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User's Manual for Desert2: A Desert Ecosystem Simulator Written in Ansi Fortran IV

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USER'S MANUAL FOR DESERT2: A DESERT ECOSYSTEM SIMULATOR WRITTEN IN ANSI FORTRAN IV

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OVERVIEW OF DESERT2

DESERT2 is a desert ecosystem simulator written in the American National Standards Institute version of FORTRAN IV. It comprises two groups of subroutines: 1) the submodels, each of which simulates a particular process in the ecosystem and 2) the non-biological subroutines, which perform input, output and "book-keeping" operations. The latter group acts as a master control program that calls, or runs the first group. The first group includes certain "utility subroutines" that are called by one or more of the submodels. The entire package has been designed to have the potential to model many features of a wide range of ecosystems. Accordingly, the state variables to be modeled are not immutably fixed in the FORTRAN code, but are specified in the data deck within constraints imposed by the various subroutines. The constraints of the non-biological subroutines are so weak that one could model a grassland or forest ecosystem as easily as a desert ecosystem. The constraints of the submodels are more severe, but still afford a good deal of flexibility. The availability of a library of submodels simulating processes in different ecosystems—or simulating the same process in the same ecosystem, but at different levels of resolution—should allow simulation of any aspect of any ecosystem that is of interest to the user (within the limits of current biological knowledge).

The submodels in the package described below are nonlinear compartment models that simulate the flow of carbon, nitrogen, water and heat through various portions of the plant, animal (grazers), abiotic and decomposer subsystems of a desert ecosystem. The information links among the four subsystems and the system environment (exogenous data) are illustrated in Figure 1. A brief statement of the function of each subroutine in DESERT2 (including both the submodels and the "non-biological subroutines") is presented in Table 1. The hierarchy of these subroutines is diagrammed in Figure 2. Various output variables, input variables, parameters and initial conditions are associated with each submodel. The output and input variables (which are continually changing during the simulation) are summarized in Table 2. Table 3 presents a synopsis of the sequence of operations performed by DESERT2 during a simulation.

Table 1. Brief description of the major function of each of the FORTRAN procedures in DESERT2

	Non-biological procedures
MAINPR	Calls subroutines which initiate and terminate the simulation. Controls the time-step loop, multiplies the state variable increments predicted in the submodels by the length of the time-step, updates the state variables and time clock, and when necessary, calls the subroutine that prints tabular reports.
BLDATA	Initializes selected variables. Simulates the function of a BLOCK DATA subroutine.
STARTR	Calls subroutines that read the data file before the start of the simulation.
MINPUT	Reads definitions of all state variables and the initial values of the plant state variables. Reads flags and variables controlling the simulation.
DATCHK	Checks validity of dates read from the input file.
READAT	Reads the dates on which reports or intermediate calculations are to be printed.
INITIL	Reads initial values of the shed seed, animal, litter and soil organic matter compartments.
GINPUT	Reads instructions for graphical output.
EINPUT	Reads exogenous data.
EXOGEN	Supplies values of the exogenous variables to the submodels during each time-step of the simulation.
STVNEG	Prints a message when there is an attempt by the submodels to drive a state variable below zero.
TOTALR	Computes a variety of totals and subtotals of chemical constituents in the plant, animal and soil subsystems.
DRYMAT	Computes the total dry matter in various groups of state variables at the end of each time-step.
FLOWSS	Computes the sums of selected groups of accumulated flows that are printed at the end of each tabular report.
PREPAR	At selected intervals during the simulation, this subroutine writes onto a scratch file the values of the variables that are to be graphed at the end of the simulation.
REPORT	Prints tabular reports of the state of the system at specified times during the simulation.
GRAPHZ	Prints graphs at the end of the simulation.
GETFIG	Called at the end of the simulation just before graphs are printed. Reads from a scratch file the values of each of the graphed variables at each of several points during the simulation.
COPYBY	Copies bytes from one word to another during the preparation of graphs.
	Plant subroutines
VEGETA	Calling program for the plant submodels. It is called by the main program during each time-step.
VINPUT	Reads data common to all the plant submodels at the start of a simulation, and then calls each of the submodels so they can read parameters needed uniquely by them.
PHENOL	Calculates which phenological stage each plant group is in at the start of each time-step.
PHOTOS	Calculates the net daily carbon fixation by each plant group.
TRANSP	Calculates the daily transpiration of water by each plant group.
RESPIR	Calculates the daily respiration by each organ of each plant group.
TRANSL	Calculates the amounts of photosynthate to be allocated to each organ, and the translocation from the shed seed pool (or from storage organs) during germination (or leafing-out).
ALOCAT	Calculates how much of the carbon added to an organ will be allocated to each of the carbon types.
STONEW	Performs the translocation of non-carbon constituents during germination and leafing-out.
NUTUPT	Calculates the uptake of nitrogen and its allocation to each of the plant organs.
DEATHH	Calculates the abscission of herbaceous organs and the death of plants during periods of drought.
	Animal subroutines
ANIMAL	A calling program for the animal submodels.
ANRESP	Calculates the daily respiration of each animal group.
FEEDNG	Computes the daily quantities of food ingested by each animal group.
MANAGE	Provides for movement of domestic grazers into and out of the system.
	Abiotic subroutines
SOILSS	A calling program for the soil submodels.
SLHEAT	Calculates the temperature in each of the soil layers.
SLWATR	Calculates the water potential in each of the soil layers.
TRIDIM	Solves a system of simultaneous linear equations in which the coefficients of the independent variables are in the form of a tri-diagonal matrix. Called by the water and heat flow models.
WBALAN	Checks whether the water budget is in balance.
WINPUT	Reads the input to the water flow model.
	Decomposer subroutine
DCOMPO	Calculates the decomposition of litter and soil organic matter.

Table 1, continued

Mathematical functions	
PWLNEG	Solves a piece-wise linear equation containing a ramp with a negative slope. Utility procedure called by several submodels.
PWLPOS	Solves a piece-wise linear equation containing a ramp with a positive slope. Utility procedure called by several submodels.
GENPDF	Solves a generalized Poisson density function. Called by the carbon fixation model.
RUNAVE	Computes running averages. Called by the phenology model to calculate the running average of soil temperature.

Table 2. Inputs and outputs associated with each of the submodels in DESERT2. Exogenous inputs are values for the current time-step. Inputs predicted by the submodels are values for the previous time-step. The only inputs listed are variables; parameters are not listed

Plant subsystem

PHENOL (phenology submodel)

inputs:

1) running average air temperature (from VEGETA)
2) soil water potential of a specified layer (from SLWATR)
3) current phenological stage (from PHENOL)
4) days elapsed during current phenological state (from PHENOL)

outputs:

1) phenological stage
2) days elapsed during current phenological stage

PHOTOS (carbon fixation submodel)

inputs:

1) air temperature (from exogenous data)
2) soil water potential of a specified layer (from SLWATR)
3) dry weight of photosynthetic tissue (result of interaction of all plant and animal submodels)
4) photoperiod (from exogenous data)

output:

1) the net amount of carbon fixed

TRANSP (transpiration submodel)

input:

1) net amount of carbon fixed during the day

output:

1) water transpired ($kg \cdot ha^{-1} \cdot day^{-1}$). (Regardless of the units of the simulation, this model calculates $kg \cdot ha^{-1} \cdot day^{-1}$ transpired, since these units are required by the water model)

RESPIR (plant respiration submodel)

inputs:

1) air temperature (from exogenous data)
2) soil water potential of a specified layer (from SLWATR)
3) labile carbon in respiring organ

output:

1) amount of carbon respired

TRANSL (translocation submodel)

inputs:

1) phenological stage (from PHENOL)
2) soil water potential in specified layer (from SLWATR)
3) biomass of each of the chemical constituents of the seed pool and of storage organs (interaction of all the plant and animal submodels)
4) photosynthate produced during current time-step

outputs:

1) translocated material from shed seeds or storage organs to newly forming organs
2) quantity of photosynthate added to each of the organs

ALOCAT (submodel for allocation of photosynthate to various classes of carbon compounds)

input:

1) amount of carbon to be distributed to the carbon classes of a particular organ (from TRANSL)

output:

1) quantity of carbon added to each carbon type

NUTUPT (nutrient uptake submodel)

input:

1) amounts of nitrogen and protein carbon in each organ

output:

1) nitrogen added to each organ

DEATHH (abscission and plant death submodel)

inputs:

1) days elapsed since start of dormant stage (from PHENOL)
2) soil water potential in a specified layer (from SLWATR)

Table 2, continued

3) biomasses of compartments experiencing abscission or death. (Result of interaction of all the plant and animal models.)

output:

1) losses due to death and abscission

Animal subsystem

ANRESP (animal respiration submodel)

inputs:

1) dry weight of the animal group respiring (from FEEDNG and ANRESP)
2) population density of the animal group (from exogenous data)

output:

1) labile carbon respired

FEEDNG (Animal intake submodel)

inputs:

1) biomasses of each of the potential food sources (result of interaction of all the plant and animal submodels)
2) biomass of the animal group that is feeding (from FEEDNG and ANRESP)

output:

1) ingested quantities of each food source

Abiotic subsystem

SLWATR (soil water submodel)

inputs:

1) precipitation (from exogenous data)
2) pan evaporation (from exogenous data)
3) transpiration (from TRANSP)

output:

1) soil water potentials by layer

SLHEAT (soil heat submodel)

input:

1) air temperature (from exogenous data)

output:

1) soil temperatures by layer

Decomposition subsystem

DCOMPO (decomposition submodel)

inputs:

1) biomasses of each of the compartments undergoing decomposition. (Result of interaction of all the plant and animal submodels.)
2) soil water potential of a specified layer (from SLWATR)

output:

1) quantities of materials decomposed

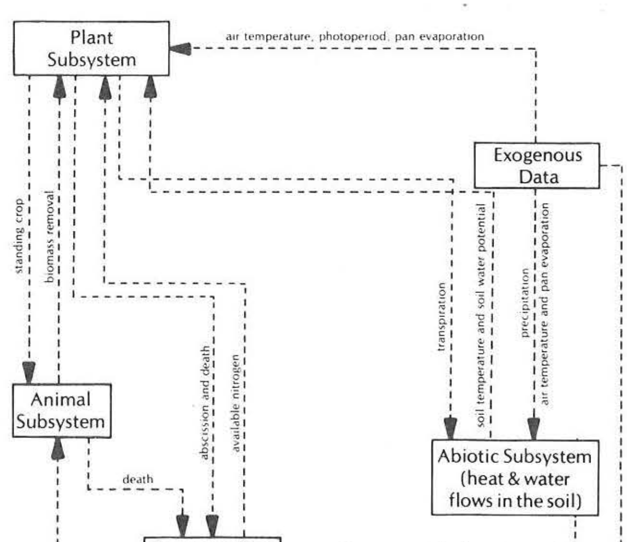


Figure 1. Information links among the subsystems modeled by DESERT2.

DESCRIPTION OF THE SUBMODELS

The following assumptions and restrictions apply to several or all of the submodels:

1) The plant and animal groups that are simulated may be species, groups of species or the life stages of a species or group of species.

2) Five plant "organs" are modeled: photosynthetic tissue, non-photosynthetic parts of new shoots, non-photosynthetic parts of old shoots, reproductive parts and below-ground parts.

3) Five chemical constituents are modeled: nitrogen, ash, protein carbon, labile carbon and structural carbon.

4) Five phenological stages are modeled: dormancy, germination, leafing-out, vegetative growth and reproductive growth.

5) During the germination (or leafing-out) stages, translocation occurs from shed seeds (or storage organs) to the nascent organs. No translocation occurs during the vegetative and reproductive stages. Instead, photosynthate is added directly to the various organs.

6) The animal models are intended for grazers only, and thus do not simulate demography. The only processes modeled are ingestion and respiration.

7) The model operates on a 360-day year consisting of twelve 30-day months. The submodels are constructed on the assumption that the time-step is always one day long. The main program makes the necessary adjustments when longer time-steps are used.

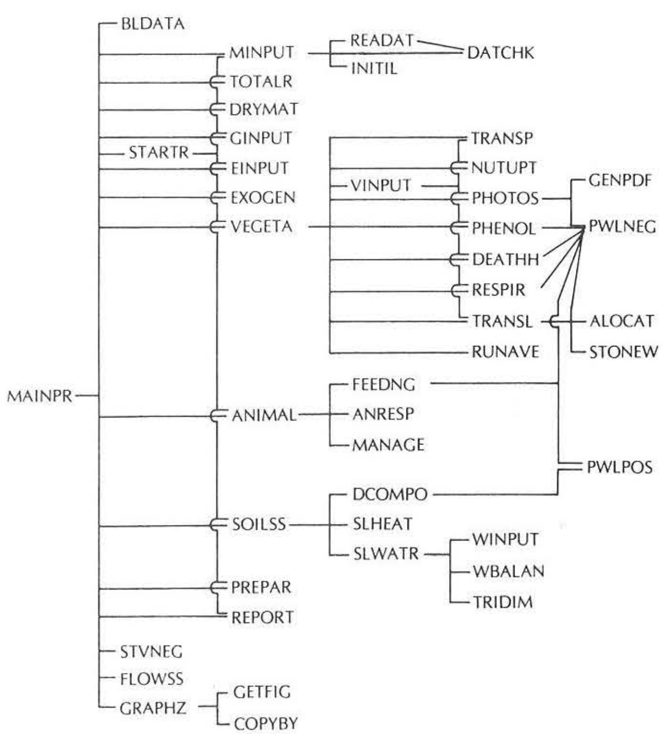


Figure 2. Hierarchy of procedures in DESERT2.

Table 3. Operation of FORTRAN implementation of DESERT2

1	Read definitions of state variables, their initial values, and miscellaneous instructions controlling the length of the simulation and the form of its print-out
2	Read instructions for graphical output
3	Read exogenous variables
4	Read values of the parameters in the plant submodels
5	Read values of the parameters in the animal submodels
6	Read values of the parameters in the abiotic and decomposer submodels
7	Print report describing initial state of the system
8	Begin cycling through the time-step loop
8.1	Begin loop for plant groups
8.1.1	Call phenology model -- if plant is dormant, skip to 8.1.7
8.1.2	Call carbon fixation model (in turn, calls translocation and carbon allocation models)
8.1.3	Call respiration model
8.1.4	Call transpiration model
8.1.5	Call translocation model if plant group is germinating or leafing-out
8.1.6	Call nutrient uptake model
8.1.7	Call model for organ abscission and death, then return to 8.1.1 for a new plant group. When all plant groups have been dealt with, go to 8.2
8.2	Call grazing model -- begin loop for animal groups
8.2.1	Call respiration model
8.2.2	Call feeding model and return to 8.2.1 for a new animal group
8.2.3	Call herd management model. When all animal groups have been dealt with, go to 8.3
8.3	Call soil models
8.3.1	Call heat flow model
8.3.2	Call water flow model
8.3.3	Call decomposition model
8.4	Main program adds state variable increments (predicted by the submodels) to the state variables, prints a report if desired, and advances the time clock in preparation for the next time-step. After the last time-step, go to 9
9	After the simulation is complete, print a final report and any graphs that were requested

Conventions Used in Descriptions of Submodels

1) All rates referred to in the following descriptions are relative rates (specific rates or proportional rates) having the units "days^{-1}" or equivalently, "grams per gram per day." These should not be confused with absolute rates (flux densities in the present context) having the units "grams per square meter per day."

2) The descriptions of the submodels are independent of one another; the symbols used in the description of one submodel bear no relation to those used in the description of another submodel.

3) For convenience only, the units "grams," "square meters" and "days" will be used as measures of mass, area and time. The FORTRAN implementation of the submodels allows one to use any units of mass and area, but requires that the unit of time be "days." The user must be sure that the units of all variables and parameters are consistent.

Phenology Submodel (PHENOL)

The sole function of the phenology model is to determine whether a plant group will shift from one phenological stage to another. A plant group will be in the dormant stage prior to the growing season (Fig. 3). If it is perennial and active during the spring or summer seasons, it will shift to the leafing-out stage when the following conditions are simultaneously satisfied: 1) the running average air temperature is both rising and above a specified threshold, P1; and 2) the soil water potential of a specified layer (hereafter called layer i) exceeds a threshold, P2. The running average temperature can be calculated over any number of days between 1 and 30. If the plant group is perennial and active during the fall or winter, it will shift to the leafing-out stage when the following conditions are simultaneously satisfied: 1) the running average air temperature is both falling and below a specified threshold, P1; and 2) the soil water potential of layer i exceeds a threshold, P2. Germination of annuals has the same requirements as leafing-out of perennials, plus an additional requirement that there be a minimum amount of precipitation in a specified interval preceeding the current time-step. Leafing-out and germination are treated as discrete events. Consequently, a shift to the vegetative stage automatically occurs during the next time-step.

The plant group will shift to the reproductive stage if the following conditions are simultaneously met: 1) a specified number of days, P4, have elapsed since the beginning of the vegetative stage; 2) the soil water potential of a specified layer (hereafter called layer j) is above a threshold, P5. Soil layers i and j may (but need not) be the same.

The plant group will pass from the reproductive stage to the dormant stage if the soil water potential of layer i falls below a threshold, P6. The plant group may move from the reproductive stage back to the vegetative stage if the soil water potential of layer j falls below another threshold, P3, where P3 > P6.

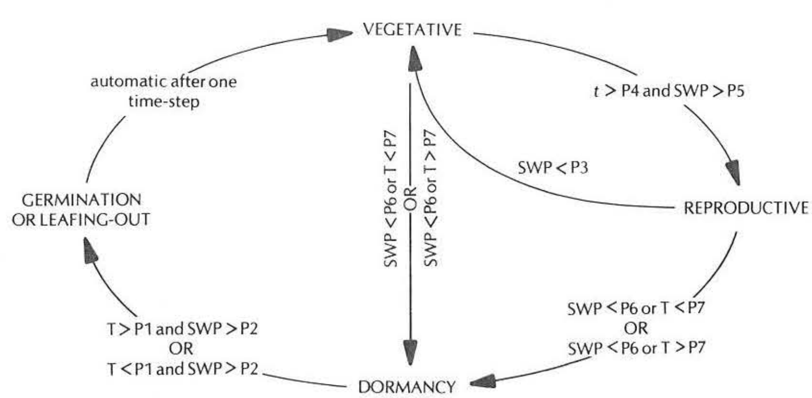
Plant groups active in the spring or summer will pass from the reproductive stage to the dormant stage if the running average air temperature falls below a threshold, P7. Vegetative plants can also become dormant when the running average temperature falls below P7, provided they have been vegetative for a total of at least P4 days. The transition of fall- or winter-active plant groups from the vegetative or reproductive stages to the dormant stage is governed by analagous requirements, but the running average air temperature must rise above P7 rather than fall below it.

Carbon Fixation Submodel (PHOTOS)

This model predicts net daytime carbon fixation by photosynthetic tissue as a function of soil water potential in a specified soil layer, maximum air temperature, mineral nitrogen content of the soil and the photoperiod, according to the equation:

$$C = A[rFGH(12/44)(.001)]Dk$$

where C is the g carbon fixed $\cdot$ m^{-2} $\cdot$ day^{-1}; A is the dry weight of photosynthetic tissue (g/m^2); r is the maximum possible relative fixation rate (mg CO_2 $\cdot$ g dry matter^{-1} $\cdot$ hr^{-1}); F, G and H are scaling factors (defined below) representing the effects of temperature, soil water potential and soil nitrogen; (12/44)(.001) converts from mg CO_2 to g carbon; D is the photoperiod (hr); and k is a constant accounting for the fact that the mean rate of fixation is different from the rate obtained at midday.



t = days spent in current phenological stage
T = running average air temperature
SWP = soil water potential in a specified layer
P1-P7 are parameters

Figure 3. Phenology model.

The scaling factor accounting for the effect of temperature is given by:

$$F = Q^c \exp[c/d(1-Q^d)]$$

and

$$Q = (b-T)/(b-a)$$

where T is the midday air temperature, a is the temperature at which fixation occurs at a maximum rate, b is the upper compensation point of temperature at which net fixation is zero, and c and d are curvature constants for the descending and ascending limbs of the curve (Fig. 4). F varies from zero to one.

The scaling factor accounting for soil water potential is given by:

$$G = \min\{1, \max[0, (W-p)/(q-p)]\}$$

where W is the soil water potential (bars) of the specified layer, p is the value of W below which fixation will not occur and q is the value of W above which the optimum fixation rate is unaffected (Fig. 5). G varies from zero to one.

The scaling factor accounting for the effect of soil nitrogen is given by:

$$H = aN^b$$

where N is the amount of nitrogen in the root zone (kg/ha) and a and b are constants (Fig. 6). H varies from zero to one.

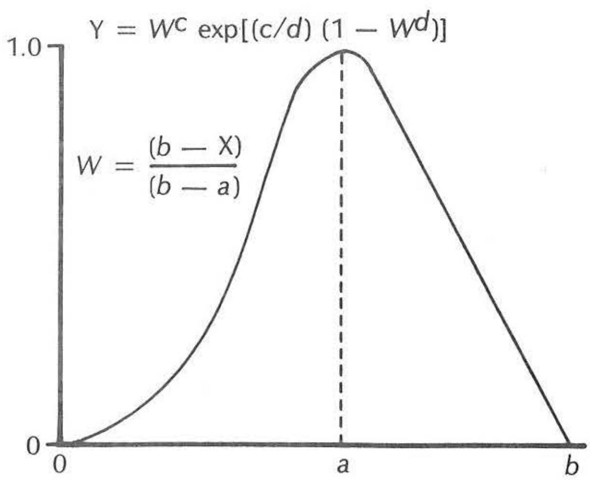


Figure 4. Generalized Poisson density function. The Y-axis is a dimensionless scaling factor varying from zero to one. The X-axis is temperature. The constants a, b, c and d are, respectively, the temperature optimum, the upper compensation point, a shape parameter for the descending limits of the curve and a shape parameter for the ascending limb. High values of c and d make the limbs sag inward. The function is not defined for values of X greater than b.

The parameters r, a and b in the above equations may vary through time (but need not) in order to account for acclimatization. Thus all three parameters are treated as variables whose values are given by:

$$Y = u \sin(J + v)$$

where J is the day of the year (assuming a 360-day year with twelve 30-day months), v is a phase shift (days), u is the amplitude of the oscillation and Y is either r, a or b (Fig. 7). The carbon that is fixed is allocated to plant parts and carbon classes by the models TRANSL and ALOCAT.

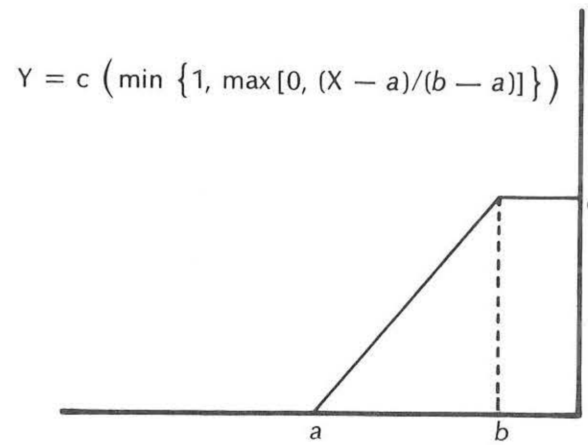


Figure 5. Piece-wise linear function having a ramp with a positive slope. The Y-axis may be a dimensionless scaling factor or a rate. The X-axis may be temperature, days elapsed since the start of the current phenological stage or soil water potential (in which case the maximum value of zero would occur at the right extremity of the axis and smaller values, e.g., —80 bars, would be found to the left). The parameter a is the value of X below which Y is zero, and b is the value of X above which Y attains its maximum value of c ($c = 1$ when Y is a scaling factor).

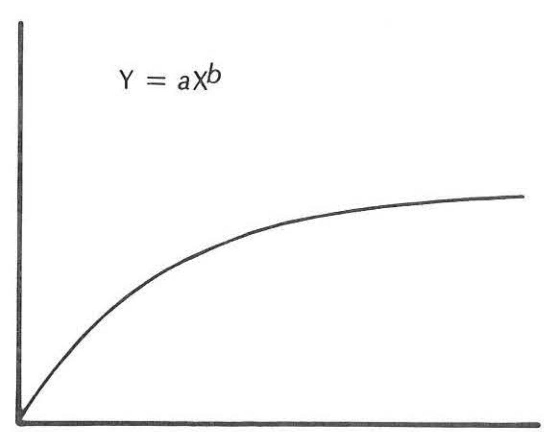


Figure 6. Power function. For $b < 1.0$, the curve increases at a decelerating rate. The curve is not asymptotic.

The scaling factor accounting for the effect of mineral nitrogen in the soil is given by:

$$H = SN^t$$

where N is the mineral nitrogen content of the soil (expressed as mass per area), t is a curvature constant whose value is < 1.0 and S is a scaling parameter. H can vary from zero to > 1.0.

Plant Respiration Submodel (RESPIR)

This model predicts the respiration of non-photosynthetic organs during a 24-hr day and the respiration of photosynthetic organs during the dark hours, according to the following equation:

$$C = (a + bF)\,G\,(12/44)\,(.001)\,HA$$

where C is g carbon respired $\cdot$ m^{-2} $\cdot$ day^{-1}, F is the adjusted temperature (defined below), *a* and *b* are the Y-intercept and slope of the straight line function relating hourly relative respiration rate (mg CO_2 $\cdot$ g dry $matter^{-1}$ $\cdot$ hr^{-1}) to adjusted temperature, G is a scaling factor (defined below) accounting for the effect of soil water potential, (12/44) (.001) converts from mg CO_2 to g carbon, H is the length of the period of respiration (24 hr for non-photosynthetic organs and 24 hr minus the photoperiod for the photosynthetic tissue) and A is the dry wt of the respiring tissue in g/m^2. The possibility of acclimatization is accounted for by adjusting the actual temperature according to the equation:

$$F = T + u \sin (J + v)$$

where F is the adjusted temperature, T is the actual temperature (mean air temperature for a 24-hr period for non-photosynthetic organs, or mean night-time air temperature for photosynthetic organs), J is the day of the year, and u and v are the amplitude and phase shift (Fig. 7). Use of this equation causes the respiration at a given temperature in the warm part of the growing season to be less than the respiration at the same temperature in the cool part of the growing season.

The scaling factor accounting for the effect of soil water potential is given by:

$$G = \min\{1, \max[0, (W-p)/(q-p)]\}$$

where W is the soil water potential (bars) of the specified layer, p is the value of W below which respiration will not occur and q is the value of W above which the optimum respiration rate is unaffected (Fig. 5).

Transpiration Submodel (TRANSP)

The transpiration model is based on the following equation:

$$W = P(a + bE_o)$$

where *W* is the kg water transpired/day, *P* is the primary production (kg dry matter/day), E_o is the pan evaporation (mm/day) and *a* and *b* are constants (Fig. 8). The transpiration model does not itself deplete soil water, but passes to the soil water model a value of W for each plant group (after having converted it to kg/ha).

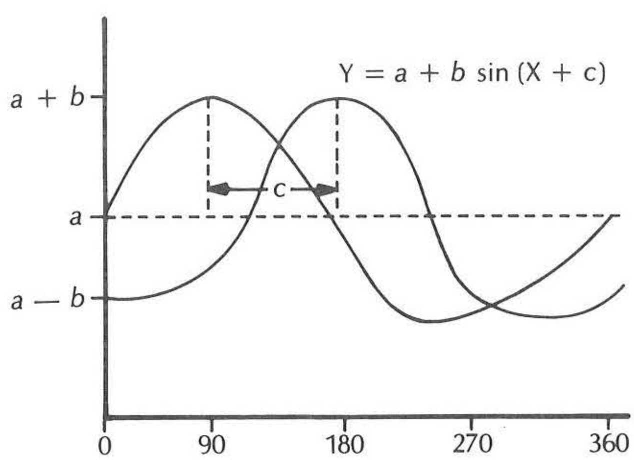


Figure 7. Sine function. The Y-axis may be any variable or any parameter which is being treated as a variable. The X-axis is the day of the year, assuming a 360-day year. The parameters *a*, *b* and *c* are, respectively, the mean value of Y, the amplitude of oscillation and the phase shift. (Note that the phase shift is an advance, and not a lag.) In the example above the phase shift is 90 days.

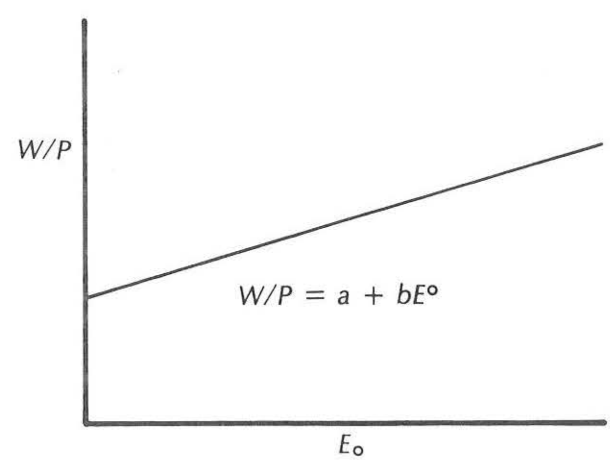


Figure 8. The relationship between the transpiration coefficient (*W/P*) and potential evaporation. *W* is the water transpired (kg/ha) and *P* is the dry matter produced during the same period (kg/ha). E_o is the potential evaporation. The value of the transpiration coefficient when potential evaporation is zero is *a*, while *b* is the slope.

TRANSLOCATION SUBMODEL (TRANSL)

This model performs three functions: 1) it allocates photosynthate to the various organs; 2) it transfers material from storage organs or seeds to nascent organs during leafing-out or germination; and 3) it calculates the fraction of the reproductive organ compartment which is in the form of mature seed.

Allocation of photosynthate is determined by a matrix of constants that specifies the fraction of photosynthate allocated to each of the organs during each of the non-dormant phenological stages.

During germination, translocation occurs from the seed pool to new shoots and roots, while during leafing-out translocation occurs from below-ground organs (and old stems of perennial species) to leaves or flowers. Translocation is calculated by the following equation:

$$R = \min\{c, \max[0, (W - p)/(q - p)]\}\ A$$

where R is the amount translocated (g material $\cdot$ $m^{-2} \cdot day^{-1}$), W is the soil water potential in a specified soil layer, p is a value of W below which translocation does not occur, q is a value of W above which translocation occurs at its maximum rate of *c* and A is the amount of material in the donor compartment, g/m^2 (Fig. 5). Constant proportions of the translocated material are allocated to the recipient organs. The translocated materials are labile carbon and the non-carbon chemical constituents.

The quantity of mature seed is calculated as follows:

$$F = \min\{c, \max[(E - p)/(q - p)]\}$$

where F is the fraction of the biomass in the reproductive organ compartment in the form of mature seed, E is the number of days elapsed since the start of the reproductive stage, p is the value of E when mature seeds begin to appear, q is the value of E when F ceases to increase and *c* is the value of F for fruits that are fully mature (Fig. 5).

SUBMODEL FOR ALLOCATION OF PHOTOSYNTHATE TO VARIOUS CLASSES OF CARBON COMPOUNDS (ALOCAT)

This model allocates translocated carbon and photosynthate to each of the three carbon types of a given organ. The allocation is determined by a matrix of constants which specifies the fractions of translocate or photosynthate that are allocated to each of the carbon types during each of the non-dormant phenological stages.

NUTRIENT UPTAKE SUBMODEL (NUTUPT)

This module merely transfers enough nitrogen from the mineral nitrogen pool in the soil to the plant so that a constant ratio between nitrogen and protein carbon is maintained. (Note that the affect of mineral nitrogen availability on photosynthesis is included in the photosynthesis model, and the release of mineral nitrogen from organic matter is included in the decomposition model.)

ABSCISSION AND PLANT DEATH SUBMODEL (DEATHH)

This model predicts the loss of herbaceous organs that normally abscise at the end of a growing period, as well as the death of whole plants as a result of drought. The abscission of herbaceous parts is given by:

$$B = \min\{1.0, \max[0, (E - q)/(p - q)]\}\ A$$

where B is the flux density of material lost ($g \cdot m^{-2} \cdot day^{-1}$), E is the number of days elapsed since the start of the dormant stage, p is the value of E when abscission begins, q is the value of E when abscission ends, and A is the quantity of material in the compartment undergoing abscission (Fig. 5).

Plants may die during periods of drought according to the equation:

$$D = c\left(\min\{1.0, \max[0, (q - W)/(q - p)]\}\right)X$$

where D is the loss due to drought ($g \cdot m^{-2} \cdot day^{-1}$), W is the soil water potential (bars) in a specified soil layer, q is the value of W above which there is no death, p is the value of W below which death occurs at the maximum specific rate (*c*) and X is the amount of material in the compartment from which the loss is occurring (Fig. 9).

ANIMAL RESPIRATION SUBMODEL (ANRESP)

The quantity of carbon respired by an animal group is given by:

$$R = a(B/p)^b P$$

where R is the carbon respired ($g \cdot m^{-2} \cdot day^{-1}$), p is the population density of the animal group ($number/m^2$) and *a* and *b* are constants in the power function (Fig. 6). The respired carbon is removed from the labile carbon compartment.

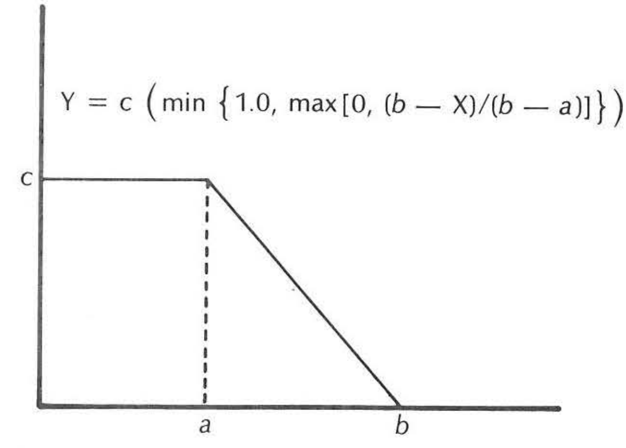


Figure 9. Piece-wise linear function having a ramp with a negative slope. The Y- and X-axes are the same as in Figure 8. The parameter *a* is the value of X below which Y attains its maximum value of *c* ($c = 1$ when Y is a scaling factor), and *b* is the value of X above which Y is zero.

Animal Intake Submodel (FEEDNG)

This model predicts the food intake of each of the animal groups as a function of their biomasses and the "effective food" available to them. The ingested material is added to the chemical constituent compartments in specified proportions, and any remaining material is transferred to litter.

The effective food available to an animal group is given by:

$$E = \sum_i c_i X_i$$

where E is the dry weight of the effective food (g/m^2), the X_i are the dry weights (g/m^2) of all the compartments in the model that can be thought of as potential food sources (including all plant parts of all plant groups, shed seeds, animal groups and litter) and the c_i are preference factors, with values between zero and one, indicating the animal group's preference for the i'the food source.

Ingestion is calculated by the following equation:

$$I = ArFG$$

where I is the ingested material ($g \cdot m^{-2} \cdot day^{-1}$), A is the dry weight of the animal group (g/m^2), r is a maximum specific feeding rate ($g \cdot g^{-1} \cdot day^{-1}$), and F and G are scaling factors with values between zero and one.

The first scaling factor, which accounts for an exploitation component of competition, is given by:

$$F = \min \{1, \max[0, (E-p)/(q-p)]\}$$

where E is again the effective food available, p is the value of E below which ingestion does not occur, and q is a value of E above which the maximum feeding rate is unaffected (Fig. 5).

The second scaling factor, which accounts for an interference component of competition, is given by:

$$G = \min \{1, \max [0, (q-A)/(q-p)]\}$$

where A is again the dry weight of the animal group, q is a value of A above which ingestion does not occur (which in practice is never approached by the model), and p is a value of A below which there is no interference (Fig. 9).

Material is then removed from each food source according to the following equation:

$$R_i = (I/E)\, c_i X_i$$

where R is the amount eaten from the i'th food source ($g \cdot m^{-2} \cdot day^{-1}$) and all other symbols are as previously defined. All classes of carbon in the ingested material are summed, and a portion of this total is allocated to the labile carbon pool of the animal to counterbalance respiration losses. Constant proportions of any remaining carbon are allocated to each of the classes of carbon. Constant proportions of non-carbon constituents are also added to the animal biomass, and any remaining material is transferred to litter.

Soil Heat and Soil Water Flow Submodels (SLHEAT and SLWATR)

These models were written by Paul W. Lommen (Ecology Center, Utah State University). The heat flow model is based on the following partial differential equation describing soil temperature (T) as a function of time (t) and depth (z):

$$\partial T/\partial t = \partial/\partial z[\sigma(\partial T)/(\partial z)]$$

where σ is the soil's thermal diffusivity (cm^2/day), which in turn is the ratio of the thermal conductivity ($cal \cdot cm^{-1} \cdot day^{-1} \cdot {}^\circ C^{-1}$) and the specific heat capacity ($cal \cdot cm^{-3} \cdot {}^\circ C^{-1}$). The only inputs required by the model are: 1) the thermal conductivity at specified depths; 2) the specific heat capacity at specified depths; and 3) the initial values of the soil temperature at specified depths.

The water flow model is based on the following partial differential equation describing the volumetric water content, Θ (dimensionless) as a function of time, t (days) and depth, z (cm):

$$\partial\Theta/\partial t = \partial/\partial z[K\Theta(\partial H)/(\partial z)] + Az$$

where $K\Theta$ is the hydraulic conductivity ($cm^2 \cdot bar^{-1} \cdot day^{-1}$) as a function of volumetric water content, H is the soil water potential (bars) and Az is the water loss due to transpiration. The input requirements of the model are: 1) values of soil water potential and hydraulic conductivity for a series of values of volumetric water content (typically at volumetric content increments of 0.01); 2) upper and lower limits of soil water potential allowed by the model; 3) the largest change in volumetric water content allowed during any time-step of the water model (this time-step may be as short as 30 minutes); and 4) initial values of the soil water potential at specified depths. Detailed descriptions of these models may be found elsewhere (Lommen and Marshall 1976).

Decomposition Submodel (DCOMPO)

Decomposition is calculated by the following equation:

$$D = X(a + bT)\left(c, \min\{1.0, \max[0, (W-p)/(q-p)]\}\right)$$

where D is the flux density of material decomposed ($g \cdot m^{-2} \cdot day^{-1}$), X is the biomass of the decomposing material (g/m^2), T is the temperature of a specified soil layer, a and b are the y-intercept and slope of the straight line relating relative respiration rate (at optimum soil moisture conditions) to the soil temperature, W is the soil water potential of a specified layer, p is the value of W below which decomposition does not occur and q is the value of W above which decomposition is not limited by a lack of moisture (Fig. 5). This equation is applied separately to each of the chemical constituent compartments in litter and soil organic matter, since these compartments should not decompose at the same rate. A specified fraction of the carbon in litter that is decomposed is lost to the environment (representing respiration by decomposers) and all the remaining decomposed material is transferred to soil organic matter. Soil organic matter which is decomposed is transferred to soil nutrients and atmospheric carbon.

Table 4. Storage requirements (in words) for DESERT2 on the UNIVAC 1108

No.	Subroutine	Code	Local data	Sum	COMMON	Local data plus COMMON	Total space
	non-biological procedures						
1	MAINPR	232	76	308			
2	BLDATA	128	414	542			
3	STARTR	116	117	233			
4	MINPUT	1327	429	1756			
5	DATCHK	146	97	243			
6	READAT	234	100	334			
7	INITIL	276	140	416			
8	GINPUT	386	244	630			
9	EINPUT	269	128	397			
10	EXOGEN	144	58	202			
11	STVNEG	145	81	226			
12	TOTALR	454	59	513			
13	DRYMAT	123	23	151			
14	FLOWSS	16	4	20			
15	PREPAR	158	70	228			
16	REPORT	1096	575	1671			
17	GRAPHZ	542	2424	2966			
18	GETFIG	153	49	202			
19	COPYBY		(not used)				
	plant subsystem						
20	VEGETA	129	53	182			
21	VINPUT	370	54	424			
22	PHENOL	584	141	725			
23	PHOTOS	440	136	576			
24	TRANSP	273	126	399			
25	RESPIR	283	72	355			
26	TRANSL	877	185	1062			
27	ALOCAT	253	99	352			
28	STONEW	157	42	199			
29	NUTUPT	89	32	121			
30	DEATHH	379	96	475			
	animal subsystem						
31	ANIMAL	87	59	146			
32	ANRESP	175	58	233			
33	FEEDNG	893	154	1047			
34	MANAGE	285	120	405			
	abiotic subsystem						
35	SOILSS	164	52	216			
36	SLHEAT	540	125	665			
37	SLWATR	1119	122	1241			
38	TRIDIM	151	64	215			
39	WBALAN	143	31	174			
40	WINPUT	683	164	847			
	decomposer subsystem						
41	DCOMPO	500	84	584			
	mathematical functions						
42	PWLNEG	35	8	43			
43	PWLPOS	35	8	43			
44	GENPDF	46	10	56			
45	RUNAVE	89	24	113			
	SUM	17,724	7,212	21,936			
	SYSTEM PROCEDURES	5,817	2,402	8,219			
	COMMON				4,356		
	ABSOLUTE ELEMENT	20,541	9,614	30,155	4,356	23,560	34,511

IMPLEMENTATION OF DESERT2

A concerted effort has been made to maximize the number of computers on which DESERT2 can be implemented. The simulator has been written in ANSI FORTRAN IV and divided into subroutines to allow execution in a 24K-word partition, provided that an overlay facility is available. The core required by each of the subroutines is given in Table 4, and a possible overlay structure is suggested in Figure 10. Communication among subroutines occurs through COMMON blocks as shown in Table 5.

Several features of DESERT2 could be changed to increase its efficiency if one wished to take advantage of the large amount of core and the more powerful FORTRAN compilers and system software available at many installations. Many of these features relate to the preparation and printing of

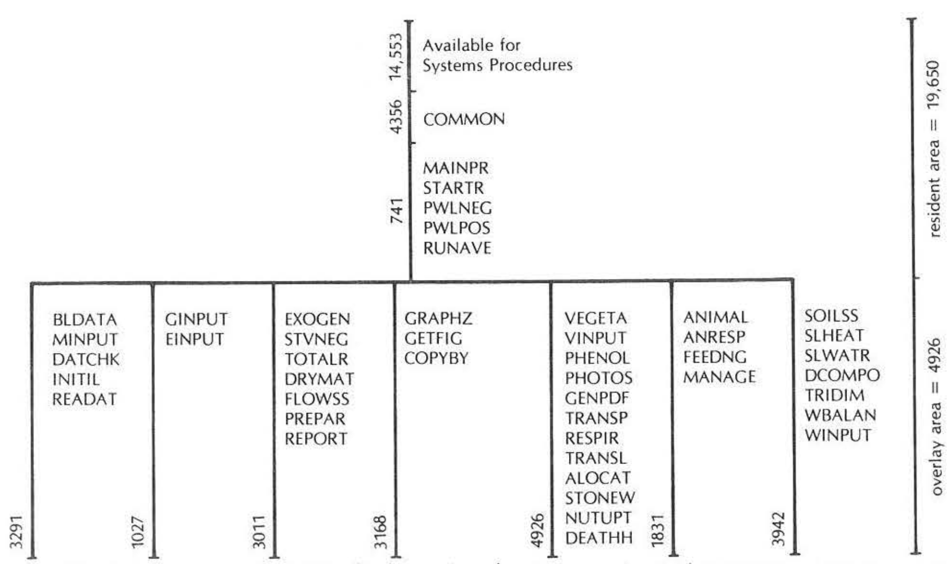


Figure 10. Recommended overplay structure for running DESERT2 in a 24-K word partition. Area sizes (given in words) are based on storage requirements on a UNIVAC 1108.

Table 5. DESERT2 COMMON block directory

DESERT2 COMMON BLOCK DIRECTORY

	FILES	NUMS	TYMES	PRTING	SWTCHS	MTSC	VBLS	WTHRV	WTHRP	CHANGE	LIMITS	GLTMS	GRINFO	GRAPHS	SVNEGC	XTENTS	CALLZ	MAR77	ECHOCH	EXSAVE	WTHRP2	PSAVF	TEMP2	FLUX2	FLUX3	FLUX4	FLUX5	FLUX6	FLUX7	FLUX8	EVAS&V	CONSAV	SAVWIP	VEGCCM	RUNA	PHOTEM	PHCSAV	PHESAV	VTOWAT	LOLAYR	PHESA2	TRFSAV	RESSAV	TRASAV	ALOSAV	DEASAV	ANISAV	ANPSAV	FEESAV	MANSAV	SOLCOM	WATSAV	WATSA2	HEASAV	WATSA3	WATSA4	SAMWBA	DCCSAV	RATNGM	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	
MAINPR	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
BLDATA	•	•	•	•	•	•	•	-	-	•	•	•	•	•	•	•	•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
STARTR	•	•	•	•	•	•	•	-	-	-	-	-	-	-	-	-	•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
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NUTUPT	•	•	•	•	-	•	•	-	-	•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28
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ANIMAL	•	•	•	•	-	•	-	-	-	-	-	-	-	-	-	-	-	-	•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	•	-	-	-	-	-	-	-	-	-	-	-	-	30
ANRESP	•	•	•	•	-	•	•	-	-	•	-	-	-	-	-	-	-	-	•	-	-	-	-	-	-	-	-	•	-	-	-	-	-	•	-	-	-	-	-	-	-	-	-	-	-	-	•	•	-	-	-	-	-	-	-	-	-	-	-	31
FEEDNC	•	•	•	•	-	•	•	-	-	•	-	-	-	-	-	-	-	-	•	-	-	-	-	-	-	-	-	-	•	-	-	-	-	•	-	-	-	-	-	-	-	-	-	-	-	-	•	-	•	-	-	-	-	-	-	-	-	-	-	32
MANAGE	•	•	•	•	-	•	•	-	-	-	-	-	-	-	-	-	-	-	•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	•	-	-	-	-	-	-	-	-	-	33
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SLHEAT	•	•	•	•	-	•	•	•	-	-	-	-	-	-	-	-	-	-	•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	•	-	-	•	-	-	-	-	-	35
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TRIDIM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	37
WBALAN	•	-	•	•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	•	-	-	38
WINPUT	•	•	•	•	-	•	•	-	-	-	-	-	-	-	-	-	-	-	•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	•	-	-	-	-	-	-	-	-	-	-	-	•	•	-	-	-	-	-	-	-	39
DCOMPO	•	•	•	•	-	•	•	•	-	•	-	-	-	-	-	-	-	-	•	-	-	-	-	-	-	•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	•	-	40
PWLNEG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	41
PWLPOS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	42
GENPDF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43
RUNAVE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	44

graphs. In addition, the use of the END and ERR options in the READ statements would enable the user to detect many format errors in a single run instead of merely the first such error, as is often the case with the programs described here.

Adaptation of the Programs to a Particular Computer Installation

One should be able to implement DESERT2 on most computers having at least 24K words of core memory by making only two changes.

The first change involves the call in the subroutine GRAPHZ to a subroutine which copies bytes from one word to another. If a FORTRAN intrinsic is not available (one is available on the Univac 1108 and Burroughs B6700). A new subroutine must be written. The subroutine is called by the following statement:

```
CALL COPYBY (G, SYMBOL, IL, IW, IB)
```

where G and SYMBOL are real vectors and the remaining arguments are integer scalars. The subroutine must move the first byte of the IL'th word in SYMBOL to the IB'th byte of the IW'th word in G. On an IBM the following subroutine can be used:

```
SUBROUTINE COPYBY (G, SYMBOL, IL, IW, IB)
LOGICAL*1 TDEB(4), TRES(4)
EQUIVALENCE (DEB, TDEB), (RES, TRES)
DIMENSION SYMBOL(IL), G(IW)
RES = G(IW)
DEB = SYMBOL(IL)
TRES(IB) = TDEB(1)
G(IW) = RES
RETURN
END
```

The second change involves the declarations of the five files used by DESERT2: a card reader (file KR), a line printer (file LP) and three direct access files (files MS1, MS2 and MS3). These files are now defined as units 5, 6, 1, 2 and 3. If one wishes to assign different numbers to these files, the following statements in the subroutine BLDATA will have to be changed:

```
MS1 = 1
MS2 = 2
MS3 = 3
KR  = 5
LP  = 6
```

On some computers it may be necessary to suppress or replace the three DEFINE FILE statements that appear in the main program just before the first executable statement. Finally, the proper Job Control cards must be written for these files. The attributes of the three direct access files are indicated in the comments at the beginning of the main program. The file "MS1" has a constant number of records (111) and a variable record size equal to one plus the number of curves allowed. The record size should be 21 for operation in a 24K-word partition. The file "MS2" has a constant record size (18) and a number of records equal to the number of graphs allowed plus the number of curves allowed. The number of records should be 20 for operation in a 24K-word partition. The file "MS3" has a record size of 4, and one record for each day of exogenous data. Files MS1 and MS2 are scratch files, while file MS3 is an input file. Each record of file MS3 contains the daily values of the following four variables: 1) minimum air temperature in degrees Celsuis; 2) maximum air temperature; 3) precipitation in millimeters; and 4) potential evaporation in millimeters. The first record of the file must contain the data for January 1 of any year equal to or preceding the first year of simulation, and each year's data must be organized into twelve 30-day months. The program will automatically begin reading from this file at the record corresponding to the first day of simulation. (See item 5 in the instructions for preparing input to the subroutine EINPUT.)

A third change that one may wish to make is an increase or decrease in the maximum numbers of curves or graphs that can be printed at the end of a simulation. No more than 20 graphs and 20 curves should be allowed if one is using overlay in a 24K-word memory. If lack of core memory is not a problem, as many as 60 curves could be allowed. One must perform the following steps to alter the maximum number of curves:

1. Change the file declaration cards and DEFINE FILE statements to reflect the changes in record size and number of records in files MS1 and MS2.

2. Set the identifier LIMCUR in the subroutine BLDATA equal to the maximum number of curves.

3. Set the dimension of the vector JADRES in the COMMON block GRAPHS equal to the maximum number of curves. This block appears in the following modules: MAINPR, BLDATA, GINPUT, PREPAR, GRAPHZ and GETFIG.

4. Set the dimension of the vector FIGS in the subroutine PREPAR, and the first dimension of the matrix FIGS in the subroutines GRAPHZ and GETFIG equal to the maximum number of curves.

One must do the following to change the number of graphs allowed:

1. Set the identifier LIMGRA in the subroutine BLDATA equal to the maximum number of graphs.

2. Set the dimensions of the vectors LMIN, LMAX, AMIN, AMAX and NCURVS equal to the maximum number of graphs. These vectors are in the COMMON block GRAPHS, which appears in the following modules: MAINPR, BLDATA, GINPUT, PREPAR, GRAPHZ and GETFIG.

Preparation of Data Decks

A data deck for DESERT2 comprises six sections. The first section (read by the subroutines MINPUT, READAT and INITIL) contains the names and initial values of the state variables to be included in the simulation, along with specifications of 1) the numbers of state variables in each of several classes of state variables; 2) the starting and ending dates of the simulation; 3) the length of the time-step; 4) the form of the print-out; and 5) the depths of the soil layers (in the event that such layers are specified). The second section of the data deck (read by the subroutine GINPUT) contains instructions for printing graphs at the end of the simulation. The third section (read by the subroutine EINPUT) contains values of exogenous variables (e.g., precipitation, temperature). The final three sections of the input deck contain the values of the parameters in the plant, animal and soil submodels. Each subroutine reads the parameters required uniquely by it.

Every READ statement in DESERT2 is followed by a WRITE statement that prints what has just been read along with the name of the subroutine and the number of the FORTRAN statement that performed the reading. Consequently, it should be easy to locate any error occurring during the input operations and to determine its cause. The information in the computer print-out, in the instructions for preparing data decks and in the description of the model should be sufficient for diagnosing and correcting errors in the format of the data deck and in the values of individual variables. In several cases the program examines the values of the data and prints a message if they are not acceptable.

Columns 73-80 of the input file are not read (with one exception) and consequently may contain sequence numbers. The exception is that comment cards describing the contents of subsections of the input deck are interspersed throughout the file, and these comment cards are read in (20A4) format.

In the following instructions, the number in the first set of parentheses in each numbered item contains the FORTRAN statement number of the statement which reads the indicated data. The second set of parentheses contains the format in which these data must appear.

SECTION I—SUBROUTINES MINPUT, READAT AND INITIL

1. (110 in MINPUT) (18A4) Any comments which the user wants printed at the beginning of the output, e. g., sources of data. (Any number of cards—including zero—followed by a blank card which signals the end of the comments.)

2. (140 in MINPUT) (18A4) The title of the simulation. This title will be printed at the tops of the tabular reports. (One card.)

3. (145 in MINPUT) (5L1) Five logical switches indicating whether the following items will be suppressed in spite of input instructions in the rest of the data deck: echo-checking of input read by the non-biological subroutines; echo-checking of input to the plant models; echo-checking of input to the animal models; echo-checking of input to the soil models; extra information useful in checking correctness of data decks. (One card.)

4. (150 in MINPUT) (6L1) Six logical switches indicating whether the following items will be suppressed in spite of the instructions in the rest of the data deck: initial report; intermediate reports; final report; graphs; intermediate calculations during specified time-steps; messages indicating attempts to assign negative values to state variables by subtracting increments larger than the current values of the state variables.

5. (160 in MINPUT) (4L1) Four logical switches indicating whether the following sections of the tabular reports will be suppressed in spite of the instructions in the rest of the data deck: plant variables; animal variables; dead organic matter variables; soil variables. (One card.)

6. (170 in MINPUT) (18A4) The units in which biomasses are expressed. These units are printed at the tops of the tabular reports. (One card.)

7. (180 in MINPUT) (8I5) A single card containing the following eight items: 1) the number of non-carbon elements included in the simulation; 2) the number of carbon types; 3) the number of plant groups; 4) the number of plant organs or tissue types; 5) the number of animal groups; 6) the number of dead organic matter types; 7) the number of soil organic matter compartments; and 8) the number of soil layers. (The number of soil organic matter compartments must equal zero, one or the number of soil layers.)

8. (380 in MINPUT) (I2, 1X, A3, 1X, I4) The date (day month and year) of the start of the simulation. The month must be denoted by the first three letters of its name. (One card.)

9. (410 in MINPUT) (I5) The length of the time-step in days. (One card.)

10. (430 in MINPUT) (I2, 1X, A3, 1X, I4) The date of the final day of simulation. (One card.)

11. (281 in READAT) (I5) The number of intermediate reports. (One card.)

12. (282 in READAT) (I2, 1X, A3, 1X, I4) The dates of each of the reports. (One card for each report.)

13. (281 in READAT) (I5) The number of time-steps during which the results of intermediate calculations are to be printed in order to more closely monitor the dynamics of the simulation. (One card.)

14. (282 in READAT) (I2, 1X, A3, 1X, I4) The dates on which the intermediate calculations are to be monitored. (One card for each date.)

15. (505 in MINPUT) (3A4) The names of each of the chemical constituents included in the simulation. (One card for each name, with the name right-adjusted to column 12.)

16. (515 in MINPUT) (5A4) The names of each of the plant groups (if any) included in the simulation. (One card for each name.)

17. (525 in MINPUT) (4A4) The names of each of the plant organ or tissue types (if any) included in the simulation. (One card for each name.)

18. (545 in MINPUT) (5A4) The names of each of the animal groups (if any) included in the simulation. (One card for each name.)

19. (565 in MINPUT) (5A4) The names of each of the dead organic matter types (if any) included in the simulation. (One card for each name.)

20. (590 in MINPUT) (20A4) A comment card which labels the following section of the input deck, namely, the initial values of the plant biomasses. (One card, which is omitted if there are no plant groups.)

21. (595 in MINPUT) (7F10.0) If the number of plant groups included in the simulation is greater than zero, then for each organ of each plant group, the dry weight of the organ and the amounts of each of the chemical constituents (expressed as decimal fractions of dry wt) are read. (One card for each organ of each plant group, with organs nested inside plant groups.) It is possible to specify default values of the proportions of dry weight in each of the chemical constituent compartments. This is done by entering, in columns 11-12 of each card, a real number which points to the appropriate column of the matrix DEFRAT. Default values for the following tissue types are stored in the indicated columns of DEFRAT.

   1 = herbaceous tissue
   2 = woody tissue
   3 = shed seed pool
   4 = mammalian tissue
   5 = unsorted litter
   6 = soil organic matter

22. (572 in INITIL) (20A4) A comment card labeling the following section of the data deck, namely, initial values for the shed seed compartments. (One card—omitted if there are no plant groups.)

23. (572 in INITIL) (7F10.0) For each plant group (if any) the dry weight of the seeds in the shed seed pool, and the biomasses of each of the chemical constituent compartments expressed as decimal fractions of dry weight. Default values can be used as explained in item 20. (One card for each plant group—omitted if there are no plant groups.)

24. (730 in MINPUT) (20A4) A comment card labelling the following data. (One card—omitted if there are no animals.)

25. (735 in MINPUT) (7F10.0) The population densities of each animal group. (One card per animal group—omitted if there are no animals.)

