAY/M',/
     $,' TRANSMISSIVITY (SATURATED FLOW)       :',E12.4,'  M**2/DAY',/
     $,' REDUCTION COEFFICIENT (ALPHAR)        :',F12.3,/
     $,' DEEP GROUNDWATER LEVEL                :',F12.0,'  CM',/
     $,' RESISTANCE OF SEMI-IMPERMEABLE LAYER :',F12.0,'  DAY',///)
      IF(KOD(2).EQ.0) GOTO 561
      READ(11,*) CHNL
      CHNL=-ABS(CHNL)
      WRITE(20,565) CHNL
565   FORMAT(1X,'THE WATER LEVEL IN  THE CHANNELS IS CONSTANT :',
     $F10.1,'CM',/)
      GOTO 700
561   READ(11,*) (GWL(I),I=L1,L2)
      DO 566 I=L1,L2
566   GWL(I)=-ABS(GWL(I))
      WRITE(20,567)
567   FORMAT(1X,//,'THE WATER LEVEL IN THE CHANNELS IS GIVEN :',///,
```

```
     $5(11X,'DAY',4X,' LEVEL'))
      GOTO 500
C
C************* FLUX-GROUNDWATER LEVEL RELATIONSHIP ********************
C             ---- ----------- ----- ------------
540   IF(KOD(1).NE.3) GOTO 545
      WRITE(20,541)
541   FORMAT(1X,'FLUX-GROUNDWATER LEVEL RELATIONSHIP',/)
      READ(11,*) GWla,icod
      GWLA=-ABS(GWLA)
      jjjj=0
      if(icod.eq.0) write(20,539)
539     format(' Assume one unique relationship')
        if(icod.eq.1) go to 543
      READ(11,*) AREL,BREL
      WRITE(20,542) AREL,BREL
542   FORMAT(1X,'FLUX =',E10.3,' * EXP(',E10.3,' * ABS(GROUNDWATER  LEVE
     $L))   (CM/DAY)',/,
     $' IN PROGRAM : QDEEPA = AREL * EXP(BREL * ABS(GWLA))')
      GOTO 700
543     read(11,*) arel,brel,scalm,scals,idicod
547      jjjj=jjjj+1
      coef=scalm+(scals*snd(jjjj,3))
        scq=idicod*(10**coef) + (1-idicod)*coef
        if(scq.le.0.08) go to 547
        write(20,544) scq,arel,brel,idicod,scalm,scals
544       format(1x,' random distribution q(h)-relation',//,
     * ' flux=(1/',f6.3,')**2[',e10.3,' *EXP(',e10.3,
     * '*ABS(groundwater level))]',
     * ' (cm/day)',/,' distribution code =',i5,' (0=normal, 1=lognormal',
     * ' distribution)',/,' mean and standard deviation scale factor,',
     *  'resp.',2f10.4)
c  next segment calculates initial groundwater level from
c  scale factor value .......
c
        qq=-arel*exp(brel*abs(gwla))
        al=alog(qq) - alog(-arel/(scq**2))
        gwla1=-(al/brel)
        if(gwla1.gt.-30.0) gwla1=-31.0
       if(gwla1.le.-150) gwla1=-149.0
       gwla=gwla1
        write(20,546) gwla
546     format(' Groundwater level at start of simulation',
     *          '= ',f10.4,' cm')
       arel=arel/(scq**2)
         go to 700
C
C********** PRESSURE HEAD OF LOWEST COMPARTMENT IS GIVEN ***************
C            -------- ---- -- ------ ----------- -- -----
545   IF(KOD(1).NE.4) GOTO 570
      IF(KOD(2).EQ.0) GOTO 580
      READ(11,*) GPRHA
      GPRHA=-ABS(GPRHA)
      WRITE(20,590) GPRHA
590   FORMAT(1X,'THE PRESSURE HEAD OF THE BOTTOM COMPARTMENT IS CONSTANT
     $:',E10.3,' CM',/)
      GOTO 700
580   READ(11,*) (GPRH(I),I=L1,L2)
      DO 585 I=1,366
585   GPRH(I)=-ABS(GPRH(I))
      GPRHA=GPRH(L1)
      WRITE(20,600)
600   FORMAT(1X,' THE PRESSURE HEAD OF THE BOTTOM COMPARTMENT IS GIVEN',
     $///,5(11X,'DAY',3X,'PR.HEAD'),/)
```

```
      GOTO 500
C
C******* ZERO FLUX AT THE BOTTOM OF AN UNSATURATED SOIL PROFILE ********
C        ---- ---- -- --- ------ -- -- ----------- ---- -------
570   IF (KOD(1).NE.5) GOTO 610
      WRITE(20,620)
620   FORMAT(1X,'ZERO FLUX AT THE BOTTOM OF THE SOIL PROFILE')
      GOTO 700
C
C********************** FREE DRAINAGE **********************************
C                       ---- --------
C
610   WRITE(20,630)
630   FORMAT(1X,' FREE DRAINAGE AT THE BOTTOM OF THE SOIL PROFILE')
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C************ READING AND PRINTING THE ROOTING DEPTH ******************
C             ------- --- -------- --- ------- -----
700   WRITE(20,6666)
      IF(KOD(6).EQ.1) THEN
         READ(11,*) DRZA
         DRZA=-ABS(DRZA)
         WRITE(20,760) DRZA
760      FORMAT(/,' THE ROOTING DEPTH IS CONSTANT =',F6.1,' CM',/,
     $          ' --- ------- ----- -- --------')
      ELSE
         IF(KOD(6).EQ.2) THEN
            READ(11,*) DRZMAX,DAYMAX
            DO 705 I=1,366
               T=I*1.0
               IF (T.GT.TCROP-0.5.AND.T.LT.TEND+0.1) THEN
                   IF (T.LT.(TCROP+DAYMAX)) THEN
                      DRZ(I)=-1.0*(T-TCROP+0.5)*ABS(DRZMAX)/DAYMAX
                   ELSE
                      DRZ(I)=-1.0*ABS(DRZMAX)
                   END IF
               ELSE
                   DRZ(I)=0.0
               END IF
705         CONTINUE
         ELSE
C ---       KOD(6)=0
            READ(11,*)(DRZ(I),I=L1,L2)
            DO 710 I=1,366
               DRZ(I)=-1.0*ABS(DRZ(I))
710         CONTINUE
         END IF
         WRITE(20,720)
720      FORMAT(' TABLE OF ROOTING DEPTH :',/,
     $          ' ----- -- ------- -----',//,5(11X,'DAY',5X,'DEPTH'),/)
C
         DO 730 I=L1,L2,5
            DO 740 J=1,5
               LC1(J)=I-1+J
               IF(LC1(J).EQ.L(2)) GOTO 750
740         CONTINUE
750         WRITE(20,5) (LC1(IL),DRZ(I+IL-1),IL=1,5)
730      CONTINUE
      END IF
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C************* READING AND PRINTING THE INITIAL CONDITION *************
C              ------- --- -------- --- ------- ---------
800   WRITE(20,6666)
```

```
      WRITE(20,810)
810   FORMAT(/,' INITIAL CONDITION :',/,
     $        ' ------- ---------',/)
C
820   FORMAT(1X,'+++++ WATER CONTENT PROFILE IS GIVEN +++++',/)
830   FORMAT(1X,'+++++ PRESSURE HEAD PROFILE IS GIVEN +++++',/)
840   FORMAT(1X,'+++++ PRESSURE HEAD PROFILE IS CALCULATED(EQUILIBRIUM
     $WITH GROUNDWATER LEVEL) +++++',/)
C
      IF(KOD(5).EQ.2) GOTO 860
      IF(KOD(5).EQ.1) GOTO 850
C
C# WATER CONTENT PROFILE IS GIVEN #
      READ(11,*) (WC(I),I-1,NCS)
      IF(KOD(1).GT.3) GOTO 845
      N1--GWLA/DX+1.499999
      DO 846 I-N1,NCS
846   WC(I)=SWCA(I)
845   WRITE(20,820)
      WRITE(20,6) (WC(I),I-1,NCS)
      GOTO 880
C
C# PRESSURE HEAD PROFILE IS GIVEN #
850   READ(11,*) (PH(I),I-1,NCS)
      IF(KOD(1).GT.3) GOTO 855
      N1--GWLA/DX+1.499999
      DO 856 I-N1,NCS
856   PH(I)=0.0
855   DO 857 I=1,NCS
857   PH(I)=-ABS(PH(I))
      WRITE(20,830)
      WRITE(20,6) (PH(I),I-1,NCS)
      GOTO 880
C
C# PRESSURE HEAD PROFILE IS CALCULATED #
860   N=-GWLA/DX+.499999
      PH(N)=-0.5*(-GWLA-(N-1)*DX)
      JJ=N-1
      DO 865 J=1,JJ
865   PH(J)=GWLA+(J-0.5)*DX
      JJ=N+1
      DO 870 J=JJ,NCS
870   PH(J)=0.0
      WRITE(20,840)
      WRITE(20,6) (PH(I),I-1,NCS)
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C********* READING AND PRINTING THE SOIL HYDRAULIC PARAMETERS **********
C          ------- --- -------- --- ---- --------- ----------
C
880   WRITE(20,6666)
      WRITE(20,890)
890   FORMAT(1H1)
      WRITE(20,6666)
900   FORMAT(/,'  mean soil hydraulic properties OF SOIL LAYER NR :',I4,
     $//,((1X,'THETA',5X,'PR.HEAD',4X,'CONDUC',4X)),/,
     $((13X,'CM',7X,'CM/DAY',4X)),/)
910   FORMAT(1X,F5.2,2X,(2E10.3))
C
      do 925 j-1,npl
        ir-ifix(100*swc(j))
        write(20,900) j
      DO 920 I-1,ir
      th-i/100.0
```

```
        if(j.eq.2.and.th.lt.0.20) go to 920
        tn=(th-ttr(j))/(swc(j)-ttr(j))
        em=1 - (1.0/ten(j))
        a1=tn**(-1.0/em) -1.0
        a2=a1**(1.0/ten(j))
        prh(j,i)=-a2/tal(j)
c
        b1=(1-tn**(1.0/em))**(em)
        b2=(1-b1)**2
        b3=b2*tn**0.5
        con(j,i)=b3*fac*tks(j)
        write(20,910) th,prh(j,i),con(j,i)
920     continue
c
925     continue
C
C#CONTINUATION OF INITIAL CALCULATIONS#
      N=-GWLA/DX+.499999
      DXN=DX
      IF(KOD(1).LT.4) DXN=-GWLA-(N-1)*DX
      DXG=0.5*(DX+DXN)
      IF(KOD(1).GT.3) GWLA=0.0
      IF(KOD(1).GT.3) N=NCS
      IF(KOD(5).EQ.0) CALL HEPR (PH,WC)
      VOL=0.0
      CALL WACO(WC,PH)
      VOLI=VOL
      VOLIR=0.0
      VISD=0.0
      DO 2600 I=1,ISD
         VOLIR=VOLIR+WC(I)*DX
         VISD=VISD+WC(I)*DX
2600  CONTINUE
      VISD1=VISD
C
C
C#REDUCTION OF POTENTIAL SOIL EVAPORATION#
      TBV=1.
      IF(PH(1).LT.-100.) TBV=5.
      ESR(L1)=AMIN1(ES(L1),AVALUE*(SQRT(TBV)-SQRT(TBV-1.)))
      L11=L1+1
C
      DO 3010 I=L11,L2
      TBV=TBV+1.
      IF(PREC(I).GT.1.0) GOTO 3000
      ESR(I)=AMIN1(ES(I),(AVALUE*(SQRT(TBV)-SQRT(TBV-1.))))
      GOTO 3010
3000  TBV=1.
      ESR(I)=AMIN1(ES(I),AVALUE)
3010  CONTINUE
C
C#COMPUTING THE COORDINATES OF NODAL POINTS#
      DO 1100 J=1,NCS
         X(J)=-DX*(J-0.5)
1100  CONTINUE
C
C#CALCULATION OF BOUNDARY CONDITIONS (T=TINIT)#
      CALL BOCO(TINIT,PH,WC)
C#CALCULATION OF DIF. MOIST. CAPACITIES AND HYDR. CONDUCTIVITIES
      CALL DMCCON(WC,ph)
C#CALCULATION OF ROOT EXTRACTION RATES#
      CALL RER(T,PH)
C#CALCULATION OF FLUXES IN BETWEEN THE NODAL POINTS#
      CALL FLUXES(PH)
```

