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DRYADS and DIFMAS, FORTRAN MODELS for INVESTIGATING SOLUTE UPTAKE and INCORPORATION into VEGETATION and LITTER

R. J. Luxmoore
C. L. Begovich
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ABSTRACT

The concepts and FORTRAN algorithms of a model describing solute movement from bulk soil solution into roots (DIFMAS) and a model of solute dynamics and accumulation in plant tissues and litter (DRYADS) are presented. Foliar uptake of solutes and gases are included in the DRYADS code. These models form components in a coupled system of models having hourly resolution of carbon, water, and solute dynamics in terrestrial ecosystems. The input data requirements of the solute models and the methods of coupling these codes with the other component models are given in detail as a guide to users. Applications showing successive hourly, monthly, and annual results illustrate the utility of the models. The DRYADS model sensitivity to both leaf solute permeability and root solute conductivity parameters suggest the importance of careful experimental determination of these plant properties. The tissues of solute entry (leaves, roots) initially accumulate solutes in a fixed form in preference to the more remote tissues (stems, fruits). Model application results suggest that root sapwood is the first major site of trace contaminant accumulation from soil borne pollutants. The algorithms describing solute movement along a concentration gradient in phloem and as mass flow in the xylem transpiration stream result in high mobility of solutes in vegetation. The simulated diurnal pattern of root solute uptake showed that more than 85% of solutes are taken up during the daylight hours. The simulations further showed that contaminants had the greatest effect on the litter system. Toxic effects of contaminants on decomposition resulted in lower mineralization losses and higher accumulations of contaminant in litter with continuing deposition.

I. INTRODUCTION

The complex interaction of processes determining carbon, water, and solute fluxes in terrestrial ecosystems may be more easily understood with the careful application of physically and physiologically based

simulation models that are coupled together with mechanistic algorithms. The development of the Unified Transport Model approach to the ecology and analysis of trace contaminants (Van Hook and Shults 1976) has been undertaken as an aid in understanding contaminant and solute movement in the environment.

Several models have been developed to represent the basic flows of carbon, water, and solutes in the soil-plant-litter system (Fig. 1). This report concerns models describing the uptake of solutes from bulk soil solution into roots (DIFMAS) and the transport and accumulation of solutes in vegetation and litter (DRYADS). The coupling of the solute models with models of carbon and water dynamics is outlined. In general the word "solute" refers to any dissolved form of an element that can flow in the soil-plant-litter system. Solutes are thus distinct from the "fixed chemical" or "insoluble chemical" that is immobile in the plant or litter. The word "element" is used to denote the total chemical (solute + fixed chemical). An application of the models to trace contaminant movement in a forested watershed in southeastern Missouri illustrates the data requirements and types of simulation results obtained.

II. CONCEPTS AND HYPOTHESES

Munch (1930) introduced a simple theory which describes the nature of material movement in plants in terms of the protoplasm continuum (symplasm) and the nonprotoplasmic continuum (apoplasm). Symplasm consists of cellular cytoplasm interconnected by plasmodesmata and includes phloem tissues. Movement of solutes in apoplasm occurs in the xylem water flow from roots to leaves and within cell walls between cells. Cellular

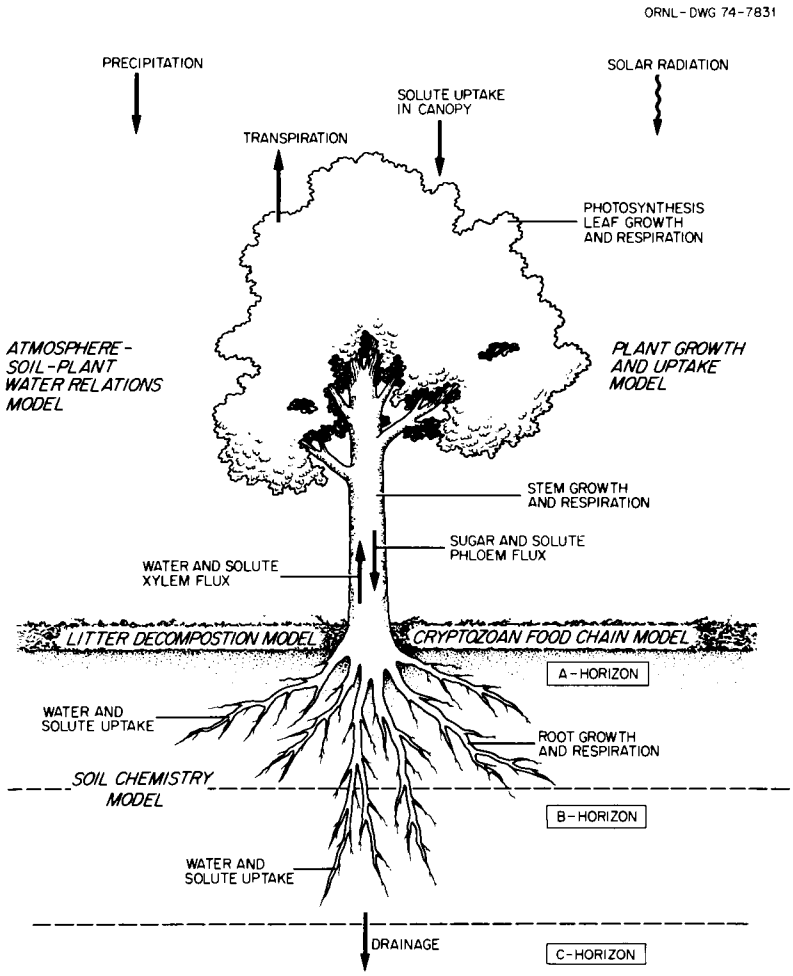

Fig. 1. Solute transport processes in the soil-plant-litter system and the associated models used to evaluate solute effects on plant growth and litter decomposition.

metabolites and products of photosynthesis have been shown to move in phloem (Nelson 1963); this is the main pathway of material movement from leaves to roots. This simple view of material movement in plants forms one of the two main bases of the DRYADS model.

The other basis is the concept of plant solute demand. Plants have requirements for some minerals for normal development and growth. These requirements are met by foliar absorption or by the uptake of solutes from the soil solution and soil matrix. Plants show preferential uptake of particular elements and can exclude others at their membrane boundaries. In the DRYADS model, vegetation is hypothesized to take up solutes so as to reach a maximum concentration in each of its leaf, stem, fruit, and root tissues. The total plant demand for solutes can be characterized by the sum of the maximum levels of the element that can occur in its tissues. In the range from deficiency to toxicity, the maximum concentration represents the level at which the plant finally stops any new growth. It is assumed that vegetation has an apparent "demand" for solutes which will prevent new growth if it is achieved. Increases in the amount of plant tissue by growth and decreases by mortality cause time varying changes in the total demand for solutes by the vegetation. Investigations with a model of this type offer the opportunity for non-intuitive situations to arise in simulations which may lead to greater understanding of solute movement in the soil-plant system.

Leaves and roots of plants are the major interfaces with the environment at which material exchange between vegetation and its surroundings takes place. Uptake of gaseous materials into leaves by diffusion through stomata has been shown to occur for sulfur dioxide, oxides of nitrogen and

other air pollutant gases (Hill 1971). Movement of solutes from wetfall and dryfall through the leaf surface can be an important pathway. Radioactive lead (^{210}Pb) and cadmium (^{109}Cd) isotopes applied to lettuce and radish leaves have been shown by Hemphill and Rule (1975) to be absorbed into the leaves and translocated. The greatest translocation was towards the leaf margins and a small amount moved into roots. It is generally considered that heavy metals that enter plants become chelated and move in the xylem and phloem tissue (Lagerwerff 1972). Beauford, Barber, and Barringer (1975) have established that ^{65}Zn taken up from nutrient solution by pea (Pisum sativum L.) and broad bean (Vicia faba L.) roots can be released to the atmosphere. A similar finding was discovered for lead, copper, mercury, and manganese. Leaching of solutes out of leaves during rainfall has also been shown to occur for many elements (Tukey and Morgan 1962). Equations describing the reversible flux of solutes through the leaf surface and the uptake of gases by diffusion have been incorporated into the leaf physiology section of the DRYADS model.

Transfer of solutes from leaves to stems and stems to roots is determined by phloem resistances and solute gradients. The xylem flux of solutes from the roots to stems and leaves depends on the transpiration water flux, the water capacity of roots and stems, and the solute content in roots and stems. One of the major consequences of water movement in plants is solute redistribution (Crafts and Crisp 1971).

The soluble forms of the solutes in leaves, stems, roots, and fruits are fixed to insoluble forms associated with the insoluble carbon fixation (growth) calculated in the forest biomass model, CERES (Dixon et al., 1976). The coupling of the DRYADS and DIFMAS with CERES is described

later. The levels of fixed chemicals and solutes in the tissues are used to determine deficiency, sufficiency, and toxicity effects of the elements on new growth calculated in the forest biomass model.

The model of solute movement to roots by diffusion and mass flow developed by Baldwin, Nye, and Tinker (1973) has been implemented in subroutine DIFMAS. The "absorbing power" of the vegetation is made a function of the root permeability to solutes and the vegetation capacity for more solutes. It has been demonstrated that uptake of solutes requires metabolic energy, and carrier mechanisms of various kinds have been proposed to mediate solute uptake across cellular membranes (Gauch 1972). The details of these processes are not included in DIFMAS or DRYADS and the assumption is made that solute uptake is neither limited by metabolic energy nor carrier sites. Root uptake of solutes is determined both by the solute demand of the vegetation and by the supply and transport of solutes in the soil.

The DIFMAS model can account for diurnal changes in solute uptake since roots are dominated by mass flow in the transpiration stream during the day and by diffusion at night. Also, seasonal changes in plant growth e.g., leaf growth and senescence, allow for transfer in the soil-plant-litter system. The elements associated with plant tissue mortality are added to the chemical pool in the litter. Mineralization of chemicals in litter is calculated at a rate proportional to the litter decomposition rate obtained from the forest biomass model. The amounts of elements in the litter are used to determine deficiency, sufficiency, and toxicity feedback effects on decomposition rates in the forest biomass model. The coupling of the forest biomass and solute transport models is an

attempt at providing physically and physiologically based simulations that can help increase our understanding of ecosystems and effects of chemical perturbations.

III. COMPUTATION METHODS

The DRYADS model of solute movement in vegetation and the DIFMAS model of solute movement and uptake by roots are coupled to three other models; a forest biomass model (CERES), a soil-plant-atmosphere water flow model (PROSPER) documented by Goldstein et al. (1974), and a soil chemistry model for heavy metals (SCEHM) documented by Begovich and Jackson (1975). The transfers in the coupling between the models (Fig. 2) are executed on a fifteen-minute basis when there is rainfall, otherwise the time step is hourly. These models are executed as subroutines in the Terrestrial Ecosystem Hydrology Model (TEHM; Huff et al. 1976). The TEHM code provides the necessary meteorological data and time step bookkeeping for the subroutines.

Calculations in DRYADS and DIFMAS are done in double precision and solute quantities are expressed in μg element per m^2 land area in DRYADS and in μg element per cm^2 land area in DIFMAS. The structural equations described below use the FORTRAN names for variables so that the listing of the code may be more readily followed. In many cases the prefixes L, S, F, R, T are used to denote leaf, stem, fruit, root, and total plant quantities respectively. For example, LFIX is the rate that leaf solute is converted to an insoluble fixed chemical in the leaf. There are similar quantities, SFIX, FFIX, and RFIX. Up to five elements in the soil system and four atmospheric gases may be investigated simultaneously; however, the feedback effects of solutes on plant growth and litter decomposition are restricted to one solute in the present formulation of the model.

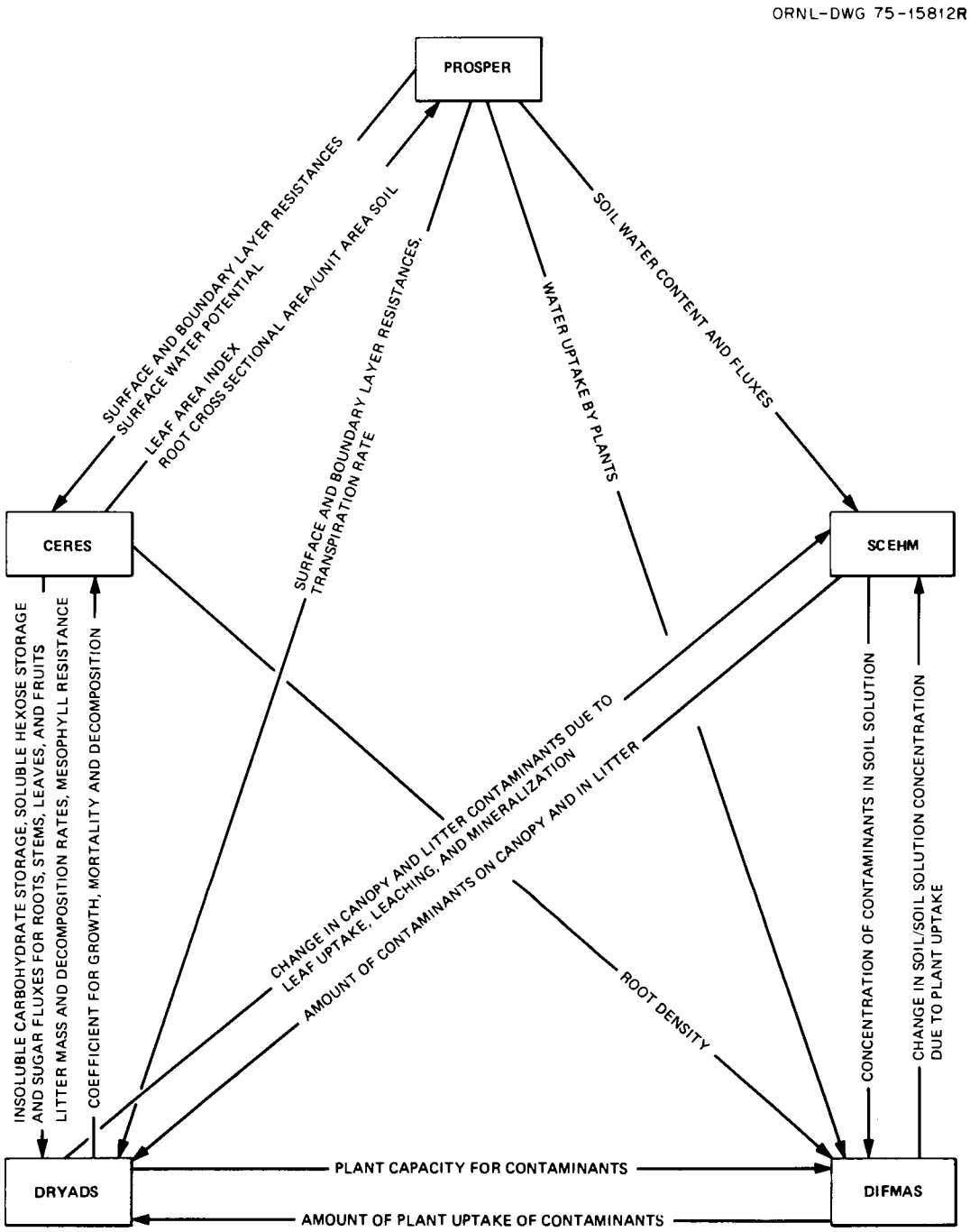

Fig. 2. Coupling of five process models that describe hourly carbon, water, and solute dynamics of the soil-plant-litter system.

(A) Structural Equations of DRYADS

There are eleven main equation groups that determine the solute flux rates between both the soluble and fixed chemical storages of the leaf, stem, root, fruit, and litter components of terrestrial ecosystems along with two equations that estimate coefficients for element effects on new plant growth and litter decomposition. A monthly element mass balance calculation is made for both vegetation and litter to evaluate computational errors. The equations are referenced with the 'DRYA' statement number in the DRYADS subroutine (shown as (Sxxx) to right of text statement) as an aid to examination of the code (Appendix A). In the case of all rate equations the time step is either 15 minutes or hourly depending on rainfall as mentioned previously.

(1) Maximum solute in solution on leaf surface (SØLMAX)

The amount of dissolved element on the leaf surface is calculated as a function of the solubility and water volume on the leaf (interception). Under dry conditions the water volume on the leaf is assumed to be due to an adsorbed moisture layer. During rainfall LVØL has a value determined by interception storage and evaporation from the canopy (calculated in TEHM code). The maximum dissolved element on the leaf surface is given by,

SØLMAX = LVØL * SP(K) * 1.D4 (S205)

IF(LVØL.LE.O.) SØLMAX = WATLAY (I) * SP (K) * LAI(I) * 1.D4 (S206)

where

LVØL	amount of water on leaf canopy ($cm^3 \cdot cm^{-2}$ land)
SP	solubility of solute ($\mu g \cdot cm^{-3}$ solution)
1.D4	10,000 $cm^2 \cdot m^{-2}$
IF( )	a switch that gives the value of SØLMAX for dry conditions

WATLAY the water film thickness on a dry leaf (cm)

LAI the leaf area index (cm^2 leaf • cm^{-2} land)

I vegetation type (1, 2, or 3)

K element type (1, 2, ... or 9).

(2) Leaf solute uptake or leaching (DIFSØL,LEACH)

The pathway for solute movement across the leaf surface is assumed to be reversible, depending on the solute gradient. Tukey (1971) explained the mechanism of cation leaching from leaves as an exchange of cations for hydrogen on cuticular exchange sites and/or cation movement from within the leaf to the surface by diffusion and mass flow through leaf surfaces devoid of cuticle (e.g., cracks). A diffusion equation has been adopted in DRYADS to represent the rate of uptake and leaching. The mass flow mechanism is too complicated to attempt at this stage of the model development. The effective cuticle permeability (PERM) is the product of the area proportion of leaf devoid of cuticle (usually less than 1%) and the conductivity of solutes in epidermal cell walls.

If the amount of solute within the leaf exceeds the amount on the leaf surface DIFSØL will be negative. The rate of solute leaking from leaves (LEACH) is determined as follows:

IF(DIFSØL.LT.O.) LEACH = -DIFSØL/10. (S216,S220)

Leaching is intuitively considered to occur at one tenth of the solute uptake rate. Leaf solute uptake is given by,

DIFSØL(I,K) = [PERM(I) * (SØLEX - SØLIN) * FTIME]/FILM(I) (S213)

where

DIFSØL rate of diffusive solute uptake ($\mu g \cdot m^{-2}$ land • $time^{-1}$)

PERM leaf cuticle permeability (cm sec^{-1})

SØLEX amount of solute on leaf (μg solute • m^{-2} land)

SØLIN amount of solute in leaf (μg solute • m^{-2} land)

FTIME seconds per time period (900 or 3600)

FILM leaf cuticle thickness (cm)

I vegetation type (1, 2, or 3)

K element type (1, 2, ... or 9).

The external dissolved solute on the leaf (SØLEX) is chosen as the lesser of the maximum amount that can be dissolved (SØLMAX) or the actual amount of chemical deposited on the leaf surfaces (CANQAN).

(3) Gas uptake by diffusion (GASDIF)

Uptake of gases is calculated with a diffusion equation depending on the gas concentration difference and pathway resistances. The exterior gas concentration is an input value that may be calculated previously by the Air Transport Model (Culkowski and Patterson, 1976). The concentration of gas within the leaf is allowed to range between zero and the exterior gas concentration (GASEX), depending on the leaf demand for the solute. If there is a high demand, i.e., if the present level of the element (LPRES) is very much less than the maximum possible level (LWANA), then the interior gas concentration (GASIN) will be close to zero. The equation used to calculate GASIN is:

$$\text{GASIN} = \text{GASEX}*(1. - \frac{(\text{LWANA}-\text{LPRES})}{\text{LWANA}}) \quad . \qquad \text{(S235)}$$

The total diffusion resistance is the sum of the boundary layer, stomatal and mesophyll resistances. The first two resistances are calculated for water vapor diffusion in the PROSPER model of soil-plant-water relations (Goldstein et al. 1974). These values are multiplied by the ratio of

the diffusion coefficients for the gas in air and water vapor in air to give the effective resistances for the gas under consideration. The mesophyll resistance is assumed to follow the same responses as the mesophyll resistance for CO_2 determined in CERES (Dixon et al. 1976). Alternative values may be substituted if suitable data are available. The diffusive gas uptake by leaves is given by,

```
GASDIF (I, M) = ((GASEX(I,M) - GASIN(I,M))/TRESIS)*
                GASDEN(M) * FTIME * 1.D+6                (S230)
```

where

GASDIF	rate of diffusive gas uptake ($\mu g \cdot cm^{-2}$ leaf $\cdot$ $time^{-1}$)
GASEX	external gas concentration ($cm^3 \cdot cm^{-3}$)
GASIN	internal gas concentration ($cm^3 \cdot cm^{-3}$)
TRESIS	total diffusion resistance ($sec \cdot cm^{-1}$)
GASDEN	gas density ($g \cdot cm^{-3}$)
FTIME	seconds per time period (900 or 3600)
1.D+6	million $\mu g\ g^{-1}$
I	vegetation type (1, 2, or 3)
M	gas type (1, .. 4).

(4) <u>Conversion of solute to fixed chemical in tissue</u> (*FIX)[+] (using leaf as an example)

The LWANT function forms the basis of the leaf demand for solutes. This represents one of the simplest hypotheses about the nature of solute uptake by tissues requiring one parameter to define the demand

---

+(Note, L, S, F, or R may be used in place of *).

function. The solute demand follows a linearly decreasing function as LPRES (present amount of element) approaches LWANA (maximum amount of element) (Fig. 3a). This demand function will cause the actual level of element in the tissue to have a "decreasing returns" time function if unlimited solute is available and the leaf biomass is constant (Fig. 3b). Some experimental evidence for this empirical relationship is given by Kramer and Kozlowski (1960). Further, the relationship between plant yield and solute concentration in its tissues (Gauch 1972) implies that plant solute uptake may be approximated with a demand function of this type.

Other hypotheses have been used to describe solute uptake, notably of the form of the Michaelis-Menten enzyme kinetic equation. This is a more complicated hypothesis requiring two parameters (a maximum solute uptake rate and a solute concentration for half maximum uptake rate). This type of hypothesis can be incorporated into DRYADS; however, at the present stage of development, the simple LWANT hypothesis is being examined. This has the initial advantage of requiring fewer input data. The following sequence of statements determines the current LWANT value and the rate of conversion of solute to fixed chemical in leaves.

```
LWANA = (LSTØR(I) + LSUGAR (I)) * LSØLUM(I,K)          (S180)
LPRES = (LINSØL(I,K) + LSØLU(I,K) + LSALT(I,K))        (S184)
LWANT = (LWANA - LPRES)/LWANA                          (S185,S194)
LFIX  = LSALT(I,K) * LWANT                             (S239)
```

where

LFIX rate of solute fixed to insoluble form ($\mu g \cdot m^{-2}$ land $\cdot$ $time^{-1}$)

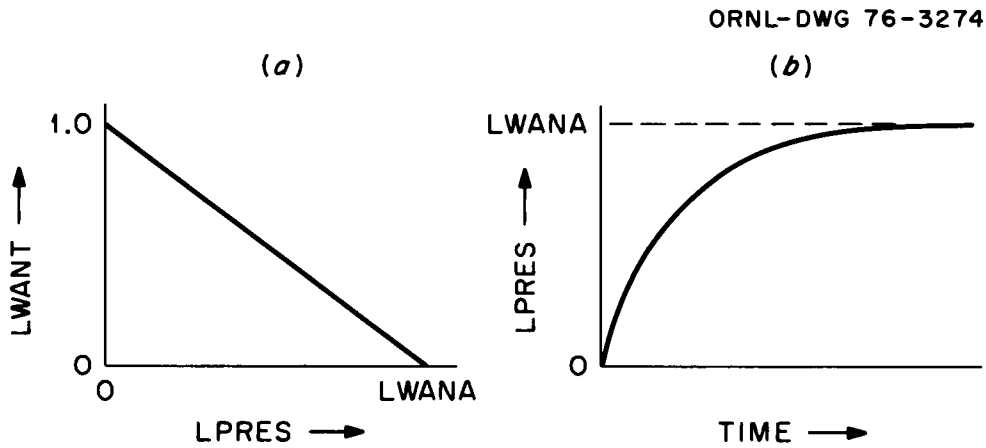

Fig. 3a. Solute demand (LWANT) as a function of amount of element in leaves (LPRES).