26. (572 in INITIL) (20A4) A comment card labeling the following data. (One card—omitted if there are no animals.)

27. (575 in INITIL) (7F10.0) For each animal group, its dry weight and the biomasses of each of the chemical constituents expressed as decimal fractions of dry weight. Default values can be used as explained in item 20. (One card for each animal group—omitted if there are no animals.)

28. (572 in INITIL) (20A4) A comment card labeling the following data. (One card—omitted if there are no categories of dead organic matter.)

29. (575 in INITIL) (7F10.0) For each dead organic matter type, its dry weight and the biomass of each of the chemical constituents expressed as a decimal fraction of dry weight. Default values can be used as explained in item 20. (One card for each dead organic matter type—omitted if there are no such compartments.)

30. (572 in INITIL) (20A4) A comment card labeling the following data. (One card—omitted if there are no soil organic matter compartments.)

31. (575 in INITIL) (7F10.0) For each soil organic matter compartment, its dry weight and the biomasses of the chemical constituents expressed as decimal fractions of the dry weight. Remember that the number of soil organic matter compartments must equal zero, one or the number of soil layers. Default values can be used as explained in item 20. (One card for each compartment—omitted if there are no such compartments.)

32. (770 in MINPUT) (20A4) A comment card labeling the following data. (One card—omitted if there are no soil organic matter compartments.)

33. (775 in MINPUT) (7F10.0) The initial levels of each of the available soil nutrients in each soil organic matter compartment. (One card—omitted if there are no such compartments.)

34. (800 in MINPUT) (20A4) A comment card labeling the following data. (One card—omitted if there are no soil layers.)

35. (810 in MINPUT) (7F10.0) The depths (cm) of the bottom surfaces of each of the soil layers. (One card—omitted if there are no soil layers.)

SECTION II—SUBROUTINE GINPUT

1. (90) (A4) A single card with the string GINP in columns 1-4 signaling the start of input to the subroutine GINPUT. Reading of the data file continues until this card is found or an end-of-file is encountered.

2. For each graph, the following cards are read:

   2a. (140) (I1, 1X, 18A4) The number of curves in the graph and the title of the graph. (One card.)
   2b. (190) (2L1, 8X, 2F10.0) Two logical variables indicating whether minimum and maximum ordinates, respectively, are to be specified for this graph. (Enter T's or F's in columns 1 and 2.) If these logical variables are true, columns 11-20 and 21-30 must contain the minimum and maximum values, respectively. If any of the curves in the graph exceeds the specified maximum or minimum ordinate, a new maximum or minimum will be established. (One card.)
   2c. (230) (A4, 1X, 3I5, 20X, 7A4) For each variable to be included in the graph, its code name (Table 5) must appear in columns 1-4, its subscripts (if any) must appear in three I5 fields from column 6 to column 20 and a label for the curve must appear in columns 41-68. Variables which can be graphed and the bounds of their dimensions (if any) are listed in Tables 6 and 7. (One card for each graph.)

3. The string STOP in columns 3-6, signaling the end of input to this subprogram. For convenience, specifications of other graphs may follow this card, but they will be ignored.

SECTION III—SUBROUTINE EINPUT

1. (110) (A4) A card with the string EINP in columns 1-4 signaling the start of exogenous data. Reading will continue until this card is found or an end-of-file is encountered. (One card.)

2. (140) (20A4) A comment card describing the following input.

3. (150) (3F10.0) Three constants which will modify the values of temperature, precipitation and evaporation. The first constant is the number of degrees which will be added to the daily minimum and maximum temperatures. The second and third constants are values by which the precipitation and evaporation will be multiplied. Use of these constants allows one to present different exogenous data to the model without creating a series of different disk files. (One card.)

Table 6. A list of variables that can be graphed

No.	Code	Fortran name	Explanation
1	VDM	PDM (7,6)	Dry matter in the J'th organ of the I'th plant group
2	VDMO	PDMO (7)	Dry matter in the I'th plant group
3	VDMV	PDMV (6)	Dry matter in the J'th organ (summed over all plant groups)
4	VDMT	PDMVO	Total dry matter in all organs of all plant groups
5	SDM	SEEDDM (7)	Dry matter in the shed seeds of the I'th plant group
6	SDMV	SEDDMV	Total dry matter in the shed seed pool
7	ADM	ADM (10)	Dry matter in the I'th animal group
8	ADMA	ADMA	Total dry matter in all animal groups
9	DDM	DDM (3)	Dry matter in the I'th type of dead organic material
10	DDMT	DDMT	Total dry matter in all dead organic material
11	ODM	SDM	Dry matter in the I'th soil organic matter compartment
12	ODMT	SDMT	Total dry matter in all soil organic matter compartments
13	TODM	TOTDM	Total dry weight of all organic matter in ecosystem
14	VVC	CVEG (7,6,5)	Amount of K'th chemical constituent in J'th organ of I'th plant group
15	SCC	SEED (7,5)	Amount of K'th chemical constituent in shed seeds of the I'th plant group
16	ACC	CBIOM (10,5)	Amount of K'th chemical constituent in the I'th animal group
17	DCC	CLIT (3,5)	Amount of K'th chemical constituent in the I'th category of dead organic matter
18	OCC	CORG (1,5)	Amount of K'th chemical constituent in the I'th soil organic matter compartment
19	ASN	CMIN (1,2)	Amount of the K'th available soil nutrient in the soil nutrient compartment corresponding to the I'th soil organic matter compartment
20	APD	POP (10)	The population density of the I'th animal group
21	VCCV	CVEGV (6,5)	The amount of the K'th chemical constituent in the J'th organ, summed over all plant groups
22	VCCO	CVEGO (7,5)	The amount of the K'th chemical constituent in the I'th plant group, summed over all organs
23	VCCT	CVEGVO (5)	Total amount of the K'th chemical constituent in all organs of all plant groups
24	VCA	AVEG (7,6)	Total carbon in the J'th organ of the I'th plant group
25	ACAV	AVEGV (6)	Total carbon in the J'th organ, summed over all plant groups
26	VCAD	AVEGO (7)	Total carbon in the I'th plant group, summed over all organs
27	VCAT	AVEGVO	Total carbon in all organs of all plant groups
28	SCCV	SEEDV (5)	Amount of the K'th chemical constituent in the shed seed pool
29	SCA	ASEED (7)	Total carbon in shed seeds of the I'th plant group
30	SCAV	ASEEDV	Total carbon in the shed seed pool
31	ACCA	CBIOMA	Amount of the K'th chemical constituent in the entire animal community
32	ACA	ABIOM (10)	Total carbon in the I'th animal group
33	ACAA	ABIOMA	Total carbon in the animal community
34	DCCD	CLITT (5)	Total amount of the K'th chemical constituent in all types of dead organic matter
35	DCA	ALIT (3)	Total carbon in the I'th type of dead organic matter
36	DCAD	ALITT	Total carbon in all types of dead organic matter
37	OCCH	CORGH (5)	Total amount of the K'th chemical constituent in all soil organic matter compartments
38	OCA	AORG (1)	Total carbon in the I'th soil organic matter compartment
39	OCAH	AORGH	Total carbon in all soil organic matter compartments
40	ASNH	CMINH (2)	The amount of the K'th available soil nutrient in all soil nutrient compartments combined
41	TCC	ECOTOT (5)	Total amount of the K'th chemical constituent in all organic matter in the ecosystem
42	TCA	AECOTO	Total organic carbon in the ecosystem
43	SWPH	SWPH (6)	Soil water potential of the I'th soil layer (bars)
44	SWPN	SWPN (8)	Soil water potential at the I'th node (bars)
45	STH	STH (6)	Soil temperature of the I'th soil layer
46	STN	STN (8)	Soil temperature at the I'th node
47	DUMV	DUMMYV (50)	Extra storage available to plant subroutines for inserting variables to be graphed
48	DUMA	DUMMYA (30)	Same as DUMMYV, but for animal subroutines
49	DUMS	DUMMYS (20)	Same as DUMMYV, but for soil subroutines

4. (200) (20A4) A comment card describing the following input.

5. (210) (I5) The years when the weather data on the random access file begin and end. (Must be four-digit numbers.) (One card.)

6. (610) (20A4) A comment card describing the following input.

7. (620) (F10.0) The latitude of the ecosystem being simulated. (Expressed as a single read number.) (One card.)

8. (660) (20A4) A comment card describing the following input.

9. (670) (L1) The letter "T" or "F" in column one, indicating whether a message is desired on time-steps when precipitation occurs.

Table 7. Current contents of the DUMMY arrays. These variables can be graphed. See text and Table 5

Code	Position in the array	Explanation
DUMV	I	Phenological stage of plant I, where I varies from 1 to the number of plant groups (NPLNTS) included in the simulation
DUMV	I + NPLNTS	Fraction of reproductive tissue that is mature seed
DUMV	I + 2(NPLNTS)	Dry matter in mature attached seeds
DUMV	I + 3(NPLNTS)	Adjusted temperature optimum for photosynthesis
DUMV	I + 4(NPLNTS)	Photosynthetic rate (mg CO_2 per g dry matter per hr)
DUMV	I + 5(NPLNTS)	Dry matter fixed during the time-step
DUMV	49	Cumulative transpiration (mm)
DUMV	50	Temperature used to predict photosynthesis
DUMA	I	Adjusted maximum hourly specific CO_2 fixation rate for plant group I
DUMA	25	Photoperiod (in hours)
DUMA	26	Potential daily evaporation (mm)
DUMA	27	Accumulated precipitation (mm)
DUMA	28	Maximum air temperature
DUMA	29	Minimum air temperature
DUMA	30	Running average air temperature
DUMS	1	Water in the soil profile (mm)
DUMS	2	Cumulative predicted evaporation (mm)
DUMS	3	Standing water (mm)

SECTION IV—PLANT SUBROUTINES

SUBROUTINE VINPUT

1. (1010) (20A4) A card with the string VEGE in columns 1-4 signaling the start of input to the plant subroutines. The program will search the data deck until this card is found or an end-of-file is encountered.

2. (2000) (20A4) A comment card labeling the following input.

3. (2010) (7I5) For each plant group, a pointer designating the soil layer whose water potential values will be used in the calculations of the phenology and translocation subroutines that concern germination and leafing-out. (One card.)

4. (2000) (20A4) A comment card labeling the following input.

5. (2010) (7I5) For each plant group, a pointer designating the soil layer whose water potential values will be used in the calculations of the phenology model concerning shifts between the vegetative, reproductive and dormant phenophases.

6. (2020) (20A4) A comment card labeling the following input.

7. (2030) (7L1) A vector of logical variables indicating whether the plant groups are herbaceous. The letter "T" denotes herbaceous species; the letter "F" denotes woody species. (One card.)

8. (2040) (20A4) A comment card labeling the following input.

9. (2050) (7L1) A vector of logical variables indicating whether the plant groups are annuals. The letter "T" denotes annuals; the letter "F" denotes perennials. (One card.)

10. (2060) (20A4) A comment card labeling the following data.

11. (2070) (7I5) A vector of pointers designating the current phenological stage of each plant group. (1 = germination; 2 = leafing-out, flowering or both; 3 = vegetative growth; 4 = reproductive growth; 5 = dormancy.) (One card.)

12. (2080) (20A4) A comment card labeling the following data.

13. (2090) (7F10.0) A vector containing the total carbon added to new leaves, flowers or fruits created during the current phenological stage. (One card.)

14. (3000) (20A4) A comment card labeling the following data.

15. (3010) (7F10.0) A vector containing the elapsed time in days spent by each plant group in its current phenological stage. (One card.)

16. (3020) (20A4) A comment card labeling the following datum.

17. (3030) (I5) The number of days over which the running average air temperature is completed.

SUBROUTINE PHENOL

1. (2020) (20A4) A card with the string PHEN in columns 1-4 signaling the start of input to the phenology model.

2. (2050) (20A4) A comment card labeling the following datum.

3. (2060) (7I5) For each plant group, the Julian day on which the entire contents of the "new twig" compartment will be transferred to the "old stem" compartment. (One card.)

4. (2080) (20A4) A comment card labeling the following data.

5. (2090) (7F10.0) A single card for each plant group containing the following seven parameters: 1) the running average air temperature above which (or below which—see item 7 below) germination or leafing-out might begin; crossing this threshold is a necessary but not sufficient condition for germination or leafing-out; 2) the minimum water potential (bars) of the soil layer specified in the data read by subroutine VINPUT that must be attained before germination or leafing-out might begin (a necessary but not sufficient condition); 3) the water potential in the soil layer specified in the data read by subroutine VINPUT below which a reproductive plant group will return to the vegetative stage; 4) the number of days a plant group must spend in the vegetative stage before it can become reproductive or dormant; 5) the water potential in the soil layer specified in the data read by subroutine VINPUT that must be exceeded before the plant group can switch from the vegetative stage to the reproductive stage; 6) the water potential in the soil layer specified in the data read by subroutine VINPUT below which a vegetative or reproductive plant will become dormant; and 7) the running average air temperature below which (or above which—see item 7 below) the plant group will become dormant.

6. (3010) (20A4) A comment card labeling the following data.

7. (3020) (7L1) A "T" or "F" for each species indicating whether germination (or leafing-out) occurs when the soil temperature falls below a given threshold (T), or when it rises above the given threshold (F).

8. (3030) (20A4) A comment card labeling the following data.

9. (3040) (7I5) Two cards containing the dates between which germination (or leafing-out) is not allowed to occur. The first card contains the starting date of this period for each plant group; the second card contains the ending date of the period for each plant group.

SUBROUTINE PHOTOS

1. (1010) (20A4) A card with the string PHOT in columns 1-4 signaling the start of input to the photosynthesis model.

2. (1040) (20A4) A comment card labeling the following data.

3. (1050) (7F10.0) A set of two cards for each plant group containing values of the following 14 items: 1) the maximum rate of net daytime CO_2 exchange in mg CO_2 per g dry matter in photosynthetic tissue per hr. This rate may change during acclimatization; 2) not used—a blank field must appear here. The next four values (3-6) are constants *a*, *b*, *c* and *d* (Fig. 4) in the generalized Poisson density function relating a scaling factor for photosynthesis to air temperature; 3) the temperature at which CO_2 exchange is maximal; 4) the upper compensation point, i.e., the temperature when CO_2 exchange has fallen to zero; 5) a curvature constant for the descending limb of the curve; 6) a curvature constant for the ascending limb of the curve; 7) the soil water potential value below which fixation will not occur (parameter *a* in Fig. 5); 8) the soil water potential value above which fixation will not be limited by scarcity of soil water (parameter *b* in Fig. 5); 9-10) the amplitude and phase shift (parameters *b* and *c* in Fig. 6) in the sine function relating the temperature optimum and upper compensation point to Julian day; 11-12) the amplitude and phase shift (parameters *b* and *c* in Fig. 6) in the sine function relating the current maximum rate of fixation to Julian day; 13-14) parameters *a* and *b* (Fig. 6) in the power function relating a scaling factor (accounting for the effect of soil nitrogen on photosynthesis) to the nitrogen content of the soil.

4. (1080) (20A4) A comment card labeling the following data.

5. (1090) (2F10.0) 1) a scaling factor that adjusts the predicted photosynthetic rate in the forenoon (when it is maximal) to its mean value for the daylight hours; and 2) a scaling factor used to calculate the forenoon air temperature from the 24-hr minimum and maximum values.

6. (2050) (20A4) A comment card labeling the following data.

7. (2060) (7F10.0) For each species, a factor by which the species' maximum specific rate of photosynthesis will be multiplied. (One card.) These values will normally be 1.0, but can be changed during tuning or sensitivity analysis.

SUBROUTINE RESPIR

1. (2020) (20A4) A card with the string RESP in columns 1-4 signaling the start of input to the respiration model.

2. (2050) (20A4) A comment card labeling the following data.

3. (2060) (7F10.0) One card for each organ, specifying values of the following seven parameters: 1-2) the intercept and slope of the straight-line function relating the relative rate of respiration to adjusted temperature (see items 6 and 7); 3) not used—a blank field must appear here; 4) the soil water potential below which respiration will not occur (parameter *a* in Fig. 5); 5) the soil water potential above which respiration is not limited by a scarcity of soil water (parameter *b* in Fig. 5); 6-7) the amplitude and phase shift (parameters *b* and *c* in Fig. 6) in the sine function relating adjusted temperature to actual temperature. This calculation allows for the possibility of acclimatization.

Subroutine TRANSP

1. (2020) (20A4) A card with the string TRAN in columns 1-4 signaling the start of input to the transpiration model.

2. (2050) (20A4) A comment card labeling the following data.

3. (2060) (F10.0) The conversion factor required to convert the units of simulation (specified in item 6 of the input to MINPUT) to kg/ha. (One card.)

4. (2070) (20A4) A comment card labeling the following data.

5. (2080) (7F10.0) One card for each plant group specifying the root biomass in each soil layer expressed as a fraction of the total root biomass of the plant group.

6. (3010) (20A4) A comment card labeling the following data.

7. (3020) (2F10.0) Parameters *a* and *b* in the straight-line function relating the transpiration coefficient to potential evaporation (Fig. 8).

Subroutine TRANSL

1. (2020) (20A4) A card with the string TRAN in columns 1-4 signaling the start of input to the translocation model.

2. (2050) (20A4) A comment card labeling the following data.

3. (2060) (7F10.0) One card for each plant group containing the following six parameters: 1-3) parameters *a*, *b* and *c* (Fig. 5) in the piece-wise linear function relating the relative rate of germination (for annuals) or leafing-out (for perennials) to the soil water potential in a specified soil layer (see item 3 in the input to VINPUT); 4-6) the fractions of the total carbon translocated from seeds (of annuals during germination) or from storage organs (of perennials during leafing-out) that go, respectively, to leaves, new stems and roots (for annuals) or to reproductive organs (for perennials).

4. (2090) (20A4) A comment card labeling the following data.

5. (3000) (7F10.0) Parameters *a*, *b* and *c* (Fig. 5) in the piece-wise linear function relating the fraction of reproductive tissue that is in the form of mature seeds to the time elapsed since the start of the reproductive stage.

6. (3010) (20A4) A comment card labeling the following data.

7. (3020) (7F10.0) Two cards for each plant group: the first card contains the decimal fractions of the carbon fixed during the current time-step that will be allocated to each organ during non-reproductive phenophases. The second card contains the analogous decimal fractions for the reproductive phenophase.

Subroutine ALOCAT

1. (2020) (20A4) A card with the string ALOC in columns 1-4 signaling the start of input to the model for allocation of photosynthate to the various organs.

2. (2050) (20A4) A comment card labeling the following data.

3. (2080) (7F10.0) One card for each of the four nondormant phenological stages, containing the fraction of carbon allocated to each of the carbon types whenever carbon is added to an organ.

Subroutine DEATHH

1. (2020) (20A4) A card with the string DEAT in columns 1-4 signaling the start of input to the model for organ abscission and plant death.

2. (2050) (20A4) A comment card labeling the following data.

3. (2060) (7F10.0) One card for each plant group containing the following five parameters: 1-2) parameters *a* and *b* (Fig. 5) in the piece-wise linear function relating the relative abscission rate of transient (herbaceous) organs to the time elapsed since the beginning of the dormant stage; 3-5) parameters *a*, *b* and *c* (Fig. 7) in the piece-wise linear function relating the relative death rate owing to drought to the soil water potential in a specified soil layer (see item 3 of the input to VINPUT).

SECTION V—ANIMAL SUBROUTINES

Subroutine ANIMAL

1. (2020) (20A4) A card with the string ANIM in columns 1-4 signaling the start of input to the animal subroutines. The program will search the data deck until this card is found or an end-of-file is encountered.

Subroutine ANRESP

1. (2020) (20A4) A card with the string ANRE in columns 1-4 signaling the start of input to the respiration model. The program will search the data deck until this card is found or an end-of-file is encountered.

2. (2065) (20A4) A comment card labeling the following data.

3. (2070) (2F10.0) One card for each animal group containing parameters *a* and *b* (Fig. 8) in the power function relating the quantity of carbon respired by an animal to the mean weight of the animals.

Subroutine FEEDNG

1. (610) (20A4) A card with the string FEED in columns 1-4 signaling the start of input to the feeding model. The program will search the data deck until this card is found or an end-of-file is encountered.

2. (620) (20A4) A comment card labeling the following data.

3. (630) (5F10.0) For each animal group, one card containing the following five parameters: 1) the maximum relative rate of feeding; 2-3) parameters *a* and *b* (Fig. 5) in the piece-wise linear function relating a scaling factor (by which the maximum feeding rate is multiplied) to the total "effective food" available to the animal group; 4-5) parameters *a* and *b* (Fig. 7) in the piece-wise linear function relating a second scaling factor (by which the maximum feeding rate is multiplied) to the dry matter in the animal compartment.

4. (650) (20A4) A comment card labeling the following data.

5. (600) (4I5) A single card containing the total number of flows (all animal groups considered together) in each of four classes of feeding: herbivory, granivory, carnivory and detritivory.

6. (670) (20A4) A comment card labeling the following data.

7. (680) (2I5, F10.0) For each feeding flow, a single card is read containing the following 3 items: 1) the number of the recipient (animal) compartment; 2) the number of the donor compartment (a two-digit number for herbivorous flows, the first digit being the number of the plant group and the second being the number of the organ compartment—a single digit suffices for the other three classes of flows) and; 3) a preference factor varying from zero to one which indicates the animal's preference for this food source relative to other sources.

Subroutine MANAGE

1. (2020) (20A4) A card with MANA in columns 1-4 signaling the start of input to the herd management model. The program will search the data deck until this card is found or an end-of-file is encountered.

2. (2040) (20A4) A comment card labeling the following data.

3. (2050) (I5) The number of movements of animals onto or off the range during the simulation.

4. (2060) (20A4) A comment card labeling the following data. (Omitted if there are no additions or removals of animals.)

5. (2070) (I2, 1X, A3, 1X, I9, I10, F10.0) For each movement, a single card with the following three items is required: 1) the date (the day of the month, the first three letters of the month, and the year, expressed as a four-digit number); 2) the number of the animal group (first, second, etc.); 3) the number of animals/ha to be moved (must be a negative number if animals are to be removed); 4) the mean dry weight of the animals (if left blank, the mean weight of the animals already in the model will be used.)

SECTION VI— SOIL SUBROUTINES

Subroutine SOILSS

1. (1060) (20A4) A card containing the string SOIL in columns 1-4 signaling the start of input to the soil subroutines. The program will search the data deck until this card is found or an end-of-file is encountered.

Subroutine SLHEAT

1. (1010) (20A4) A card containing the string HEAT in columns 1-4 signaling the start of input to the heat flow model. The program will search the data deck until this card is found or an end-of-file is encountered.

2. (2100) (20A4) A comment card labeling the following data.

3. (2105) (7F10.0) The specific heat capacity of each soil layer in cal · cm^{-3} · $°C^{-1}$. (One card.)

4. (2110) (20A4) A comment card labeling the following data.

5. (2120) (7F10.0) The thermal conductivity of each region between soil nodes in cal· cm^{-3} · $°C^{-1}$. There is a node at the center of each soil layer, as well as one at the top surface of the top layer and one at the bottom surface of the bottom layer. (Seven values per card.)

6. (2130) (20A4) A comment card labeling the following data.

7. (2140) (7F10.0) The initial value of the soil temperature at each soil node. (Seven values per card.)

SUBROUTINE WINPUT

1. (20) (20A4) A card containing the string WATE in columns 1-4 signaling the start of input to the water flow model. The program will search the data deck until this card is found or an end-of-file is encountered.

2. (80) (20A4) A comment card labeling the following data.

3. (90) (I5) The number of entries in the following two tables (matric potential [bars] vs. volumetric water content, and hydraulic conductivity [$cm^2 \cdot bar^{-1} \cdot day^{-1}$] vs. volumetric water content). The first entry in each table is a hypothetical value at a volumetric water content of zero. Successive entries are the values at increasing and equidistant values of volumetric water content. (One card.)

4. (100) (20A4) A comment card labeling the following data.

5. (110) (F10.0) The increment between successive values of volumetric water content in the following two tables. (One card.)

6. (120) (20A4) A comment card labeling the following data.

7. (130) (7F10.0) A table of soil water potential (bars) vs. volumetric water content. (See item 3 above.) This table applies to all soil layers. (Seven values per card.)

8. (154) (20A4) A comment card labeling the following data.

9. (156) (F10.0) A factor by which the following values of hydraulic conductivity will be multiplied. This value is normally 1.0 but can be changed during tuning or sensitivity analysis.

10. (160) (20A4) A comment card labeling the following data.

11. (170) (7F10.0) A table of hydraulic conductivity ($cm^2 \cdot bar^{-1} \cdot day^{-1}$) vs. volumetric water content. (See item 3 above.) This table applies to all soil layers. (Seven values per card.)

12. (180) (20A4) a comment card labeling the following data.

13. (190) (2F10.0) The lower and upper limits of predicted soil water potential which will be allowed by the model. (One card.)

14. (220) (20A4) A comment card labeling the following data.

15. (230) (F10.0) The largest change in predicted volumetric water content allowed during a single time-step of the water model. The length of the time-step in the water model is variable and may be less than the length of the time-step of the main program. (One card.)

16. (260) (20A4) A comment card labeling the following data.

17. (270) (7F10.0) The initial value (bars) of the soil water potential at each soil node. (One or two cards, depending on number of soil nodes.)

18. (272) (20A4) A comment card labeling the following data.

19. (274) (F10.0) The initial value of standing water on the soil surface (mm). (One card.)

SUBROUTINE DCOMPO

1. (2020) (20A4) A card with the string DCOM in columns 1-4 signaling the start of input to the decomposition model. The program will search the data deck until this card is found or an end-of-file is encountered.

2. (2040) (20A4) A comment card labeling the following data.

3. (2045) (I5) The number of the soil layer whose temperature and water potential values control decomposition rates. (One card.)

4. (2050) (20A4) A comment card labeling the following data.

5. (2055) (2F10.0) The values of temperature and water potential (in the specified layer) below which decomposition will not occur. (One card.)

6. (2060) (20A4) A comment card labeling the following data.

7. (2065) (F10.0) The rate of respiration of litter decomposers expressed as a fraction of the overall relative rate of decomposition. (One card.)

8. (2070) (20A4) A comment card labeling the following data.

9. (2075) (4F10.0) For each chemical constituent, one card is read containing the following four items: 1-2) the Y-intercept and slope of the straight-line function relating the relative rate of litter decomposition to temperature in the specified soil layer; 3-4) parameters *a* and *b* (Fig. 5) in the piece-wise linear function relating a scaling factor (varying from zero to one, which multiplies the relative decomposition rate of litter) to water potential in the specified soil layer.

10. (2100) (20A4) A comment card labeling the following data.

11. (2105) (4F10.0) For each chemical constituent, one card is read containing the same parameters as described in item 9 above, but with reference to soil organic matter instead of litter.

ACKNOWLEDGMENT

The author expresses his appreciation to Dr. Paul W. Lommen who provided models of heat and water flow in the soil. These models were appropriately modified for inclusion into the DESERT2 package.

COMPLETE PROGRAM LISTING

```
BIOME*DESERT2SYM(1).MAINPR
      C          **********  D E S E R T 2  **********
      C
      C     WRITTEN BY -
      C        W. D. VALENTINE
      C        U. S. DESERT BIOME
      C        ECOLOGY CENTER
      C        UTAH STATE UNIVERSITY
      C        LOGAN, UTAH 84322
      C
      C     FILES USED-
      C        KR   CARD READER
      C        LP   LINE PRINTER
      C        MS1  RANDOM ACCESS FILE  (Y-COORDINATES OF CURVES TO BE GRAPHED)
      C        MS2  RANDOM ACCESS FILE  (TITLES OF GRAPHS AND CURVES)
      C        MS3  RANDOM ACCESS FILE  (EXOGENOUS WEATHER DATA)
      C
      C        MS1 AND MS2 ARE SCRATCH FILES WRITTEN AND READ BY THE PROGRAM
      C        MS3 IS AN INPUT FILE.   EACH RECORD CONTAINS THE DAILY VALUES
      C        OF THE FOLLOWING FOUR VARIABLES-- MINIMUM AIR TEMPERATURE IN
      C        DEGREES CELSIUS, MAXIMUM AIR TEMPERATURE, PRECIPITATION IN MM,
      C        AND POTENTIAL EVAPORATION IN MM.   THE FIRST RECORD OF THE FILE
      C        MUST CONTAIN THE DATA FOR JANUARY 1 OF ANY YEAR EQUAL TO OR
      C        PRECEDING THE FIRST YEAR OF SIMULATION, AND EACH YEAR'S DATA MUST
      C        BE ORGANIZED INTO TWELVE 30-DAY MONTHS.
      C
      C        ALL FIVE FILES MUST BE ASSIGNED VALUES IN THE SUBROUTINE
      C        'PLDATA' AND MUST BE APPROPRIATELY DECLARED IN JCL CARDS
      C        MS1 HAS A CONSTANT NUMBER OF RECORDS (111) AND A VARYING
      C        RECORD-SIZE EQUAL TO 1 PLUS THE NUMBER OF CURVES ALLOWED
      C        MS2 HAS A CONSTANT RECORD-SIZE (18) AND A NUMBER OF RECORDS EQUAL
      C        TO THE NUMBER OF GRAPHS ALLOWED PLUS THE NUMBER OF CURVES ALLOWED
      C        MS3 HAS A CONSTANT RECORD SIZE (4) AND A NUMBER OF RECORDS EQUAL
      C        TO 360 TIMES THE NUMBER OF YEARS OF WEATHER DATA.
      C
      CILE  1(KIND=PACK,MAXRECSIZE=61,BLOCKSIZE=610,AREASIZE=10,AREAS=12)
      CILE  2(KIND=PACK,MAXRECSIZE=18,BLOCKSIZE=540,AREASIZE=30,AREAS=4)
      C
      C
            LOGICAL SUCALC, SUCUME
            LOGICAL CALLV,CALLA,CALLS
            LOGICAL ERROR,PRINT,LMIN,LMAX,RAINCH
            LOGICAL SUINIT,SUINTM,SULAST,SUGRFS
            LOGICAL SUPLNT,SUANIM,SUDOM,SUSOIL
            COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
            COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
           -        NFRELM,NFRELP,HORDEP(6),NHOPTZ,NSCMPT
            COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
           -        XMONTH(12),ISTEP,NSTEPS,NDAYS
            COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
           -        PLACE(18),UNITS(8)
            COMMON /SWTCHS/SUINIT,SUINTM,SULAST,SUGRFS,SUPLNT,SUANIM,SUDOM,
           -        SUSOIL
            COMMON /MISC/ ERROR,RCHECK(20),BLANK
            COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEEDMV,
           1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
           2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),PCP(10),CVEGV(6,5),
           3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
           4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITI(5),
           5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
           6  AECOTC,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
           7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
           8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
           9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
           -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
           A  ALINAM(3,5)
            COMMON /WTHRV/ DATMIN,DATMAX,DARAIN,DAEVAP,DAPHOT
            COMMON /WTHRP/ FACTOR,APHT,BPHT,RAINCH
            COMMON /CHANGE/ CVEGOO(7,6,5),SEEDOO(7,5),CBIOMO(10,5),
           -        CLITOO(3,5),CORGOO(1,5),CMINOO(1,2)
            COMMON /LIMITS/ MAXCHE,MAXPLA,MAXORG,MAXANI,MAXDOM,MAXSOM,MAXHOR
            COMMON /GLIMS/ LIMGRA,LIMPG,LIMCUR
            COMMON /GRINFO/ VNAM(60),TBOUND(60,3),IADRES(60),NVBLS
            COMMON /GRAPHS/ PERIOD,JXXX,NGRAFS,NCURVZ,
           -                JDAT(12),XDAT(12),LDAT(12),
           -                LMIN(40),LMAX(40),AMIN(40),AMAX(40),
           -                NCURVS(40),JADRES(60)
            COMMON /SVNEGC/ ERRSUM,ISVADR(6)
            COMMON /XTENTS/ LIMIT,LIMTOT,LIMDRY
            COMMON /CALLZ/ CALLV,CALLA,CALLS,LASTDA
            COMMON /MAR77/ SUCALC, SUCUME
            DIMENSION STATE(317),DECINC(317)
            EQUIVALENCE (DECINC,CVEGOO), (STATE,CVEG)
      C
      C
            DEFINE FILE 1(111,61,U,MS1REC)
            DEFINE FILE 2(100,18,U,MS2REC)
            DEFINE FILE 3(2160,4,U,MS3REC)
      C
      C
            CALL BLDATA
            CALL STARTR
      C-----------------------------------------------------------------
      C     START TIME STEP LOOP
      C-----------------------------------------------------------------
        200 IDAY = IDAY+ISTEP
            NSTEPS = NSTEPS + 1
            NDAYS = NDAYS + ISTEP
            IF(IDAY.GT.KDAY)IDAY=KDAY
            IYRDAY=MOD(IDAY,360)
            IF(IYRDAY.EQ.0)IYRDAY=360
            MONTH=(IYRDAY-1)/30+1
            MDAY=MOD(IYRDAY,30)
            IF(MDAY.EQ.0)MDAY=30
            IF(IYRDAY.GT.LASTDA)GO TO 250
            IYR=IYR+1
        250 LASTDA=IYRDAY
            IF (IDAY.EQ.KDAY) WRITE(LP,260)
        260 FORMAT ('0',T30,28('-')/T30,'LAST TIME STEP OF SIMULATION'/
           -        T30,28('-')//)
            PRINT=.FALSE.
            IF (SUCALC) GO TO 300
            IF(IDAY.LT.MPRINT(IPRINT))GO TO 300
            PRINT=.TRUE.
            WRITE(LP,270)MDAY,XMONTH(MONTH),IYR,IYRDAY,IDAY,NDAYS,NSTEPS
        270 FORMAT ('1',T30,39('-')/T30,
           -        'INTERMEDIATE CALCULATIONS ON ',I2,1X,A3,I5/
           -        T30,39('-')//T7,
           -  ' IYRDAY =',I4,7X,'IDAY =',I5,7X,'DAYS ELAPSED =',I5,7X,
           -  'TIME-STEPS ELAPSED =',I5)
        280 IPRINT=IPRINT+1
            IF (IDAY.GE.MPRINT(IPRINT))GO TO 280
        300 CALL EXOGEN
            IF(CALLV)CALL VEGETA
            IF(CALLA)CALL ANIMAL
            IF(CALLS)CALL SOILSS
            IF(TOTDM.LE.0.0)GO TO 720
            DO 500 I=1,LIMIT
            S = STATE(I)
            D=DECINC(I)*ISTEP
            SUM = S + D
            IF (SUM .LE. 0.0) GO TO 400
            STATE(I) = SUM
            GO TO 500
        400 IF (-SUM .GT. 0.1E-5) CALL STVNEG(I,D,S,SUCUME)
            STATE(I)=0.0
        500 DECINC(I) = 0.0
            CALL TOTALR
            CALL DRYMAT
        720 CALL FLOWSS
            IF(.NOT.SUGRFS)CALL PREPAR
            IF (IDAY.EQ.KDAY)GO TO 850
            IF (SUINTM) GO TO 800
            IF (IDAY.LT.MREP(IREP)) GO TO 800
            CALL REPORT
        750 IREP = IREP + 1
            IF (IDAY.GE.MREP(IREP)) GO TO 750
        800 GO TO 200
      C-----------------------------------------------------------------
      C     TIME STEP LOOP COMPLETED
      C-----------------------------------------------------------------
        850 CALL STVNEG(0, 0.0, 0.0, SUCUME)
            IF (.NOT. SULAST) CALL REPORT
            IF (.NOT. SUGRFS .AND. NGRAFS .GT. 0) CALL GRAPHZ
            WRITE (LP,900)
        900 FORMAT (/T50,30('-')/T50,'EXECUTION OF DESERT2 COMPLETED'/
           -  T50,30('-'))
            STOP
            END
```

Subroutine BLDATA

```
BIOME*DESERT2SYM(1).BLDATA
            SUBROUTINE BLDATA
      C
            LOGICAL CALLV,CALLA,CALLS
            LOGICAL ERROR,PRINT,LMIN,LMAX
            LOGICAL SUINIT,SUINTM,SULAST,SUGRFS
            LOGICAL SUPLNT,SUANIM,SUDOM,SUSOIL
            COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
            COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
           -        NFRELM,NFRELP,HORDEP(6),NHOPTZ,NSCMPT
            COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
           -        XMONTH(12),ISTEP,NSTEPS,NDAYS
            COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
           -        PLACE(18),UNITS(8)
            COMMON /SWTCHS/SUINIT,SUINTM,SULAST,SUGRFS,SUPLNT,SUANIM,SUDOM,
           -        SUSOIL
            COMMON /MISC/ ERROR,RCHECK(20),BLANK
            COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEEDMV,
           1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
           2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
           3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
           4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITI(5),
           5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
           6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
           7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
           8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
           9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
           -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
           A  ALINAM(3,5)
            COMMON /CHANGE/ CHANGQ(317)
            COMMON /LIMITS/ MAXCHE,MAXPLA,MAXORG,MAXANI,MAXDOM,MAXSOM,MAXHOR
            COMMON /GLIMS/ LIMGRA,LIMPG,LIMCUR
            COMMON /GRINFO/ VNAM(60),TBOUND(60,3),IADRES(60),NVBLS
            COMMON /GRAPHS/ PERIOD,JXXX,NGRAFS,NCURVZ,
           -                JDAT(12),XDAT(12),LDAT(12),
           -                LMIN(40),LMAX(40),AMIN(40),AMAX(40),
           -                NCURVS(40),JADRES(60)
            COMMON /SVNEGC/ ERRSUM,ISVADR(6)
            COMMON /XTENTS/ LIMIT,LIMTOT,LIMDRY
            COMMON /CALLZ/ CALLV,CALLA,CALLS,LASTDA
      C
            DIMENSION IBOUNX(180),IBOUNQ(180),XXXMON(12),IADREQ(60)
            DIMENSION DEFRAQ(90),DEFRAX(90)
            DIMENSION VNAMA(32),VNAMB(28),VB(1210)
      C
            EQUIVALENCE (IBOUND,TBOUNQ)
            EQUIVALENCE (DEFRAT,DEFRAQ), (VB,PDM)
      C
            DATA BLANQ/'    '/
```

```
      DATA XXXMON/'JAN','FEB','MAR','APR','MAY','JUN',
     -            'JUL','AUG','SEP','OCT','NOV','DEC'/
      DATA VNAMA
     -      /'VDM ','VDMO','VDMV','VDMT','SDM ','SDMV','ADM ','ADMA',
     1       'DDM ','DDMT','ODM ','ODMT','TODM','VVC ','SCC ','ACC ',
     2       'DCC ','OCC ','ASN ','APD ','VCCV','VCCO','VCCT','VCA ',
     3       'VCAV','VCAO','VCAT','SCCV','SCA ','SCAV','ACCA','ACA '/
      DATA VNAMB/
     4       'ACAA','DCCD','DCA ','DCAD','OCCH','OCA ','OCAH','ASNH',
     5       'TCC ','TCA ','SWPH','SWPN','STH ','STN ','DUMV','DUMA',
     6       'DUMS','    ','    ','    ','    ','    ','    ','    ',
     7       '    ','    ','    ','    '/
      DATA IBOUNX/7,7,6,0,7,0,10,0,3,0,1,0,0,7,7,10,3,1,1,10,6,7,5,7,6,
     2  7,0,5,7,0,5,10,0,5,3,0,5,1,0,2,5,0,6,8,6,8,50,30,20,11*0,
     3  6,12*0,6,5,5,5,5,2,0,5,5,0,6,36*0,
     4  13*0,5,46*0/
      DATA IADREQ/0,42,49,55,56,63,64,74,75,78,79,80,81,82,292,327,377,
     1  392,397,399,409,439,474,479,521,527,534,535,540,547,548,553,
     2  563,564,569,572,573,578,579,580,582,587,588,594,602,608,616,
     3  666,696,716,717,718,719,720,721,722,723,724,725,726/
C     1=HERBACEOUS,  2=WOOD,  3=SEEDS    4=ANIMALS 5=UNSORTED LITTER,
C     6=SOIL ORGANIC MATTER
C     DEFRAT IS THE CHEMICAL CONSTITUENTS AS A PROPORTION OF DRY WT
C     THE LAST COLUMN IS TOTAL CARBON AS A PROPORTION OF DRY WT
      DATA DEFRAX/
     1 .020,.080,.060,.200,.160,.420,  .020,.080,.060,.050,.310,.420,
     2  .050,.050,.150,.240,.050,.440,  .040,.030,.080,.230,.190,.500,
     3  .003,.100,.009,.010,.390,.409,  .015,.030,.040,.040,.320,.400,
     4  54*0.0/
C    1 /.020, .080, .060, .200, .160, .420,
C    2  .020, .080, .060, .050, .310, .420,
C    3  .050, .050, .150, .240, .050, .440,
C    4  .040, .030, .080, .230, .190, .500,
C    5  .003, .100, .009, .010, .390, .409,
C    6  .015, .030, .040, .040, .320, .400,
C    7   54*0.0/
C
C-----------------------------------------------------------------------
C     ALPHAMERIC
C-----------------------------------------------------------------------
      DO 110 I=1,32
  110 VNAM(I) = VNAMA(I)
      DO 120 I=1,28
      J = 32 + I
  120 VNAM(J) = VNAMB(I)
      DO 130 I=1,12
  130 XMONTH(I) = XXXMON(I)
      BLANK = BLANQ
C-----------------------------------------------------------------------
C     REAL
C-----------------------------------------------------------------------
      DO 200 I=1,1210
  200 VP(I) = 0.0
      DO 210 I=1,317
  210 CHANQQ(I) = 0.0
      ERRSUM = 0.0
      DO 220 I=1,90
  220 DEFRAQ(I) = DEFRAX(I)
C-----------------------------------------------------------------------
C     LOGICAL
C-----------------------------------------------------------------------
      ERROR = .FALSE.
      PRINT = .FALSE.
      CALLV = .TRUE.
      CALLA = .TRUE.
      CALLS = .TRUE.
C-----------------------------------------------------------------------
C     INTEGER
C-----------------------------------------------------------------------
      MS1 = 1
      MS2 = 2
      MS3 = 3
      KR = 5
      LP = 6
      LIMIT = 317
      LIMTOT = 179
      LIMDRY = 82
      LIMPG  = 8
      LIMGRA = 40
      LIMCUR = 60
      MAXCHE = 5
      MAXPLA = 7
      MAXORG = 6
      MAXANI = 10
      MAXDOM = 3
      MAXSOM = 1
      MAXHOR = 6
      NCATEG = 15
      NVBLS = 60
      NQ = NVBLS*3
      DO 400 I=1,NQ
  400 IBOUNQ(I) = IBOUNX(I)
      DO 410 I=1,NVBLS
  410 IADRES(I) = IADREQ(I)
      ISVADR(1) = 1
      ISVADR(2) = 211
      ISVADR(3) =246
      ISVADR(4) = 296
      ISVADR(5) = 311
      ISVADR(6) = 316
      NSTEPS = 0
      RETURN
      END
```

SUBROUTINE STARTR

```
BIOME*DESERT2SYM(1).STARTR
      SUBROUTINE STARTR
C
      LOGICAL ERROR,PRINT
      LOGICAL CALLV,CALLA,CALLS
      LOGICAL SUINIT,SUINTM,SULAST,SUGRFS
      LOGICAL SUPLNT,SUANIM,SUDOM,SUSOIL
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     -        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCMPT
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
     -        PLACE(18),UNITS(8)
      COMMON /SWTCHS/SUINIT,SUINTM,SULAST,SUGRFS,SUPLNT,SUANIM,SUDOM,
     -        SUSOIL
      COMMON /MISC/ ERROR,RCHECK(20),BLANK
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /CALLZ/ CALLV,CALLA,CALLS,LASTDA
C
C
      WRITE(LP,10)
   10 FORMAT('1'///T30,12('*****'),2(/T30,'*',T89,'*')
     - /T30,'*',T55,'D E S E R T 2',T89,'*'
     - /T30,'*',T55,'= = = = = = =',T89,'*',2(/T30,'*',T89,'*')
     - /T30,'*',T49,'UNITED STATES DESERT BIOME',T89,'*'   )
      WRITE (LP,12)
C     -/T30,'*',T89,'*'
   12 FORMAT ( T30,'*',T89,'*'
     - /T30,'*',T54,'ECOSYSTEM MODEL',T89,'*'  )
      WRITE (LP,15)
C     -/T30,'*',T89,'*'
   15 FORMAT (T30,'*',T89,'*'
     - /T30,'*',T56,'MARCH 1975 ', T89,'*'   )
      WRITE (LP,18)
C     -/T30,'*',T89,'*'
   18 FORMAT ( T30,'*',T89,'*'
     - /T30,'*',T51,'LAST UPDATE - FEB 1978',T89,'*'
     -   ,2(/T30,'*',T89,'*')/T30,12('*****')///'     ')
      CALL MINPUT
      IF (MPRINT(1) .EQ. JDAY) PRINT = .TRUE.
      IF(NPLNTS.EQ.0)CALLV=.FALSE.
      IF(NANIMS.EQ.0)CALLA=.FALSE.
      IF(NOLIT.EQ.0 .AND. NSCMPT.EQ.0 .AND. NHORIZ.EQ.0)CALLS=.FALSE.
      CALL TOTALR
      CALL DRYMAT
      CALL CINPUT
      IF (PRINT) WRITE (LP,50)
   50 FORMAT ('0', T23, 'DUMMY VARIABLE DIRECTORY (THESE VARIABLES CAN B
     -E GRAPHED) --'/
     - T25, 'DUMA(30)', T50, 'RUNNING AVERAGE MEAN AIR TEMPERATURE'/
     - T25, 'DUMA(29)', T50, 'MINIMUM AIR TEMPERATURE'/
     - T25, 'DUMA(28)', T50, 'MAXIMUM AIR TEMPERATURE'/
     - T25, 'DUMA(27)', T50, 'ACCUMULATED PRECIPITATION'/
     - T25, 'DUMA(26)', T50, 'POTENTIAL DAILY EVAPORATION'/
     - T25, 'DUMA(25)', T50, 'PHOTOPERIOD'/
     - T25, 'DUMA(I)', T50, 'ADJUSTED MAX HOURLY SPECIFIC CO2 FIXATION R
     -ATE FOR PLANT I'/
     - T25, 'DUMS(1)',  T50,  'MM OF WATER IN PROFILE'/
     - T25, 'DUMS(2)',  T50,  'CUMULATIVE PREDICTED EVAPORATION'/
     - T25, 'DUMS(3)',  T50,  'STANDING WATER')
      IF (PRINT) WRITE (LP,55)
   55 FORMAT (' ', T25, 'DUMV(I)', T50, 'PHENOLOGICAL STAGE (WHERE I VAR
     -IES FROM 1 TO NPLNTS)'/
     - T25, 'DUMV(I + NPLNTS)', T50, 'FRACTION OF REPRODUCTIVE TISSUE TH
     -AT IS MATURE SEED'/
     - T25,   'DUMV(I + 2*NPLNTS)', T50, 'DRY MATTER IN MATURE ATTACHED
     -SEEDS'/
     - T25, 'DUMV(I + 3*NPLNTS)', T50, 'ADJUSTED OPTIMUM TEMPERATURE FOR
     - PHOTOSYNTHESIS'/
     - T25,'DUMV(I + 4*NPLNTS)',T50,'PHOTOSYNTHETIC RATE, MG CO2 PER G D
     -RY MATTER PER HR'/
     - T25, 'DUMV(I + 5*NPLNTS)', T50, 'DRY MATTER FIXED DURING TIME-STE
     -P'/
     - T25, 'DUMV(49)', T50, 'CUMULATIVE TRANSPIRATION'/
     - T25, 'DUMV(50)', T50, 'TEMPERATURE USED TO PREDICT PHOTOSYNTHESIS
     - RATE')
      CALL EINPUT
      CALL EXOGEN
      WRITE (LP,60) ERROR
   60 FORMAT (' ERROR = ', L1)
      IF(CALLV)CALL VEGETA
      WRITE (LP,60) ERROR
      IF(CALLA)CALL ANIMAL
      WRITE (LP,60) ERROR
      IF(CALLS)CALL SOILSS
      WRITE (LP,60) ERROR
      WRITE(LP,70)
   70 FORMAT(  '0',50('=*')/' ',50('*='))
      IF(.NOT.ERROR)GO TO 100
      WRITE(LP,80)
   80 FORMAT(  '0READING OF INPUT FILE COMPLETED  --  EXECUTION ABORTED
     -DUE TO ERRORS NOTED ABOVE')
      STOP
  100 WRITE(LP,120)
  120 FORMAT(  '0READING OF INPUT FILE COMPLETED  --  NO DETECTABLE ERRO
     -RS')
      LASTDA=IYRDAY
      NDAYS = 0
      NSTEPS = 0
      IF(.NOT.SUGRFS)CALL PREPAR
      IF (.NOT.SUINIT)CALL REPORT
      RETURN
      END
```