```
C
      IF(KOD(1).LT.5) CFLBU=0.0
      IF(KOD(1).LT.5) CFLBUP=0.0
      IF(KOD(1).EQ.0.OR.KOD(1).GT.3) CQDP=0.0
      IF(KOD(1).EQ.0.OR.KOD(1).GT.3) CQD=0.0
      IF(KOD(1).GT.0.AND.KOD(1).LT.4) CDEL=0.0
C
      IF(KOD(1).GT.0.AND.KOD(1).LT.4) CDELP=0.0
C
1      FORMAT(8E10.4)
2      FORMAT(4E10.4)
3      FORMAT(5E10.4)
4      FORMAT(7E10.4)
5     FORMAT(5(I14,F10.1))
6     FORMAT(5(2X,E12.4))
7     FORMAT(I5,F13.2,F16.1,F16.1,F16.3,F16.3)
8     FORMAT(I5,F13.2,F16.1,F16.3,F16.1,F16.3,F16.3,F16.2,F16.3)
9     FORMAT(I5,F13.2,(2(F16.1)),F16.3,F16.1,F16.2,F16.3)
6666  FORMAT(1X,130('.'))
C
c       close(unit=20)
      CLOSE(UNIT=11)
      RETURN
      END
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
      SUBROUTINE WACO(WC,PH)
C     SUBROUTINE WACO :  CALCULATES THE WATER CONTENTS AT THE NODAL
C                        POINTS FROM PRESSURE HEAD DATA AND WATER
C                        STORAGE IN THE SOIL PROFILE
      DIMENSION PH(100),WC(100)
      COMMON/INTRS/ IAD,N,NPL,NCS,IRZ,IRER,INL,IPRT,ISD,NPR,
     $LV(10),MV(10),NC(10),KOD(10),L(8),LC1(5),ICOD,IDICOD
      COMMON/REALS/ VISD,VISD1,TEM(366),GPRH(366),SC(366),QDEEP(366),
     $P0,PU1,PL1,P2H,P2L,P2,P3,RNAM,CGWLAM,DSP,DX,DXG,DXH,DXN,CS1,ESRA,
     $FAC,DT,DT1,DTI,DTM,DTHM,TINIT,TEND,TPRINT,TOUTP,TMD,T2,TB,TE,
     $VOL1,VOLI,VOL,FINA,GWLA,DRZA,GPRHA,QDEEPA,ESA,EPA,PHSA,PRECA,FLXA,
     $ARER,BRER,AREL,BREL,FLX1,CHNL,CHND,CHNR,DKD,ALPHAR,DGRWL,SIMPR,
     $TPR(52),PREC(366),FIN(366),PHS(366),EP(366),ES(366),DRZ(366),
     $HNT(366),HSH(366),X(100),PRH(10,81),CON(10,81),CONDUC(101),
     $conin(101),SCALM,SCALS,SND(100,3),
     $DMCAP(100),RTEX(100),FLXS(101),THETA(4),SWC(10),SWCA(100),
     $ttr(10),tal(10),ten(10),tks(10),TLA(100),
     $DOUTP(366,13),ESR(366),GWL(366),VPD(366),VOLIR
C
c       write(6,1)
1      format(' waco')
      NLA=1
      NNL=NC(1)
      DO 10 I=1,NCS
       IF(I.LE.NNL) GOTO 20
       NLA=NLA+1
       NNL=NC(NLA)
20     al=1+(tal(nla)*abs(ph(i)*TLA(i)))**ten(nla)
         em = 1 - (1.0/ten(nla))
         wc(i)=(swca(i)-ttr(nla))*(al**-em) + ttr(nla)
         if (ph(i).ge.0.00) wc(i)=swca(i)
10    CONTINUE
C
      VOL1=VOL
      VOL=0.0
      DO 360 I=1,NCS
         VOL=VOL+WC(I)*DX
360   CONTINUE
```

```
      IF(KOD(1).LT.4) VOL=VOL+(N*DX+GWLA)*(SWCA(N+1)-WC(N))
C
      RETURN
      END
C
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
       subroutine boco(t,ph,wc)
C     SUBROUTINE BOCO : DETERMINES THE VALUES OF THE BOUNDARY CONDITIONS
C                       AT ANY STAGE OF COMPUTATION
      DIMENSION PH(100),WC(100)
C
      REAL LAI
C
      COMMON/INTRS/ IAD,N,NPL,NCS,IRZ,IRER,INL,IPRT,ISD,NPR,
     $LV(10),MV(10),NC(10),KOD(10),L(8),LC1(5),ICOD,IDICOD
      COMMON/REALS/ VISD,VISD1,TEM(366),GPRH(366),SC(366),QDEEP(366),
     $P0,PU1,PL1,P2H,P2L,P2,P3,RNAM,CGWLAM,DSP,DX,DXG,DXH,DXN,CS1,ESRA,
     $FAC,DT,DT1,DTI,DTM,DTHM,TINIT,TEND,TPRINT,TOUTP,TMD,T2,TB,TE,
     $VOL1,VOLI,VOL,FINA,GWLA,DRZA,GPRHA,QDEEPA,ESA,EPA,PHSA,PRECA,FLXA,
     $ARER,BRER,AREL,BREL,FLX1,CHNL,CHND,CHNR,DKD,ALPHAR,DGRWL,SIMPR,
     $TPR(52),PREC(366),FIN(366),PHS(366),EP(366),ES(366),DRZ(366),
     $HNT(366),HSH(366),X(100),PRH(10,81),CON(10,81),CONDUC(101),
     $conin(101),SCALM,SCALS,SND(100,3),
     $DMCAP(100),RTEX(100),FLXS(101),THETA(4),SWC(10),SWCA(100),
     $ttr(10),tal(10),ten(10),tks(10),TLA(100),
     $DOUTP(366,13),ESR(366),GWL(366),VPD(366),VOLIR
      COMMON/CUM/ CPREC,CINTC,CINF,CPTRA,CPSEV,CTRA,CTRA1,CTRA2,CSEV,
     $CSEV2,CFLSD,CFLSDP,CFLBU,CQD,CQDP,CQDN,CDEL,CDELP,DEL,DVOL,
     $CRTEX(100)
      COMMON/CROP/FSX(6),FSY(6),FTX(6),FTY(6),TWOPI,HALFPI,DVS,LAI,
     *FACLAI,EPSFAC,CVF,AMAX,QINIT,QPOT,QTOT,QLEAVE,QTUBER,TCROP,
     *FLA,FLB,FLC
C
c       write(6,1)
1         format(' boco')
      IF(T.GT.T2) GOTO 100
C
      M=T+1
      TA=T+1-M
      EPA=EP(M)
      ESA=ES(M)
      ESRA=ESR(M)
      PRECA=PREC(M)
      FINA=FIN(M)
      PHSA=PHS(M)
      FLXA=ESRA-(PRECA-FINA)
      IF(FLXA.LT.0.0) PHSA=0.0
      IF(KOD(6).NE.1) DRZA=DRZ(M)+TA*(DRZ(M+1)-DRZ(M))
C
      IF(KOD(1).NE.0) GOTO 10
      IF(KOD(2).NE.0) GOTO 100
      GWLA=GWL(M)+TA*(GWL(M+1)-GWL(M))
      GOTO 50
C
10    IF(KOD(1).NE.1) GOTO 20
      IF(KOD(2).EQ.0) QDEEPA=QDEEP(M)
      GOTO 100
C
20    IF(KOD(1).NE.2) GOTO 30
      IF(KOD(2).EQ.0) CHNL=GWL(M)+TA*(GWL(M+1)-GWL(M))
      QDEEP1=(CHNL-GWLA)/(CHND*CHNR+(CHND**2)/(8.0*DKD))
      QDEEP2=-(CHNL+ALPHAR*(GWLA-CHNL)-DGRWL)/SIMPR
      QDEEPA=QDEEP1+QDEEP2
```

```
      GOTO 100
C
30    IF(KOD(1).NE.3) GOTO 40
      QDEEPA=AREL*EXP(BREL*ABS(GWLA))
c      type *,arel,qdeepa
      GOTO 100
C
40    IF(KOD(1).NE.4) GOTO 100
      IF(KOD(2).EQ.0) GPRHA=GPRH(M)+TA*(GPRH(M+1)-GPRH(M))
      GOTO 100
C
50    N=-GWLA/DX+0.499999
      DXN=-GWLA-(N-1)*DX
      DXG=0.5*(DX+DXN)
      PH(N)=-DXN/2.
      PH(N+1)=0.0
      NLA=0
60    NLA=NLA+1
      IF(N.GT.NC(NLA)) GOTO 60
       al=1+(tal(nla)*abs(ph(n)*TLA(N)))**ten(nla)
         em=1-(1.0/ten(nla))
         wc(n)=(swca(n)-ttr(nla))*(al**-em) + ttr(nla)
80    WC(N+1)=SWCA(N+1)
C
100   RETURN
      END
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
      SUBROUTINE HEPR(PH,WC)
C     SUBROUTINE HEPR :  CALCULATES THE PRESSURE HEADS FOR EACH NODAL
C                        POINT WHEN THE INITIAL CONDITION IS GIVEN AS
C                        VALUES OF MOISTURE CONTENT           [KOD(5)=0]
      DIMENSION WC(100),PH(100)
      COMMON/INTRS/ IAD,N,NPL,NCS,IRZ,IRER,INL,IPRT,ISD,NPR,
     $LV(10),MV(10),NC(10),KOD(10),L(8),LC1(5),ICOD,IDICOD
      COMMON/REALS/ VISD,VISD1,TEM(366),GPRH(366),SC(366),QDEEP(366),
     $PO,PU1,PL1,P2H,P2L,P2,P3,RNAM,CGWLAM,DSP,DX,DXG,DXH,DXN,CS1,ESRA,
     $FAC,DT,DT1,DTI,DTM,DTHM,TINIT,TEND,TPRINT,TOUTP,TMD,T2,TB,TE,
     $VOL1,VOLI,VOL,FINA,GWLA,DRZA,GPRHA,QDEEPA,ESA,EPA,PHSA,PRECA,FLXA,
     $ARER,BRER,AREL,BREL,FLX1,CHNL,CHND,CHNR,DKD,ALPHAR,DGRWL,SIMPR,
     $TPR(52),PREC(366),FIN(366),PHS(366),EP(366),ES(366),DRZ(366),
     $HNT(366),HSH(366),X(100),PRH(10,81),CON(10,81),CONDUC(101),
     $conin(101),SCALM,SCALS,SND(100,3),
     $DMCAP(100),RTEX(100),FLXS(101),THETA(4),SWC(10),SWCA(100),
     $ttr(10),tal(10),ten(10),tks(10),TLA(100),
     $DOUTP(366,13),ESR(366),GWL(366),VPD(366),VOLIR
C
c        write(6,1)
1        format(' hepr')
      NLA=1
      NNL=NC(1)
C
      DO 10 I=1,NCS
         IF(I.LE.NNL) GOTO 20
         NLA=NLA+1
         NNL=NC(NLA)
20     em = 1 - (1.0/ten(nla))
       if(wc(i).le.0.01) wc(i)=0.01
         r1=(wc(i)-ttr(nla))/(swca(i)-ttr(nla))
         al=(r1**(-1.0/em)-1)**(1.0/ten(nla))
         ph(i)=(-al/tal(nla))/TLA(i)
10    CONTINUE
C
      RETURN
```