3b. Amount of element in leaves (LPRES) as a function of time assuming unlimited solute in soil and constant leaf mass.

LWANT fractional element demand (range of 0 to 1)

LPRES current amount of leaf element ($\mu g \cdot m^{-2}$ land)

LWANA current maximum leaf element demand ($\mu g \cdot m^{-2}$ land)

LINSØL amount of leaf insoluble chemical ($\mu g \cdot m^{-2}$ land)

LSØLU amount of leaf solute in xylem pathway ($\mu g \cdot m^{-2}$ land)

LSALT amount of leaf solute in phloem pathway ($\mu g \cdot m^{-2}$ land)

LSTØR amount of leaf insoluble carbon material ($g \cdot m^{-2}$ land)

LSUGAR amount of leaf sugar ($g \cdot m^{-2}$ land)

LSØLUM maximum leaf element concentration ($\mu g \cdot m^{-1}$ leaf)

I and K as above.

Similar equations are used to calculate FFIX, SFIX, and RFIX, the rate of solute fixed in fruits, stems, and roots respectively.

(5) Phloem salt movement (LSSALT, SFSALT, and SRSALT)

A simple gradient equation is used to move dissolved chemical forms between vegetative tissues. This gradient is based on the total amount of solute in each of the tissues and a phloem resistance having the same value as the phloem resistance used in CERES in the sugar flux equations. This provides a weighted diffusion equation along the lines that Thornley (1972) used in his equations for sugar translocation. The leaf to stem translocation of solute is given by,

LSSALT(I,K) = ((LSALT(I,K) − SSALT(I,K))/LSPHLD) * FTIME (S250)

where

LSSALT rate of leaf to stem solute flux ($\mu g \cdot m^{-2}$ land $\cdot$ time^{-1})

LSALT amount of leaf phloem solute ($\mu g \cdot m^{-2}$ land)

SSALT amount of stem phloem solute ($\mu g \cdot m^{-2}$ land)

LSPHLD phloem resistance to solute movement (sec^{-1})

FTIME, I, K as above.

A similar equation describes salt movement from stem to fruit (SFALT) and from stem to root (SRSALT).

(6) Xylem solute movement (RSSØLU and SLSØLU)

The movement of solutes in the xylem occurs at a rate determined by transpiration. In both stems and roots the solutes in the tissues are assumed to be uniformly dispersed in the liquid phase. A slug of liquid at the average root concentration is moved from roots to stems prior to the addition of new solutes to the root by uptake from the soil solution. Similarly, liquid at the average stem concentration is moved from stems to leaves prior to the addition of new solutes from the roots. The root to stem xylem solute flux is given by,

RSSØLU(I,K) = WFLUX * (RSØLU(I,K)/RCAP) *1.D4 (S268)

where

RSSØLU rate of solute flux from roots to stem ($\mu g \cdot m^{-2}$ land $\cdot$ $time^{-1}$)

WFLUX rate of transpiration water flux ($cm^3 \cdot cm^{-2}$ land $\cdot$ $time^{-1}$)

RSØLU amount of root xylem solute ($\mu g \cdot m^{-2}$ land)

RCAP amount of water in root system ($cm^3 \cdot m^{-2}$ land)

1.D4 10,000 $cm^2 \cdot m^{-2}$.

A similar equation describes solute flux from stem to leaves (SLSØLU).

(7) Solutes fixed in heartwood (SDEAD and RDEAD)

(applies to stems and roots)

The transfer of solutes from the fixed chemical pool (SINSØL, RINSØL) to the heartwood chemical pool is proportional to the rate of heartwood formation (SHART, RHART) calculated in the CERES model. The rate of chemical fixation into stem heartwood is given by,

SDEAD = SINSØL(I,K) * SHART(I)/SSTØR(I) (S309)

where

SINSØL amount of stem insoluble chemical ($\mu g \cdot m^{-2}$ land)

SHART rate of heartwood production ($g \cdot m^{-2}$ land $\cdot$ $time^{-1}$)

SSTØR amount of stem carbon storage ($g \cdot m^{-2}$ land)

SDEAD rate of solute fixation to insoluble form in stem heartwood ($\mu g \cdot m^{-2}$ land $\cdot$ $time^{-1}$).

(8) Plant tissue equilibration

At the end of each time period, the salts in the phloem pathway (*SALT) are equilibrated with the solutes in the xylem pathway (*SØLU). The dissolved chemical equilibration for stems is given by,

SSALT(I,K) = (SALT(I,K) + SSØLU(I,K))/2.0 (S330)

SSØLU(I,K) = SSALT(I,K).

These adjustments are included since the close proximity of xylem and phloem elements occurs over long lengths in each of the tissues.

(9) Root absorbing power (ABSPØW)

The root absorbing power for solutes is determined by the fractional plant tissue capacity for additional solute (TWANT) and an input value for the root solute conductivity (CØNDUC). The absorbing power (ABSPØW) is transferred to subroutine DIFMAS which determines the actual solute uptake (CHCØN) by the vegetation. The actual solute uptake is added into the root solute chemical pool (RSØLU, see statements S278 and S279 in subroutine DRYADS). The following sequence of statements determines the current value of TWANT and the root absorbing power for solutes.

TWANA = LWANA + SWANA + RWANA + FWANA (S335)

TPRES = (LINSØL(I,K) + SINSØL(I,K) + RINSØL(I,K) +
(LSØLU(I,K) + SSØLU(I,K) + RSØLU(I,K)) * 2.0 +
FSALT(I,K) + FINSØL(I,K) (S336)

TWANT = (TWANA − TPRES)/TWANA (S338)

ABSPØW(I,K) = TWANT * CØNDUC(I) (S342)

where

TWANA current maximum amount of element allowed in whole plant ($\mu g \cdot m^{-2}$ land)

LWANA, SWANA, RWANA, FWANA current maximum amount of element allowed in leaf, stem, root, and fruit respectively ($\mu g \cdot m^{-2}$ land)

LINSØL, SINSØL, RINSØL, FINSØL amount of insoluble chemical in leaf, stem, root, and fruit respectively ($\mu g \cdot m^{-2}$ land)

LSØLU, SSØLU, RSØLU amount of solutes in leaf, stem, and root xylem respectively ($\mu g \cdot m^{-2}$ land)

*2.0 accounts for LSALT, SSALT, and RSALT which are numerically equal to *SØLU terms at the time of this calculation

FSALT current amount of solute in fruit phloem ($\mu g \cdot m^{-2}$ land)

TWANT fractional tissue capacity for additional solute (ratio from 0.0 to 1.0)

ABSPØW root absorbing power ($cm \cdot sec^{-1}$)

CØNDUC root conductivity to solutes ($cm \cdot sec^{-1}$).

(10) Element effects on new plant growth (*GRØW)

Coefficients (*GRØW) are calculated in DRYADS to describe deficiency and toxicity effects of the chemical on the growth of new tissues

calculated in the forest biomass model (CERES). An intuitive function (Fig. 4) is used to describe these effects (leaf used as an example). The following sequence of statements determines the current value of the growth coefficient.

```
LGRØW  = 1.0                                                    (S348)
DEFLEV = DEFCØN(I) * (LSUGAR(I) + LSTØR(I))                     (S351)
DIMLEV = DIMCØN(I) * (LSUGAR(I) + LSTØR(I))                     (S352)
IF(LPRES.LT.DEFLEV) LGRØW(I) = LPRES/DEFLEV                     (S354)
```

$$\text{IF(LPRES.LT.DEFLEV) LGRØW(I)} = 1. - \frac{(\text{LPRES} - \text{DIMLEV})}{(\text{LWANA} - \text{DIMLEV})} \qquad \text{(S355)}$$

where

LGRØW leaf growth coefficient (0 to 1 range)

DEFLEV amount of element below which coefficient is less than 1 ($\mu g \cdot m^{-2}$ land)

DEFCØN element concentration below which growth is suppressed ($\mu g \cdot g^{-1}$ tissue)

LSUGAR amount of leaf sugar ($g \cdot m^{-2}$ land)

LSTØR amount of leaf insoluble carbon storage ($g \cdot m^{-2}$ land)

DIMLEV amount of element above which coefficient diminishes ($\mu g \cdot m^{-2}$ land)

DIMCØN element concentration above which plant growth is suppressed by toxicity ($\mu g \cdot g^{-1}$)

IF ( ) a switch that calculates coefficients in the deficiency and toxicity ranges

LPRES amount of element in leaf ($\mu g \cdot m^{-2}$ land).

Similar equations are used for stem, fruit, and root growth coefficients.

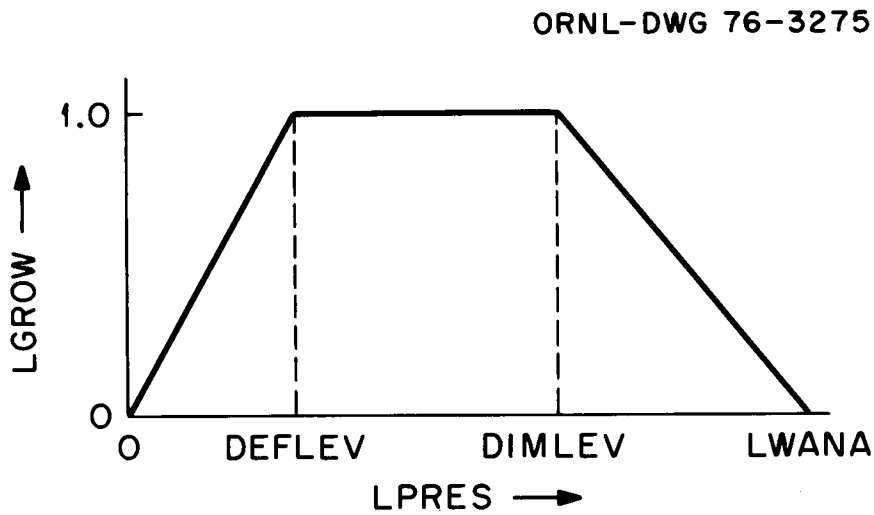

Fig. 4. The relationship between the leaf growth coefficient (LGRØW) and the amount of element in the leaves (LPRES) used to represent deficiency (LPRES < DEFLEV), sufficiency (DEFLEV $\leq$ LPRES $\leq$ DIMLEV) and toxicity (LPRES > DIMLEV) effects of the element on leaf growth rate.

(11) Chemical losses from vegetation by mortality (*LIT, *HUM, *FALL, SINC) (using stems as an example)

The transfer of chemical from the vegetation to the standing dead or litter chemical pools is determined by the rate of mortality of tissues as a proportion of the amount of tissue. The plant mortality rates and weight of tissues are calculated in subroutine CERES. The following statements determine solute losses by stem biomass mortality.

```
SLIT  = SINSØL(I,K) * SSTMRT(I)/SSTØR(I)          (S428)
SHUM  = SSØLU(I,K) * 2.0 * SSGMRT(I)/SSUGAR(I)    (S431)
SFALL = SDØRM(I,K) * SWDMRT(I)/SWØØD(I)           (S435)
SINC  = SHØLD(I,) * SFLØP(I)/STDEAD(I)            (S438)
```

where

SLIT rate of insoluble chemical in stem storage tissue added to standing dead ($\mu g \cdot m^{-2} \cdot time^{-1}$)

SINSØL amount of insoluble chemical in living stem storage ($\mu g \cdot m^{-2}$)

SSTMRT rate of stem carbon storage mortality ($g \cdot m^{-2} \cdot time^{-1}$)

SSTØR amount of living stem carbon storage tissue ($g \cdot m^{-2}$)

SHUM rate of solutes in stem added to standing dead ($\mu g \cdot m^{-2} \cdot time^{-1}$)

SSØLU amount of stem solutes in xylem ($\mu g \cdot m^{-2}$)

2.0 accounts for SSALT, since SSALT = SSØLU

SSGMRT rate of stem sugar mortality ($g \cdot m^{-2} \cdot time^{-1}$)

SSUGAR amount of stem sugar ($g \cdot m^{-2}$)

SFALL rate of insoluble chemical in dead stem heartwood added to standing dead ($\mu g \cdot m^{-2} \cdot time^{-1}$)

SDØRM amount of insoluble chemical in stem heartwood ($\mu g \cdot m^{-2}$)

SWDMRT rate of stem wood mortality ($g \cdot m^{-2} \cdot time^{-1}$)

SWØØD amount of stem heartwood ($g \cdot m^{-2}$)

SINC rate of chemical in standing dead pool added to stem litter pool ($\mu g \cdot m^{-2} \cdot time^{-1}$)

SHØLD amount of chemical in standing dead pool ($\mu g \cdot m^{-2}$)

SFLØP rate of standing dead mass falling to litter ($g \cdot m^{-2} \cdot time^{-1}$)

STDEAD amount of standing dead mass ($g \cdot m^{-2}$)

*FALL applies to stems and roots but not to leaf and fruit tissue.

The stem mortality has the additional stage of standing dead mass before the stem material is added to the litter. Leaves, fruits and roots do not have standing dead mass in the forest biomass model (CERES). In the case of these three components each of *LIT, *HUM and *FALL are added directly to the litter chemical pools (*PØØL); whereas, for stems they are added to the standing dead chemical pool (SHØLD). Addition of the chemical in the standing dead mass to the litter pool (SPØØL) depends on SFLØP which is a function of wind speed. There is no decomposition or solute loss considered for the standing dead mass.

(12) <u>Solute mineralization in litter</u> (*MINL)

(using roots as an example)

The loss of solutes from litter is considered to occur at a rate proportional to the rate of litter decomposition and litter mass as follows,

RMINL(I,K) = RPØØL(I,K) * RDECØM(I)/RCARB(I) (S521)

where

RMINL rate of solutes mineralized from the root organic matter ($\mu g \cdot m^{-2} \cdot time^{-1}$)

RPØØL amount of element in root litter ($\mu g \cdot m^{-2}$)

RDECØM rate of root litter decomposition ($g \cdot m^{-2}$ land $\cdot$ $time^{-1}$)

RCARB amount of root litter mass ($g \cdot m^{-2}$ land).

(13) Solute effects on litter decomposition (*TØX)

Coefficients (*TØX) are determined in DRYADS to describe element deficiency and toxicity effects on litter decomposition rates calculated in the forest biomass model (CERES). An ituitive function (Fig. 5) is used to describe these effects (using fruits as an example). The following sequence of statements determines the current solute effect on the rate of litter decomposition.

```
IF (K.EQ.KS)
    FTØX(I) = 1.0                                                    (S504)
    TØXAMT = FCARB(I) * TØXCØN(K)                                    (S511)
    TØXLEV = FCARB(I) * TØXPNT(K)                                    (S512)
    FULLEV = FCARB(I) * FULCØN(K)                                    (S513)
    IF(FPØØL(I,K).LT.FULLEV) FTØX(I) = FPØØL(I,K)/FULLEV             (S514)
    IF(FPØØL(I,K).GT.TØXLEV) FTØX(I) = 1. - (FPØØL(I,K) -
        TØXLEV)/(TØXAMT - TØXLEV)                                    (S515)
    IF(FPØØL(I,K).GT.TØXAMT) FTØX(I) = 0.                            (S517)
```

where

FTØX fruit litter decomposition coefficient (0 to 1 range)

TØXAMT amount of element above which the coefficient is zero ($\mu g \cdot m^{-2}$)

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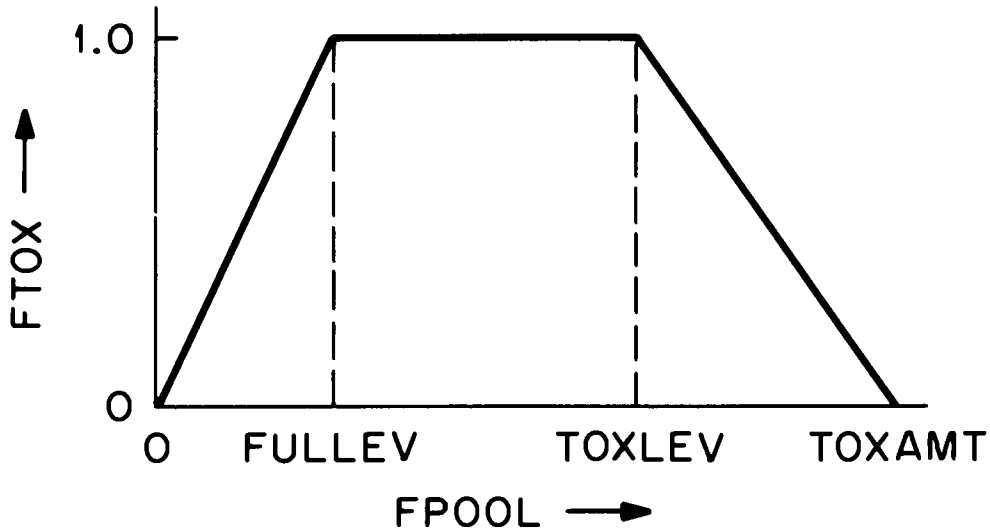


Fig. 5. The relationship between the fruit decomposition coefficient (FTØX) and the amount of element in the fruit litter pool (FPØØL) used to represent deficiency (FPØØL < FULLEV), sufficiency (FULLEV ≤ FPOOL ≤ TØXLEV) and toxicity (FPØØL > TØXLEV) effects of the element on fruit decomposition rate.

TØXLEV amount of element above which the coefficient is less than 1. ($\mu g \cdot m^{-2}$)

FULLEV amount of element below which the coefficient is less than 1. ($\mu g \cdot m^{-2}$)

FCARB fruit litter mass ($g \cdot m^{-2}$)

TØXCØN element litter concentration at which decomposition ceases due to toxicity ($\mu g \cdot g^{-1}$)

TØXPNT element litter concentration above which decomposition is reduced by toxicity ($\mu g \cdot g^{-1}$)

FULCØN element litter concentration below which decomposition is reduced by deficiency ($\mu g \cdot g^{-1}$)

FPØØL amount of solute in fruit litter ($\mu g \cdot m^{-2}$ land)

K number for current element

KS number for element determining solute effects.

(14) Element mass balances

The element inputs (DIFSØL, GASFIX, CHCØN), outputs (mortality terms) and changes in element storages of each vegetation type are used to calculate computational errors for each element on a monthly basis. A similar error mass balance is also calculated for each element in the litter and standing dead on a monthly time basis.

(B) Structural Equations of DIFMAS

This subroutine calculates the mass flow and diffusive flow of solutes to plant roots. The algorithms are taken from the solute uptake model of Baldwin, Nye and Tinker (1973). The main equations in DIFMAS are described below using FORTRAN names for variables along with the appropriate 'DIFM' statement number in the DIFMAS subroutine (shown as

(Nxxx) to right of text statement). The solute quantities in DIFMAS are in $\mu g \cdot cm^{-2}$ land area.

The method consists of determining the solute uptake per unit length of root and multiplying the result by the root density (length per unit soil volume). This product is summed over the soil volumes for each of the layers to give the uptake per unit soil area.

(1) Root density and soil cylinder radius around roots

The root distribution is calculated in DIFMAS, using the total root mass from CERES and the soil layer thicknesses from PROSPER and SCEHM (Fig. 6). The root mass was assumed to drop off exponentially with distance from the surface. The equation used is

$$f(X) = C_1 \sqrt{X} \exp (C_2 * X)$$

where

$f(X)$ = cumulative dry mass of roots (g) from the surface to the depth X (cm),

C_1, C_2 = constants.

C_1 and C_2 are determined by assuming that a certain proportion of roots are in the first PROSPER soil layer (ARAT), and that all the root mass is contained within the top two PROSPER soil layers. Thus,

C2 = DLOG(ARAT(1) * TRDEPS * HORS)/(HOR(1) - TRDEP) (N76)

where

ARAT(1) proportion of roots in first PROSPER layer (0 to 1 range)

TRDEPS square root of total depth of all root layers ($cm^{1/2}$)

TRDEP total depth of all root layers (cm)

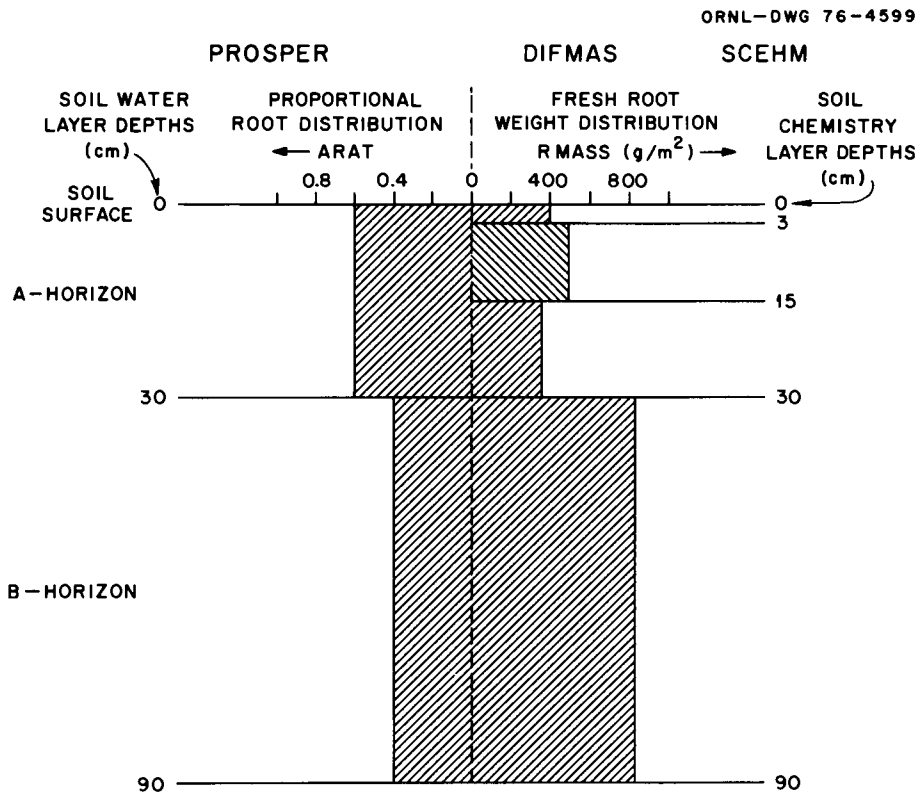


Fig. 6. Soil water layers and proportional root distribution of the PROSPER model used to determine soil chemistry layers in SCEHM and the fresh root mass distribution in DIFMAS. The represented root mass gives 2080 g fresh root /m^2 land.

HØRS inverse of the square root of thickness of first PROSPER soil layer ($cm^{-1/2}$)

HØR(1) thickness of first PROSPER soil layer (cm)

DLØG FORTRAN natural logarithm function

and

C1(N) = RTØT(N)/(TRDEPS * DEXP(C2 * TRDEP)) (N80)

RTØT total root dry weight of vegetation "N" ($g \cdot m^{-2}$)

DEXP FORTRAN exponential function

N vegetation type (1,2, or 3).

The dry weight of roots in each of the soil chemistry layers of SCEHM is calculated in DIFMAS with these C1(N) and C2 values used in the root distribution function f(X). The value of C1(N) is updated each time period to account for changes in root weight in the CERES model.

The fresh weight of roots in a given soil chemistry layer (RMASS) is obtained from the dry weight of roots in the layer by adding the appropriate weight of water per unit dry weight of roots (RWATER). Root volume (RVØL) in a soil chemistry layer is given by RMASS/RDEN, where RDEN is an input value for fresh root density ($g \cdot cm^{-3}$).

The number of roots in each soil chemistry layer is

RNØ = RVØL/(DELX(J)*1.414 * PI * R * R) (N99)

where

DELX(J) the thickness of the Jth soil chemistry layer (cm)

PI 3.1416

R root radius (cm)

It follows that the root density (L) as cm root per cm^3 soil for a soil chemistry layer of thickness DELX is given by

$$L = \frac{RN\emptyset * 1.414 * DELX}{1. * DELX} , \qquad (N110)$$

assuming that roots penetrate through the layer at a 45° angle on the average. The same assumption is made in the calculation of root number (RNØ).