SUBROUTINE MINPUT

```
BIOME*DESERT2SYM(1).MINPUT
      SUBROUTINE MINPUT
      LOGICAL SUEXTR,SUCALC,SUCUME
      LOGICAL SUMINP,SUVINP,SUAINP,SUSTNP
      LOGICAL ERROR,PRINT
      LOGICAL SUINIT,SUINTM,SULAST,SUGRFS
      LOGICAL SUPLNT,SUANIM,SUDOM,SUSOIL
      COMMON /ECHOCH/ SUMINP,SUVINP,SUAINP,SUSTNP
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     1        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCMPT
      COMMON /TYMES/ IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     1        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),
     1        PRINT,PLACE(18),UNITS(8)
      COMMON /SWTCHS/ SUINIT,SUINTM,SULAST,SUGRFS,SUPLNT,SUANIM,
     1        SUDOM,SUSOIL
      COMMON /MISC/ ERROR,RCHECK(20),BLANK
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /LIMITS/ MAXCHE,MAXPLA,MAXORG,MAXANI,MAXDOM,MAXSOM,MAXHOR
      COMMON /MAR77/ SUCALC, SUCUME
C
      DATA MDIM/21/
      DATA AMON/'    '/, SUBNAM/'MINP'/
C
   10 FORMAT(7F10.0)
```

```
   20 FORMAT(14I5)
   30 FORMAT(20A4)
   40 FORMAT(70L1)
   50 FORMAT (T7,I5,' MINPUT',4X,20A4)
   60 FORMAT(T7,I5,' MINPUT',7F16.5)
   70 FORMAT(T7,I5,' MINPUT',14I8)
   80 FORMAT(T7,I5,' MINPUT',4X,20A4)
   90 FORMAT(T7,I5,' MINPUT',10L5)
  100 FORMAT(/T30,8('* '),'*'/T30,'*     E R R O R     *'/T30,8('* '),'*')
C-----------------------------------------------------------------------
C     PRINT HEADINGS
C-----------------------------------------------------------------------
      WRITE(LP,120)
C-----------------------------------------------------------------------
C     READ EXPLANATORY INFORMATION REGARDING THE CURRENT
C     SIMULATION (FOLLOWED BY A BLANK CARD)
C-----------------------------------------------------------------------
      IREAD=110
  110 READ(KR,30)PLACE
      WRITE(LP,80)IREAD,PLACE
      DO 115 I=1,18
      IF (PLACE(I) .NE. BLANK) GO TO 110
  115 CONTINUE
  120 FORMAT('0',100('-')/' BEGINNING EXECUTION OF SUBROUTINE MINPUT  --
     1- DEFINITIONS AND INITIALIZATIONS OF STATE VARIABLES'/1X,100('-'
     2 )/'      ')
C-----------------------------------------------------------------------
C     READ TITLE OF SIMULATION
C-----------------------------------------------------------------------
  130 IREAD=140
  140 READ(KR,30)PLACE
      WRITE(LP,80)IREAD,PLACE
C-----------------------------------------------------------------------
C     READ LOGICAL VARIABLES (3 CARDS)
C-----------------------------------------------------------------------
      IREAD=145
  145 READ(KR,40)SUMINP,SUVINP,SUAINP,SUSINP,SUEXTR
      IF(.NOT.SUMINP)WRITE(LP,90)IREAD,SUMINP,SUVINP,SUAINP,SUSINP
     -  ,SUEXTR
      PRINT = .TRUE.
      IF (SUEXTR) PRINT = .FALSE.
      IREAD=150
  150 READ(KR,40)SUINIT,SUINTM,SULAST,SUGRFS,SUCALC,SUCUME
      IF(.NOT.SUMINP)WRITE(LP,90)IREAD,SUINIT,SUINTM,SULAST,SUGRFS
     -  , SUCALC,SUCUME
      IREAD=160
  160 READ(KR,40)SUPLNT,SUANIM,SUDOM,SUSOIL
      IF(.NOT.SUMINP)WRITE(LP,90)IREAD,SUPLNT,SUANIM,SUDOM,SUSOIL
C-----------------------------------------------------------------------
C     READ UNITS IN WHICH BIOMASSES ARE GIVEN, E.G., KILOGRAMS PER HA
C-----------------------------------------------------------------------
      IREAD=170
  170 READ(KR,30)UNITS
      IF(.NOT.SUMINP)WRITE(LP,80)IREAD,UNITS
C-----------------------------------------------------------------------
C     READ NUMBERS OF NON-CARBON CHEMICAL CONSTITUENTS, CARBON TYPES,
C     PLANT GROUPS, PLANT ORGANS, ANIMAL GROUPS, DEAD ORGANIC MATTER
C     TYPES, SOIL ORGANIC MATTER COMPARTMENTS, AND SOIL HORIZONS
C-----------------------------------------------------------------------
      IREAD=180
  180 READ(KR,20)NELEMS,NFRACT,NPLNTS,NORGAN,NANIMS,NOLIT,NSCMPT,NHORIZ
      IF(.NOT.SUMINP)WRITE(LP,70)IREAD,NELEMS,NFRACT,NPLNTS,NORGAN,
     -       NANIMS,NOLIT,NSCMPT,NHORIZ
      NFRAC1=NELEMS + 1
      NFRELM=NELEMS+NFRACT
      NFRELP = NFRELM + 1
      IF(.NOT.SUMINP)WRITE(LP,190)NELEMS,NFRACT,NPLNTS,NORGAN,NANIMS,
     -   NOLIT,NSCMPT,NHORIZ,BLANK
  190 FORMAT('0',I19,' NONCARBON CHEMICAL CONSTITUENTS(S)'/
     1I20,' TYPE(S) OF CARBON'/I20,' PLANT GROUP(S)'/I20,' PLANT ORGAN(S
     2)'/I20,' ANIMAL GROUP(S)'/ I20,' TYPE(S) OF DEAD ORGANIC MATTER'/
     3 I20,' SOIL ORGANIC MATTER COMPARTMENT(S)'/ I20,' SOIL HORIZON(S)'
     4  /A4)
      IF(NFRACT.GT.0)GO TO 210
      ERROR=.TRUE.
      WRITE (LP,100)
      WRITE(LP,200)
  200 FORMAT('0NUMBER OF CARBON TYPES MUST BE GREATER THAN ZERO')
C
  210 IF(NELEMS.GT.0)GO TO 230
      ERROR=.TRUE.
      WRITE (LP,100)
      WRITE(LP,220)
  220 FORMAT('0NUMBER OF NON-CARBON CONSTITUENTS MUST BE GREATER THAN ZE
     1RO (NITROGEN MUST BE INCLUDED)')
C
  230 IF(NPLNTS.LE.MAXPLA)GO TO 250
      ERROR=.TRUE.
      WRITE (LP,100)
      WRITE(LP,240)MAXPLA
  240 FORMAT('0NUMBER OF PLANT GROUPS EXCEEDS LIMIT OF ',I2)
C
  250 IF(NANIMS.LE.MAXANI)GO TO 270
      ERROR=.TRUE.
      WRITE (LP,100)
      WRITE(LP,260)MAXANI
  260 FORMAT('0NUMBER OF ANIMAL GROUPS EXCEEDS LIMIT OF ',I2)
C
  270 IF(NFRELM.LE.MAXCHE)GO TO 290
      ERROR=.TRUE.
      WRITE (LP,100)
      WRITE(LP,280)MAXCHE
  280 FORMAT('0NUMBER OF CHEMICAL CONSTITUENTS EXCEEDS LIMIT OF ',I2)
C
  290 IF(NORGAN.LE.MAXORG)GO TO 310
      ERROR=.TRUE.
      WRITE (LP,100)
      WRITE(LP,300)MAXORG
  300 FORMAT('0NUMBER OF PLANT ORGANS EXCEEDS LIMIT OF ',I2)
C
  310 IF(NHORIZ.LE.MAXHOR)GO TO 330
      ERROR=.TRUE.
      WRITE (LP,100)
      WRITE(LP,320)MAXHOR
  320 FORMAT('0NUMBER OF SOIL HORIZONS EXCEEDS LIMIT OF',I1)
C
  330 IF(NOLIT.LE.MAXDOM)GO TO 350
      ERROR=.TRUE.
      WRITE (LP,100)
      WRITE (LP,340) MAXDOM
  340 FORMAT('0NUMBER OF TYPES OF DEAD ORGANIC MATTER EXCEEDS LIMIT OF '
     1,I2)
C
  350 IF(NSCMPT.EQ.0 .OR. NSCMPT.EQ.1 .OR. NSCMPT.EQ.NHORIZ)GO TO 370
      ERROR=.TRUE.
      WRITE (LP,100)
      WRITE(LP,360)MAXSOM
  360 FORMAT('0NUMBER OF SOIL ORGANIC MATTER COMPARTMENTS MUST EQUAL ZER
     1O OR ONE OR THE NUMBER OF SOIL LAYERS (',I1,')')
  370 CONTINUE
C-----------------------------------------------------------------------
C     READ STARTING DATE OF SIMULATION
C-----------------------------------------------------------------------
      IREAD=380
  380 READ(KR,390)LDAY,AMON,LYR
  390 FORMAT(I2,1X,A3,I5)
      IF(.NOT.SUMINP)WRITE(LP,400)IREAD,LDAY,AMON,LYR
  400 FORMAT(T7,I5,' MINPUT',I5,1X,A3,I5)
      MDAY=LDAY
C     SAVEMO IS USED IN FORTRAN STATEMENT 218
      SAVEMO=AMON
      IYR=LYR
      JYR=LYR
      CALL DATCHK(LDAY,AMON,LYR,LMONTH,LYRDAY,IREAD,1)
      MONTH=LMONTH
      IYRDAY = LYRDAY
      IDAY=IYRDAY
      JDAY=IYRDAY
C-----------------------------------------------------------------------
C     READ LENGTH OF TIME STEP IN DAYS
C-----------------------------------------------------------------------
      IREAD=410
  410 READ(KR,20)ISTEP
      IF(.NOT.SUMINP)WRITE(LP,70)IREAD,ISTEP
      IF(ISTEP.LE.0)ISTEP=1
C-----------------------------------------------------------------------
C     READ ENDING DATE OF SIMULATION
C-----------------------------------------------------------------------
  420 IREAD=430
  430 READ(KR,390)LDAY,AMON,LYR
      IF(.NOT.SUMINP)WRITE(LP,400)IREAD,LDAY,AMON,LYR
      KYR=LYR
      CALL DATCHK(LDAY,AMON,LYR,LMON,NDAY,IREAD,2)
      KDAY=NDAY
      KSTEPS = FLOAT(KDAY-JDAY) / FLOAT(ISTEP) + 0.99
  440 WRITE(LP,450)MDAY,SAVEMO,JYR,LDAY,AMON,KYR,JDAY,KDAY,ISTEP,KSTEPS,
     1  BLANK
  450 FORMAT('0',T22,'SIMULATION WILL RUN FROM',I3,1X,A3,I5, ' TO',I3,
     1  1X,A3,I5/
     2   T22,'JDAY =',I4,6X,'KDAY =',I6/
     3   T22,'LENGTH OF TIME-STEP IN DAYS =',I4/
     4   T22,'NUMBER OF TIME-STEPS DURING SIMULATION =',I5/A4)
      IF(KDAY.GT.JDAY)GO TO 470
      ERROR=.TRUE.
      WRITE (LP,100)
      WRITE(LP,460)
  460 FORMAT('0ENDING DATE OF SIMULATION EQUALS OR PRECEDES STARTING DAT
     1E')
  470 KLIMIT = 3600
      IF (KSTEPS .LE. KLIMIT) GO TO 490
      ERROR = .TRUE.
      WRITE (LP,100)
      WRITE (LP,480) KLIMIT
  480 FORMAT('0',T20,'NUMBER OF TIME-STEPS EXCEEDS LIMIT OF', I6/
     1     T20,'DATA WILL BE READ BUT SIMULATION WILL NOT BE PERFORMED')
  490 CONTINUE
C-----------------------------------------------------------------------
C     READ DATES OF INTERMEDIATE REPORTS
C-----------------------------------------------------------------------
      CALL READAT(MREP,MDIM,NREP,IREP,ERROR,RCHECK,KR,LP,3)
C-----------------------------------------------------------------------
C     READ DATES FOR PRINTING INTERMEDIATE CALCULATIONS
C-----------------------------------------------------------------------
      CALL READAT(MPRINT,MDIM,NPRINT,IPRINT,ERROR,RCHECK,KR,LP,4)
C-----------------------------------------------------------------------
C     READ DEFINITIONS (NAMES) OF STATE VARIABLES
C-----------------------------------------------------------------------
  500 IREAD=505
      DO 510 I=1,NFRELM
  505 READ(KR,30)(FRANAM(I,J),J=1,3)
  510 IF(.NOT.SUMINP)WRITE(LP,80) IREAD,(FRANAM(I,J),J=1,3)
      IF(NPLNTS.LE.0)GO TO 540
      IREAD=515
      DO 520 I=1,NPLNTS
  515 READ(KR,30)(VSPNAM(I,J),J=1,5)
  520 IF(.NOT.SUMINP)WRITE(LP,80) IREAD,(VSPNAM(I,J),J=1,5)
      IREAD=525
      DO 530 I=1,NORGAN
  525 READ(KR,30)(ORGNAM(I,J),J=1,4)
  530 IF(.NOT.SUMINP)WRITE (LP,80) IREAD, (ORGNAM(I,J),J=1,4)
  540 IF(NANIMS.LE.0)GO TO 560
      IREAD=545
      DO 550 I=1,NANIMS
  545 READ(KR,30)(ASPNAM(I,J),J=1,5)
  550 IF(.NOT.SUMINP)WRITE(LP,80)IREAD,(ASPNAM(I,J),J=1,5)
  560 IF(NOLIT.LE.0)GO TO 580
      IREAD=565
      DO 570 I=1,NOLIT
  565 READ(KR,30)(ALINAM(I,J),J=1,5)
  570 IF(.NOT.SUMINP)WRITE(LP,80)IREAD,(ALINAM(I,J),J=1,5)
C-----------------------------------------------------------------------
C     READ PLANT INITIAL CONDITIONS
C-----------------------------------------------------------------------
  580 IF(NPLNTS.LE.0)GO TO 720
      IREAD=590
  590 READ(KR,30)RCHECK
      IF(.NOT.SUMINP)WRITE(LP,50)IREAD,RCHECK
      IREAD=595
      DO 710 I=1,NPLNTS
      DO 710 J=1,NORGAN
  595 READ(KR,10)DW,(VRATIO(I,J,K),K=1,NFRELM)
  600 IF(.NOT.SUMINP)WRITE(LP,60)IREAD,DW,(VRATIO(I,J,K),K=1,NFRELM)
      Q=VRATIO(I,J,1)
      IF(Q.LT.0.9)GO TO 660
      IF(NFRELM.EQ.5)GO TO 620
      ERROR=.TRUE.
      WRITE (LP,100)
      WRITE(LP,610)
  610 FORMAT('0DEFAULT VALUES OF CHEMICAL COMPOSITION MAY BE USED ONLY W
     1HEN THERE ARE 3 CARBON FRACTIONS PLUS NITROGEN AND ASH ELEMENTS'/
     2 ' EXECUTION OF SUBROUTINE ABORTED')
      GO TO 860
  620 L=Q+0.1
      IF(L.LE.NCATEG)GO TO 640
      WRITE(LP,100)
      WRITE(LP,630)NCATEG,IREAD,Q
  630 FORMAT(' POINTER TO DEFAULT VALUES FOR CHEMCIAL COMPOSITION EXCEED
     1S LIMIT OF',I3,5X,'ERROR OCCURRED AT FORTRAN STATEMENT NO.',I4/
     2 ' UNROUNDED VALUE OF POINTER IS ',F6.3)
      GO TO 710
  640 DO 650 K=1,NFRELM
  650 VRATIO(I,J,K)=DEFRAT(K,L)
      SUM = DEFRAT(NFRELP   ,L)
      GO TO 690
  660 SUM=0.0
      DO 670 K=NFRAC1,NFRELM
  670 SUM=SUM+VRATIO(I,J,K)
      IF(SUM.GT.0.0)GO TO 690
      WRITE(LP,100)
      WRITE(LP,680)IREAD
  680 FORMAT('0CHEMICAL COMPOSITION VALUES MISSING AT FORTRAN STATEMENT
     1NO.',I4)
      ERROR=.TRUE.
      WRITE (LP,100)
      GO TO 710
  690 DF = 1.0/SUM
      FACTV(I,J)=DF
C     TOTAL CARBON TIMES DF EQUALS DRY WT
      DO 700 K=1,NFRELM
      CVEG(I,J,K)=DW*VRATIO(I,J,K)
C     VRATIO IS SCALED SO IT EQUALS CHEMICAL CONSTITUENT AS A PROPORTION
C     OF TOTAL CARBON INSTEAD OF A PROPORTION OF DRY MATTER
```

```
  700 VRATIO(I,J,K) = VRATIO(I,J,K)*DF
  710 CONTINUE
C------------------------------------------------------------------
C     READ SHED SEED POOL INITIAL CONDITIONS
C------------------------------------------------------------------
      CALL INITIL(SEED,SRATIO,MAXPLA,MAXCHE,NPLNTS,NFRELM,DEFRAT,
     1 NFRELP,NCATEG,FACTS,NFRAC1,ERROR,KR,LP)
C------------------------------------------------------------------
C     READ INITIAL ANIMAL POPULATION DENSITIES
C------------------------------------------------------------------
  720 IF(NANIMS .LE. 0) GO TO 750
      IREAD=730
  730 READ(KR,30)RCHECK
      IF(.NOT.SUMINP)WRITE(LP,50)IREAD,RCHECK
      IREAD=735
      DO 740 I=1,NANIMS
  735 READ(KR,10)POP(I)
  740 IF(.NOT.SUMINP)WRITE(LP,60)IREAD,POP(I)
C------------------------------------------------------------------
C     READ INITIAL VALUES OF ANIMAL BIOMASSES
C------------------------------------------------------------------
      CALL INITIL(CBIOM,ARATIO,MAXANI,MAXCHE,NANIMS,NFRELM,DEFRAT,
     1 NFRELP,NCATEG,FACTA,NFRAC1,ERROR,KR,LP)
C------------------------------------------------------------------
C     READ INITIAL BIOMASSES OF DEAD ORGANIC MATTER TYPES
C------------------------------------------------------------------
  750 IF (NOLIT .LE. 0) GO TO 760
      CALL INITIL(CLIT,ORATIO,MAXDOM,MAXCHE,NOLIT,NFRELM,DEFRAT,
     1 NFRELP,NCATEG,FACTO,NFRAC1,ERROR,KR,LP)
C------------------------------------------------------------------
C     READ INITIAL BIOMASSES OF SOIL ORGANIC MATTER
C------------------------------------------------------------------
  760 IF (NSCMPT .LE. 0) GO TO 790
      CALL INITIL(CORG,ORATIO,MAXSOM,MAXCHE,NSCMPT,NFRELM,DEFRAT,
     1 NFRELP,NCATEG,FACTO,NFRAC1,ERROR,KR,LP)
C------------------------------------------------------------------
C     READ INITIAL VALUES OF AVAILABLE SOIL NUTRIENTS
C------------------------------------------------------------------
      IREAD=770
  770 READ(KR,30)RCHECK
      IF(.NOT.SUMINP)WRITE(LP,50)IREAD,RCHECK
      IREAD=775
      DO 780 I=1,NSCMPT
  775 READ(KR,10)(CMIN(I,K),K=1,NELEMS)
  780 IF(.NOT.SUMINP)WRITE(LP,60)IREAD,(CMIN(I,K),K=1,NELEMS)
C------------------------------------------------------------------
C     READ DEPTHS OF LOWER SURFACES OF SOIL LAYERS
C------------------------------------------------------------------
  790 IF (NHORIZ.LE.0)GO TO 850
      IREAD=800
  800 READ(KR,30)RCHECK
      IF(.NOT.SUMINP)  WRITE(LP,50)IREAD,RCHECK
      IREAD=810
  810 READ(KR,10)(HORDEP(I),I=1,NHORIZ)
      IF(.NOT.SUMINP)WRITE(LP,60)IREAD,(HORDEP(I),I=1,NHORIZ)
      IF(HORDEP(1).LE.0.0)GO TO 830
      DO 820 I=2,NHORIZ
      IF(HORDEP(I).LE.HORDEP(I-1))GO TO 830
  820 CONTINUE
      GO TO 850
  830 ERROR=.TRUE.
      WRITE (LP,100)
      WRITE(LP,840) (HORDEP(I),I=1,NHORIZ)
  840 FORMAT('0ERROR IN DEPTHS OF SOIL HORIZONS.',6X,'DEPTHS ARE',6F7.0)
  850 CONTINUE
  860 RETURN
      END
```

Subroutine DATCHK

```
BIOME*DESERT2SYM(1).DATCHK
      SUBROUTINE DATCHK (LDAY,AMON,LYR,LMONTH,NDAY,IREAD,K)
      LOGICAL ERROR
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -          XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /MISC/ ERROR,RCHECK(20),BLANK
C
      IF(LDAY.NE.31)GO TO 20
      WRITE(LP,10)LDAY,AMON,LYR,AMON,LYR
   10 FORMAT('0A YEAR CONSISTS OF TWELVE 30-DAY MONTHS.  THE DATE',I3,
     -  1X,A3,I5,'  WILLBE CHANGED TO 30 ',A3,I5)
      LDAY=30
   20 IF(LDAY.LE.0 .OR. LDAY.GT.30)GO TO 100
      IF (LYR.LE.0) GO TO 100
      DO 70 I=1,12
      IF(AMON .EQ. XMONTH(I))GO TO 820
   70 CONTINUE
  100 ERROR=.TRUE.
      WRITE (LP,8745)
 8745 FORMAT(/T30,8('* '),'*'/T30,'*    E R R O R    *'/T30,8('* '),'*')
      GO TO (101,102,103,104),K
  101 WRITE(LP,190)LDAY,AMON,LYR
      GO TO 800
  102 WRITE(LP,220)LDAY,AMON,LYR
      GO TO 800
  103 WRITE(LP,290)LDAY,AMON,LYR
      GO TO 800
  104 WRITE(LP,322)LDAY,AMON,LYR
  190 FORMAT('0THE FOLLOWING DATE OF THE START OF THE SIMULATION IS MEAN
     -INGLESS',10X,I2,1X,A3,I5)
  220 FORMAT('0THE FOLLOWING DATE OF THE END OF THE SIMULATION IS MENAIN
     -GLESS',10X,I2,1X,A3,I5)
  290 FORMAT('0THE FOLLOWING DATE OF A REPORT IS MEANINGLESS',10X,I2,1X,
     -A3,I5)
  322 FORMAT('0THE FOLLOWING DATE FOR PRINTING INTERMEDIATE RESULTS IS M
     -EANINGLESS',10X,I2,1X,A3,I5)
  800 RETURN
  820 LMONTH = I
      NDAY=30 * (LMONTH-1) + LDAY
      IF(LYR.EQ.IYR)GO TO 900
      NDAY = (LYR-IYR)*360 + NDAY
  900 RETURN
      END
```

Subroutine READAT

```
BIOME*DESERT2SYM(1).READAT
      SUBROUTINE READAT(MREP,MDIM,NREP,IREP,ERROR,RCHECK,KR,LP,ISWTCH)
      LOGICAL ERROR
      LOGICAL SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /ECHOCH/ SUMINP,SUVINP,SUAINP,SUSINP
      DIMENSION MREP(MDIM),RCHECK(20)
    2 FORMAT(14I5)
    7 FORMAT(T7,I5,' READAT',14I8)
  180 FORMAT(I2,1X,A3,I5)
  185 FORMAT(T7,I5,' READAT',I5,1X,A3,I5)
C
C     READ NUMBER OF DATES
C
      IREAD=281
  281 READ(KR,2)NREP
      IF(.NOT.SUMINP)WRITE(LP,7)IREAD,NREP
      IF(NREP.EQ.0)GO TO 309
C
C     READ DATES
C
      IREAD=282
      DO 300 IREP=1,NREP
  282 READ(KR,180)LDAY,AMON,LYR
      IF(.NOT.SUMINP)WRITE(LP,185)IREAD,LDAY,AMON,LYR
      MMINUS=MDIM-1
      IF(IREP.LE.MMINUS)GO TO 288
      ERROR=.TRUE.
      WRITE (LP,8745)
 8745 FORMAT(/T30,8('* '),'*'/T30,'*    E R R O R    *'/T30,8('* '),'*')
      GO TO (283,283,283,284),ISWTCH
  283 WRITE(LP,285)MMINUS
      GO TO 300
  284 WRITE(LP,286)MMINUS
      GO TO 300
  285 FORMAT('0MAXIMUM OF',I3,' INTERMEDIATE REPORTS HAS BEEN EXCEEDED')
  286 FORMAT('0MAXIMUM OF',I3,' DATES FOR PRINTING INTERMEDIATE CALCULAT
     -IONS HAS BEEN EXCEEDED')
  288 CALL DATCHK(LDAY,AMON,LYR,LMON,NDAY,IREAD,ISWTCH)
      MREP(IREP)=NDAY
  300 CONTINUE
      IF(NREP.LE.1)GO TO 309
      DO 308 I=2,NREP
      IF(MREP(I).GT.MREP(I-1))GO TO 308
      ERROR = .TRUE.
      WRITE (LP,8745)
      GO TO (301,301,301,302),ISWTCH
  301 WRITE(LP,303)
      GO TO 306
  302 WRITE(LP,304)
  303 FORMAT('0DATES OF REPORTS ARE OUT OF ORDER')
  304 FORMAT('0DATES FOR PRINTING INTERMEDIATE CALCULATIONS ARE OUT OF O
     -RDER')
  306 WRITE(LP,307)(MREP(L),L=1,NREP)
  307 FORMAT(' DATES ARE ',20I5)
  308 CONTINUE
  309 MREP(NREP+1)=9999
      DO 310 IREP=1,NREP
      IF(MREP(IREP).GE.JDAY)GO TO 311
  310 CONTINUE
  311 RETURN
      END
```

Subroutine INITIL

```
BIOME*DESERT2SYM(1).INITIL
      SUBROUTINE INITIL (SV,XRATIO,MI,MK,NI,NK,DEFRAT,NFRELP,NCATEG,
     -  FACTX,NFRAC1,ERROR,KR,LP)
      LOGICAL SUMINP,SUVINP,SUAINP,SUSINP
      LOGICAL ERROR
      COMMON /ECHOCH/ SUMINP,SUVINP,SUAINP,SUSINP
      DIMENSION SV(MI,MK),XRATIO(MI,MK),FACTX(MI),RCHECK(20)
      DIMENSION DEFRAT(NFRELP,NCATEG)
    1 FORMAT(7F10.0)
    3 FORMAT(20A4)
    5 FORMAT(T7,I5,' INITIL',4X,20A4)
    6 FORMAT(T7,I5,' INITIL',7F16.5)
 8745 FORMAT(/T30,8('* '),'*'/T30,'*    E R R O R    *'/T30,8('* '),'*')
      IREAD=572
  572 READ(KR,3)RCHECK
      IF(.NOT.SUMINP)WRITE(LP,5)IREAD,RCHECK
      IREAD=575
      DO 595 I=1,NI
  575 READ(KR,1)DW,(XRATIO(I,K),K=1,NK)
      IF(.NOT.SUMINP)WRITE(LP,6)IREAD,DW,(XRATIO(I,K),K=1,NK)
C
C     BECAUSE OF THE FOLLOWING STATEMENT, THE FIRST CHEMICAL CONSTITUENT
C     SHOULD NEVER BE MORE THAN 100 PER CENT OF DRY MATTER
C
      L=XRATIO(I,1)+0.01
      IF(L.LT.1)GO TO 578
      IF(L.LE.NCATEG)GO TO 576
      ERROR=.TRUE.
      WRITE (LP,8745)
      WRITE(LP,443)NCATEG,IREAD,L
  443 FORMAT ('0',T20,'POINTER TO DEFAULT VALUES FOR CHEMICAL COMPOSITIO
     -N EXCEEDS LIMIT OF',I3/T20,'ERROR OCCURED AT FORTRAN STATEMENT NO.
     -',I4,' OF SUBROUTINE INITIL'/T20,'VALUE OF POINTER WAS',I3)
      GO TO 595
  576 DO 577 K=1,NK
  577 XRATIO(I,K) = DEFRAT(K,L)
      SUM = DEFRAT(NFRELP,L)
      GO TO 585
  578 SUM=0.0
      DO 580 K=NFRAC1,NK
  580 SUM=SUM+XRATIO(I,K)
      IF(SUM.GT.0.0)GO TO 585
      ERROR = .TRUE.
      WRITE (LP,8745)
      WRITE(LP,460)IREAD
  460 FORMAT('0CHEMICAL COMPOSITION VALUES MISSING AT FORTRAN STATEMENT
     -NO.',I5,' IN SUBROUTINE INITIL')
      GO TO 595
  585 DF=1.0/SUM
      FACTX(I)=DF
      DO 590 K=1,NK
      SV(I,K)=DW*XRATIO(I,K)
  590 XRATIO(I,K)=XRATIO(I,K)*DF
  595 CONTINUE
      RETURN
      END
```

Subroutine GINPUT

```
BIOME*DESERT2SYM(1).GINPUT
      SUBROUTINE GINPUT
      LOGICAL SUMINP,SUVINP,SUAINP,SUSINP
      LOGICAL SUINIT,SUINTM,SULAST,SUGRFS,LMIN,LMAX,ERROR
      LOGICAL SUPLNT,SUANIM,SUDOM,SUSOIL
      COMMON /ECHOCH/ SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /SWTCHS/SUINIT,SUINTM,SULAST,SUGRFS,SUPLNT,SUANIM,SUDOM,
     1         SUSOIL
      COMMON /MISC/ ERROR,RCHECK(20),BLANK
      COMMON /GLIMS/ LIMGRA,LIMPG,LIMCUR
      COMMON /GRINFO/ VNAM(60),IBOUND(60,3),IADRES(60),NVBLS
      COMMON /GRAPHS/ PERIOD,JXXX,NGRAFS,NCURVZ,
     -                    JDAT(12),XDAT(12),LDAT(12),
     -                    LMIN(40),LMAX(40),AMIN(40),AMAX(40),
     -                    NCURVS(40),JADRES(60)
      DIMENSION JJ(3),FILLER(11),TITLE(18),EXPLAN(7)
```

```
      EQUIVALENCE (JJ(1),JJI), (JJ(2),JJJ), (JJ(3),JJK)
      DATA FILLER/11*0.0/, SUBNAM/'GINP'/
      DATA STOPP/'STOP'/
C
   10 FORMAT('0',100('-')/' BEGINNING EXECUTION OF SUBROUTINE GINPUT
     1-  READING OF INSTRUCTIONS FOR GRAPHICAL OUTPUT'/1X,100('-'))
   20 FORMAT(14I5)
   30 FORMAT(20A4)
   40 FORMAT('0',T20,'GRAPHICAL INPUT WILL BE SKIPPED AS REQUESTED')
   50 FORMAT(A4,1X,3I5,20X,7A4)
   60 FORMAT('0',T20,'REQUESTED NUMBER OF GRAPHS EXCEEDS LIMIT OF',I3)
   70 FORMAT(/T30,8('* '),'*'/T30,'*    E R R O R    *'/T30,8('* '),'*')
C
      IF(.NOT.SUMINP)WRITE(LP,10)
      ISAVE = 1
      IF(.NOT.SUGRFS)GO TO 80
      WRITE(LP,40)
      GO TO 370
   80 IREAD=90
   90 READ(KR,30)RCHECK
      IF(.NOT.SUMINP)WRITE(LP,100)IREAD,RCHECK
      IF(RCHECK(1).NE.SUBNAM)GO TO 90
  100 FORMAT (T7,I5,' GINPUT',4X,20A4)
C     KCURV IS A COUNTER FOR CURVES IN THE SIMULATION
C     ICURV IA A COUNTER FOR CURVES IN A SINGLE GRAPH
      KCURV=0
  120 FORMAT (T7,I5,' GINPUT',14I8)
      IGRAF=0
C-----------------------------------------------------------------------
C     BEGIN LOOP FOR EACH GRAPH
C-----------------------------------------------------------------------
  135 CONTINUE
      IREAD=140
C     'NC' IS THE NUMBER OF CURVES ON THE GRAPH.
C     'TITLE' IS THE TITLE OF THE GRAPH
  140 READ(KR,150)NC,TITLE
  150 FORMAT(I1,1X,18A4)
      IF(.NOT.SUMINP)WRITE(LP,160)IREAD,NC,TITLE
  160 FORMAT (T7,I5,' GINPUT',I5,1X,20A4)
      IF (TITLE(1) .EQ. STOPP) GO TO 338
      IGRAF=IGRAF+1
      IF (IGRAF  .GT. LIMGRA) GO TO 335
      MS2REC = ISAVE
      WRITE(MS2'MS2REC)TITLE
      ISAVE = ISAVE + 1
      IF(NC.LE.LIMPG .AND. NC.GT.0) GO TO 180
      ERROR=.TRUE.
      WRITE (LP,70)
      WRITE(LP,170)IGRAF,LIMPG
  170 FORMAT('0REQUESTED NUMBER OF CURVES IN GRAPH NO.',
     1  I3,' EXCEEDS LIMIT OF',I3)
  180 NCURVS(IGRAF)=NC
      IREAD=190
  190 READ (KR,200) LMIN(IGRAF),LMAX(IGRAF),AMIN(IGRAF),AMAX(IGRAF)
  200 FORMAT (2L1,8X,2F10.0)
      IF(.NOT.SUMINP)WRITE (LP,210) IREAD,LMIN(IGRAF),LMAX(IGRAF),
     -  AMIN(IGRAF),AMAX(IGRAF)
  210 FORMAT (T7,I5,' GINPUT',4X,2L1,8X,2F10.2)
C-----------------------------------------------------------------------
C     BEGIN LOOP FOR EACH CURVE IN THIS GRAPH
C-----------------------------------------------------------------------
      IREAD=230
      DO 320 ICURV=1,NC
      KCURV=KCURV+1
      IF (KCURV .LE. LIMCUR) GO TO 230
      ERROR=.TRUE.
      WRITE (LP,70)
      WRITE(LP,220) LIMCUR
  220 FORMAT('0REQUESTED TOTAL NUMBER OF CURVES EXCEEDS LIMIT OF',I3)
      GO TO 370
C     'STORE' HOLDS THE VARIABLE NAME TO BE GRAPHED
C     'JJ(I)' HOLDS THE 3 SUBSCRIPTS (IF ANY)OF THE ELEMENT IN THE
C          VARIABLE NAME.  IT IS EQUIVALENCED TO JJI,JJJ AND JJK
C     'EXPLAN' HOLDS THE LABEL OF THE CURVE
C     'FILLER' IS A DUMMY ARRAY USED TO MAKE THE RECORD LENGTH 18
C          WORDS, THE SAME AS THE LENGTH OF THE 'TITLE' ARRAY
  230 READ (KR,50) STORE,JJ,EXPLAN
      IF(.NOT.SUMINP)WRITE (LP,240) IREAD, STORE,JJ,EXPLAN
  240 FORMAT (T7,I5,' GINPUT',4X,A4,1X,3I5,20X,7A4)
      MS2REC = ISAVE
      WRITE(MS2'MS2REC) EXPLAN,FILLER
      ISAVE = ISAVE + 1
      DO 250 I=1,NVBLS
      IF(STORE.EQ.VNAM(I))GO TO 270
  250 CONTINUE
      ERROR = .TRUE.
      WRITE (LP,70)
      WRITE(LP,260)STORE,IGRAF
  260 FORMAT('0THE VARIABLE NAME "',A4,'" IN GRAF NO.',I3,' IS INVALID
     1  ')
      GO TO 320
C     'I' NO POINTS TO THE VARIABLE NAME BEING GRAPHED
  270 DO 280 J=1,3
      IF(JJ(J).GT.IBOUND(I,J))GO TO 290
  280 CONTINUE
      GO TO 310
  290 ERROR=.TRUE.
      WRITE (LP,70)
      WRITE (LP,300) J,STORE,JJ,(IBOUND(I,K),K=1,3)
  300 FORMAT('0VALUE OF DIMENSION',I3,' OF ',A4,'(',I2,',',I2,',',I2,
     1  ') IS TOO HIGH',5X,'BOUNDS ARE (',I2,',',I2,',',I2,')')
      GO TO 320
C     NOW CONVERT THE SUBSCRIPT ADDRESS TO THE RELATIVE ADDRESS IN
C     CORE USING THE STANDARD FORMULA, AND REMEMBERING THAT IN FORTRAN
C     ARRAYS THE FIRST SUBSCRIPT VARIES FASTEST AND THE LAST SUBSCRIPT
C     VARIES SLOWEST
  310 L1=0
      IF (JJK.GT.0) L1=IBOUND(I,1)*IBOUND(I,2)*(JJK-1)
      L2=0
      IF (JJJ.GT.0) L2=IBOUND(I,1)*(JJJ-1)
      IF (JJI.LE.0) JJI=1
      JADRES(KCURV)=IADRES(I)+L1+L2+JJI
  320 CONTINUE
  330 GO TO 135
  335 WRITE (LP,60) LIMGRA
      IGRAF=IGRAF-1
C-----------------------------------------------------------------------
C     END LOOP FOR EACH GRAPH
C-----------------------------------------------------------------------
  338 CONTINUE
      NGRAFS = IGRAF
  340 IF(.NOT.SUMINP)WRITE(LP,350)KCURV,NGRAFS
  350 FORMAT ('0',T23,'A TOTAL OF',I3,' CURVES WILL BE PLOTTED ON',
     1 I3,' GRAPHS')
      NCURVZ = KCURV
      IF(.NOT.SUMINP)WRITE (LP,360) (JADRES(I),I=1,NCURVZ)
  360 FORMAT (T23,'ADDRESSES OF VARIABLES TO BE GRAPHED=',
     1   10(/T23,10I10))
  370 RETURN
      END
```

SUBROUTINE EINPUT

```
BIOME*DESERT2SYM(1).EINPUT
      SUBROUTINE EINPUT
C
C     VERSION FOR USE WITH RANDOM ACCESS FILE OF EXOGENOUS DATA
C
      REAL LAT
      LOGICAL SUMINP,SUVINP,SUAINP,SUSINP,RAINCH,ERROR,PRINT
      COMMON /ECHOCH/ SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     1          XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
     1          PLACE(18),UNITS(8)
      COMMON /MISC/ ERROR,RCHECK(20),BLANK
      COMMON /WTHRV/ DATMIN,DATMAX,DARAIN,DAEVAP,DAPHOT
      COMMON /WTHRP/ FACTOR,APHT,BPHT,RAINCH
      COMMON /EXSAVE/LREC, JYREXO, KYREXO, LASREC
      COMMON /WTHRP2/ FACTT, FACTE
      DATA SUBNAM/'EINP'/
C
C
   10 FORMAT (7F10.0)
   20 FORMAT(10I5)
   25 FORMAT (T7, I5, ' EINPUT', 4X, 10I5)
   30 FORMAT(10F5.0)
   40 FORMAT(20A4)
   50 FORMAT (T7,I5,' EINPUT',4X,20A4)
   60 FORMAT (L1)
   70 FORMAT (T7,I5,' EINPUT',4X,L1)
   80 FORMAT(/T30,8('* '),'*'/T30,'*    E R R O R    *'/T30,8('* '),'*')
C
C
   95 IF(.NOT.SUMINP)WRITE (LP,100)
  100 FORMAT('0',100('-')/' BEGINNING EXECUTION OF SUBROUTINE EINPUT
     1--  READING OF EXOGENOUS VARIABLES'/1X,100('-'))
C-----------------------------------------------------------------------
C     READ HEADER CARD
C-----------------------------------------------------------------------
      IREAD=110
  110 READ(KR,40,END=900)RCHECK
      IF(.NOT.SUMINP) WRITE (LP,50) IREAD,RCHECK
      IF(RCHECK(1).NE.SUBNAM)GO TO 110
C-----------------------------------------------------------------------
C     READ FACTORS WHICH MULTIPLY TEMP, RAIN AMOUNTS, AND EVAPORATION
C-----------------------------------------------------------------------
      IREAD = 140
  140 READ (KR,40) RCHECK
      IF (.NOT. SUMINP) WRITE (LP,50) IREAD, RCHECK
      IREAD=150
  150 READ (KR,10) FACTT, FACTOR, FACTE
      IF (.NOT. SUMINP) WRITE (LP,160) IREAD,FACTT,FACTOR,FACTE
  160 FORMAT(T7,I5,' EINPUT',7F16.4)
C-----------------------------------------------------------------------
C     READ YEARS WHEN WEATHER DATA BEGIN BEGIN AND END
C-----------------------------------------------------------------------
      IREAD = 200
  200 READ (KR,40) RCHECK
      IF (.NOT. SUMINP) WRITE (LP,50) IREAD, RCHECK
      IREAD = 210
  210 READ (KR,20) JYREXO,KYREXO
      IF (.NOT. SUMINP) WRITE (LP,25) IREAD, JYREXO, KYREXO
      LASREC  = (KYREXO - JYREXO + 1) * 360
C-----------------------------------------------------------------------
C     READ LATITUDE
C-----------------------------------------------------------------------
      IREAD = 610
  610 READ (KR,40) RCHECK
      IF (.NOT.SUMINP) WRITE (LP,50) IREAD, RCHECK
      IREAD=620
  620 READ(KR,10)LAT
      IF(.NOT.SUMINP)WRITE(LP,630)IREAD,LAT
  630 FORMAT(T7,I5,' EINPUT',F16.5)
      IF (LAT .GE. 25.0 .AND. LAT .LE. 45.0) GO TO 638
      WRITE (LP,637)
  637 FORMAT (' =*=*=*=  POSSIBLE ERROR  =*=*=*=  VALUE FOR LATITUDE LOO
     -KS SUSPICIOUS')
  638 CONTINUE
      APHT = 730.0 - 0.27*LAT + 0.00793*LAT*LAT
      BPHT = 34.2 - 0.78*LAT + 0.1*LAT*LAT
C-----------------------------------------------------------------------
C     READ WHETHER RAIN AMOUNTS WILL BE PRINTED DURING SIMULATION
C-----------------------------------------------------------------------
      IREAD = 660
  660 READ (KR,40) RCHECK
      IF (.NOT. SUMINP) WRITE (LP,50) IREAD, RCHECK
      IREAD=670
  670 READ(KR,60)RAINCH
      IF(.NOT.SUMINP)WRITE(LP,70)IREAD,RAINCH
  900 RETURN
      END
```

SUBROUTINE EXOGEN

```
BIOME*DESERT2SYM(1).EXOGEN
      SUBROUTINE EXOGEN
C
C     VERSION FOR USE WITH RANDOM ACCESS FILE OF EXOGENOUS DATA
C
      LOGICAL RANGRM, GERMOK
      LOGICAL PRINT, RAINCH
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -          XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
     -          PLACE(18),UNITS(8)
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),ORATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTC(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /WTHRV/ DATMIN,DATMAX,DARAIN,DAEVAP,DAPHOT
      COMMON /WTHRP/ FACTOR,APHT,BPHT,RAINCH
      COMMON /EXSAVE/LREC, JYREXO, KYREXO, LASREC
      COMMON /WTHRP2/ FACTT, FACTE
      COMMON /RAINGM/ RANVEC(4), RANGRM, GERMOK
C
C
      IF (IDAY .GT. JDAY) GO TO 105
      LREC = (IYR-JYREXO) * 360   + IYRDAY - ISTEP
      DUMMYA(27) = 0.0
      JREC = LREC + 1
      WRITE (LP,100) JREC
  100 FORMAT('0FIRST RECORD READ FROM WEATHER FILE WILL BE',I7)
```

```
      IF (JREC .LT. 1) WRITE (LP,102)
  102 FORMAT ('+', T53, '+ 360')
      DO 104 L=1,4
  104 RANVEC(L) = 0.0
      RANGRM = .FALSE.
      GERMOK = .FALSE.
  105 CONTINUE
      Z=(IYRDAY+280.)*3.1416/180.
      DAPHOT=(APHT+BPHT*SIN(Z))/60.
      Q1 = 0.0
      Q2 = 0.0
      Q3 = 0.0
      Q4 = 0.0
      JREC = LREC + 1
      KREC = LREC + ISTEP
      DO 260 IREC = JREC,KREC
      MS3REC = IREC
      IF (MS3REC .LT. 1) MS3REC = MS3REC + 360
  240 IF  (MS3REC .LE. LASREC) GO TO 250
      MS3REC = MS3REC - 360
      GO TO 240
  250 MS3SAV = MS3REC
      READ (MS3'MS3REC) DATMIN, DATMAX, PPT, DAEVAP
      IF (RAINCH .AND. PPT .GT. 0.0) WRITE (LP,251) IYRDAY, MS3SAV,
     - DATMIN, DATMAX, PPT, DAEVAP, DAPHOT
  251 FORMAT (T6,'IYRDAY,IREC,DATMIN,DATMAX,PPT,DAEVAP,DAPHOT=',
     -  2I8,5F10.2)
      DO 252 L=1,3
  252 RANVEC(L) = RANVEC(L+1)
      RANVEC(4) = PPT
      SUM = 0.0
      DO 253 L=1,4
  253 SUM = SUM + RANVEC(L)
      IF (SUM .GE. 10.0) RANGRM = .TRUE.
      Q1 = Q1 + DATMIN * FACTT
      Q2 = Q2 + DATMAX * FACTT
      Q3 = Q3 + PPT*FACTOR
      Q4 = Q4 + DAEVAP  * FACTE
  260 CONTINUE
      LREC = KREC
      DATMIN = Q1 / ISTEP
      DATMAX = Q2 / ISTEP
      DARAIN = Q3
      DAEVAP = Q4 / ISTEP
      IF (IDAY .EQ. JDAY) DARAIN = 0.0
      OWATER(1)=OWATER(1)+DARAIN
      IF (PRINT .OR. IDAY .EQ. JDAY) WRITE (LP,300) DATMIN, DATMAX,
     -    DARAIN, DAEVAP, DAPHOT
  300 FORMAT ('0---* EXECUTING SUBROUTINE EXOGEN'/T7,'  DATMIN  DATMAX
     -DARAIN  DAEVAP  DAPHOT'/ T7,5F8.1)
      IF (DATMIN .GE. DATMAX .OR. DATMIN .LT. -20. .OR. DATMAX .GT. 45.)
     -    WRITE (LP,400) DATMIN, DATMAX, TYR, IYRDAY,IREC
  400 FORMAT ('OTHE FOLLOWING VALUES OF MIN AND MAX TEMPERATURE LOOK SUS
     -PICIOUS -', 2F10.1/  ' YEAR =',I5,5X,'JULIAN DAY =',I5,5X,
     -    'RECORD =',I5)
      DUMMYA(29) = DATMIN
      DUMMYA(28) = DATMAX
      DUMMYA(27) = DUMMYA(27) + DARAIN
      DUMMYA(26) = DAEVAP
      DUMMYA(25) = DAPHOT
      RETURN
      END
```

SUBROUTINE STVNEG

```
BIOME*DESERT2SYM(1).STVNEG
      SUBROUTINE STVNEG (IADR, A, X, SUCUMF)
      LOGICAL SUCUMF
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYP,JYR,KYR,IDAY,JDAY,KDAY,
     -         XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /GRINFO/ VNAM(60),IBOUND(60,3),IADRES(60),NVBLS
      COMMON /SVNEGC/ERRSUM,ISVADR(6)
C
      DATA NQQ/13/,NNAMES/6/
C
C     NQQ IS THE NO. OF VARIABLE NAMES PRECEDING THE STATE VARIABLE
C     NAMES IN THE /VBLS/ COMMON BLOCK
C
C     IADR IS THE ADDRESS OF THE ELEMENT RELATIVE TO CVEG(1,1,1)
      IF(IADR.EQ.0)GO TO 600
      DO 10 I=1,NNAMES
      K=NNAMES + 1 -I
      IF(IADR.GE.ISVADR(K))GO TO 30
   10 CONTINUE
      WRITE(LP,20)
   20 FORMAT('0',T20,'ERROR IN SUBROUTINE STVNEG'/
     -  T20,'CHECK COMMON BLOCKS AND INITIAL VALUE STATEMENTS')
      GO TO 900
C     JADR IS THE ADDRESS OF THE ELEMNT RELATIVE TO THE FIRST ELEMENT
C     IN THE KNQ'TH VARIABLE NAME IN THE /VBLS/ COMMON BLOCK
   30 JADR=IADR-ISVADR(K)+1
      KNQ = K + NQQ
C     KNQ POINTS TO THE VBL NAME IN COMMON
      J1 = IBOUND(KNQ,1)
      J2 = IBOUND(KNQ,2)
      J3 = IBOUND(KNQ,3)
      I1=0
      I2=0
      I3=0
      IF (J1.EQ.0)GO TO 460
      IF (J2.NE.0)GO TO 35
      I1=JADR
      GO TO 460
   35 CONTINUE
C     NOW WE HAVE EITHER A 2 OR 3 DIM ARRAY
      IF(J3.EQ.0)GO TO 60
C     3 DIM ARRAYS
      JJ=J1*J2
      L1=JADR/JJ
      JADR=MOD(JADR,JJ)
      I3=L1+1
      IF(JADR.NE.0)GO TO 60
      I3=I3-1
      JADR=JJ
C     I3 IS NOW FIXED, AND 2 DIMS ARE LEFT TO WORK WITH
   60 L1=JADR/J1
      JADR=MOD(JADR,J1)
      I2=L1+1
      IF(JADR.NE.0)GO TO 80
      I2=I2-1
      JADR=J1
C     I2 IS NOW FIXED
   80 I1=JADR
  460 ERRSUM = ERRSUM +X + A
      IF (SUCUMF) GO TO 550
      WRITE(LP,500)MDAY,XMONTH(MONTH),IYR,VNAM(KNQ),I1,I2,I3,X,A,ERRSUM
  500 FORMAT(' ',T2,1X,A3,1X,I4,4X,A4,'(',I2,',',I2,',',I2,
     -  ') = ',G14.6,5X,'DECINC = ',G14.6,10X,'CUMULATIVE ERROR =',G14.6
     -)
  550 CONTINUE
      GO TO 900
  600 WRITE(LP,610)ERRSUM
  610 FORMAT('OCUMULATIVE ERROR IN DECINC AT END OF SIMULATION =',G13.5)
  900 RETURN
      END
```

SUBROUTINE TOTALR

```
BIOME*DESERT2SYM(1).TOTALR
      SUBROUTINE TOTALR
C
      DIMENSION SUMS(179)
C
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     -        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCMPT
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /XTENTS/ LIMIT,LIMTOT,LIMDRY
      EQUIVALENCE (SUMS,CVEGV)
C
C
      DO 200 I=1,LIMTOT
  200 SUMS(I)=0.0
C--------------------------------------------------------------
COMPUTE TOTALS OF PLANT STATE VARIABLES
C--------------------------------------------------------------
      IF (NPLNTS .LE. 0) GO TO 490
      DO 435 I = 1,NPLNTS
      C=0.0
      DO 430 J = 1,NORGAN
      B=0.0
      DO 428 K = 1,NELEMS
      A = CVEG(I,J,K)
      CVEGO(I,K) = CVEGO(I,K) + A
  428 CVEGV(J,K) = CVEGV(J,K) + A
      DO 429 K =NFRAC1,NFRELM
      A = CVEG(I,J,K)
      B=B+A
      CVEGO(I,K) = CVEGO(I,K) + A
  429 CVEGV(J,K) = CVEGV(J,K) + A
      AVEG(I,J)=B
      AVEGV(J)=AVEGV(J)+B
  430 C=C+B
      AVEGO(I)=C
  435 AVEGVO=AVEGVO + C
      DO 460 J=1,NORGAN
      DO 460 K = 1,NFRELM
  460 CVEGVO(K) = CVEGVO(K) + CVEGV(J,K)
C--------------------------------------------------------------
COMPUTE TOTALS OF DEAD ORGANIC MATTER STATE VARIABLES
C--------------------------------------------------------------
  490 IF (NOLIT .LE. 0) GO TO 520
      DO 510 I = 1,NOLIT
      B=0.0
      DO 498 K = 1,NELEMS
  498 CLITT(K) = CLITT(K) + CLIT(I,K)
      DO 500 K = NFRAC1,NFRELM
      A = CLIT(I,K)
      CLITT(K) = CLITT(K) + A
  500 B=B+A
      ALIT(I)=B
  510 ALITT=ALITT+B
C--------------------------------------------------------------
COMPUTE TOTALS OF SOIL STATE VARIBLES
C--------------------------------------------------------------
  520 IF(NHORIZ.LE.0)GO TO 560
      DO 540 I = 1,NSCMPT
      B=0.0
      DO 528 K = 1,NELEMS
      CORGH(K) = CORGH(K) + CORG(I,K)
  528 CMINH(K) = CMINH(K) + CMIN(I,K)
      DO 530 K = NFRAC1,NFRELM
      A = CORG(I,K)
      CORGH(K) = CORGH(K) + A
  530 B=B+A
      AORG(I)=B
  540 AORGH=AORGH+B
C--------------------------------------------------------------
COMPUTE TOTALS OF SHED SEEDS
C--------------------------------------------------------------
  560 IF (NPLNTS .LE. 0) GO TO 700
      DO 585 I = 1,NPLNTS
      B=0.0
      DO 578 K = 1,NELEMS
  578 SEEDV(K) = SEEDV(K) + SEED(I,K)
      DO 580 K = NFRAC1,NFRELM
      A = SEED(I,K)
      B=B+A
  580 SEEDV(K) = SEEDV(K) + A
      ASEED(I)=B
  585 ASEEDV=ASEEDV+B
C--------------------------------------------------------------
COMPUTE TOTALS OF ANIMAL STATE VARIABLES
C--------------------------------------------------------------
  700 IF (NANIMS.LE.0) GO TO 740
      DO 730 I = 1, NANIMS
      B=0.0
      POPA = POPA + POP(I)
      DO 720 K = 1, NELEMS
  720 CBIOMA(K)=CBIOMA(K) + CBIOM(I,K)
      DO 725 K=NFRAC1,NFRELM
      A = CBIOM(I,K)
      B=B+A
  725 CBIOMA(K) = CBIOMA(K) + A
      ABIOM(I) = B
  730 ABIOMA = ABIOMA + B
C--------------------------------------------------------------
COMPUTE TOTALS FOR THE WHOLE ECOSYSTEM
C--------------------------------------------------------------
  740 DO 750 K=1,NFRELM
  750 ECOTOT(K)=CVEGVO(K)+SEEDV(K)+CBIOMA(K)+CLITT(K)+CORGH(K)
      AECOTO=0.0
      DO 770 K=NFRAC1,NFRELM
  770 AECOTO=AECOTO+ECOTOT(K)
      RETURN
      END
```

Subroutine DRYMAT

```
BIOME*DESERT2SYM(1).DRYMAT
      SUBROUTINE DRYMAT
C
      DIMENSION DMTOTS(82)
C
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     -        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCHPT
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /XTENTS/ LIMIT,LIMTOT,LIMDRY
      EQUIVALENCE (DMTOTS,PDM)
C
C
      B = 0.0
      C = 0.0
      DO 50 I=1,LIMDRY
   50 DMTOTS(I)=0.0
      DO 200 I=1,NPLNTS
      D=0.0
      DO 100 J=1,NORGAN
      A = AVEG(I,J) * FACTV(I,J)
      PDMV(J) = PDMV(J) + A
      PDM(I,J) = A
  100 D=D+A
      PDMO(I) = D
      B = B+D
      A = ASEED(I)*FACTS(I)
      SEEDDM(I)=A
  200 C=C+A
      PDMVO = B
      SEDDMV=C
      DO 400 I=1,NANIMS
      A = ABIOM(I)*FACTA(I)
      ADM(I)=A
  400 ADMA=ADMA+A
      DO 500 I=1,NOLIT
      A = ALIT(I)*FACTD(I)
      DDM(I)=A
  500 DDMT=DDMT+A
      DO 600 I=1,NSCHPT
      A = AORG(I)*FACTO(I)
      SDM(I) = A
  600 SDMT=SDMT + A
      TOTDM=PDMVO+SEDDMV+ADMA+DDMT+SDMT
      RETURN
      END
```

Subroutine FLOWSS

```
BIOME*DESERT2SYM(1).FLOWSS
      SUBROUTINE FLOWSS
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
C
C
      OCARBO(5) = OCARBO(1) - (OCARBO(2)+OCARBO(3)+OCARBO(4))
      OPRODU(3) = OPRODU(1) + OPRODU(2)
      RETURN
      END
```

Subroutine PREPAR

```
BIOME*DESERT2SYM(1).PREPAR
      SUBROUTINE PREPAR
      LOGICAL LMIN,LMAX
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /VBLS/ VBLSA(1350)
      COMMON /GRAPHS/ PERIOD,JXXX,NGRAFS,NCURVZ,
     -                JDAT(12),XDAT(12),LDAT(12),
     -                LMIN(40),LMAX(40),AMIN(40),AMAX(40),
     -                NCURVS(40),JADRES(60)
      COMMON /PSAVE/ IRSAVE
      DIMENSION FIGS(60)
C
      IF(IDAY.GT.JDAY)GO TO 100
      JX=1
      IRSAVE = 1
C     PERIOD=THE LENGTH OF TIME (IN DAYS) REPRESENTED BY ONE OF
C     THE 110 X-AX-S INTERVALS IN THE GRAPHS
      PERIOD=FLOAT(KDAY-JDAY)/110.
      GO TO 200
  100 JX=(IDAY-JDAY)/PERIOD+1.1
C     JX=COLUMN OF THE GRAPH TO BE FILLED DURING THE CURRENT EXECUTION
C     OF THIS SUBROUTINE
C     JXXX=THE NEXT AVAILABLE COLUMN AFTER THE ONE THAT WAS FILLED
C     DURING THE LAST CALL TO 'PREPAR'
      IF(JX.EQ.JXXX)RETURN
  200 DO 300 I=1,NCURVZ
      K=JADRES(I)
C     K=THE ADDRESS IN THE /VBLS/ COMMON BLOCK OF THE I'TH VARIABLE
C     TO BE GRAPHED
  300 FIGS(I)=VBLSA(K)
  550 JXXX=JX
      MS1REC = IRSAVE
      WRITE(MS1'MS1REC)JX,FIGS
      IRSAVE = IRSAVE + 1
      IF(JX.EQ.111)GO TO 600
      RETURN
C-----------------------------------------------------------------
C     AFTER SIMULATION IS COMPLETE, SET UP LABELS FOR X=AXIS OF GRAPHS
C-----------------------------------------------------------------
  600 Q=FLOAT(KDAY-JDAY)/11.0
      P=FLOAT(JDAY)-Q
      DO 700 I=1,111,10
      P=P+Q
C     ID=ACCUMULATED JULIAN DAY
      ID=P+0.1
C     NOW EXTRACT THE YEAR, MONTH AND DAY OF MONTH FROM 'ID'
      IY=JYR+ID/360
C     IY=YEAR
C     IM=MONTH
C     IA=DAY OF MONTH
      IJ=MOD(ID,360)
      IF(IJ.EQ.0)IJ=360
      IM=(IJ-1)/30+1
      IA=MOD(IJ,30)
      IF(IA.EQ.0)IA=30
      K=I/10+1
      JDAT(K)=IA
      XDAT(K)=XMONTH(IM)
      LDAT(K)=IY
  700 CONTINUE
      RETURN
      END
```