```
      END
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
      SUBROUTINE DMCCON(WC,ph)
C     SUBROUTINE DMC :  CALCULATES THE DIFFERENTIAL MOISTURE CAPACITIES
C                       AND HYDRAULIC CONDUCTIVITIES (AS A FUNCTION OF
C                       WATER CONTENT) FOR EACH NODAL POINT
      DIMENSION WC(100),ph(100)
      COMMON/INTRS/ IAD,N,NPL,NCS,IRZ,IRER,INL,IPRT,ISD,NPR,
     $LV(10),MV(10),NC(10),KOD(10),L(8),LC1(5),ICOD,IDICOD
      COMMON/REALS/ VISD,VISD1,TEM(366),GPRH(366),SC(366),QDEEP(366),
     $P0,PU1,PL1,P2H,P2L,P2,P3,RNAM,CGWLAM,DSP,DX,DXG,DXH,DXN,CS1,ESRA,
     $FAC,DT,DT1,DTI,DTM,DTHM,TINIT,TEND,TPRINT,TOUTP,TMD,T2,TB,TE,
     $VOL1,VOLI,VOL,FINA,GWLA,DRZA,GPRHA,QDEEPA,ESA,EPA,PHSA,PRECA,FLXA,
     $ARER,BRER,AREL,BREL,FLX1,CHNL,CHND,CHNR,DKD,ALPHAR,DGRWL,SIMPR,
     $TPR(52),PREC(366),FIN(366),PHS(366),EP(366),ES(366),DRZ(366),
     $HNT(366),HSH(366),X(100),PRH(10,81),CON(10,81),CONDUC(101),
     $conin(101),SCALM,SCALS,SND(100,3),
     $DMCAP(100),RTEX(100),FLXS(101),THETA(4),SWC(10),SWCA(100),
     $ttr(10),tal(10),ten(10),tks(10),TLA(100),
     $DOUTP(366,13),ESR(366),GWL(366),VPD(366),VOLIR
C
c         write(6,1)
1          format(' dmccon')
      CSURF=CS1
      IF(PHSA.GE.0.0) GOTO 20
       em=1-(1.0/ten(1))
        tn=(1+(tal(1)*abs(phsa*TLA(1)))**ten(1))**(-em)
        b1=(1-tn**(1.0/em))**em
        b2=(1-b1)**2
        b3=b2*tn**0.5
        csurf=fac*tks(1)*b3*TLA(1)*TLA(1)
C
20    NLA=1
      NNL=NC(1)
C
      DO 30 I=1,NCS
         IF(I.LE.NNL) GOTO 40
         NLA=NLA+1
         NNL=NC(NLA)
40     em=1-(1.0/ten(nla))
        q1=(1.0+(tal(nla)*abs(ph(i)*TLA(i)))**ten(nla))**(-em-1.0)
        q2=ten(nla)*(tal(nla)**ten(nla))
        Q2=Q2*(abs(ph(i)*TLA(i))**(ten(nla)-1))
        dmcap(i)=(swca(i)-ttr(nla))*em*q1*q2*TLA(i)
c
        if(wc(i).le.0.01) wc(i)=0.01
        tn=(wc(i)-ttr(nla))/(swca(i)-ttr(nla))
        b1=(1-tn**(1.0/em))**em
        b2=(1-b1)**2
        b3=b2*tn**0.5
        conduc(i)=fac*b3*tks(nla)*TLA(i)*TLA(i)
30    CONTINUE
C
      CONIN(1)=SQRT(CSURF*CONDUC(1))
C
      DO 50 I=2,NCS
         CONIN(I)=SQRT(CONDUC(I)*CONDUC(I-1))
50    CONTINUE
C
      CONIN(N+1)=SQRT(CONDUC(N+1)*CONDUC(N))
C
      RETURN
      END
```

```
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
      SUBROUTINE RER(T,PH)
C     SUBROUTINE RER : CALCULATES THE ROOT EXTRACTION RATES (AS A
C                      FUNCTION OF PRESSURE HEAD) FOR EACH NODAL
C                      POINT (IF ROOTS ARE PRESENT)
      DIMENSION PH(100)
      COMMON/INTRS/ IAD,N,NPL,NCS,IRZ,IRER,INL,IPRT,ISD,NPR,
     $LV(10),MV(10),NC(10),KOD(10),L(8),LC1(5),ICOD,IDICOD
      COMMON/REALS/ VISD,VISD1,TEM(366),GPRH(366),SC(366),QDEEP(366),
     $P0,PU1,PL1,P2H,P2L,P2,P3,RNAM,CGWLAM,DSP,DX,DXG,DXH,DXN,CS1,ESRA,
     $FAC,DT,DT1,DTI,DTM,DTHM,TINIT,TEND,TPRINT,TOUTP,TMD,T2,TB,TE,
     $VOL1,VOLI,VOL,FINA,GWLA,DRZA,GPRHA,QDEEPA,ESA,EPA,PHSA,PRECA,FLXA,
     $ARER,BRER,AREL,BREL,FLX1,CHNL,CHND,CHNR,DKD,ALPHAR,DGRWL,SIMPR,
     $TPR(52),PREC(366),FIN(366),PHS(366),EP(366),ES(366),DRZ(366),
     $HNT(366),HSH(366),X(100),PRH(10,81),CON(10,81),CONDUC(101),
     $conin(101),SCALM,SCALS,SND(100,3),
     $DMCAP(100),RTEX(100),FLXS(101),THETA(4),SWC(10),SWCA(100),
     $ttr(10),tal(10),ten(10),tks(10),TLA(100),
     $DOUTP(366,13),ESR(366),GWL(366),VPD(366),VOLIR
      COMMON/CUM/ CPREC,CINTC,CINF,CPTRA,CPSEV,CTRA,CTRA1,CTRA2,CSEV,
     $CSEV2,CFLSD,CFLSDP,CFLBU,CQD,CQDP,CQDN,CDEL,CDELP,DEL,DVOL,
     $CRTEX(100)
C
c        write(6,1)
1          format(' rer')
      RNA=0.0
      IF(T.GE.TE) GOTO 10
      IF(T.GT.TB) RNA=RNAM*(T-TB)/(TE-TB)
      GOTO 20
10    RNA=RNAM
20    QM=0.0
      IF(RNA-DRZA.GT.0.0) QM=EPA/(RNA-DRZA)
      IF(IRER.eq.1) QM=1.
      IRZ=-DRZA/DX+.99999
        IP=IRZ-1
       if(irer.eq.2) goto 300
      P1=PU1
      IF(IRER.EQ.1) GOTO 25
      P2=P2H
      IF(EPA.LT.0.1) GOTO 21
      IF(EPA.GT.0.5) GOTO 25
      P2=P2H+((0.5-EPA)/0.4)*(P2L-P2H)
      GOTO 25
21    P2=P2L
25    DO 30 I=1,IRZ
         RTEX(I)=0.0
         IF(PH(I).LE.P3.OR.PH(I).GE.P0) GOTO 30
         IF(PH(I).LE.P2) GOTO 40
         RTEX(I)=QM
         IF(I.GT.NC(1)) P1=PL1
         IF(PH(I).GT.P1) RTEX(I)=QM*(P0-PH(I))/(P0-P1)
         GOTO 30
40       IF(INL.EQ.0) RTEX(I)=QM*(P3-PH(I))/(P3-P2)
         IF(INL.NE.0) RTEX(I)=QM*(P2/PH(I))
30    CONTINUE
C
C***************** EXTRACTION PATTERN FEDDES,KOWALIK,ZARADNY ***********
      IF(IRER.NE.0) GOTO 100
      IF(RNA.EQ.0.0) GOTO 50
      IF(-RNA.GT.DX) RTEX(1)=0.0
      IF(-RNA.LT.DX) RTEX(1)=RTEX(1)*(DX+RNA)/DX
C
C
```

```
      DO 60 J=2,IP
         IF(-RNA.LT.(J-1)*DX) GOTO 50
         IF(-RNA.GT.J*DX) RTEX(J)=0.0
         IF(-RNA-(J-1)*DX.LT.DX) RTEX(J)=RTEX(J)*(J*DX+RNA)/DX
60    CONTINUE
C
50    RTEX(IRZ)=RTEX(IRZ)*(-DRZA-(IP*DX))/DX
      GOTO 200
C
C***************** EXTRACTION PATTERN HOOGLAND,BELMANS,FEDDES **********
100   CRDEM=EPA
      J1=1
110   IF(J1*DX.GT.-RNA) GOTO 120
      RTEX(J1)=0.
      J1=J1+1
      GOTO 110
120   RTEX(J1)=AMIN1(RTEX(J1)*(ARER-BRER*ABS(X(J1)))
     $*(J1*DX+RNA)/DX,CRDEM/DX)
      CRDEM=CRDEM-RTEX(J1)*DX
      J2=J1
      IF(CRDEM.LT.1.E-10) GOTO 160
      J1=J1+1
      DO 130 I=J1,IP
         RTEX(I)=AMIN1(RTEX(I)*(ARER+BRER*X(I)),CRDEM/DX)
         CRDEM=CRDEM-RTEX(I)*DX
         J2=I
         IF(CRDEM.LT.1.E-10) GOTO 160
130   CONTINUE
135   J2=IRZ
      RTEX(J2)=RTEX(J2)*(ARER+BRER*X(J2))*(-DRZA-IP*DX)/DX
      RTEX(J2)=AMIN1(RTEX(J2),CRDEM/DX)
      goto 160
c
c******EXTRACTION PATTERN OF MODEL  M U S T   FOR GRASLAND**********************
c
c     evapotranspiration demand is equally distributed over the root zone
c     sink term calculated for each dx
c
300     CONTINUE
c
       do 330 i=1,irz
c
      a10=-(ph(I)-10049.)
      a20=(ph(i)-10049)**2 + 40196*ph(i)
      rpla=10000.0
      a30=5.96e+04*EPA*rpla*0.98
      bb=0.04
       if(conduc(i).le.1.0e-08) go to 320
       a40=(1+(bb/(-drza*conduc(i))))
      pl10=(a10+(a20+a30*a40)**.5)/-2.
      go to 321
320      pl10=-25000.0
321      rcmea=65.
      rm10=500.
      p10=-15000.
      p20=-25000.
       rc10=rcmea+((rm10-rcmea)*(p10-pl10)/(p10-p20))
      if(pl10.ge.-15000) rc10=65
      if(pl10.le.-25000) rc10=500
       ea=(epa*2.6318)/(1.17+.67*(1+(rc10/55)))
       if(epa.eq.0.0) rtex(i)=0.0
       if(epa.ne.0.0)  rtex(i)=qm*ea/epa
       RTEX(I)=RTEX(I)*(-DRZA-(IP*DX))/DX
330    continue
```

```
160   continue
      DO 140 I=irz+1,NCS
         RTEX(I)=0.0
140   CONTINUE
C
200   RETURN
      END
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
      SUBROUTINE FLUXES(PH)
C     SUBROUTINE FLUXES : CALCULATES THE DARCIAN FLUXES IN BETWEEN THE
C                         NODAL POINTS
      DIMENSION PH(100)
      COMMON/INTRS/ IAD,N,NPL,NCS,IRZ,IRER,INL,IPRT,ISD,NPR,
     $LV(10),MV(10),NC(10),KOD(10),L(8),LC1(5),ICOD,IDICOD
      COMMON/REALS/ VISD,VISD1,TEM(366),GPRH(366),SC(366),QDEEP(366),
     $PO,PU1,PL1,P2H,P2L,P2,P3,RNAM,CGWLAM,DSP,DX,DXG,DXH,DXN,CS1,ESRA,
     $FAC,DT,DT1,DTI,DTM,DTHM,TINIT,TEND,TPRINT,TOUTP,TMD,T2,TB,TE,
     $VOL1,VOLI,VOL,FINA,GWLA,DRZA,GPRHA,QDEEPA,ESA,EPA,PHSA,PRECA,FLXA,
     $ARER,BRER,AREL,BREL,FLX1,CHNL,CHND,CHNR,DKD,ALPHAR,DGRWL,SIMPR,
     $TPR(52),PREC(366),FIN(366),PHS(366),EP(366),ES(366),DRZ(366),
     $HNT(366),HSH(366),X(100),PRH(10,81),CON(10,81),CONDUC(101),
     $conin(101),SCALM,SCALS,SND(100,3),
     $DMCAP(100),RTEX(100),FLXS(101),THETA(4),SWC(10),SWCA(100),
     $ttr(10),tal(10),ten(10),tks(10),TLA(100),
     $DOUTP(366,13),ESR(366),GWL(366),VPD(366),VOLIR
      COMMON/CUM/ CPREC,CINTC,CINF,CPTRA,CPSEV,CTRA,CTRA1,CTRA2,CSEV,
     $CSEV2,CFLSD,CFLSDP,CFLBU,CQD,CQDP,CQDN,CDEL,CDELP,DEL,DVOL,
     $CRTEX(100)
C
c        write(6,1)
1        format(' fluxes')
      FLXS(1)=-CONIN(1)*(PHSA-PH(1)+DXH)/DXH
      IF(FLXS(1).GT.0.0.AND.FLXA.GT.0.0) GOTO 10
      IF(FLXS(1).LT.0.0.AND.FLXA.LT.0.0) GOTO 20
      FLXS(1)=0.0
      GOTO 30
10    IF(FLXS(1).GT.FLXA) FLXS(1)=FLXA
      GOTO 30
c   next change was made sothat no runoff can occur !!!!!!
c
20          flxs(1)=flxa
c20    IF(FLXS(1).LT.FLXA) FLXS(1)=FLXA
C
30    DO 40 I=2,NCS
         FLXS(I)=-CONIN(I)*((PH(I-1)-PH(I))/DX+1.)
40    CONTINUE
C
      IF(N.GT.1) FLXS(N)=-CONIN(N)*((PH(N-1)-PH(N))/DXG+1.)
      FLXS(NCS+1)=-CONDUC(NCS)
      IF(KOD(1).LE.4) FLXS(N+1)=FLXS(N)
      IF(KOD(1).EQ.5) FLXS(NCS+1)=0.0
C
C
      RETURN
      END
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
      SUBROUTINE PRHEAD(PH)
      DIMENSION R1(100),R2(100),PH(100)
      COMMON/INTRS/ IAD,N,NPL,NCS,IRZ,IRER,INL,IPRT,ISD,NPR,
     $LV(10),MV(10),NC(10),KOD(10),L(8),LC1(5),ICOD,IDICOD
      COMMON/REALS/ VISD,VISD1,TEM(366),GPRH(366),SC(366),QDEEP(366),
     $PO,PU1,PL1,P2H,P2L,P2,P3,RNAM,CGWLAM,DSP,DX,DXG,DXH,DXN,CS1,ESRA,
```