The mean soil area per root is given by 1/RNØ and the mean radius of the soil cylinder around a root (XDIS) is given by

$$XDIS = DSQRT\ [1./(RN\emptyset * PI)] \qquad (N103)$$

where

DSQRT FORTRAN square root function.

The effective distance from bulk soil solution (X1) to the root may be much less than XDIS when root densities are low. The empirical function (XLIM) of Baldwin and Nye (1974) is used to calculate X1 at low root densities and X1 = XDIS at high root densities. At low root densities the empirical function is

$$XLIM = 2. * DSQRT\ [DL * VLFL * DELT] + R \qquad (N107)$$

where

DL diffusion coefficient of solute in free solution (cm^2/sec)

VLFL square of volumetric soil water content (cm^6/cm^6)

DELT seconds in time step.

When XLIM > XDIS then X1 = XDIS, otherwise X1 = XLIM.

The product (DL * VLFL) describes the apparent diffusion coefficient of the solute in soil and accounts for the effective water filled pore area for diffusion and the tortuosity impedance factors. This representation is an approximation based on the assumption that only solution phase ions are mobile (Baldwin, Nye and Tinker (1973), p. 625).

(2) The basis for determining uptake from mass and diffusive flow to roots, is Baldwin, Nye, and Tinker's equation [X]:

$$\frac{CLL}{CLI} = \exp\left[A * \frac{-6.283 * R * ABSPOW * L * DELT}{BØG + (1. - BØG) * \frac{2.}{2.-G} * \frac{(Y^{**(2.-G)} - 1.)}{(Y2 - 1.)}}\right]$$

where

CLL	adjusted average soil solute concentration ($\mu g/cm^3$ solution)
CLI	initial soil solute concentration ($\mu g/cm^3$ solution)
R	root radius (cm)
ABSPØW	root absorbing power (cm/sec)
L	root density (cm root/cm^3 soil)
DELT	time step (sec)
A	average buffer power
VEL	water flux at root surface (cm^3/cm^2 root/sec)
BØG	ABSPØW/VEL
G	R * VEL/Z

where

$$Z = DL * VLFL \qquad (N121)$$

$$Y = X1/R \text{ and } Y2 = Y * Y . \qquad (N128,N130)$$

The average buffer power A is obtained from the distribution coefficient (KD), soil bulk density (BD) and soil water content (CHETA) as follows:

KD	$\frac{\mu g \text{ adsorbed element/g soil}}{\mu g \text{ dissolved element/ml solution}}$
BD	g soil/ml soil
CLL	μg dissolved element/ml solution
CHETA	volumetric soil water content (ml/ml).

Thus,

KD * BD * CLL = μg adsorbed element/ml soil

CLL * CHETA = μg dissolved element/ml soil

and

$$\frac{CLL * (KD * BD + CHETA)}{CLL} = \frac{\mu g \text{ (adsorbed + dissolved)/ml soil}}{\mu g \text{ dissolved/ml solution}} .$$

Buffer power is defined as the change in total diffusible solute/ml soil per unit change in dissolved solute/ml solution (Baldwin, Nye and Tinker 1973). This derivative may be approximated by the solute ratio at low soil solute concentrations if the relationship between total diffusible solute and dissolved solute may be assumed to be both linear and passing through the origin. Thus,

$$A = \frac{(KD * BD) + CHETA - 0.}{1. - 0.}$$

$$= (KD * BD) + CHETA \quad . \qquad \text{(N118)}$$

The root solute uptake per cm root length (UPT) is calculated iteratively in DIFMAS as a function of CLL as follows:

```
UNUM  = 6.283 * ABSPØW(N,I) * R * DELT                          (N129)

BØG   = ABSPØW(N,I)/VEL                                         (N157)

DENØM = BØG + (1.-BØG) * (2./(2.-G) * (Y**(2.-G)-1.)/(Y2-1.))   (N158)

UPT   = UNUM * CLL/DENØM.                                       (N161)
```

An average root radius (R) is assumed for all calculations during a simulation. The proportional uptake of solutes by a range of root radii has not been included at this stage of model development. The initial solute concentration in the soil solution (CLI) for the time step is supplied by subroutine SCEHM. The water flux at the root surface (VEL) is calculated from the simulated root water uptake in PROSPER. The volumetric soil water content (CHETA) from PROSPER is also transferred to DIFMAS. The root absorbing power (ABSPØW) is calculated in DRYADS. Input values are supplied for the diffusion coefficient of the solute (DL).

(3) For solute uptake per cm root length by diffusion only, Baldwin, Nye, and Tinker's Equation [V] is used:

$$\frac{CLL}{CLI} = \exp\left[A * \frac{-6.283 * R * ABSPØW * DELT}{\left(1-B\,\frac{Y2*DLØG(Y)}{Y2 - 1} - .5\right)}\right]$$

where

```
Y2 = Y * Y                                                      (N130)

B = R * ABSPØW/Z                                                (N127)
```

The solute uptake per cm root length by diffusion only (UPT) is calculated iteratively as a function of CLL as follows:

```
DENØM = 1 + B * (Y2 * DLØG(Y)/(Y2-1) - .5)                      (N134)

UPT = UNUM * CLL/DENØM                                          (N136)
```

This UPT equation is used when the root water uptake flux is negligible.

(4) Adjustment of average soil solute concentration (CLL)

An iterative loop (ITIM = 1,10) is used during the calculation of the solute uptake per cm of root in which the average soil solute concentration is updated for the effect of the incremental solute uptake DELC) and the soil buffer power (A). The following algorithm based on Baldwin, Nye and Tinker's equations (IV and X) is used:

CLL = DEXP (DLØG(CLI) - DELC * A) . (N141,N166)

The updated CLL value is used in the diffusion only and diffusion plus mass flow solute uptake calculations.

(5) Total root solute uptake (CHCØN)

To supply DRYADS with the amount of the elements adsorbed by the vegetation per cm^2 of land the following equations are used:

DELC = UPT * L + DELC for each iteration step (ITIM=1,10), (N138,N163)

and finally

CHCØN(N,I) = CHCØN(N,I) + DELC * DELX(J) (N185)

where

UPT and L are defined as before

DELC incremental solute uptake ($\mu g/cm^3$ soil)

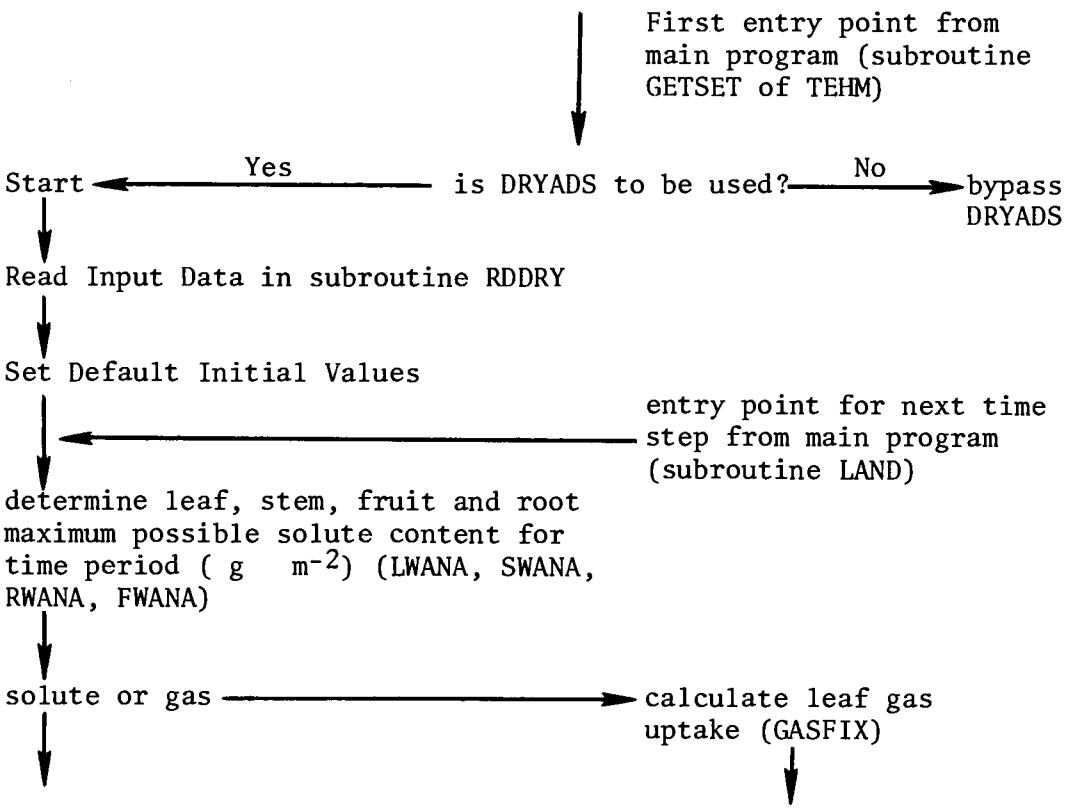
DELX(J) thickness of Jth soil layer (cm)

CHCØN total solute uptake ($\mu g/cm^2$ land/time).

The total solute uptake, CHCØN ($\mu g \cdot cm^{-2}$ land $\cdot$ $time^{-1}$) is relayed to DRYADS. The amounts of element in the soil water and on the soil exchange are updated and returned to the soil chemistry subroutine SCEHM.

(C) DRYADS FLOW DIAGRAM

An overview of the compartments in DRYADS and the fluxes between compartments is given in Fig. 7 for the vegetation and Fig. 8 for the litter. The *SALT and *SØLU represent phloem and xylem solutes respectively. The fixed chemical in living and heartwood tissue is represented by *INSØL and *DØRM respectively. The prefix "*" represents L, S, R, F for leaf, stem, root and fruit as appropriate. The standing dead stem chemical is SHØLD and the litter element pool is *PØØL. The sequence of calculation of solute fluxes is indicated by the numbering in Figs. 7 and 8. A brief flow chart of DRYADS calculations follows. The FORTRAN names for fluxes, pools and coefficients are included so that reference to section III A, Figs. 7 and 8 and the code (Appendix A) may be made.



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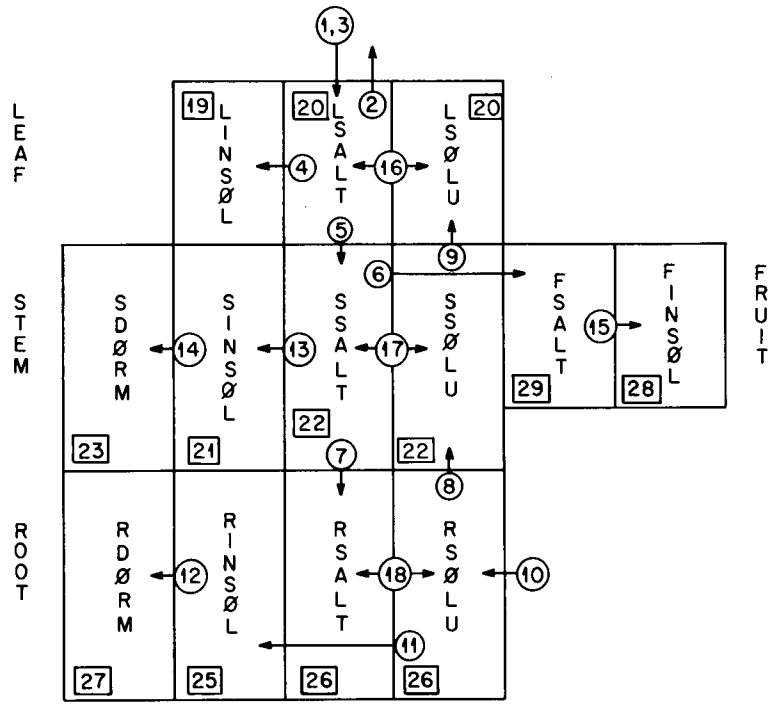

FØRTRAN NAMES FOR THE SØLUTE FLUXES IN VEGETATION

THE NUMBERS INDICATE THE SEQUENCE OF CALCULATIONS IN DRYADS

1 DIFSØL	11 RFIX	20 LHUM
2 LEACH	12 RDEAD	21 SLIT
3 GASFIX	13 SFIX	22 SHUM
4 LFIX	14 SDEAD	23 SFALL
5 LSSALT	15 FFIX	25 RLIT
6 SFSALT	16 } SØLUTE	26 RHUM
7 SRSALT	17 } EQUILIBRATIØN	27 RFALL
8 RSSØLU	18 }	28 FLIT
9 SLSØLU	MØRTALITY RATES	29 FHUM
10 CHCØN	19 LLIT	

Fig. 7. Vegetation element compartments and sequence of solute fluxes between compartments.

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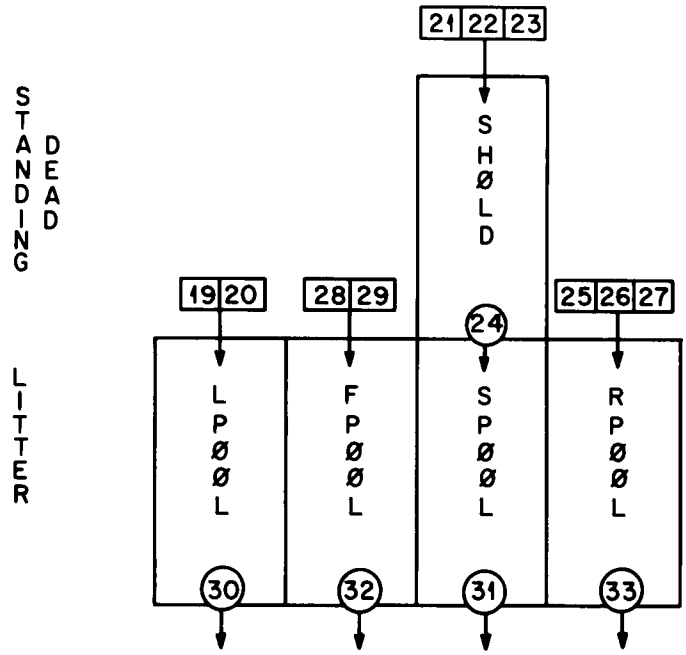

FORTRAN NAMES FOR THE SOLUTE FLUXES IN THE STANDING DEAD AND LITTER

THE NUMBERS INDICATE THE SEQUENCE OF CALCULATIONS IN DRYADS

MORTALITY INPUTS	WIND FALL
19 LLIT	24 SINC
20 LHUM	MINERALIZATION
21 SLIT	30 LMINL
22 SHUM	31 SMINL
23 SFALL	32 FMINL
25 RLIT	33 RMINL
26 RHUM	
27 RFALL	
28 FLIT	
29 FHUM	

Fig. 8. Standing dead and litter element compartments and sequence of solute fluxes between compartments.

calculate leaf salt uptake or leaching (DIFSØL, LEACH)

↓

adjust leaf soluble salt pool and external leaf salt pool

↓

convert leaf soluble salts to fixed form (LFIX)

↓

calculate phloem salt movement from leaf to stem, stem to fruit and stem to root and adjust pools (LSSALT, SFSALT, SRSALT)

↓

calculate transpiration stream solute movement from roots to stems and stems to leaves (RSSØLU, SLSØLU)

↓

add root solute uptake to root pool, convert solutes to insoluble form and convert fixed form to dormant form (RFIX, RDEAD)

← root solute flux from DIFMAS (CHCØN)

↓

convert stem and fruit solutes to a fixed form and fixed form to dormant form for stems (SFIX, FFIX, SDEAD)

↓

equilibrate soluble solutes in xylem with soluble salts in phloem for leaves, stems and roots (*SALT = *SØLU)

↓

determine chemical levels in plant and coefficients for new leaf, stem, fruit and root growth (deficiency or toxicity effects) (LGRØW, SGRØW, FGRØW, RGRØW)

↓

determine chemical losses from vegetation due to mortality (LLIT, LHUM, SLIT, SHUM, SINC, SFALL, RLIT, RHUM, RFALL, FLIT, FHUM) and adjust litter solute pools for additions by mortality

↓

calculate litter mineralization rates (LMINL, SMINL, RMINL, FMINL), adjust litter pools for mineralization. Determine litter solute coefficient for decomposition (deficiency or toxicity effects) (LTØX, STØX, RTØX, FTØX)

↓

Determine quantities for plotting, monthly data summary and mass balance calculations. → Return to Calling Program

(D) DIFMAS FLOW DIAGRAM

↓ Calling Program (Subroutine FLØ of SCEHM)

is DRYADS running? —Yes→ run DIFMAS

is DRYADS running? —No→ bypass DIFMAS

↓

calculate number of seconds in this time step (DELT)

↓

calculate C1 and C2 for exponential distribution of roots with depth

↓

calculate fresh root mass (RMASS) root volume (RVØL) and number of roots (RNØ) in soil chemistry layer

↓

determine root water uptake per unit root area (VEL)

↓

calculate effective distance from bulk soil solution to root (X1) and root density (L)

↓

calculate soil buffer power (A) and some intermediate terms

↓

is root water uptake greater than zero? —No→ calculate incremental solute uptake by roots per cm^3 soil (DELC) by diffusion only

↓ Yes

calculate incremental solute uptake by roots per cm^3 soil (DELC) by mass flow and diffusion

↓

calculate actual solute uptake (CHCØN) from each soil chemistry layer

↓

is hourly solar radiation greater than zero? —No→ add solute uptake to monthly total of nocturnal uptake (TDIFFL)

↓ Yes

add solute uptake to monthly total of uptake during day (TMASFL)

↓

adjust soil chemical exchange for solute uptake from exchange by soil buffer power adjustments

↓

Return to Calling Program.

(E) DRYADS CALL LIST AND INPUT DATA

(i) The call list for the subroutine is (PRES, IHR, MIN, MØNTH, YEAR, KDAY) where, PRES is a switch that has a value of 0 for an hourly time step and 1 for 15 minute time step.

IHR the hour of the day (1 to 24)

MIN cumulative minutes in this hour (0, 15, 30, 45)

MØNTH the month ($\leq$ 12)

YEAR the year (eg 76)

KDAY the day of the month ($\leq$ 31)

These variables are calculated in subroutine LAND of TEHM which is the main calling program for DRYADS.

(ii) INPUT DATA. A separate subroutine, RDDRY, is set up for inputting data to be used for DRYADS. To cause the subroutine to be called a card with 11 RDDRY must be inserted into the input data stream of the TEHM (see Huff et al. 1976). This instruction will cause the following list of data in the necessary order and format to be read by subroutine RDDRY.

CARD

1. Variables: CFRAC, NMIN, NTØT, KS

   Format: (F10.0, 3I5)

   CFRAC fraction of interception storage associated with the canopy (0 to 1 range)

   NMIN the number of the first chemical to be considered ($1 \leq$ NMIN $\leq$ NTØT)

   NTØT the total number of chemicals being considered (NTØT $\leq$ 9)

   KS The element used to determine the growth and decomposition coefficients and the element plotted by the DRYADS plot subroutines.

2. Variables: (MØLWT (J), J = 1, M1)

   Format: (4F8.2)

   MØLWT molecular weight of each gas being considered where M1 is the number of gases

3. Variables: (GASDEN (J), J = 1, M1)

Format: (4F10.0)

GASDEN gas density (g/cc) of each gas to be considered

4. Variables: (GASNAM (J), J = 1, M1)

Format: (4A8)

GASNAM identification of gas, e.g., SØ2 for sulfur dioxide

5. Variables: (DIFCØ (J), J = 1, M2)

Format: (5F10.0)

DIFCØ diffusion coefficients of each gas being considered and of water vapor where M2 is one more than the number of gases (M2 = M1 + 1)

6-8. (optional) Variables: (SWATER(I), PERM(I), FILM(I), WATLAY(I), CØNDUC(I), I = 1, NSTRAT)

Format: (6D10.0)

I is the vegetation type (NSTRAT $\leq$ 3)

SWATER amount of water in fresh stems per g dry stem (g/g)

PERM leaf cuticle permeability (cm/sec)

FILM cuticle thickness (cm)

WATLAY water film thickness on dry leaf (cm)

CØNDUC root conductivity to solutes (cm/sec)

One card is required for each vegetation type I being considered.

9-35. (optional) Variables: (LSØLUM(I,K), SSØLUM(I,K), RSØLUM(I,K), FSØLUM(I,K), I = 1, NSTRAT)

Format: (4D10.0)

LSØLUM maximum leaf solute concentration (μg/g)

SSØLUM, RSØLUM, FSØLUM maximum solute concentration in stem, root, and fruit, respectively (μg/g)

One card is required for each vegetation type (NSTRAT) being considered and one set for each chemical (K $\leq$ 9) being considered. Maximum number of cards is 27.

CARD

36-62. (optional) Variables: (LSALT(I,K), SSALT(I,K), RSALT(I,K), FSALT(I,K), LSØLU(I,K),SSØLU(I,K), RSØLU(I,K), LINSØL(I,K), SINSØL(I,K), RINSØL(I,K), FINSØL(I,K), I = 1, NSTRAT)

Format: (11F7.0)

LSALT, SSALT, RSALT, FSALT initial amount of solute in phloem pathway of leaf, stem, root, and fruit, respectively ($\mu g/m^2$)

LSØLU, SSØLU, RSØLU initial amount of solute in xylem pathway for leaf, stem, and root, respectively ($\mu g/m^2$)

One card for each vegetation layer being considered ($I \leq 3$) and one set for each chemical ($K \leq 9$) being considered. Maximum number of cards is 27.

63-89. (optional) Variables: (LPØØL(I,K), SPØØL(I,K), RPØØL(I,K), FPØØL(I,K), SHØLD(I,K), I = 1, NSTRAT)

Format: (4F10.0)

LPØØL, SPØØL, RPØØL, FPØØL initial amount of element in litter pool for leaf, stem, root, and fruit, respectively ($\mu g/m^2$)

SHØLD amount of element in standing dead pool ($\mu g/m^2$)

One card for each vegetation layer ($I \leq 3$) and one set of cards for each chemical ($K \leq 9$) being considered. Maximum number of cards is 27.

90-116. (optional) Variables: (RDØRM(I,K), SDØRM(I,K), I = 1, NSTRAT)

Format: (2F10.0)

RDØRM, SDØRM amount of insoluble chemical in heartwood of root and stem, respectively ($\mu g/m^2$)

One card for each vegetation layer ($I \leq 3$) and one for each chemical ($K \leq 9$) being considered. Maximum number of cards is 27.

117-125. (optional) Variables: (DEFCØN(I), DIMCØN(I), TØXCØN(I), TØXPNT(I), FULCØN(I), I = NMIN, NTØT)

Format: (5F10.0)

CARD

DEFCØN plant solute concentration (μg/g) below which plant growth is limited by deficiency

DIMCØN plant solute concentration above which plant growth is diminished by toxicity

TØXCØN litter solute concentration at which decomposition is zero

TØXPNT litter solute concentration above which decomposition is diminished by toxicity

FULCØN litter solute concentration (μg/g) below which decomposition is limited by deficiency

One card for each chemical ($I \leq 9$) being considered. Maximum number of cards is 9.

126-128. (optional) Variables: (GASEX(I,M), M = 1, M1)

Format: (4F10.0)

GASEX external gas concentration (cc/cc)

One card for each vegetation layer ($I \leq 3$). Maximum number of cards is 3.

129. Variables: CPART

Format: F10.0

CPART fraction of dryfall that collects in the canopy (0 to 1 range).

(F) Data Transferred Between DRYADS and Other Subroutines

DRYADS is designed to couple to several other models that describe plant growth (CERES) and plant water relations (PROSPER). It also couples to the LAND subroutine of the Terrestrial Ecosystem Hydrology Model (TEHM). CØMMØN statements are used to transfer data between the several models. Only the variables used in DRYADS are described.