Subroutine REPORT

```
BIOME*DESERT2SYM(1).REPORT
      SUBROUTINE REPORT
      REAL MMINPR
      LOGICAL SUINIT,SUINTM,SULAST,SUGRFS
      LOGICAL SUPLNT,SUANIM,SUDOM,SUSOIL
      LOGICAL PFINT
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     -        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCHPT
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
     -        PLACE(18),UNITS(8)
      COMMON /SWTCHS/SUINIT,SUINTM,SULAST,SUGRFS,SUPLNT,SUANIM,SUDOM,
     -        SUSOIL
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /TEMP2/ PRODSP(7)
      COMMON /FLUX2/ FLUXLO(7)
      COMMON /FLUX3/FX1(7),FX2(7),FX3(7),FX4(7)
      COMMON /FLUX4/ FX6,FX7,FX8,FX9
      COMMON /FLUX5/ FX10(7)
      COMMON /FLUX6/FX15(10)
      COMMON /FLUX7/FX11(10),FX12(10),FX13(10),FX14(10)
      COMMON /FLUX8/ FX16(9,5)
      COMMON /EVASAV/ FSUM
      COMMON /CONSAV/ CVF
      COMMON /SAVWIP/ MMINPR
      DIMENSION TOTCAR(3),DRYMA(3),PPP(3)
      DATA TOTCAR/'    ',' TOT','AL C'/
      DATA DRYMA /' DR','Y MA','TTER'/
      DATA PPP   /'    ',' DEN','SITY'/
C
C
C-----------------------------------------------------------------
C     IF THERE IS ONLY 1 CARBON FRACTION, THEN DO NOT PRINT IT AS ONE
C     OF THE CHEMICAL CONSTITUENTS BECAUSE IT WILL AUTOMATICALLY BE
C     PRINTED AS TOTAL CARBON. NFRELM IS RESET TO ITS PROPER
C     VALUE AT END OF SUBROUTINE.
C-----------------------------------------------------------------
      ISAVE=NFRELM
      IF(NFRACT.LE.1)NFRELM=NELEMS
C-----------------------------------------------------------------
C     PRINT HEADINGS
C-----------------------------------------------------------------
      WRITE(LP,10)PLACE
   10 FORMAT('1',20A4)
      IF(IDAY.EQ.KDAY)GO TO 60
      IF(IDAY.GT.JDAY)GO TO 30
      WRITE(LP,20)MDAY,XMONTH(MONTH),IYR,IYRDAY
   20 FORMAT('0INITIAL CONDITIONS ON',I3,1X,A3,I5,7X,'JULIAN DAY =',I4)
      GO TO 100
   30 WRITE(LP,40)IREP,MDAY,XMONTH(MONTH),IYR,IYRDAY,NDAYS,NSTEPS
   40 FORMAT('0REPORT NUMBER ',I3,' ON',I3,1X,A3,I5,7X,'JULIAN DAY =',
     -  I4,7X,'DAYS ELAPSED =',I5,7X,'TIME-STEPS ELAPSED =',I5)
      GO TO 100
   60 WRITE(LP,70)MDAY,XMONTH(MONTH),IYR,IYRDAY,NDAYS,NSTEPS
   70 FORMAT('0FINAL REPORT ON',I3,1X,A3,I5,7X,'JULIAN DAY =',I4,
     -  7X,'DAYS ELAPSED =',I5,7X,'TIME-STEPS ELAPSED =',I5)
  100 IF(TOTDM.LE.0.0)GO TO 425
      WRITE(LP,105)UNITS
  105 FORMAT('0ALL BIOMASS UNITS ARE ',8A4)
C -----------------------------------------------------------------
C     PRINT PLANT BIOMASSES
C -----------------------------------------------------------------
      IF(SUPLNT) GO TO 295
      IF(NPLNTS.EQ.0)GO TO 295
      WRITE(LP,110)
  110 FORMAT(/'0CONSITITUENTS OF VEGETATIONAL BIOMASS')
      WRITE(LP,120)((FRANAM(I,J),J=1,3),I=1,NFRELM),TOTCAR,DRYMA
  120 FORMAT(T22,9(3A4))
      DO 145 I=1,NPLNTS
      WRITE(LP,290)(VSPNAM(I,K),K=1,5)
      DO 130 J=1,NORGAN
      IF(PDM(I,J).LE.0.0)GO TO 130
      WRITE(LP,140)(ORGNAM(J,K),K=1,4),(CVEG(I,J,K),K=1,NFRELM),
     -   AVEG(I,J),PDM(I,J)
  130 CONTINUE
  140 FORMAT(5X,4A4,9F12.4)
  145 WRITE(LP,150)(CVEGO(I,K),K=1,NFRELM),AVEGO(I),PDMO(I)
  150 FORMAT(9X,'TOTAL',T22,9F12.4)
      IF(NPLNTS.EQ.1)GO TO 260
      WRITE(LP,210)
  210 FORMAT(' ALL SPECIES')
      DO 220 J=1,NORGAN
  220 WRITE(LP,140)(ORGNAM(J,K),K=1,4),(CVEGV(J,K),K=1,NFRELM),AVEGV(J),
     -  PDMV(J)
      WRITE(LP,150)(CVEGVO(K),K=1,NFRELM),AVEGVO,PDMVO
C -----------------------------------------------------------------
C     PRINT SHED SEED POOL BIOMASSES
C -----------------------------------------------------------------
  260 WRITE (LP,270)
  270 FORMAT(/'0CONSTITUENTS OF SHED SEEDS')
```

```
      WRITE(LP,120)((FRANAM(I,J),J=1,3),I=1,NFRELM),TOTCAR,DRYMA
      DO 280 I=1,NPLNTS
  280 WRITE(LP,290)(VSPNAM(I,K),K=1,5),(SEED(I,K),K=1,NFRELM),ASEED(I),
     -  SEEDDM(I)
  290 FORMAT(1X,5A4,9F12.4)
      IF (NPLNTS.EQ.1)GO TO 295
      WRITE(LP,150)(SEEDV(K),K=1,NFRELM),ASEEDV,SEDDMV
C ----------------------------------------------------------------
C     PRINT ANIMAL BIOMASSES AND POPULATION DENSITIES
C ----------------------------------------------------------------
  295 IF(SUANIM)GO TO 335
      IF(NANIMS.EQ.0)GO TO 335
      WRITE(LP,300)((FRANAM(K,L),L=1,3),K=1,NFRELM),TOTCAR,DRYMA,PPP
  300 FORMAT(/'OCONSTITUENTS OF ANIMAL BIOMASS, AND ANIMAL POPULATION DE
     -NSITIES'/T22,9(3A4))
      DO 310 I=1,NANIMS
  310 WRITE(LP,320)(ASPNAM(I,K),K=1,5),(CBIOM(I,K),K=1,NFRELM),
     -  ABIOM(I),ADM(I),POP(I)
  320 FORMAT(1X,5A4,9F12.5)
      IF (NANIMS.EQ.1)GO TO 335
      WRITE(LP,330)(CBIOMA(K),K=1,NFRELM),ABIOMA,ADMA
  330 FORMAT(9X,'TOTAL',T22,9F12.5)
C ----------------------------------------------------------------
C     PRINT BIOMASSES OF DEAD ORGANIC MATTER
C ----------------------------------------------------------------
  335 IF(SUDOM)GO TO 365
      IF(NOLIT.EQ.0)GO TO 365
      WRITE(LP,340)
  340 FORMAT(/'OCONSTITUENTS OF DEAD ORGANIC MATERIAL')
      WRITE(LP,120)((FRANAM(I,J),J=1,3),I=1,NFRELM),TOTCAR,DRYMA
      DO 350 I=1,NOLIT
  350 WRITE(LP,360)(ALINAM(I,K),K=1,5),(CLIT(I,K),K=1,NFRELM),ALIT(I),
     - DDM(I)
  360 FORMAT(1X,5A4,T22,9F12.2)
      IF(NOLIT.EQ.1)GO TO 365
      WRITE(LP,362)(CLITT(K),K=1,NFRELM),ALTTT,DDMT
  362 FORMAT(9X,'TOTAL',T22,9F12.2)
C ----------------------------------------------------------------
C     PRINT BIOMASSES OF SOIL ORGANIC MATTER
C ----------------------------------------------------------------
  365 IF(SUSOIL)GO TO 385
      IF(NSCMPT.EQ.0)GO TO 385
      WRITE(LP,370)
  370 FORMAT(/'OCONSTITUENTS OF SOIL ORGANIC MATTER')
      WRITE(LP,120)((FRANAM(I,K),K=1,3),I=1,NFRELM),TOTCAR,DRYMA
      A=0.0
      DO 380 I=1,NSCMPT
      Q=HORDEP(I)
      IF(NSCMPT.EQ.1)Q=HORDEP(NHORIZ)
      WRITE(LP,375)A,Q,(CORG(I,K),K=1,NFRELM),AORG(I),SOM(I)
  375 FORMAT(3X,F6.1,' TO',F6.1,' CM',9F12.2)
  380 A=HORDEP(I)
      IF(NSCMPT.EQ.1)GO TO 385
      WRITE(LP,362)(CORGH(K),K=1,NFRELM),AORGH,SOMT
C ----------------------------------------------------------------
C     PRINT BIOMASSES OF TOTAL ORGANIC MATTER IN ECOSYSTEM
C ----------------------------------------------------------------
  385 WRITE(LP,390)
  390 FORMAT(/'OCONSTITUENTS OF TOTAL ORGANIC MATTER IN ECOSYSTEM')
      WRITE(LP,120)((FRANAM(I,K),K=1,3),I=1,NFRELM),TOTCAR,DRYMA
      WRITE(LP,395)(ECOTOT(K),K=1,NFRELM),AECOTO,TOTDM
  395 FORMAT(T22,9F12.2)
C ----------------------------------------------------------------
C     PRINT AMOUNTS OF AVAILABLE SOIL MINERALS
C ----------------------------------------------------------------
      IF(NSCMPT.EQ.0)GO TO 425
      IF(SUSOIL)GO TO 445
      WRITE(LP,400)
  400 FORMAT(/'OAVAILABLE SOIL MINERALS')
      WRITE(LP,120)((FRANAM(I,K),K=1,3),I=1,NELEMS)
      A=0.0
      DO 410 I=1,NSCMPT
      Q=HORDEP(I)
      IF (NSCMPT.LT.NHORIZ)Q=HORDEP(NHORIZ)
      WRITE(LP,375)A,Q,(CMIN(I,K),K=1,NELEMS)
  410 A=HORDEP(I)
      IF(NSCMPT.GT.1)WRITE(LP,362)(CMINH(K),K=1,NELEMS)
C ----------------------------------------------------------------
C     PRINT VALUES OF SOIL WATER POTENTIAL AND SOIL TEMPERATURE
C ----------------------------------------------------------------
  425 IF(NHORIZ.EQ.0)GO TO 445
      WRITE(LP,430)
  430 FORMAT(/'0',13X,'SOIL WATER POTENTIAL (BAPS)',4X,
     -  'SOIL TEMPERATURE (CELSIUS)')
      A=0.0
      DO 440 I=1,NHORIZ
      WRITE(LP,437) A,HORDEP(I),SWPH(I),STH(I)
  437 FORMAT(3X,F6.1,' TO',F6.1,' CM',T22,F10.1,20X,F10.1)
  440 A=HORDEP(I)
C ----------------------------------------------------------------
C     PRINT WATER BUDGET
C ----------------------------------------------------------------
  445 CONTINUE
      WRITE(LP,450)
  450 FORMAT ('OWATER BUDGET (MILLIMETERS)'/
     - 10X,'PRECIPITATION', 5X, 'TRANSPIRATION', 5X, 'EVAPORATION', 5X,
     -  'WATER IN PROFILE', 5X, 'CHANGE IN PROFILE',5X,'STANDING WATER')
C     'MMINPR' WAS CALCULATED BY SOILSS AT START OF SIMULATION
C     OWATER(4) = MMINPR + OWATER(1) - OWATER(3) - OWATER(7)
C     OWATER(4), I.E. EVAPORATION, IS NOW ASSIGNED A VALUE IN SLWATR
      DELTPR = OWATER(7) - MMINPR
      WRITE (LP,460) OWATER(1), OWATER(3), OWATER(4), OWATER(7),DELTPR
     -  ,DUMMYS(3)
  460 FORMAT (F21.2, F18.2, F16.2, F21.2, F22.2, F19.2)
C----------------------------------------------------------------
C     PRINT ACCUMULATED FLOWS
C----------------------------------------------------------------
      IF(IDAY.EQ.JDAY)GO TO 900
      IF(TOTDM.LE.0.0)GO TO 900
      WRITE(LP,470)
  470 FORMAT('OACCUMULATED EXCHANGES OF CARBON BETWEEN ECOSYSTEM AND ATM
     -OSPHERE'/10X,'CARBON FIXATION',5X,
     -'PLANT RESPIRATION',5X,'ANIMAL RESPIRATION',5X,'DECOMPOSER RESPIRA
     -TION',5X,'NET CHANGE IN ECOSYSTEM')
      WRITE(LP,480) OCARBO
  480 FORMAT(F23.2,F22.2,F23.2,F27.2,F26.2)
      WRITE(LP,490)
  490 FORMAT('OSELECTED CUMULATIVE ENDOGENOUS CARBON FLOWS'/
     -  10X,'GRANIVORY',5X,'HERBIVORY',5X,'WASTAGE',5X,  'ABSCI',
     -SSION AND DEATH',5X,'GERMINATION',5X,'LEAFING-OUT')
      WRITE(LP,500) OENDOG
  500 FORMAT(F17.2,F14.2,F12.2,F23.2,F17.2,F16.2)
      WRITE(LP,510)
  510 FORMAT('OESTIMATED CUMULATIVE NET PRODUCTION OF DRY MATTER'/
     -10X,'ANNUAL',5X,'PERENNIAL',5X,'PRIMARY',5X,'SECONDARY',
     -   5X,'ANNUAL-BG',5X,'PERENNIAL-BG')
      WRITE(LP,520)OPRODU
  520 FORMAT(F15.2,F14.2,F12.2,F14.2,F14.2,F17.2)
      WRITE(LP,530)
  530 FORMAT('OACCUMULATED NITROGEN FLOWS'/10X,'MINERALIZATION',
     -  5X,'PLANT UPTAKE')
      WRITE(LP,540)ONITRO
  540 FORMAT(F24.2,F17.2)
C----------------------------------------------------------------
C     PRINT FLOWS BY PLANT GROUP
C----------------------------------------------------------------
      WRITE(LP,550) (PRODSP(I),I=1,NPLNTS)
  550 FORMAT ('OGROSS DRY MATTER PRODUCTION BY PLANT GROUP'/7F10.3)
      WRITE (LP,560)
  560 FORMAT('OCARBON FLOWS BY PLANT GROUPS')
      WRITE (LP,570) (FLUXLO(I), I=1,NPLNTS)
  570 FORMAT (T5,'GERMINATION AND LEAFING-OUT',T35,7F10.3)
      WRITE(LP,580)(FX1(I),I=1,NPLNTS)
  580 FORMAT (T5,'PHOTOSYNTHESIS',T35,7F10.3)
      WRITE(LP,590)(FX2(I),I=1,NPLNTS)
  590 FORMAT (T5,'RESPIRATION',T35,7F10.3)
      WRITE(LP,600)(FX10(I),I=1,NPLNTS)
  600 FORMAT (T5,'SEED MATURATION',T35,7F10.3)
      WRITE(LP,610)(FX3(I),I=1,NPLNTS)
  610 FORMAT (T5,'SEED SHEDDING',T35,7F10.3)
      WRITE(LP,620)(FX4(I),I=1,NPLNTS)
  620 FORMAT (T5,'ABSCISSION AND DEATH',T35,7F10.3)
C----------------------------------------------------------------
C     PRINT DECOMPOSITION FLOWS
C----------------------------------------------------------------
      WRITE (LP,680) FX6,FX7,FX8,FX9
  680 FORMAT ('OLOSS FROM STANDING DEAD + LITTEP, PORTION PASSED TO SOIL
     - ORGANIC MATTER, PORTION LOST AS RESPIRATION, RESPIRATION LOSS FRO
     -M SOM'/1X,4F10.3)
C----------------------------------------------------------------
C     PRINT FLOWS BY ANIMAL GROUP
C----------------------------------------------------------------
      IF (NANIMS .EQ. 0) GO TO 749
      WRITE (LP,700)
  700 FORMAT ('OCARBON FLOWS BY ANIMAL GROUP')
      WRITE (LP,710) (FX15(I),I=1,NANIMS)
  710 FORMAT (T5,'RESPIRATION',T30,10F9.3)
      WRITE (LP,720) (FX11(I),I=1,NANIMS)
  720 FORMAT (T5,'HERBIVORY',T30,10F9.3)
      WRITE (LP,730) (FX12(I),I=1,NANIMS)
  730 FORMAT (T5,'GRANIVORY',T30,10F9.3)
      WRITE (LP,740) (FX13(I),I=1,NANIMS)
  740 FORMAT (T5,'CARNIVORY',T30,10F9.3)
      WRITE (LP,750) (FX14(I),I=1,NANIMS)
  750 FORMAT (T5,'DETRITIVORY',T30,10F9.3)
  749 CONTINUE
C----------------------------------------------------------------
C     PRINT PHOTOSYNTHATE ADDED TO EACH ORGAN OF EACH PLANT GROUP
C----------------------------------------------------------------
      IX = NPLNTS + 1
      IXX = NPLNTS + 2
      SS = 0.0
      DO 752 J=1,NORGAN
      S = 0.0
      DO 751 I=1,NPLNTS
  751 S = S + FX16(I,J)
      FX16(IX,J) = S
  752 SS = SS + S
      IF (SS .LE. 0.0) GO TO 755
      DO 753 J=1,NORGAN
  753 FX16(IXX,J) = FX16(IX, J) / SS
  755 WRITE (LP,760) NORGAN,NPLNTS
  760 FORMAT ('OPHOTOSYNTHETIC CARBON ADDED TO EACH OF', I3,' ORGANS OF
     -EACH OF', I3, ' SPECIES, AND TOTAL TO EACH ORGAN FOR ALL SPECIES,'
     -/' AND LATTER TOTAL AS PERCENTAGE OF GRAND TOTAL')
      DO 770 J=1,NORGAN
  770 WRITE (LP,780) J,(FX16(I,J), I=1,IXX)
  780 FORMAT (I5, I5, 12F9.3)
C----------------------------------------------------------------
C     PRINT WEIGHTED POTENTIAL EVAPORATION AND TRANSPIRATION COEFFICIENT
C----------------------------------------------------------------
      IF (OCARBO(1) .GT. 0.0) AVEEZ =(ESUM / OCARBO(1)) * ISTEP
C     'CVF' (FROM TRANSP) CONVERTS FROM UNITS OF SIMULATION TO KG/HA
      QT = OCARBO(1) * 2.5 * CVF
C     'OWATER(O)' IS TRANSPIRATION IN MM
C     ONE MM OF WATER = 1000.0 KG/HA
      IF (QT .GT. 0.0) WUE = OWATER(3) * 1.0E4 / QT
      WRITE (LP,800) AVEEZ, WUE
  800 FORMAT ('OMEAN WEIGHTED POTENTIAL EVAPORATION (MM/DAY)',F5.1,
     -  15X, 'TRANSPIRATION COEFFICIENT', F7.0)
  900 NFRELM=ISAVE
      WRITE(LP,910)
  910 FORMAT(///)
      RETURN
      END
```

Subroutine GRAPHZ

```
BIOME*DESERT2SYM(1).GRAPHZ
      SUBROUTINE GRAPHZ
C
C     INTEGER G,SYMBOL,PLUS,BAR,BLANK
      LOGICAL LMIN,LMAX
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /GRAPHS/ PERIOD,JXXX,NGRAFS,NCURVZ,
     -                JDAT(12),XDAT(12),LDAT(12),
     -                LMIN(40),LMAX(40),AMIN(40),AMAX(40),
     -                NCURVS(40),JADRES(60)
      COMMON /VBLS/ PAD(1350)
      DIMENSION G(1189),SYMBOL(8),FIGS(60,111),TITLE(18),EXPLAN(7)
      DIMENSION S(41),FTL(11)
      EQUIVALENCE (G,PAD)
      DATA SYMBOL/'A','B','C','D','E','F','G','H'/
      DATA BAR/'- '/, PLUS/'+ '/, BLANK/'  '/
      DATA N3/1189/, NBYTES/4/
C
C
C     NBYTES = NO OF BYTES USED IN EACH WORK OF STORAGE (MAY BE LESS
C              THAN THE NUMBER OF BYTES IN A WORD)
C     N1=NO. OF WORDS OF STORAGE NEEDED TO PRINT ONE LINE
C     N2=WORDS OF STORAGE NEEDED FOR 5 LINES
C     N3=WORDS OF STORAGE NEEDED TO PRINT THE WHOLE GRAPH (41 LINES)
C     MS1REC POINTS TO THE NEXT RECORD TO BE READ FROM LOGICAL UNIT MS1
C     MS2REC POINTS TO THE NEXT RECORD TO BE READ FROM LOGICAL UNIT MS2
C
C
      N1=N3/41
      N2=N1*5
      ISAVE = 1
      CALL GETFIG (FIGS)
      KCURV=0
      DO 900 IGRAF=1,NGRAFS
      DO 10 I=1,N3
   10 G(I)=BLANK
      JCURV=KCURV+1
      KCURV=JCURV+NCURVS(IGRAF)-1
      BIG=-9.9E30
      SMALL=9.9E30
      IF(LMIN(IGRAF))SMALL=AMIN(IGRAF)
      IF(LMAX(IGRAF))BIG=AMAX(IGRAF)
      MS2REC = ISAVE
      READ(MS2'MS2REC)TITLE
      ISAVE = ISAVE + 1
      WRITE(LP,30)TITLE
   30 FORMAT('1',20X,18A4/'      ')
      MS2REC = ISAVE
      READ(MS2'MS2REC)EXPLAN,FTL
      ISAVE = ISAVE + 1
      IF(NCURVS(IGRAF).EQ.1.AND.EXPLAN(1).EQ.BLANK)GO TO 35
```

```
      WRITE(LP,50)SYMBOL(1),EXPLAN
      LLL=NCURVS(IGRAF)
      IF(LLL.EQ.1)GO TO 35
      DO 33 I=2,LLL
      MS2REC = ISAVE
      READ(MS2=MS2REC)EXPLAN,FIL
      ISAVE = ISAVE + 1
   33 WRITE(LP,50)SYMBOL(I),EXPLAN
   35 DO 40 ICURV=JCURV,KCURV
      DO 40 J=1,111
      Q=FIGS(ICURV,J)
      IF(Q.GT.BIG)BIG=Q
      IF(Q.LT.SMALL)SMALL=Q
   40 CONTINUE
   50 FORMAT(15X,A1,' = ',7A4)
      WRITE(LP,55)
   55 FORMAT('      ')
   60 YDIV=(BIG-SMALL)/40.
      IF(YDIV.LE.0.0)GO TO 880
      YDIVR=1.0/YDIV
      Q=BIG+YDIV
      DO 70 I=1,41
      Q=Q-YDIV
   70 S(I)=Q
      DO 100 I=1,N3,N1
      G(I)=BAR
  100 G(I+28)=BAR
      DO 200 I=1,N3,N2
      G(I+28)=PLUS
  200 G(I)=PLUS
      L=0
      DO 300 ICURV=JCURV,KCURV
      L=L+1
      DO 300 J=1,111
C
C     IL POINTS TO THE LINE (COUNTING FROM TOP OF PAGE) WHERE THE POINT
C     TO BE GRAPHED IS LOCATED
C     IW POINTS TO THE WORD IN THE 'G' ARRAY WHERE THE POINT WILL BE
C     PLACED
C     IB POINTS TO THE BYTE WHERE THE POINT WILL BE PLACE (ASSUMING
C     THE LEFT-MOST BYTE OF THE WORD IS THE FIRST)
C
      IL=41.5-(FIGS(ICURV,J)-SMALL)*YDIVR
      IW=1+(IL-1)*N1+J/NBYTES
      IB=MOD(J+1,NBYTES)
      IF (IB.EQ.0) IB=NBYTES
C
C     USE THE NEXT 2 EXECUTABLE STATEMENTS FOR THE BURROUGHS B6700
C     IBIT = 47 - (IB-1)*8
C     G(IW) = CONCAT(G(IW),SYMBOL(L),IBIT,47,8)
C
C     USE THE NEXT EXECUTABLE STATEMENT FOR
C     THE IBM 360/65 AT CITIM (MONTPELLIER)
C     OR THE NCR AT THE AMERICAN UNIVERSITY IN CAIRO
C     CALL COPYBY (G,SYMBOL,L,IW,IB)
C     CALL COPYBY (G,SYMBOL,L,IW,IB)
C
C     USE THE FOLLOWING EXECUTABLE STATEMENT WITH THE UNIVAC 1108
C     FLD( (IB-1)*6, 6, G(IW) )  =  FLD(0,6,SYMBOL(L))
      FLD( (IB-1)*6, 6, G(IW) )  =  FLD(0,6,SYMBOL(L))
C
  300 CONTINUE
      WRITE(LP,700)
      Q=AMAX1(ABS(BIG),ABS(SMALL))
      NF=1
      R=100000.
      DO 380 I=2,9
      R=R*0.1
  380 IF(Q.LT.R)NF=I
      DO 550 I=1,41
      K1=(I-1)*N1+1
      K2=K1+N1-1
      GO TO (415,425,435,445,455,465,475,485,495),NF
  415 WRITE(LP,501)S(I),(G(J),J=K1,K2)
      GO TO 550
  425 WRITE(LP,502)S(I),(G(J),J=K1,K2)
      GO TO 550
  435 WRITE(LP,503)S(I),(G(J),J=K1,K2)
      GO TO 550
  445 WRITE(LP,504)S(I),(G(J),J=K1,K2)
      GO TO 550
  455 WRITE(LP,505)S(I),(G(J),J=K1,K2)
      GO TO 550
  465 WRITE(LP,506)S(I),(G(J),J=K1,K2)
      GO TO 550
  475 WRITE(LP,507)S(I),(G(J),J=K1,K2)
      GO TO 550
  485 WRITE(LP,508)S(I),(G(J),J=K1,K2)
      GO TO 550
  495 WRITE(LP,509)S(I),(G(J),J=K1,K2)
  501 FORMAT(1X,F13.0,2X,29A4)
  502 FORMAT(1X,F13.1,2X,29A4)
  503 FORMAT(1X,F13.2,2X,29A4)
  504 FORMAT(1X,F13.3,2X,29A4)
  505 FORMAT(1X,F13.4,2X,29A4)
  506 FORMAT(1X,F13.5,2X,29A4)
  507 FORMAT(1X,F13.6,2X,29A4)
  508 FORMAT(1X,F13.7,2X,29A4)
  509 FORMAT(1X,E13.5,2X,29A4)
  550 CONTINUE
      WRITE(LP,700)
      WRITE(LP,600)JDAT
      WRITE(LP,650)XDAT
      WRITE(LP,600)LDAT
  600 FORMAT(8X,12I10)
  650 FORMAT(8X,12(7X,A3))
  700 FORMAT(17X,11('+---------'),'+')
      GO TO 900
  880 WRITE(LP,890)BIG
  890 FORMAT(//////T20,'MINIMUM AND MAXIMUM VALUFS OF THIS GRAPH EQUAL',
     -  G13.5)
  900 CONTINUE
      RETURN
      END
```

Subroutine GETFIG

```
BIOME*DESERT2SYM(1).GETFIG
      SUBROUTINE GETFIG (FIGS)
      LOGICAL LMIN,LMAX
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /GLIMS/ LIMGRA,LIMPG,LIMCUR
      COMMON /GRAPHS/ PERIOD,JXXX,NGRAFS,NCURVZ,
     -                JDAT(12),XDAT(12),LDAT(12),
     -                LMIN(40),LMAX(40),AMIN(40),AMAX(40),
     -                NCURVS(40),JADRES(60)
      DIMENSION FIGS(60,111)
C
C
      ISAVE  = 1
      MS1REC = ISAVE
      READ(MS1=MS1REC)JX,(FIGS(I,1),I=1,LIMCUR)
      ISAVE = ISAVE + 1
      IF(JX.NE.1)WRITE(LP,50)JX
   50 FORMAT('0ERROR IN SUBROUTINE GETFIG. THE FIRST VALUE OF JX SHOULD
     - BE 1, BUT INSTEAD IS',I20)
      JY=2
  100 MS1REC = ISAVE
      READ(MS1=MS1REC)JX,(FIGS(I,JX),I=1,LIMCUR)
      ISAVE = ISAVE + 1
      IF(JX.EQ.JY)GO TO 500
C     SINCE JX IS GREATER THAN JY WE MUST FILL COLUMNS JY TO (JX=1) BY
C     LINEAR INTERPOLATION
      JXA=JX-1
      D=1.0/(JX-JY+1)
      DO 350 I=1,NCURVZ
      B=FIGS(I,JY-1)
      A=(FIGS(I,JX)-B)*D
      DO 350 K=JY,JXA
      B=B+A
  350 FIGS(I,K)=B
  500 JY = JX + 1
      IF(JX.LT.111)GO TO 100
      RETURN
      END
```

Subroutine VINPUT

```
BIOME*DESERT2SYM(1).VINPUT
      SUBROUTINE VINPUT
C
C     PROGRAM FOR READING INPUT NEEDED BY MORE THAN ONE PLANT SUBMODEL
C
      LOGICAL ERROR,PRINT
      LOGICAL ANNUAL,HERB
      LOGICAL SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /ECHOCH/ SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     -        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCMPT
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPPINT,MPRINT(21),PRINT,
     -        PLACE(18),UNITS(8)
      COMMON /MISC/ ERROR,RCHECK(20),BLANK
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV,
     1 ADM(10),ADMA,DOM(3),DOMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTC(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALTNAM(3,5)
      COMMON /VEGCOM/ IN,IW,IP,IR,IS,ILF,INS,IOS,IFR,IRT,ILAYER(7),
     1 ANNUAL(7),HERB(7),IPHENO(7),TISNEW(7),TIME(7),PHSATE,I,SEDFRA(7)
      COMMON /FLUX2/ FLUXLO(7)
      COMMON /FLUX3/FX1(7),FX2(7),FX3(7),FX4(7)
      COMMON /WTHRV/ DATMIN,DATMAX,DARAIN,DAEVAP,DAPHOT
      COMMON /RUNA/ AVEAT(30), LRA
      COMMON /LOLAYR/ JLAYER(7)
      DATA SUBNAM/'VEGE'/
C
 1000 FORMAT('0',100('-')/' BEGINNING READING OF INPUT TO PLANT SUBROUTI
     -NES'/1X,100('-'))
      IREAD=1010
 1010 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1030)IREAD,RCHECK
      IF(RCHECK(1).NE.SUBNAM)GO TO 1010
 1020 FORMAT(20A4)
 1030 FORMAT(T7,I5,' VINPUT',4X,20A4)
 1050 FORMAT(14I5)
 1055 FORMAT(T7,I5,' VINPUT',14I8)
 1060 FORMAT(14L1)
 1065 FORMAT(T7,I5,' VINPUT',14L8)
 1070 FORMAT(7F10.0)
 1075 FORMAT(T7,I5,' VINPUT',7F16.5)
C
      IREAD = 1980
 1980 READ (KR,1020) RCHECK
      IF (.NOT. SUVINP) WRITE (LP,1030) IREAD, RCHECK
      IREAD = 1990
 1990 READ (KR,1050) (JLAYER(I), I=1, NPLNTS)
      IF (.NOT. SUVINP) WRITE (LP,1055) IREAD, (JLAYER(I),I=1,NPLNTS)
C
      IREAD=2000
 2000 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1030)IREAD,RCHECK
      IREAD=2010
 2010 READ(KR,1050) (ILAYER(I), I=1,NPLNTS)
      IF(.NOT.SUVINP)WRITE(LP,1055)IREAD,(ILAYER(I),I=1,NPLNTS)
C
      IREAD=2020
 2020 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1030)IREAD,RCHECK
      IREAD=2030
 2030 READ(KR,1060)(HERB(I),I=1,NPLNTS)
      IF(.NOT.SUVINP)WRITE(LP,1065)IREAD,(HERB(I),I=1,NPLNTS)
C
      IREAD=2040
 2040 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1030)IREAD,RCHECK
      IREAD=2050
 2050 READ(KR,1060)(ANNUAL(I),I=1,NPLNTS)
      IF(.NOT.SUVINP)WRITE(LP,1065)IREAD,(ANNUAL(I),I=1,NPLNTS)
C
      IREAD=2060
 2060 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1030)IREAD,RCHECK
      IREAD=2070
 2070 READ(KR,1050)(IPHENO(I),I=1,NPLNTS)
      IF(.NOT.SUVINP)WRITE(LP,1055)IREAD,(IPHENO(I),I=1,NPLNTS)
C
      IREAD=2080
 2080 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1030)IREAD,RCHECK
      IREAD=2090
 2090 READ(KR,1070)(TISNEW(I),I=1,NPLNTS)
      IF(.NOT.SUVINP)WRITE(LP,1075)IREAD,(TISNEW(I),I=1,NPLNTS)
C
      IREAD=3000
 3000 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1030)IREAD,RCHECK
      IREAD=3010
 3010 READ(KR,1070)(TIME(I),I=1,NPLNTS)
      IF(.NOT.SUVINP)WRITE(LP,1075)IREAD,(TIME(I),I=1,NPLNTS)
C
      IREAD = 3020
 3020 READ(KR,1020) RCHECK
      IF (.NOT. SUVINP) WRITE (LP,1030) IREAD, RCHECK
      IREAD = 3030
```

```
 3030 READ (KR,1050) LRA
      IF (.NOT. SUVINP) WRITE (LP,1055) IREAD, LRA
      IF (LRA .LE. 30) GO TO 3050
      ERROR = .TRUE.
      WRITE (LP,3040)
 3040 FORMAT ('0ERROR  =*=*=*=*=*=*=*=*=*=*=*'/
     -  ' PERIOD OVER WHICH RUNNING AVERAGE AIR TEMPERATURE IS COMPUTED
     -EXCEEDS MAXIMUM OF 30 DAYS')
 3050 CONTINUE
      Q =(DATMIN + DATMAX) * 0.5
      DUMMYA(30) = RUNAVE(AVEAT,LRA,Q,ISTEP,1)
C
      IN = 1
      IW = 2
      IP = 3
      IR = 4
      IS = 5
      ILF = 1
      INS = 2
      IOS = 3
      IFR = 4
      IRT = 5
C
      CALL PHENOL
      CALL PHOTOS
      CALL RESPIR
      CALL TRANSP
      CALL TRANSL(0.0)
      CALL ALOCAT(0,0.0)
      CALL DEATHH
      DO 8000 I=1,NPLNTS
      FLUXLO(I) = 0.0
      FX1(I) = 0.0
      FX2(I) = 0.0
      FX3(I) = 0.0
 8000 FX4(I) = 0.0
      RETURN
      END
```

Subroutine PHENOL

```
IME*DESERT2SYM(1).PHENOL
      SUBROUTINE PHENOL
C
C     PHENOLOGY MODEL
C
C  P1                 SOIL TEMPERATURE THRESHOLD THAT MUST BE CROSSED
C                     (EITHER BY A FALLING TEMPERATURE OR BY A RISING
C                     TEMPERATURE, DEPENDING ON THE PLANT GROUP) BEFORE
C                     GERMINATION OR LEAFING-OUT IS ALLOWED TO OCCUR.
C  P2                 SOIL WATER POTENTIAL THRESHOLD THAT MUST BE
C                     EXCEEDED FOR GERMINATION OR LEAFING-OUT TO OCCUR
C P3                  THE SOIL WATER POTENTIAL BELOW WHICH A JUMP WILL
C                     OCCUR FROM THE REPRODUCTIVE STAGE TO THE VEGETATIVE
C                     STAGE, PROVIDED THE ACTUAL POTENTIAL IS NOT SO LOW
C                     AS TO CAUSE A SHIFT TO THE DORMANT STAGE.
C  P4                 MINIMUM NUMBER OF DAYS SPENT IN VEGETATIVE STAGE
C                     BEFORE A JUMP TO REPRODUCTIVE STAGE CAN OCCUR
C  P5                 SOIL WATER POTENTIAL THRESHOLD THAT MUST BE EXCEEDED
C                     FOR FLOWERING TO BEGIN
C  P6                 SOIL WATER POTENTIAL VALUE BELOW WHICH THE PLANT
C                     WILL BE DORMANT
C  P7                 IS TRUE IF TEMP MUST BE BELOW P1 FOR GERMINATION
C                     (OR LEAFING-OUT) TO OCCUR
C  P8,9               JULIAN DATES BETWEEN WHICH GERMINATION (OR
C                     LEAFING-OUT) IS NOT ALLOWED
C  P10                TEMPERATURE THRESHOLD, WHICH WHEN CROSSED (EITHER BY
C                     A FALLING TEMPERATURE OR BY A RISING TEMPERATURE,
C                     DEPENDING ON THE PLANT GROUP) WILL CAUSE A JUMP TO
C                     THE DORMANT PHENOPHASE
C  IEND               JULIAN DATE DURING OFF-SEASON WHEN NEW TWIG
C                     BIOMASS IS TRANSFERRED TO OLD STEM BIOMASS
C
      INTEGER P8,P9
      LOGICAL RANGRM, GERMOK
      LOGICAL P7
      LOGICAL JUMP,ANNUAL,HERB,ERROR,PRINT
      LOGICAL SUMINP,SUVINP,SUATNP,SUSINP
      COMMON /ECHOCH/ SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     -        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCMPT
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPPINT,MPRINT(21),PRINT,
     -        PLACE(18),UNITS(8)
      COMMON /MISC/ ERROR,PCHECK(20),BLANK
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OFNDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),ORATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /VEGCOM/ IN,IW,IP,IR,IS,ILF,INS,IOS,IFR,IRT,ILAYER(7),
     1 ANNUAL(7),HERB(7),IPHENO(7),TISNEW(7),TIME(7),PHSATE,I,SEDFRA(7)
      COMMON /PHESAV/ P1(7),P2(7),P3(7),P4(7),P5(7),P6(7),IEND(7),
     1              JUMP(7),P7(7),P8(7),P9(7),A,B,PREVA,PREVB,LSL
     2              ,P10(7)
      COMMON /LOLAYR/ JLAYER(7)
      COMMON /PHESA2/ TIME2(7)
      COMMON /RAINGM/ RANVEC(4), RANGRM, GERMOK
      DATA SUBNAM/'PHEN'/
C
C
      IF(IDAY.EQ.JDAY)GO TO 1000
      IF(PRINT)WRITE(LP,10)
   10 FORMAT('0--* EXECUTING SUBROUTINE PHENOL')
      TIME(I)=TIME(I)+ISTEP
      JUMP(I)=.FALSE.
      LSOIL = ILAYER(I)
      LSOIL2 = JLAYER(I)
      B=SWPH(LSOIL)
      B2 = SWPH(LSOIL2)
      C=TIME(I)
      ISTAGE=IPHENO(I)
C     ACCUMULATE TIME SINCE GERMINATION OR LEAFING-OUT
      IF (ISTAGE .EQ. 5) GO TO 30
      TIME2(I) = TIME2(I) + ISTEP
      GO TO 40
   30 TIME2(I) = 0.0
   40 CONTINUE
      LQ7 = LSOIL
      IF (ISTAGE .EQ. 5) LQ7 = LSOIL2
C     'Y4' IS ONLY USED FOR PRINTING
      Y4 = B
      IF (ISTAGE .EQ. 5) Y4 = B2
      IF (PRINT) WRITE (LP,50) A,Y4,C,LQ7,  ISTAGE,P1(I),P2(I),P3(I),
     -   P4(I),P5(I),P6(I),P7(I),P8(I),P9(I),P10(I)
   50 FORMAT (T7,'RAAT=',F5.1,4X,'SWP=',F6.1,4X,'TIME=',F5.0,4X,
     -   'LSOIL=',I2,4X,'ISTAGE=',I2/T7,'PARMS=',6F8.1,4X,L1,2I8,F6.1)
      GO TO (200,200,300,400,100),ISTAGE
C-----------------------------------------------------------------
C     PLANT IS DORMANT
C-----------------------------------------------------------------
C     TEST FOR JUMP FROM DORMANT STAGE TO GERMINATING OR LEAFING-OUT
C     STAGE
  100 CONTINUE
      IF ( P8(I) .GT. P9(I) ) GO TO 110
      IF ( IYRDAY .GE. P8(I) .AND. IYRDAY .LE. P9(I) ) GO TO 600
      GO TO 120
  110 IF ( IYRDAY .GE. P8(I) .OR. IYRDAY .LE. P9(I) ) GO TO 600
  120 CONTINUE
      IF ( P7(I) ) GO TO 150
C     JUMP WHEN TEMP THRESHOLD IS EXCEEDED
      IF(A.LT.P1(I).OR.B2.LT.P2(I))GO TO 600
C     IF(A.LT.P1(I)                 )GO TO 600
      IF (A .LE. PREVA) GO TO 600
      GO TO 160
  150 CONTINUE
C     JUMP WHEN TEMP IS LESS THAN THRESHOLD
C     IF (A .GT. P1(I)                 ) GO TO 600
      IF (A .GT. P1(I) .OR. B2 .LT. P2(I)) GO TO 600
      IF (A .GE. PREVA) GO TO 600
  160 CONTINUE
      IF (ANNUAL(I)) GO TO 170
  165 JUMP(I) = .TRUE.
      IPHENO(I)=2
      IF(ANNUAL(I))IPHENO(I)=1
      GO TO 600
  170 CONTINUE
      IF (.NOT. GERMOK) GO TO 175
      GERMOK = .FALSE.
      RANGRM = .FALSE.
      GO TO 165
  175 IF (RANGRM) GERMOK = .TRUE.
      GO TO 600
C-----------------------------------------------------------------
C     PLANT IS GERMINATING OR LEAFING-OUT
C-----------------------------------------------------------------
C     GERMINATION AND LEAFING-OUT ARE TREATED AS DISCRETE EVENTS
  200 CONTINUE
      JUMP(I)=.TRUE.
      IPHENO(I)=3
      GO TO 600
C-----------------------------------------------------------------
C     PLANT IS VEGETATIVE
C-----------------------------------------------------------------
C     TEST FOR JUMP FROM VEGETATIVE STAGE TO DORMANT STAGE
  300 CONTINUE
      IF (TIME2(I) .LT. P4(I)) GO TO 600
      IF(B.GE.P6(I))GO TO 320
C     ALLOW TIME FOR RAINS OF NEW SEASON TO REACH LOWER LAYERS
      IF (C .LT. 21-ISTEP) GO TO 320
      JUMP(I)=.TRUE.
      IPHENO(I)=5
      GO TO 600
C     CHECK WHETHER TOO COLD OR HOT
  320 IF (P7(I)) GO TO 330
C     JUMP IF TOO COLD
      IF ( A .GT. P10(I)) GO TO 350
      GO TO 410
C     JUMP IF TOO HOT
  330 IF (A .LT. P10(I)) GO TO 350
      GO TO 410
C     TEST FOR JUMP FROM VEGETATIVE STAGE TO REPRODUCTIVE STAGE
  350 IF(C.LT.P4(I))GO TO 600
      IF(B.LT.P5(I))GO TO 600
      JUMP(I)=.TRUE.
      IPHENO(I)=4
      GO TO 600
C-----------------------------------------------------------------
C     PLANT IS REPRODUCTIVE
C-----------------------------------------------------------------
C     TEST FOR JUMP FROM REPRODUCTIVE STAGE TO DORMANT STAGE
  400 IF(B.GE.P6(I))GO TO 500
  410 JUMP(I)=.TRUE.
      IPHENO(I)=5
      GO TO 600
C     CHECK WHETHER TOO COLD OR TOO HOT
  500 IF (P7(I)) GO TO 530
C     JUMP IF TOO COLD
      IF (A .GT. P10(I)) GO TO 550
      GO TO 410
C     JUMP IF TOO HOT
  530 IF (A .LT. P10(I)) GO TO 550
      GO TO 410
C     TEST FOR JUMP FROM REPRODUCTIVE STAGE TO VEGETATIVE STAGE
  550 IF (B .GE. P3(I)) GO TO 600
      JUMP(I) = .TRUE.
      IPHENO(I) = 3
C-----------------------------------------------------------------
C     WRAP-UP
C-----------------------------------------------------------------
  600 IF(.NOT.JUMP(I))GO TO 630
C     'QY' IS ONLY USED FOR PRINTING
      QY = PDM(I,IOS) + PDM(I,IRT)
      IF (HERB(I)) QY = PDM(I,IRT)
      IF (ANNUAL(I)) QY = SEEDDM(I)
      WRITE (LP,610) I,MDAY,XMONTH(MONTH),IYR,IYRDAY,ISTAGE,IPHENO(I),A
     -     ,Y4, QY
  610 FORMAT (' CHANGE IN PHENOPHASE OF SPECIES',I2,I5,1X,A3,I5,3X,'JULI
     -AN DAY',I4,3X,'OLD=',I1, 3X,'NEW=',I1,3X,
     -  'RAAT=',F5.1,3X,'SWP=',F7.1,3X,'STORE=',F9.4)
      TIME(I)=0.0
      TISNEW(I)=0.0
  630 IF(PRINT)WRITE(LP,640)IPHENO(I),JUMP(I),TISNEW(I),TIME(I)
  640 FORMAT(T7,'PHENOLOGICAL STAGE =',I2,6X,'JUMP =',L2,6X,
     -  'TISNEW =',F9.4,6X,'TIME =',F5.0)
      IF (IEND(I).GE.IYRDAY .AND. IEND(I).LE.IYRDAY+ISTEP-1) GO TO 650
      GO TO 700
  650 DO 660 K=1,NFRELM
      CVEG(I,IOS,K) = CVEG(I,IOS,K) + CVEG(I,INS,K)
  660 CVEG(I,INS,K) = 0.0
  700 RETURN
C -----------------------------------------------------------------
C     INPUT AND INITIALIZATION
C -----------------------------------------------------------------
 1000 IF(.NOT.SUVINP)WRITE(LP,1010)
 1010 FORMAT('0--* BEGINNING READING OF INPUT TO SUBROUTINE PHENOL')
 1020 FORMAT(20A4)
 1025 FORMAT(T7,I5,' PHENOL',4X,20A4)
 1030 FORMAT(14I5)
 1035 FORMAT(T7,I5,' PHENOL',14I8)
 1050 FORMAT(7F10.0)
 1055 FORMAT(T7,I5,' PHENOL',5(I19,7F16.5/))
 1060 FORMAT (70L1)
```

```
 1065 FORMAT (T7,I5,' PHENOL ',4X,70L3)
C
      IREAD=2020
 2020 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1025)IREAD,RCHECK
      IF(RCHECK(1).NE.SUBNAM)GO TO 2020
C
      IREAD=2050
 2050 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRTTE(LP,1025)IREAD,RCHECK
      IREAD=2060
 2060 READ(KR,1030) (IEND(I), I=1,NPLNTS)
      IF(.NOT.SUVINP)WRTTE(LP,1035)IREAD,(IEND(I), I=1,NPLNTS)
C
      IREAD=2080
 2080 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRTTE(LP,1025)IREAD,RCHECK
      IREAD=2090
      DO 3000 I=1,NPLNTS
 2090 READ(KR,1050)P1(I),P2(I),P3(I),P4(I),P5(I),P6(I),P10(I)
      IF(.NOT.SUVINP)WRITE(LP,1055)IREAD,P1(I),P2(I),P3(I),P4(I),P5(I),
     -   P6(I),P10(I)
 3000 CONTINUE
C
      IREAD = 3010
 3010 READ (KR,1020) RCHECK
      IF (.NOT. SUVINP) WRITE (LP,1025) IREAD, RCHECK
      IREAD = 3020
 3020 READ (KR,1060)      (P7(I), I=1,NPLNTS)
      IF (.NOT. SUVINP) WRITE (LP,1065) IREAD,      (P7(I), I=1,NPLNTS)
      IREAD = 3030
 3030 READ (KR,1020) RCHECK
      IF (.NOT.SUVINP) WRITE (LP,1025) IREAD, RCHECK
      IREAD = 3040
 3040 READ (KR,1030) (P8(I),I=1,NPLNTS)
      IF (.NOT.SUVINP) WRITE (LP,1035) IREAD, (P8(I),I=1,NPLNTS)
      IREAD = 3050
 3050 READ (KR,1030) (P9(I),I=1,NPLNTS)
      IF (.NOT.SUVINP) WRITE (LP,1035) IREAD, (P9(I),I=1,NPLNTS)
C
      A = DUMMYA(30)
      B = 0.0
      LSL = LSOIL
      DO 3060 I=1,NPLNTS
 3060 TIME2(I) = 0.0
      RETURN
      END
```

SUBROUTINE PHOTOS

```
BIOME*DESERT2SYM(1).PHOTOS
      SUBROUTINE PHOTOS
C
C
C
C     PHOTOSYNTHESIS MODEL
C     COMPUTES NET CARBON FIXATION BY PHOTOSYNTHETIC TISSUE DURING
C     DAYLIGHT HOURS
C
C P1             MAX RATE IN MG CO2 PER G DRY MATTER PER HOUR
C P2             NOT USED
C P3-6           PARAMETERS IN GENERALIZED POISSON DENSITY FUNCTION
C                RELATING SCALING FACTOR FOR TEMP TO DAILY HIGH TEMP.
C P7-8           LOWER AND UPPER BREAKPOINTS IN PIECEWISE LINEAR
C                FCTN RELATING SWP SCALING FACTOR TO SWP
C P9,10          PARAMETERS IN SINE FUNCTION RELATING OPTIMUM
C                TEMPERATURE TO JULIAN DAY
C P11,12         PARAMETERS IN SINE FCTN RELATING MAX RATE TO
C                JULIAN DAY
C P13,14         PARAMETERS A AND B IN THEPOWER FUNCTION RELATING SOIL
C                NITROGEN SCALING FACTOR TO NITROGEN CONTENT OF THE SC
C                SOIL
C SCALFF         ADJUSTS ACTUAL PS RATE IN FORE-NOON WHEN IT IS MAX
C                TO A MEAN VALUE FOR THE DAY-LIGHT HOURS
C TP             PARAMETER USED TO CALCULATE TEMP USED IN
C                COMPUTATION OF RATE OF CARBON FIXATION
C
      LOGICAL ERROR,PRINT
      LOGICAL ANNUAL,HERB
      LOGICAL SUMINP,SUVINP,SUATNP,SUSINP
      COMMON /ECHOCH/ SUMINP,SUVINP,SUAINP,SUSTNP
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLITI,NFRAC1,
     -        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCMPT
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPPINT,NPRINT,MPRINT(21),PPINT,
     -        PLACE(18),UNITS(8)
      COMMON /MTSC/ ERROR,RCHECK(20),BLANK
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDOM(7),SEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /WTHRV/ DATMIN,DATMAX,DARAIN,DAEVAP,DAPHOT
      COMMON /VEGCOM/ IN,IW,IP,IR,IS,ILF,INS,IOS,IFR,IRT,ILAYER(7),
     1 ANNUAL(7),HERB(7),IPHENO(7),TISNEW(7),TIME(7),PHSATE,I,SEDFRA(7)
      COMMON/PHOSAV/P1(7),P2(7),P3(7),P4(7),P5(7),P6(7),P7(7),P8(7),
     1 P9(7),P10(7),P11(7),P12(7),P13(7),P14(7),SCALEF,TP
      COMMON /TEMP2/ PRODSP(7)
      COMMON /FLUX3/FX1(7),FX2(7),FX3(7),FX4(7)
      COMMON /EVASAV/ ESUM
      COMMON /PHOTEM/ DMT, TPSAVE, TOPT
      DIMENSION P1M(7)
      DATA SUBNAM/'PHOT'/
C
      FUNSIN(A,B,C,I)=A+B*SIN(.0174533*(I+C))
C
      IF(IDAY.EG.JDAY)GO TO 1000
      IF(PRINT)WRITE(LP,10)
   10 FORMAT('0---* EXECUTING SUBROUTINE PHOTOS')
      IF (PRINT) WRITE (LP,15) P1(I),P2(I),P3(I),P4(I),P5(I),P6(I),
     -  P7(I),P8(I),P9(I),P10(I),P11(I),P12(I),P13(I),P14(I)
   15 FORMAT (T7,'PARAMETERS-',14F8.3)
      LSOIL = ILAYER(I)
C ---------------------------------------------------------------
C     SECTION FOR ADJUSTING, ACCORDING TO JULIAN DAY, THE MAXIMUM
C     NET FIXATION RATE AND THE TEMPERATURE AT WHICH IT IS ACHIEVED,
C     AND THE TEMPERATURE AT WHICH THE UPPER COMPENSATION POINT
C     IS ATTAINED.
C ---------------------------------------------------------------
      PSRMAX=FUNSIN(P1(I),P11(I),P12(I),IYRDAY)
      THI=FUNSIN(P4(I),P9(I),P10(I),IYRDAY)
C ---------------------------------------------------------------
C     SECTION FOR EFFECT OF TEMPERATURE
C ---------------------------------------------------------------
      TEMPF=0.0
      IF( DMT  .LT.THI)TEMPF=GENPDF(TOPT,THI,P5(I),P6(I),DMT)
      IF (PRINT) WRITE (LP,20) TEMPF,TOPT,THI,P5(I),P6(I),DMT
   20 FORMAT(T7,'TEMPF, TOPT, THI, P5, P6, DMT. ',6F12.4)
C ---------------------------------------------------------------
C     SECTION FOR THE EFFECT OF WATER
C ---------------------------------------------------------------
      WATERF=PWLPOS(P7(I),P8(I),1.0,SWPH(LSOIL))
C----------------------------------------------------------------
C     SECTION FOR EFFECT OF SOIL NITROGEN PERCENTAGE
C----------------------------------------------------------------
      SOILNF = 0.0
      Q = CMINH(1)
      IF (Q .GT. 0.0) SOILNF = P13(I) * Q**P14(I)
C ---------------------------------------------------------------
C     CALCULATE RATE AND PRINT RESULTS
C ---------------------------------------------------------------
C
C     PSRATE IS IN MG CO2 PER G DRY MATTER PER HOUR
C
      PSRATE=PSRMAX*TEMPF*WATERF*SOILNF
      DUMMYV(I + 4*NPLNTS) = PSRATE
C
C     PHSATE=PSRATE*PDM(I,ILF)*12./44.*.001*DAPHOT * 0.64
      PHSATE=PSRATE*PDM(I,ILF)*DAPHOT * 2.7272E-04  * SCALEF
      DUMMYV(I + 5*NPLNTS) = PHSATE * ISTEP
      OCARBO(1)=OCARBO(1)+PHSATE*ISTEP
      IF(PRINT)WRITE(LP,125)PSRMAX,TEMPF,WATERF,PSRATE,PHSATE,PDM(I,ILF)
     -   ,DAPHOT,SOILNF
  125 FORMAT(6X,'PSRMAX,TEMPF,WATERF,PSRATE,PHSATE,PDM,DAPHOT,SOILNF =',
     -   /T7,8G11.4)
      IF(PRINT)WRITE(LP,126)P3(I),P4(I),P5(I),P6(I),TOPT,THI,DMT,TEMPF
  126 FORMAT(T7,'4 PARMS, FIRST 2 ADJUSTED, TEMP, TEMP FACTOR'/
     -   T7,8G12.5)
      IQ = 2
      IF (ANNUAL(I)) IQ=1
      Y = PHSATE*2.5*ISTEP
      FX1(I) = FX1(I) + PHSATE*ISTEP
      OPRODU(IQ) = OPRODU(IQ) + Y
      PRODSP(I) = PRODSP(I) + Y
      ESUM = ESUM + PHSATE*DAEVAP
      IF(PHSATE.GT.0.0)CALL TRANSL(PHSATE)
      RETURN
C ---------------------------------------------------------------
C     INPUT AND INTIALIZATION
C ---------------------------------------------------------------
 1000 IF(.NOT.SUVINP)WRITE(LP,1001)
 1001 FORMAT('0---* BEGINNING READING OF INPUT TO SUBROUTINE PHOTOS')
      IREAD=1010
 1010 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1030)IREAD,RCHECK
 1020 FORMAT(20A4)
 1030 FORMAT(T7,I5,' PHOTOS',4X,20A4)
      IF(RCHECK(1).NE.SUBNAM)GO TO 1010
C
      IREAD=1040
 1040 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRTTE(LP,1030)IREAD,RCHECK
      IREAD=1050
      DO 1065 I=1,NPLNTS
 1050 READ(KR,1060)P1(I),P2(I),P3(I),P4(I),P5(I),P6(I),P7(I),P8(I),
     1 P9(I),P10(I),P11(I),P12(I),P13(I),P14(I)
 1060 FORMAT(7F10.0)
      IF(.NOT.SUVINP)WRITE(LP,1070)IREAD,P1(I),P2(I),P3(I),P4(I),P5(I),
     -     P6(I),P7(I),P8(I),P9(I),P10(I),P11(I),P12(I),P13(I),P14(I)
      IF (P4(I) .GT. P3(I)) GO TO 1064
      WRITE (LP,1063) P3(I), P4(I)
 1063 FORMAT(' =*=*=*=  ERROR  =*=*=*=  P4 MUST BE GREATER THAN P3')
 1064 CONTINUE
 1065 CONTINUE
 1070 FORMAT(T7,I5,' PHOTOS',7F16.5,5(/T19,7F16.5))
C
      IREAD = 1080
 1080 READ (KR,1020) RCHECK
      IF (.NOT. SUVINP) WRITE (LP,1030) IREAD, RCHECK
      IREAD = 1090
 1090 READ (KR,1060) SCALEF, TP
      TPSAVE = TP
      IF (.NOT. SUVINP) WRTTE(LP,1070) IREAD, SCALEF, TP
      IF (SCALEF .GT. 0.0 .AND. SCALEF .LT. 1.0) GO TO 2020
      ERROR = .TRUE.
      WRITE (LP,2000)
 2000 FORMAT (' =*=*=*=  ERROR  =*=*=*=  SCALING FACTOR HAS UNREASONABLE
     - VALUE')
 2020 IF (TP .GT. 0.0 .AND. TP .LT. 1.0) GO TO 2040
      ERROR = .TRUE.
      WRITE (LP,2030)
 2030 FORMAT (' =*=*=*=  ERROR  =*=*=*=  PARAMETER FOR ADJUSTING TEMPERA
     -TURE HAS UNREASONABLE VALUE')
 2040 CONTINUE
C
C     READ MULTIPLIER OF MAX PHOTOSYNTHETIC RATES
      IREAD = 2050
 2050 READ (KR,1020) RCHECK
      IF (.NOT. SUVINP) WRITE (LP,1030) IREAD, RCHECK
      IREAD = 2060
 2060 READ (KR,1060) (P1M(I), I=1,NPLNTS)
      IF (.NOT. SUVINP) WRITE (LP,1070) IREAD, (P1M(I),I=1,NPLNTS)
      DO 2070 I=1,NPLNTS
 2070 P1(I) = P1(I)*P1M(I)
C
      ESUM = 0.0
      DO 3000 I=1,NPLNTS
      TOPT=FUNSIN(P3(I),P9(I),P10(I),IYRDAY)
      DUMMYV(I + 3*NPLNTS) = TOPT
      PSRMAX=FUNSIN(P1(I),P11(I),P12(I),IYRDAY)
      DUMMYA(I) = PSRMAX
 3000 CONTINUE
      RETURN
      END
```

SUBROUTINE TRANSP

```
BIOME*DESERT2SYM(1).TRANSP
      SUBROUTINE TRANSP
      LOGICAL ERROR, PRINT
      LOGICAL ANNUAL,HERB
      LOGICAL SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /ECHOCH/ SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     -        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCMPT
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
     -        PLACE(18),UNITS(8)
      COMMON /MISC/ ERROR,RCHECK(20),BLANK
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDOM(7),SEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
```

```
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /WTHRV/ DATMIN,DATMAX,DARAIN,DAEVAP,DAPHOT
      COMMON /VEGCOM/ IN,IW,IP,TR,IS,ILF,INS,IOS,IFR,IRT,ILAYER(7),
     1 ANNUAL(7),HERB(7),IPHENO(7),TISNEW(7),TIME(7),PHSATE,I,SEDFRA(7)
      COMMON/VTOWAT/CVRDST(7,8),CVTSPR(7)
      COMMON /TRPSAV/ CONVF, P1(7), P2(7)
      COMMON /CONSAV/ CVF
      DATA SUBNAM/'TRAN'/
C
C
      IF(IDAY.EQ.JDAY)GO TO 1000
      IF(PRINT)WRITE(LP,10)
   10 FORMAT('0---* EXECUTING SUBROUTINE TRNSPR')
      DRYMAT = PHSATE * 2.5
      WATER = DRYMAT * (P1(I) + P2(I) * DAEVAP)
C     WATER MODEL REQUIRES TRANSPIRATION IN KILOGRAMS PER HECTARE.
C     THE NECESSARY CONVERSION IS NOW PERFORMED
      X = WATER * CONVF
C     'CVRDST' IS THE ROOT DISTRIBUTION BY HORIZON (DECIMAL FRACTIONS)
C     'CVTSPR', WHICH IS PASSED TO THE SOIL WATER SUBMODEL, IS THE
C     'REQUESTED' AMOUNT OF TRANSPIRATION (KG/HA)
      CVTSPR(I) = X
C     'OWATER(3)' IS IN MM
      OWATER(3) = OWATER(3) + X*1.0E-4*ISTEP
      DUMMYV(49) = OWATER(3)
      IF (PRINT) WRITE (LP,30) WATER,PHSATE,DRYMAT,DAEVAP,X,P1(I), P2(I)
   30 FORMAT(T7,'REQUESTED TRANSPIRATION IN UNITS OF SIMULATION =',F15.5
     - /T7,'PHSATE,DRYMAT,DAEVAP,CVTSPR,P1,P2 =',6F15.5)
      RETURN
C ------------------------------------------------------------------
C     INPUT AND INITIALIZATION
C ------------------------------------------------------------------
 1000 IF(.NOT.SUVINP)WRITE(LP,1010)
 1010 FORMAT('0---* BEGINNING READING OF INPUT TO SUBROUTINE TRANSP')
 1020 FORMAT(20A4)
 1025 FORMAT(T7,I5,' TRANSP',4X,20A4)
 1050 FORMAT(7F10.0)
 1055 FORMAT(T7,I5,' TRANSP',7F16.5)
C
      IREAD=2020
 2020 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1025)IREAD,RCHECK
      IF(RCHECK(1).NE.SUBNAM)GO TO 2020
C
      IREAD=2050
 2050 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1025)IREAD,RCHECK
      IREAD=2060
 2060 READ(KR,1050) CONVF
      IF(.NOT.SUVINP)WRITE(LP,1055)IREAD, CONVF
      CVF = CONVF
 2064 IF (CONVF .GT. 0.0) GO TO 2068
      ERROR = .TRUE.
      WRITE (LP,2066)
 2066 FORMAT (' =*=*=*=  ERROR  =*=*=*=  CONVERSION FACTOR MUST BE GREAT
     -ER THAN ZERO')
 2068 CONTINUE
C
      IREAD=2070
 2070 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1025)IREAD,RCHECK
      IREAD=2080
      DO 3000 I=1,NPLNTS
 2080 READ(KR,1050)(CVRDST(I,J),J=1,NHORIZ)
      IF(.NOT.SUVINP)WRITE(LP,1055)IREAD,(CVRDST(I,J),J=1,NHORIZ)
      QS = 0
      DO 2085 J=1,NHORIZ
 2085 QS = QS + CVRDST(I,J)
      IF (QS .GE. .999 .AND. QS .LE. 1.001) GO TO 3000
      ERROR = .TRUE.
      WRITE (LP,2090) QS
 2090 FORMAT (' =*=*=*=  ERROR  =*=*=*=  ROOT DISTRIBUTION VALUES MUST S
     -UM TO ONE BUT INSTEAD THEY SUM TO',G11.3)
 3000 CONTINUE
C
      IREAD = 3010
 3010 READ (KR,1020) RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1025)IREAD,RCHECK
      IREAD = 3020
      DO 3030 I=1,NPLNTS
 3020 READ (KR,1050) P1(I), P2(I)
      IF (.NOT. SUVINP) WRITE (LP,1055) IREAD,  P1(I), P2(I)
 3030 CONTINUE
      RETURN
      END
```