```
     $FAC,DT,DT1,DTI,DTM,DTHM,TINIT,TEND,TPRINT,TOUTP,TMD,T2,TB,TE,
     $VOL1,VOLI,VOL,FINA,GWLA,DRZA,GPRHA,QDEEPA,ESA,EPA,PHSA,PRECA,FLXA,
     $ARER,BRER,AREL,BREL,FLX1,CHNL,CHND,CHNR,DKD,ALPHAR,DGRWL,SIMPR,
     $TPR(52),PREC(366),FIN(366),PHS(366),EP(366),ES(366),DRZ(366),
     $HNT(366),HSH(366),X(100),PRH(10,81),CON(10,81),CONDUC(101),
     $conin(101),SCALM,SCALS,SND(100,3),
     $DMCAP(100),RTEX(100),FLXS(101),THETA(4),SWC(10),SWCA(100),
     $ttr(10),tal(10),ten(10),tks(10),TLA(100),
     $DOUTP(366,13),ESR(366),GWL(366),VPD(366),VOLIR
C
c         write(6,1)
1        format('prhead')
      H1=DT/DX
      H2=H1/DX
C******* CALCULATION OF COEFFICIENTS OF TRIDIAGONAL MATRIX *************
C
C#CALCULATION OF COEFFICIENTS FOR I=1#
      A=H2*CONIN(2)/DMCAP(1)
      B=1.0+A
      E=PH(1)-H1*(CONIN(2)+FLXS(1))/DMCAP(1)-DT*RTEX(1)/DMCAP(1)
      R1(1)=A/B
      R2(1)=-E/A
C
C#CALCULATION OF COEFFICIENTS FOR 1<I<N#
      J=N-1
      DO 10 I=2,J
         C=H2*CONIN(I)/DMCAP(I)
         IF(I.EQ.N-1) H2=DT/(DX*DXG)
         A=H2*CONIN(I+1)/DMCAP(I)
         B=1.0+A+C
         E=PH(I)-H1*(CONIN(I+1)-CONIN(I))/DMCAP(I)-DT*RTEX(I)/DMCAP(I)
         R1(I)=A/(B-C*R1(I-1))
         R2(I)=(C*R1(I-1)*R2(I-1)-E)/A
10    CONTINUE
C
      IF(KOD(1).LT.5) GOTO 20
C
C#CALCULATION OF COEFFICIENTS FOR I=N#
      C=H2*CONIN(N)/DMCAP(N)
      B=1.0+C
      E=PH(N)+H1*(FLXS(N+1)+CONIN(N))/DMCAP(N)-DT*RTEX(N)/DMCAP(N)
      GOTO 30
C
C********** CALCULATION OF PRESSURE HEAD VALUES AT TIME (T) ************
20    IF(KOD(1).EQ.4) PH(N)=GPRHA
      GOTO 40
30    PH(N)=(E-C*R1(N-1)*R2(N-1))/(B-C*R1(N-1))
40    J=N+1
50    J=J-1
      IF(J.LT.2) GOTO 60
      PH(J-1)=AMIN1(0.0,R1(J-1)*(PH(J)-R2(J-1)))
      GOTO 50
C
60    RETURN
      END
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
      SUBROUTINE INTGRL(PH)
C     SUBROUTINE INTGRL : CALCULATION OF CUMULATIVE VALUES
      DIMENSION PH(100)
      COMMON/INTRS/ IAD,N,NPL,NCS,IRZ,IRER,INL,IPRT,ISD,NPR,
     $LV(10),MV(10),NC(10),KOD(10),L(8),LC1(5),ICOD,IDICOD
      COMMON/REALS/ VISD,VISD1,TEM(366),GPRH(366),SC(366),QDEEP(366),
     $P0,PU1,PL1,P2H,P2L,P2,P3,RNAM,CGWLAM,DSP,DX,DXG,DXH,DXN,CS1,ESRA,
```

```
     $FAC,DT,DT1,DTI,DTM,DTHM,TINIT,TEND,TPRINT,TOUTP,TMD,T2,TB,TE,
     $VOL1,VOLI,VOL,FINA,GWLA,DRZA,GPRHA,QDEEPA,ESA,EPA,PHSA,PRECA,FLXA,
     $ARER,BRER,AREL,BREL,FLX1,CHNL,CHND,CHNR,DKD,ALPHAR,DGRWL,SIMPR,
     $TPR(52),PREC(366),FIN(366),PHS(366),EP(366),ES(366),DRZ(366),
     $HNT(366),HSH(366),X(100),PRH(10,81),CON(10,81),CONDUC(101),
     $conin(101),SCALM,SCALS,SND(100,3),
     $DMCAP(100),RTEX(100),FLXS(101),THETA(4),SWC(10),SWCA(100),
     $ttr(10),tal(10),ten(10),tks(10),TLA(100),
     $DOUTP(366,13),ESR(366),GWL(366),VPD(366),VOLIR
      COMMON/CUM/ CPREC,CINTC,CINF,CPTRA,CPSEV,CTRA,CTRA1,CTRA2,CSEV,
     $CSEV2,CFLSD,CFLSDP,CFLBU,CQD,CQDP,CQDN,CDEL,CDELP,DEL,DVOL,
     $CRTEX(100)
C
c        write(6,1)
1         format(' intgrl')
      CPREC=CPREC+PRECA*DT
      CINTC=CINTC+FINA*DT
      CPSEV=CPSEV+ESA*DT
      CPTRA=CPTRA+EPA*DT
C
      IF(FLXS(1).GT.1.0E-10) GOTO 10
      CINF=CINF-FLXS(1)*DT+ESRA*DT
      CSEV=CSEV+ESRA*DT
      GOTO 20
10    CSEV=CSEV+FLXS(1)*DT
      IF(PRECA.LE.1.0E-10) GOTO 20
      CSEV=CSEV+(PRECA-FINA)*DT
      CINF=CINF+(PRECA-FINA)*DT
C
20    IF(QDEEPA.GT.1.0E-10) CQDP=CQDP+QDEEPA*DT
      CQD=CQD+QDEEPA*DT
C
      CTRA1=CTRA
      DO 30 I=1,IRZ
         CTRA=CTRA+RTEX(I)*DX*DT
         CRTEX(I)=CRTEX(I)+RTEX(I)*DX*DT
30    CONTINUE
C
      IF(KOD(1).LT.6) GOTO 40
      IF(FLXS(N+1).GT.1.0E-10) CFLBUP=CFLBUP+FLXS(N+1)*DT
      CFLBU=CFLBU+FLXS(N+1)*DT
C
40    RETURN
      END
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
      SUBROUTINE CALGWL(PH,wc,iflagl)
      DIMENSION PH(100),PH1(100),WC(100),R1(100),R2(100)
      COMMON/INTRS/ IAD,N,NPL,NCS,IRZ,IRER,INL,IPRT,ISD,NPR,
     $LV(10),MV(10),NC(10),KOD(10),L(8),LC1(5),ICOD,IDICOD
      COMMON/REALS/ VISD,VISD1,TEM(366),GPRH(366),SC(366),QDEEP(366),
     $PO,PU1,PL1,P2H,P2L,P2,P3,RNAM,CGWLAM,DSP,DX,DXG,DXH,DXN,CS1,ESRA,
     $FAC,DT,DT1,DTI,DTM,DTHM,TINIT,TEND,TPRINT,TOUTP,TMD,T2,TB,TE,
     $VOL1,VOLI,VOL,FINA,GWLA,DRZA,GPRHA,QDEEPA,ESA,EPA,PHSA,PRECA,FLXA,
     $ARER,BRER,AREL,BREL,FLX1,CHNL,CHND,CHNR,DKD,ALPHAR,DGRWL,SIMPR,
     $TPR(52),PREC(366),FIN(366),PHS(366),EP(366),ES(366),DRZ(366),
     $HNT(366),HSH(366),X(100),PRH(10,81),CON(10,81),CONDUC(101),
     $conin(101),SCALM,SCALS,SND(100,3),
     $DMCAP(100),RTEX(100),FLXS(101),THETA(4),SWC(10),SWCA(100),
     $ttr(10),tal(10),ten(10),tks(10),tla(100),
     $DOUTP(366,13),ESR(366),GWL(366),VPD(366),VOLIR
      COMMON/CUM/ CPREC,CINTC,CINF,CPTRA,CPSEV,CTRA,CTRA1,CTRA2,CSEV,
     $CSEV2,CFLSD,CFLSDP,CFLBU,CQD,CQDP,CQDN,CDEL,CDELP,DEL,DVOL,
     $CRTEX(100)
```

```
C
c         write(6,1)
1        format(' calgwl')
      DVOL=DVOL+DEL-QDEEPA*DT
      IF(ABS(DVOL).LT.0.10) GOTO 200
      VOL2=VOL
      CGWLA=CGWLAM
      IF(DVOL.LT.0.0) CGWLA=-CGWLA
C
10    GWLA=GWLA-CGWLA
      IF(-GWLA.GE.DSP) iflag1=999
      N=-GWLA/DX+.499999
      IF(N.LE.2)        iflag1=999
       if(iflag1.eq.999) go to 200
      DXN=-GWLA-(N-1)*DX
      DXG=0.5*(DX+DXN)
      PH(N+1)=0.0
      WC(N+1)=SWCA(N+1)
      PH(N)=-DXN/2.0
      NLA=0
15    NLA=NLA+1
      IF(N.GT.NC(NLA)) GOTO 15
       a1=1+(tal(nla)*abs(ph(n)*TLA(n)))**ten(nla)
       em=1-(1.0/ten(nla))
       wc(n)=(swca(n)-ttr(nla))*(a1**-em) + ttr(nla)
        if(ph(n).ge.0.00) wc(n)=swca(n)
      DT2=DT/10.
      H1=DT2/DX
      H2=H1/DX
      JJ=MAX0(N-3,2)
      JJJ=N-1
      CONJJ=CONIN(JJ)
      CONIN(JJ)=0.0
C
      DO 20 I=JJ,JJJ
         PH1(I)=PH(I)
         C=H2*CONIN(I)/DMCAP(I)
         IF(I.EQ.N-1) H2=DT2/(DX*DXG)
         A=H2*CONIN(I+1)/DMCAP(I)
         B=1.0+A+C
         E=PH(I)-H1*(CONIN(I+1)-CONIN(I))/DMCAP(I)
         R1(I)=A/(B-C*R1(I-1))
         R2(I)=(C*R1(I-1)*R2(I-1)-E)/A
20    CONTINUE
C
      CONIN(JJ)=CONJJ
      J=N+1
30    J=J-1
      IF(J.LT.JJ+1) GOTO 40
      PH(J-1)=R1(J-1)*(PH(J)-R2(J-1))
      WC(J-1)=WC(J-1)+(PH(J-1)-PH1(J-1))*DMCAP(J-1)
      GOTO 30
C
40    VOL1=VOL
      VOL=0.0
      DO 50 I=1,NCS
       VOL=VOL+WC(I)*DX
50    CONTINUE
      N1=-GWLA/DX+1
      VOL=VOL+(N*DX+GWLA)*(SWCA(N1)-WC(N))
C
      DVOL1=DVOL
      DVOL=DVOL-(VOL1-VOL)
      IF(ABS(VOL1-VOL).GT.ABS(DVOL1)) GOTO 200
```