(i) Transfers from the LAND subroutine to DRYADS

CØMMØN/MISC/STØT, ATØT, SINTR, SMD, SSUR, SIMP, SINT,

SBAS, SRCH, SRA, SNET, SPET, TØTELH, RES, SRGX, SCEP, REP

SCEP the amount of water (cm^3/cm^2 land) in interception storage.

The other variables in MISC are not used in DRYADS but all these variables must be specified as single precision in DRYADS.

(ii) Transfers between SCEHM and DRYADS

CØMMØN/CHMGEN/DUMMY(6,25), ENAME(5), Q, ID (25),

IPRINT, NELM

NELM number of chemicals being considered in the soil chemistry calculations.

COMMON/VAL/KD(5,25), SP(5), EQWT(5)

SP solubility of the chemical ($\mu g \cdot cm^{-3}$ solution)

CØMMØN/DEPØ/DEP(5,12), AMT(5), CANAMT(5), STRCPR

AMT amount of chemical in the litter layer ($\mu g \cdot cm^{-2}$)

CANAMT amount of chemical in the canopy ($\mu g \cdot cm^{-2}$)

CØMMØN/PLANTU/CHCØN(3,5), HØRS, TRDEP, TRDEPS, R, DL(5),

RDEN, LMIN

CHCØN rate of solute uptake by roots from the soil ($\mu g/cm^2$/time)

(iii) Transfers between CERES and DRYADS

CØMMØN/TRUNK/LAI(3), LSTØR(3), SSTØR(3), RSTØR(3), LSPHLØ(3),

SRPHLØ(3), LSUGAR(3), SSUGAR(3), RSUGAR(3), CENTMP

LAI leaf area index (cm^2/cm^2)

LSTØR leaf insoluble carbon storage (g/m^2)

SSTØR stem insoluble carbon storage (g/m^2)

RSTØR root insoluble carbon storage (g/m^2)

LSPHLØ leaf to stem phloem resistance (sec^{-1})

SRPHLØ stem to root phloem resistance (sec^{-1})

LSUGAR leaf sugar pool (g/m^2)

SSUGAR stem sugar pool (g/m^2)

RSUGAR root sugar pool (g/m^2)

CENTMP current hourly air temperature (°C).

CØMMØN/TISSUE/RWATER(3), ABSPØW(3,9), SHART(3), RHART(3), RMESØ(3), NSTRAT

RWATER amount of water in fresh roots per unit root dry wt (g/g)

ABSPØW absorbing power of vegetation for solutes (cm/sec)

SHART rate of stem heartwood production (g/m^2/time)

RHART rate of root heartwood production (g/m^2/time)

RMESØ mesophyll resistance

NSTRAT number of vegetation layers or types being considered (1, 2 or 3)

CØMMØN/MØRTAL/LSTMRT(3), SSTMRT(3), SSGMRT(3), SWDMRT(3), RSTMRT(3), RSGMRT(3), RWDMRT(3), FSTMRT(3), FSGMRT(3), LSGMRT(3), TMPLIT

LSTMRT rate of leaf storage mortality ($g \cdot m^{-2} \cdot time^{-1}$)

SSTMRT rate of stem storage mortality ($g \cdot m^{-2} \cdot time^{-1}$)

SSGMRT rate of stem sugar mortality

SWDMRT rate of stem wood mortality

RSTMRT rate of root carbon storage mortality

RSGMRT rate of root sugar mortality

RWDMRT rate of root wood mortality

FSTMRT rate of fruit carbon storage mortality

FSGMRT rate of fruit sugar mortality

LSGMRT rate of leaf sugar mortality ($g \cdot m^{-2} \cdot time^{-1}$)

TMPLIT litter temperature (°C).

CØMMØN/REVIVE/LCARB(3), SCARB(3), FCARB(3), RCARB(3),

LDECØM(3), SDECØM(3), FDECØM(3), RDECØM(3), STDEAD(3),

SFLØP(3)

LCARB leaf litter mass ($g \cdot m^{-2}$)

SCARB, FCARB, RCARB similarly for stems, fruits and roots, respectively

LDECØM rate of leaf litter decomposition ($g \cdot m^{-2} \cdot time^{-1}$)

SDECØM, FDECØM, RDECØM similarly for stems, fruits and roots, respectively

STDEAD standing dead mass (g/m^2)

SFLØP rate of windfall from standing dead (g/m^2/time)

CØMMØN/GRØWCØ/LGRØW(3), SGRØW(3), FGRØW(3), RGRØW(3)

LGRØW leaf element coefficient for leaf growth (0 to 1)

SGRØW, FGRØW, RGRØW similarly for stems, fruits and roots, respectively

CØMMØN/TØXCØ/LTØX(3), STØX(3), FTØX(3), RTØX(3)

LTØX leaf litter element coefficient for rate of decomposition (0 to 1)

STØX, FTØX, RTØX similarly for stems, fruits and roots, respectively.

CØMMØN/CERPAR/FSTØR(3), FSUGAR(3), SWØØD(3), RWØØD(3),

P1, P5, B1, B2, FBIØM(3), RBIØM(3), LBIØM(3), SBIØM(3),

SFPHLØ(3), FRESTD(3), LRESTD(3), RRESTD(3), SRESTD(3),

SUGMAX(3), TMPSTD(3), CØ2A(3), CØ2C(3), CHANGE, SUGCØN,

T1, T2, T3, T4, CØ2X, LAIMAX

FSTØR fruit storage ($g \cdot m^{-2}$)

FSUGAR fruit sugar($g \cdot m^{-2}$)

SWØØD stem wood ($g \cdot m^{-2}$)

RWØØD root wood ($g \cdot m^{-2}$)

SFPHLØ stem to fruit phloem resistance (day)

FBIØM total fruit biomass(g/m^2)

RBIØM, LBIØM, SBIØM similarly for roots, leaves and stems, respectively

T1 day of bud break (Julian date)

T4 final day of growing season (Julian date)

CØMMØN/PLTALL/SMIN, XMAX, INC1, ISTRA, NQUES, KS used for plotting part of DRYADS

CØMMØN/PRSPLC/NPRPLT, NMPLT, NSPLTS, NMSPLT, MØNSPL(12), MØNPLT(12), PØRPLT(36), NBEG(12), NEND(12), MACHIN used for plotting part of DRYADS

(iv) Transfers between PRØSPER and DRYADS

CØMMØN/HUMID/FØLTYP, PAIR, CPO, RA, RX, SIGMA, XL, GM, GV, HT, ALEAF

RA boundary layer resistance to water vapor ($sec \cdot cm^{-1}$)

RX stomatal resistance to water vapor ($sec \cdot cm^{-1}$)

CØMMØN/CHMMØS/SWFBL(8), CHETA(8), SWRF1, SWRF2, RLAT(8)

SWRF1 soil water root flux for first root layer (cm^3/cm^2/time)

SWRF2 soil water root flux for second root layer (cm^3/cm^2/time)

CØMMØN/BLØCKE/RN, GND, TTT, EE, PWP, EV, VEL, JDATE

JDATE Julian calendar date ($\leq$ 366)

(v) Transfers between other subroutines and DRYADS

Subroutine RDDRY transfers input data to DRYADS in the CØMMØN statements called DRYPAR, INTSØL, DECAY, SUMDRY, PLTALL.

The Oak Ridge National Laboratory computer system plotting package ORGRAPH (Nestor et al. 1975) uses the CØMMØN statements called PLTALL, PRSPLC, PLTDRY.

(G) DIFMAS Call List and Input Data

DIFMAS Call List: MIN, HØUR

MIN minute of the hour (0, 15, 30, or 45)

HØUR hour of the day (0-23)

No data are specifically read in for use in DIFMAS. All the data required are transferred to it.

(H) Data Transferred Between DIFMAS and Other Subroutines

The transfer of data to DIFMAS in the CØMMØN statements listed below includes a description of the variables used in DIFMAS. Other variables are not described.

(i) Between PROSPER and DIFMAS

CØMMØN/CHMMØS/SWFBL(8), CHETA(8), SWRF1, SWRF2, RLAT(8)

SWRF1 soil water root flux for first PROSPER soil layer ($cm^3/cm^2/time$)

SWRF2 soil water root flux for second PROSPER soil layer ($cm^3/cm^2/time$)

CHETA soil water content (cc/cc)

CØMMØN/GEØMET/HØR(8), AT(2), ARAT(2), FC(8), THETA(8), SWT(8)

HØR depth of PROSPER layers (cm)

ARAT fraction of roots in each root layer (0 to 1 range)

(ii) Between CERES and DIFMAS

CØMMØN/SHINE/SUNHR

SUNHR solar radiation (langleys/hr)

CØMMØN/TISSUE/RWATER(3), ABSPØW(3,9), SHART(3), RHART(3), RMESØ(3), NSTRAT

RWATER amount of water in fresh roots per unit root weight (g/g)

ABSPØW absorbing power of vegetation for solutes (cm/sec)

NSTRAT number of vegetation layers being considered.

CØMMØN/TRUNK/LAI(3), LSTØR(3), SSTØR(3), RSTØR(3), LSPHLØ(3), SRPHLØ(3), LSUGAR(3), SSUGAR(3), RSUGAR(3), CENTMP

RSTØR root insoluble carbon storage(g/m^2)

RSUGAR root sugar pool (g/m^2).

(iii) Between DIFMAS and SCEHM

CØMMØN/CHMGEN/DEPTH(25), DELX(25), XTRACT(25), CH2Ø(25), MØIST(25), MØISIN(25), ENAME(5), Q, ID(25), IPRINT, NELM

DEPTH depth of each soil chemistry layer (cm)

DELX thickness of each soil chemistry layer (cm)

CH2Ø amount of water in each soil chemistry layer (ml/cm)

Q number of soil chemistry layers

ID number for the PROSPER layer corresponding with each soil chemistry layer

NELM number of elements being considered.

CØMMØN/CØNCEN/EC(25), BD(25), EX(5,25), CØN(5,25), TCØNC(5)

BD bulk density of each soil chemistry layer (g/cm^3)

EX exchangeable amount of element in each soil layer (μg/g)

CØN amount of element in soil water ($\mu g/cm^2$)

CØMMØN/VAL/KD(5,25), SP(5), EQWT(5)

KD distribution coefficient $\frac{\mu g \text{ adsorbed element/g soil}}{\mu g \text{ dissolved element/ml water}}$

CØMMØN/PLANTU/CHCØN(3,5), HØRS, TRDEP, TRDEPS, R, DL(5), RDEN, LMIN

CHCØN rate of chemical taken up by roots from soil ($\mu g/cm^2/time$)

HØRS inverse of the square root of depth of first PROSPER soil layer ($cm^{-1/2}$)

TRDEP total depth of all root layers (cm)

TRDEPS square root of total depth of all root layers ($cm^{1/2}$)

R root radius (cm)

DL diffusion coefficient of element in free solution (cm^2/sec)

RDEN root density (cm/cm^2 land)

LMIN time (0, 15, 30, 45 minutes) of last pass through DIFMAS.

(iv) Transfers between other subroutines and DIFMAS

Monthly data is transferred in CØMMØN statements ØUTCØN and FLØW.

IV. SOME APPLICATIONS

Results of successive hourly, monthly, and annual simulations are presented to illustrate the utility of the models. An application to experimental studies of heavy metal transport and effects on an oak forest at the Crooked Creek Watershed in Southeastern Missouri (Van Hook and Shults 1976, Watson 1976) is made. Lead mining and smelting plants have been in operation in this area since 1968 and the atmospheric transport of pollutants has resulted in lead, cadmium, zinc, and copper accumulation in the soil-plant-litter system during the last eight years. Periodic releases of sulfur dioxide have also occurred from the smelter. Input values for the simulations have been obtained from experimental data, literature values or chosen intuitively (Table 1) to represent the parameter values for four heavy metals (Pb, Cd, Zn, Cu) and one gas (SO_2). The data for soil, vegetation, meteorological variables and atmospheric contaminant fallout values (Appendix B) were chosen to represent the

TABLE 1. Values for input variables in the sequence read by subroutine RDDRY

Input Description (units)	FORTRAN Name	Values	Reference+
Proportion of interception caught in canopy	CFRAC	0.8	Helvey & Patric (1965)
First element of interest	NMIN	1	uc
Last element of interest	NTØT	5	uc
Element for plots and solute effects	KS	1	uc
Molecular weights of gases	MØLWT	64	Handbook (1973)
Gas densities (g/cc)	GASDEN	.003	Handbook (1973)
Names of gases	GASNAM	SØ2	uc
Diffusion coefficients of gases and water vapor in air (cm^2/sec)	DIFCØ	.118 .239	Handbook (1973)
gWater content of fresh stem/gdry stem	SWATER	5.7	e
Leaf cuticle permeability (cm/sec)	PERM	10^{-11}	e
Leaf cuticle thickness (cm)	FILM	10^{-5}	Martin & Juniper 1970
Molecular water film on dry leaf (cm)	WATLAY	10^{-5}	e
Root solute conductivity (cm/sec)	CØNDUC	10^{-8}	Table 5
Maximum solute concentration in leaf (ug/g)	LSØLUM	1000,...	Chapman (1965)
Maximum solute concentration in stem (ug/g)	SSØLUM	1000,...	Chapman (1965)
Maximum solute in root (ug/g)	RSØLUM	1000,...	Chapman (1965)
Maximum solute in fruit (ug/g)	FSØLUM	1000,...	Chapman (1965)
Initial leaf phloem solute (ug/m^2)	LSALT	0.0	ic
Initial stem phloem solute (ug/m^2)	SSALT	0.0	ic

TABLE 1. (Continued)

Input Description (units)	FORTRAN Name	Values	Reference+
Initial root phloem solute (ug/m^2)	RSALT	0.0	ic
Initial fruit phloem solute (ug/m^2)	FSALT	0.0	ic
Initial leaf xylem solute (ug/m^2)	LSØLU	0.0	ic
Initial stem xylem solute (ug/m^2)	SSØLU	0.0	ic
Initial root xylem solute (ug/m^2)	RSØLU	0.0	ic
Initial leaf storage solute (ug/m^2)	LINSØL	0.0	ic
Initial stem storage solute (ug/m^2)	SINSØL	0.0	ic
Initial root storage solute (ug/m^2)	RINSØL	0.0	ic
Initial fruit storage solute (ug/m^2)	FINSØL	0.0	ic
Initial leaf litter solute (ug/m^2)	LPØØL	0.0	ic
Initial stem litter solute (ug/m^2)	SPØØL	0.0	ic
Initial root liter solute (ug/m^2)	RPØØL	0.0	ic
Initial fruit litter solute (ug/m^2)	FPØØL	0.0	ic
Initial solute in standing dead (ug/m^2)	SHØLD	0.0	ic
Initial root heartwood solute (ug/m^2)	RDØRM	0.0	ic
Initial shoot heartwood solute (ug/m^2)	SDØRM	0.0	ic
Solute conc. for initial plant deficiency (ug/g)	DEFCØN	0.0...	ic
Solute conc. for initial plant toxicity (ug/g)	DIMCØN	900....	e
Solute conc. for total litter toxicity (ug/g)	TØXCØN	25000....	Watson (1976)
Solute conc. for initial litter toxicity (ug/g)	TØXPNT	2500....	Watson (1976)

TABLE 1. (Continued)

Input Description (units)	FORTRAN Name	Values	Reference+
Solute conc. for initial litter deficiency (ug/g)	FULCØN	0.0	e
Mean ambient gas concentration (ml/ml)	GASEX	$2X10^{-8}$	e
Proportion of dryfall caught in canopy	CPART	0.9	e

+ uc = user choice
e = estimate
ic = initial condition
... = only data for lead shown. Data for other elements in Appendix B.

Crooked Creek Watershed situation. Application results are given for lead and sulfur only. Some comparisons between results for the four heavy metals may be made from Appendix C.

A. Hourly Applications

A twenty-four-hour exposure to SO_2 at 2.5×10^{-7} ml/ml was given on August 25 as a pulse event in the model. The cumulative SO_2 uptake of the vegetation for an eleven-day period (August 22 - August 31) shows the ready adsorption of the gas during the day (Fig. 9). The simulated mobility of the sulfur within the vegetation is evident from both the leaf to stem phloem translocation rate (Fig. 10) and the trace amounts of sulfur moving back from roots to stems in the xylem pathway (Fig. 11). The accumulation of sulfur in the stem, leaf and root tissues (Fig. 12) shows the preferential accumulation in leaves. The model is constructed such that solutes are first utilized within the entry tissue (i.e., leaves or roots). The hourly patterns of heavy metal uptake from soil is illustrated with lead uptake results for ten days in May (Fig. 13). Solute uptake by mass flow during the day is a dominant process and the transpiration stream transports solutes from root to stem (Fig. 14). The accumulation of lead in leaves shows a continuous buildup due to leaf uptake (Fig. 15). The addition of lead from stem to leaves is insignificant. The hourly mineralization release of lead solutes from leaf litter (Fig. 16) shows a marked daily peak that is related to diurnal temperature changes.

B. Monthly Results in an Annual Cycle

The monthly lead accumulation in the canopy and litter and the mineralization release of the heavy metal (Table 2) in the oak forest

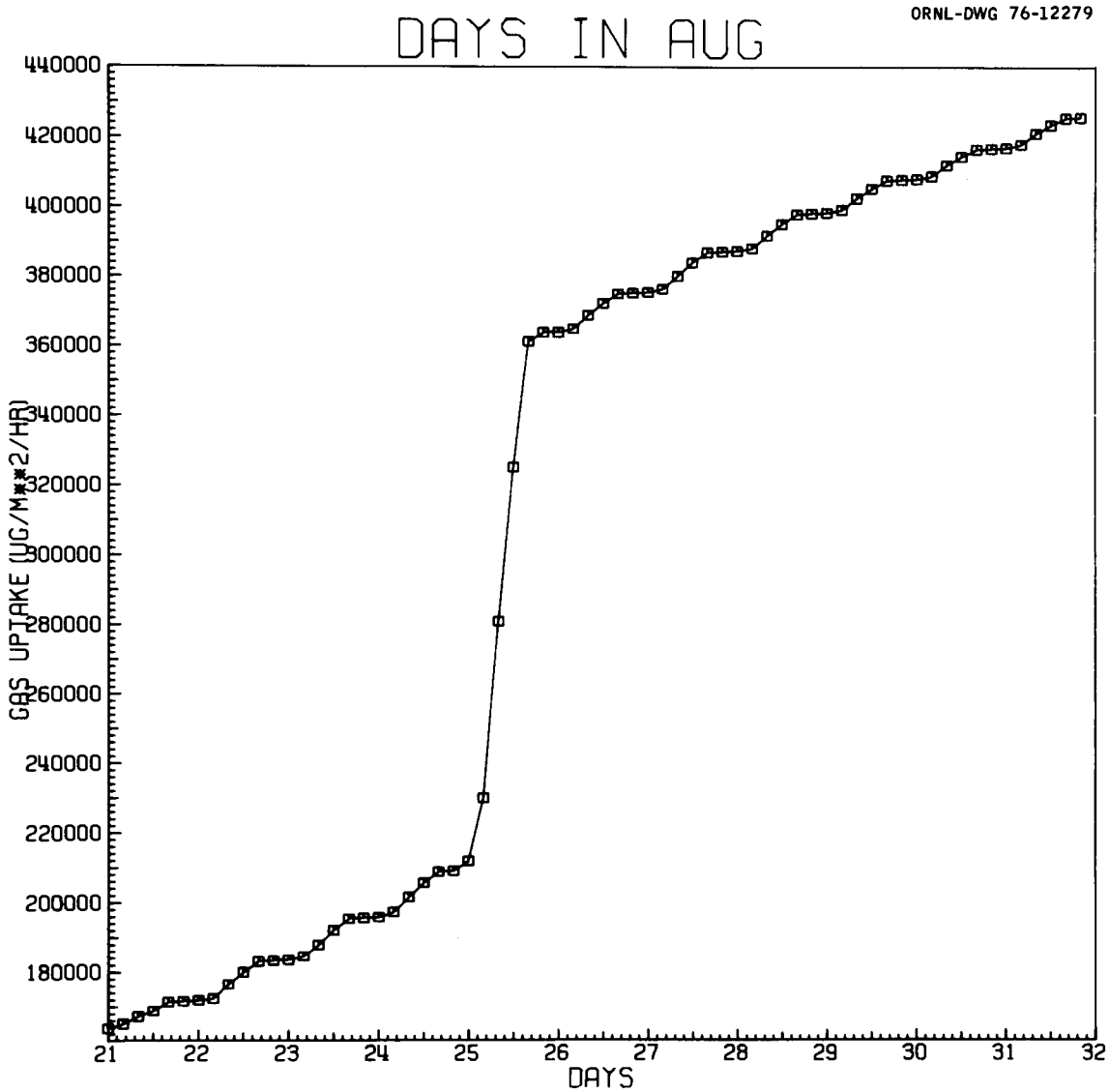

Fig. 9. Sulfur dioxide uptake by vegetation ($\mu g/m^2/hr$) for eleven days in August.

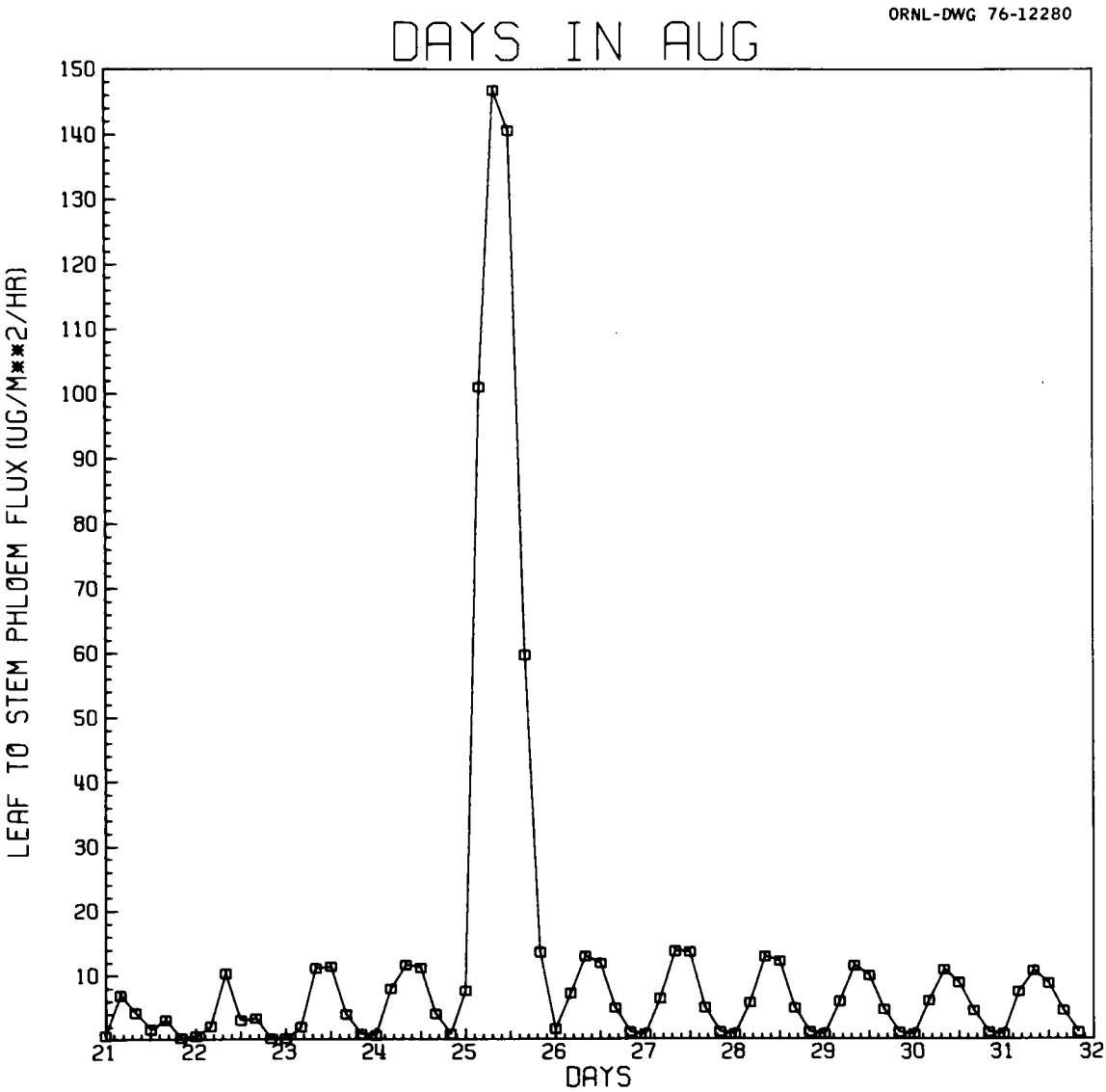

Fig. 10. Leaf to stem phloem translocation ($\mu g/m^2/hr$) of sulfur solute for eleven days in August.