Subroutine RESPIR

```
BIOME*DESERT2SYM(1).RESPIR
      SUBROUTINE RESPIR
C
C     RESPIRATION MODEL
C
C     COMPUTES RESPIRATION OF PHOTOSYNTHETIC TISSUE DURING DARK HOURS,
C     AND RESPIRATION OF NON-PHOTOSYNTHETIC ORGANS
C
C  P1,2                PARAMETERS IN THE FCTN RELATING RESPIRATION RATE TO
C                      TEMPERATURE
C  P3                  NOT USED
C  P4,5                PARAMETERS IN FCTN RELATING RESPIRATION RATE TO SWP
C  P6,7                PARAMETERS IN FCTN WHICH ADJUSTS THE TEMP IN
C                      ORDER TO ACCOUNT FOR ACCLIMITIZATION
C  RSRATE              RELATIVE RESPIRATION RATE (MG CO2 RESPIRED PER
C                      GRAM DRY MATTER PER HOUR)
C
      LOGICAL ERROR,PRINT
      LOGICAL ANNUAL,HERB
      LOGICAL SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /ECHOCH/ SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     -        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCMPT
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
     -        PLACE(18),UNITS(8)
      COMMON /MISC/ ERROR,RCHECK(20),BLANK
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OFNDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /WTHRV/ DATMIN,DATMAX,DARAIN,DAEVAP,DAPHOT
      COMMON /CHANGE/ CVEGQQ(7,6,5),SEEDQQ(7,5),CBIOMQ(10,5),
     -        CLITQQ(3,5),CORGQQ(1,5),CMINQQ(1,2)
      COMMON /VEGCOM/ IN,IW,IP,TR,IS,ILF,INS,IOS,IFR,IRT,ILAYER(7),
     1 ANNUAL(7),HERB(7),IPHENO(7),TISNEW(7),TIME(7),PHSATE,I,SEDFRA(7)
      COMMON/RESSAV/P1(5),P2(5),P3(5),P4(5),P5(5),P6(5),P7(5)
      COMMON /FLUX3/FX1(7),FX2(7),FX3(7),FX4(7)
      DATA SUBNAM/'RESP'/
      FUNSIN(A,B,C,I)=A+B*SIN(.0174533*(I+C))
C
C
      IF(IDAY.EQ.JDAY)GO TO 1000
      IF(PRINT)WRITE(LP,10)
   10 FORMAT('0---* EXECUTING SUBROUTINE RESPIR')
      DATAVE = (DATMAX + DATMIN) * 0.5
      LSOIL = ILAYER(I)
      DO 200 J=1,NORGAN
      IF(PDM(I,J).LE.0.0)GO TO 200
C ------------------------------------------------------------------
C     EFFECT OF SWP
C ------------------------------------------------------------------
      WATERF=PWLPOS(P4(J),P5(J),1.0,SWPH(LSOIL))
C ------------------------------------------------------------------
C     CALCULATE RATE IN MG CO2 PER G DRY MATTER PER HOUR
C ------------------------------------------------------------------
      Q=DATAVE
      IF(J.EQ.1)Q=DATMIN+0.6667*(DATAVE-DATMIN)
C
C     ADJUST THE TEMPERATURE TO ACCOUNT FOR ACCLIMITIZATION
C
      Q=FUNSIN(G,P6(J),P7(J),IYRDAY)
C
C     CALCULATE RATE AS STRAIGHT LINE FUNCTION OF ADJUSTED TEMPERATURE
C     MULTIPLIED BY A SCALING FACTOR FOR THE EFFECT OF SWP
C
      RSRATE=(P1(J)+P2(J)*Q)*WATERF
      IF(RSRATE.LE.0.0)RSRATE=0.0
C     UNITS FOR 'RSRATE' ARE MG CO2 PER GRAM DRY MATTER PER HOUR
C ------------------------------------------------------------------
C     CONVERT TO AMOUNT RESPIRED PER DAY AND PRINT RESULTS
C ------------------------------------------------------------------
      Q=24.0
      IF(J.EQ.ILF)Q=(24.0-DAPHOT)
      RSATE=RSRATE*PDM(I,J)*Q * 2.727E-04
C     RSATE=RSRATE*PDM(I,J)*12./44.*.001*Q
C     DON'T RESPIRE MORE THAN IS PRESENT
      B = CVEG(I,J,IR)
      IF (RSATE*ISTEP .GT. B) RSATE = B/FLOAT(ISTEP)
      OCARBO(2)=OCARBO(2)+RSATE*ISTEP
      IQ = 2
      IF (ANNUAL(I)) IQ=1
      OPRODU(IQ) = OPRODU(IQ) - RSATE*2.5*ISTEP
      FX2(I) = FX2(I) + RSATE*ISTEP
      CVEGQQ(I,J,IR)=CVEGQQ(I,J,IR)-RSATE
      IF (PRINT) WRITE (LP,125) J,WATERF,RSRATE,RSATE,PDM(I,J)
  125 FORMAT (T7,'ORGAN,WATERF,RSRATE,RSATE,PDM =',I2,4G15.4)
  200 CONTINUE
      RETURN
C ------------------------------------------------------------------
C     INPUT AND INITIALIZATION
C ------------------------------------------------------------------
 1000 IF(.NOT.SUVINP)WRITE(LP,1010)
 1010 FORMAT('0---* BEGINNING READING OF INPUT TO SUBROUTINE RESPIR')
 1020 FORMAT(20A4)
 1025 FORMAT(T7,I5,' RESPIR',4X,20A4)
 1050 FORMAT(7F10.0)
 1055 FORMAT(T7,I5,' RESPIR',7F16.5)
C
      IREAD=2020
 2020 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP )WRITE(LP,1025)IREAD,RCHECK
      IF(RCHECK(1).NE.SUBNAM)GO TO 2020
C
      IREAD=2050
 2050 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1025)IREAD,RCHECK
      IREAD=2060
      DO 2090 J=1,NORGAN
 2060 READ(KR,1050)P1(J),P2(J),P3(J),P4(J),P5(J),P6(J),P7(J)
 2090 IF(.NOT.SUVINP)WRITE(LP,1055)IREAD,P1(J),P2(J),P3(J),P4(J),P5(J),
     -        P6(J),P7(J)
      RETURN
      END
```

Subroutine TRANSL

```
BIOME*DESERT2SYM(1).TRANSL
      SUBROUTINE TRANSL (AMOUNT)
C
C     TRANSLOCATION MODEL
C
C  TRATE               RELATIVE TRANSLOCATION RATE
C  TRNSLC              AMOUNT OF CARBON TRANSLOCATED
C  PTALOC(I,J,M)       OF THE CARBON FIXED DURING THE CURRENT TIME-STEP BY
C                      THE I'TH PLANT GROUP, PTALOC GIVES THE DECIMAL
C                      FRACTION ALLOCATED TO THE J'TH ORGAN DURING
C                      NON-REPRODUCTIVE PHENOPHASES(M=1E AND DURING THE
C                      REPRODUCTIVE PHENOPHASE(M=2)
C  P1,P2,P3            PARAMETERS IN THE PIECE-WISE LINEAR FUNCTION
C                      RELATING THE RELATIVE RATE OF GERMINATION
C                      OR LEAFING-OUT TO SOIL WATER POTENTIAL IN A
C                      SPECIFIED SOIL LAYER
C  P4,P5,P6            THE FRACTION OF TOTAL CARBON TRANSLOCATED FROM
C                      SEEDS (OR STORAGE ORGANS OF PERENNIALS) TO
C                      LEAVES, NEW SHOOTS AND ROOTS (OR REPRODUCTIVE
C                      ORGANS IN PERENNIALS) , RESPECTIVELY
C  PSF1-3              PARAMETERS IN THE PIECEWISE LINEAR FUNCTION RELATING
C                      FRACTION OF REPRODUCTIVE TISSUE THAT IS IN THE FORM
C                      OF MATURE SEEDS TO TIME ELAPSED DURING REPRODUCTIVE
C                      STAGE
C
      LOGICAL ERROR,PRINT
      LOGICAL ANNUAL,HERB
      LOGICAL SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /ECHOCH/ SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     -        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCMPT
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
     -        PLACE(18),UNITS(8)
      COMMON /MISC/ ERROR,RCHECK(20),BLANK
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
```

```
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /CHANGE/ CVEGQQ(7,6,5),SEEDQQ(7,5),CBIOMQ(10,5),
     -        CLITQQ(3,5),CORGQQ(1,5),CMINQQ(1,2)
      COMMON /LIMITS/ MAXCHE,MAXPLA,MAXORG,MAXANI,MAXDOM,MAXSCM,MAXHOR
      COMMON /VEGCOM/ IN,IW,IP,IR,IS,ILF,INS,IOS,IFR,IRT,ILAYER(7),
     1 ANNUAL(7),HERB(7),IPHENO(7),TISNEW(7),TIME(7),PHSATE,I,SEDFRA(7)
      COMMON /TRASAV/ PTALOC(7,6,2), P1(7),P2(7),P3(7),P4(7),P5(7),
     -  P6(7), PSF1(7), PSF2(7), PSF3(7), SDPOOL
      DATA SDPOOL /5.0/
      COMMON /FLUX2/ FLUXLO(7)
      COMMON /FLUX5/ FX10(7)
      COMMON /FLUX8/ FX16(9,5)
      COMMON /LOLAYR/ JLAYER(7)
      DATA SUBNAM/'TRAN'/
C
C
      IF(IDAY.EQ.JDAY)GO TO 1000
      IF(PRINT)WRITE(LP,10)
   10 FORMAT('0---* EXECUTING SUBROUTINE TRANSL')
C
C     X328 IS THE CARBON IN ATTACHED, MATURE SEEDS
C     X329 IS THE CARBON ADDED TO MATRUE ATTACHED SEEDS DURING
C     THE CURRENT TIME-STEP
      X328 = AVEG(I,IFR) * SEDFRA(I)
      X329 = 0.0
C
C     IPHENO(I) IS THE CURRENT PHENOLOGICAL STAGE OF THE I'TH PLANT
C     GROUP. IT MUST COME THROUGH COMMON FROM SUBROUTINE 'PHENOL'
C
C     1=GERMINATION
C     2=LEAFING-OUT
C     3=VEGETATIVE
C     4=REPRODUCTIVE
C     5=DORMANT
C
      ISTAGE=IPHENO(I)
      LSOIL = ILAYER(I)
      LSOIL2 = JLAYER(I)
      IF(AMOUNT.GT.0.0)GO TO 400
      GO TO (100,200,400,400,600),ISTAGE
C ------------------------------------------------------------------
C     GERMINATION SECTION
C     GERMINATION IS TREATED AS A DISCRETE EVENT -- IT IS INDEPENDENT
C     OF THE LENGTH OF THE TIME STEP
C     GERMINATION COMES FROM EXTERNAL SOURCE
C ------------------------------------------------------------------
  100 CONTINUE
      TRATE = PWLPOS(P1(I),P2(I),P3(I),SWPH(LSOIL2))
      TRNSLC = TRATE * SDPOOL
      WRITE (LP,120) TRNSLC, TRATE
  120 FORMAT (T50, 'CARBON TRANSLOCATED =', G12.4,5X,
     -     'SPECIFIC RATE =', G12.4)
      FLUXLO(I) = FLUXLO(I) + TRNSLC
      OENDOG(5) = OENDOG(5) + TRNSLC
      TISNEW(I)=TISNEW(I)+TRNSLC
C     THE FOLLOWING DIVISION MAKES SIZE OF TRNSLC INDEPENDENT OF
C     TIME-STEP
      TRNSLC = TRNSLC/ISTEP
C     ALLOCATE TO ORGAN AND CARBON FRACTION.
      Q=TRNSLC*P4(I)
      CALL ALOCAT(ILF,Q)
      QQ=TRNSLC*P5(I)
      CALL ALOCAT(INS,QQ)
      QQQ = TRNSLC * P6(I)
      CALL ALOCAT(IRT, QQQ)
C     CARBON HAS BEEN TRANSFERRED. NOW TRANSFER NON-CARBON CONSTITUENTS
      DO 130  K=1,NELEMS
      CVEGQQ(I,ILF,K) = CVEGQQ(I,ILF,K) + Q * VRATIO(I,ILF,K)
      CVEGQQ(I,INS,K) = CVEGQQ(I,INS,K) + QQ *  VRATIO(I,INS,K)
  130 CVEGQQ(I,IRT,K) = CVEGQQ(I,IRT,K) + QQQ * VRATIO(I,IRT,K)
      GO TO 600
C ------------------------------------------------------------------
C     LEAFING-OUT OR FLOWERING AND LEAFING-OUT
C     TREATED AS DISCRETE EVENT INDEPENDENT OF LENGTH OF TIME-STEP
C ------------------------------------------------------------------
  200 Q=0.0
      DO 201 J=IRT,NORGAN
  201 Q=Q+PDM(I,J)
      Q = Q + PDM(I,IOS)
C     'Q' IS THE DRY MATTER IN DONOR ORGANS
      IF(Q.LE.0.0)GO TO 600
C     FOR THE TIME BEING THE TRANSLOCATION RATE DEPENDS ON THE SOIL
C     WATER POTENTIAL ONLY
      TRATE = PWLPOS(P1(I),P2(I),P3(I),SWPH(LSOIL2))
      TRATE = TRATE / ISTEP
      TRNSLC=0.0
      DO 205 J=IRT,NORGAN
      A=TRATE*CVEG(I,J,IR)
      CVEGQQ(I,J,IR)=CVEGQQ(I,J,IR)-A
  205 TRNSLC=TRNSLC+A
      B=TRATE*CVEG(I,IOS,IR)
      CVEGQQ(I,IOS,IR)=CVEGQQ(I,IOS,IR)-B
      TRNSLC=TRNSLC+B
C     'TRNSLC' IS NOW THE TOTAL CARBON TRANSLOCATED DURING ONE DAY
      X23 = TRATE * ISTEP
      X24 = TRNSLC* ISTEP
      WRITE (LP,120) X24 , X23
      OENDOG(6) = OENDOG(6) + X24
      TISNEW(I) = TISNEW(I) + X24
      FLUXLO(I) = FLUXLO(I) + X24
      Q=TRNSLC*(P4(I) + P5(I))
C     'Q' IS THE TOTAL CARBON TRANSLOCATED TO PHOTOSYNTHETIC TISSUE
      IF(Q.LE.0.0)GO TO 210
      IF(PRINT)WRITE(LP,208)Q
  208 FORMAT(T7,'TRANSLOCATE FROM STORAGE TO PHOTOSYNTHETIC TISSUE =',
     - G15.5)
      CALL ALOCAT(ILF,Q)
C     MOVE NON-CARBON ELEMENTS FROM STORAGE TO LEAVES
      CALL STONEW(I,ILF,Q,VRATIO,MAXPLA,MAXORG,MAXCHE,CVEGQQ,CVEG,
     - IRT,NORGAN,IOS,NELEMS)
  210 Q=TRNSLC*P6(I)
C     'Q' IS NOW THE TOTAL CARBON TRANSLOCATED TO FLOWERS
      IF(Q.LE.0.0)GO TO 220
      IF (PRINT)WRITE(LP,206)Q
  206 FORMAT(T7,'TRANSLOCATE FROM STORAGE TO FLOWERS=',G15.5)
      CALL ALOCAT(IFR,Q)
C     MOVE NON-CARBON ELEMENTS FROM STORAGE TO FLOWERS
      CALL STONEW(I,IFR,Q,VRATIO,MAXPLA,MAXORG,MAXCHE,CVEGQQ,CVEG,
     - IRT,NORGAN,IOS,NELEMS)
  220 GO TO 600
C------------------------------------------------------------------
C     ALLOCATION OF PHOTOSYNTHATE DURING ANY OF THE NON-DORMANT
C     PHENOPHASES
C------------------------------------------------------------------
C
C     'AMOUNT' IS AN ARGUMENT PASSED TO SUBROUTINE TRANSL FROM
C     SUBROUTINE PHOTOS. IT EQUALS THE AMOUNT OF TOTAL CARBON FIXED,
C     AN MUST BE ALLOCATED TO THE PROPER ORGANS AND CARBON TYPES
C
  400 DO 510 J=1,NORGAN
C
C     ASSUME FOR NOW THAT ALL PLANT GROUPS HAVE THE SAME PARAMETER
C     VALUES
C
      M=1
      IF(ISTAGE.EQ.4)M=2
      Q=AMOUNT*PTALOC(I,J,M)
      FX16(I,J) = FX16(I,J) + Q*ISTEP
      IF(J.EQ.IFR)TISNEW(I)=TISNEW(I)+Q*ISTEP
      IF (J.EQ.IFR) X329 = Q*ISTEP
      IF(PRINT)WRITE(LP,505)J,Q,PTALOC(I,J,M),AMOUNT,ISTAGE
  505 FORMAT(T7,'CARBON ALLOCATED TO ORGAN NO.',I2,' =',G13.5,
     -  6X,'BEING',F7.4,' OF ',G13.5,6X,'ISTAGE=',I2)
      IF(Q.LE.0.0)GO TO 510
      IF(J.LT.IRT)GO TO 509
      IF(ANNUAL(I))GO TO 508
      OPRODU(6)=OPRODU(6)+Q*2.5*ISTEP
      GO TO 509
  508 OPRODU(5)=OPRODU(5)+Q*2.5*ISTEP
  509 CALL ALOCAT(J,Q)
  510 CONTINUE
      IF(ISTAGE.NE.4)GO TO 600
C------------------------------------------------------------------
C     FRUIT MATURATION
C     ASSUME THAT MATURE SEED BIOMASS EXPRESSED AS A FRACTION OF
C     THE BIOMASS OF THE REPRODUCTIVE TISSUE IS A PIECE-WISE LINEAR
C     FUNCTION OF DAYS ELAPSED SINCE THE START OF THE FRUITING STAGE
C------------------------------------------------------------------
      SEDFRA(I)=PWLPOS(PSF1(I),PSF2(I),PSF3(I),TIME(I))
      X330 = (AVEG(I,IFR) + X329) * SEDFRA(I) - X328
      IF (X330 .GT. 0.0) FX10(I) = FX10(I) + X330
      IF(PRINT)WRITE(LP,550)SEDFRA(I)
  550 FORMAT(T7,'TIME,SEDFRA=',2G15.5)
  600 RETURN
C------------------------------------------------------------------
C     INPUT AND INTIALIZATION SECION
C------------------------------------------------------------------
 1000 IF(.NOT.SUVINP)WRITE(LP,1010)
 1010 FORMAT('0---* BEGINNING READING OF INPUT TO SUBROUTINE TRANSL')
 1020 FORMAT(20A4)
 1025 FORMAT(T7,I5,' TRANSL',4X,20A4)
 1030 FORMAT(14I5)
 1035 FORMAT(T7,I5,' TRANSL',4X,14I5)
 1050 FORMAT(7F10.0)
 1055 FORMAT(T7,I5,' TRANSL',5(T19,7F16.5/))
C
      IREAD=2020
 2020 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1025)IREAD,RCHECK
      IF(RCHECK(1).NE.SUBNAM)GO TO 2020
C
      IREAD=2050
 2050 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1025)IREAD,RCHECK
      IREAD=2060
      DO 2080 I=1,NPLNTS
 2060 READ (KR,1050) P1(I),P2(I),P3(I),P4(I),P5(I),P6(I)
      IF(.NOT.SUVINP)WRITE(LP,1055)IREAD,P1(I),P2(I),P3(I),P4(I),P5(I),
     -   P6(I)
      Q = P4(I) + P5(I) + P6(I)
      IF (Q.GT. .999 .AND. Q .LT. 1.001) GO TO 2080
      ERROR = .TRUE.
      WRITE (LP,2070) Q
 2070 FORMAT (' =*=*=*=  ERROR  =*=*=*=  PARAMETERS 4, 5, AND 6 MUST SUM
     - TO ONE BUT INSTEAD THEY SUM TO',F10.4)
 2080 CONTINUE
C
      IREAD=2090
 2090 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1025)IREAD,RCHECK
      IREAD=3000
      DO 3001 I=1,NPLNTS
 3000 READ(KR,1050)PSF1(I),PSF2(I),PSF3(I)
 3001 IF(.NOT.SUVINP)WRITE(LP,1055)IREAD,PSF1(I),PSF2(I),PSF3(I)
C
      IREAD=3010
 3010 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1025)IREAD,RCHECK
      IREAD=3020
      DO 3021 I=1,NPLNTS
      DO 3021 M=1,2
 3020 READ(KR,1050)(PTALOC(I,J,M),J=1,NORGAN)
 3021 IF(.NOT.SUVINP)WRITE(LP,1055)IREAD,(PTALOC(I,J,M),J=1,NORGAN)
C
      DO 3050 I=1,NPLNTS
 3050 FX10(I) = 0.0
      IX = NPLNTS + 1
      DO 3060 I=1,IX
      DO 3060 J=1,NORGAN
 3060 FX16(I,J) = 0.0
      RETURN
      END
```

Subroutine ALOCAT

```
BIOME*DESERT2SYM(1).ALOCAT
      SUBROUTINE ALOCAT(J,AMOUNT)
C
C     PROGRAM TO ALLOCATE A GIVEN AMOUNT OF CARBON TO EACH OF THE CARBON
C     FRACTIONS IN THE J'TH ORGAN OF THE I'TH PLANT GROUP ('I' IS
C     PASSED THROUGH COMMON)
C
C  PAALOC(N,L)      FRACTION OF CARBON ALLOCATED TO THE N'TH CARBON
C                   FRACTION DURING THE L'TH PHENOLOGICAL STAGE  (THIS
C                   FRACTION OF THE L'TH ORGAN TYPE (L=1 FOR HERBACEOUS
C                   ORGANS, L =2 FOR WOODY ORGANS)
C
      LOGICAL ERROR,PRINT
      LOGICAL SUMINP,SUVINP, SUAINP,SUSINP
      LOGICAL ANNUAL,HERB
      COMMON /ECHOCH/ SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLITD,NFRACD,
     -        NFRELM,NFRELP,NORDEP(6),NHORIZ,NSCMPT
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
     -        PLACE(18),UNITS(8)
      COMMON /MISC/ ERROR,RCHECK(20),BLANK
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /CHANGE/ CVEGQQ(7,6,5),SEEDQQ(7,5),CBIOMQ(10,5),
     -        CLITQQ(3,5),CORGQQ(1,5),CMINQQ(1,2)
      COMMON /VEGCOM/ IN,IW,IP,IR,IS,ILF,INS,IOS,IFR,IRT,ILAYER(7),
     1 ANNUAL(7),HERB(7),IPHENO(7),TISNEW(7),TIME(7),PHSATE,I,SEDFRA(7)
      COMMON/ALOSAV/PAALOC(3,2)
```

```
      DIMENSION Q(3)
      DATA SUBNAM/'ALOC'/
C
C
      IF(IDAY.EQ.JDAY)GO TO 1000
      IF(PRINT)WRITE(LP,10)
   10 FORMAT (T7,'---* EXECUTING SUBROUTINE ALOCAT')
C
C
C     ADD CARBON TO RESERVE IF LATTER IS DEPLETED
      A=CVEG(I,J,IR)
      B=AVEG(I,J)
      IF(B.LE.0.0)GO TO 90
      C=A/B
      IF(C.GE.0.1)GO TO 90
      D=0.1*B-A
      D=AMIN1(AMOUNT,D)
      CVEGQQ(I,J,IR)=CVEGQQ(I,J,IR)+D
      IF(PRINT)WRITE(LP,80)J,C,AMOUNT,D
   80 FORMAT(T13,'ORGAN = ',I1,5X,'RC/TC =',F6.4,5X,'AMOUNT =',G12.4,5X,
     - 'ADDED TO RESERVE =',G12.4)
      AMOUNT=AMOUNT-D
      IF(AMOUNT.LE.0.0)RETURN
   90 CONTINUE
C
C
C      DISTRIBUTE CARBON AMONG CARBON TYPES
      IF (HERB(I)) GO TO 95
      L2 = 2
      IF (J .EQ. ILF .OR. J .EQ. IFR) L2 = 1
      GO TO 97
   95 L2 = 1
   97 CONTINUE
      DO 100 K=NFRAC1,NFRELM
      L=K-NELEMS
      Q(L) = AMOUNT * PAALOC(L,L2)
  100 CVEGQQ(I,J,K)=CVEGQQ(I,J,K)+Q(L)
      IF (PRINT) WRITE (LP,150)Q,AMOUNT,J
  150 FORMAT (T13,'INCREMENTS TO CARBON FRACTIONS=',3G15.5,5X,
     -  'TOTAL =',G15.5,5X,'ORGAN',I2)
      RETURN
C-----------------------------------------------------------------
C     INPUT AND INITIALIZATION
C-----------------------------------------------------------------
 1000 IF(.NOT.SUVINP)WRITE(LP,1010)
 1010 FORMAT('0---* BEGINNING READING OF INPUT TO SUBROUTINE ALOCAT')
 1020 FORMAT(20A4)
 1025 FORMAT(T7,I5,' ALOCAT',4X,20A4)
 1050 FORMAT(7F10.0)
 1055 FORMAT(T7,I5,' ALOCAT',7F16.5)
C
      IREAD=2020
 2020 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1025)IREAD,RCHECK
      IF(RCHECK(1).NE.SUBNAM)GO TO 2020
C
      IREAD=2050
 2050 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1025)IREAD,RCHECK
      IREAD=2060
      DO 2065 L2=1,2
 2060 READ(KR,1050)(PAALOC(K,L2),K=1,NFRACT)
 2065 IF(.NOT.SUVINP)WRITE(LP,1055)IREAD,(PAALOC(K,L2),K=1,NFRACT)
      RETURN
      END
```

Subroutine STONEW

BIOME*DESERT2SYM(1).STONEW

```
      SUBROUTINE STONEW(I,J,Q,VR,I1,I2,I3,CVQ,CV,IRT,NO,IOS,NE)
      DIMENSION VR(I1,I2,I3),CVQ(I1,I2,I3),CV(I1,I2,I3)
C
      DO 100 K=1,NE
C     'Q' IS THE CARBON TRANSLOCATED FROM STORAGE (ROOTS AND OLD
C     STEMS)
C     'A' IS THE AMOUNT OF NON-CARBON CONSTITUENT NEEDED BY THE
C     RECIPIENT ORGAN
C     'SUM' IS THE AMOUNT AVAILALBE IN DONOR ORGANS
      A=Q*VR(I,J,K)
      B=CV(I,IOS,K)
      SUM=B
      DO 30 JJ=IRT,NO
   30 SUM=SUM+CV(I,JJ,K)
      IF (SUM .LE. 0.0) GO TO 100
      RSUM=1.0/SUM
      D = A/SUM
      CVQ(I,J,K)=CVQ(I,J,K)+A
      CVQ(I,IOS,K)=CVQ(I,IOS,K)-B*D
      DO 40 JJ=IRT,NO
   40 CVQ(I,JJ,K)=CVQ(I,JJ,K)-CV(I,JJ,K)*D
  100 CONTINUE
      RETURN
      END
```

Subroutine NUTUPT

BIOME*DESERT2SYM(1).NUTUPT

```
      SUBROUTINE NUTUPT
C
C     NUTRIENT UPTAKE MODEL
C
C     AT PRESENT, THIS MODEL DOES NOTHING BUT TAKE UP NITROGEN SO AS
C     TO MAINTAIN A CONSTANT PROTEIN CARBON TO NITROGEN
C     RATIO IN ALL ORGANS.
C
      LOGICAL ERROR,PRINT
      LOGICAL ANNUAL,HERB
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     -        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCMPT
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
     -        PLACE(18),UNITS(8)
      COMMON /MISC/ ERROR,RCHECK(20),BLANK
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATTO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /CHANGE/ CVEGQQ(7,6,5),SEEDQQ(7,5),CBIOMQ(10,5),
     -        CLITQQ(3,5),CORGQQ(1,5),CMINQQ(1,2)
      COMMON /VEGCOM/ IN,IW,IP,IR,IS,ILF,INS,IOS,IFR,IRT,ILAYER(7),
     1 ANNUAL(7),HERB(7),IPHENO(7),TISNEW(7),TIME(7),PHSATE,I,SEDFRA(7)
C
C
      IF(IDAY.EQ.JDAY)GO TO 1000
      IF(PRINT)WRITE(LP,100)
  100 FORMAT('0---* EXECUTING SUBROUTINE NUTUPT')
      DO 200 J=1,NORGAN
      UPT=(CVEG(I,J,IP)+CVEGQQ(I,J,IP))*0.32-CVEG(I,J,IN)
      IF(UPT.LT.0.0)UPT=0.0
      IF(PRINT)WRITE(LP,150)J,UPT
  150 FORMAT(T20,'ORGAN',I2,5X,'NITROGEN UPTAKE=',G15.5)
      IF(UPT.LE.0.0)GO TO 200
      CVEGQQ(I,J,IN)=CVEGQQ(I,J,IN)+UPT
      CMINQQ(1,IN)=CMINQQ(1,IN)-UPT
      ONITRO(2)=ONITRO(2)+UPT*ISTEP
  200 CONTINUE
 1000 CONTINUE
      RETURN
      END
```

Subroutine DEATHH

BIOME*DESERT2SYM(1).DEATHH

```
      SUBROUTINE DEATHH
C
C     MODEL OF ORGAN ABSCISSION AND DEATH
C
C P1,2           PARAMETERS IN PIECEWISE LINEAR FUNCTION RELATING
C                RELATIVE ABSCISSION RATE TO TIME ELAPSED
C                IN CURRENT PHENOLOGICAL STAGE
C P3,5           PARAMETERS IN PIECEWISE LINEAR FUNCTION RELATING
C                DEATH RATE TO SOIL WATER POTENTIAL
C DRATE          RELATIVE ABSCISSION OR DEATH RATE
C
      LOGICAL ERROR,PRINT
      LOGICAL ANNUAL,HERB
      LOGICAL SUMINP,SUVINP,SUATNP,SUSINP
      COMMON /ECHOCH/ SUMINP,SUVINP,SUATNP,SUSINP
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     -        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCMPT
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
     -        PLACE(18),UNITS(8)
      COMMON /MISC/ ERROR,RCHECK(20),BLANK
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITPO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATTO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /CHANGE/ CVEGQQ(7,6,5),SEEDQQ(7,5),CBIOMQ(10,5),
     -        CLITQQ(3,5),CORGQQ(1,5),CMINQQ(1,2)
      COMMON /VEGCOM/ IN,IW,IP,IR,IS,ILF,INS,IOS,IFR,IRT,ILAYER(7),
     1 ANNUAL(7),HERB(7),IPHENO(7),TISNEW(7),TIME(7),PHSATE,I,SEDFRA(7)
      COMMON/DEASAV/P1(7),P2(7),P3(7),P4(7),P5(7)
      COMMON /FLUX3/FX1(7),FX2(7),FX3(7),FX4(7)
      DATA SUBNAM/'DEAT'/
C
C
      IF(IDAY.EQ.JDAY)GO TO 1000
      IF(PRINT)WRITE(LP,10)
   10 FORMAT('0---* BEGINNING EXECUTION OF SUBROUTINE DEATHH')
      SUMA=0.0
      SUMB=0.0
      LSOIL = ILAYER(I)
C-----------------------------------------------------------------
C     COMPUTE LOSS OF TRANSIENT ORGANS AS A FUNCTION OF TIME
C-----------------------------------------------------------------
      Q = 1.0
      ARATE=PWLPOS(P1(I),P2(I),  Q,TIME(I))
      IF (ARATE*ISTEP .GT. 1.0) ARATE = 1.0/FLOAT(ISTEP)
      IF(ARATE.LE.0.0)GO TO 250
C     'ARATE' IS THE RELATIVE ABSCISSION RATE
C     NOW PERFORM THE TRANSFERS
      DO 200 J=1,NORGAN
      IF(PDM(I,J).LE.0.0)GO TO 200
      IF(ANNUAL(I))GO TO 100
      IF(.NOT.HERB(I))GO TO 50
      IF(J.GE.IRT)GO TO 200
      GO TO 100
   50 IF(J.NE.ILF.AND.J.NE.IFR)GO TO 200
  100 DO 150 K=1,NFRELM
      Q=ARATE*CVEG(I,J,K)
      Q2 = Q
      IF (Q*ISTEP .LE. CVEG(I,J,K)+CVEGQQ(I,J,K) ) GO TO 120
      Q2 = CVEG(I,J,K) / ISTEP
      Q = 0.0
      CVEG(I,J,K) = 0.0
      CVEGQQ(I,J,K) = 0.0
  120 CONTINUE
      IF(K.GT.NELEMS)SUMA=SUMA+Q2*ISTEP
      CVEGQQ(I,J,K)=CVEGQQ(I,J,K)-Q
      IF(J.NE.IFR)GO TO 150
      QQ=Q2*SEDFRA(I)
      SEEDQQ(I,K)=SEEDQQ(I,K)+QQ
      IF (K.GT.NELEMS) FX3(I) = FX3(I) + QQ*ISTEP
      Q2 = Q2 - QQ
C     THIS MODEL ASSUMES THERE IS ONLY ONE TYPE OF DEAD ORGANIC MATTER
  150 CLITQQ(1,K)=CLITQQ(1,K)+Q2
  200 CONTINUE
C-----------------------------------------------------------------
C     COMPUTE DEATH DUE TO DROUTH
C-----------------------------------------------------------------
  250 DRATE=PWLNEG(P3(I),P4(I),P5(I),SWPH(LSOIL))
      IF (DRATE*ISTEP .GT. 1.0) DRATE = 1.0/FLOAT(ISTEP)
      IF(DRATE.LE.0.0)GO TO 500
      DO 460 J=1,NORGAN
      IF (PDM(I,J) .LE. 0.0) GO TO 460
      DO 450 K=1,NFRELM
      Q=DRATE*CVEG(I,J,K)
      Q2 = Q
      IF (Q*ISTEP .LE. CVEG(I,J,K)+CVEGQQ(I,J,K) ) GO TO 260
      Q2 = CVEG(I,J,K) / ISTEP
      Q = 0.0
      CVEG(I,J,K) = 0.0
      CVEGQQ(I,J,K) = 0.0
  260 CONTINUE
      IF(K.GT.NELEMS)SUMB=SUMB+Q2*ISTEP
      CVEGQQ(I,J,K)=CVEGQQ(I,J,K)-Q
C     THIS MODEL ASSUMES THERE IS ONLY ONE TYPE OF DEAD ORGANIC MATTER
  450 CLITQQ(1,K)=CLITQQ(1,K)+Q2
```

```
  460 CONTINUE
  500 CONTINUE
      OENDOG(4)=OENDOG(4)+SUMA+SUMB
      FX4(I) = FX4(I) + SUMA + SUMB
      IF(PRINT)WRITE(LP,600)ARATE,DRATE,TIME(I),SUMA,SUMB
  600 FORMAT(T7,'REL. ABSCISSION RATE =',G12.4,5X,'REL. DEATH RATE =',
     - G12.4,5X,'DAYS ELAPSED DURING PHENOPHASE =',G12.4/
     -  T7,'TOTAL ABSCISSION =',G12.4,5X,'TOTAL DEATH =',G12.4)
      RETURN
C-----------------------------------------------------------------------
C     INPUT AND INITIALIZATION
C-----------------------------------------------------------------------
 1000 IF(.NOT.SUVINP)WRITE(LP,1010)
 1010 FORMAT('0--* BEGINNING READING OF INPUT TO SUBROUTINE DEATHH')
 1020 FORMAT(20A4)
 1025 FORMAT(T7,I5,' DEATHH',4X,20A4)
 1050 FORMAT(7F10.0)
 1055 FORMAT(T7,I5,' DEATHH',7F16.5)
C
      IREAD=2020
 2020 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1025)IREAD,RCHECK
      IF(RCHECK(1).NE.SUBNAM)GO TO 2020
C
      IREAD=2050
 2050 READ(KR,1020)RCHECK
      IF(.NOT.SUVINP)WRITE(LP,1025)IREAD,RCHECK
      IREAD=2060
      DO2068 I=1,NPLNTS
 2060 READ(KR,1050)P1(I),P2(I),P3(I),P4(I),P5(I)
 2068 IF(.NOT.SUVINP)WRITE(LP,1055)IREAD,P1(I),P2(I),P3(I),P4(I),P5(I)
      RETURN
      END
```

Subroutine ANIMAL

```
BIOME*DESERT2SYM(1).ANIMAL
      SUBROUTINE ANIMAL
C
C     CALLING PROGRAM FOR ANIMAL SUBMODELS
C
      LOGICAL ERROR,PRINT
      LOGICAL SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /ECHOCH/ SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
     -        PLACE(18),UNITS(8)
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     -        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCMPT
      COMMON /MISC/ ERROR,RCHECK(20),BLANK
      COMMON/ANTSAV/I,RSPIRD
      DATA SUBNAM/'ANIM'/
C
C
      IF(IDAY.EQ.JDAY)GO TO 1000
      IF(PRINT)WRITE(LP,10)
   10 FORMAT('0',100('*')/' BEGINNING EXECUTION OF ANIMAL SUBROUTINES'/
     -  1X,100('*'))
      DO 100 I=1,NANIMS
      IF(PRINT) WRITE(LP,20) I
   20 FORMAT('0',T11,38('-')/
     -  T11,'STARTING CYCLE FOR ANIMAL GROUP NO.',I3/
     -  T11,38('-'))
      CALL ANRESP
      CALL FEEDNG
      CALL MANAGE
  100 CONTINUE
      RETURN
C-----------------------------------------------------------------------
C     INPUT AND INITIALIZATION
C-----------------------------------------------------------------------
 1000 IF(.NOT.SUAINP)WRITE (LP,1010)
 1010 FORMAT('0',100('-')/' BEGINNING READING OF INPUT TO ANIMAL SUBROUT
     -INES'/' ',100('-'))
 1020 FORMAT(20A4)
 1025 FORMAT(T7,I5,' ANIMAL',4X,20A4)
      IREAD=2020
 2020 READ(KR,1020)RCHECK
      IF(.NOT.SUAINP)WRITE(LP,1025)IREAD,RCHECK
      IF(RCHECK(1).NE.SUBNAM)GO TO 2020
      CALL ANRESP
      CALL FEEDNG
      CALL MANAGE
      RETURN
      END
```

Subroutine ANRESP

```
BIOME*DESERT2SYM(1).ANRESP
      SUBROUTINE ANRESP
C
C     ANIMAL RESPIRATION MODEL
C
C  P1,2             PARAMETERS IN POWER FUNCTION RELATING RELATIVE
C                   RESPIRATION RATE TO MEAN WEIGHT OF ANIMALS IN
C                   I'TH GROUP
C  RSPIRD           CARBON RESPIRED (MASS PER AREA PER DAY)
C  R                RELATIVE RESPIRATION RATE  (KILOGRAMS CARBON RESPIRED
C                   PER KILOGRAM DRY WEIGHT IN THE I'TH ANIMAL GROUP
C
      LOGICAL ERROR,PRINT,ANNUAL,HERB
      LOGICAL SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /ECHOCH/ SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     -        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCMPT
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
     -        PLACE(18),UNITS(8)
      COMMON /MISC/ ERROR,RCHECK(20),BLANK
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /CHANGE/ CVEGQQ(7,6,5),SEEDQQ(7,5),CBIOMQ(10,5),
     -        CLITQQ(3,5),CORGQQ(1,5),CMINQQ(1,2)
      COMMON/ANTSAV/I,RSPIRD
      COMMON/ANRSAV/P1(8),P2(8)
      COMMON/VEGCOM/IN,IW,IP,IR,IS,ILF,INS,IOS,IFR,IRT,LSOIL,
     1 ANNUAL(7),HERB(7),IPHENO(7),TISNEW(7),TIME(7),PHSATE,IZ,SEDFRA(7)
      COMMON /FLUX6/FX15(10)
      DATA SUBNAM/'ANRE'/
C
C
      IF(IDAY.EQ.JDAY)GO TO 1000
      IF(PRINT)WRITE(LP,10)
   10 FORMAT('0--* BEGINNING EXECUTION OF SUBROUTINE ''ANRESP''')
      R=P1(I)*(ADM(I)/POP(I))**P2(I)
      RSPIRD=R*POP(I)
C     DON'T RESPIRE MORE THAN IS THERE
      A=CBIOM(I,IR)
      IF(RSPIRD.GT.A)RSPIRD=A
      CBIOMQ(I,IR)=CBIOMQ(I,IR)-RSPIRD
      OCARBO(3)=OCARBO(3)+RSPIRD*ISTEP
      FX15(I) = FX15(I) + RSPIRD*ISTEP
      IF (PRINT) WRITE(LP,200) RSPIRD,ADM(I),POP(I),P1(I),P2(I)
  200 FORMAT(T7,'RESPIRED, DRY MATTER, DENSITY, 2 PARMS=',5G13.5)
      RETURN
C-----------------------------------------------------------------------
C     INPUT AND INITIALIZATION
C-----------------------------------------------------------------------
 1000 IF(.NOT.SUAINP)WRITE(LP,1010)
 1010 FORMAT('0--* BEGINNING READING OF INPUT TO SUBROUTINE ANRESP')
 1020 FORMAT(20A4)
 1025 FORMAT(T7,I5,' ANRESP',4X,20A4)
 1050 FORMAT(7F10.0)
 1055 FORMAT(T7,I5,' ANRESP',7F16.5)
C
      IREAD=2020
 2020 READ(KR,1020)RCHECK
      IF(.NOT.SUAINP)WRITE(LP,1025)IREAD,RCHECK
      IF(RCHECK(1).NE.SUBNAM)GO TO 2020
C
      IREAD = 2065
 2065 READ (KR,1020) RCHECK
      IF(.NOT.SUAINP)WRITE (LP,1025) IREAD,RCHECK
      IREAD=2070
      DO 2075 I=1,NANIMS
 2070 READ(KR,1050)P1(I),P2(I)
 2075 IF(.NOT.SUAINP)WRITE(LP,1055)IREAD,P1(I),P2(I)
      IF (IR.EQ.0)IR=4
      DO 3000 I=1,NANIMS
 3000 FX15(I) = 0.0
      RETURN
      END
```

Subroutine FEEDNG

```
BIOME*DESERT2SYM(1).FEEDNG
      SUBROUTINE FEEDNG
C
C     'IFROM' IS A VECTOR OF POINTERS DESIGNATING THE SOURCE
C     COMPARTMENTS OF EACH OF A MAXIMUN OF 'IDIM' FEEDING FLOWS. 'ITO'
C     IS A VECTOR OF POINTERS DESIGNATING THE RECIPIENT COMPARTMENTS.
C     'PREF' IS AN ARRAY OF SCALING FACTORS,VARYING FROM ZERO TO ONE,
C     THAT INDICATE THE PREFERENCE FOR EACH FOOD SOURCE. THE FIRST 'NH'
C     ELEMENTS IN EACH VECTOR REPRESENT HERBIVORY, THE NEXT 'NG'
C     ELEMENTS REPRESENT GRANIVORY, THE NEXT 'NC' ELEMENTS REPRESENT
C     CARNIVORY AND THE NEXT 'ND' ELEMENTS REPRESENT DETRITIVORY. AT
C     PRESENT, FEEDING FLOWS DEPEND ON ONLY THE LEVELS OF THE RECIPIENT
C     COMPARTMENTS AND THE WEIGHTED LEVELS OF THE DONOR COMPARTMENTS.
C     EACH RELATIVE RATE OF FEEDING (RELATIVE TO THE LEVEL OF THE
C     RECIPIENT COMPARTMENT) EQUALS A MAXIMUM RELATIVE RATE MULTIPLIED
C     BY TWO SCALING FACTORS, VARYING FROM ZERO TO ONE, THAT ACCOUNT FOR
C     EXPLOITATION AND INTERFERENCE, RESPECTIVELY. THESE TWO FACTORS
C     ARE PIECE-WISE LINEAR FUNCTIONS OF THE LEVELS OF THE DONOR AND
C     RECIPIENT COMPARTMENTS, RESPECTIVELY.
C
      LOGICAL ERROR,PRINT,ANNUAL,HERB
      LOGICAL SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /ECHOCH/ SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     1        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCMPT
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     1        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
     1        PLACE(18),UNITS(8)
      COMMON /MISC/ ERROR,RCHECK(20),BLANK
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /CHANGE/ CVEGQQ(7,6,5),SEEDQQ(7,5),CBIOMQ(10,5),
     1        CLITQQ(3,5),CORGQQ(1,5),CMINQQ(1,2)
      COMMON/VEGCOM/IN,IW,IP,IR,IS,ILF,INS,IOS,IFR,IRT,LSOIL,
     1 ANNUAL(7),HERB(7),IPHENO(7),TISNEW(7),TIME(7),PHSATE,IZ,SEDFRA(7)
      COMMON/ANISAV/I,RSPIRD
      COMMON/FEESAV/IFROM(150),ITO(150),PREF(150),P1(8),P2(8),P3(8),
     1  P4(8),P5(8),NH,NG,NC,ND,SUM(5),NGG,NCC,NDD,NT
      COMMON /FLUX7/FX11(10),FX12(10),FX13(10),FX14(10)
      DATA SUBNAM/'FEED'/,IDIM/150/
C
      IF(IDAY.EQ.JDAY)GO TO 510
      IF(PRINT)WRITE(LP,10)
   10 FORMAT('0--* BEGINNING EXECUTION OF SUBROUTINE ''FEEDNG''')
C-----------------------------------------------------------------------
C     CALCULATE TOTAL FOOD AVAILABLE TO ANIMAL GROUP
C-----------------------------------------------------------------------
C
C     HERBIVORY
C
      FOOD=0.0
      IA=1
   20 IF (IA .GT. NH) GO TO 40
      IF (ITO(IA) - I) 35,30,40
   30 LQ=IFROM(IA)
      IQ=LQ/10
      JQ=LQ-IQ*10
      FOOD=FOOD+PDM(IQ,JQ)*PREF(IA)
   35 IA = IA + 1
      GO TO 20
   40 IA=NH+1
C
C     GRANIVORY
C
   50 IF (IA .GT. NGG) GO TO 80
      IF (ITO(IA)-I)70,60,80
   60 IF=IFROM(IA)
      FOOD=FOOD+SDM(IF)*PREF(IA)
   70 IA=IA+1
      GO TO 50
   80 IA=NGG+1
```

```
C
C     CARNIVORY
C
  100 IF (IA .GT. NCC) GO TO 130
      IF(ITO(IA)-I)120,110,130
  110 IF=IFROM(IA)
      FOOD=FOOD+ ADM(IF)*PREF(IA)
  120 IA=IA+1
      GO TO 100
  130 IA=NCC+1
C
C     DETRITIVORY
C
  150 IF (IA .GT. NT) GO TO 180
      IF(ITO(IA)-I)170,160,180
  160 IF=IFROM(IA)
      FOOD=FOOD+ DDM(IF)*PREF(IA)
  170 IA=IA+1
      GO TO 150
  180 CONTINUE
C ------------------------------------------------------------
C     CALCULATE RELATIVE FEEDING RATE AND AMOUNT OF DRY MATTER
C     INGESTED
C ------------------------------------------------------------
      IF (FOOD .LE. 0.0) GO TO 490
      F1=PWLPOS(P2(I),P3(I),1.0,FOOD)
      F2=PWLNEG(P4(I),P5(I),1.0,ADM(I))
      RFR=P1(I)*F1*F2
      AMT=RFR*ADM(I)
      FRAC=AMT/FOOD
      IF(PRINT)WRITE(LP,190)RFR,P1(I),F1,F2,AMT,FOOD,FRAC
  190 FORMAT ('0REL RATE,  MAX RATE,  FACTOR 1,  FACTOR 2,  DRY MATTER E
     1ATEN,  EFFECTIVE DRY MATTER AVAILABLE,  RATIO OF LAST 2 ITEMS'/
     2   7G15.5)
C ------------------------------------------------------------
C     DECREMENT FOOD COMPARTMENTS AND ACCUMULATE AMOUNT OF EACH
C     CHEMICAL CONSTITUENT INGESTED.
C ------------------------------------------------------------
      DO 200 K=1,NFRELM
  200 SUM(K)=0.0
C
C     HERBIVORY
C
      IA=1
  210 IF (IA .GT. NH) GO TO 240
      IF (ITO(IA) - I) 235,220,240
  220 LQ=IFROM(IA)
      IQ=LQ/10
      JQ=LQ-IQ*10
      DO 230 K=1,NFRELM
      Q=CVEG(IQ,JQ,K)*FRAC*PREF(IA)
      CVEGQQ(IQ,JQ,K)=CVEGQQ(IQ,JQ,K)-Q
      IF (K .GT. NELEMS) FX11(I) = FX11(I) + Q*ISTEP
      IF (K .GT. NELEMS) OENDOG(2) = OENDOG(2) + Q*ISTEP
  230 SUM(K)=SUM(K)+Q
  235 IA = IA + 1
      GO TO 210
  240 IA=NH+1
C
C     GRANIVORY
C
  250 IF (IA .GT. NGG) GO TO 290
      IF(ITO(IA)-I)280,260,290
  260 IF=IFROM(IA)
      DO 270 K=1,NFRELM
      Q = SEED(IF,K) * FRAC * PREF(IA)
      IF (K .GT. NELEMS) FX12(I) = FX12(I) + Q*ISTEP
      IF (K .GT. NELEMS) OENDOG(1) = OENDOG(1) + Q*ISTEP
  270 SEEDQQ(IF,K)=SEEDQQ(IF,K)-Q
  280 IA=IA+1
      GO TO 250
  290 IA=NGG+1
C
C     CARNIVORY
C
  310 IF (IA .GT. NCC) GO TO 350
      IF(ITO(IA)-I)340,320,350
  320 IF=IFROM(IA)
      DO 330 K=1,NFRELM
      Q = CBIOM(IF,K) * FRAC * PREF(IA)
      IF (K .GT. NELEMS) FX13(I) = FX13(I) + Q*ISTEP
  330 CBIOMQ(IF,K)=CBIOMQ(IF,K)-Q
  340 IA=IA+1
      GO TO 310
  350 IA=NCC+1
C
C     DETRITIVORY
C
  370 IF (IA .GT. NT) GO TO 410
      IF(ITO(IA)-I)400,380,410
  380 IF=IFROM(IA)
      DO 390 K=1,NFRELM
      Q = CLIT(IF,K) * FRAC * PREF(IA)
      IF (K .GT. NELEMS) FX14(I) = FX14(I) + Q*ISTEP
  390 CLITQQ(IF,K)=CLITQQ(IF,K)-Q
  400 IA=IA+1
      GO TO 370
  410 CONTINUE
      TC=0.0
      DO 420 K=NFRAC1,NFRELM
  420 TC=TC+SUM(K)
C
C     NOW ALLOCATE THE INGESTED MATERIAL TO EACH OF THE CHEMICAL
C     CONSTITUENTS. FIRST ALLOCATE TO LABILE CARBON AS MUCH AS WAS
C     RESPIRED. THE REMAINDER, IF ANY, IS ALLOCATED TO CARBON TYPES
C     ACCORDING TO THE RATIOS IN THE 'ARATIO' MATRIX. (RESPIRATION
C     MODEL MUST BE CALLED BEFORE THE FEEDING MODEL.)
C
      Q=TC-RSPIRD
      IF(Q)430,430,440
  430 CBIOMQ(I,IR)=CBIOMQ(I,IR)+TC
      GO TO 470
  440 CBIOMQ(I,IR)=CBIOMQ(I,IR)+RSPIRD
      DO 450 K=NFRAC1,NFRELM
  450 CBIOMQ(I,K)=CBIOMQ(I,K)+Q*ARATIO(I,K)
      DO 460 K=1,NELEMS
      T=Q*ARATIO(I,K)
      SUM(K)=SUM(K)-T
  460 CBIOMQ(I,K)=CBIOMQ(I,K)+T
  470 CONTINUE
      IF (PRINT) WRITE (LP,475) SUM
  475 FORMAT (T7,'SUM(*)=',5G13.5)
      DO 480 K=1,NELEMS
  480 CLITQQ(1,K) = CLITQQ(1,K) + AMAX1(0.0,SUM(K))
      RETURN
C------------------------------------------------------------
C     NO AVAILABLE 'EFFECTIVE FOOD'
C------------------------------------------------------------
  490 IF (PRINT) WRITE (LP,500)
  500 FORMAT('0NO AVAILABLE EFFECTIVE FOOD')
      RETURN
C ------------------------------------------------------------
C     INPUT AND INITIALIZATION
C ------------------------------------------------------------
  510 IF(.NOT.SUAINP)WRITE(LP,520)
  520 FORMAT('0---* BEGINNING READING OF INPUT TO SUBROUTINE FEEDNG')
  530 FORMAT(20A4)
  540 FORMAT(T7,I5,' FEEDNG',4X,20A4)
  550 FORMAT(14I5)
  560 FORMAT(T7,I5,' FEEDNG',14I8)
  590 FORMAT(7F10.0)
  600 FORMAT(T7,I5,' FEEDNG',7F16.5)
C
      IREAD=610
  610 READ(KR,530)RCHECK
      IF(.NOT.SUAINP)WRITE(LP,540)IREAD,RCHECK
      IF(RCHECK(1).NE.SUBNAM)GO TO 610
C
      IREAD=620
  620 READ (KR,530)RCHECK
      IF(.NOT.SUAINP)WRITE(LP,540)IREAD,RCHECK
      IREAD=630
      DO 640 I=1,NANIMS
  630 READ(KR,590)P1(I),P2(I),P3(I),P4(I),P5(I)
  640 IF(.NOT.SUAINP)WRITE(LP,600)IREAD,P1(I),P2(I),P3(I),P4(I),P5(I)
C
      IREAD=650
  650 READ(KR,530)RCHECK
      IF(.NOT.SUAINP)WRITE(LP,540)IREAD,RCHECK
      IREAD=660
  660 READ(KR,550)NH,NG,NC,ND
      IF(.NOT.SUAINP)WRITE(LP,560)IREAD,NH,NG,NC,ND
      NGG=NH+NG
      NCC=NGG+NC
      NDD=NCC+ND
      NT=NH+NG+NC+ND
      LIMIT = 10*NPLNTS + NORGAN
C
      IREAD=670
  670 READ(KR,530)RCHECK
      IF(.NOT.SUAINP)WRITE(LP,540)IREAD,RCHECK
      IREAD=680
      DO 690 I=1,NT
  680 READ(KR,700)ITO(I),IFROM(I),PREF(I)
      IF(.NOT.SUAINP)WRITE(LP,710)IREAD,ITO(I),IFROM(I),PREF(I)
      IF (ITO(I).GE.1 .AND. ITO(I).LE.NANIMS) GO TO 682
      ERROR = .TRUE.
      WRITE (LP,681)
  681 FORMAT (' =*=*=*=  ERROR  =*=*=*=  ITO VALUE IS OUT OF BOUNDS')
  682 IF (I .GT. NH) GO TO 684
      IF (IFROM(I).GE.10 .AND. IFROM(I).LE.LIMIT) GO TO 684
      ERROR = .TRUE.
      WRITE (LP,683)
  683 FORMAT (' =*=*=*=  ERROR  =*=*=*=  IFROM VALUE IS OUT OF BOUNDS')
  684 IF (I .LE. NH .OR. I .GT. NGG) GO TO 686
      IF (IFROM(I) .GE. 1 .AND. IFROM(I) .LE. NPLNTS) GO TO 686
      ERROR = .TRUE.
      WRITE (LP,683)
  686 IF (I .LE. NGG .OR. I .GT. NCC) GO TO 688
      IF (IFROM(I) .GE. 1 .AND. IFROM(I) .LE. NANIMS) GO TO 688
      ERROR = .TRUE.
      WRITE (LP,683)
  688 IF (I .LE. NCC) GO TO 690
      IF (IFROM(I) .GE. 1 .AND. IFROM(I) .LE. NOLIT) GO TO 690
      ERROR = .TRUE.
      WRITE (LP,683)
  690 CONTINUE
  700 FORMAT(2I5,F10.0)
  710 FORMAT(T7,I5,' FEEDNG',2I8,F16.5)
      IF (NT .LE. IDIM) GO TO 750
      ERROR = .TRUE.
      WRITE (LP,740) IDIM
  740 FORMAT (' =*=*=*=  ERROR  =*=*=*=  NUMBER OF FEEDING FLOWS EXCEEDS
     - LIMIT OF',I5)
  750 CONTINUE
      DO 800 I=1,NANIMS
      FX11(I) = 0.0
      FX12(I) = 0.0
      FX13(I) = 0.0
  800 FX14(I) = 0.0
      RETURN
      END
```