```
      IF(ABS(DVOL).GT.0.05) CALL DMCCON(wc,ph)
60    GOTO 10
C
200   RETURN
      END
C
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
      SUBROUTINE CALCDT(T,its,iflag2)
C     SUBROUTINE CALCDT : CALCULATION OF THE TIME STEP (DT)
      COMMON/INTRS/ IAD,N,NPL,NCS,IRZ,IRER,INL,IPRT,ISD,NPR,
     $LV(10),MV(10),NC(10),KOD(10),L(8),LC1(5),ICOD,IDICOD
      COMMON/REALS/ VISD,VISD1,TEM(366),GPRH(366),SC(366),QDEEP(366),
     $P0,PU1,PL1,P2H,P2L,P2,P3,RNAM,CGWLAM,DSP,DX,DXG,DXH,DXN,CS1,ESRA,
     $FAC,DT,DT1,DTI,DTM,DTHM,TINIT,TEND,TPRINT,TOUTP,TMD,T2,TB,TE,
     $VOL1,VOLI,VOL,FINA,GWLA,DRZA,GPRHA,QDEEPA,ESA,EPA,PHSA,PRECA,FLXA,
     $ARER,BRER,AREL,BREL,FLX1,CHNL,CHND,CHNR,DKD,ALPHAR,DGRWL,SIMPR,
     $TPR(52),PREC(366),FIN(366),PHS(366),EP(366),ES(366),DRZ(366),
     $HNT(366),HSH(366),X(100),PRH(10,81),CON(10,81),CONDUC(101),
     $conin(101),SCALM,SCALS,SND(100,3),
     $DMCAP(100),RTEX(100),FLXS(101),THETA(4),SWC(10),SWCA(100),
     $ttr(10),tal(10),ten(10),tks(10),TLA(100),
     $DOUTP(366,13),ESR(366),GWL(366),VPD(366),VOLIR
C
c         write(6,1)
1        format(' calcdt')
      DTDT=RTEX(1)+ABS((FLXS(1)-FLXS(2))/DX)
      J=N-1
      DO 10  I=2,J
         DTDT=AMAX1(DTDT,RTEX(I)+ABS((FLXS(I)-FLXS(I+1))/DX))
10    CONTINUE
      DTDT=AMAX1(DTDT,RTEX(N)+ABS((FLXS(N)-FLXS(N+1))/DXN))
      IF(DTDT.GT.0.0) DT=DTHM/DTDT
      DT=AMIN1(DT,DTM)
      DT1=DT
      IF(T+DT.LT.TMD) GOTO 20
      DT=TMD-T
      ITS=1
      TMD=TMD+1.
      IF(T+DT.GE.TOUTP) IPRT=1
      IF(T+DT.GE.TEND)  IPRT=1
20    IF(T+DT.GT.TEND) iflag2=999
C
      RETURN
      END
C
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
      SUBROUTINE POTATO(T)
C --- SUBROUTINE TO CALCULATE CROP DRY MATTER PRODUCTION OF POTATOES.
      REAL LAI
C
      COMMON/INTRS/ IAD,N,NPL,NCS,IRZ,IRER,INL,IPRT,ISD,NPR,
     *LV(10),MV(10),NC(10),KOD(10),L(8),LC1(5),ICOD,IDICOD
      COMMON/REALS/ VISD,VISD1,TEM(366),GPRH(366),SC(366),QDEEP(366),
     *P0,PU1,PL1,P2H,P2L,P2,P3,RNAM,CGWLAM,DSP,DX,DXG,DXH,DXN,CS1,
     *ESRA,FAC,DT,DT1,DTI,DTM,DTHM,TINIT,TEND,TPRINT,TOUTP,TMD,T2,
     *TB,TE,VOL1,VOLI,VOL,FINA,GWLA,DRZA,GPRHA,QDEEPA,ESA,EPA,PHSA,
     *PRECA,FLXA,ARER,BRER,AREL,BREL,FLX1,CHNL,CHND,CHNR,DKD,ALPHAR,
     *DGRWL,SIMPR,TPR(52),PREC(366),FIN(366),PHS(366),EP(366),
     *ES(366),DRZ(366),HNT(366),HSH(366),X(100),PRH(10,81),CON(10,81),
     *CONDUC(101),CONIN(101),SCALM,SCALS,SND(100,3),
     *DMCAP(100),RTEX(100),FLXS(101),THETA(4),
```

```
     *SWC(10),SWCA(100),
     $ttr(10),tal(10),ten(10),tks(10),TLA(100),
     $doutp(366,13),esr(366),gwl(366),vpd(366),volir
      COMMON/CUM/ CPREC,CINTC,CINF,CPTRA,CPSEV,CTRA,CTRA1,CTRA2,CSEV,
     *CSEV2,CFLSD,CFLSDP,CFLBU,CQD,CQDP,CQDN,CDEL,CDELP,DEL,DVOL,
     *CRTEX(100)
      COMMON/CROP/FSX(6),FSY(6),FTX(6),FTY(6),TWOPI,HALFPI,DVS,LAI,
     *FACLAI,EPSFAC,CVF,AMAX,QINIT,QPOT,QTOT,QLEAVE,QTUBER,TCROP,
     *FLA,FLB,FLC
C
      DATA FPCA,FPCS,FPCC/220.,10.,310./
      DATA FPOA,FPOS,FPOC/110.,9.,136./
      DATA FRCA,FRCS,FRCC/90.,9.,104./
C
C --- SPECIAL SINDERHOEVE OUTPUT
      SAVE TQASYMA,TQASYMP,TQALT,TXMAINT,TXMAINP
C
C --- FREEZING?
c        write(6,1)
1       format(' potato')
      M=INT(T+0.9)
      IF(TEM(M).LE.270.15) THEN
         TCROP=T
         CALL SCCALC
         DVS=0.0
         QLEAVE=QINIT/3.
         RETURN
      END IF
C
C --- NEW DVS
      DVS=(T-TCROP)/(TEND-TCROP)
C
C --- FACLAI
      IF(DVS.GT.0.30) THEN
         FACLAI=0.8
      ELSE
         FACLAI=0.7 + 0.1 * DVS / 0.30
      END IF
C
C --- TRANSPIRATION AT THE END OF THE PAST DAY
      TRA=CTRA-CTRA2
C
C --- CALCULATION OF SOIL COVER
      CALL SCCALC
C
C --- LAI
      LAI=FLA*SC(M)+FLB*SC(M)**2.0+FLC*SC(M)**3.0
C
C --- TUBER
      IF(DVS.LT.FTX(6)) THEN
         DO 50 I=2,6
            K=I
            IF(DVS.GE.FTX(K-1).AND.DVS.LE.FTX(K))GO TO 60
50       CONTINUE
60       FTUBER=FTY(K-1)+(DVS-FTX(K-1))*(FTY(K)-FTY(K-1))/
     *   (FTX(K)-FTX(K-1))
      ELSE
         FTUBER=1.0
      END IF
C
C --- RADIATION AND PRODUCTION
      PO = FPOA * SIN(TWOPI*(T+FPOS)/365. - HALFPI) + FPOC
      PC = FPCA * SIN(TWOPI*(T+FPCS)/365. - HALFPI) + FPCC
      RC = FRCA * SIN(TWOPI*(T+FRCS)/365. - HALFPI) + FRCC
```

```
C
      GAM=(RC-0.5*HSH(M))/(0.8*RC)
C
C --- STANDARD CROP
      PST=GAM*PO+(1.0-GAM)*PC
C
C --- YIELD
      fac1=2.0**(.1*(TEM(M)-298.15))
      XMAINT=0.01*QTOT*Fac1
      XMAINP=0.01*QPOT*Fac1
      IF (TRA.GT.EP(M)) TRA=EP(M)
C
C --- ASYMPTOTIC LEVEL FOR ACTUAL PRODUCTION
      QASYMA=(PST-XMAINT)*(1.0-EXP(-FACLAI*LAI))*CVF
      TVPD=TRA/VPD(M)
      B=AMAX*TVPD+QASYMA
C
C --- ACTUAL PRODUCTION
      QDTOT=0.5*(B-SQRT(B*B-4.0*QASYMA*AMAX*TVPD*(1.0-EPSFAC)))
C
C --- ASYMPTOTIC LEVEL FOR POTENTIAL PRODUCTION
      QASYMP=(PST-XMAINP)*(1.0-EXP(-FACLAI*LAI))*CVF
      TVPD=EP(M)/VPD(M)
      B=AMAX*TVPD+QASYMP
C
C --- POTENTIAL PRODUCTION
      QDPTOT=0.5*(B-SQRT(B*B-4.0*QASYMP*AMAX*TVPD*(1.0-EPSFAC)))
C
C --- PARTITION OF CROP
      QDTUB=QDTOT*FTUBER
      QDPTUB=QDPTOT*FTUBER
C
C --- YIELD
      QTOT=QTOT+QDTOT
      QPOT=QPOT+QDPTOT
      QTUBER=QTUBER+QDTUB
      QPTUBE=QPTUBE+QDPTUB
C
      RETURN
      END
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
      SUBROUTINE SCCALC
c --- SUBROUTINE TO CALCULATE SOIL COVER IF KOD(8) = 1
      REAL LAI
C
      DIMENSION PH(100),PH1(100),WC(100)
C
      COMMON/INTRS/ IAD,N,NPL,NCS,IRZ,IRER,INL,IPRT,ISD,NPR,
     *LV(10),MV(10),NC(10),KOD(10),L(8),LC1(5),ICOD,IDICOD
      COMMON/REALS/ VISD,VISD1,TEM(366),GPRH(366),SC(366),QDEEP(366),
     *PO,PU1,PL1,P2H,P2L,P2,P3,RNAM,CGWLAM,DSP,DX,DXG,DXH,DXN,CS1,ESRA,
     *FAC,DT,DT1,DTI,DTM,DTHM,TINIT,TEND,TPRINT,TOUTP,TMD,T2,TB,TE,
     *VOL1,VOLI,VOL,FINA,GWLA,DRZA,GPRHA,QDEEPA,ESA,EPA,PHSA,PRECA,FLXA,
     *ARER,BRER,AREL,BREL,FLX1,CHNL,CHND,CHNR,DKD,ALPHAR,DGRWL,SIMPR,
     *TPR(52),PREC(366),FIN(366),PHS(366),EP(366),ES(366),DRZ(366),
     *HNT(366),HSH(366),X(100),PRH(10,81),CON(10,81),CONDUC(101),
     *conin(101),SCALM,SCALS,SND(100,3),
     *DMCAP(100),RTEX(100),FLXS(101),THETA(4),SWC(10),SWCA(100),
     *ttr(10),tal(10),ten(10),tks(10),TLA(100),
     *DOUTP(366,13),ESR(366),GWL(366),VPD(366),VOLIR
      COMMON/CUM/ CPREC,CINTC,CINF,CPTRA,CPSEV,CTRA,CTRA1,CTRA2,CSEV,
     *CSEV2,CFLSD,CFLSDP,CFLBU,CQD,CQDP,CQDN,CDEL,CDELP,DEL,DVOL,
```