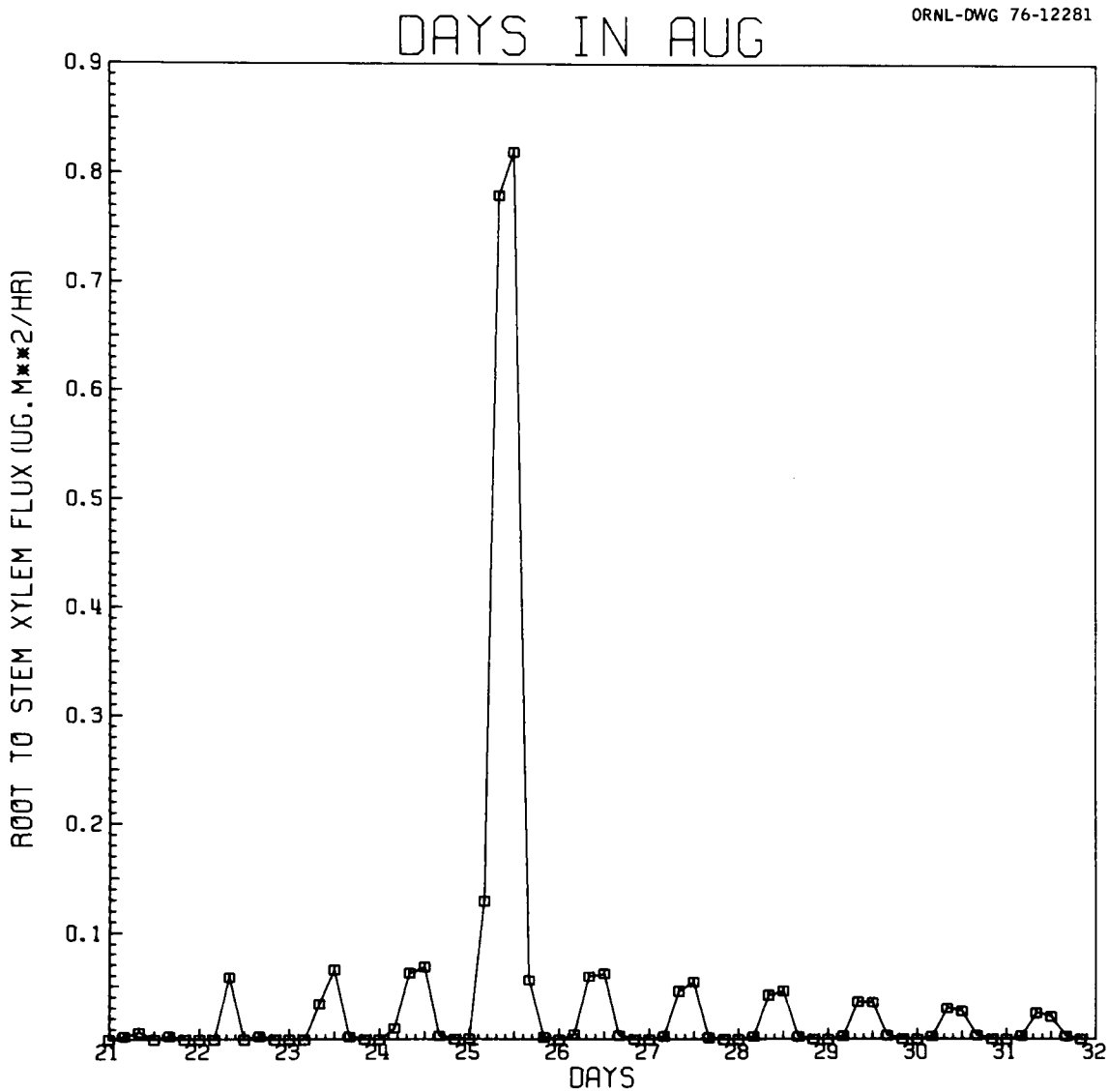

Fig. 11. Root to stem xylem translocation ($\mu g/m^2/hr$) of sulfur solute for eleven days in August.

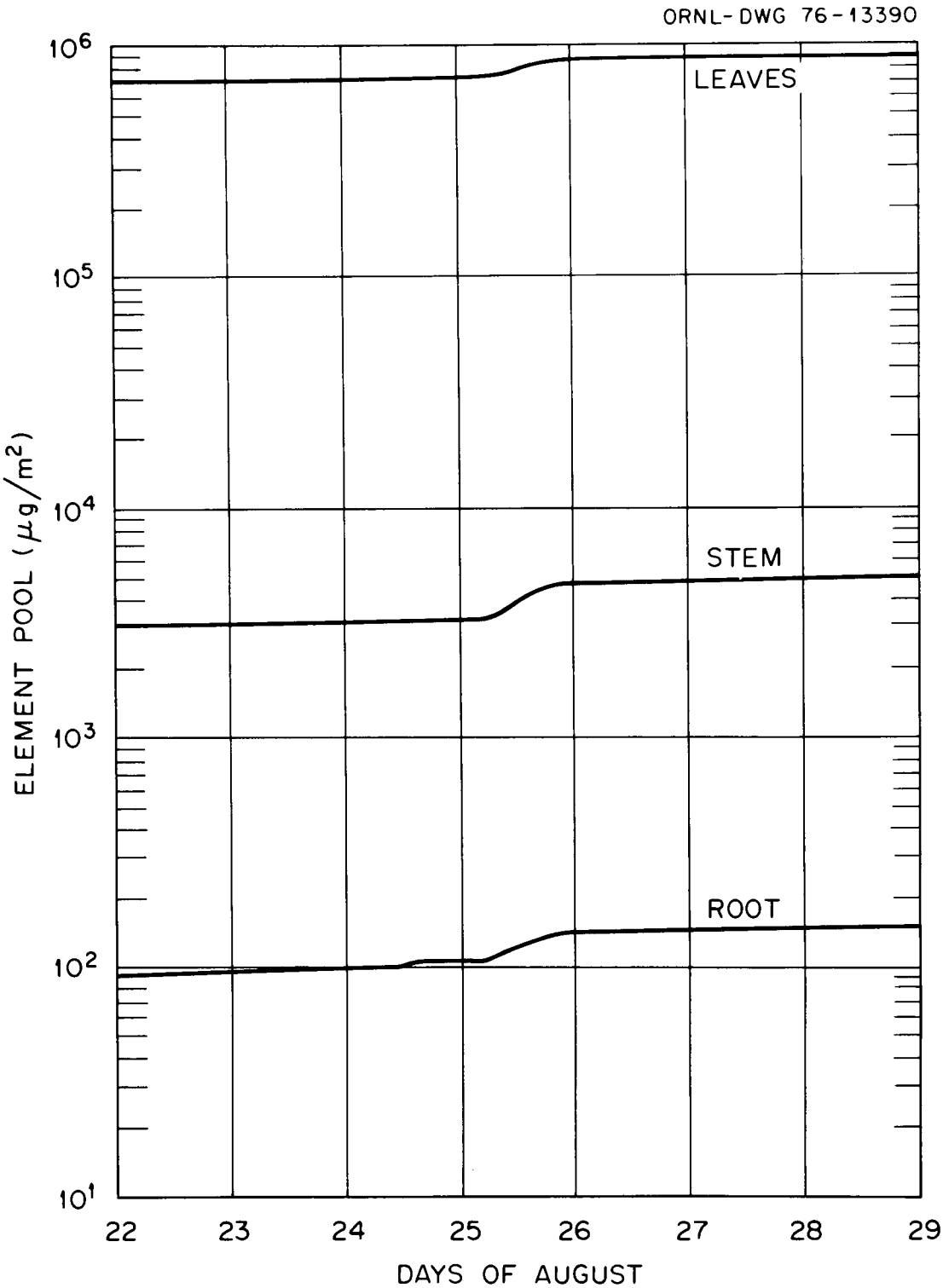

Fig. 12. Sulfur elemental accumulation in leaf, stem and root tissue ($\mu g/m^2$) resulting from gaseous uptake.

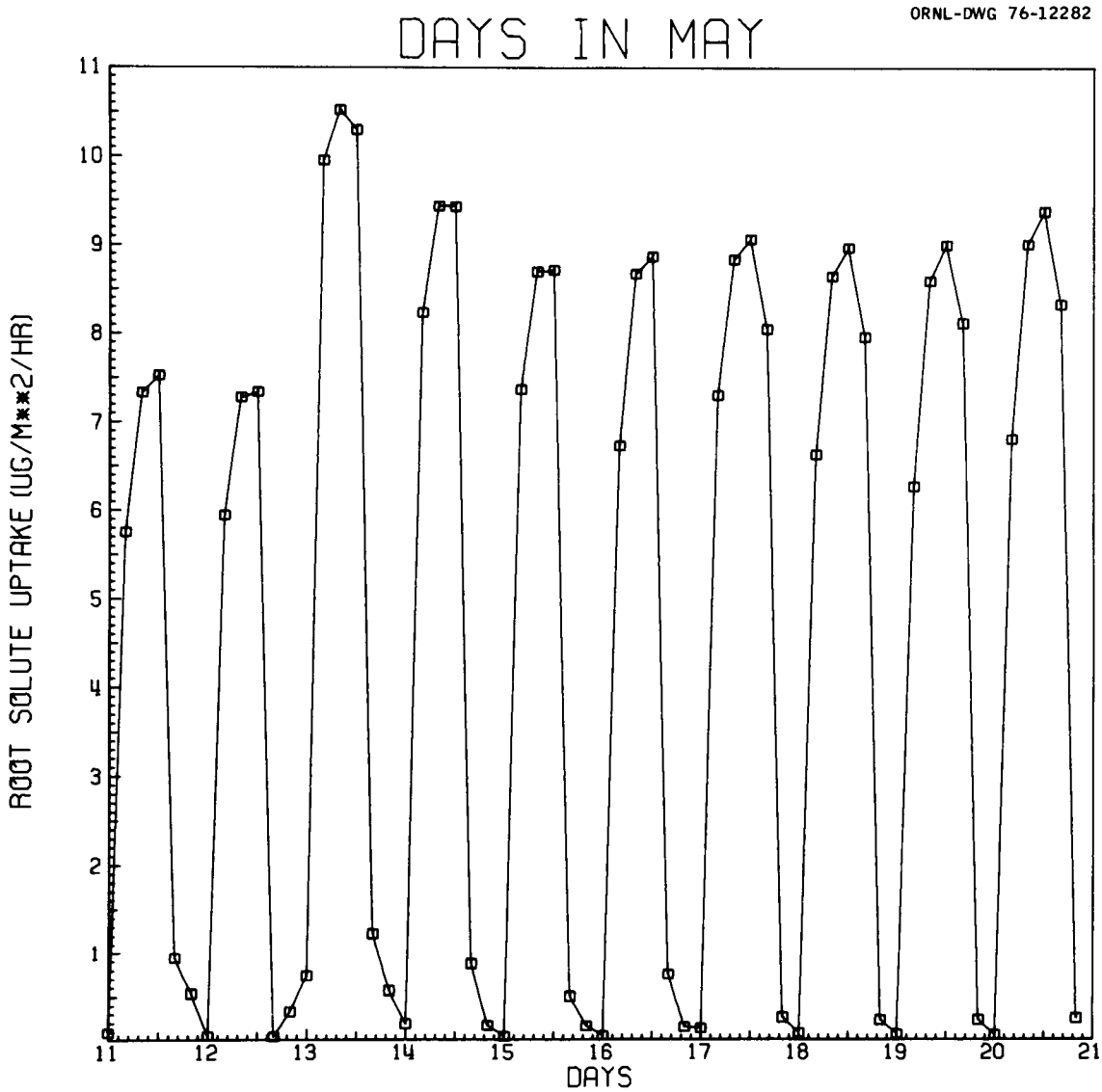

Fig. 13. Diurnal pattern of lead uptake by roots ($\mu g/m^2/hr$) for ten days in May.

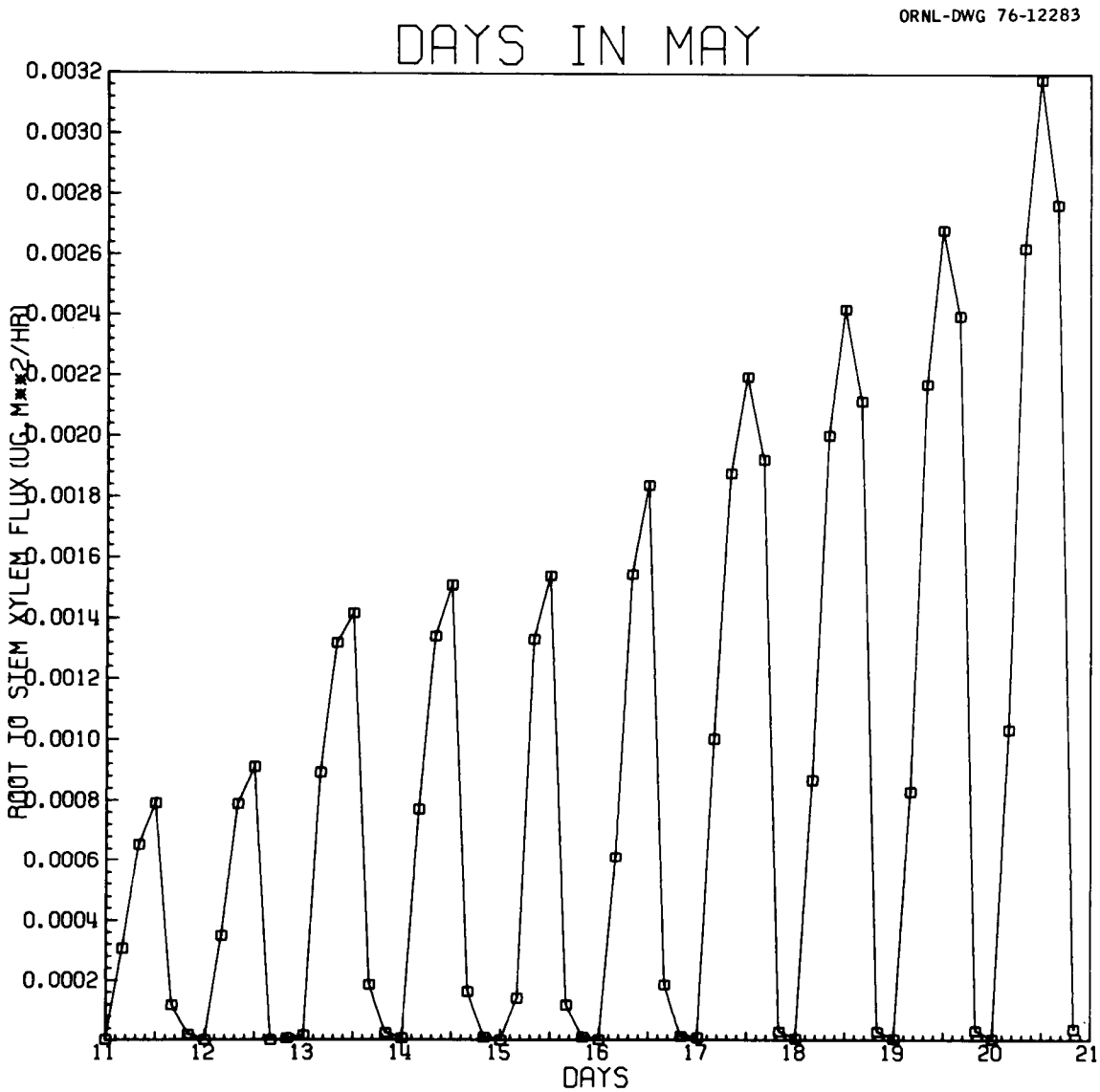

Fig. 14. Diurnal root to stem xylem translocation of lead solutes ($\mu g/m^2/hr$) for ten days in May.

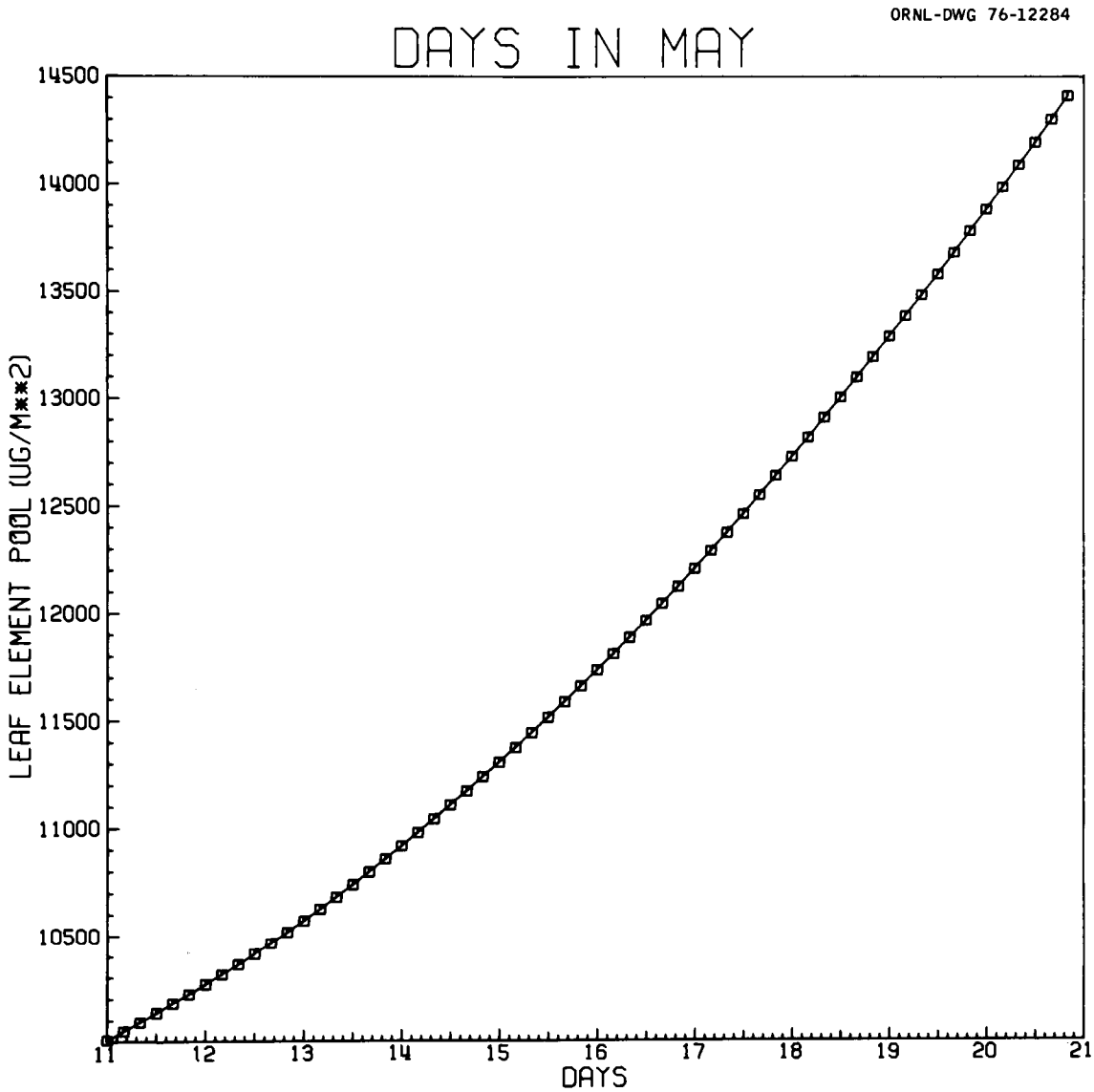

Fig. 15. Accumulation of lead in leaf tissue ($\mu g/m^2$) for ten days in May.

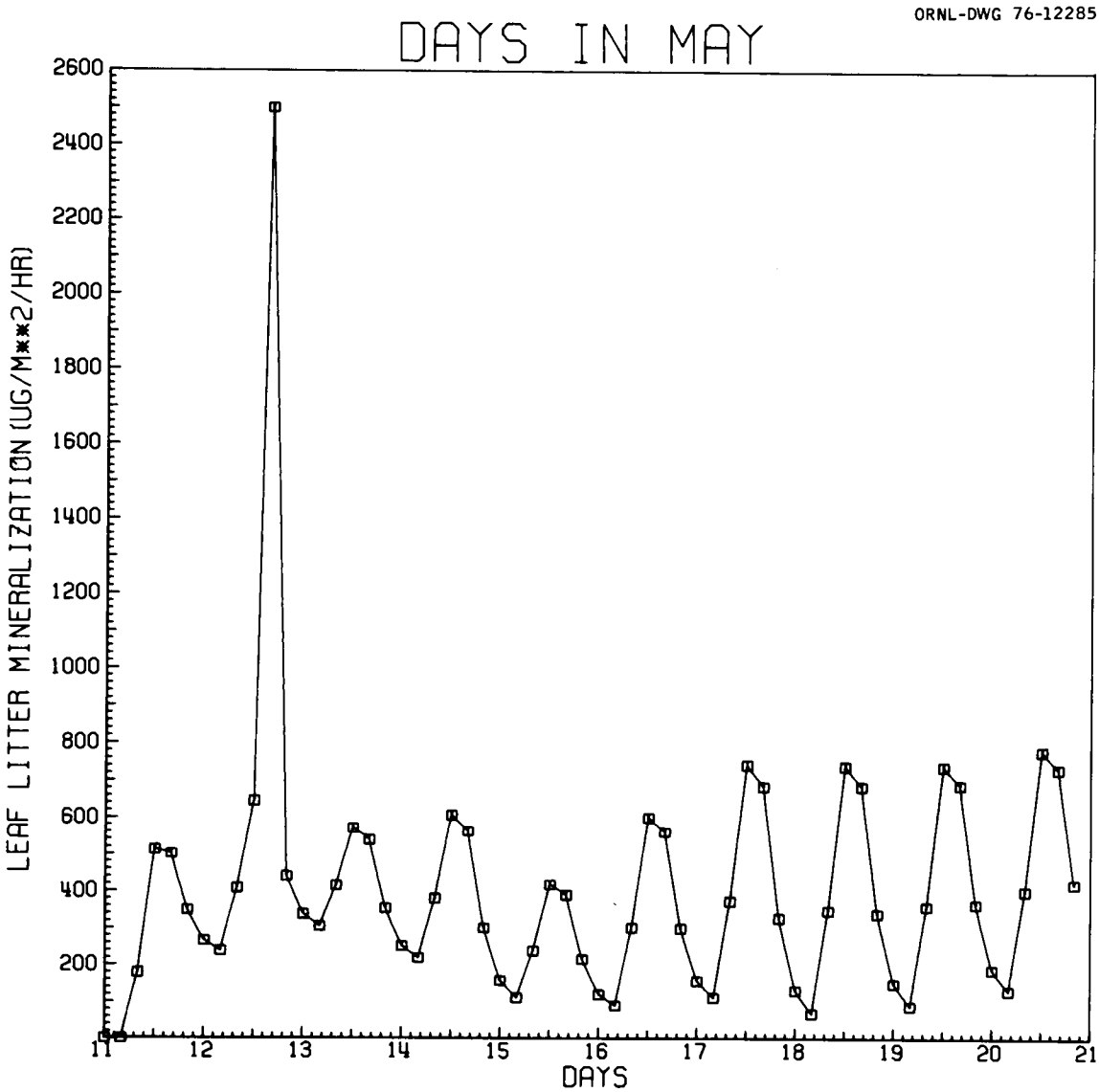

Fig. 16. Leaf litter mineralization of lead ($\mu g/m^2/hr$) for ten days in May.