Subroutine MANAGE

```
BIOME*DESERT2SYM(1).MANAGE
      SUBROUTINE MANAGE
C
      LOGICAL ERROR,PRINT
      LOGICAL SUMINP,SUVINP,SUATNP,SUSTNP
      COMMON /ECHOCH/ SUMINP,SUVINP,SUATNP,SUSTNP
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
     -        PLACE(18),UNITS(8)
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     -        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCMPT
      COMMON /MISC/ ERROR,RCHECK(20),BLANK
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),CRATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /MANSAV/ NMOVE,IMOVE,MOVDAT(15),IGROUP(15),XNUM(15),DW(15)
      DIMENSION Q2(5)
      DATA SUBNAM/'MANA'/
      DATA MDIM/15/
C
C
      IF (IDAY.EQ.JDAY) GO TO 1000
   10 IF (IDAY.LT.MOVDAT(IMOVE)) GO TO 900
      L = IGROUP(IMOVE)
      F = XNUM(IMOVE)
      G = DW(IMOVE) * POP(L)
      IF (G .EQ. 0.0) G = ADM(L) / POP(L)
      IF (F .LT. 0.0 .AND. G .GT. 0.0) G = -G
      POP(L) = POP(L) + F
      DO 100 K=1,NFRELM
      Q2(K) = G * 0.4 * ARATIO(L,K)
  100 CBIOM(L,K) = CBIOM(L,K) + Q2(K)
      WRITE (LP,110) MDAY,XMONTH(MONTH), IYR, IGROUP(L), XNUM(L),
     -    DW(L), G, (Q2(K), K=1,NFRELM)
  110 FORMAT ('0HERD MANAGEMENT EVEN', I5,A4,I5,5X,'ANIMAL GROUP',I2,
     - 5X,'NUMBER PER AREA =', F10.3, 5X,'MEAN WEIGHT PER ANIMAL=',
     -  5X,'TOTAL WEIGHT PER AREA =', F10.3/
     - ' TOTAL ADDED TO EACH CHEMICAL CONSTITUENT =', 5F12.5)
      IMOVE = IMOVE + 1
      GO TO 10
  900 RETURN
C------------------------------------------------------------
```

```
C      READ INPUT
C-----------------------------------------------------------------------
 1000 CONTINUE
      IF(.NOT.SUAINP)WRITE(LP,1010)
 1010 FORMAT('0--* BEGINNING READING OF INPUT TO SUBROUTINE MANAGE')
 1020 FORMAT(20A4)
 1025 FORMAT(T7,I5,' MANAGE',4X,20A4)
 1030 FORMAT (16I5)
 1035 FORMAT (T7,I5,' MANAGE',4X,16I5)
 1040 FORMAT (I2, 1X, A3, 1X, I4, I9, 2F10.0)
 1045 FORMAT (T7,I5,' MANAGE',I2,1X,A3,1X,I4,I9,2F12.2)
C
      IREAD=2020
 2020 READ(KR,1020)RCHECK
      IF(.NOT.SUAINP)WRITE(LP,1025)IREAD,RCHECK
      IF(RCHECK(1).NE.SUBNAM)GO TO 2020
C
      IREAD = 2040
 2040 READ(KR,1020)RCHECK
      IF (.NOT.SUAINP) WRITE (LP,1025) IREAD,RCHECK
      IREAD = 2050
 2050 READ (KR,1030) NMOVE
      IF (.NOT. SUAINP) WRITE (LP,1035) IREAD, NMOVE
      IF (NMOVE .LE. 0) GO TO 3000
      IF (NMOVE .LE. MDIM) GO TO 2055
      ERROR = .TRUE.
      WRITE (LP,2053)
 2053 FORMAT ('*=*=*=*   ERROR   =*=*=*=   NUMBER OF ANIMAL MOVEMENTS EX
     -CEEDS MAXIMUM NUMBER ALLOWED')
 2055 CONTINUE
C
      IREAD = 2060
 2060 READ (KR,1020) RCHECK
      IF (.NOT. SUAINP) WRITE (LP,1025) IREAD,RCHECK
      IREAD = 2070
      DO 2080 I=1,NMOVE
 2070 READ (KR,1040) I7,A8,I9,IGROUP(I),XNUM(I),DW(I)
      IF(.NOT.SUAINP)WRITE(LP,1045)IREAD,I7,A8,I9,IGROUP(I),XNUM(I),DW(I
     -)
      DO 2071 M=1,12
      IF (A8 .EQ. XMONTH(M)) GO TO 2072
 2071 CONTINUE
 2072 MOVDAT(I) = (I9-JYR)*360 + (M-1)*30 + I7
 2080 CONTINUE
      IMOVE = 1
      DO 2090 I=1,NMOVE
      IF (MOVDAT(I) .LE. JDAY) GO TO 2085
      GO TO 3000
 2085 IMOVE = IMOVE + 1
 2090 CONTINUE
 3000 CONTINUE
      RETURN
      END
```

Subroutine SOILSS

```
BIOME*DESERT2SYM(1).SOILSS
      SUBROUTINE SOILSS
C
C      PMN = NO. OF NODES
C      PMDT = LENGTH OF TIME-STEP IN DAYS
C
C
      LOGICAL SUMINP,SUVINP,SUATNP,SUSINP
      LOGICAL ERROR,PRINT
      REAL MMINPR
      INTEGER PMN
      COMMON /ECHOCH/ SUMINP,SUVINP,SUATNP,SUSINP
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     -        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCMPT
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
     -        PLACE(18),UNITS(8)
      COMMON /MISC/ ERROR,RCHECK(20),BLANK
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /VTHRV/ DATMIN,DATMAX,DARAIN,DAEVAP,DAPHOT
      COMMON /SOLCOM/ PMN,CHD(8),CHDX(8),CHDXX(8),CWPSI(6),XHSOLT(8)
      COMMON/WATSAV/PWWC(8),PWK(8),TWA(8),TWB(8),TWC(8),TWD(8),
     1  TWTHA(8),TWTHB(8),TWHA(8),TWHB(8),TWWA(8),TWWB(8),PWKIN(60),
     2  PWH(60),PWKSUM(60),PWT(60),TWU(8),           TWTSPR(8),TWKSA(8),
     3  TWHHA(8),TWDTHP(8),TWTHAA(8),TWTHTS(8),TWAAA(8),LL(8),TWTA(8),
     4 TWTM(8),TWDT,TWTRN,TWTTOT,Y,Z,TWEVAP,TWR,TWRAIN,TWRP,TWSTND
     5, TWDTP,R,PWTLIM,S,T,J,TWJM,TW,TWSF,TWTK,PWLLIM,TGONE,PWM,TWJA,
     6  PWDELW,TWAA,TWTHC,TWJB,PWHWET,PWHDRY,TWSFC,TWIN,TWSFD,TWDTO,
     7  TWMIN,TWSTRO,PWRNRF,PWKCAL,TWI,ZPINT,XWSTND,CWINF
      COMMON /VTOWAT/ CVRDST(7,8),CVTSPR(7)
      COMMON /WATSA2/ RSFCUM,TWCUM,STDCUM,VAPCUM
      COMMON /SAVWIP/ MMINPR
      DATA SUBNAM/'SOIL'/
C
C
      IF (IDAY.EQ.JDAY) GO TO 1000
      IF (PRINT) WRITE (LP,20)
   20 FORMAT('0',100('*')/' BEGINNING EXECUTION OF SOIL SUBROUTINES'/
     -  1X,100('*'))
      IF (NHORIZ .EQ. 0) GO TO 100
      CALL SLHEAT
      CALL SLWATR
C      COMPUTE MM OF WATER IN THE SOIL PROFILE
   30 SUM = 0.0
      DO 40 I=1,NHORIZ
      T = HORDEP(1)
      IF (I.GT.1) T = HORDEP(I) - HORDEP(I-1)
      A = SWPH(I)
      DO 10 J=2,PWM
      B2 = PWH(J)
      IF (A .LE. B2) GO TO 15
   10 CONTINUE
   15 B1 = PWH(J-1)
C      'V' IS THE VOLUMETRIC WATER CONTENT
      V = (A-B1) / (B2-B1) * PWDELW + (J-2) * PWDELW
C      'T' * 10. IS DEPTH OF SOIL LAYER IN MM
   40 SUM = SUM + V * T * 10.0
      Q1 = SUM * 0.1
      Q2 = (SUM - MMINPR) * 0.1
      IF (PRINT .OR. IDAY .EQ. KDAY) WRITE (LP,45) Q1, Q2
   45 FORMAT (T16, 'WATER IN SOIL PROFILE', T81, F8.3/
     - T16, 'CHANGE IN PROFILE', T81, F8.3)
      OWATER(7) = SUM
      DUMMYS(1) = SUM
C      OWATER(4) = MMINPR + OWATER(1) - OWATER(3) - OWATER(7)
C      OWATER(4), I.E. EVAPORATION, IS NOW ASSIGNED A VALUE IN SLWATER
      DUMMYS(2) = OWATER(4)
      IF (IDAY .GT. JDAY) GO TO 80
      MMINPR = SUM
      WRITE (LP,60) SUM
   60 FORMAT ('0',T20,'MM OF WATER IN SOIL PROFILE AT START OF SIMULATIO
     -N =', F8.1)
      OWATER(4) = 0.0
      DUMMYS(2) = 0.0
      GO TO 1070
   80 CONTINUE
  100 CONTINUE
      IF(NOLIT.GT.0 .OR. NSCMPT.GT.0)CALL DCOMPO
      RETURN
C-----------------------------------------------------------------------
C      INPUT AND INITIALIZATION
C-----------------------------------------------------------------------
 1000 IF(.NOT.SUSINP)WRITE (LP,1010)
 1010 FORMAT ('0',100('-')/' BEGINNING READING OF INPUT TO SOIL SUBROUTI
     -NES'/' ',100('-'))
 1020 FORMAT(20A4)
 1025 FORMAT (T7,I5,' SOILSS',4X,20A4)
      IREAD = 1060
 1060 READ(KR,1020)RCHECK
      IF(.NOT.SUSINP)WRITE(LP,1025)IREAD,RCHECK
      IF(RCHECK(1).NE.SUBNAM) GO TO 1060
      WRITE (LP,1065) ERROR
 1065 FORMAT (' ERROR = ', L1)
      IF(NHORIZ.GT.0)CALL SLHEAT
      WRITE (LP,1065) ERROR
      IF(NHORIZ.GT.0)CALL SLWATR
      WRITE (LP,1065) ERROR
      GO TO 30
 1070 CONTINUE
      IF(NOLIT.GT.0 .OR. NSCMPT.GT.0)CALL DCOMPO
      WRITE (LP,1065) ERROR
      RETURN
      END
```

Subroutine SLHEAT

```
BIOME*DESERT2SYM(1).SLHEAT
      SUBROUTINE SLHEAT
C
C   THIS IS THE FIRST DRAFT OF THE HEAT SUBMODEL OF THE DESERT
C   BIOME BOX ELDER MODEL.   JUNE 7, 1974  PAUL LOMMEN
C
C
C   THIS PROGRAM IS JUST AS IT WAS RUN IN GENERATING OUTPUT FOR THE
C   DESERT BIOME INFORMATIONAL MEETING, MARCH, 1975.
C   WRITTEN BY   PAUL W. LOMMEN
C                DESERT BIOME - ECOLOGY CENTER  UMC 52
C                UTAH STATE UNIVERSITY
C                LOGAN, UTAH 84322
C
C      MODIFIED BY W. D. VALENTINE FOR INCLUSION INTO 'DESERT2',
C     SUMMER 1975
C
C   FOR THIS FIRST DRAFT THE FOLLOWING SIMPLIFICATIONS ARE MADE.
C
C   ONE, FOR SOIL SURFACE TEMPERATURE I'LL USE THE MEAN DAILY TEMPERATURE
C   OR HAVE A MEASURED OR SIMULATED TEMPERATURE READ IN.  IF DESIRED AN
C   ENERGY BALANCE APPROACH MIGHT BE BETTER, ALTHOUGH  R. J. HANKS
C   THOUGHT THAT WOULD BE PRETTY HAIRY AND HENCE PROBABLY NOT WORTHWHILE
C   FOR US (REF.  W.A. BECKMAN, J.W. MITCHELL, AND W.P. PORTER, 1973,
C   THERMAL MODEL FOR PREDICTION OF A DESERT IGUANA'S DAILY AND SEASONAL
C   BEHAVIOR, TRANS. ASME, SERIES C 95, 257-262.)
C
C   TWO, FOR THERMAL DIFFUSIVITY I'LL ASSUME IT'S INDEPENDENT OF WATER
C   CONTENT.  BOTH HEAT CONDUCTIVITY AND HEAT CAPACITY HAVE A DEPENDENCE
C   ON WATER CONTENT BUT DIFFUSIVITY, THEIR RATIO HAS ONLY A WEAK WATER
C   DEPENDENCE (R. J. HANKS , PERSONAL COMMUNICATIONS 5-24-74).
C   IF DESIRED WE CAN INCLUDE WATER AS IN  R.J. HANKS, D.D. AUSTIN,
C   AND W.T. ONDRECHEN, SOIL TEMPERATURE ESTIMATION BY A NUMERICAL
C   METHOD, SOIL SCI. SOC. AM. PROC. 1971 ORMAYBE 1970.    THEY GIVE A
C   SIMPLE RELATIONSHIP BETWEEN HEAT CAPACITY AND WATER CONTENT.
C   FOR HEAT CONDUCTIVITY THEY USE METHOD OF DE VRIES, D.A., 1963,
C   THERMAL PROPERTIES OF SOILS. CHAPTER 7 IN   PHYSICS OF PLANT
C   ENVIRONMENT, ED. BY VAN WIJK. JOHN WILEY AND SONS, INC., NEW YORK.
C
C   THREE, FOR THE BOTTOM BOUNDARY CONDITION, I'LL SAY FOR NOW THAT THE
C   SOIL TEMPERATURE AT 60 CM  EQUALS THE MEAN MONTHLY AIR TEMPERATURE AT
C   2M (MITCHELL ET AL., OP. CIT., AND DE VRIES, OP. CIT.).
C
C   THE PROGRAM IS TAKEN PRETTY MUCH FROM    R.J. HANKS, D.D. AUSTIN,
C   AND W.T. ONDRECHEN, 1971, SOIL TEMPERATURE ESTIMATION BY A NUMERICAL
C   METHOD.   SOIL SCI. SOC. AM. PROC. 35, 665.
C   OCCASIONAL INSPIRATION IS TAKEN FROM   HANKS, R.J., AND S.A.
C   BOWERS. 1962. NUMERICAL SOLUTION OF THE MOISTURE FLOW EQUATION FOR
C   INFILTRATION IN LAYERED SOILS.  SOIL SCI. SOC. AMER. PROC. 26,530-534
C   THE FINAL PRODUCT IS CONCEPTUALLY ALMOST THE SAME AS THE TEMPERATURE
C   SECTION OF  R.A. GRIFFIN, R.J. HANKS, AND S. CHILDS, 1973, MODEL
C   FOR ESTIMATING WATER, SALT, AND TEMPERATURE DISTRIBUTION IN THE SOIL
C   PROFILE, US/IBP DESERT BIOME PROGRAM PUBLICATION  USU, LOGAN, UTAH.
C
C   THIS ROUTINE MUST BE CALLED AFTER THE WATER SUBROUTINE IF A THETA
C   DEPENDENCE ON DIFFUSIVITY IS TO BE INCLUDED.
C   6-7-74  THIS DEPENDENCE IS NOT NOW INCLUDED
C
C   6-7-74  FOR NOW THE TEMPERATURE OF THE WATER MOVING BETWEEN LAYERS
C   IS NOT CONSIDERED IN THE TEMPERATURE OF THE LAYER.  NO VAPORIZATION
C   OR CONDENSATION EFFECTS ARE INCLUDED EITHER.
C
C   DON AND I HAVE TO DECIDE SOMETHING ABOUT ZHAIRT.  TILL THEN I'LL
C   INCLUDE SEPARATE DIMENSION STATEMENT
C
C
C
      INTEGER PMN, THM
      LOGICAL ERROR,PRINT
      LOGICAL SUMINP,SUVINP,SUATNP,SUSINP
      COMMON /ECHOCH/ SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     -        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCMPT
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
     -        PLACE(18),UNITS(8)
      COMMON /MISC/ ERROR,RCHECK(20),BLANK
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
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     -   NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A   ALINAM(3,5)
      COMMON /WTHRV/ DATMIN,DATMAX,DARAIN,DAEVAP,DAPHOT
      COMMON /HEASAV/ ZHAIRT(31),PHCV(8),PHK(8),THTA(8),THTB(8),THA(8),
     -         THB(8),THC(8),THD(8),THU(8),THM,TH,THMR,THTHA(8),THTHB(8)
      COMMON /SOLCOM/ PMN,CHD(8),CHDX(8),CHDXX(8),CWPSI(6),XHSOLT(8)
      DATA NDIM/8/, SUBNAM/'HEAT'/
C
C
      ZAIRT = (DATMAX + DATMIN) * 0.5
      PMDT = ISTEP
      PMJDAT = IYRDAY
      IF (IDAY .EQ. JDAY) GO TO 1000
    5 IF (PRINT) WRITE (LP,10)
   10 FORMAT('0---* EXECUTING SUBROUTINE SLHEAT')
      JPMN = PMN-1
      KPMN = PMN-2
C--------------------------------------------------------------------
C  INITIALIZE TEMPERATURES
C  SET THE TEMPERATURES CALCULATED  LAST TIME STEP (OR JUST READ IN)
C  EQUAL TO THTA(.),  THE TEMPERATURE AT THE BEGINNING OF THE TIME STEP
C     THTA = TEMP OF NODE AT END OF TIME STEP
C     THTB = TEMP OF NODE AT END OF TIME STEP
C--------------------------------------------------------------------
   14 DO 16 I = 1, PMN
   16 THTA(I) = THTB(I)
C  6-7-74  ASSUME FOR NOW THAT SURFACE TEMPERATURE EQUALS ZAIRT
   17 THTB(1) = ZAIRT
C  6-7-74  ASSUME TEMPERATURE AT 60 CM IS AVERAGE AIR TEMPERATURE FOR
C  THIRTY PREVIOUS DAYS
C  ZHAIRT IS THE ARRAY WHICH HOLDS THE LAST 30 DAYS OF AIR TEMPS
      LMN = THM-1
      DO 18 I=1,LMN
   18 ZHAIRT(I) = ZHAIRT(I+1)
      ZHAIRT(THM) = ZAIRT
      TH =0.
      DO 20 I = 1, THM
   20 TH = TH + ZHAIRT(I)
      THMR = THM
      THTB(PMN) = TH / THMR
C--------------------------------------------------------------------
C  IF A WATER CONTENT DEPENDENCE ON SPECIFIC HEAT AND THERMAL
C  CONDUCTIVITY IS TO BE INCLUDED SOMEDAY IT CAN GO IN HERE
C  CV WILL HAVE TO BE AN AVERAGE OVER DT
C  FOR K WILL NEED VALUES AT BEGINNING AND END OF DT
C  HERE ARE THE MAIN EQUATIONS
C--------------------------------------------------------------------
   28 DO 30 I=1,KPMN
   30 THD(I) = THTA(I) * THTHA(I) + THTA(I+1) *
     *  (THTHB(I) - THTHA(I) - THTHA(I+1) ) + THTA(I+2) * THTHA(I+1)
C  NOW THE FIRST AND LAST EQUATIONS NEED TOUCHING UP.
      THD(1) = THD(1) + THTB(1) * THTHA(1)
      THD(PMN-2) = THD(PMN-2) + THTB(PMN) * THTHA(PMN-1)
C--------------------------------------------------------------------
C  NOW CALL TRIDIM TO GET THOSE PMN-2 TEMPERATURES
C--------------------------------------------------------------------
      CALL TRIDIM(THA, THB, THC, THD, THU, PMN-2)
C--------------------------------------------------------------------
C  NOW LOAD THTB AND XHSOLT
C--------------------------------------------------------------------
      DO 32 I=1,KPMN
   32 THTB(I+1) = THU(I)
C  6-7-74  FOLLOWING CALCULATION MAKES XHSOLT THE AVERAGE TEMPERATURE
C  OF THE NODE DURING PMDT
      DO 34 I=1,PMN
   34 XHSOLT(I) = (THTA(I) + THTB(I)) / 2.
C
      DO 60 I=1,NHORIZ
   60 STH(I) = XHSOLT(I+1)
C
      IF (PRINT) WRITE (LP,F80) XHSOLT
  F80 FORMAT ('0SOIL TEMPERATURES=',10F6.2)
      RETURN
C--------------------------------------------------------------------
C     INPUT AND INITIALIZATION
C--------------------------------------------------------------------
 1000 IF(.NOT.SUSINP) WRITE(LP,1001)
 1001 FORMAT('0---* BEGINNING READING OF INPUT TO SUBROUTINE SLHEAT')
      IREAD=1010
 1010 READ(KR,1020)RCHECK
      IF(.NOT.SUSINP)WRITE(LP,1030)IREAD,RCHECK
      IF(RCHECK(1).NE.SUBNAM)GO TO 1010
 1020 FORMAT(20A4)
 1030 FORMAT(T7,I5,' SLHEAT',4X,20A4)
 1040 FORMAT(7F10.0)
 1050 FORMAT(T7,I5,' SLHEAT',7F16.5,10(/T17,7F16.5))
C
C     NODES OCCUR AT THE MIDDLE OF EVERY HORIZON AND AT THE TOP OF THE
C     FIRST HORIZON AND THE BOTTOM OF THE BOTTOM HORIZON.
C
C     THERE ARE 3 TERMS OF INTEREST= NODES, REGIONS BETWEEN NODES, AND
C     LAYERS SURROUNDING THE INTERNAL NODES
C
C     PMN = NUMBER OF NODES
C     PMN-1 = NUMBER OF REGIONS
C     PMN-2 = NUMBER OF LAYERS
C
C     WATER POTENTIAL (CWPSI) IS CALCULATED AT THE (PMN-2) INTERNAL
C     NODES, AND THESE VALUES ARE TAKEN AS THE MEAN VALUES FOR THE
C     (PMN-2) LAYERS.  TEMPERATURES (XHSOLT) ARE CALCULATED AT EVERY
C     NODE.
C
C     REGIONS= CONDUCTIVITIES
C     LAYERS= SPECIFIC HEAT, WATER REMOVAL, WATER CONTENT, WATER POTENT.
C
C     CHD=DEPTHS TO NODES        (PMN VALUES)
C     CHDX=THICKNESSES OF LAYERS AROUND EACH NODE (PMN-2 VALUES)
C     CHDXX=DISTANCES BETWEEN NODES  (PMN-1 VALUES)
      PMN=NHORIZ+2
      JPMN = PMN-1
      KPMN = PMN-2
      CHD(1)=0.0
      CHD(2)=(HORDEP(1)-1.0)/2.0+1.0
      CHD(PMN)=(HORDEP(NHORIZ)-HORDEP(NHORIZ-1))/2.0+HORDEP(NHORIZ)
      JKL = NHORIZ-1
      DO 3000 I=1,JKL
      Q=HORDEP(I)
      CHD(I+2)=(HORDEP(I+1)-Q)/2.0+Q
 3000 CHDX(I+1)=HORDEP(I+1)-HORDEP(I)
      CHDX(1)=(HORDEP(1)-CHD(2))*2
      DO 3005 I=1,JPMN
 3005 CHDXX(I)=CHD(I+1)-CHD(I)
      IF(.NOT.PRINT)GO TO 3010
      WRITE(LP,3006) (HORDEP(I),I=1,NHORIZ)
      WRITE(LP,3007) (CHD(I),I=1,PMN)
      WRITE(LP,3008) (CHDX(I),I=1,KPMN)
      WRITE(LP,3009) (CHDXX(I),I=1,JPMN)
 3006 FORMAT (T23,'HORDEP =',10F10.2)
 3007 FORMAT (T23,'CHD    =',10F10.2)
 3008 FORMAT (T23,'CHDX   =',10F10.2)
 3009 FORMAT (T23,'CHDXX  =',10F10.2)
      WRITE (LP,4009)
 4009 FORMAT (T30,'HORDEP = DEPTHS OF BOTTOM SURFACES OF SOIL LAYERS'/
     -        T30,'CHD    = DEPTHS TO NODES'/
     -        T30,'CHDX   = THICKNESSES OF LAYERS AROUND EACH NODE'/
     -        T30,'CHDXX  = DISTANCES BETWEEN NODES')
 3010 CONTINUE
C
C     READ SPECIFIC HEATS FOR EACH OF THE (PMN-2) SOIL LAYERS
C     SURROUNDING INNER NODES
      IREAD=2100
 2100 READ(KR,1020)RCHECK
      IF(.NOT.SUSINP)WRITE(LP,1030)IREAD,RCHECK
      IREAD=2105
 2105 READ(KR,1040)(PHCV(I),I=1,NHORIZ)
      IF(.NOT.SUSINP)WRITE(LP,1050)IREAD,(PHCV(I),I=1,NHORIZ)
C
C     READ CONDUCTIVITIES OF EACH OF THE (PMN-1) REGIONS BETWEEN NODES
      IREAD=2110
 2110 READ(KR,1020)RCHECK
      IF(.NOT.SUSINP)WRITE(LP,1030)IREAD,RCHECK
      IREAD=2120
 2120 READ (KR,1040) (PHK(I),I=1,JPMN)
      IF(.NOT.SUSINP)WRITE (LP,1050) IREAD,(PHK(I),I=1,JPMN)
C
C     READ INITIAL SOIL TEMPERATURES AT EACH OF THE PMN NODES
      IREAD=2130
 2130 READ(KR,1020)RCHECK
      IF(.NOT.SUSINP)WRITE(LP,1030)IREAD,RCHECK
      IREAD=2140
 2140 READ(KR,1040)(XHSOLT(I),I=1,PMN)
      IF(.NOT.SUSINP)WRITE(LP,1050)IREAD,(XHSOLT(I),I=1,PMN)
C
C     READ PREVIOUS 31 DAYS OF AIR TEMPES.
C     IREAD=2150
C2150 READ(KR,1020)RCHECK
C     IF(.NOT.SUSINP)WRITE(LP,1030)IREAD,RCHECK
C     IREAD=2160
C2160 READ(KR,1040)ZHAIRT
C     IF(.NOT.SUSINP)WRITE(LP,1050)IREAD,ZHAIRT
C     USE CURRENT TEMP AS VALUE OF AIR TEMP FOR LAST 30 DAYS
      DO 2170 K=1,31
 2170 ZHAIRT(K) = ZAIRT
C
C     PERFORM OTHER INITIALIZATIONS
C
      DO 120 I=1,PMN
  120 THTA(I)=XHSOLT(I)
C     THM IS THE CLOSEST INTEGER TO THE NO. OF TIME STEPS IN 30 DAYS
      THM=31./PMDT
C     SINCE NO THETA DEPENDENCE ON CV OR K INCLUDED, THESE
C     CALCULATIONS HAVE TO BE MADE ONLY ONCE
      DO 140 I=1,JPMN
      THTHA(I)=PHK(I)/CHDXX(I)
  140 THTHB(I)=2.*PHCV(I)*CHDX(I)/PMDT
C     PHCV(PMN-1) AND CHDX(PMN-1) ARE NOT USED SO CAN JUST LOAD
C     ZEROES IN
      DO 160 I=1,KPMN
      THA(I)=THTHA(I+1)
      THB(I)=THTHB(I)+THTHA(I)+THTHA(I+1)
  160 THC(I)=THTHA(I)
      THA(PMN-2)=0.
      THC(1)=0.
C     END OF EQUATIONS WHICH CAN BE CALCULATED ONLY ONCE IF NO
C     THETA DEPENDENCE IS INCLUDED IN CV OR K
      DO 170 I=1,PMN
  170 THTB(I)=XHSOLT(I)
      DO 175 I=1,NHORIZ
  175 STH(I) = XHSOLT(I+1)
      RETURN
      END
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Subroutine SLWATR

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BIOME*DESERT2SYM(1).SLWATR
      SUBROUTINE SLWATR
C
C  THIRD EDITION OF SUBROUTINE WATER FOR BOXELDER, 12-13-74 PAUL LOMMEN
C
C  WRITTEN BY    PAUL W. LOMMEN
C                DESERT BIOME - ECOLOGY CENTER  UMC 52
C                UTAH STATE UNIVERSITY
C                LOGAN, UTAH 84322
C
C  THIS PROGRAM IS JUST AS IT WAS RUN IN GENERATING OUTPUT FOR THE
C  DESERT BIOME INFORMATIONAL MEETING, MARCH, 1975, EXCEPT FOR
C  EXTENSIVE COSMETIC CHANGES MADE BY W. D. VALENTINE FOR INCLUSION
C  OF THE SUBROUTINE INTO THE 'DESERT2' SIMULATOR
C
C  CHD(10)     DEPTHS, CM, OF NODES BELOW SURFACE (A NODE IS A POINT
C              WHERE A WATER POTENTIAL IS CALCULATED) STARTING AT SURFACE
C  CHDX(10)    THICKNESS OF REGION CENTERED ON NODE WHERE COUNTING
C              STARTS AT FIRST NODE BELOW SURFACE AND GOES DOWN
C  CHDXX(10)   CHDXX(I)=CHD(I+1) - CHD(I)
C  CVTSPR(I)   KG/HA OF TRANSPIRATION WATER REQUESTED BY PLANT MODEL FOR
C              I'TH PLANT GROUP.
C  CWINF       NET SURFACE FLUX (IN CM) DURING PMDT, NOT INCLUDING
C              TRANSPIRATION
C  CWPSI(10)   SOIL WATER POTENTIAL, BARS, VALUE AT END OF PMDT
C  PMDT        TIME STEP DETERMINED IN MAIN, DAYS
C  PMN         NUMBER OF NODES, SAME AS NUMBER OF NODES IN HEAT,
C              COUNTING STARTS AT SURFACE
C  PWDELW      INCREMENT IN VWC, TYPICALLY 0.01-0.02
C  PWH(60)     TABLE OF HYDRAULIC PRESSURE HEAD VERSUS THETA, BARS,
C              USING SAME THETA SCALE AND SPACING AS PWKIN
C  PWHDRY      ALLOWABLE LOW PRESSURE LIMIT FOR ANY LAYER
C  PWHWET      ALLOWABLE HIGH PRESSURE LIMIT FOR ANY LAYER
C  PWK(10)     HYDRAULIC CONDUCTIVITY, CM2 BAR-1 DAY-1, PWK(I) IS
C              CONDUCTIVITY AVERAGED OVER TWDT, IN REGION BETWEEN NODES
C              I AND I+1, WHERE COUNTING STARTS AT SURFACE.
C  PWKCAL      CONDUCTIVITY OF CALICHE LAYER
C  PWKIN(60)   TABLE OF CONDUCTIVITY VERSUS THETA, CM2 BAR-1 DAY-1,
C              STARTING WITH VALUE AT THETA = 0.0,  READ IN IN WINIT.
C  PWKSUM(60)  ARRAY USED TO CALCULATE AVERAGE K, (CM-BARS)/DAY
C  PWLLTM      LOWER LIMIT OF THETA, DIMENSIONLESS
C              CALCULATED IN WINIT AND = SUM OF CONDUCTIVITY X DELTA H
C  PWM         NUMBER OF ENTRIES IN CONDUCTIVITY AND PRESURE TABLES
C  PWRNRF      RUNON TO RUNOFF RATIO PER DAY
C  PWT(60)     ARRAY CONTAINING UNIFORMLY DISTRIBUTED VALUES OF THETA
C  PWTLIM      LARGEST CHANGE IN THETA ALLOWED FOR NODES 2 TO PMN-1
C              DURING ANY TIME STEP TWDT. TYPICAL VALUE .01 TO .02
C  PWWC(10)    WATER CAPACITY, BAR-1, OF REGIONS SURROUNDING NODES,
C              COUNTING STARTS AT  FIRST NODE BELOW SURFACE
C  SWINIT      INITIAL VALUE OF STANDING WATER
C  TWAA        FRACTION OF PWDELW INTERVAL, USED IN INTERPOLATING
C  TWA(10)     PARAMETER A FOR TRI-DIAGONAL MATRIX ROUTINE (TDM ROUTINE)
C  TWAAA(10)   ARRAY CONTAINING VALUES OF TWTHA(I) FOR I=2,PMN-1
C  TWB(10)     PARAMETER B FOR TDM ROUTINE
C  TWBB(10)    CONTAINS ORDERED VALUES OF TWAAA.
C  TWC(10)     PARAMETER C FOR TDM ROUTINE
C  TWD(10)     PARAMETER D FOR TDM ROUTINE
C  TWDT        ACTUAL TIME STEP WATER IS USING
C  TWDTHP(10)  CHANGE IN THETA DURING LAST TWDT
C  TWDTP       LENGTH OF PREVIOUS WATER TIME STEP
C  TWEVAP      EVAPORATIVE DEMAND, MM, WATER TO EVAPORATE FROM SURFACE
C              DURING REMAINDER OF PMDT
C  TWFRZN      TRUE IF TEMPERATURE OF UPPER SOIL LAYER .LE. -1.0
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C   TWHA(10)    PRESSURE HEAD AT BEGINNING OF TWDT, BARS
C   TWHB(10)    PRESSURE HEAD AT END OF TWDT, BARS
C   TWHHA       INTERPOLATED VALUES OF PWH
C   TWHHB       INTERPOLATED VALUES OF PWH
C   TWIN        EQUALS .TRUE. IF SURFACE PRESSURE IS WITHIN LIMITS
C   TWJA        INTEGER USED IN PICKING VALUES OF K, H OFF TABLES
C   TWJB        INTEGER USED IN PICKING VALUES OF K, H OFF TABLES
C   TWJM        INTEGER COUNTER USED TO LIMIT NUMBER OF TWDT HALVINGS
C   TWKSA       INTERPOLATED VALUE OF PWKSUM
C   TWKSB       INTERPOLATED VALUE OF PWKSUM
C   TWONE       EQUALS .TRUE. IFFIRST DELTA THETA APPROXIMATION HAS
C               ALREADY BEEN DONE DURING CURRENT TWDT.
C   TWR         RAIN (IN MM) THAT HAS YET TO BE DISPOSED OF DURING
C               REMAINDER OF PMDT
C   TWRAIN      EQUALS .TRUE. IF RAIN OCCURS DURING TWDT
C   TWRP        EQUALS .TRUE. IF TWRAIN WAS TRUE LAST TWDT.
C   TWSF        THIS IS FIRST THE REQUESTED (BEFORE LABEL 380) AND THEN
C               THE ACTUAL (AFTER LABEL 380) SURFACE FLUX (IN CM) FOR
C               THE TWDT
C   TWSFC       CALCULATED SURFACE FLUX FOR TWDT USING TWHB(1) AND PWK(1)
C   TWSFD       EQUALS TWSF-TWSFC
C   TWSTND      STANDING WATER, MM, AFTER RUNON-RUNOFF ASSUMPTIONS HAVE
C               BEEN CONSIDERED.
C   TWTA(10)    WATER AVAILABLE IN LAYERS, DIMENSIONLESS
C   TWTHAA(10)  VOLUMETRIC WATER CONTENT AT BEGINNING OF PMDT
C   TWTHA(10)   VOLUMETRIC WATER CONTENT (VWC) AT BEGINNING OF TWDT
C   TWTHB(10)   VWC AT END OF TWDT
C   TWTHC       THETA AVERAGED OVER TWDT FOR WHATEVER LAYER WE'RE
C               CALCULATING AT THE MOMENT
C   TWTHTS(10)  RUNNING SUM OVER TWDT'S OF TRANSPIRATION BY LAYER, CM
C   TWTSPR(10)  TRANSPIRATION LOSS FROM LAYERS DURING TWDT
C   TWTTOT      TOTAL TIME THAT HAS ELAPSED IN PMDT. DOES NOT INCLUDE
C               CURRENT TWDT, DAYS
C   TWTW(10)    TRANSPIRATIONAL DEMAND BY FUNCTIONAL GROUP, CM
C   TWWA(10)    USED IN SETTING UP CALL TO TDM
C   TWWB(10)    USED IN SETTING UP CALL TO TDM
C   XWTHTA(10)  THETA AT END OF PMDT
C   ZRINT       RAINFALL INTENSITY, MM/HR
C
      INTEGER PMN,PWM,TWJA,TWJB,TWJM
      LOGICAL TWIN,TWRAIN,TWRP,TWONE,PRINT,TWFRZN
      COMMON /FILES/ KP, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     1       NFRELM,NFRFLP,HORDEP(6),NHORIZ,NSCMPT
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYP,JYR,KYR,IDAY,JDAY,KDAY,
     1       XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
     1       PLACE(18),UNITS(8)
      COMMON /VBLS/ PDM(7,6),PDMC(7),PDMV(6),PDMVO,SEEDDM(7),SEEDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),PCP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),ORATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /WTHRV/ DATMIN,DATMAX,DARAIN,DAEVAP,DAPHOT
      COMMON /SOLCOM/ PMN,CHD(8),CHDX(8),CHDXX(8),CWPST(6),XHSOLT(8)
      COMMON/WATSAV/PWWC(8),PWK(8),TWA(8),TWB(8),TWC(8),TWD(8),
     1  TWTHA(8),TWTHB(8),TWHA(8),TWHB(8),TWWA(8),TWWB(8),PWKIN(60),
     2  PWH(60),PWKSUM(60),PWT(60),TWU(8),          TWTSPR(8),TWKSA(8),
     3  TWHHA(8),TWDTHP(8),TWTHAA(8),TWTHTS(8),TWAAA(8),LL(8),TWTA(8),
     4 TWTW(8),TWDT,TWTRN,TWTTOT,Y,Z,TWEVAP,TWR,TWRAIN,TWRP,TWSTND
     5, TWDTP,R,PWTLIM,S,T,J,TWJM,TW,TWSF,TWTK,PWLLIM,TOONE,PWM,TWJA,
     6  PWDELW,TWAA,TWTHC,TWJB,PWHWET,PWHDRY,TWSFC,TWIN,TWSFD,TWDTG,
     7  TWWIN,TWSTRD,PWRNRF,PWKCAL,TWI,ZPRINT,XWSTND,CWINF
      COMMON /VTOWAT/ CVRDST(7,8),CVTSPR(7)
      COMMON /WATSA3/ CWINFT
      COMMON /WATSA4/ SWINIT
      DIMENSION XWTHTA(8)
C
      IF(IDAY.EQ.JDAY) GO TO 680
C-----------------------------------------------------------------------
C  INITIAL DECISIONS AND SETTING UP (MADE ONCE EACH CALL TO WATER)
C-----------------------------------------------------------------------
      IF (PRINT) WRITE(LP,10)
   10 FORMAT('0---*  EXECUTING SUBROUTINE WATER')
      IF (IDAY .EQ. JDAY + ISTEP) SWINIT = TWSTND
      PMDT = ISTEP
      JPMN = PMN-1
      KPMN = PMN-2
      LPMN = PMN-3
      ZZRINT = ZRINT
      TWDT=PMDT
      CWINF=0.0
      TWTRN=0.0
      TWTTOT=0.
      TWFRZN = .FALSE.
      IF (XHSOLT(2) .LE. -1.0) TWFRZN = .TRUE.
      TWEVAP = DAEVAP * ISTEP
      TWR = DARAIN
      IF (TWR .LE. 0.0) ZRINT = 0.0
C  INITIALIZE VOLUMETRIC WATER CONTENT (VWC) AND PRESSURE HEAD
      DO 20 I=1,PMN
C     THE FIRST TIME THROUGH THIS PROGRAM TWTHB(*) AND TWHB(*) COME FROM
C     SUBROUTINE WINPUT
      TWTHAA(I)=TWTHB(I)
      TWTHA(I)=TWTHB(I)
   20 TWHA(I)=TWHB(I)
C  TWTHAA HOLDS VWC AT BEGINNING OF PMDT WHICH ISN'T ALWAYS THE SAME
C  AS THE BEGINNING OF TWDT.
C  TWTHA AND TWTHB NOW CONTAIN VWC AT BEGINNING OF TWDT
C  TWHA AND TWHB NOW CONTAIN PRESSURE HEAD AT BEGINNING OF TWDT
      DO 30 I=1,KPMN
   30 TWTHTS(I)=0.0
C     TWTW(I) IS WATER DEMAND OF THE I'TH FUNCTIONAL PLANT GROUP FOR
C     THE PMDT, IN CM
C     CVTSPR IS IN KILOGRAMS PER HECTARE
      DO 40 I=1,NPLNTS
   40 TWTW(I) = .00001 * CVTSPR(I)*ISTEP
C-----------------------------------------------------------------------
C     STATEMENT LABEL 50 IS THE START OF THE LOOP FOR THE INNER
C     TIME-STEP
C-----------------------------------------------------------------------
C  INITIAL STAB AT TWDT
C  IF CONDITIONS ARE ROUGHLY THE SAME AS PAST TIME STEP, KEEP TWDT SAME.
C  IF RAINFALL DURING PMDT IS GREATER THAN 4MM, SAY, MAKE TIME STEP IN
C  WATER  1/48 DAY(1/48=0.02083).
   50 CONTINUE
      IF (.NOT. TWFRZN) GO TO 60
      TWRAIN=.FALSE.
      TWEVAP=0.0
      TWRP=.FALSE.
      GOTO90
   60 IF((TWR+TWSTND).LE.4.)GOTO70
      TWRAIN = .TRUE.
      TWDT = 0.02083
      IF(TWRP)GOTO80
      GO TO 110
   70 TWRAIN=.FALSE.
   80 TWDT=TWDTP
   90 CONTINUE
C  REFINED TWDT ESTIMATE 12-23-74
C  CHECK IF LARGEST VALUE OF TWDTHP, CHANGE IN THETA LAST TWDT IS
C  BETWEEN 0.3 AND 0.9 TIMES PWTLIM.   IF IT IS ESTIMATE NEXT TWDT FROM
C  IT.
      R=0.3*PWTLIM
      S=0.9*PWTLIM
      T=0.0
      DO 100 I=2,JPMN
      U=ABS(TWDTHP(I))
      IF(U.LT.R)GOTO100
      IF(U.GT.S)GOTO110
      IF(U.GT.T)T=U
  100 CONTINUE
      IF(T.LT.R)T=R
      IF(T.LE.0.0)GOTO110
      TWDT=0.9*TWDT*(PWTLIM/T)
  110 IF(TWDT .GT. (PMDT-TWTTOT)) TWDT=PMDT-TWTTOT
C  END INITIAL STAB AT TWDT
      TWJM = 0
C  TWJM IS A COUNTER WHICH ALLOWS A LIMITED NUMBER OF TWDT
C  HALVINGS
C-----------------------------------------------------------------------
C     STATEMENT LABEL 120 IS START OF LOOP TO CALCULATE PRESSURES ONCE
C     TWDT IS SET
C-----------------------------------------------------------------------
  120 CONTINUE
      TWSF = 0.0
      IF (TWFRZN) GO TO 160
C  SURFACE FLUX CONSIDERS RAIN, STANDING WATER AND EVAPORATION (BUT NOT
C  TRANSPIRATION).
C  WATER IN IS PLUS, OUT IS MINUS.  THIS IS POTENTIAL FLUX.
C
C  BEGIN MAIN ITERATION LOOP WITHIN TWDT
C  TWSF NOT TWSFC IS USED FOR SURFACE FLUX IN EQUATIONS SECTION.
C  THE ALTERNATIVE IS TO USE TWSFC AND PASS ON A CORRECTION = TWSF -
C  TWSFC TO NEXT TIME STEP.
C
C  SURFACE FLUX SCHEME REVAMPED 12-3-74 PWL
      TW=AMIN1(TWR,(ZRINT*TWDT*24.))
      Q=TWEVAP*TWDT/PMDT
      TWSF = (TW + TWSTND - Q) * 0.1
  160 CONTINUE
C     'TWSF' IS NOW THE INITIALLY REQUESTED SURFACE FLUX (IN CM) FOR
C     THE INNER TIME-STEP.   IT CAN BE ALTERED DURING THE TWDT AFTER
C     STATEMENT LABEL 380 IF THE REQUEST CAN NOT BE MET
C-----------------------------------------------------------------------
C  TRANSPIRATION SECTION 1-7-75
C-----------------------------------------------------------------------
C  WITHDRAW WATER FROM A LAYER PROPORTIONAL TO WATER AVAILABLE AND
C  FRACTION OF ROOTS IN THAT LAYER.   TWTK IS PROPORTIONALITY CONSTANT
C  FOR FUNCTIONAL GROUP BEING CALCULATED.
C  TWTSPR(I) IS TRANSPIRATION FROM LAYER I DURING TWDT, CM.
      R=TWDT/PMDT
      DO 170 I=1,KPMN
  170 TWTSPR(I)=0.0
      DO 200 J=1,NPLNTS
      TWTK=0.0
      DO 180 I=1,KPMN
C  TWTA IS WATER AVAILABLE IN LAYER, DIMENSIONLESS
      TWTA(I)=TWTHA(I+1)-PWLLIM
  180 TWTK=TWTK+TWTA(I)*CVRDST(J,I)
      TWTK=R*TWTW(J)/TWTK
      DO 190 I=1,KPMN
  190 TWTSPR(I)=TWTSPR(I)+TWTK*TWTA(I)*CVRDST(J,I)
  200 CONTINUE
C  FIND LARGEST DELTA THETA THIS WOULD RESULT IN FOR THIS TWDT.
      TW=0.0
      DO 220 I=1,KPMN
      S=TWTSPR(I)/CHDX(I)
C  NEVER TAKE ALL THE AVAILABLE WATER.
      IF(S.LE.(TWTA(I)*0.5))GOTO210
      TWTSPR(I)=TWTA(I)*0.5*CHDX(I)
      S=TWTSPR(I)
  210 CONTINUE
      IF(TW.LT.S)TW=S
  220 CONTINUE
C  IF TW IS TOO LARGE, REDUCE TWDT ACCORDINGLY
      IF((TW.LE.PWTLIM).OR.(TWJM.GE.2).OR.(TWDT.LE.0.02083))GOTO230
      TWJM=TWJM+1
      TWDT=TWDT*0.9*PWTLIM/TW
      IF(TWDT.LE.0.02083)TWDT=0.02083
      GO TO 120
  230 CONTINUE
C-----------------------------------------------------------------------
C  GENERATE VALUES OF CONDUCTIVITY AND SPECIFIC WATER CAPACITY
C  FROM VALUES OF VWC
C-----------------------------------------------------------------------
C  IF CONDITIONS ARE ROUGHLY THE SAME THIS TWDT AS LAST,
C  APPROXIMATE CHANGES IN THETA BY ASSUMING FOR NOW THAT CHANGES
C  THIS TWDT EQUAL CHANGES LAST TWDT.   IF CONDITIONS ARE NOT THE SAME
C  ASSUME FOR NOW THAT BEGINNING AND END VALUES ARE THE SAME.
C  GO THROUGH THIS SECTION ONLY ONCE FOR EACH TWDT
      IF(TWONE) GO TO 280
      TWONE=.TRUE.
      IF((TWRP .AND. TWRAIN) .OR. ((.NOT. TWRP) .AND. (.NOT. TWRAIN)))
     1 GO TO 250
      GO TO 280
  250 CONTINUE
      DO 270 I=2,PMN
      S=TWDT/TWDTP
      IF(S.GT.1.)S=SQRT(S)
      TW=TWTHB(I)+S*TWDTHP(I)
      IF(TW .GE. PWT(PWM)) GO TO 260
      IF(TW .LT. PWLLIM) TW=PWLLIM
      TWTHB(I)=TW
      IF(I.GT.2)GOTO270
C  RECALCULATE PRESSURE VALUE OF TOP LAYER
C  PWT(TWJA) AND PWT(TWJA+1) BRACKET TWTHB(I)
      TWJA=TWTHB(I) / PWDELW + 1.
C  TWAA IS FOR INTERPOLATING
      TWAA=(TWTHB(I)-PWT(TWJA))/PWDELW
      TWHB(I)=PWH(TWJA)+(PWH(TWJA+1)-PWH(TWJA))*TWAA
      GO TO 270
  260 TWTHB(I)=PWT(PWM)
      TWHB(I)=PWH(PWM)
  270 CONTINUE
  280 CONTINUE
      DO 320 I=2,JPMN
      TWTHC =(TWTHA(I)+TWTHB(I)) / 2.
      IF(TWTHC .GT. PWT(PWM)) TWTHC=PWT(PWM)
      IF(TWTHC .LT. PWLLIM) TWTHC=PWLLIM
C  PWT(TWJA) AND PWT(TWJA+1) BRACKET TWTHC
      TWJA=TWTHC/PWDELW + 1.
      IF(TWJA .GE. PWM) TWJA=PWM-1
C  TWAA IS FOR INTERPOLATING
      TWAA=(TWTHC-PWT(TWJA))/PWDELW
C  TWKSA AND TWHHA ARE PART OF AVERAGE CONDUCTIVITY CALCULATION
      TWKSA(I)=PWKSUM(TWJA)+(PWKSUM(TWJA+1)-PWKSUM(TWJA))*TWAA
      TWHHA(I)=PWH(TWJA)+(PWH(TWJA+1)-PWH(TWJA))*TWAA
C  CALCULATE WATER CAPACITY
C  IT IS SIMPLY THE RECIPROCAL OF THE SLOPE OF PRESSURE VS. THETA
      PWWC(I-1) = PWDELW/(PWH(TWJA+1)-PWH(TWJA))
      IF(I.LE.2)GOTO310
      IF(TWJB .EQ. TWJA) GO TO 300
      PWK(I-1)=(TWKSA(I)-TWKSA(I-1))/(TWHHA(I)-TWHHA(I-1))
      GO TO 310
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  300 PWK(I-1)=(PWKSUM(TWJA+1)-PWKSUM(TWJA)) / (PWH(TWJA+1)-PWH(TWJA))
  310 TWJB=TWJA
C  TWJB IS USED TO HOLD ON TO THE VALUE OF TWJA FOR ONE MORE PASS
C  THROUGH DO LOOP
  320 CONTINUE
C  END CONDUCTIVITY (EXCEPT FOR TOP LAYER) AND WATER CAP. CALCULATIONS
C-----------------------------------------------------------------------
C  BOUNDARY CONDITION SECTION
C-----------------------------------------------------------------------
C  FOR THE BOTTOM BOUNDARY CONDITION MUST BE ABLE TO SET CONDUCTIVITY IN
C  THE REGION IMMEDIATELY ABOVE THE BOTTOM NODE.  WE MUST ALSO SET
C  PRESSURE HEAD AT BOTTOM NODE.   PRESSURE HEAD WILL BE CALCULATED
C  FOR NODES 2 THROUGH PMN-1
C  PWK(PMN-1) AND TWHB(PMN) WERE READ IN IN WINIT.  THEY REPRESENT
C  CALICHE LAYER CHARACTERISTICS.
C
C  TOP BOUNDARY CONDITION
C  EARLIER IN THIS ROUTINE ACTUAL SURFACE FLUX WAS SET EQUAL TO
C  POTENTIAL EVAPORATION OR RAIN
      IF(TWSF.LT.0.0)GOTO330
C  TWSF GREATER THAN OR EQUAL TO ZERO
C  CAN TWSF BE MET WITH MAXIMUM (WETTEST) CONDITIONS>
      TWHB(1)=PWHWET
      TWTHB(1)=PWT(PWM)
      GOTO340
  330 CONTINUE
C  TWSF LESS THAN ZERO
C  CAN TWSF BE MET WITH MAXIMUM (DRTEST) CONDITIONS>
      TWHB(1)=PWHDRY
      TWTHB(1)=PWLLTM
  340 CONTINUE
C  CALCULATE PWK(1)
      TWTHC=TWTHB(1)
      IF(TWTHC .GT. PWT(PWM)) TWTHC=PWT(PWM)
      IF(TWTHC .LT. PWLLIM) TWTHC=PWLLIM
C  PWT(TWJA) AND PWT(TWJA+1) BRACKET TWTHC
      TWJA=TWTHC/PWDELW + 1.
      IF(TWJA .GE. PWM) TWJA=PWM-1
C  CHECK IF WATER CONTENTS OF FIRST TWO NODES ARE VERY CLOSE
      IF((TWKSA(2) .GE. PWKSUM(TWJA)) .AND. (TWKSA(2) .LE. PWKSUM(TWJA+1
     1 ))) GO TO 350
C  TWAA IS FOR INTERPOLATING
      TWAA=(TWTHC-PWT(TWJA))/PWDELW
      TWKSA(1)=PWKSUM(TWJA)+(PWKSUM(TWJA+1)-PWKSUM(TWJA))*TWAA
      TWHHA(1)=TWHB(1)
      PWK(1)=(TWKSA(2)-TWKSA(1))/(TWHHA(2)-TWHHA(1))
      GO TO 360
  350       PWK(1) = (PWKSUM(TWJA+1)-PWKSUM(TWJA)) / (PWH(TWJA+1)
     1 - PWH(TWJA))
  360 CONTINUE
C       THE NEXT LINE IS THE ONLY TIME TWSFC APPEARS TO THE LEFT OF AN
C       EQUAL SIGN
      TWSFC=PWK(1)*TWDT*(TWHB(1)-TWHB(2)+9.833E-4*CHDXX(1))/CHDXX(1)
      IF(TWSF.LT.0.0)GOTO370
C       REQUESTED SURFACE FLUX IS POSITIVE, WATER IS INFILTRATING
      IF(TWSFC.GE.TWSF)GOTO390
      GOTO380
C       REQUESTED SURFACE FLUX IS NEGATIVE, WATER IS EVAPORATING
  370 IF(TWSFC.LE.TWSF)GOTO390
  380 CONTINUE
C  CANNOT MEET TWSF EVEN WITH MAXIMUM SURFACE CONDITIONS
      TWIN=.FALSE.
      TWSFD=TWSF-TWSFC
      TWSF=TWSFC
      GOTO400
  390 CONTINUE
C  CAN MEET OR EXCEED DEMAND BUT THERE'S NO POINT FINDING MORE
C  ACCURATE VALUES FOR TWHB(1) OR PWK(1) SINCE NEITHER DON NOR I
C  USE EITHER ONE.
      TWIN=.TRUE.
      TWSFD=0.0
  400 CONTINUE
C       TWSF, TWSFC AND TWSFD ARE NOW IMMUTABLY FIXED FOR THE
C       REMAINDER OF THE TWDT.   HOWEVER, IF POTENTIALS ARE NOT WITHIN
C       LIMITS, THE CALCULATIONS FOR THIS TWDT WILL BE THROWN OUT, AND
C       NEW ONES WILL BE MADE, INCLUDING NEW VALUE FOR TWSF
C  CHECK IF PROFILE FROZEN    3-12-75
C  IF YES, DECREASE CONDUCTIVITY GREATLY AND PREVENT WATER MOVEMENT
C  WITHIN PROFILE.   LEAVE CALICHE LAYER CONDUCTIVITY AS IS.
      IF (.NOT. TWFRZN) GO TO 420
      DO 410 I=1,KPMN
  410 PWK(I)=PWK(I)*1.E-6
  420 CONTINUE
C  END TOP BOUNDARY CONDITION CALCULATION
C-----------------------------------------------------------------------
C  NOW, HAUL OUT THE MAIN EQUATIONS, CALCULATE THE COEFFICIENTS AND
C  CALL TRIDIM (THE  TRI-DIAGONAL-MATRIX ROUTINE) TO DETERMINE THE
C  PRESSURE HEAD AT THE PMN-2 NODES.
C-----------------------------------------------------------------------
C  I:M AFRAID SOME OF THE NUMBERING IN HERE CAN BE CONFUSING.  THE
C  PRESSURE AT NODES 2 THROUGH PMN-1 ARE DETERMINED BY THE TDM
C  ROUTINE.   AT NODE 1, SURFACE FLUX DETERMINES PRESSURE (TWHB(1))
C  AND AT NODE PMN THE PRESSURE IS A CONSTANT WHICH IS READ IN.
C  THE CONDUCTIVITIES ARE AVERAGES OVER TWDT FOR THE REGIONS BETWEEN THE
C  NODES.   THE FIRST VALUE IS FOR THE REGION BETWEEN NODES 1 AND 2,
C  AND THE LAST VALUE, PWK(PMN-1), IS FOR THE REGION BETWEEN NODES
C  PMN-1 AND PMN AND IS READ IN AND REPRESENTS THE CONDUCTIVITY OF THE
C  CALICHE LAYER.   THE WATER CAPACITY PWWC(I) IS AN AVERAGE OVER TWDT
C  FOR A REGION CENTERED ON NODE I+1.   VALUES ARE NEEDED FOR NODES
C  2 THROUGH PMN-1.   THE THICKNESS OF A REGION CENTERED ON A NODE I+1
C  IS CHDX(I).   VALUES ARE NEEDED FOR NODES 2 THROUGH PMN-1.
C  THERE IS FURTHER POSSIBILITY FOR CONFUSION BECAUSE EQUATION I IN
C  TDM IS FOR NODE I+1.
C
C  IT HAS BEEN DECIDED (NOT BY ME OBVIOUSLY) THAT THE UNITS FOR
C  PRESSURE IN THIS SUBROUTINE ARE BARS.   THUS, CONDUCTIVITY HAS UNITS
C  OF CM*2 BAR-1 DAY-1.   WATER CAPACITY IS IN BAR-1.  PRESSURE HEADS
C  DUE TO HEIGHT DIFFERENCES MUST BE MULTIPLIED BY 9.833E-4 BAR/CM
C  TO GET BARS.   TO CONVERT TO PRESSURE UNITS IN CM MUST MULTIPLY
C  CONDUCTIVITY BY 9.833E-4 BAR/CM AND GET UNITS OF CM/DAY.   CAN USE
C  PRESSURE DUE TO HEIGHT DIFFERENCES DIRECTLY IN CM.  THE CONVERSION
C  FACTOR IS 9.833E-4 BAR/CM OR 1017 CM/BAR.
      DO 430 I=1,JPMN
      TWWA(I) = PWK(I) / CHDXX(I)
      IF(I .EQ. PMN-1) GO TO 430
      TWWB(I) = (2.*PWWC(I)*CHDX(I)) / TWDT
  430 CONTINUE
C  WITH TWWA AND TWWB GENERATE ABCD'S FOR TDM
      DO 440 I=2,LPMN
      TWA(I) = TWWA(I+1)
      TWC(I) = TWWA(I)
      TWB(I) = TWWB(I)+TWA(I)+TWC(I)
  440 TWD(I) = TWHA(I+1)*(TWWB(I)-TWA(I)-TWC(I)) + TWHA(I)*TWC(I)
     1 + TWHA(I+2)*TWA(I) + 2.*(PWK(I) - PWK(I+1))  *9.833E-4
     2 -2.*TWTSPR(I)/TWDT
C  CALCULATE FIRST AND LAST VALUES
      TWA(1) = TWWA(2)
      TWC(1) = 0.
      TWB(1) = TWWB(1) + TWA(1)
      TWD(1) = TWHA(2)*(TWWB(1)-TWA(1)) + TWHA(3)*TWA(1)
     1  + TWSF*2./TWDT   -2.*PWK(2)*9.833E-4
     2 -2.*TWTSPR(1)/TWDT
      TWA(PMN-2) = 0.
      TWC(PMN-2) = TWWA(PMN-2)
      TWB(PMN-2) = TWWB(PMN-2) + TWC(PMN-2) +TWWA(PMN-1)
      TWD(PMN-2) = TWHA(PMN-1)*(TWWB(PMN-2)-TWC(PMN-2)-TWWA(PMN-1))
     1 + TWHA(PMN-2)*TWC(PMN-2) + 2.*TWHB(PMN)*TWWA(PMN-1)
     2 +2.*(PWK(PMN-2)-PWK(PMN-1)) *9.833E-4
     3 -2.*TWTSPR(PMN-2)/TWDT
C  END EQUATION SECTION
C-----------------------------------------------------------------------
C  CALL TRIDIM TO CALCULATE PMN-2 PRESSURES FOR NODES 2 THROUGH PMN-1
C-----------------------------------------------------------------------
      CALL TRIDIM(TWA, TWB, TWC, TWD, TWU, PMN-2)
C-----------------------------------------------------------------------
C      MISCELLANEOUS CALCULATIONS
C-----------------------------------------------------------------------
C  CALCULATE THETA FOR NODES 2 TO PMN-1 USING PRESSURE VALUES JUST
C  OBTAINED FROM TDM.   USE WATER CAPACITY A LA HANKS.   DELTA THETA=
C  DELTA PRESSURE TIMES WATER CAPACITY.
      DO 450 I=2,JPMN
      TWTHB(I)=TWTHA(I)+PWWC(I-1)*(TWU(I-1)-TWHA(I))
      IF(TWTHB(I) .GT. PWT(PWM)) TWTHB(I)=PWT(PWM)
      IF(TWTHB(I) .LT. PWLLTM) TWTHB(I)=PWLLTM
  450 CONTINUE
C  CALCULATE TWHB FROM TWTHB
      DO 460 I=2,JPMN
      TWJA=TWTHB(I)/PWDELW+1.
      IF(TWJA .GE. PWM) TWJA=PWM-1
      TWAA=(TWTHB(I)-PWT(TWJA))/PWDELW
  460 TWHB(I)=PWH(TWJA)+(PWH(TWJA+1) - PWH(TWJA))*TWAA
C  CHECK IF ANY DELTA THETA'S TOO LARGE.  IF YES, REDUCE TWDT
      DO 470 I=2,JPMN
      S=ABS(TWTHB(I)-TWTHA(I))
      IF(S.GT.PWTLIM)GOTO480
  470 CONTINUE
      GO TO 510
  480 IF(TWJM.GE.2)GOTO510
      TWDTQ=TWDT
      TWDT=TWDT*0.9*PWTLIM/S
      TWJM=TWJM+1
C  DON'T LET TWDT GET SMALLER THAN 30 MINUTES
      IF(TWDT.LT.0.02083)TWDT=0.02083
      R=TWDT/TWDTQ
  490 DO 500 I=2,JPMN
      TWHB(I)=TWHA(I)+(TWHB(I)-TWHA(I))*R
  500 TWTHB(I)=TWTHA(I)+(TWTHB(I)-TWTHA(I))*R
      GO TO 120
C-----------------------------------------------------------------------
C      END OF LOOP TO CALCULATE PRESSURES ONCE TWDT IS SET
C-----------------------------------------------------------------------
  510 CONTINUE
C  CHECK WATER BALANCE
      CALL WBALAN(TWTSPR,TWSF,TWTHA,TWTHB,CHDX,PMN,TWWIN,TWSTRD,R,1)
      IF(TWDT.LT.0.05)GOTO520
C  WATER IS SOMETIMES NOT CONSERVED
C  WHEN THIS IS THE CASE, HALVE TWDT.
      IF((R.GT.99.).OR.(ABS(TWWIN).LT.0.006)
     1 .OR.(ABS(R-1.).LT.0.01))GOTO520
      TWDT=0.5*TWDT
      R=0.5
      GOTO490
  520 CONTINUE
C-----------------------------------------------------------------------
C  THIS IS THE WRAP UP SECTION.  ONCE WE'RE HERE WE EITHER RETURN TO
C  CALLING PROGRAM OR DO ANOTHER TWDT.
C-----------------------------------------------------------------------
      IF (.NOT. PRINT) GO TO 550
      TQ = 0.0
      DO 522 K=1,KPMN
  522 TQ = TQ + TWTSPR(K)
      WRITE (LP,525) TWDT, TWRP,TWRAIN,TWONE,TWIN,TWJM,TWWIN,TWSTRD,R
  525 FORMAT (' START INNER TIME-STEP.   LENGTH IN DAYS=',F6.3,4X,
     1  4L1, I4, T70, 3G12.4)
      WRITE (LP,530) (TWTHB(K), K=1,PMN)
  530 FORMAT (T6,'THETA AT NODES AT END OF INNER TIME-STEP', T65,8F7.3)
      WRITE (LP,535) (TWHB(K), K=1,PMN)
  535 FORMAT (T6,'SOIL WATER POTENTIAL AT NODES AT END OF INNER TIME-STE
     1P', T65, 8F7.3)
      WRITE (LP,538) TQ, TWSF
  538 FORMAT (T6, 'ACTUAL TRANSPIRATION AND SURFACE FLUX DURING INNER TI
     1ME-STEP =', T70, 2G12.4)
      WRITE (LP,539) TWR, TWSTND
  539 FORMAT (T6, 'UNDISPOSED OF RAIN AND STANDING WATER AT START OF TWD
     1T =', T70, 2G12.4)
  550 CONTINUE
C  SET SOME VALUES UP FOR NEXT TWDT.
      TWDTP=TWDT
      TWRP=TWRAIN
      TWONE=.FALSE.
      DO 560 I=2,JPMN
      TWHA(I)=TWHB(I)
      TWDTHP(I)=TWTHB(I)-TWTHA(I)
      TWTHA(I)=TWTHB(I)
  560 CONTINUE
      CWINF=CWINF+TWSF
      IF (.NOT. TWFRZN) GO TO 570
      TWSTND=TWSTND+TWR
      TWR=0.0
      GO TO 620
  570 CONTINUE
C      DETERMINE WHETHER THERE IS STANDING WATER
      IF(TWIN) GO TO 580
C  TWSFD  = RAIN + STANDING WATER - EVAPORATION - ACTUAL SURFACE FLUX
      TWSTND=TWSFD*10.*PWRNPF**TWDT
      IF (TWSTND .LT. 0.0) TWSTND=0.0
      GO TO 590
  580 TWSTND=0.0
  590 CONTINUE
C  DETERMINE AMOUNT OF RAIN REMAINING TO INFILTRATE.
  600 TWR=TWR-ZRINT*TWDT*24.
  610 IF(TWR .LT. 0.0) TWR=0.0
  620 CONTINUE
C  CALCULATE SUM OF TRANSPIRATION, CM
      DO 630 I=1,KPMN
  630 TWTHTS(I)=TWTHTS(I)+TWTSPR(I)
C      AT THIS POINT, TWTHTS AND TWTSPR ARE ACTUAL TRANSPIRATION IN CM,
C      WHICH MAY BE LESS THAN REQUESTED TRANSPIRATION
      IF (PRINT) WRITE (LP,635) TWR, TWSTND
  635 FORMAT (T6, 'UNDISPOSED OF RAIN AND STANDING WATER AT END OF TWDT'
     1  , T70, 2G12.4)
C  RESET TIMING
      TWTTOT=TWTTOT+TWDT
      IF(ABS((TWTTOT-PMDT)/PMDT) .GT. 0.002) GO TO 50
C  END WRAP UP SECTION FOR TWDT
C-----------------------------------------------------------------------
C      EXIT FROM INNER TIME-STEP LOOP HAS JUST OCCURRED
C  DO THE LAST COUPLE OF THINGS NECESSARY BEFORE END OF SUBROUTINE
C-----------------------------------------------------------------------
      DO 640 I=1,KPMN
      XWTHTA(I)=TWTHB(I+1)
  640 CWPSI(I)=TWHB(I+1)
      CWINFT = CWINFT + CWINF
      CALL WBALAN(TWTHTS,CWINF,TWTHAA,TWTHB,CHDX,PMN,TWWIN,TWSTRD,R,2)
```

```
        DO 670 I=1,NHORIZ
  670   SWPH(I) = CWPSI(I)
        DUMMYS(3) = TWSTND
        OWATER(4) = OWATER(1) - DUMMYS(3) - CWINFT * 10.0 + SWINIT
        Q1 = OWATER(1) * 0.1
        Q2 = DUMMYS(3) * 0.1
        Q3 = OWATER(4) * 0.1
        IF (PRINT .OR. IDAY .EQ. KDAY) WRITE (LP,675) Q1, Q2, Q3
  675   FORMAT (T16,'PRECIPITATION', T81, F8.3/
       1  T16, 'STANDING WATER', T81, F8.3/
       2  T16, 'EVAPORATION', T81, F8.3)
        ZPRINT = ZZRINT
        RETURN
C---------------------------------------------------------------------
C       INPUT AND INITIALIZATION
C---------------------------------------------------------------------
  680   CALL WINPUT
        CWINFT = 0.0
        RETURN
        END
```