```
      *CRTEX(100)
       COMMON/CROP/FSX(6),FSY(6),FTX(6),FTY(6),TWOPI,HALFPI,DVS,LAI,
      *FACLAI,EPSFAC,CVF,AMAX,QINIT,QPOT,QTOT,QLEAVE,QTUBER,TCROP,
      *FLA,FLB,FLC
C
c           write(6,1)
1         format(' sccalc')
       TIMDIF=TEND-TCROP
       LH1=TCROP
       LH2=TEND
       DO 50 I=1,LH2
          TYD=I
          IF(TYD.GT.TCROP)GO TO 10
          SC(I)=0.0
          GO TO 50
10        DVSH=(TYD-TCROP)/TIMDIF
          IF(DVSH.LT.FSX(6))GO TO 20
          SC(I)=0.0
          GO TO 50
20        DO 30 J=2,6
             K=J
             IF(DVSH.GE.FSX(K-1).AND.DVSH.LE.FSX(K))GO TO 40
30        CONTINUE
40        SC(I)=FSY(K-1)+(DVSH-FSX(K-1))*(FSY(K)-FSY(K-1))/
      *   (FSX(K)-FSX(K-1))
50     CONTINUE
C
       RETURN
       END
C
C
C=================================================================
       SUBROUTINE PRTPLT(T,WC,PH,ITS,NTS,NPRA)
C      SUBROUTINE PRTPLT : PRINTING AND PLOTTING
       DIMENSION WC(100),PH(100),IA(99),NDGIFT(366)
       INTEGER TRAIN,TDIF
       REAL LAI
       LOGICAL TGIFT
C
       COMMON/INTRS/ IAD,N,NPL,NCS,IRZ,IRER,INL,IPRT,ISD,NPR,
      $LV(10),MV(10),NC(10),KOD(10),L(8),LC1(5),ICOD,IDICOD
       COMMON/REALS/ VISD,VISD1,TEM(366),GPRH(366),SC(366),QDEEP(366),
      $P0,PU1,PL1,P2H,P2L,P2,P3,RNAM,CGWLAM,DSP,DX,DXG,DXH,DXN,CS1,ESRA,
      $FAC,DT,DT1,DTI,DTM,DTHM,TINIT,TEND,TPRINT,TOUTP,TMD,T2,TB,TE,
      $VOL1,VOLI,VOL,FINA,GWLA,DRZA,GPRHA,QDEEPA,ESA,EPA,PHSA,PRECA,FLXA,
      $ARER,BRER,AREL,BREL,FLX1,CHNL,CHND,CHNR,DKD,ALPHAR,DGRWL,SIMPR,
      $TPR(52),PREC(366),FIN(366),PHS(366),EP(366),ES(366),DRZ(366),
      $HNT(366),HSH(366),X(100),PRH(10,81),CON(10,81),CONDUC(101),
      $conin(101),SCALM,SCALS,SND(100,3),
      $DMCAP(100),RTEX(100),FLXS(101),THETA(4),SWC(10),SWCA(100),
      $ttr(10),tal(10),ten(10),tks(10),tla(100),
      $DOUTP(366,13),ESR(366),GWL(366),VPD(366),VOLIR
       COMMON/CUM/ CPREC,CINTC,CINF,CPTRA,CPSEV,CTRA,CTRA1,CTRA2,CSEV,
      $CSEV2,CFLSD,CFLSDP,CFLBU,CQD,CQDP,CQDN,CDEL,CDELP,DEL,DVOL,
      $CRTEX(100)
       COMMON/IRRI/ SIZE,TDIF,PHCRIT,TRAIN,NCRIT,TGIFT(366)
       COMMON/CROP/FSX(6),FSY(6),FTX(6),FTY(6),TWOPI,HALFPI,DVS,LAI,
      *FACLAI,EPSFAC,CVF,AMAX,QINIT,QPOT,QTOT,QLEAVE,QTUBER,TCROP,
      *FLA,FLB,FLC
C
       DATA IPL/'+'/,IMN/'-'/,IBL/' '/,ISL/'/'/
C
C******************** PRINTING AND PLOTTING *************************
c         write(6,1)
```

```
1       format(' prtplt')
        CPETR=CPTRA+CPSEV
        CETR=CTRA+CSEV
        CPINF=CPREC-CINTC
        CRUNO=CPINF-CINF
        CFLSDN=CFLSD-CFLSDP
        FLXBUA=FLXS(N+1)
        IF(KOD(1).LT.6) FLXBUA=0.0
        IF(KOD(1).EQ.0.OR.KOD(1).GT.3) QDEEPA=0.0
        CQDN=CQD-CQDP
        CDELN=CDEL-CDELP
        IF(IPRT.EQ.0) GOTO 150
        WRITE(21,10) T,DT1,NTS,CPREC,CINTC,CPINF,CINF,CPETR,
       $CPTRA,CPSEV,CRUNO,CETR,CTRA,CSEV,FLXS(1),CFLSD,CFLSDP,CFLSDN,
       2FLXS(ISD+1),ISD,CFLBU,FLXBUA,CQD,CQDP,CQDN,QDEEPA,CDEL,CDELP,
       3CDELN,DEL,VOLI,VOL,GWLA,DRZA,N,QPOT,QTOT,QTUBER
10      FORMAT(1H1,'TIME :',F6.0,' DAYS',45X,'TIME STEP=',E10.3,' DAY',5X,
       $'NUMBER OF TIME STEP=',I4,//,
       $' CPREC   =',F7.3,' CM',6X,'CINTCEP =',F7.3,' CM',6X,'CPINFILT=',
       $F7.3,' CM',6X,'CINFILT =',F10.3,' CM',/,
       $' CPETR   =',F7.3,' CM',6X,'CPTRANSP=',F7.3,' CM',6X,'CPSEVAP =',
       $F7.3,' CM',6X,'CRUNOFF =',F10.3,' CM',/,
       $' CETR    =',F7.3,' CM',5X,'*CTRANSP =',F7.3,' CM*',4X,'*CSEVAP  =
       $',F7.3,' CM*',5X,'FLUX1   =',F10.6,' CM/DAY',/,
       $' CFLXSD  =',F7.3,' CM',6X,'CFLXSDP =',F7.3,' CM',6X,'CFLXSDN =',
       $F7.3,' CM',6X,'FLXSD   =',F10.6,' CM/DAY',7X,'ISD=',I3,/,
       $' CFLXBU  =',F7.3,' CM',56X,'FLXBU   =',F10.6,' CM/DAY',/
       $' CQDEEP  =',F7.3,' CM',6X,'CQDEEPP =',F7.3,' CM',6X,'CQDEEPN =',
       $F7.3,' CM',6X,'QDEEPA  =',F10.6,' CM/DAY',/,
       $' CDELTA  =',F7.3,' CM',6X,'CDELTAP =',F7.3,' CM',6X,'CDELTAN =',
       $F7.3,' CM',6X,'DELTA   =',E10.3,' CM',/,
       $' VOLINIT =',F7.3,' CM',6X,'VOL     =',F7.3,' CM',6X,'GWLA    =',
       $F7.1,' CM',6X,'DRZA    =',F10.1,' CM',11X,'N  =',I3,/,
       $' QPOT    =',F7.0,' KG/HA',3X,'QTOT    =',F7.0,' KG/HA',2X,
       $' QTUBER  =',F7.0,' KG/HA')
        WRITE(21,20)
20      FORMAT(1X,/,' COMP. NR',2X,' LEVEL',3X,'THETA',4X,'PR.HEAD',3X,
       $' CONDUC',4X,'ROOT EXT',2X,'C.ROOT EXT',2X,'CUM.WATER',10X,
       $' FLUXES',5x,'SCALE FACT',/,
       $13X,'(CM)',3X,'(VOL)',5X,'(CM)',5X,'(CM/DAY)',4X,'(1/DAY)',5X,
       $'  (CM)',6X,'(CM)',13X,'(CM/DAY)',/)
C
        IF(N.EQ.NCS) GOTO 26
        N1=N+1
        DO 25 I=N1,NCS
           IF(KOD(1).EQ.0) FLXS(I+1)=DEL/DT
           IF(KOD(1).GT.0.AND.KOD(1).LT.4) FLXS(I+1)=QDEEPA
25      CONTINUE
26      V=0.0
        DO 30 I=1,NCS
           V=V+WC(I)*DX
           PHI=AMIN1(PH(I),0.0)
           WRITE(21,40) I,X(I),WC(I),PHI,CONDUC(I),RTEX(I),CRTEX(I),V,
       $   FLXS(I+1),tla(i)
30      CONTINUE
        go to 111
C
40      FORMAT(I8,F9.1,F8.3,(4(1X,G10.4)),F11.3,8X,G11.5,f10.5)
        IF(NCS.GT.20) WRITE(21,45)
45       FORMAT(1H1,//)
        WRITE(21,50) T
50      FORMAT(/,1X,'******************************** SOIL MOISTURE  CONTEN
       $T PROFILE AT TIME :',F6.0,' DAYS ********************************')
        WRITE(21,60)
```

```
60     FORMAT(1X,' LEVEL THETA',1X,'.0',7X,'0.1',7X,'0.2',7X,'0.3',7X,
      $'0.4',7X,'0.5',7X,'0.6',7X,'0.7',7X,'0.8',7X,'0.9',7X,'1.')
       WRITE(21,70)
70     FORMAT(1X,'  CM    VOL. +****+****+****+****+****+****+****+****+*
      $***+****+****+****+****+****+****+****+****+****+****+****+')
C
C
       DO 80 J=1,NCS
          IY=WC(J)*100.0+0.5
          I1=SWCA(J)*100.+.5
C
          DO 90 I=1,I1
             IF(IY.GT.I) IA(I)=IMN
             IF(IY.EQ.I) IA(I)=IPL
             IF(IY.LT.I) IA(I)=IBL
90       CONTINUE
C
          NY=I1+1
          DO 100 I=NY,99
             IA(I)=ISL
100       CONTINUE
          WRITE(21,110) X(J),WC(J),(IA(I),I=1,99)
80     CONTINUE
110     FORMAT(1X,F6.1,1X,F5.3,2H +,99A1,1H+)
       WRITE(21,70)
       WRITE(21,60)
C
111          continue
       NPRA=NPRA+1
       IPRT=0
       TOUTP=TEND
       IF(NPRA.GT.NPR) GOTO 150
       IF(KOD(7).EQ.0) TPRINT=TPR(NPRA)
       TOUTP=T+TPRINT
       IF(NTS.EQ.1) TOUTP=TINIT+TPRINT
       IF(NPRA.EQ.1) DT1=0.05
C
C********* STORAGE OF THE OUTPUT DATA AT THE END OF THE DAY ************
150    IF(ITS.EQ.0) GOTO 300
       IF (KOD(8).EQ.1.AND.T.GE.TCROP) CALL POTATO(T)
       WS1=DX*(WC(1)+0.5*WC(2))
       WS2=0.
       WS3=0.
       WS4=0.
       DO 1000 I=2,5
        WS2=WS2+WC(I)
        WS3=WS3+WC(I+3)
        WS4=WS4+WC(I+6)
1000   CONTINUE
       WS2=DX*(WS2-0.5*(WC(2)+WC(5)))
       WS3=DX*(WS3-0.5*(WC(5)+WC(8)))
       WS4=DX*(WS4-0.5*(WC(8)+WC(11)))
       WS5=WS1+WS2+WS3+WS4
       ITS=0
C
C --- ORIGINAL OUTPUT FORM
         DOUTP(IAD,1)=CTRA
         DOUTP(IAD,2)=CINF
         DOUTP(IAD,3)=CFLSD
           IF(KOD(1).GT.0.AND.KOD(1).LE.3) THEN
             DOUTP(IAD,4)=CQDP+CQDN
           ELSE IF (KOD(1).EQ.5) THEN
             DOUTP(IAD,4)=0.0
           ELSE
```

```
            DOUTP(IAD,4)=CDELP+CDELN
          END IF

        VOLR=0.0
         DO 160 I=1,ISD
         VOLR=VOLR+WC(I)*DX
 160     CONTINUE
        DOUTP(IAD,5)=VOLR-VOLIR
        DOUTP(IAD,6)=VOL-VOLI

        REDUCT=(1-CTRA/CPTRA)*100
        DOUTP(IAD,7)=REDUCT
        doutp(iad,10)=cptra-ctra
        PHROOT=0.0
        DO 161 I=1,isd
        PHROOT=PHROOT+PH(I)
 161    CONTINUE
        PHROOT=PHROOT/isd
        DOUTP(IAD,8)=PHROOT