TABLE 2. Canopy and litter lead levels, litter concentration and mineralization rate of a forest stand in the vicinity of a mine-smelter complex during the first year of operation. (Atmospheric deposition is 2.1 $g/m^2/mo$).

Month	Storage Levels (g/m^2) Canopy	Litter	Litter Concentration ($\mu g/g$)	Litter Mineralization ($g/m^2/mo$)
Jan.	0.0	2.03	943	.005
Feb.	0.0	3.97	1841	.019
Mar.	0.093	5.78	2694	.090
Apr.	0.082	7.11	3369	.278
May	0.257	8.52	4150	.386
Jun.	0.546	9.66	4877	.574
Jly.	0.478	10.93	5735	.663
Aug.	0.270	12.36	6695	.671
Sep.	0.042	13.82	7230	.595
Oct.	0.0	15.06	6643	.521
Nov.	0.0	16.59	7352	.206
Dec.	0.0	17.95	7923	.101
TOTAL				4.109

stand shows a steady buildup of lead in litter during the first year of the mine-smelter operation and maximum canopy interception and litter mineralization rates during August. The accompanying patterns of root and leaf solute uptake (Table 3) show a seasonal maximum canopy uptake during midsummer and a late summer maximum for root uptake. The root-lead uptake during the day was more than seven times higher than the nocturnal uptake. There was no simulated lead uptake during the leafless period. Lead accumulation in plant tissues (fixed chemical) shows a preferential accumulation in root sapwood (Table 3) and a general increase in lead concentration in all tissues with time. Mortality of plant parts resulted in a peak addition of lead to the litter during the fall (Table 3). The soluble lead fluxes in the phloem and xylem pathways (Table 4) indicate that the phloem solute gradients and the transpiration stream can account for mobility of solutes in vegetation. Since the root uptake of lead greatly exceeded the leaf uptake, the accumulation of lead in roots induced upward flow of lead in both the xylem and phloem pathways to stems (shown by negative stem to root phloem fluxes). The movement of lead into fruit (acorns in this case) was very small.

C. Longterm Uptake and Effects

The consequences of continuing lead contamination for six years on the oak forest stand met with simulated disaster during several of the early runs due to the choice of parameters. The DRYADS-DIFMAS models are very sensitive to the value of the root conductivity to solutes parameter (CØNDUC) as shown by some sensitivity results with this term (Table 5). The annual solute uptake and tissue concentrations prior to leaf fall (September) are smaller with lower CØNDUC values. The leaf

TABLE 3. Diurnal root uptake, leaf uptake, tissue levels and mortality losses of lead solute in oak vegetation in the vicinity of a mine-smelter complex during the first year of operation.

Month	Root Uptake ($g/m^2/mo$) Day	Root Uptake ($g/m^2/mo$) Night	Leaf Uptake ($g/m^2/mo$)	Tissue Concentration (ug/g) Leaf	Stem Sapwood	Stem Heartwood	Root Sapwood	Root Heartwood	Fruit	Total Mortality Loss ($mg/m^2/mo$)
Jan.	0.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0
Feb.	0.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0
Mar.	56.5	3.6	0.25	810.	0.46	t+	16.9	0.01	28.5	0.0029
Apr.	213.2	13.2	0.41	46.3	0.80	t	76.7	0.11	0.48	0.0209
May	243.3	27.8	0.89	45.8	1.21	t	154.	0.38	0.71	0.0588
Jun.	196.4	44.9	1.19	68.1	1.54	t	226.	.80	0.84	0.0914
Jly.	285.7	41.0	1.13	90.1	2.47	t	314.	1.38	1.20	0.136
Aug.	284.8	37.4	0.89	110.0	3.47	0.01	388.	2.14	1.38	0.308
Sep.	314.9	39.5	0.42	113.0	5.06	0.13	432.	3.11	1.23	13.1
Oct.	225.7	38.1	0.02		6.99	0.21	511.	4.20		40.9
Nov.	0.0	0.0	0.0		7.33	0.31	518.	5.42		.304
Dec.	0.0	0.0	0.0		7.6	0.41	524.	6.74		.344
TOTAL	1820.5	245.5	5.2							55.27

+t = trace

TABLE 4. Monthly and annual lead solute fluxes in oak vegetation in the vicinity of a mine-smelter complex during the first year of operation.

	Solute Fluxes in Vegetation ($mg/m^2/mo$)				
	Phloem			Xylem	
Month	Leaf to Stem	Stem to Root	Stem to Fruit	Root to Stem	Stem to Leaf
Jan.	0.0	0.0	0.0	0.0	0.0
Feb.	0.0	0.0	0.0	0.0	0.0
Mar.	355.	10.0	0.52	3.8	.15
Apr.	19.7	- 2.76	0.27	155.	12.0
May	12.2	- 10.7	0.40	246.	15.1
Jun.	26.1	- 17.6	0.39	215.	7.1
Jly.	28.7	- 35.6	1.57	980.	63.8
Aug.	22.6	- 50.2	2.03	1300.	63.8
Sep.	0.8	- 68.3	3.44	2180.	104.0
Oct.	121.0	- 67.9	2.17	1230.	42.7
Nov.	0.0	t	0.0	0.0	0.0
Dec.	0.0	0.0	0.0	0.0	0.0
TOTAL	586.1	-243.1	10.8	6309.8	308.7

TABLE 5. Sensitivity of annual root lead uptake and September tissue concentrations to change in the root solute conductivity parameter (CØNDUC).

CØNDUC (cm/sec)	Annual Root Uptake ($ug/cm^2/yr$)	September Tissue Concentration (ppm)					
		Leaf	Stem Sapwood	Stem Heartwood	Root Sapwood	Root Heartwood	Fruit
10^{-4}	156.1	309	854	3.30	967	10.2	264
10^{-5}	143.3	258	774	2.80	961	9.9	191
10^{-6}	128.0	242	683	2.32	993	11.7	251
10^{-8}	20.7	113	5.06	0.01	432	3.1	1.2
10^{-10}	0.52	112	0.48	0.003	11	0.1	.1

tissue reaches a minimum value of 112 μg/g resulting from leaf uptake of lead (leaf permeability, PERM was 10^{-11} cm/sec). Since a maximum tissue concentration of 1000 μg/g was chosen for the simulations (Table 1), the root sapwood concentration approached this value at higher CØNDUC values. A similar set of sensitivity results were obtained with test runs on the leaf permeability term (PERM). Both CONDUC and PERM are important plant interface properties with the environment and characterization of these properties would greatly assist the impact assessment of continuing contamination on vegetation.

The September plant tissue concentrations of lead during six years of atmospheric deposition (25.2g lead/m^2/year) were simulated to show a rapid buildup of contaminant in the root sapwood and an increase in concentration in the other plant parts with time (Table 6). There were no toxic effects of the lead on plant growth since the level of 900 μg/g was not exceeded (see DIMCØN in Table 1) in the simulations. A buildup in leaf concentration occurred in the fifth and following year as a result of increased lead transport from roots and stems. During the first four years the leaf lead concentration was due mainly to uptake through the leaf surface. Some experimental results collected in 1974 (six years of plant operation) at Crooked Creek Watershed at several distances from the smelter stack (Van Hook and Shults 1976) suggest that the simulations may be representative of a site between 0.4 to 0.8 km from the stack. The atmospheric deposition rate used (2.1 g lead/m^2/year) is representative of about 0.5 km from the stack in the NW direction (Van Hook and Shults 1976).

Annual root uptake of lead (Table 7) increased with the accompanying buildup of lead in the soil system (Begovich and Jackson 1975). Leaf

TABLE 6. September tissue concentration of lead (ug/g) in oak vegetation following successive years of lead atmospheric deposition.

Years	Leaf	Stem Sapwood	Stem Heartwood	Root Sapwood	Root Heartwood	Fruit
1	176.	2.32	0.012	181.	1.24	0.264
2	172.	8.92	0.074	436.	9.44	0.805
3	174.	27.9	0.287	662.	26.0	2.37
4	178.	80.5	0.932	790.	49.0	6.80
5	186.	182.	2.65	805.	74.4	14.9
6	191.	282.	6.07	807.	99.0	20.0

TABLE 7. Lead uptake and losses of vegetation and litter and lead content of litter following successive years of lead atmospheric deposition.

	Vegetation ($mg/m^2/yr$)			Litter		
				End of Year Lead		
Years	Root Uptake	Leaf Uptake	Mortality Loss	Content (g/m^2)	Concentration (ug/g)	Mineralization Loss ($g/m^2/yr$)
1	97.6	82.6	84.5	10.9	6600.	4.15
2	168.9	82.6	85.2	21.1	11100.	6.48
3	208.1	82.6	89.4	31.0	14100.	6.80
4	233.4	82.6	95.5	40.8	16200.	6.79
5	254.6	82.6	102.7	50.7	17800.	6.66
6	268.1	82.6	108.0	60.9	19000.	6.56

uptake was constant through the six-year simulation period. The recycling of lead back to litter from mortality of plant parts increased with time and can be mainly attributed to the fall of leaves and fruits during autumn (see Table 3). The reduced rate of contaminant buildup in the plant tissues and the reduced rate of plant uptake with time is due to the structure of the plant demand function (Fig. 3) and the input values for plant properties.

There was a buildup of litter lead of about $10 g/m^2/yr$ and the average litter concentration increased, however, at a decreasing rate with time (Table 7). This latter effect was the result of toxic effects reducing the rate of litter decomposition and causing a buildup of litter mass (Dixon et al., 1976). Mineralization losses of lead from litter reached a maximum in the third and fourth year (Table 7). A decrease in mineralization rate per unit litter mass with increase in litter lead concentration and an increase in litter mass after the second year resulted in the annual mineralization loss being about $6.5 g/m^2/yr$ for the 2nd - 6th years (Table 7). The decline in mineralization loss in the sixth year is due to the increased simulated toxic effect of lead on the rate of litter decomposition.

V. DISCUSSION

The DRYADS and DIFMAS models provide an essential link in the coupled process models of carbon, water and solute fluxes of terrestrial ecosystems. Simple algorithms have been chosen to represent plant and soil processes in a unified treatment. The DRYADS model has not been extensively reviewed and it will have further development as specific applications

are undertaken. DIFMAS is based on the FORTRAN model of Baldwin, Nye and Tinker (1973) and this model has had extensive review and presentation in the open literature. These authors recommend their model as suitable for inclusion in models of whole plant processes.

There are many assumptions and hypotheses contributing to the basis of the DIFMAS and DRYADS models. DRYADS is founded on a simplified view of plant anatomy and physiological function. The concept of the plant solute demand has no mechanistic basis; however, empirical evidence suggests that plants behave in a way that may be described with this demand approximation. The concept is operationally well defined in terms of the maximum tissue concentration at which new growth ceases. The fact that plants do show toxicity responses illustrates that a solute uptake function should include excessive uptake. The phloem solute gradient equation and xylem solute transport within the transpiration stream are consistent with current understanding of solute movement in plants. However, the phloem mechanism may depend more on the gradient of total solutes rather than a specific solute gradient. In the case of sucrose translocation, Noble (1974) along with others has explained the mass flow of material in phloem being the result of a hydrostatic pressure gradient induced by the difference in the osmotic effect of high sucrose in leaf phloem and low sucrose in the root phloem. A process of sucrose loading in the leaf and unloading in the root is hypothesized to maintain translocation during the day. Phloem transport in DRYADS is not always consistent with this mechanism. Programming changes could be introduced to use the sucrose translocation rate from CERES as the driving force for solute movement in DRYADS. This could give rise to solute movement against its own concentration gradient.

The DIFMAS model calculates plant solute uptake by diffusion and mass flow to randomly dispersed roots of a developing root system. Each root is considered to exploit a finite volume of soil which decreases with increasing root density. All roots have the same root radius in the present code. Only the solution phase ions are considered mobile and there are no rhizosphere effects. Baldwin (1975) has shown that the model accounts for the significant variables in the absorption process in a study of nitrogen and potassium uptake by rape (Brassica napus L.) which is a non mycorrhizal species. A careful evaluation of the hypotheses and assumptions made in the coupled system of models has not been feasible at this stage.

The treatment of litter and litter solute dynamics is very much simplified in the DRYADS code. The four types of plant parts and their solutes are considered along with the release of elements during mineralization. Litter water content and microbial population effects are not included in the decomposition simulations. However, diurnal changes in litter temperature consistently result in higher mineralization rates during the day than at night (Fig. 16). Differences in substrate quality is taken into account with input values in CERES for the decomposition characteristics of stem, leaf, root, and fruit materials. The solutes entering the litter layer from atmospheric fallout and canopy washoff (calculated in SCEHM) are proportionally allocated at each time-step to the litter components (leaf, stem, root, and fruit) in proportion to the mass of each component. There is a logical problem with this formulation since roots which are normally in the soil receive some of the atmospheric solute input instantaneously rather than by a soil

water flow mechanism. This could result in lower root decomposition rates (due to solute toxicity effects) occurring at an earlier stage of the simulation than might be expected in the real world. This would not be the case for roots in the litter layer, however.

The time limitation for completion of this modeling task has resulted in some inconsistencies in matching resolutions of the component models. One particular example of this is the difference in root distribution resolution (Fig. 5) for water uptake (PROSPER), solute uptake (DIFMAS) and soil chemical reactions (SCEHM). The consequences of this disparity have not been evaluated. Also, the solutes released in litter mineralization have not been added back into the soil chemistry model at this stage. The inclusion of algorithms to describe organic-metal complex formation and stability should accompany this step. The present model development is a foundation for further refinement which will arise out of applications with the code and comparison with experimental studies.

The computational errors in DRYADS have been consistently low ($< 10^{-6}$ μg solute/m^2 land/month) for both vegetation and litter compartments in the test applications (Appendix C). The sequential calculations having 15-minute or hourly time steps provided mathematically stable results. The soil chemical mass balance errors also display low values ($< 10^{-12}$ μg solute/cm^2 land/month) for both mobile solutes (zinc) and insoluble elements (lead) (Appendix C). These results suggest that the inclusion of root uptake dynamics into the soil chemistry model has not caused any computational instability in the cases examined.

An annual simulation, executed from a HEX deck of the complete set of coupled models (Fig. 2) required 285 seconds of total CPU time on an

IBM 360-91 computer. The ORNL job cost was $25. This simulation was accomplished with 3295 card images read and 11916 lines printed providing detailed hourly print-plots of 27 water, carbon, and solute parameters for an eleven-day period, printout of daily soil-plant water status and detailed monthly tabulation of components of the carbon, water, and solute budgets. Annual print-plot results for 15 plant growth components and a final annual summary of the water budget for the landscape were also given.

The fruits of the modeling exercise include the insights gained from applications to the terrestrial ecosystem of interest. For example, the present results suggest that root sapwood is the first major site of trace contaminant accumulation from soil borne pollutants (Table 3). Further, the model sensitivity to both leaf permeability and root conductivity of solutes highlights the importance of careful experimental determination of these plant properties. The simulated diurnal patterns of root solute uptake suggest that about 85% of solutes are taken up during the daylight hours. Although much is understood about the mechanisms of solute movement in soil, there is less understanding of the diurnal and seasonal dynamics of solute uptake by whole plants.

The litter system was shown to receive the highest amounts of contaminant from both atmospheric deposition and as a pulse with the fall of leaves and fruits in autumn. Toxic effects of lead on litter decomposition and the buildup of lead with time resulted in the mineralization release of lead to reach a maximum after three to four years of atmospheric deposition. Simulations suggest that the continuing

years of lead deposition would result in higher accumulations of contaminant in the litter unless some non-biological mechanism could cause mobilization.

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VII. APPENDICES

APPENDIX A

FORTRAN IV Listing of Code

Subroutine RDDRY — reads in data for DRYADS.

Subroutine DRYPLT — prepares DRYADS and DIFMAS data for print plot output.

Subroutine DIFMAS — mass flow and diffusive solute uptake by roots.

Subroutine DRYADS — solute accumulation in vegetation and litter.