SUBROUTINE TRIDIM

```
BIOME*DESERT2SYM(1).TRIDIM
        SUBROUTINE TRIDIM(A, B, C, D, U, N)
C
C
C     5-28-74     PAUL LOMMEN
C
C     THIS SUBROUTINE SOLVES A SET OF N LINEAR EQUATIONS IN N UNKNOWNS
C     IF THE COEFFICIENTS OF THE UNKNOWNS FORM A TRI-DIAGONAL MATRIX.
C     DIFFERENCE EQUATION APPROXIMATIONS TO THE DIFFUSION EQUATION ARE
C     TYPICALLY OF THE TRI-DIAGONAL TYPE.  THERE ARE SEVERAL MEANS OF
C     SOLVING SUCH A SET OF EQUATIONS.  THE MOST STRAIGHTFORWARD, AND THE
C     ONE THAT I USE HERE AND HANKS USES IN SEVERAL OF HIS MODELS COMES
C     FROM,     ROBERT O. RICHTMYER, 1957, DIFFERENCE METHODS FOR
C     INITIAL-VALUE PROBLEMS, INTERSCIENCE PUBLISHERS, INC., NEW YORK.
C     SEE PAGE 103.   NOTATION USED HERE IS RICHTMYERS'.
C
C     BRIEFLY, THIS ROUTINE GOES FORWARD THROUGH THE EQUATIONS ONCE,
C     ELIMINATING THE U(J) FOR THE SMALLEST J AT EACH STEP.     AT THE
C     N-1  EQUATION ONE IS LEFT WITH 2 EQUATIONS IN 2 UNKNOWNS.  THEN
C     U(N) IS SOLVED FOR AND THEN THE ROUTINE GOES BACKWARDS THROUGH THE
C     EQUATIONS SOLVING FOR A VALUE OF U AT EACH STEP.
C
C     A, B, C, ARE THE COEFFICIENTS OF THE U'S TO THE RIGHT OF THE MAIN
C     DIAGONAL, ON THE DIAGONAL AND TO THE LEFT OF THE DIAGONAL
C     RESPECTIVELY.    THE D'S ARE THE CONSTANT, RIGHT HAND SIDES OF THE
C     EQUATIONS.    THE U'S ARE WHAT IS SOLVED FOR.     A, B, C, D MUST
C     BE EVALUATED IN THE ROUTINE WHICH CALLS  TDM.
C
C
C
        DIMENSION A(10), B(10), C(10), D(10), E(10), F(10), U(10)
        E(1) = A(1) / B(1)
        F(1) = D(1) / B(1)
        NN = N-1
        DO 10 I=2,NN
        DD =   B(I) - C(I)*E(I-1)
        E(I) = A(I) / DD
   10   F(I) = ( D(I) + C(I)*F(I-1) ) / DD
        U(N) = ( C(N)*F(N-1) + D(N) ) / ( B(N) - C(N)*E(N-1) )
        I=N
   20   I=I-1
        U(I) = U(I+1) * E(I) + F(I)
        IF ( I .GT. 1 ) GO TO 20
        RETURN
        END
```

SUBROUTINE WBALAN

```
BIOME*DESERT2SYM(1).WBALAN
        SUBROUTINE WBALAN(TSPR,SF,THTAI,THTAF,DX,PMN,WIN,WSTRD,RATIO,JK)
C
C     12-23-74      PAUL LOMMEN
C     THIS FUNCTION CHECKS WATER BALANCE OF A TIME PERIOD
C     TSPR IS TRANSPIRATION, CM
C     SF IS SURFACE FLUX, CM  -  INCLUDES PRECIP AND EVAP BUT NOT TRANSP
C     THTAI IS THETA INITIAL  , CM/CM
C     THTAF IS THETA FINAL, CM/CM
C     DX IS THICKNESSES OF LAYERS, CM
C     PMN IS NUMBER OF SOIL NODES
C
        INTEGER PMN
        LOGICAL PRINT
        COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
        COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -          XMONTH(12),ISTEP,NSTEPS,NDAYS
        COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPPINT,MPRINT(21),PRINT,
     -          PLACE(18),UNITS(8)
        COMMON /SAVWBA/ QSF,QA,QWIN,ISWICH,QWSTRD
        DIMENSION TSPR(PMN),THTAI(PMN),THTAF(PMN),DX(PMN)
C
        KPMN = PMN-2
        IF(ISWTCH.NE.11327)GO TO 300
   50   A=0.0
        WSTRD=0.0
        DO 100 I=1,KPMN
        A=A+TSPR(I)
  100   WSTRD=WSTRD+(THTAF(I+1)-THTAI(I+1))*DX(I)
C       'A' IS THE REQUESTED TRANSPIRATION IN CM
C       'WSTRD' IS THE CHANGE IN THE AMOUNT OF WATER IN THE PROFILE
        WIN=SF-A
C       'WIN' IS THE SUM OF INFLOWS TO AND OUTFLOWS FROM THE SOIL PROFILE
C       IT SHOULD EQUAL WSTRD
        IF(ABS(WSTRD).LT.1.E-3)RATIO=99.9
        IF(ABS(WSTRD).GE.1.E-3)RATIO=WIN/WSTRD
        IF (JK .EQ. 1) RETURN
        QSF=QSF+SF
        QA=QA+A
        QWIN=QWIN+WIN
        QWSTRD = QWSTRD + WSTRD
        IF ( ABS(QWSTRD) .LT. 1.E-3) R2 = 99.9
        IF ( ABS(QWSTRD) .GE. 1.E-3) R2 = QWIN/QWSTRD
        IF (PRINT .OR. IDAY .EQ. KDAY) WRITE (LP,200) SF,QSF,A,QA,WIN,
       1        QWIN, WSTRD, QWSTRD, RATIO, R2
  200   FORMAT ('0---* WATER BUDGET AT END OF TIME-STEP  --  ALL VALUES AR
     -E CENTIMETERS'/
       1  T61, 'FOR TIME-STEP', T81, 'CUMULATIVE'/
       2 T16,'SURFACE FLUX NOT INCLUDING TRANSPIRATION',T61,G13.4,T81,
       3   F8.3/ T16, 'TRANSPIRATION', T61, G13.4, T81,  F8.3/
       4  T16, 'SURFACE FLUX INCLUDING TRANSPIRATION',T61,G13.4,T81,F8.3/
       5T16,'CHANGE IN PROFILE', T61, G13.4, T81,  F8.3/
       6 T16, 'RATIO OF LINES 3 AND 4', T61, E13.4, T81, E11.4)
        RETURN
  300   QSF=0.0
        QA=0.0
        QWIN=0.0
        QWSTRD = 0.0
        ISWTCH=11327
        GO TO 50
        END
```

SUBROUTINE WINPUT

```
BIOME*DESERT2SYM(1).WINPUT
        SUBROUTINE WINPUT
        INTEGER PMN,PWM,TWJA,TWJB,TWJM
        LOGICAL ERROR,PRINT
        LOGICAL TWONE,TWRP
        LOGICAL SUMINP,SUVINP,SUAINP,SUSINP
        COMMON /ECHOCH/ SUMINP,SUVINP,SUAINP,SUSINP
        COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
        COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     -          NFRELM,NFRFLP,HORDEP(6),NHORIZ,NSCMPT
        COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -          XMONTH(12),ISTEP,NSTEPS,NDAYS
        COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
     -          PLACE(18),UNITS(8)
        COMMON/MISC/ERROR,RCHECK(20),BLANK
        COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV,
       1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
       2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),POP(10),CVEGV(6,5),
       3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVECO(7),AVEGVO,
       4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
       5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
       6  AECOTC,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
       7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),OPRODU(6),
       8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
       9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
       A  ALINAM(3,5)
        COMMON /SOLCOM/ PMN,CHD(8),CHDX(9),CHDXX(8),CWPSI(6),XHSOLT(8)
        COMMON/WATSAV/PWWC(8),PWK(8),TWA(8),TWB(8),TWC(8),TWD(8),
       1  TWTHA(8),TWTHB(8),TWHA(8),TWHB(8),TWWA(8),TWWB(8),PWKIN(60),
       2  PWH(60),PWKSUM(60),PWT(60),TWU(8),          TWTSPR(8),TWKBA(8),
       3  TWHHA(8),TWDTHP(8),TWTHAA(8),TWTHTS(8),TWAAA(8),LL(8),TWTA(8),
       4 TWTW(8),TWDT,TWTRN,TWTTOT,Y,Z,TWEVAP,TWR,TWRAIN,TWRP,TWSTND
       5, TWDTP,R,PWTLIM,S,T,J,TWJM,TW,TWSF,TWTK,PWLLIM,TWONE,PWM,TWJA,
       6  PWDELW,TWAA,TWTHC,TWJB,PWHWET,PWHDRY,TWSFC,TWIN,TWSFD,TWDTG,
       7  TWWIN,TWSTRD,PWRNRF,PWKCAL,TWI,ZRINT,XWSTND,CWINF
        COMMON /VTOWAT/ CVRDST(7,8),CVTSPR(7)
        DATA SUBNAM/'WATE'/
C
C
        IF(.NOT.SUSINP) WRITE(LP,10)
   10   FORMAT('0---* BEGINNING READING OF INPUT TO SUBROUTINE SLWATR')
        PMDT = ISTEP
        IREAD=20
   20   READ(KR,30)RCHECK
        IF(.NOT.SUSINP)WRITE(LP,40)IREAD,RCHECK
   30   FORMAT(20A4)
   40   FORMAT(T7,I5,' WINPUT',4X,20A4)
        IF(RCHECK(1).NE.SUBNAM)GO TO 20
   50   FORMAT(7F10.0)
   55   FORMAT(T7,I5,' WINPUT',7F16.5,10(/T19,7F16.5))
   60   FORMAT(14I5)
   65   FORMAT(T7,I5,' WINPUT',14I8)
   70   FORMAT(7E10.4)
   75   FORMAT(T7,I5,' WINPUT',7E16.4,10(/T19,7E16.5))
C
C       READ NUMBER OF ENTRIES IN CONDUCTIVITY AND PRESSURE TABLES
        IREAD=80
   80   READ(KR,30)RCHECK
        IF(.NOT.SUSINP)WRITE(LP,40)IREAD,RCHECK
        IREAD=90
   90   READ(KR,60)PWM
        IF(.NOT.SUSINP)WRITE(LP,65)IREAD,PWM
C
C       READ INCREMENT IN THETA IN HYDRAULIC CONDUCTIVITY AND PRESSURE
C       TABLES
        IREAD=100
  100   READ(KR,30)RCHECK
        IF(.NOT.SUSINP)WRITE(LP,40)IREAD,RCHECK
        IREAD=110
  110   READ(KR,50)PWDELW
        IF(.NOT.SUSINP)WRITE(LP,55)IREAD,PWDELW
C
C       READ TABLE OF HYDRAULIC PRESSURE HEAD VS. THETA (IN BARS)
        IREAD=120
  120   READ(KR,30)RCHECK
        IF(.NOT.SUSINP)WRITE(LP,40)IREAD,RCHECK
        IREAD=130
  130   READ(KR,70) (PWH(I),I=1,PWM)
        IF (.NOT. SUSINP) WRITE (LP,75) IREAD, (PWH(I), I=1,PWM)
C
C       READ CONDUCTIVITY OF CALICHE LAYER CM*2 BAR=1 DAY=1
C       IREAD=140
C 140   READ(KR,30)RCHECK
C       IF(.NOT.SUSINP)WRITE(LP,40)IREAD,RCHECK
C       IREAD=150
C 150   READ(KR,70)PWKCAL
C       IF(.NOT.SUSINP)WRITE(LP,75)IREAD,PWKCAL
        PWKCAL = 0.1E-10
C
C       READ MULTIPLIER OF HYDRAULIC CONDUCTIVITIES
        IREAD = 154
  154   READ (KR,30) RCHECK
        IF (.NOT. SUSINP) WRITE (LP,40) IREAD, RCHECK
        IREAD = 156
  156   READ (KR,50) HCM
        IF (.NOT. SUSINP) WRITE (LP,55) IREAD, HCM
C
C       READ TABLE OF CONDUCTIVITY VS. THETA CM*2 BAR=1 DAY=1
        IREAD=160
  160   READ(KR,30)RCHECK
        IF(.NOT.SUSINP)WRITE(LP,40)IREAD,RCHECK
        IREAD=170
  170   READ(KR,70) (PWKIN(I),I=1,PWM)
        DO 175 I=1,PWM
  175   PWKIN(I) = PWKIN(I) * HCM
        IF (.NOT. SUSINP) WRITE (LP,75) IREAD, (PWKIN(I), I=1,PWM)
C
C       READ LOW AND HIGH PRESSURE LIMITS FOR ANY LAYER, BARS
        IREAD=180
  180   READ(KR,30)RCHECK
        IF(.NOT.SUSINP)WRITE(LP,40)IREAD,PCHECK
        IREAD=190
  190   READ(KR,50)PWHDRY,PWHWET
        IF(.NOT.SUSINP)WRITE(LP,55)IREAD,PWHDRY,PWHWET
        IF (PWHDRY.GE.PWH(1)) GO TO 192
        ERROR = .TRUE.
        WRITE (LP,191)
  191   FORMAT('0',T23,'LOWER LIMIT OF PRESSURE HEAD EXCEEDS LIMIT OF TABL
```

```
     -F OF PRESSURE HEAD VS. THETA.')
  192 IF (PWHWET.LE.PWH(PWM)) GO TO 194
      ERROR = .TRUE.
      WRITE (LP,193)
  193 FORMAT ('0', I15, '* = * = *    ERROR    * = * = *'/ T25,
     1 '    UPPER LIMIT OF PRESSURE HEAD EXCEEDS LIMIT OF TABLE OF PRESSU
     2RE HEAD VS. THETA')
  194 CONTINUE
C
C     READ LARGEST CHANGE IN THETA ALLOWED DURING ANY TWDT
      IREAD=220
  220 READ(KR,30)RCHECK
      IF(.NOT.SUSINP)WRITE(LP,40)IREAD,RCHECK
      IREAD=230
  230 READ(KR,50)PWTLIM
      IF(.NOT.SUSINP)WRITE(LP,55)IREAD,PWTLIM
C
C     MODIFICATION BY W.D.V.
C     CALCULATE LOWER LIMIT OF THETA
      DO 231 I=1,PWM
      IF (PWHDRY-PWH(I))236,234,231
  231 CONTINUE
  234 PWLLIM = (I-1)*PWDELW
      GO TO 238
  236 Q = PWH(I-1)
      PWLLIM = ((I-2) + (Q-PWHDRY)/(Q-PWH(I)))*PWDELW
  238 IF(.NOT.SUSINP)WRITE (LP,239) PWLLIM
  239 FORMAT (T23,'LOWER LIMIT OF THETA =',F8.4)
C
C     TEMPORARY FIX FOR STANDING WATER
C
      TWSTND=0.0
C
C     READ RUNON TO RUNOFF RATIO
C     IREAD=240
C 240 READ(KR,30)RCHECK
C     IF(.NOT.SUSINP)WRITE(LP,40)IREAD,RCHECK
C     IREAD=250
C 250 READ(KR,50)PWRNRF
C     IF(.NOT.SUSINP)WRITE(LP,55)IREAD,PWRNRF
      PWRNRF  = 1.0
C
C     READ INITIAL SWP VALUES AT NODES
      IREAD=260
  260 READ(KR,30)RCHECK
      IF(.NOT.SUSINP)WRITE(LP,40)IREAD,RCHECK
      IREAD=270
  270 READ(KR,50) (SWPN(I),I=1,PMN)
      IF(.NOT.SUSINP)WRITE(LP,55)IREAD, SWPN
C
C     MODIFICATION BY W.D.V
C     CALCULATE INITIAL VALUES OF THETA FROM INITIAL SWP VALUES
C
      DO 320 K=1,PMN
      Q2 = SWPN(K)
      DO 275 I=1,PWM
      IF (Q2-PWH(I))285,280,275
  275 CONTINUE
  280 TWTHB(K) = (I-1)*PWDELW
      GO TO 320
  285 Q1 = PWH(I-1)
      TWTHB(K) = ((I-2) + (Q1-Q2)/(Q1-PWH(I)))*PWDELW
  320 CONTINUE
      IF(.NOT.SUSINP)WRITE (LP,325) TWTHB
  325 FORMAT(T23,'INITIAL VOLUMETRIC WATER CONTENTS AT NODES='/
     -               T23,8F10.5)
      DO 328 I=1,NHORIZ
  328 SWPH(I) = SWPN(I+1)
C
      IF (PRINT) WRITE (LP,330) NHORIZ,PMN
  330 FORMAT ('0',T23,'NHORIZ =',I5,7X,'PMN =',I5)
C
C     READ INITIAL VALUE OF STANDING WATER
      IREAD = 272
  272 READ (KR,30) RCHECK
      IF (.NOT. SUSINP) WRITE (LP,40) IREAD, RCHECK
      IREAD = 274
  274 READ (KR,50) TWSTND
      IF (.NOT. SUSINP) WRITE (LP,55) IREAD, TWSTND
      DUMMYS(3) = TWSTND
C
C     END OF READING NOW DO INITIALIZATIONS
      TWRP=.FALSE.
      TWONE = .FALSE.
      TWDT=PMDT
      TWDTP=PMDT
      PWK(PMN-1)=PWKCAL
      DO 350 I=1,PWM
      TWI=I-1
  350 PWT(I)=TWI*PWDELW
C
C     CALCULATE INITIAL TWHB VALUES FROM TWTHB VALUES JUST READ IN.
C
      DO351 I=1,PMN
      TWJA=TWTHB(I)/PWDELW+1.
      IF(TWJA.GE.PWM)TWJA=PWM-1
      TWAA=(TWTHB(I)-PWT(TWJA))/PWDELW
  351 TWHB(I)=PWH(TWJA)+(PWH(TWJA+1)-PWH(TWJA))*TWAA
C
C     CALCULATE SUM OF CONDUCTIVITY TIMES DELTA PRESSURE
C
      PWKSUM(1)=PWKIN(1)+PWKIN(2)*(PWH(2)-PWH(1))*0.5
      IPWM = PWM-1
      DO 352 I=2,IPWM
  352 PWKSUM(I)=(PWKIN(I)+PWKIN(I+1))*(PWH(I+1)-PWH(I))*0.5+PWKSUM(I-1)
C
C     THIS GIVES US PWM-1 VALUES OF PWKSUM.  I NEED PWM VALUES.  HOKE UP
C     LAST VALUE BY MAKING DIFFERENCE BETWEEN PWM AND PWM-1 VALUES
C     SAME AS BETWEEN PWM-1 AND PWM-2 VALUES.
C
      PWKSUM(PWM)=2.*PWKSUM(PWM-1)-PWKSUM(PWM-2)
      IF (PRINT) WRITE (LP,360)
  360 FORMAT('0',T23,'PWKSUM, SUM OF CONDUCTIVITY TIMES DELTA PRESSURE')
      IF(      PRINT ) WRITE(LP,370)PWKSUM
  370 FORMAT (10(T23,1P7E12.3/))
C
C     TEMPORARY FIX FOR RAIN INTENSITY  (MM/HR)
C
      ZRINT = 1.76
C
      IF (PRINT) WRITE(LP,380)
  380 FORMAT(/T23,'REMEMBER THAT IN CURRENT VERSION OF PROGRAM THERE IS
     -NO RUN-OFF OR RUN-ON, AND RAIN INTENSITY IS FIXED AT 1.76 MM/HR')
C
C
C     IF THE PLANT MODELS ARE NOT BEING USED, WE MUST LOAD
C     NON-ZERO VALUES INTO THE FIRST ROW (I.E., PLANT GROUP) OF 'CVRDST'
C
      IF (NPLNTS .GT. 0) GO TO 500
      Q = 1.0/NHORIZ
      DO 400 I=1,NHORIZ
  400 CVRDST(1,I) = Q
  500 CONTINUE
      RETURN
      END
```

SUBROUTINE DCOMPO

```
BIOME*DESERT2SYM(1).DCOMPO
      SUBROUTINE DCOMPO
C
C     MODEL FOR DECOMPOSITION OF LITTER AND SOIL ORGANIC MATTER
C
C  P81             SOIL TEMPERATURE THRESHOLD BELOW WHICH DECOMPOSITION
C                  DOES NOT OCCUR
C  P82             SOIL WATER POTENTIAL THRESHOLD BELOW WHICH
C                  DECOMPOSITION DOES NOT OCCUR
C  P83             RATE OF RESPIRATION BY LITTER DECOMPOSERS
C                  EXPRESSED AS A FRACTION OF THE OVERALL RELATIVE
C                  RATE OF DECOMPOSITION
C  P1-2            PARAMETERS IN THE LINEAR FUNCTION RELATING SOIL
C                  TEMPERATURE TO DECOMPOSITION RATE OF LITTER
C  P3-4            PARAMETERS IN THE PIECE-WISE LINEAR FUNCTION
C                  RELATING SOIL WATER POTENTIAL TO DECOMPOSITION
C                  RATE OF LITTER
C  P5-8            SAME AS P1-4 BUT FOR SOIL ORGANIC MATTER
C  ILAYER          THE SOIL LAYER WHOSE TEMPERATURE AND SWP VALUES
C                  CONTROL DECOMPOSITION RATES
C
C
      LOGICAL ERROR,PRINT
      LOGICAL SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /ECHOCH/ SUMINP,SUVINP,SUAINP,SUSINP
      COMMON /FILES/ KR, LP, MS1, MS2, MS3, MS1REC, MS2REC, MS3REC
      COMMON /NUMS/ NPLNTS,NANIMS,NORGAN,NELEMS,NFRACT,NOLIT,NFRAC1,
     -        NFRELM,NFRELP,HORDEP(6),NHORIZ,NSCMPT
      COMMON /TYMES/IYRDAY,MDAY,MONTH,IYR,JYR,KYR,IDAY,JDAY,KDAY,
     -        XMONTH(12),ISTEP,NSTEPS,NDAYS
      COMMON /PRTING/ IREP,NREP,MREP(21),IPRINT,NPRINT,MPRINT(21),PRINT,
     -        PLACE(18),UNITS(8)
      COMMON /MISC/ ERROR,RCHECK(20),BLANK
      COMMON /VBLS/ PDM(7,6),PDMO(7),PDMV(6),PDMVO,SEEDDM(7),SEDDMV,
     1 ADM(10),ADMA,DDM(3),DDMT,SDM(1),SDMT,TOTDM,CVEG(7,6,5),SEED(7,5),
     2  CBIOM(10,5),CLIT(3,5),CORG(1,5),CMIN(1,2),PCP(10),CVEGV(6,5),
     3  CVEGO(7,5),CVEGVO(5),AVEG(7,6),AVEGV(6),AVEGO(7),AVEGVO,
     4  SEEDV(5),ASEED(7),ASEEDV,CBIOMA(5),ABIOM(10),ABIOMA,CLITT(5),
     5  ALIT(3),ALITT,CORGH(5),AORG(1),AORGH,CMINH(2),ECOTOT(5),
     6  AECOTO,SWPH(6),SWPN(8),STH(6),STN(8),DUMMYV(50),DUMMYA(30),
     7  DUMMYS(20),OWATER(7),OCARBO(5),OENDOG(6),ONITRO(2),CPRODU(6),
     8  VRATIO(7,6,5),SRATIO(7,5),ARATIO(10,5),DRATIO(3,5),ORATIO(1,5),
     9  FACTV(7,6),FACTS(7),FACTA(10),FACTD(3),FACTO(1),DEFRAT(6,15),
     -  NCATEG,VSPNAM(7,5),ASPNAM(10,5),ORGNAM(6,4),FRANAM(5,3),
     A  ALINAM(3,5)
      COMMON /WTHRV/ DATMIN,DATMAX,DARAIN,DAEVAP,DAPHOT
      COMMON /CHANGE/ CVEGQQ(7,6,5),SEEDQQ(7,5),CBIOMQ(10,5),
     -        CLITQQ(3,5),CORGQQ(1,5),CMINQQ(1,2)
      COMMON /DCOSAV/ P81,P82,P83,ILAYER,P1(5),P2(5),P3(5),P4(5),
     -        P5(5),P6(5),P7(5),P8(5)
      COMMON /FLUX4/ FX6,FX7,FX8,FX9
      DATA SUBNAM/'DCOM'/
C
C
      IF (IDAY.EQ.JDAY)GO TO 1000
      IF(PRINT)WRITE (LP,10)
   10 FORMAT('0--* BEGINNING EXECUTION OF SUBROUTINE ''DCOMP''')
      QT=STH(ILAYER)
      QW=SWPH(ILAYER)
      IF(QT.LT.P81.OR.QW.LT.P82)GO TO 900
C ----------------------------------------------------------------------
C     DECOMPOSITION OF LITTER (INCLUDING STANDING DEAD MATERIAL ABOVE
C     AND BELOW GROUND)
C     ASSUME EACH CHEMICAL CONSTITUENT HAS A DIFFERENT RELATIVE RATE OF
C     DECOMPOSITION
C     ASSUME ONLY ONE LITTER COMPARTMENT
C ----------------------------------------------------------------------
      IF (NOLIT.EQ.0) GO TO 120
      DO 100 K=1,NFRELM
      IF (CLIT(1,K) .LE. 0.0) GO TO 100
      RATE=(P1(K)+P2(K)*QT)*PWLPOS(P3(K),P4(K),1.0,QW)
      IF (RATE*ISTEP .GT. 1.0) RATE = 1.0/FLOAT(ISTEP)
      Q=RATE*CLIT(1,K)
      CLITQQ(1,K)=CLITQQ(1,K)-Q
      IF(K.GT.NELEMS)GO TO 50
      CORGQQ(1,K)=CORGQQ(1,K)+Q
      GO TO 100
   50 A=P83*Q
      FX6 = FX6 + Q*ISTEP
      FX7 = FX7 + (Q-A)*ISTEP
      FX8 = FX8 + A*ISTEP
      CORGQQ(1,K)=CORGQQ(1,K)+(Q-A)
      OCARBO(4)=OCARBO(4)+A* ISTEP
      IF (PRINT)WRITE(LP, 90)K,RATE,Q
   90 FORMAT(T10,'LITLOS FROM K =',I2,' IS ',G15.5,10X,'RATE =',G15.5)
  100 CONTINUE
C ----------------------------------------------------------------------
C     DECOMPOSITION OF SOIL ORGANIC MATTER
C     ASSUME EACH CHEMICAL CONSTITUENT HAS A DIFFERENT RELATIVE RATE
C     OF DECOMPOSITION
C     ASSUME ONLY ONE SOIL ORGANIC MATTER COMPARTMENT
C ----------------------------------------------------------------------
  120 IF (NSCMPT.EQ.0) GO TO 900
      DO 200 K=1,NFRELM
      IF (CORG(1,K) .LE. 0.0) GO TO 200
      RATE=(P5(K)+P6(K)*QT)*PWLPOS(P7(K),P8(K),1.0,QW)
      IF (RATE*ISTEP .GT. 1.0) RATE = 1.0/FLOAT(ISTEP)
      Q=RATE*CORG(1,K)
      IF (K .EQ. IN) ONITRO(1) = ONITRO(1) + Q*ISTEP
      CORGQQ(1,K)=CORGQQ(1,K)-Q
      IF (K.GT.NELEMS)GO TO 150
      CMINQQ(1,K)=CMINQQ(1,K)+Q
      GO TO 200
  150 OCARBO(4)=OCARBO(4)+Q*ISTEP
      FX9 = FX9 + Q*ISTEP
      IF(PRINT)WRITE(LP,190)K,RATE,Q
  190 FORMAT(T10,'SOMLOS FROM K =',I2,' IS ',G15.5,10X,'RATE =',G15.5)
  200 CONTINUE
  900 RETURN
C ----------------------------------------------------------------------
C     INPUT AND INITIALIZATION
C ----------------------------------------------------------------------
 1000 IF(.NOT.SUSINP)WRITE (LP,1010)
 1010 FORMAT('0--* BEGINNING READING OF INPUT TO SUBROUTINE DCOMPO')
 1020 FORMAT(20A4)
 1025 FORMAT(T7,I5,' DCOMP ',4X,20A4)
 1030 FORMAT(14I5)
 1035 FORMAT(T7,I5,' DCOMP ',14I8)
 1050 FORMAT(7F10.0)
 1055 FORMAT(T7,I5,' DCOMP ',7F16.5,10(/T19,7F16.5))
C
C     READ HEADER CARD
      IREAD=2020
```

```
 2020 READ(KR,1020)RCHECK
      IF(.NOT.SUSINP)WRITE(LP,1025)IREAD,RCHECK
      IF(RCHECK(1).NE.SUBNAM)GO TO 2020
C
C     READ SOIL LAYER WHOSE TEMP AND SWP VALUES CONTROL DECOMPOSITION
      IREAD=2040
 2040 READ(KR,1020)RCHECK
      IF(.NOT.SUSINP)WRITE(LP,1025)IREAD,RCHECK
      IREAD =2045
 2045 READ(KR,1030)ILAYER
      IF(.NOT.SUSINP)WRITE(LP,1035)IREAD,ILAYER
C
C     READ TEMP AND SWP THRESHOLDS FOR DECOMPOSITION
      IREAD=2050
 2050 READ(KR,1020)RCHECK
      IF(.NOT.SUSINP)WRITE(LP,1025)IREAD,RCHECK
      IREAD=2055
 2055 READ(KR,1050)P81,P82
      IF(.NOT.SUSINP)WRITE(LP,1055)IREAD,P81,P82
C
C     ---------------------------
C     INPUT FOR LITTER DECOMPOSITION
C     ---------------------------
C
      IF(NOLIT.EQ.0)GO TO 2080
C
C     READ FRACTION OF DECOMPOSITION WHICH IS RESPIRATION
      IREAD=2060
 2060 READ(KR,1020)RCHECK
      IF(.NOT.SUSINP)WRITE(LP,1025)IREAD,RCHECK
      IREAD=2065
 2065 READ(KR,1050)P83
      IF(.NOT.SUSINP)WRITE(LP,1055)IREAD,P83
C
C     READ PARAMETERS FOR LITTER DECOMPOSITION RATES
      IREAD=2070
 2070 READ(KR,1020)RCHECK
      IF(.NOT.SUSINP)WRITE(LP,1025)IREAD,RCHECK
      IREAD=2075
      DO 2076 K=1,NFRELM
 2075 READ(KR,1050)P1(K),P2(K),P3(K),P4(K)
 2076 IF(.NOT.SUSINP)WRITE(LP,1055)IREAD,P1(K),P2(K),P3(K),P4(K)
C
C     ------------------------------------------
C     INPUT FOR SOIL ORGANIC MATTER DECOMPOSITION
C     ------------------------------------------
C
 2080 IF(NSCMPT.EQ.0) GO TO 3000
C
C     READ PARAMETERS FOR SOM DECOMPOSITION
      IREAD = 2100
 2100 READ(KR,1020)RCHECK
      IF(.NOT.SUSINP)WRITE(LP,1025)IREAD,RCHECK
      IREAD=2105
      DO 2106 K=1,NFRELM
 2105 READ(KR,1050)P5(K),P6(K),P7(K),P8(K)
 2106 IF(.NOT.SUSINP)WRITE(LP,1055)IREAD,P5(K),P6(K),P7(K),P8(K)
      FX6 = 0.0
      FX7 = 0.0
      FX8 = 0.0
      FX9 = 0.0
 3000 RETURN
      END
```

Subroutine PWLNEG

```
BIOME*DESERT2SYM(1).PWLNEG
      FUNCTION PWLNEG (A,B,C,X)
C
C     EVALUATION OF A PIECE-WISE LINEAR FUNCTION CONSISTING OF A RAMP
C     (WITH NEGATIVE SLOPE) BETWEEN TWO HORIZONTAL LINES.  THE
C     Y ORDINATE FOR THE LOWER HORIZONTAL LINE IS ZERO AND THE
C     Y ORDINATE FOR THE UPPER HORIZONTAL LINE IS THE PARAMETER 'C'.
C     'A' IS THE VALUE OF X AT THE TOP OF THE RAMP AND 'B' IS THE
C     VALUE OF THE X-INTERCEPT OF THE RAMP.
C
      PWLNEG = 0.0
      D = (B-A)
      IF (D .EQ. 0.0) GO TO 90
      Q =    (B-X) / D
      IF (Q.LT.0.0) Q = 0.0
      IF (Q.GT. 1.0) Q = 1.0
      PWLNEG = Q * C
   90 RETURN
      END
```

Subroutine PWLPOS

```
BIOME*DESERT2SYM(1).PWLPOS
      FUNCTION PWLPOS (A,B,C,X)
C
C     EVALUATION OF A PIECE-WISE LINEAR FUNCTION CONSISTING OF A RAMP
C     (WITH POSITIVE SLOPE) BETWEEN TWO HORIZONTAL LINES.  THE
C     Y ORDINATE FOR THE LOWER HORIZONTAL LINE IS ZERO AND THE
C     Y-ORDINATE FOR THE UPPER HORIZONTAL LINE IS THE PARAMETER 'C'.
C     'A' IS THE X-INTERCEPT OF THE RAMP AND 'B' IS THE VALUE OF X AT
C     THE TOP OF THE RAMP.
C
      PWLPOS = 0.0
      D = (B-A)
      IF (D .EQ. 0.0) GO TO 90
      Q =    (X-A) / D
      IF (Q .LT. 0.0) Q = 0.0
      IF (Q .GT. 1.0)  Q = 1.0
      PWLPOS = Q * C
   90 RETURN
      END
```

Subroutine GENPDF

```
BIOME*DESERT2SYM(1).GENPDF
      FUNCTION GENPDF (A,B,C,D,X)
C
C     EVALUATION OF THE GENERALIZED POISSON DENSITY FUNCTION.  'A' IS
C     THE VALUE OF X WHEN THE FUNCTION ATTAINS ITS MAXIMUM VALUE
C     OF 1.0.  'B' IS THE UPPER X-INTERCEPT.  THE FUNCTION IS NOT
C     DEFINED FOR X B.  'C' AND 'D' ARE CURVATURE PARAMETERS FOR THE
C     DESCENDING AND ASCENDING LIMBS, RESPECTIVELY.  LARGER VALUES
C     MAKE THE LIMS SAG INWARDS.  (ACTUALLY, EACH PARAMETER AFFECTS
C     BOTH LIMBS, BUT TO DIFFERENT DEGREES.)  'X' IS THE VALUE OF
C     THE INDEPENDENT VARIABLE.  AS X BECOMES VERY SMALL THE FUNCTION
C     APPROACHES A HORIZONTAL ASSYMPTOTE WHOSE VALUE IS ZERO.
C
C
      G = (B-X) / (B-A)
      IF (G .LE. 0.0) GO TO 90
      GENPDF = G**C   *   EXP(C/D * (1.0 - G**D) )
      RETURN
   90 GENPDF = 0.0
      RETURN
      END
```

Subroutine RUNAVE

```
BIOME*DESERT2SYM(1).RUNAVE
      FUNCTION RUNAVE (X, N, XX, ISTEP, IS)
      DIMENSION X(N)
C
C     'XX' IS THE NEW VALUE OF X
C     IF 'IS' .EQ. 1, IT IS FIRST DAY OF SIMULATION AND 'X' VECTOR
C     WILL BE FILLED WITH SINGLE VALUE.   IF 'IS' .EQ. 0, 'RA' WILL
C     BE DIRECTLY CALCULATED
C
      IF (IS .EQ. 1) GO TO 50
   10 L = N - ISTEP
      DO 20 I=1,L
      M = I + ISTEP
   20 X(I) = X(M)
      LP1 = L + 1
      DO 30 I=LP1,N
   30 X(I) = XX
      S = 0.0
      DO 40 I=1,N
   40 S = S + X(I)
      RUNAVE = S / N
      RETURN
   50 DO 60 I=1,N
   60 X(I) = XX
      RUNAVE = XX
      RETURN
      END
```

LITERATURE CITED

LOMMEN, P. W., and K. A. MARSHALL. 1976. Programming phase of water response ecosystem model. II. Abiotic submodels. US/IBP Desert Biome Res. Memo. 76-37. Utah State Univ., Logan. 91 pp.