          IF (KOD(1).GT.3) THEN
            DOUTP(IAD,9)=0.0
          ELSE
            DOUTP(IAD,9)=GWLA
          END IF

        IAD=IAD+1
C
C************** PRINTING OF THE OUTPUT DATA  ***************************
      IF(T.LT.TEND) GOTO 300
c      WRITE(21,200)
        WRITE(22,200)
C
C --- FORMAT OF ORIGINAL OUTPUT FORM
C200    FORMAT(1H1,25X,'******** TERMS OF THE WATER BALANCE AND CROP PRO',
C      $'DUCTION ********',//,
C      $1X,'TIME',T9,'CINFILT',T20,'TRANSP',T29,'CTRANSP',T40,'SEVAP',
C      $T49,'CSEVAP',T59,'CFLXBOTP',T68,'CFLXBOTN',T78,'VOL-VOLI',T86,
C      $'GROUNDW.LEV',T99,'QPOT',T110,'QTOT',T116,'QTUBER',T123,'TIME',/
C      $T12,'CM',T20,'CM/DAY',T32,'CM',T39,'CM/DAY',T51,'CM',T62,'CM',
C      $T71,'CM',T81,'CM',T91,'CM',T100,'KG/HA',T107,'KG/HA',T118,
C      $'KG/HA',/)
C --- FORMAT OF ALTERNATIVE OUTPUT FORM
200   FORMAT(1H1,25X,'******** TERMS OF THE WATER BALANCE AND ',
     *'CUMULATIVE REDUCTION OF TRANSPIRATION RATE ********',//,
     *1X,'TIME',T16,'E',T28,'I',T35,'QROOTZ',T46,'QBOTTOM',
     *T58,'DELTAWR',T71,'DELTAW',T81,'REDUCT',T92,'PHROOTZ',T106,
     *'GWL',T111,'CUM REDUCTION',/
     *T15,'CM',T27,'CM',T39,'CM',T51,'CM',T63,'CM',T75,'CM',
     *T82,'PERCT',T97,'CM',t107,'cm',t112,'cm',
     */)
C
      IFD=TINIT+1
      ILD=T
C
        ji=1
      DO 210 I=IFD,ILD
      if((i-ifd).ne.(ji*7).and.i.ne.ild.and.i.ne.ifd) go to 210
        ji=ji+1
C
C ---    OUTPUT ORIGINAL FORM
C         WRITE(21,220) I,(DOUTP(I,J),J=1,12),I
C
C ---    OUTPUT ALTERNATIVE FORM
```