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          COMPILER OPTIONS - NAME=  MAIN,OPT=C2,LINECNT=60,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,NOXREF
ISN 0002            SUBROUTINE RDDRY                                                RDDR   1
ISN 0003            IMPLICIT REAL*8(A-H,O-Z)                                        RDDR   2
ISN 0004            REAL*8 LSALT,LSOLU,LINSCL,LSOLUM,MOISIN,MOIST,LPOOL,MOLWT       RDDR   3
ISN 0005            INTEGER Q                                                       RDDR   4
ISN 0006            COMMON/DRYPAR/CFRAC,GASDEN(4),GASCON(4),GASEX(3,4),DIFCO(5),    RDDR   5
                   1SWATER(3),PERM(3),FILM(3),WATLAY(3),CONDUC(3),LSOLUM(3,9),      RDDR   6
                   2SSOLUM(3,9),RSOLUM(3,9),FSOLUM(3,9),GASNAM(4),MOLWT(4),NMIN,NTOT RDDR   7
ISN 0007            COMMON/SUMDRY/TDIF(3,9),TLEA(3,9),TGAS(3,9),TLSS(3,9),TSPS(3,9),TSRDDR   8
                   1RS(3,9),TRSS(3,9),TSLS(3,9),TLMO(3,9),TSMO(3,9),TFMO(3,9),      RDDR   9
                   2TRMO(3,9),TLMI(3,9),TSMI(3,9),TFMI(3,9),TRMI(3,9),TCIN(3,9),    RDDR  10
                   3TPUDDL(3,9)                                                     RDDR  11
ISN 0008            DIMENSION ZERDRY(486)                                           RDDR  12
ISN 0009            EQUIVALENCE(ZERDRY(1),TDIF(1,1))                                RDDR  13
ISN 0010            COMMON/PLTDRY/ PLTDIF(66),PLTGAS(66),PLTLPS(66),PLTSPS(66),     RDDR  14
                   1PLTRPS(66),PLTLSS(66),PLTRSS(66),PLTCHC(66),PLTAMT(66),PLTMNS(66) RDDR  15
                   2,PLTTWA(66)                                                     RDDR  16
ISN 0011            REAL*4 PLTDIF,PLTGAS,PLTLPS,PLTSPS,PLTRPS,PLTLSS,PLTRSS         RDDR  17
                   1,PLTCHC,PLTAMT,PLTMNS,PLTTWA                                    RDDR  18
ISN 0012            COMMON/INTSOL/LSALT(3,9),SSALT(3,9),RSALT(3,9),FSALT(3,9),      RDDR  19
                   1LSOLU(3,9),SSOLU(3,9),RSOLU(3,9),LINSOL(3,9),SINSOL(3,9),       RDDR  20
                   2RINSOL(3,9),FINSOL(3,9),GASIN(3,4),DEFCON(9),                   RDDR  21
                   3DIMCON(9),TOXCON(9),TOXPNT(9),FULCON(9),SDORM(3,9),RDORM(3,9)   RDDR  22
ISN 0013            COMMON/DECAY/IPOOL(3,9),SPOOL(3,9),RPOOL(3,9),FPOOL(3,9),       RDDR  23
                   1SHOLD(3,9),TGOODY(3,9)                                          RDDR  24
ISN 0014            COMMON/TISSUE/RWATER(3),ABSPOW(3,9),SHART(3),RHART(3),          RDDR  25
                   1RMESO(3),NSTRAT                                                 RDDR  26
ISN 0015            COMMON/DEPO/DEP(5,12),AMT(5),CANAMT(5),STRCPR                   RDDR  27
ISN 0016            COMMON/PLTALL/XMIN,XMAX,INC1,ISTRA,NQUES,KS                     RDDR  28
ISN 0017            REAL*4 XMIN,XMAX                                                RDDR  29
ISN 0018            COMMON/OPTS/CHMOPT,CEROPT,DRYOPT                                RDDR  30
ISN 0019            COMMON/CHMGEN/DEPTH(25),DELX(25),XTRACT(25),CH20(25),MOIST(25), MORDDR  31
                   1ISIN(25),ENAME(5),Q,ID(25),IPRINT,NELM                          RDDR  32
ISN 0020            LOGICAL CHMOPT,CEROPT,DRYOPT                                    RDDR  33
ISN 0021            READ(5,8000) CFRAC,NMIN,NTOT,KS                                 RDDR  34
ISN 0022       8000 FORMAT(F10.0,3I5)                                               RDDR  35
ISN 0023            IF(KS.LE.0) KS=1                                                RDDR  36
ISN 0025            DRYOPT=.TRUE.                                                   RDDR  37
ISN 0026       8005 FORMAT('0SOLUTE MOVEMENT IN VEG.,FIRST CHEMICAL,TOTALCHEMICALS', RDDR  38
                   1F10.2,2I5)                                                      RDDR  39
ISN 0027            WRITE(6,8005) CFRAC,NMIN,NTOT                                   RDDR  40
ISN 0028            M1=NTOT-NELM                                                    RDDR  41
ISN 0029            M2=M1+1                                                         RDDR  42
ISN 0030            IF(M1) 105,105,100                                              RDDR  43
ISN 0031        100 READ(5,8010) (MOLWT(J),J=1,M1)                                  RDDR  44
ISN 0032       8010 FORMAT(4F8.2)                                                   RDDR  45
ISN 0033            WRITE(6,8015) (MOLWT(J),J=1,M1)                                 RDDR  46
ISN 0034       8015 FORMAT(' MOLECULAR WEIGHT OF GAS ',4E8.2)                       RDDR  47
ISN 0035            READ(5,8030) (GASDEN(J),J=1,M1)                                 RDDR  48
ISN 0036            WRITE(6,8035) (GASDEN(J),J=1,M1)                                RDDR  49
ISN 0037            READ(5,8020) (GASNAM(J),J=1,M1)                                 RDDR  50
ISN 0038       8020 FORMAT(4A8)                                                     RDDR  51
ISN 0039            WRITE(6,8025) (GASNAM(J),J=1,M1)                                RDDR  52
ISN 0040       8025 FORMAT ('0GASES TO BE CONSIDERED'/,1X,4A8)                      RDDR  53
ISN 0041       8030 FORMAT(4F10.0)                                                  RDDR  54
ISN 0042       8035 FORMAT('0GAS DENSITIES(G/CC)',4F10.3)                           RDDR  55
ISN 0043            READ(5,8040) (DIFCO(J),J=1,M2)                                  RDDR  56
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```
ISN 0044          WRITE(6,8045) (DIFCO(J),J=1,M2)                          RDDR  57
ISN 0045     8040 FORMAT(5F10.0)                                           RDDR  58
ISN 0046     8045 FORMAT('0DIFFUSION COEFFICIENTS OF GASES AND H20',4F10.2) RDDR  59
ISN 0047      105 READ(5,8050)  (SWATER(I),PERM(I),FILM(I),WATLAY(I),      RDDR  60
                 1CONDUC(I),I=1,NSTRAT)                                    RDDR  61
ISN 0048     8050 FORMAT(6E10.0)                                           RDDR  62
ISN 0049          WRITE(6,8055)                                            RDDR  63
ISN 0050     8055 FORMAT(4X,'STEM H20 CONTENT',                            RDDR  64
                 15X,'L CUTICLE COND.',5X,'CUTICLE THICKNESS',3X,          RDDR  65
                 2'DRY LEAF H20 FILM',5X,'R.SOLUTE CON.'/)                 RDDR  66
ISN 0051          WRITE(6,8060) (SWATER(I),PERM(I),FILM(I),WATLAY(I),      RDDR  67
                 1CONDUC(I),I=1,NSTRAT)                                    RDDR  68
ISN 0052     8060 FORMAT(6E20.5)                                           RDDR  69
ISN 0053          WRITE(6,8065)                                            RDDR  70
ISN 0054     8065 FORMAT('0MAX.CONCENTRATION'/                             RDDR  71
                 14X,'LEAF',6X,'STEM',6X,'ROOT',6X,'FRUIT')                RDDR  72
ISN 0055          DO 110 K=NMIN,NTOT                                       RDDR  73
ISN 0056          READ(5,8070)  (LSOLUM(I,K),SSOLUM(I,K),RSOLUM(I,K),FSOLUM(I,K),  RDDR  74
                 1I=1,NSTRAT)                                              RDDR  75
ISN 0057          WRITE(6,8075)  (LSOLUM(I,K),SSOLUM(I,K),RSOLUM(I,K),FSOLUM(I,K),  RDDR  76
                 1I=1,NSTRAT)                                              RDDR  77
ISN 0058      110 CONTINUE                                                 RDDR  78
ISN 0059     8070 FORMAT(4E10.0)                                           RDDR  79
ISN 0060     8075 FORMAT(4E10.2)                                           RDDR  80
ISN 0061          WRITE(6,8105)                                            RDDR  81
ISN 0062          DO 115 K=NMIN,NTOT                                       RDDR  82
ISN 0063          READ(5,8080)(LSALT(I,K),SSALT(I,K),RSALT(I,K),FSALT(I,K),  RDDR  83
                 1LSOLU(I,K),SSOLU(I,K),RSOLU(I,K),LINSOL(I,K),SINSOL(I,K),  RDDR  84
                 2RINSOL(I,K),FINSOL(I,K),I=1,NSTRAT)                      RDDR  85
ISN 0064     8080 FORMAT(11F7.0)                                           RDDR  86
ISN 0065          WRITE(6,8110)  (LSALT(I,K),SSALT(I,K),RSALT(I,K),FSALT(I,K),  RDDR  87
                 1LSOLU(I,K),SSOLU(I,K),RSOLU(I,K),LINSOL(I,K),SINSOL(I,K),  RDDR  88
                 2RINSOL(I,K),FINSOL(I,K),I=1,NSTRAT)                      RDDR  89
ISN 0066      115 CONTINUE                                                 RDDR  90
ISN 0067          DO 120 K=NMIN,NTOT                                       RDDR  91
ISN 0068          READ(5,8085)  (LPOOL(I,K),SPOOL(I,K),RPOOL(I,K),         RDDR  92
                 1FPOOL(I,K),SHOLD(I,K),I=1,NSTRAT)                        RDDR  93
ISN 0069     8085 FORMAT(5F10.0)                                           RDDR  94
ISN 0070          WRITE(6,8090)  (LPOOL(I,K),SPOOL(I,K),RPOOL(I,K),FPOOL(I,K),  RDDR  95
                 1SHOLD(I,K),I=1,NSTRAT)                                   RDDR  96
ISN 0071     8090 FORMAT('0LPOOL,SPOOL,RPOOL,FPOOL,SHOLD'/(1X,5E10.3/))    RDDR  97
ISN 0072      120 CONTINUE                                                 RDDR  98
ISN 0073          DO 125 K=NMIN,NTOT                                       RDDR  99
ISN 0074          READ(5,8095)  (RDORM(I,K),SDORM(I,K),I=1,NSTRAT)         RDDR 100
ISN 0075     8095 FORMAT(2F10.0)                                           RDDR 101
ISN 0076          WRITE(6,8100)  (RDORM(I,K),SDORM(I,K),I=1,NSTRAT)        RDDR 102
ISN 0077     8100 FORMAT('0RDORM,SDORM'/(1X,2E10.3/))                      RDDR 103
ISN 0078      125 CONTINUE                                                 RDDR 104
ISN 0079     8105 FORMAT('0CONC',16X,'SALT',27X,'SOLUBLE',28X,'INSOLUBLE'/  RDDR 105
                 19X,3(3X,'LEAF',6X,'STEM',6X,'ROOT'6X,'FRUIT',3X))        RDDR 106
ISN 0080     8110 FORMAT(9X,4F10.2,3F10.2,10X,4F10.2)                      RDDR 107
ISN 0081          READ(5,8115)  (DEFCON(I),DIMCON(I),TOXCON(I),TOXPNT(I)   RDDR 108
                 1,FULCON(I),I=NMIN,NTOT)                                  RDDR 109
ISN 0082     8115 FORMAT(5F10.0)                                           RDDR 110
ISN 0083          WRITE(6,8120)  (DEFCON(I),DIMCON(I),TOXCON(I),TOXPNT(I),  RDDR 111
                 1FULCON(I),I=NMIN,NTOT)                                   RDDR 112
ISN 0084     8120 FORMAT('0DEFCON,DIMCON,TOXCON,TOXPNT,FULCON'/(1X,5E10.2/))  RDDR 113
ISN 0085          IF(M1) 142,142,127                                       RDDR 114
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                C     DO FOR ONLY GASES.                                          RDDR 115
ISN 0086          127 DO 130 I=1,NSTRAT                                           RDDR 116
ISN 0087              READ(5,8125) (GASEX(I,M),M=1,M1)                            RDDR 117
ISN 0088          130 CONTINUE                                                    RDDR 118
ISN 0089              WRITE(6,8130) ((GASEX(I,M),M=1,M1),I=1,NSTRAT)              RDDR 119
ISN 0090         8125 FORMAT(4F10.0)                                              RDDR 120
ISN 0091         8130 FORMAT('0GASEX'/(1X,4E10.3/))                               RDDR 121
ISN 0092              DO 140 M=1,M1                                               RDDR 122
ISN 0093              DO 135 I=1,NSTRAT                                           RDDR 123
ISN 0094              GASIN(I,M)=GASEX(I,M)/2.                                    RDDR 124
ISN 0095          135 CONTINUE                                                    RDDR 125
ISN 0096              DIFCO(M)=DIFCO(M)/DIFCO(M2)                                 RDDR 126
ISN 0097          140 CONTINUE                                                    RDDR 127
ISN 0098          142 READ(5,8135) CPART                                          RDDR 128
ISN 0099         8135 FORMAT(F10.0)                                               RDDR 129
ISN 0100              STRAT=NSTRAT                                                RDDR 130
ISN 0101              STRCPR=STRAT*CPART                                          RDDR 131
ISN 0102              WRITE(6,8140) CPART                                         RDDR 132
ISN 0103         8140 FORMAT('0FRACTION OF CANOPY DEP. ON LITTER',F10.2)          RDDR 133
ISN 0104              DO 145 J=1,9                                                RDDR 134
ISN 0105              DO 145 K=1,3                                                RDDR 135
ISN 0106              ABSPOW(K,J)=0.0                                             RDDR 136
ISN 0107          145 CONTINUE                                                    RDDR 137
ISN 0108              DO 150 K=1,486                                              RDDR 138
ISN 0109          150 ZERDRY(K)=0.0D0                                             RDDR 139
                C     SET INITIAL STORAGE PCOLS                                   RDDR 140
ISN 0110              DO 155 I=1,NSTRAT                                           RDDR 141
ISN 0111              DO 155 K=NMIN,NTOT                                          RDDR 142
ISN 0112          155 TGOODY(I,K)=LINSOL(I,K)+SINSOL(I,K)+RINSOL(I,K)+FINSOL(I,K) RDDR 143
                     1+LSOLU(I,K)+SSOLU(I,K)+RSOLU(I,K)+SDORM(I,K)+RDORM(I,K)     RDDR 144
                     2+LSALT(I,K)+SSALT(I,K)+RSALT(I,K)+FSALT(I,K)                RDDR 145
ISN 0113              DO 160 J=1,66                                               RDDR 146
ISN 0114              PLTLSS(J)=0.0                                               RDDR 147
ISN 0115              PLTRSS(J)=0.0                                               RDDR 148
ISN 0116              PLTCHC(J)=0.0                                               RDDR 149
ISN 0117              PLTMNS(J)=0.0                                               RDDR 150
ISN 0118          160 CONTINUE                                                    RDDR 151
ISN 0119              RETURN                                                      RDDR 152
ISN 0120              END                                                         RDDR 153
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          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=60,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,NOXREF
   ISN 0002          SUBROUTINE DRYPLT(INC1,XMIN,XMAX,MONTH,KS,NELM)                    DRYP   1
   ISN 0003          COMMON/PLTDRY/ PLTDIF(66),PLTGAS(66),PLTLPS(66),PLTSPS(66),        DRYP   2
                    1PLTRPS(66),PLTLSS(66),PLTRSS(66),PLTCHC(66),PLTAMT(66),PLTMNS(66)  DRYP   3
                    2,PLTTWA(66)                                                        DRYP   4
   ISN 0004          COMMON/PRSPLC/NPRPLT,NMPLT,NSPLTS,NMSPLT,MONSPL(12),               DRYP   5
                    1MONPLT(12),PORPLT(36),NBEG(12),NEDN(12),MACHIN                     DRYP   6
   ISN 0005          INTEGER*2 MONSPL,MONPLT,PORPLT,NBEG,NEND                           DRYP   7
   ISN 0006          REAL MACHIN                                                        DRYP   8
   ISN 0007          COMMON/BUF/BUFFER(3000)                                            DRYP   9
   ISN 0008          DIMENSION NAME(4),MONNAM(12)                                       DRYP  10
   ISN 0009          DATA NAME(1)/4HDAYS/,NAME(2)/4H IN /,NAME(4)/4H$   /               DRYP  11
   ISN 0010          DATA MONNAM/'JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC '/    DRYP  12
   ISN 0011          IF(KS.LE.NELM)  YMIN1=PLTDIF(1)                                    DRYP  13
   ISN 0013          IF(KS.LE.NELM)YMAX1=YMIN1                                          DRYP  14
   ISN 0015          IF(KS.GT.NELM)YMIN2=PLTGAS(1)                                      DRYP  15
   ISN 0017          IF(KS.GT.NELM)YMAX2=YMIN2                                          DRYP  16
   ISN 0019          YMIN3=PLTLSS(1)                                                    DRYP  17
   ISN 0020          YMAX3=YMIN3                                                        DRYP  18
   ISN 0021          YMIN4=PLTRSS(1)                                                    DRYP  19
   ISN 0022          YMAX4=YMIN4                                                        DRYP  20
   ISN 0023          YMIN5=PLTCHC(1)                                                    DRYP  21
   ISN 0024          YMAX5=YMIN5                                                        DRYP  22
   ISN 0025          YMIN6=PLTMNS(1)                                                    DRYP  23
   ISN 0026          YMAX6=YMIN6                                                        DRYP  24
   ISN 0027          YMIN7=PLTLPS(1)                                                    DRYP  25
   ISN 0028          YMAX7=YMIN7                                                        DRYP  26
   ISN 0029          YMIN8=PLTSPS(1)                                                    DRYP  27
   ISN 0030          YMAX8=YMIN8                                                        DRYP  28
   ISN 0031          YMIN9=PLTRPS(1)                                                    DRYP  29
   ISN 0032          YMAX9=YMIN9                                                        DRYP  30
   ISN 0033          YMIN10=PLTAMT(1)                                                   DRYP  31
   ISN 0034          YMAX10=YMIN10                                                      DRYP  32
   ISN 0035          YMIN11=PLTTWA(1)                                                   DRYP  33
   ISN 0036          YMAX11=YMIN11                                                      DRYP  34
   ISN 0037          XINC=(XMAX-XMIN)/FLOAT(INC1)                                       DRYP  35
   ISN 0038          NAME(3)=MONNAM(MONTH)                                              DRYP  36
   ISN 0039          DO 110 K=1,INC1                                                    DRYP  37
   ISN 0040          IF(KS.GT.NELM) GO TO 100                                           DRYP  38
   ISN 0042          IF(PLTDIF(K).LT.YMIN1) YMIN1=PLTDIF(K)                             DRYP  39
   ISN 0044          IF(PLTDIF(K).GT.YMAX1) YMAX1=PLTDIF(K)                             DRYP  40
   ISN 0046      100 IF(KS.LE.NELM) GO TO 105                                           DRYP  41
   ISN 0048          IF(PLTGAS(K).LT.YMIN2) YMIN2=PLTGAS(K)                             DRYP  42
   ISN 0050          IF(PLTGAS(K).GT.YMAX2) YMAX2=PLTGAS(K)                             DRYP  43
   ISN 0052      105 CONTINUE                                                           DRYP  44
   ISN 0053          IF(PLTLSS(K).LT.YMIN3) YMIN3=PLTLSS(K)                             DRYP  45
   ISN 0055          IF(PLTLSS(K).GT.YMAX3) YMAX3=PLTLSS(K)                             DRYP  46
   ISN 0057          IF(PLTRSS(K).LT.YMIN4) YMIN4=PLTRSS(K)                             DRYP  47
   ISN 0059          IF(PLTRSS(K).GT.YMAX4) YMAX4=PLTRSS(K)                             DRYP  48
   ISN 0061          IF(PLTCHC(K).LT.YMIN5) YMIN5=PLTCHC(K)                             DRYP  49
   ISN 0063          IF(PLTCHC(K).GT.YMAX5) YMAX5=PLTCHC(K)                             DRYP  50
   ISN 0065          IF(PLTMNS(K).LT.YMIN6) YMIN6=PLTMNS(K)                             DRYP  51
   ISN 0067          IF(PLTMNS(K).GT.YMAX6) YMAX6=PLTMNS(K)                             DRYP  52
   ISN 0069          IF(PLTLPS(K).LT.YMIN7) YMIN7=PLTLPS(K)                             DRYP  53
   ISN 0071          IF(PLTLPS(K).GT.YMAX7) YMAX7=PLTLPS(K)                             DRYP  54
   ISN 0073          IF(PLTSPS(K).LT.YMIN8) YMIN8=PLTSPS(K)                             DRYP  55
   ISN 0075          IF(PLTSPS(K).GT.YMAX8) YMAX8=PLTSPS(K)                             DRYP  56
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ISN 0077          IF(PLTRPS(K).LT.YMIN9) YMIN9=PLTRPS(K)                DRYP  57
ISN 0079          IF(PLTRPS(K).GT.YMAX9) YMAX9=PLTRPS(K)                DRYP  58
ISN 0081          IF(PLTAMT(K).GT.YMIN10) YMIN10=PLTAMT(K)              DRYP  59
ISN 0083          IF(PLTAMT(K).LT.YMAX10) YMAX10=PLTAMT(K)              DRYP  60
ISN 0085          IF(PLTTWA(K).LT.YMIN11) YMIN11=PLTTWA(K)              DRYP  61
ISN 0087          IF(PLTTWA(K).GT.YMAX11) YMAX11=PLTTWA(K)              DRYP  62
ISN 0089      110 CONTINUE                                              DRYP  63
ISN 0090          NINC=-INC1                                            DRYP  64
ISN 0091          IF(KS.GT.NELM) GO TO 115                              DRYP  65
ISN 0093          IF(YMIN1.EQ.YMAX1) GO TO 115                          DRYP  66
ISN 0095          CALL RNDPLT(XMIN,XMAX,YMIN1,YMAX1,'LINEAR',MACHIN,-1.,-1.,  DRYP  67
                 1BUFFER,3000,'BEGOVICH$')                              DRYP  68
ISN 0096          CALL TITLE(.4,NAME,'DAYS$','LEAF UPTAKE(UG/M**2/HR)$')  DRYP  69
ISN 0097          CALL RAYPLT(XINC,PLTDIF,NINC)                         DRYP  70
ISN 0098      115 IF(KS.LE.NELM) GO TO 120                              DRYP  71
ISN 0100          IF(YMIN2.EQ.YMAX2) GO TO 120                          DRYP  72
ISN 0102          CALL RNDPLT(XMIN,XMAX,YMIN2,YMAX2,'LINEAR',MACHIN,-1.,-1.,  DRYP  73
                 1BUFFER,3000,'BEGOVICH$')                              DRYP  74
ISN 0103          CALL TITLE(.4,NAME,'DAYS$','GAS UPTAKE(UG/M**2/HR)$')  DRYP  75
ISN 0104          CALL RAYPLT(XINC,PLTGAS,NINC)                         DRYP  76
ISN 0105      120 IF(YMIN3.EQ.YMAX3) GO TO 125                          DRYP  77
ISN 0107          CALL RNDPLT(XMIN,XMAX,YMIN3,YMAX3,'LINEAR',MACHIN,-1.,-1.,  DRYP  78
                 1BUFFER,3000,'BEGOVICH$')                              DRYP  79
ISN 0108          CALL TITLE(.4,NAME,'DAYS$'                            DRYP  80
                 1,'LEAF TO STEM PHLOEM FLUX(UG/M**2/HR)$')             DRYP  81
ISN 0109          CALL RAYPLT(XINC,PLTLSS,NINC)                         DRYP  82
ISN 0110      125 IF(YMIN4.EQ.YMAX4) GO TO 130                          DRYP  83
ISN 0112          CALL RNDPLT(XMIN,XMAX,YMIN4,YMAX4,'LINEAR',MACHIN,-1.,-1.,  DRYP  84
                 1BUFFER,3000,'BEGOVICH$')                              DRYP  85
ISN 0113          CALL TITLE(.4,NAME,'DAYS$',                           DRYP  86
                 1'ROOT TO STEM XYLEM FLUX(UG.M**2/HR)$')               DRYP  87
ISN 0114          CALL RAYPLT(XINC,PLTRSS,NINC)                         DRYP  88
ISN 0115      130 IF(YMIN5.EQ.YMAX5) GO TO 135                          DRYP  89
ISN 0117          CALL RNDPLT(XMIN,XMAX,YMIN5,YMAX5,'LINEAR',MACHIN,-1.,-1.,  DRYP  90
                 1BUFFER,3000,'BEGOVICH$')                              DRYP  91
ISN 0118          CALL TITLE(.4,NAME,'DAYS$','ROOT SOLUTE UPTAKE(UG/M**2/HR)$')  DRYP  92
ISN 0119          CALL RAYPLT(XINC,PLTCHC,NINC)                         DRYP  93
ISN 0120      135 IF(YMIN6.EQ.YMAX6) GO TO 140                          DRYP  94
ISN 0122          CALL RNDPLT(XMIN,XMAX,YMIN6,YMAX6,'LINEAR',MACHIN,-1.,-1.,  DRYP  95
                 1BUFFER,3000,'BEGOVICH$')                              DRYP  96
ISN 0123          CALL TITLE(.4,NAME,'DAYS$'                            DRYP  97
                 1,'LEAF LITTER MINERALIZATION(UG/M**2/HR)$')           DRYP  98
ISN 0124          CALL RAYPLT(XINC,PLTMNS,NINC)                         DRYP  99
ISN 0125      140 IF(YMIN7.EQ.YMAX7) GO TO 145                          DRYP 100
ISN 0127          CALL RNDPLT(XMIN,XMAX,YMIN7,YMAX7,'LINEAR',MACHIN,-1.,-1.,  DRYP 101
                 1BUFFER,3000,'BEGOVICH$')                              DRYP 102
ISN 0128          CALL TITLE(.4,NAME,'DAYS$','LEAF ELEMENT POOL(UG/M**2)$')  DRYP 103
ISN 0129          CALL RAYPLT(XINC,PLTLPS,NINC)                         DRYP 104
ISN 0130      145 IF(YMIN8.EQ.YMAX8) GO TO 150                          DRYP 105
ISN 0132          CALL RNDPLT(XMIN,XMAX,YMIN8,YMAX8,'LINEAR',MACHIN,-1.,-1.,  DRYP 106
                 1BUFFER,3000,'BEGOVICH$')                              DRYP 107
ISN 0133          CALL TITLE(.4,NAME,'DAYS$','STEM ELEMENT POOL(UG/M**2)$')  DRYP 108
ISN 0134          CALL RAYPLT(XINC,PLTSPS,NINC)                         DRYP 109
ISN 0135      150 IF(YMIN9.EQ.YMAX9) GO TO 155                          DRYP 110
ISN 0137          CALL RNDPLT(XMIN,XMAX,YMIN9,YMAX9,'LINEAR',MACHIN,-1.,-1.,  DRYP 111
                 1BUFFER,3000,'BEGOVICH$')                              DRYP 112
ISN 0138          CALL TITLE(.4,NAME,'DAYS$','ROOT ELEMENT POOL(UG/M*:2$')  DRYP 113
ISN 0139          CALL RAYPLT(XINC,PLTRPS,NINC)                         DRYP 114
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ISN 0140        155 IF(YMIN10.EQ.YMAX10) GO TO 160                                  DRYP 115
ISN 0142            CALL RNDPLT(XMIN,XMAX,YMIN10,YMAX10,'LINEAR',MACHIN,-1.,-1.,    DRYP 116
                   1BUFFER,3000,'BEGOVICH$')                                         DRYP 117
ISN 0143            CALL TITLE(.4,NAME,'DAYS$','LITTER ELEMENT POOI(UG/M**2)$')      DRYP 118
ISN 0144            CALL RAYPLT(XINC,PLTANT,NINC)                                    DRYP 119
ISN 0145        160 IF(YMIN11.EQ.YMAX11) GO TO 165                                  DRYP 120
ISN 0147            CALL RNDPLT(XMIN,XMAX,YMIN11,YMAX11,'LINEAR',MACHIN,-1.,-1.,    DRYP 121
                   1BUFFER,3000,'BEGOVICH$')                                         DRYP 122
ISN 0148            CALL TITLE(.4,NAME,'DAYS$','TOTAL PLANT SOLUTE DEMANT$')         DRYP 123
ISN 0149            CALL RAYPLT(XINC,PLTTWA,NINC)                                    DRYP 124
ISN 0150        165 CONTINUE                                                         DRYP 125
ISN 0151            CALL ADVANS                                                      DRYP 126
ISN 0152            RETURN                                                           DRYP 127
ISN 0153            END                                                              DRYP 128
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LEVEL  21.6  (DEC 72)                    OS/360  FORTRAN H