APPENDIX I

Sample Output for Ecosystem Model

```
**************************************************************
*                                                            *
*                       D E S E R T 2                        *
*                       = = = = = = =                        *
*                                                            *
*               UNITED STATES DESERT BIOME                   *
*                                                            *
*                    ECOSYSTEM MODEL                         *
*                                                            *
*                      MARCH 1975                            *
*                                                            *
*                 LAST UPDATE - FEB 1978                     *
*                                                            *
**************************************************************


-------------------------------------------------------------------------------------------
BEGINNING EXECUTION OF SUBROUTINE MINPUT  ---  DEFINITIONS AND INITIALIZATIONS OF STATE VARIABLES
-------------------------------------------------------------------------------------------

  110 MINPUT    CURLEW VALLEY   SOUTHERN SAGE SITE
  110 MINPUT    UPDATED 8 DEC 77 - WDV
  110 MINPUT    UPDATED 5 MAY 78
  110 MINPUT    UPDATED 11 MAY 1978
  110 MINPUT    UPDATED 23 JUNE 1978
  110 MINPUT    CURLEW VALLEY WEATHER FILE UPDATED 27 JUNE 1978
  110 MINPUT
  140 MINPUT    CURLEW VALLEY   SOUTHERN SAGE SITE
  145 MINPUT    F    F    F    F    T
  150 MINPUT    F    F    F    F    T    T
  160 MINPUT    F    F    F    F
  170 MINPUT    GRAMS PER SQUARE METER
  180 MINPUT       2      3      3      5      0      1      1      6

             2 NONCARBON CHEMICAL CONSTITUENTS(S)
             3 TYPE(S) OF CARBON
             3 PLANT GROUP(S)
             5 PLANT ORGAN(S)
             0 ANIMAL GROUP(S)
             1 TYPE(S) OF DEAD ORGANIC MATTER
             1 SOIL ORGANIC MATTER COMPARTMENT(S)
             6 SOIL HORIZON(S)

  380 MINPUT     1 JAN 1973
  410 MINPUT       1
  430 MINPUT     1 JAN 1976

                SIMULATION WILL RUN FROM  1 JAN 1973 TO  1 JAN 1976
                JDAY =   1      KDAY =  1081
                LENGTH OF TIME-STEP IN DAYS =   1
                NUMBER OF TIME-STEPS DURING SIMULATION = 1080

  281 READAT       2
  282 READAT     1 JAN 1974
  282 READAT     1 JAN 1975
  281 READAT       0
  505 MINPUT        NITROGEN
  505 MINPUT             ASH
  505 MINPUT       PROTEIN C
  505 MINPUT        LABILE C
  505 MINPUT        STRUCT C
  515 MINPUT    ARTEMISIA TRIDENTATA
  515 MINPUT    ATRIPLEX CONFERTIFOL
  515 MINPUT    SITANION HYSTRIX
  525 MINPUT    LEAVES
  525 MINPUT    TWIGS
  525 MINPUT    OLD STEMS
  525 MINPUT    INFLORESCENCES
  525 MINPUT    ROOTS
  565 MINPUT    LITTER
  590 MINPUT    PLANT BIOMASS
  595 MINPUT         .00000        1.00000        .00000        .00000        .00000        .00000
  595 MINPUT         .00000        2.00000        .00000        .00000        .00000        .00000
  595 MINPUT      300.00000        2.00000        .00000        .00000        .00000        .00000
  595 MINPUT         .00000        1.00000        .00000        .00000        .00000        .00000
  595 MINPUT     1935.00000        2.00000        .00000        .00000        .00000        .00000
  595 MINPUT         .00000        1.00000        .00000        .00000        .00000        .00000
  595 MINPUT         .00000        2.00000        .00000        .00000        .00000        .00000
  595 MINPUT      150.00000        2.00000        .00000        .00000        .00000        .00000
  595 MINPUT         .00000        1.00000        .00000        .00000        .00000        .00000
  595 MINPUT      963.00000        2.00000        .00000        .00000        .00000        .00000
  595 MINPUT         .00000        1.00000        .00000        .00000        .00000        .00000
  595 MINPUT         .00000        1.00000        .00000        .00000        .00000        .00000
  595 MINPUT         .00000        1.00000        .00000        .00000        .00000        .00000
  595 MINPUT         .00000        1.00000        .00000        .00000        .00000        .00000
  595 MINPUT       97.00000        1.00000        .00000        .00000        .00000        .00000
  572 INITIL    SEED BIOMASSES
  575 INITIL        .10000        3.00000        .00000        .00000        .00000        .00000
  575 INITIL       3.00000        3.00000        .00000        .00000        .00000        .00000
  575 INITIL       1.50000        3.00000        .00000        .00000        .00000        .00000
  572 INITIL    DEAD ORGANIC MATTER
  575 INITIL     625.00000        5.00000        .00000        .00000        .00000        .00000
  572 INITIL    SOIL ORGANIC MATTER
  575 INITIL    9000.00000        6.00000        .00000        .00000        .00000        .00000
  770 MINPUT    AVAILABLE SOIL MINERALS
  775 MINPUT      50.00000      100.00000
  800 MINPUT    DEPTHS OF LOWER SURFACES OF SOIL LAYERS  --  IN CM
  810 MINPUT       5.00000       15.00000       25.00000     3[illegible].00000     45.00000     [illegible].00000

-------------------------------------------------------------------------------------------
BEGINNING EXECUTION OF SUBROUTINE GINPUT  ---  READING OF INSTRUCTIONS FOR GRAPHICAL OUTPUT
-------------------------------------------------------------------------------------------

   90 GINPUT    GINPUT
  140 GINPUT    3 TOTAL DRY MATTER
  190 GINPUT    FF                 .00        .00
  230 GINPUT    DDMT      0      0      0                       DEAD, LITTER
  230 GINPUT    ODMT      0      0      0                       SOIL ORG MATTER
  230 GINPUT    TODM      0      0      0                       ECOSYSTEM
  140 GINPUT    3 ARTEMISIA
  190 GINPUT    FF                 .00        .00
  230 GINPUT    VDM       1      1      0                       LEAF
  230 GINPUT    VDM       1      2      0                       TWIG
  230 GINPUT    VDM       1      4      0                       INFLORESCENCE
  140 GINPUT    3 ATRIPLEX
  190 GINPUT    FF                 .00        .00
  230 GINPUT    VDM       2      1      0                       LEAF
  230 GINPUT    VDM       2      2      0                       TWIG
  230 GINPUT    VDM       2      4      0                       INFLORESCENCE
  140 GINPUT    1 SITANION
  190 GINPUT    FF                 .00        .00
  230 GINPUT    VDM       3      1      0                       ABOVE-GROUND GREEN
  140 GINPUT    3 BELOW-GROUND LIVE
  190 GINPUT    FF                 .00        .00
  230 GINPUT    VDM       1      5      0                       ARTEMISIA
```

```
     230 GINPUT     VDM      2     5     0                        ATRIPLEX
     230 GINPUT     VDM      3     5     0                        SITANION
     140 GINPUT     2 OLD LIVE STEM
     190 GINPUT     FF                  .00         .00
     230 GINPUT     VDM      1     3     0                        ARTEMISIA
     230 GINPUT     VDM      2     3     0                        ATRIPLEX
     140 GINPUT     2 SOIL WATER POTENTIALS
     190 GINPUT     FF                  .00         .00
     230 GINPUT     SWPH     1     0     0                        LAYER 1
     230 GINPUT     SWPH     4     0     0                        LAYER 4
     140 GINPUT     2 SOIL WATER POTENTIALS
     190 GINPUT     FF                  .00         .00
     230 GINPUT     SWPH     2     0     0                        LAYER 2
     230 GINPUT     SWPH     5     0     0                        LAYER 5
     140 GINPUT     2 SOIL WATER POTENTIALS
     190 GINPUT     FF                  .00         .00
     230 GINPUT     SWPH     3     0     0                        LAYER 3
     230 GINPUT     SWPH     6     0     0                        LAYER 6
     140 GINPUT     1 MM OF WATER IN SOIL PROFILE
     190 GINPUT     FF                  .00         .00
     230 GINPUT     DUMS     1     0     0                        MM IN PROFILE
     140 GINPUT     3 WATER BUDGET -     MILLIMETERS
     190 GINPUT     FF                  .00         .00
     230 GINPUT     DUMV    49     0     0                        TRANSPIRATION
     230 GINPUT     DUMS     2     0     0                        EVAPORATION
     230 GINPUT     DUMS     3     0     0                        STANDING WATER
     140 GINPUT     2 TEMPERATURES USED BY CO2 FIXATION SUBMODEL
     190 GINPUT     FF                  .00         .00
     230 GINPUT     DUMV    50     0     0                        ACTUAL TEMP
     230 GINPUT     DUMV    10     0     0                        ART, OPTIMUM
     140 GINPUT     2 CO2 FIXATION  --  MG CO2 PER GRAM DRY MATTER PER HOUR
     190 GINPUT     FF                  .00         .00
     230 GINPUT     DUMA     1     0     0                        ART, MAXIMUM
     230 GINPUT     DUMV    13     0     0                        ART, PREDICTED
     140 GINPUT     2 CO2 FIXATION  --  MG CO2 PER GRAM DRY MATTER PER HOUR
     190 GINPUT     FF                  .00         .00
     230 GINPUT     DUMA     3     0     0                        SIT, MAXIMUM
     230 GINPUT     DUMV    15     0     0                        SIT, PREDICTED
     140 GINPUT     3 DRY MATTER FIXED DURING TIME-STEP
     190 GINPUT     FF                  .00         .00
     230 GINPUT     DUMV    16     0     0                        ARTEMISIA
     230 GINPUT     DUMV    17     0     0                        ATRIPLEX
     230 GINPUT     DUMV    19     0     0                        SITANION
     140 GINPUT     1 RUNNING AVERAGE OF MEAN AIR TEMP  -  USED BY PHENOLOGY MODEL
     190 GINPUT     FF                  .00         .00
     230 GINPUT     DUMA    30     0     0
     140 GINPUT     2 SOIL TEMPERATURES
     190 GINPUT     FF                  .00         .00
     230 GINPUT     STH      1     0     0                        LAYER 1
     230 GINPUT     STH      6     0     0                        LAYER 6
     140 GINPUT     0 STOP

                    A TOTAL OF 37 CURVES WILL BE PLOTTED ON 17 GRAPHS
                    ADDRESSES OF VARIABLES TO BE GRAPHED:
                          79        81        82         1         8        22         2         9        27         7
                          29        30        31        15        16       589       592       590       593       591
                         594       697       665       698       699       666       626       667       629       669
                         631       632       633       634       696       603       608

--------------------------------------------------------------------------------------------------------
BEGINNING EXECUTION OF SUBROUTINE EINPUT    --  READING OF EXOGENOUS VARIABLES
--------------------------------------------------------------------------------------------------------
     110 EINPUT     EINPUT                                                            00014800
     140 EINPUT     ADJUSTMENT CONSTANTS FOR TEMP , RAIN, AND EVAP
     150 EINPUT           .0000          1.0000         1.0000
     200 EINPUT     YEARS WHEN WEATHER DATA ON DISK BEGIN AND END
     210 EINPUT      1973 1975
     610 EINPUT     LATITUDE
     620 EINPUT          42.0000
     660 EINPUT     FLAG PRECIPITATION EVENTS
     670 EINPUT     F

FIRST RECORD READ FROM WEATHER FILE WILL BE          1

---* EXECUTING SUBROUTINE EXOGEN
      DATMIN  DATMAX  DARAIN  DAEVAP  DAPHOT
      -11.1    -2.2     .0      .0      9.3
ERROR = F
    1010 VINPUT     VEGET INPUT                                                       00017800
    1980 VINPUT     SOIL LAYER FOR LEAF-OUT
    1990 VINPUT        4        4        4
    2000 VINPUT     SOIL LAYER FOR REPRODUCTIVE PHASE
    2010 VINPUT        4        4        4
    2020 VINPUT     HERB                                                              00018100
    2030 VINPUT        F        F        T
    2040 VINPUT     ANNUAL                                                            00018300
    2050 VINPUT        F        F        F
    2060 VINPUT     CURRENT PHENOLOGICAL STAGES                                       00018500
    2070 VINPUT        5        5        5
    2080 VINPUT     TISNEW                                                            00018700
    2090 VINPUT           .00000          .00000          .00000
    3000 VINPUT     TIME                                                              00018900
    3010 VINPUT           .00000          .00000          .00000
    3020 VINPUT     NUMBER OF DAYS FOR COMPUTING RUNNING AVE OF AIR TEMP
    3030 VINPUT       30

---* BEGINNING READING OF INPUT TO SUBROUTINE PHENOL

    2020 PHENOL     PHENOL                                                            00019100
    2050 PHENOL     JULIAN DATE OF TRANSFER FROM YOUNG STEMS TO OLD STEMS             00021900
    2060 PHENOL        1        1        1
    2080 PHENOL     THRESHOLDS FOR PHENOLOGY -- ONE CARD PER PLANT GROUP
    2090 PHENOL          6.00000     -20.00000     -55.00000      80.00000     -40.00000     -80.00000      9.00000

    2090 PHENOL          5.00000     -20.00000     -16.00000      30.00000     -15.00000     -80.00000      9.00000

    2090 PHENOL          5.00000     -20.00000     -20.00000      30.00000     -15.00000     -80.00000      9.00000

    3010 PHENOL     GERMINATION WITH FALLING TEMP
    3020 PHENOL       F   F   F
    3030 PHENOL     DATES BETWEEN WHICH THERE CAN BE NO GERMINATION OR LEAFING-OUT
    3040 PHENOL        1        1        1
    3050 PHENOL       60       60       60

---* BEGINNING READING OF INPUT TO SUBROUTINE PHOTOS
    1010 PHOTOS     PHOTOS                                                            00022000
    1040 PHOTOS     1-MAXRATE, 1-NOT USED, 4-TEMP, 2-SWP, 2-TEMP SHIFT, 2-MAX RATE SHIFT  00022100
    1050 PHOTOS         20.00000        .00000      15.00000      30.00000       3.50000       1.50000     -80.00000
                        -5.00000        .00000     210.00000       5.00000     340.00000       1.00000        .00000

    1050 PHOTOS         28.00000        .00000      15.00000      30.00000       3.50000       1.50000     -80.00000
                        -5.00000        .00000     210.00000       5.00000     340.00000       1.00000        .00000

    1050 PHOTOS         24.00000        .00000      15.00000      30.00000       3.50000       1.50000     -90.00000
                        -5.00000        .00000        .00000        .00000        .00000       1.00000        .00000

    1080 PHOTOS     SCALING FACTOR        TEMP ADJ FACTOR
    1090 PHOTOS          .64000          .75000
    2050 PHOTOS     MULTIPLIERS OF MAX PHOTOSYNTHETIC RATES
    2060 PHOTOS         1.00000         1.00000         1.00000

---* BEGINNING READING OF INPUT TO SUBROUTINE RESPIR
    2020 RESPIR     RESPIR                                                            00023600
    2050 RESPIR     2-TEMP, 1-NOT USED, 2-SWP, 2-TEMP. ADJUSTMENT                     00023700
    2060 RESPIR          .00000         .00000         .00000     -40.00000      -5.00000        .00000        .00000
    2060 RESPIR          .00000         .00000         .00000     -40.00000      -5.00000        .00000        .00000
```

```
     2060 RESPIR         .00000         .00000         .00000     -40.00000      -5.00000        .00000        .00000
     2060 RESPIR         .00000         .00000         .00000     -40.00000      -5.00000        .00000        .00000
     2060 RESPIR         .00000         .00000         .00000     -40.00000      -5.00000        .00000        .00000

---* BEGINNING READING OF INPUT TO SUBROUTINE TRANSP
     2020 TRANSP    TRANSP                                                    00024300
     2050 TRANSP    CONVERT FROM UNITS OF SIMULATION TO KG/HA
     2060 TRANSP        10.00000
     2070 TRANSP    ROOT DISTRIBUTION      1 CARD FOR EACH PLANT GROUP        00024600
     2080 TRANSP         .15000         .25000         .40000         .21000         .00000        .00000
     2080 TRANSP         .10000         .20000         .25000         .20000         .15000        .10000
     2080 TRANSP         .10000         .20000         .25000         .20000         .15000        .10000
     3010 TRANSP    PARAMETERS IN TRANSPIRATION FUNCTION  -  2 FOR EACH PLANT GROUP
     3020 TRANSP       180.00000       10.00000
     3020 TRANSP       180.00000       10.00000
     3020 TRANSP       180.00000       10.00000

---* BEGINNING READING OF INPUT TO SUBROUTINE TRANSL
     2020 TRANSL    TRANSL                                                    00025400
     2050 TRANSL    3 FOR G/LO RATE, 3 FOR DIST TO ORGANS, 1 CARD PER SPECIES
     2060 TRANSL      -40.00000      -15.00000         .05900        1.00000         .00000        .00000
     2060 TRANSL      -40.00000      -15.00000         .09400        1.00000         .00000        .00000
     2060 TRANSL      -40.00000      -15.00000         .27300        1.00000         .00000        .00000
     2090 TRANSL    3-FRACTION OF REPR TISSUE IN SEED AS FCTN OF TIME         00026000
     3000 TRANSL       20.00000       40.00000         .50000
     3000 TRANSL       20.00000       40.00000         .50000
     3000 TRANSL       20.00000       40.00000         .50000
     3010 TRANSL    ALLOCATION OF PHOTOSYNTHATE TO ORGANS - 2 CARDS FOR EACH PLANT GROUP   00000283
     3020 TRANSL         .16000         .02000         .07000         .00700         .75000
     3020 TRANSL         .13000         .02000         .05000         .09000         .75000
     3020 TRANSL         .19000         .02000         .04000         .00000         .75000
     3020 TRANSL         .14000         .02000         .03000         .06000         .75000
     3020 TRANSL         .25000         .00000         .00000         .00000         .75000
     3020 TRANSL         .19000         .00000         .00000         .06000         .75000

---* BEGINNING READING OF INPUT TO SUBROUTINE ALOCAT
     2020 ALOCAT    ALOCAT                                                    00027300
     2050 ALOCAT    ALLOCATION TO CARBON TYPES   -  HERB AND WOODY
     2060 ALOCAT         .14000         .48000         .38000
     2060 ALOCAT         .14000         .12000         .74000

---* BEGINNING READING OF INPUT TO SUBROUTINE DEATHH
     2020 DEATHH    DEATH                                                     00027900
     2050 DEATHH    2-ABSCISSION, 3-DEATH
     2060 DEATHH       14.00000       60.00000     -100.00000       -5.00000         .00072
     2060 DEATHH       14.00000       60.00000     -100.00000       -5.00000         .00290
     2060 DEATHH       14.00000       60.00000     -100.00000       -5.00000         .01500
ERROR = F
ERROR = F

-------------------------------------------------------------------------------------
BEGINNING READING OF INPUT TO SOIL SUBROUTINES
-------------------------------------------------------------------------------------
     1060 SOILSS    SOILS INPUT                                               00038800
ERROR = F

---* BEGINNING READING OF INPUT TO SUBROUTINE SLHEAT
     1010 SLHEAT    HEAT                                                      00038900
     2100 SLHEAT    SPECIFIC HEAT OF EACH SOIL HORIZON                        00039000
     2105 SLHEAT         .08500         .08600         .08700         .08800         .08900        .09000
     2110 SLHEAT    CONDUCTIVITY AT PMN-1 POINTS                              00039200
     2120 SLHEAT      390.00000      380.00000      370.00000      360.00000      350.00000     340.00000     330.00000

     2130 SLHEAT    INITIAL SOIL TEMPERATURES                                 00039400
     2140 SLHEAT       -5.80000       -5.80000       -5.80000       -5.70000       -5.60000      -5.60000      -5.50000
                   -5.50000
ERROR = F

---* BEGINNING READING OF INPUT TO SUBROUTINE SLWATR
       20 WINPUT    WATER                                                     00040300
       80 WINPUT    NO ENTRIES IN TABLES          -PWM-
       90 WINPUT      53
      100 WINPUT    INCREMENT IN TABLES         -PWDELW-
      110 WINPUT         .01000
      120 WINPUT    HYDRAULIC PRESSURE HEAD TABLE         -PWH-
      130 WINPUT      -.8063+03      -.4916+03      -.1967+03      -.9830+02      -.6500+02     -.3930+02     -.2920+02
                     -.26000+02     -.22950+02     -.20180+02     -.17650+02     -.15360+02    -.13280+02    -.11380+02
                     -.96600+01     -.80900+01     -.66700+01     -.53800+01     -.42000+01    -.31300+01    -.21600+01
                     -.16700+01     -.13800+01     -.11300+01     -.98000+00     -.88000+00    -.81000+00    -.74000+00
                     -.68000+00     -.62000+00     -.57000+00     -.52000+00     -.47000+00    -.42000+00    -.37000+00
                     -.34000+00     -.31000+00     -.28000+00     -.25000+00     -.22000+00    -.20000+00    -.18000+00
                     -.16000+00     -.14000+00     -.12000+00     -.10000+00     -.80000-01    -.60000-01    -.40000-01
                     -.20000-01     -.10000-01     -.10000-02     -.10000-03
      154 WINPUT    MULTIPLIER OF HYDRAULIC CONDUCTIVITIES
      156 WINPUT        1.00000
      160 WINPUT    CONDUCTIVITY TABLE       -PWKIN-
      170 WINPUT       .1950-03       .2440-03       .3660-03       .4880-03       .6830-03      .9270-03      .1270-02
                     .17100-02      .23400-02      .31700-02      .41500-02      .56100-02     .78100-02     .10700-01
                     .14600-01      .19800-01      .26800-01      .36600-01      .51300-01     .70800-01     .92700-01
                     .13200+00      .17600+00      .24200+00      .34200+00      .46300+00     .10000+00     .85400+00
                     .11700+01      .15900+01      .22000+01      .29300+01      .41500+01     .56100+01     .78100+01
                     .10740+02      .14160+02      .17080+02      .20990+02      .24400+02     .29300+02     .36600+02
                     .43900+02      .53700+02      .63500+02      .78100+02      .92800+02     .11230+03     .13670+03
                     .16110+03      .19530+03      .23920+03      .29230+03
      180 WINPUT    PWHDRY    PWHWET                                          00042800
      190 WINPUT      -80.00000       -.00100
      220 WINPUT    LARGEST CHANGE IN THETA ALLOWED DURING ANY TWDT      -PWTLTM-
      230 WINPUT         .01000
                    LOWER LIMIT OF THETA =    .0355
      260 WINPUT    INITIAL PRESSURE HEAD VALUES AT PMN NODES  - IN BARS
      270 WINPUT       -6.30000       -6.30000       -7.30000      -21.00000      -45.10000     -40.60000     -30.50000
                     -30.50000
                    INITIAL VOLUMETRIC WATER CONTENTS AT NODES=
                        .16287     .16287     .15556     .09704     .04774     .04949     .05871     .05871
      272 WINPUT    INITIAL VALUE OF STANDING WATER
      274 WINPUT       17.00000
ERROR = F

                 MM OF WATER IN SOIL PROFILE AT START OF SIMULATION =    48.0

---* BEGINNING READING OF INPUT TO SUBROUTINE DCOMPO
     2020 DCOMP     DCOMP MODEL                                               00043700
     2040 DCOMP     ILAYER                                                    00043800
     2045 DCOMP       4
     2050 DCOMP     ST AND SWP THRESHOLDS                                     00044000
     2055 DCOMP        1.00000      -80.00000
     2060 DCOMP     RESP AS FRACTION OF DCOMP                                 00044200
     2065 DCOMP         .75000
     2070 DCOMP     2-DOM RATE VS. TEMP.  2-DOM RATE VS. SWP
     2075 DCOMP         -.00001         .00001      -80.00000       -1.00000
     2075 DCOMP         -.00001         .00001      -80.00000       -1.00000
     2075 DCOMP         -.00001         .00001      -80.00000       -1.00000
     2075 DCOMP         -.00001         .00001      -80.00000       -1.00000
     2075 DCOMP         -.00001         .00001      -80.00000       -1.00000
     2100 DCOMP     2-SOM RATE VS. TEMP.  2-SOM RATE VS. SWP
     2105 DCOMP         -.00001         .00001      -80.00000       -1.00000
     2105 DCOMP         -.00001         .00001      -80.00000       -1.00000
     2105 DCOMP         -.00001         .00001      -80.00000       -1.00000
     2105 DCOMP         -.00001         .00001      -80.00000       -1.00000
     2105 DCOMP         -.00001         .00001      -80.00000       -1.00000
ERROR = F
ERROR = F

   =*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*
   *=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=

   READING OF INPUT FILE COMPLETED  --  NO DETECTABLE ERRORS
```

CURLEW VALLEY SOUTHERN SAGE SITE

INITIAL CONDITIONS ON 1 JAN 1973 JULIAN DAY = 1

ALL BIOMASS UNITS ARE GRAMS PER SQUARE METER

CONSITIUENTS OF VEGETATIONAL BIOMASS

	NITROGEN	ASH	PROTEIN C	LABILE C	STRUCT C	TOTAL C	DRY MATTER
ARTEMISIA TRIDENTATA							
OLD STEMS	6.0000	24.0000	18.0000	15.0000	93.0000	126.0000	300.0000
ROOTS	38.7000	154.8000	116.1000	96.7500	599.8500	812.7000	1935.0000
TOTAL	44.7000	178.8000	134.1000	111.7500	692.8500	939.7000	2234.9999
ATRIPLEX CONFERTIFOL							
OLD STEMS	3.0000	12.0000	9.0000	7.5000	46.5000	63.0000	150.0000
ROOTS	19.3600	77.4400	58.0800	48.4000	300.0800	406.5600	968.0000
TOTAL	22.3600	89.4400	67.0800	55.9000	346.5800	469.5600	1118.0000
SITANION HYSTRIX							
ROOTS	1.9400	7.7600	5.8200	19.4000	15.5200	40.7400	97.0000
TOTAL	1.9400	7.7600	5.8200	19.4000	15.5200	40.7400	97.0000
ALL SPECIES							
LEAVES	.0000	.0000	.0000	.0000	.0000	.0000	.0000
TWIGS	.0000	.0000	.0000	.0000	.0000	.0000	.0000
OLD STEMS	9.0000	36.0000	27.0000	22.5000	139.5000	189.0000	450.0000
INFLORESCENCES	.0000	.0000	.0000	.0000	.0000	.0000	.0000
ROOTS	60.0000	240.0000	180.0000	164.5500	915.4500	1260.0000	2999.9999
TOTAL	69.0000	276.0000	207.0000	187.0500	1054.9500	1449.0000	3449.9999

CONSTITUENTS OF SHED SEEDS

	NITROGEN	ASH	PROTEIN C	LABILE C	STRUCT C	TOTAL C	DRY MATTER
ARTEMISIA TRIDENTATA	.0050	.0050	.0150	.0240	.0050	.0440	.1000
ATRIPLEX CONFERTIFOL	.1500	.1500	.4500	.7200	.1500	1.3200	3.0000
SITANION HYSTRIX	.0750	.0750	.2250	.3600	.0750	.6600	1.5000
TOTAL	.2300	.2300	.6900	1.1040	.2300	2.0240	4.6000

CONSTITUENTS OF DEAD ORGANIC MATERIAL

	NITROGEN	ASH	PROTEIN C	LABILE C	STRUCT C	TOTAL C	DRY MATTER
LITTER	1.87	62.50	5.62	6.25	243.75	255.62	625.00

CONSTITUENTS OF SOIL ORGANIC MATTER

	NITROGEN	ASH	PROTEIN C	LABILE C	STRUCT C	TOTAL C	DRY MATTER
.0 TO 55.0 CM	135.00	270.00	360.00	360.00	2880.00	3600.00	9000.00

CONSTITUENTS OF TOTAL ORGANIC MATTER IN ECOSYSTEM

NITROGEN	ASH	PROTEIN C	LABILE C	STRUCT C	TOTAL C	DRY MATTER
206.10	608.73	573.31	554.40	4178.93	5306.65	13079.60

AVAILABLE SOIL MINERALS

	NITROGEN	ASH
.0 TO 55.0 CM	50.00	100.00

	SOIL WATER POTENTIAL (BARS)	SOIL TEMPERATURE (CELSIUS)
.0 TO 5.0 CM	-6.3	-5.8
5.0 TO 15.0 CM	-7.3	-5.8
15.0 TO 25.0 CM	-21.0	-5.7
25.0 TO 35.0 CM	-45.1	-5.5
35.0 TO 45.0 CM	-40.6	-5.6
45.0 TO 55.0 CM	-30.5	-5.5

WATER BUDGET (MILLIMETERS)

PRECIPITATION	TRANSPIRATION	EVAPORATION	WATER IN PROFILE	CHANGE IN PROFILE	STANDING WATER
.00	.00	.00	48.00	.00	17.00

CURLEW VALLEY SOUTHERN SAGE SITE

FINAL REPORT ON 1 JAN 1976 JULIAN DAY = 1 DAYS ELAPSED = 1080 TIME-STEPS ELAPSED = 1080

ALL BIOMASS UNITS ARE GRAMS PER SQUARE METER

CONSITIUENTS OF VEGETATIONAL BIOMASS

	NITROGEN	ASH	PROTEIN C	LABILE C	STRUCT C	TOTAL C	DRY MATTER
ARTEMISIA TRIDENTATA							
OLD STEMS	5.6840	31.4665	17.7626	12.5707	92.0215	122.3548	291.3209
ROOTS	38.0543	121.0093	118.9196	84.5986	616.5352	820.0534	1952.5081
TOTAL	43.7383	152.4758	136.6822	97.1693	708.5567	942.4082	2243.8290
ATRIPLEX CONFERTIFOL							
OLD STEMS	2.1818	6.6281	6.8180	4.7982	35.4238	47.0400	112.0000
ROOTS	17.6379	42.7735	55.1184	39.5060	287.3752	381.9996	909.5228
TOTAL	19.8196	49.4016	61.9364	44.3042	322.7990	429.0396	1021.5228
SITANION HYSTRIX							
ROOTS	1.5836	.0000	4.9487	14.4420	13.4166	32.8073	78.1126
TOTAL	1.5836	.0000	4.9487	14.4420	13.4166	32.8073	78.1126
ALL SPECIES							
LEAVES	.0000	.0000	.0000	.0000	.0000	.0000	.0000
TWIGS	.0000	.0000	.0000	.0000	.0000	.0000	.0000
OLD STEMS	7.8658	27.0947	24.5806	17.3689	127.4453	169.3948	403.3209
INFLORESCENCES	.0000	.0000	.0000	.0000	.0000	.0000	.0000
ROOTS	57.2757	174.7828	178.9866	138.5466	917.3270	1234.8603	2940.1435
TOTAL	65.1415	201.8774	203.5672	155.9155	1044.7723	1404.2551	3343.4644

CONSTITUENTS OF SHED SEEDS

	NITROGEN	ASH	PROTEIN C	LABILE C	STRUCT C	TOTAL C	DRY MATTER
ARTEMISIA TRIDENTATA	.0189	.0050	.0582	.1721	.1222	.3525	.8010
ATRIPLEX CONFERTIFOL	.1604	.1500	.4824	.8309	.2378	1.5511	3.5253
SITANION HYSTRIX	.0838	.0750	.2524	.4541	.1495	.8560	1.9454
TOTAL	.2630	.2300	.7930	1.4571	.5095	2.7596	6.2717

CONSTITUENTS OF DEAD ORGANIC MATERIAL

	NITROGEN	ASH	PROTEIN C	LABILE C	STRUCT C	TOTAL C	DRY MATTER
LITTER	33.48	132.76	104.01	187.78	637.91	929.70	2273.11

CONSTITUENTS OF SOIL ORGANIC MATTER

	NITROGEN	ASH	PROTEIN C	LABILE C	STRUCT C	TOTAL C	DRY MATTER
.0 TO 55.0 CM	130.09	262.92	345.81	346.12	2767.00	3458.92	8647.31

CONSTITUENTS OF TOTAL ORGANIC MATTER IN ECOSYSTEM

NITROGEN	ASH	PROTEIN C	LABILE C	STRUCT C	TOTAL C	DRY MATTER
228.98	597.79	654.18	691.27	4450.19	5795.64	14270.15

AVAILABLE SOIL MINERALS

	NITROGEN	ASH
.0 TO 55.0 CM	27.13	111.05

	SOIL WATER POTENTIAL (BARS)	SOIL TEMPERATURE (CELSIUS)
.0 TO 5.0 CM	-.2	-6.6
5.0 TO 15.0 CM	-2.1	-6.4
15.0 TO 25.0 CM	-65.0	-6.1
25.0 TO 35.0 CM	-72.3	-5.9
35.0 TO 45.0 CM	-62.1	-5.7
45.0 TO 55.0 CM	-44.5	-5.6

WATER BUDGET (MILLIMETERS)

PRECIPITATION	TRANSPIRATION	EVAPORATION	WATER IN PROFILE	CHANGE IN PROFILE	STANDING WATER
742.50	399.76	353.56	56.47	8.47	.00

ACCUMULATED EXCHANGES OF CARBON BETWEEN ECOSYSTEM AND ATMOSPHERE

CARBON FIXATION	PLANT RESPIRATION	ANIMAL RESPIRATION	DECOMPOSER RESPIRATION	NET CHANGE IN ECOSYSTEM
651.44	.00	.00	162.46	488.98

SELECTED CUMULATIVE ENDOGENOUS CARBON FLOWS

GRANIVORY	HERBIVORY	WASTAGE	ABSCISSION AND DEATH	GERMINATION	LEAFING-OUT
.00	.00	.00	696.18	.00	42.82

ESTIMATED CUMULATIVE NET PRODUCTION OF DRY MATTER

ANNUAL	PERENNIAL	PRIMARY	SECONDARY	ANNUAL-BG	PERENNIAL-BG
.00	1628.59	1628.59	.00	.00	1221.44

ACCUMULATED NITROGEN FLOWS

MINERALIZATION	PLANT UPTAKE
.00	28.37

GROSS DRY MATTER PRODUCTION BY PLANT GROUP
459.174 717.524 452.895

CARBON FLOWS BY PLANT GROUPS

GERMINATION AND LEAFING-OUT	18.619	13.560	10.645
PHOTOSYNTHESIS	183.270	287.010	181.158
RESPIRATION	.000	.000	.000
SEED MATURATION	.312	.243	.252
SEED SHEDDING	.308	.231	.196
ABSCISSION AND DEATH	179.561	327.530	183.091

LOSS FROM STANDING DEAD + LITTER, PORTION PASSED TO SOIL ORGANIC MATTER, PORTION LOST AS RESPIRATION, RESPIRATION LOSS FROM SOM
21.371 5.343 16.028 146.432

PHOTOSYNTHETIC CARBON ADDED TO EACH OF 5 ORGANS OF EACH OF 3 SPECIES, AND TOTAL TO EACH ORGAN FOR ALL SPECIES, AND LATTER TOTAL AS PERCENTAGE OF GRAND TOTAL

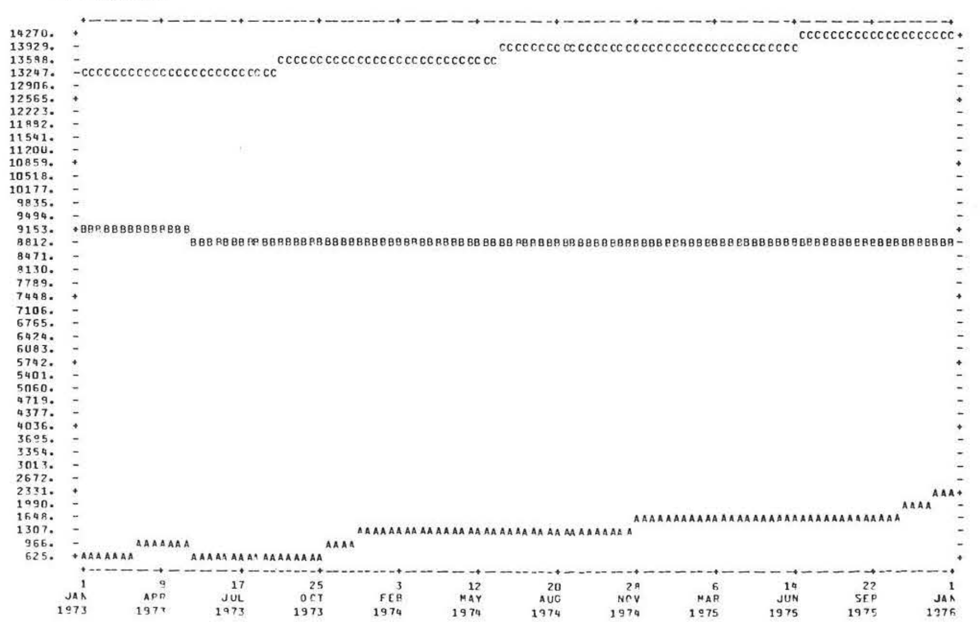
1	28.728	51.566	42.536	122.831	.189
2	3.665	5.740	.000	9.406	.014
3	12.432	10.887	.000	23.320	.036
4	.991	3.559	2.753	7.303	.011
5	137.452	215.257	135.868	488.578	.750

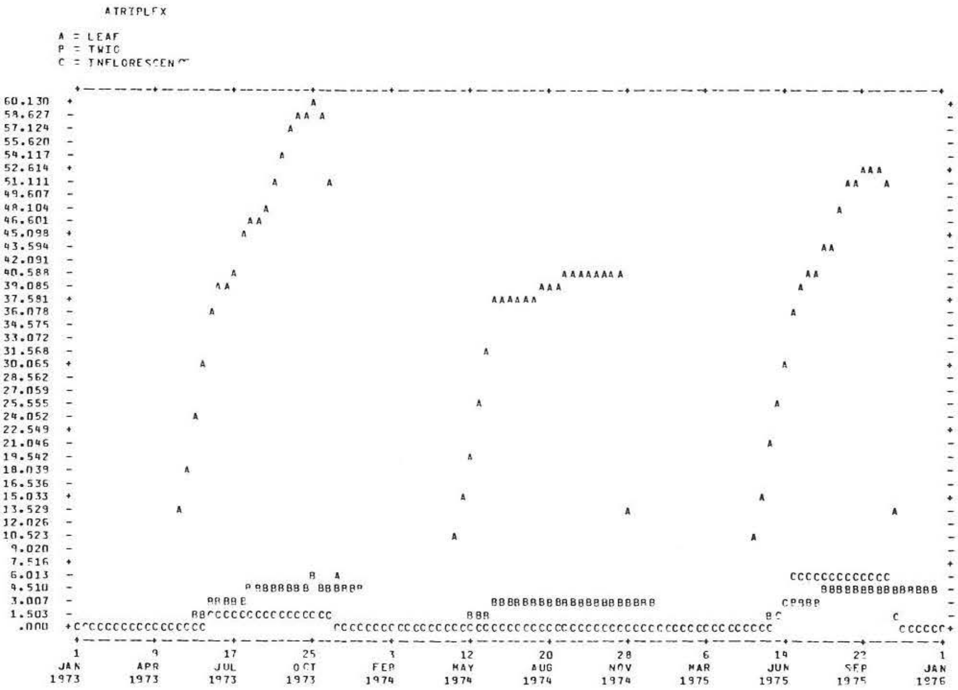
MEAN WEIGHTED POTENTIAL EVAPORATION (MM/DAY) 6.5 TRANSPIRATION COEFFICIENT 245.

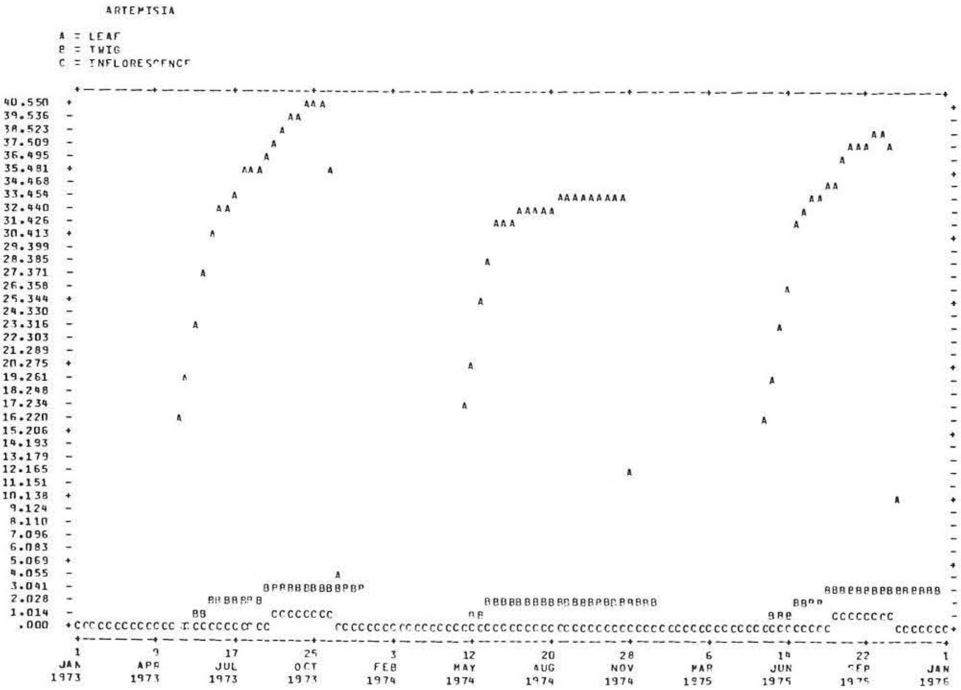
GROSS PRIMARY PRODUCTION BY PLANT GROUPS DURING YEAR JUST ENDING
162.941 266.571 182.471

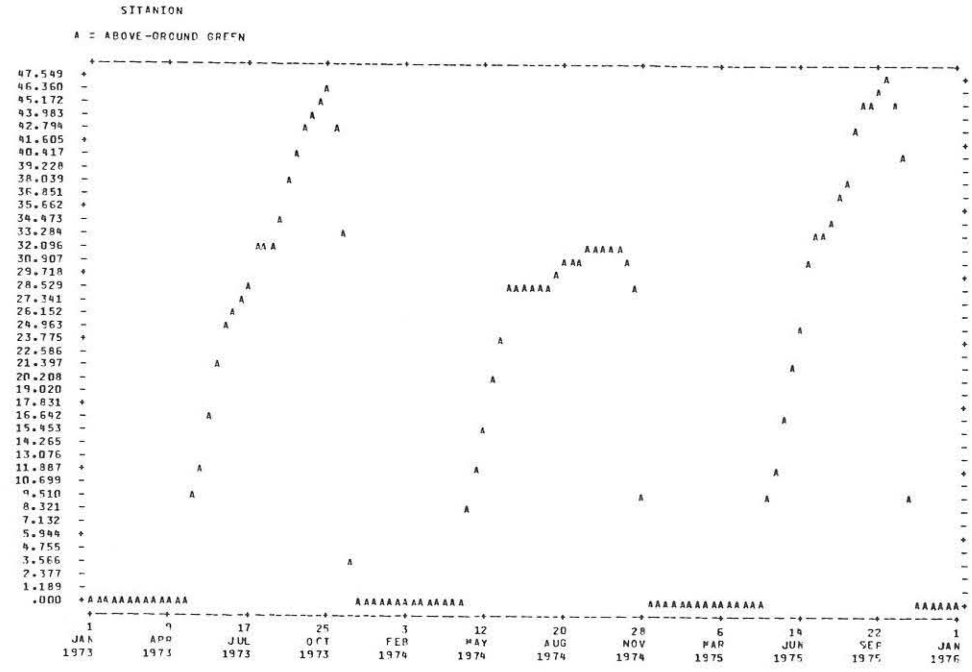
TOTAL DRY MATTER

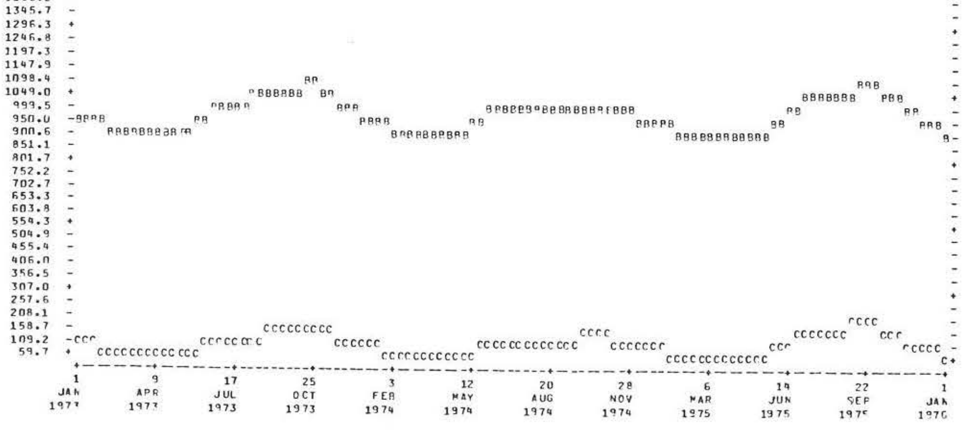
A = DEAD, LITTER
B = SOIL ORG MATTER
C = ECOSYSTEM

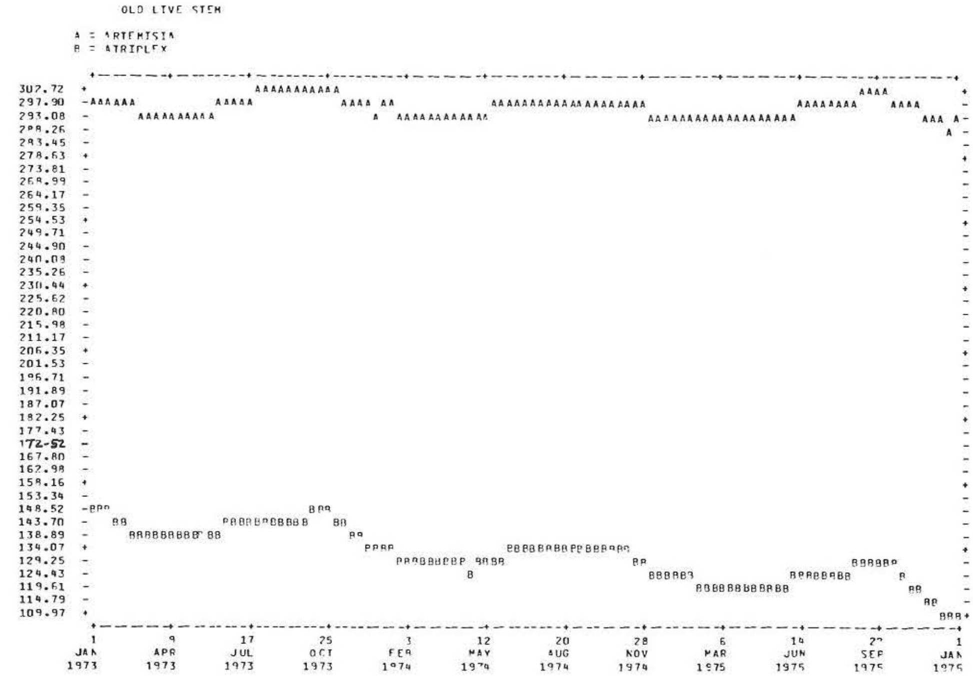


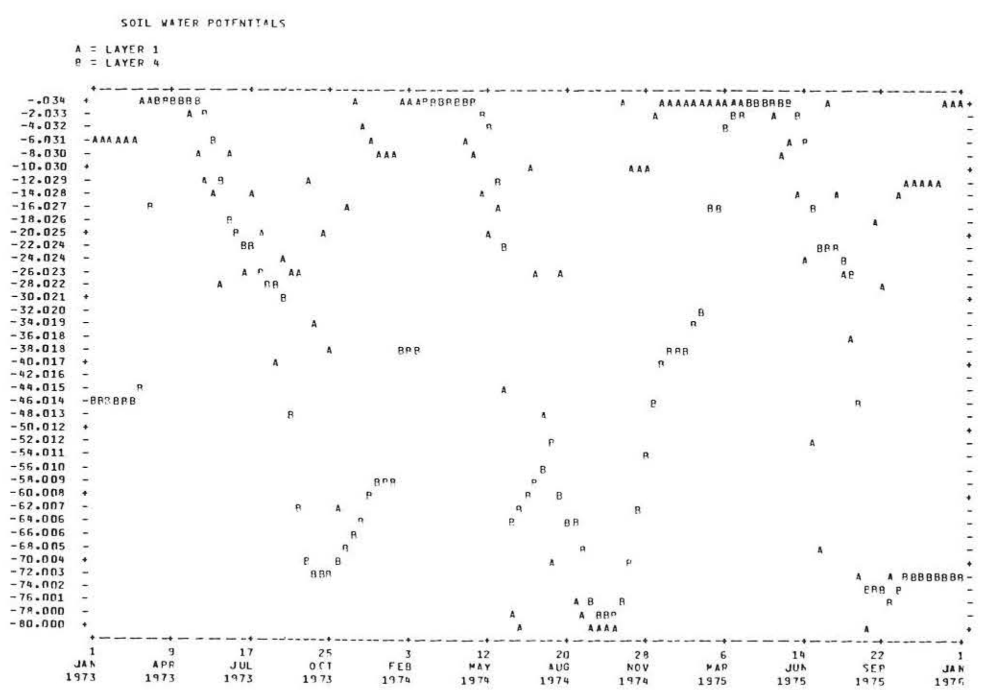

ATRIPLEX
A = LEAF
B = TWIG
C = INFLORESCENCE
1 JAN 1973
9 APR 1973
17 JUL 1973
25 OCT 1973
3 FEB 1974
12 MAY 1974
20 AUG 1974
28 NOV 1974
6 MAR 1975
14 JUN 1975
22 SEP 1975
1 JAN 1976

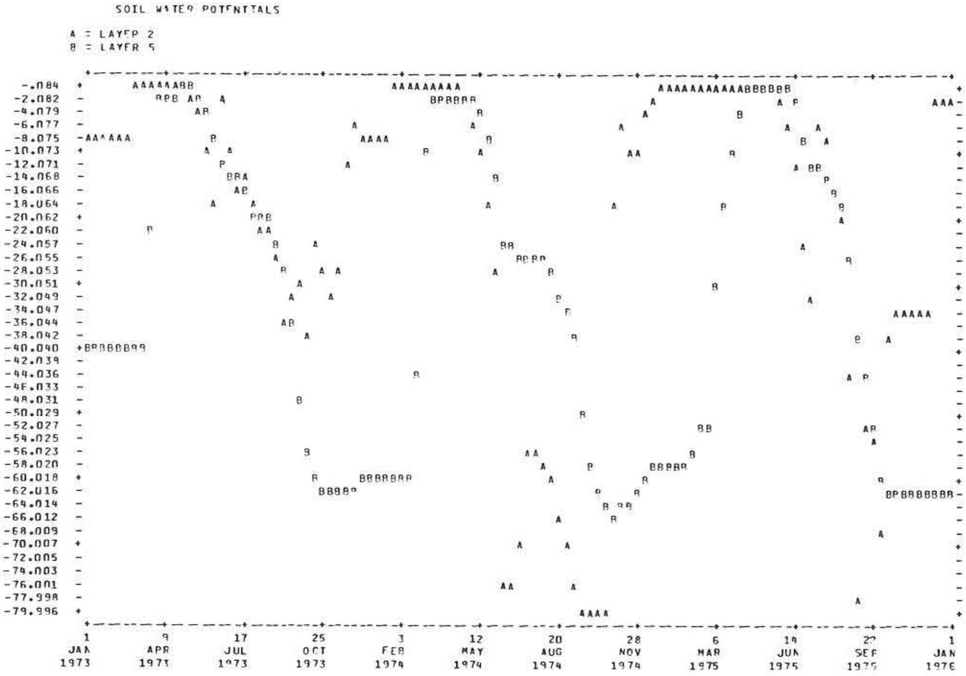

ARTEMISIA
A = LEAF
B = TWIG
C = INFLORESCENCE
1 JAN 1973
9 APR 1973
17 JUL 1973
25 OCT 1973
3 FEB 1974
12 MAY 1974
20 AUG 1974
28 NOV 1974
6 MAR 1975
14 JUN 1975
22 SEP 1975
1 JAN 1976

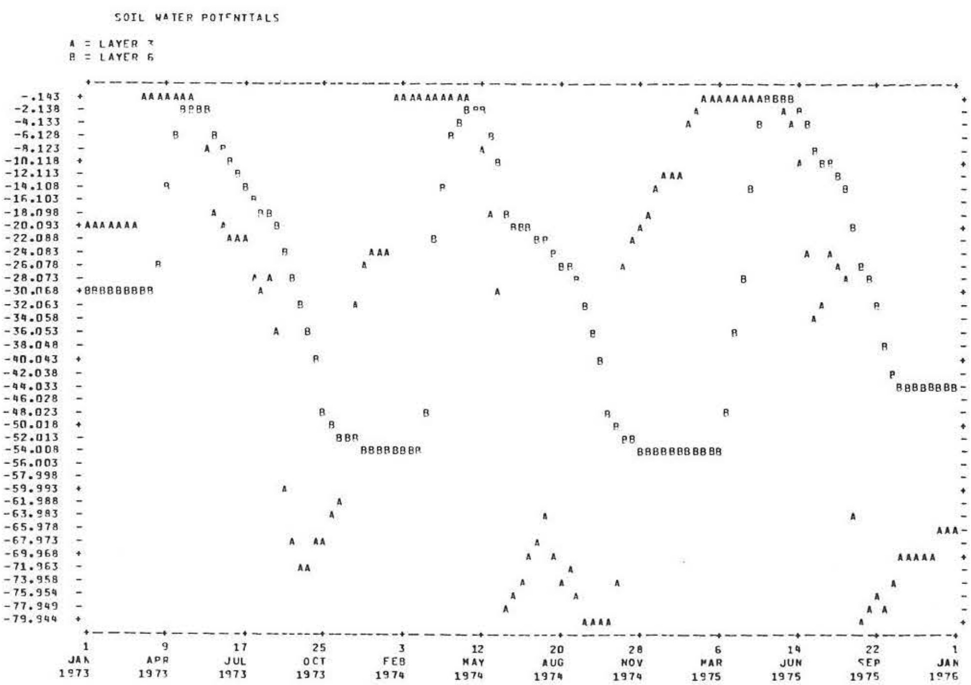

SITANION
A = ABOVE-GROUND GREEN
1 JAN 1973
9 APR 1973
17 JUL 1973
25 OCT 1973
3 FEB 1974
12 MAY 1974
20 AUG 1974
28 NOV 1974
6 MAR 1975
14 JUN 1975
22 SEP 1975
1 JAN 1976

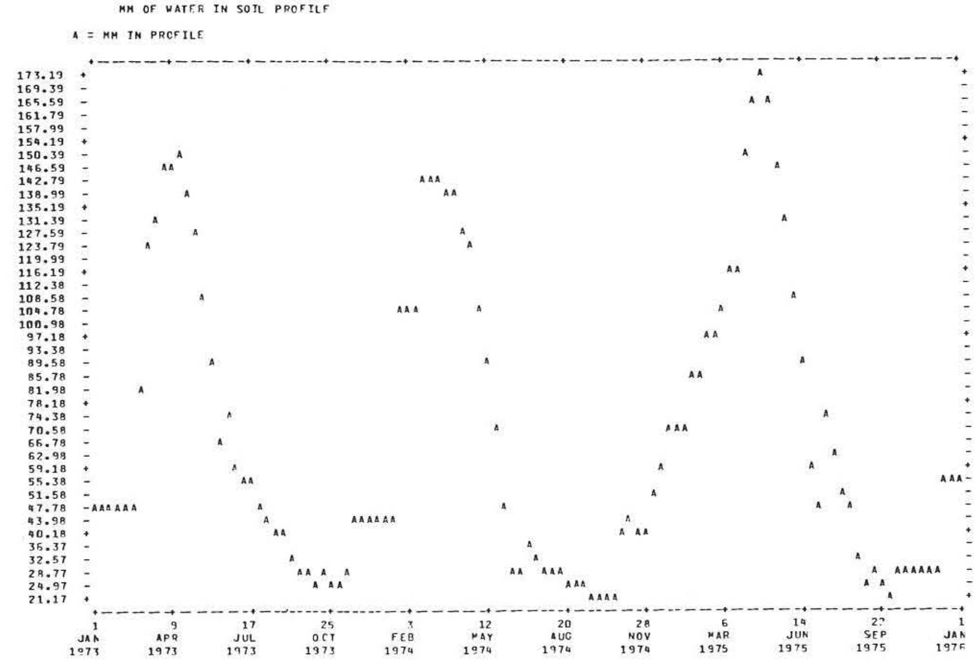

BELOW-GROUND LIVE
A = ARTEMISIA
B = ATRIPLEX
C = SITANION
1 JAN 1973
9 APR 1973
17 JUL 1973
25 OCT 1973
3 FEB 1974
12 MAY 1974
20 AUG 1974
28 NOV 1974
6 MAR 1975
14 JUN 1975
22 SEP 1975
1 JAN 1976

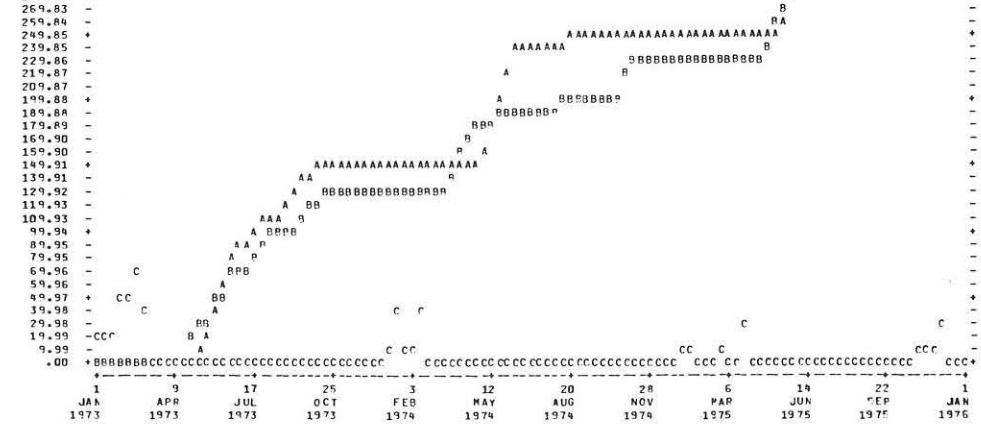

OLD LIVE STEM
A = ARTEMISIA
B = ATRIPLEX

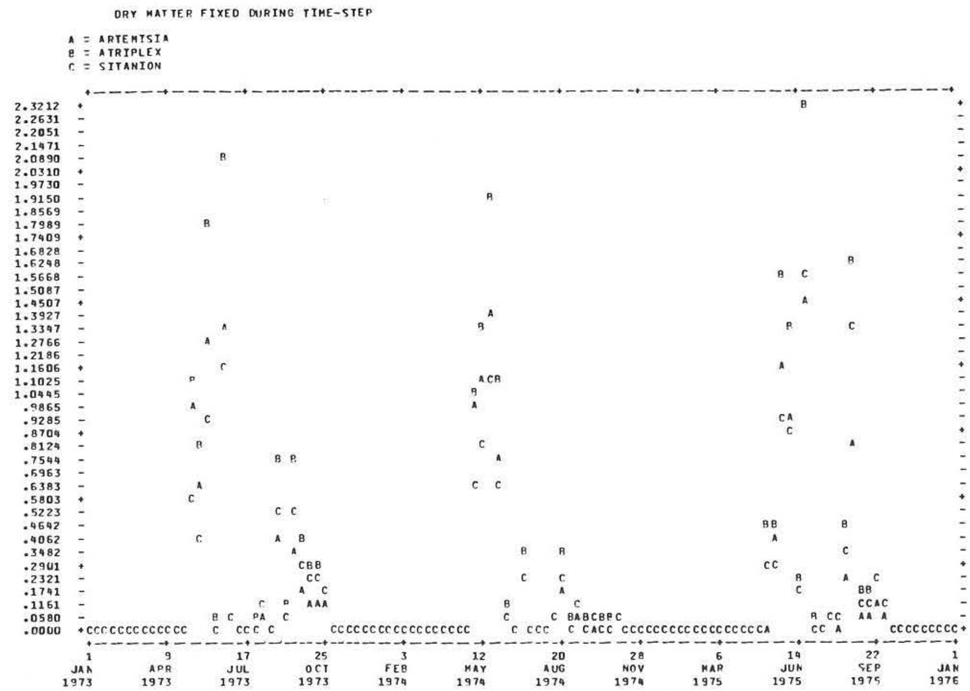

SOIL WATER POTENTIALS
A = LAYER 1
B = LAYER 4

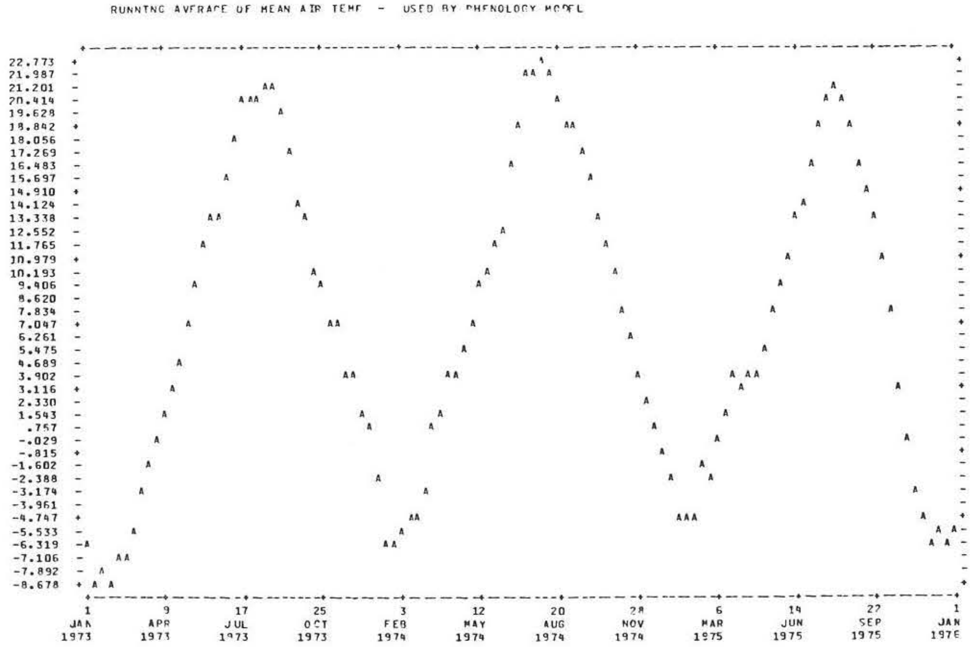

SOIL WATER POTENTIALS
A = LAYER 2
B = LAYER 5

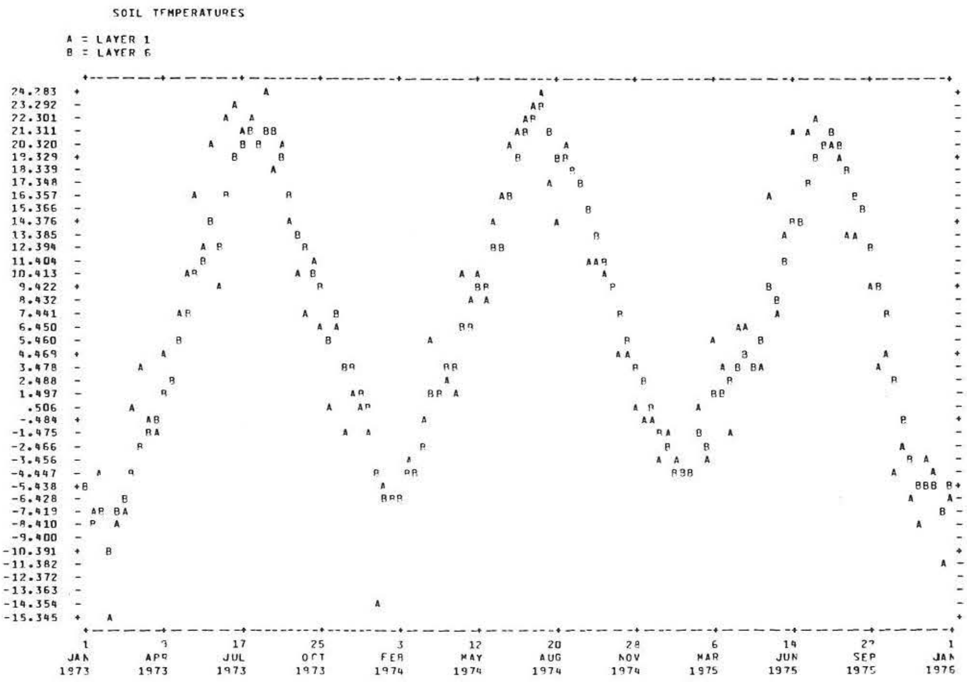

SOIL WATER POTENTIALS
A = LAYER 3
B = LAYER 6


MM OF WATER IN SOIL PROFILE
A = MM IN PROFILE


WATER BUDGET - MILLIMETERS
A = TRANSPIRATION
B = EVAPORATION
C = STANDING WATER


DRY MATTER FIXED DURING TIME-STEP
A = ARTEMISIA
B = ATRIPLEX
C = SITANION
1 JAN 1973
9 APR 1973
17 JUL 1973
25 OCT 1973
3 FEB 1974
12 MAY 1974
20 AUG 1974
28 NOV 1974
6 MAR 1975
14 JUN 1975
22 SEP 1975
1 JAN 1976


RUNNING AVERAGE OF MEAN AIR TEMP - USED BY PHENOLOGY MODEL
1 JAN 1973
9 APR 1973
17 JUL 1973
25 OCT 1973
3 FEB 1974
12 MAY 1974
20 AUG 1974
28 NOV 1974
6 MAR 1975
14 JUN 1975
22 SEP 1975
1 JAN 1976



EXECUTION OF DESERT2 COMPLETED