```
c          WRITE(21,220) I,(DOUTP(I,J),J=1,10)
         WRITE(22,220) I, (DOUTP(I,J),J=1,10)
C
C ---    FORMAT ORIGINAL OUTPUT FORM
C220     FORMAT(I4,9(2X,F8.2),3F7.0,3X,I4)
C
C ---    FORMAT ALTERNATIVE OUTPUT FORM
220      FORMAT(I4,6(2X,F10.2),2X,F8.1,2X,E10.3,2X,F8.1,2x,f8.3)
222      FORMAT(I4,6(2X,F10.2),2X,F8.1,2X,E10.3,2X,F8.1,2X,I4)
210   CONTINUE
C
C --- IRRIGATION DATA
      IF (KOD(9).EQ.1) THEN
         IGIFT=0
         DO 230 I=L(1),L(2)
            IF (TGIFT(I)) THEN
               IGIFT=IGIFT+1
               NDGIFT(IGIFT)=I
            END IF
230      CONTINUE
         WRITE(21,240)IGIFT,SIZE,(NDGIFT(I),I=1,IGIFT)
240      FORMAT(//////1X,20('*'),' IRRIGATION ',20('*')//
     $   ' IRRIGATION : ',I3,' TIMES ',F4.1,' CM.'/
     $   ' ON DAYNRS. : ',23(I5)/6(14X,23(I5))//52('*'))
      END IF
C
300   RETURN
      END
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
      BLOCK DATA
      COMMON/CUM/ CPREC,CINTC,CINF,CPTRA,CPSEV,CTRA,CTRA1,CTRA2,CSEV,
     $CSEV2,CFLSD,CFLSDP,CFLBU,CQD,CQDP,CQDN,CDEL,CDELP,DEL,DVOL,
     $CRTEX(100)
      DATA CPREC,CINTC,CINF,CPTRA,CPSEV,CTRA,CTRA1,CTRA2,CSEV,
     $CSEV2,CFLSD,CFLSDP,CFLBU,CQD,CQDP,CDEL,CDELP,DEL,DVOL
     $/19*0.0/,CRTEX/100*0.0/
      END
```

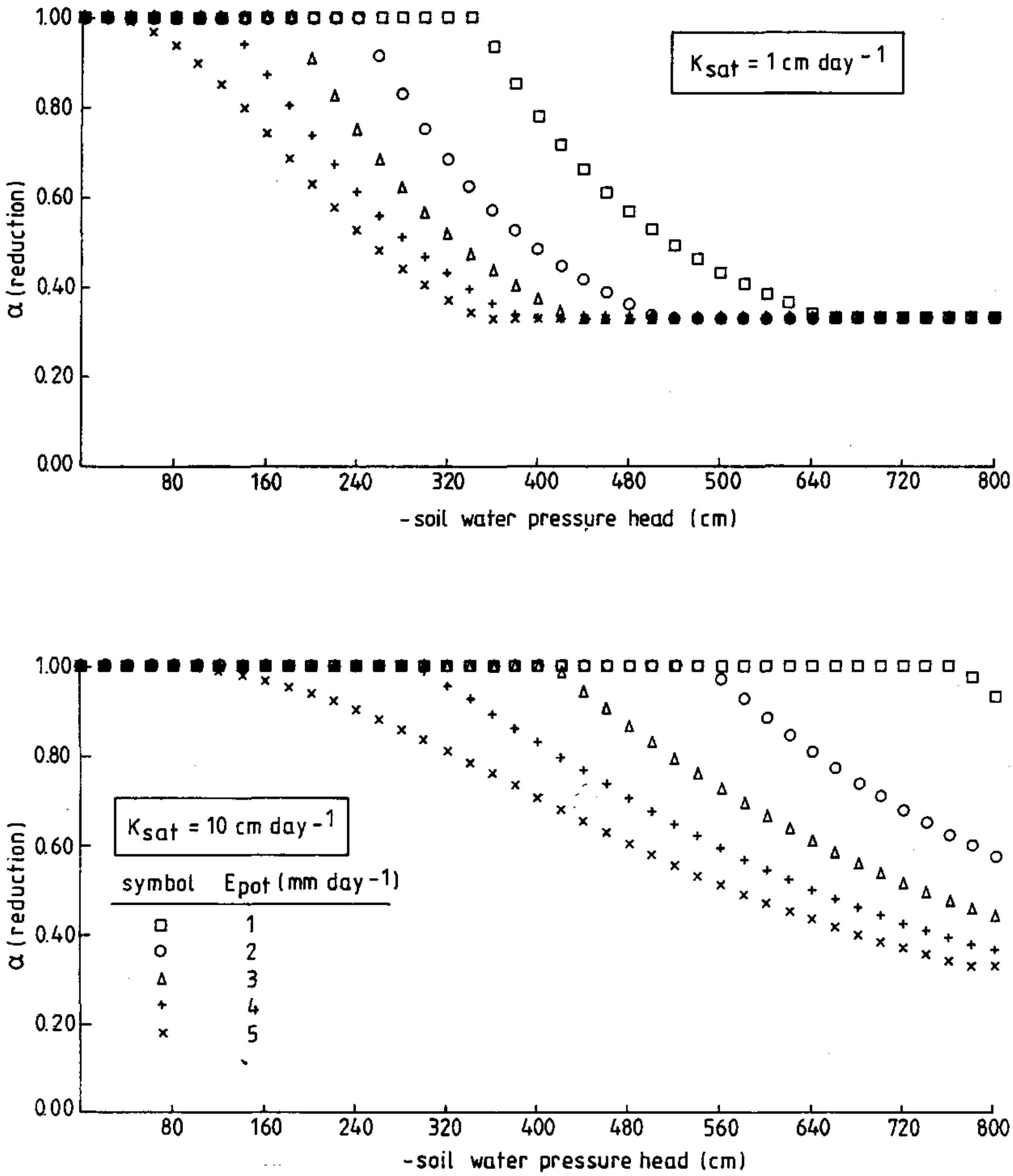
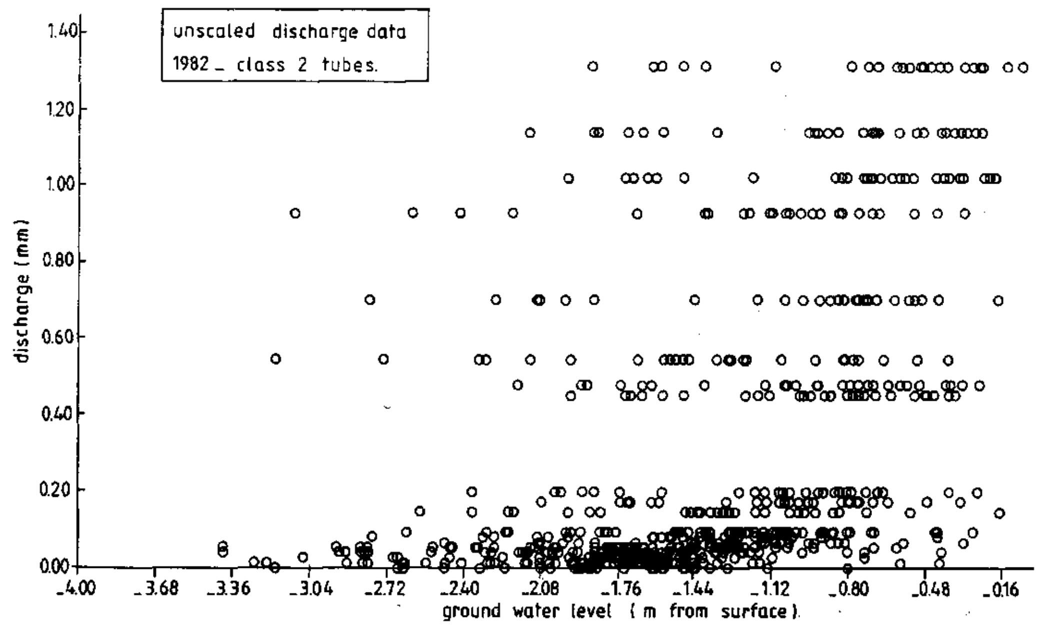


Figure 4 Effect of K(Ψ) on sinkterm (α) as a function of Ψ and E_{pot}



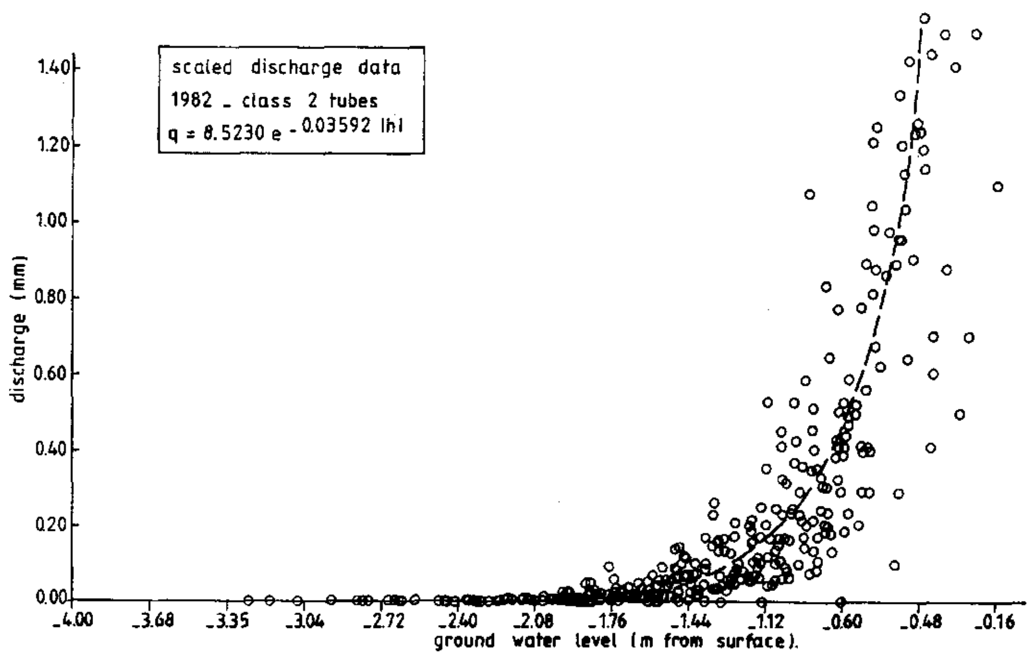


Figure 3 Unscaled and scaled discharge data 1982.

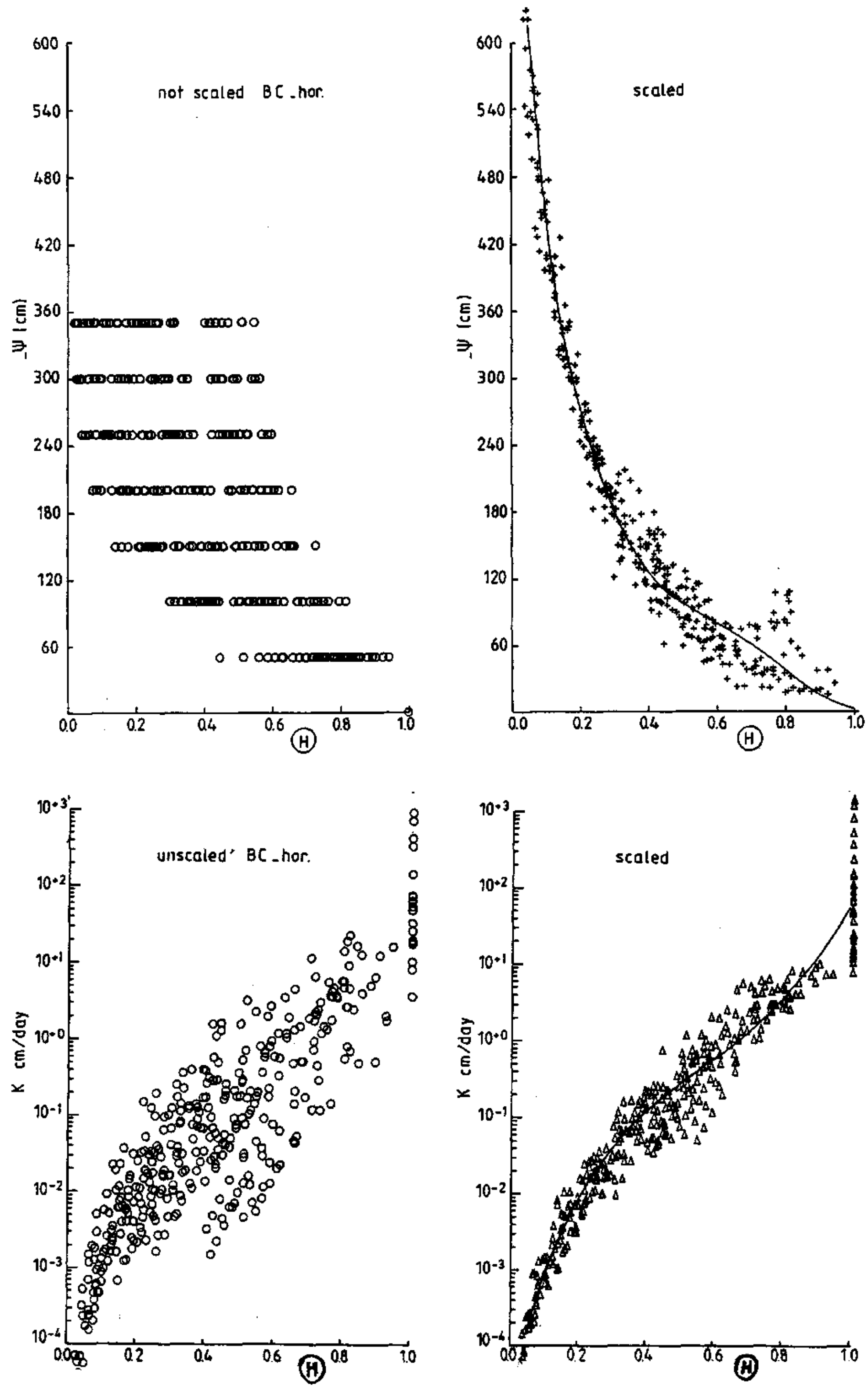


Figure 2b Unscaled and scaled hydraulic data BC-horizon.

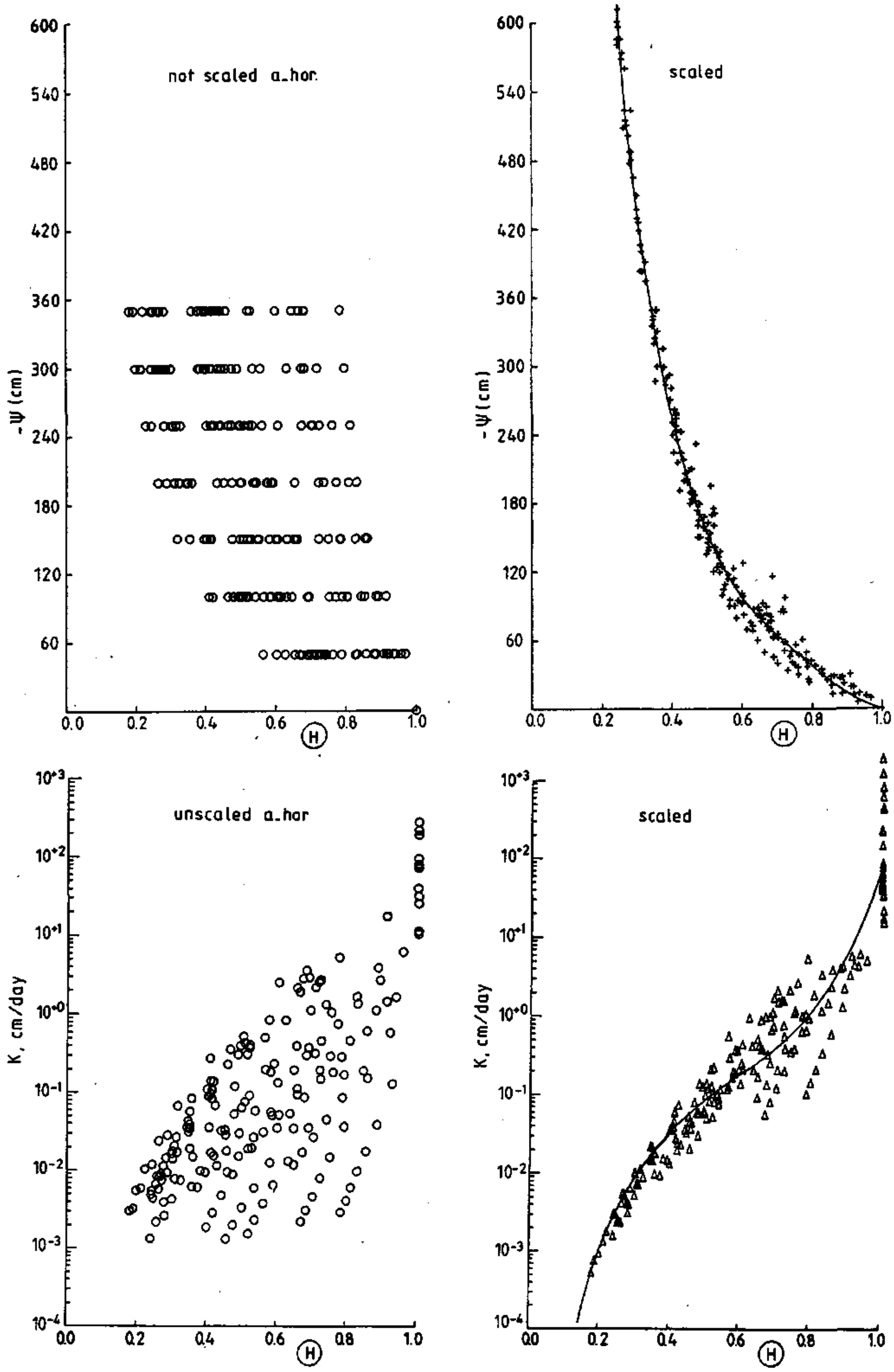


Figure 2a Unscaled and scaled hydraulic data A-horizon.

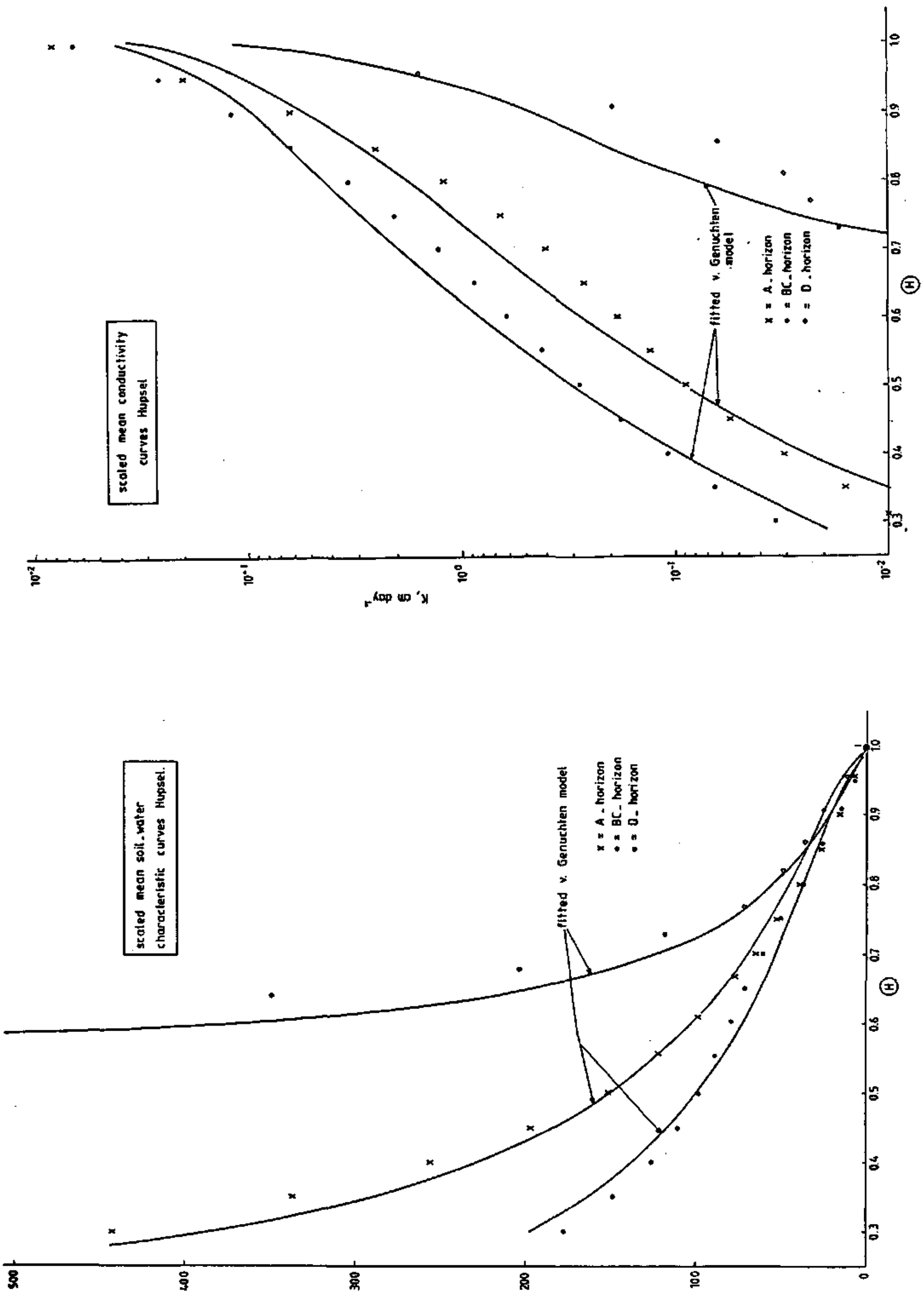


Figure 1 Scaled mean hydraulic functions Hupsel.

SOME MAJOR MODIFICATIONS OF THE SIMULATION MODEL SWATRE

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INTRODUCTION

The program SWATR was developed by Feddes et al. (1978). This original version was later extended by Belmans et al. in 1981 (SWATRE) and most recently by Belmans, Wesseling, Feddes and Kroonen (SWAPRO). The SWAPRO-version can simulate a potato crop yield and allows irrigation if soil moisture conditions are unfavourable for optimal crop growth.
As compared with the latter program, the following major extensions are added.

1. Instead of providing tables that describe the soil physical characteristics of each soil layer, analytical expressions are introduced such that only the parameters of these expressions are needed to fully describe the soil-water characteristic and hydraulic conductivity curve.

2. The definition of a new sink term that allows water extraction by roots to be influenced by the hydraulic conductivity of the soil in the rootzone.

3. From the distribution type, mean and standard deviation of a set of scale factor values, it is possible to simulate water flow with variable soil hydraulic properties. A set of scale factor values for each soil layer or compartment is calculated through generation of a standard normal distribution and the statistical properties of scale factor values.

---

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