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=60,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,NOXREF
 ISN 0002            SUBROUTINE DIFMAS(MIN,HOUR)                                    DIFM   1
                 C   THIS SUBROUTINE IS BASED ON THE FORTRAN PROGRAM DEVELOPED BY   DIFM   2
                 C   BALDWIN,MYE AND TINKER (1973) PLANT AND SOIL 38:621-635        DIFM   3
                 C                                                                  DIFM   4
                 C   CHCON=AMOUNT OF SOLUTE TAKEN UP IN TIME PERIOD (UG/CM**2 LAND/T) DIFM   5
                 C   CON=AVERAGE SOIL SOLUTION CHEMICAL CONCENTRATION (UG/ML)        DIFM   6
                 C   RF(ID(J))=ROOT WATER UPTAKE FROM PROSPER LAYER J (ML/CM**2 LAND) DIFM   7
                 C   ID(J)=PROSPER LAYER ASSOCIATED WITH SOIL CHEMISTRY LAYER 'J'   DIFM   8
                 C   RTOT(N)=PLANT ROOTS OF VEGETATION N (G/CM**2 LAND)             DIFM   9
                 C   RALL=MASS OF ALL ROOTS (G/CM**2 LAND)                          DIFM  10
                 C   RMASS=ROOT MASS IN JTH SIOL CHEM LAYER (G)                     DIFM  11
                 C   RVOL=ROOT VOLUME IN JTH SOIL CHEM LAYER (ML)                   DIFM  12
                 C   RNO=ROOT NUMBER IN JTH SOIL CHEM LAYER                         DIFM  13
                 C   L=ROOT DENSITY (CM/ML)                                         DIFM  14
                 C   RDEN=DENSITY OF FRESH ROOTS (G/ML)                             DIFM  15
                 C   RWATER=ROOT WATER CONTENT/G DRY WEIGHT (G/G)                   DIFM  16
                 C   WATUP=WATER UPTAKE RATE/G ROOT FOR PROSPER LAYER (ML/G/TIME)   DIFM  17
                 C   WEL=ROOT WATER UPTAKE RATE IN JTH SOIL CHEM LAYER (ML/TIME)    DIFM  18
                 C   VEL=ROOT WATER UPTAKE RATE/CM**2 ROOT AREA (ML/CM**2/SEC)      DIFM  19
                 C   CHETA(ID(J))=PROSPER SOIL WATER CONTENT (ML/ML)                DIFM  20
                 C   DELT=SECONDS IN TIME STEP (900 OR 3600)                        DIFM  21
                 C   DELC=SOLUTE UPTAKE INCREMENT IN LOOP 'DO 90,DO 100' (UG/ML SOIL) DIFM  22
                 C   CLI=INITIAL SOIL SOLUTION CONCENTRATION (UG/ML SOIL WATER)     DIFM  23
                 C   CLL=UPDATED 'CLI' IN LOOP 'DO 90,DO 100'                       DIFM  24
                 C   DELX=SOIL CHEMISTRY LAYER THICKNESS (CM)                       DIFM  25
                 C   DIFF=SOLUTE UPTAKE FROM SOIL SOLUTION (UG/CM**2 LAND)          DIFM  26
                 C   EXDIFF=SOLUTE UPTAKE FROM SOIL EXCHANGE (UG/ML SOIL)           DIFM  27
                 C   EX(I,J)=SOIL EXCHANGE CHEMICAL (UG/G SOIL)                     DIFM  28
                 C   CON(I,J)=SOIL SOLUTION CHEMICAL IN JTH LAYER (UG/CM**2 LAND)   DIFM  29
                 C   BD(J)=BULK DENSITY OF SOIL LAYER 'J' (G/ML SOIL)               DIFM  30
                 C   KD=DISTRIBUTION COEFFICIENT (UG ADSORBED/G SOIL/UG DISSOLVED/ML DIFM  31
                 C     SOLUTION)                                                    DIFM  32
                 C   A=BUFFER POWER (TOTAL SOLUTE/ML SOIL/DISSOLVED SOLUTE/ML SOLUTION) DIFM  33
 ISN 0003            IMPLICIT REAL*8 (A-H,O-Z)                                      DIFM  34
 ISN 0004            REAL*8 L,MOIST,MOISIN,KD,LAI,LSTOR,LSPHLO,LSUGAR               DIFM  35
 ISN 0005            DIMENSION RTOT(3),C1(3)                                        DIFM  36
 ISN 0006            INTEGER Q,HOUR                                                 DIFM  37
 ISN 0007            COMMON/CHMMOS/SWFBL(8),CHETA(8),SWRF1,SWRF2,RLAT(8)            DIFM  38
 ISN 0008            COMMON/CHMGEN/DEPTH(25),DELX(25),XTRACT(25),CH2O(25),MOIST(25), MODIFM  39
                    1ISIN(25),ENAME(5),Q,ID(25),IPRINT,NELM                         DIFM  40
 ISN 0009            COMMON/FLOW/FL(5,25),RFL(5,25),FLAT(5,25)                      DIFM  41
 ISN 0010            COMMON/CONCEN/EC(25),BD(25),EX(5,25),CON(5,25),TCONC(5)        DIFM  42
 ISN 0011            COMMON/VAL/KD(5,25),SP(5),EQWT(5)                              DIFM  43
 ISN 0012            COMMON/PLANTU/CHCON(3,5),HOBS,TRDEP,TRDEPS,R,DI(5),RDEN,       DIFM  44
                    1LMIN                                                           DIFM  45
 ISN 0013            COMMON/OUTCON/DUM(3,5),TCHCON(5),TMASFL(5),TDIFFL(5)           DIFM  46
 ISN 0014            COMMON/TISSUE/RWATER(3),ABSPOW(3,9),SHART(3),RHART(3),         DIFM  47
                    1RMESO(3),NSTRAT                                                DIFM  48
 ISN 0015            COMMON/SHINE/SUNHR                                             DIFM  49
 ISN 0016            COMMON/TRUNK/LAI(3),LSTOR(3),SSTOR(3),RSTOR(3),LSPHLO(3),      DIFM  50
                    1SRPHLO(3),LSUGAR(3),SSUGAR(3),RSUGAR(3),CENTMP                 DIFM  51
 ISN 0017            COMMON/GEOMET/HOR(8),AT(2),ARAT(2),PC(8),THETA(8),             DIFM  52
                    1SWT(8)                                                         DIFM  53
 ISN 0018            DIMENSION RF(2)                                                DIFM  54
 ISN 0019            EQUIVALENCE(RF(1),SWRF1)                                       DIFM  55
 ISN 0020            DATA PI/3.1416/                                                DIFM  56
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ISN 0021          DO 100 K=1,NELM                                                DIFM  57
ISN 0022          DO 100 N=1,NSTRAT                                              DIFM  58
ISN 0023          CHCON(N,K)=0.0                                                 DIFM  59
ISN 0024      100 CONTINUE                                                       DIFM  60
ISN 0025          RATIOL=0.0                                                     DIFM  61
            C      DETERMINE NUMBER OF SECONDS IN THIS TIME STEP                 DIFM  62
ISN 0026          IDMN=MIN-LMIN                                                  DIFM  63
ISN 0027          IF(IDMN) 105,110,115                                           DIFM  64
ISN 0028      105 DELT=(MIN+60-LMIN)*60                                          DIFM  65
ISN 0029          GO TO 120                                                      DIFM  66
ISN 0030      110 DELT=3600                                                      DIFM  67
ISN 0031          GO TO 120                                                      DIFM  68
ISN 0032      115 DELT=IDMN*60                                                   DIFM  69
ISN 0033      120 LMIN=MIN                                                       DIFM  70
            C     FIND CUMULATIVE DRY ROOT MASS (QQ) AS A FUNCTION OF DEPTH ASSUMINGDIFM  71
            C      THAT THE FRACTION OF ROOTS IN THE 1ST AND 2ND PROSPER LAYERS IS DIFM  72
            C      ARAT(1) AND ARAT(2) RESPECTIVELY.                             DIFM  73
            C**** FIND C1 AND C2 FOR QQ= C1*DSQRT(X)*DEXP(C2*X) TO DIVIDE UP ROOTS DIFM  74
            C      INTO EACH SOIL CHEMISTRY LAYER.                               DIFM  75
ISN 0034          C2=DLOG(ARAT(1)*TRDEPS*HORS)/(HOR(1)-TRDEP)                    DIFM  76
ISN 0035          RALL=0.                                                        DIFM  77
ISN 0036          DO 125 N=1,NSTRAT                                              DIFM  78
ISN 0037          RTOT(N)=(RSTOR(N)+RSUGAR(N))*1.D-4                             DIFM  79
ISN 0038          C1(N)=RTOT(N)/(TRDEPS*DEXP(C2*TRDEP))                          DIFM  80
ISN 0039          RALL=RALL+RTOT(N)                                              DIFM  81
ISN 0040      125 CONTINUE                                                       DIFM  82
ISN 0041          IF(RALL.LT.1.D-10) GO TO 255                                   DIFM  83
ISN 0043          RATIOL=0.0D0                                                   DIFM  84
ISN 0044          TTUPT=0.0D0                                                    DIFM  85
ISN 0045          DO 250 J=2,Q                                                   DIFM  86
ISN 0046          RMASS=0.                                                       DIFM  87
ISN 0047          IF(ID(J).GT.2) GO TO 250                                       DIFM  88
ISN 0049          WATUP=RF(ID(J))/(RALL*ARAT(ID(J)))                             DIFM  89
            C***** FIND THE DRY ROOT MASS (G/CM**2) IN THE JTH SOIL CHEM LAYER   DIFM  90
ISN 0050          DO 130 N=1,NSTRAT                                              DIFM  91
ISN 0051          TRATIO=DSQRT(DEPTH(J))*C1(N)*DEXP(C2*DEPTH(J))                 DIFM  92
ISN 0052          RATIO=TRATIO-RATIOL                                            DIFM  93
ISN 0053          RATIOL=TRATIO                                                  DIFM  94
            C***** CALCULATE THE MASS,VOLUME, AND NUMBER OF THE ROOTS IN THIS LAYERDIFM  95
ISN 0054      130 RMASS=RATIO*(1.+RWATER(N))+RMASS                               DIFM  96
ISN 0055          WEL=WATUP/RMASS                                                DIFM  97
ISN 0056          RVOL=RMASS/RDEN                                                DIFM  98
ISN 0057          RNO=RVCL/(DELX(J)*1.414*PI*R*R)                                DIFM  99
ISN 0058          VEL=WEL/(RNO*2.*R*PI*DELT)                                     DIFM 100
            C***** X1 IS THE EFFECTIVE DISTANCE FROM BULK SOLUTION TO ROOT       DIFM 101
            C        BASED ON BALDWIN AND NYE (1974) PLANT AND SOIL 40:703-706   DIFM 102
ISN 0059          XDIS=DSQRT(1./(RNO*PI))                                        DIFM 103
ISN 0060          VLFL=CHETA(ID(J))*CHETA(ID(J))                                 DIFM 104
ISN 0061          XFAC=DL(ID(J))*VLFL*DELT                                       DIFM 105
ISN 0062          XF=DSQRT(XFAC)                                                 DIFM 106
ISN 0063          XLIM=(2.D0*XF)+R                                               DIFM 107
ISN 0064          X1=XLIM                                                        DIFM 108
ISN 0065          IF(XLIM.GT.XDIS) X1=XDIS                                       DIFM 109
ISN 0067          L=RNO*1.414                                                    DIFM 110
            CIF(HOUR.EQ.0) PRINT 2000,L,X1,J,C1(1),C2,TRATIO,RATIO               DIFM 111
            C2000   FORMAT('0L,X,J,C1,C2,TRATIO,RATIO',2E10.2,I5,4E10.2)         DIFM 112
ISN 0068      135 CONTINUE                                                       DIFM 113
ISN 0069          DELT=DELT/10.                                                  DIFM 114
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ISN 0070          IF(VEL.EQ.0.) VEL=-99.                                  DIFM 115
ISN 0072          TTUPT=0.0D0                                             DIFM 116
ISN 0073          DO 245 I=1,NELM                                         DIFM 117
ISN 0074          A=((KD(I,J)*BD(J))+CHETA(ID(J)))                        DIFM 118
ISN 0075          TUPT=0.0D0                                              DIFM 119
ISN 0076          DELC=0.0D0                                              DIFM 120
ISN 0077          Z=VLPL*DL(I)                                            DIFM 121
ISN 0078          ZI=1./Z                                                 DIFM 122
ISN 0079          G=R*VEL*ZI                                              DIFM 123
ISN 0080          CLI=CON(I,J)/CH2O(J)                                    DIFM 124
ISN 0081          CLL=CLI                                                 DIFM 125
ISN 0082          DO 240 N=1,NSTRAT                                       DIFM 126
ISN 0083          B=R*ABSPOW(N,I)*ZI                                      DIFM 127
ISN 0084          Y=X1/R                                                  DIFM 128
ISN 0085          UNUM=6.283*ABSPOW(N,I)*B*DELT                           DIFM 129
ISN 0086          Y2=Y*Y                                                  DIFM 130
ISN 0087          IF(VEL.GT.0.)GO TO 175                                  DIFM 131
            C     UPTAKE BY DIFFUSION ONLY (B,N&T 1973 EQUATION V)        DIFM 132
ISN 0089      140 G=0.                                                    DIFM 133
ISN 0090          DENOM=1.+B*(Y2*DLOG(Y)/(Y2-1.)-.5)                      DIFM 134
ISN 0091      145 DO 150 ITIM=1,10                                        DIFM 135
ISN 0092          UPT=UNUM*CLL/DENOM                                      DIFM 136
ISN 0093          TUPT=TUPT+UPT                                           DIFM 137
ISN 0094          DELC=DELC+UPT*L                                         DIFM 138
ISN 0095          IF(CLI.LE.0.) GO TO 245                                 DIFM 139
ISN 0097          ATERM=DLOG(CLI)-DELC*A                                  DIFM 140
ISN 0098          CLL=DEXP(ATERM)                                         DIFM 141
ISN 0099          DIFEX=DELC+(CIL-CLI)*CH2O(J)                            DIFM 142
ISN 0100          IF(DIFEX.GT.EX(I,J)/BD(J)) GO TO 155                    DIFM 143
ISN 0102      150 CONTINUE                                                DIFM 144
ISN 0103          GO TO 205                                               DIFM 145
ISN 0104      155 DELC=CLL*CH2O(J)+EX(I,J)/BD(J)-1.D-12                   DIFM 146
ISN 0105          IF(DELC) 160,165,165                                    DIFM 147
ISN 0106      160 TEX=-DELC                                               DIFM 148
ISN 0107          DELC=0.                                                 DIFM 149
ISN 0108          GO TO 170                                               DIFM 150
ISN 0109      165 TEX=1.D-12                                              DIFM 151
ISN 0110      170 CLL=0.                                                  DIFM 152
ISN 0111          CLI=0.                                                  DIFM 153
ISN 0112          GO TO 205                                               DIFM 154
ISN 0113      175 CONTINUE                                                DIFM 155
            C      UPTAKE BY MASS FLOW AND DIFFUSION (B,N&T 1973 EQUATION X)  DIFM 156
ISN 0114          BOG=ABSPOW(N,I)/VEL                                     DIFM 157
ISN 0115          DENOM=BOG+(1.-BOG)*(2./(2.-G)*(Y**(2.-G)-1.)/(Y2-1.))   DIFM 158
ISN 0116          IF(DENOM.EQ.0.0D0) GO TO 140                            DIFM 159
ISN 0118          DO 180 ITIM=1,10                                        DIFM 160
ISN 0119          UPT=UNUM*CLL/DENOM                                      DIFM 161
ISN 0120          TUPT=TUPT+UPT                                           DIFM 162
ISN 0121          DELC=DELC+UPT*L                                         DIFM 163
ISN 0122          IF(CLI.LE.0.) GO TO 245                                 DIFM 164
ISN 0124          BTERM=DLOG(CLI)-DELC*A                                  DIFM 165
ISN 0125          CLL=DEXP(BTERM)                                         DIFM 166
ISN 0126          DIFBIT=DELC+(CLL-CLI)*CH2O(J)                           DIFM 167
ISN 0127          IF(DIFBIT.GT.EX(I,J)/BD(J)) GO TO 185                   DIFM 168
ISN 0129      180 CONTINUE                                                DIFM 169
ISN 0130          GO TO 205                                               DIFM 170
ISN 0131      185 DELC=CLL*CH2O(J)+EX(I,J)/BD(J)-1.D-12                   DIFM 171
ISN 0132          IF(DELC) 190,195,195                                    DIFM 172
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ISN 0133        190 TEX=-DELC                                   DIFM 173
ISN 0134            DELC=0.                                     DIFM 174
ISN 0135            GO TO 200                                   DIFM 175
ISN 0136        195 TEX=1.D-12                                  DIFM 176
ISN 0137        200 CLL=0.                                      DIFM 177
ISN 0138            CLI=0.                                      DIFM 178
ISN 0139        205 CONTINUE                                    DIFM 179
ISN 0140            DCDX=DELC*DELX(J)                           DIFM 180
ISN 0141            CON(I,J)=CLL*CH2O(J)                        DIFM 181
ISN 0142            IF(CLL.LT.0.) CALL ERROR                    DIFM 182
ISN 0144            DIFF=(CLI-CLL)*CH2O(J)                      DIFM 183
ISN 0145            EXDIFF=DELC-DIFF/DELX(J)                    DIFM 184
ISN 0146            CHCON(N,I)=DCDX+CHCON(N,I)                  DIFM 185
ISN 0147            IF(SUNHR) 215,215,210                       DIFM 186
ISN 0148        210 TMASFL(I)=TMASFL(I)+DCDX                    DIFM 187
ISN 0149            GO TO 220                                   DIFM 188
ISN 0150        215 TDIFFL(I)=TDIFFL(I)+DCDX                    DIFM 189
ISN 0151        220 TCHCON(I)=TCHCON(I)+DCDX                    DIFM 190
ISN 0152            IF(CLI) 225,225,230                         DIFM 191
ISN 0153        225 EX(I,J)=TEX                                 DIFM 192
ISN 0154            GO TO 235                                   DIFM 193
ISN 0155        230 EX(I,J)=EX(I,J)-EXDIFF/BD(J)                DIFM 194
ISN 0156        235 CONTINUE                                    DIFM 195
ISN 0157            IF(EX(I,J).LT.0.) CALL ERROR                DIFM 196
ISN 0159        240 CONTINUE                                    DIFM 197
ISN 0160        245 CONTINUE                                    DIFM 198
ISN 0161        250 CONTINUE                                    DIFM 199
ISN 0162        255 RETURN                                      DIFM 200
ISN 0163            END                                         DIFM 201
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LEVEL  21.6  (DEC 72)                    OS/360  FORTRAN H

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=60,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,NOXREF
  ISN 0002            SUBROUTINE DRYADS(PRES,IHR,MIN,MONTH,YEAR,KDAY)                    DRYA    1
                C     THE UPTAKE AND MOVEMENT OF SOLUTES IN VEGETATION.                  DRYA    2
                C     THERE ARE SEVERAL STEPS ; LEAF SURFACE CHEMISTRY,LEAF UPTAKE       DRYA    3
                C      THROUGH STOMATA AND CUTICLE,TRANSLOCATION,SOLUTE INCORPORATION INDRYA    4
                C      VEGETATION,ROOT UPTAKE AND XYLEM TRANSPORT.                       DRYA    5
                C                                                                        DRYA    6
                C     INPUTS TO THE LEAF SURFACE CHEMISTRY CAN BE SUPPLIED BY AN AIR     DRYA    7
                C      TRANSPORT MODEL AND INPUTS TO THE ROOT UPTAKE SUPPLIED BY A SOIL  DRYA    8
                C      -ROOT UPTAKE MODEL.                                               DRYA    9
                C                                                                        DRYA   10
                C     THIS SUBROUTINE MUST BE RUN WITH THE PLANT GROWTH MODEL(CERES)     DRYA   11
                C      THAT COUPLES TO THE HOURLY PROSPER VERSION OF LAND IN THE WHTM.   DRYA   12
                C                                                                        DRYA   13
                C     DRYADS ARE WOOD NYMPHS WHICH COME INTO EXISTANCE WITH TREES AND    DRYA   14
                C      PERISH WITH TREES.                                                DRYA   15
                C                                                                        DRYA   16
                C     UP TO NINE CHEMICAL SPECIES CAN BE EXAMINED FOR THE NUMBER OF      DRYA   17
                C      VEGETATION TYPES DEFINED IN CERES.                                DRYA   18
                C                                                                        DRYA   19
                C     FIVE SOLUTE CHEMICALS AND FOUR GASES CAN BE EXAMINED               DRYA   20
                C     THE SOLUTES ARE CONSIDERED IN THE FOLLOWING SEQUENCE. PB,CD,ZN,CU,DRYA   21
                C     THE GASES ARE CONSIDERED IN THE ORDER. SO2,NO2,F2,CL2              DRYA   22
                C-----DESCRIPTION OF VARIABLES IN MODEL.                                 DRYA   23
                C     NSTRAT=NUMBER OF PLANT SPECIES (NSTRAT.LE.3)                       DRYA   24
                C     NELM=NUMBER OF SOLUTES ENTERING LEAF CUTICLE AND ROOTS             DRYA   25
                C     NMIN=NUMBER OF FIRST SOLUTE OF INTEREST IN THE SEQUENCE (PB,CD,ZN,DRYA   26
                C     NTOT=TOTAL NUMBER OF SOLUTES AND GASES                             DRYA   27
                C                                                                        DRYA   28
                C     SOME VARIABLES ARE MADE DOUBLE PRECESION BY INCLUDING 'D' IN THE NDRYA   29
                C     THE PREFIXED L,S,R,T REFER TO LEAF,STEM,ROOT AND TOTAL RESPECTIVELDRYA   30
                C     TLAI=SUM OF LAI FOR ALL PLANT SPECIES                              DRYA   31
                C     TROOT=SUM OF ROOT STORAGE FOR ALL PLANT SPECIES (G/M**2)           DRYA   32
                C     LAI=LEAF AREA INDEX                                                DRYA   33
                C     RSTOR=ROOT STORAGE (G/M**2)                                        DRYA   34
                C     CANAMT=AMOUNT OF DEPOSITION IN CANOPY (UG/CM**2)                   DRYA   35
                C    .SALT IS SOLUTE ASSOCIATED WITH THE PHLOEM PATHWAY (SUGAR COUPLED)  DRYA   36
                C    .SOLU IS SOLUTE ASSOCIATED WITH THE XYLEM PATHWAY (WATER COUPLED)   DRYA   37
                C     DIFSOL=AMOUNT OF SOLUTE PASSING THROUGH THE LEAF CUTICLE (UG/M**2)DRYA   38
                C     PERM=CUTICLE CONDUCTIVITY (CM/SEC)                                 DRYA   39
                C     FILM=CUTICLE THICKNESS (CM)                                        DRYA   40
                C     SOLEX=AMOUNT OF SOLUTE ON LEAF SURFACE (UG/M**2 OF GROUND)         DRYA   41
                C     SOLIN=AMOUNT OF SOLUTE WITHIN LEAF (UG/M**2 OF GROUND)             DRYA   42
                C     SOLMAX=MAXIMUM AMOUNT OF SOLUBLE SOLUTE ON LEAF SURFACE (UG/M**2 ODRYA   43
                C     SP=SOLUBILITY OF SOLUTE (UG/ML OF SOLUTION)                        DRYA   44
                C     WATLAY=LEAF WATER FILM THICKNESS IN DRY STATE (CM)                 DRYA   45
                C     XCESS=EXCESS OF CANAMT TO SOLMAX (UG/M**2)                         DRYA   46
                C     DIFCO=RATIO OF DIFFUSION COEF OF GAS TO WATER VAPOR                DRYA   47
                C     TRESIS=TOTAL RESISTANCE TO GAS UPTAKE (SEC/CM)                     DRYA   48
                C     RSTOM=STOMATAL RESISTANCE (SEC/CM)                                 DRYA   49
                C     RBOUND=BOUNDARY LAYER RESISTANCE (SEC/CM)                          DRYA   50
                C     RMESO=MESOPHYLL RESISTANCE (SEC/CM)                                DRYA   51
                C     GASEX=ATMOSPHERIC GAS CONCENTRATION (CC/CC)                        DRYA   52
                C     GASIN=INTERNAL GAS CONCENTRATION (CC/CC)                           DRYA   53
                C     GASDEN=GAS DENSITY (G/CC)                                          DRYA   54
                C     GASDIF=GAS UPTAKE (UG/CM**2 OF LEAF/TIME PERIOD)                   DRYA   55
                C     GASFIX=COMPOUND EQUIVALENT TO GASDIF (UG/M**2 LAND/TIME PERIOD)    DRYA   56
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C      WASH=NUMBER OF TIMES INTERCEPTION CAN BE FILLED IN GIVEN RAINFALL DRYA  57
C      WASHOF=AMOUNT OF MATERIAL MOVED FROM CANOPY TO LITTER DURING RAINFDRYA  58
C      LVOL=INTERCEPTION VOLUME PER UNIT OF LEAF AREA (CM**3/CM**2)       DRYA  59
C      CFRAC=FRACTION OF INTERCEPTION CAUGHT IN CANOPY                    DRYA  60
C      LEACH=AMOUNT OF SOLUTE WASHED OUT OF LEAF DURING RAINFALL (UG/M**2DRYA  61
C      SCEP=WATER CONTENT IN INTERCEPTION STORAGE (CM)                    DRYA  62
C      LSSALT=AMOUNT OF SOLUTE MOVED FROM LEAF TO STEM IN PHLOEM (UG/M**2DRYA  63
C      SRSALT=AMOUNT OF SOLUTE MOVED FROM STEM TO ROOTS IN PHLOEM (UG/M**DRYA  64
C      LSPHLD=PHLOEM RESISTANCE TO SOLUTE MOVEMENT FROM LEAF TO STEM (SECDRYA  65
C      SRPHLD=PHLOEM RESISTANCE TO SOLUTE MOVEMENT FROM STEM TO ROOT (SECDRYA  66
C     .WANT=DEMAND FOR SOLUTE USED TO CONVERT SOLUBLE FORM TO FIXED FORM DRYA  67
C     .WATER=WATER CONTENT PER UNIT DRY WEIGHT (G/G)                      DRYA  68
C     .CAP=WATER CAPACITY OF STEM OR ROOT (G/M**2)                        DRYA  69
C     .SOLUM=MAXIMUM SOLUTE CONCENTRATION IN TISSUE (UG/G)                DRYA  70
C      WFLUX=WATER FLUX INTO ROOT SYSTEM (CM/M**2)                        DRYA  71
C      RSSOLU=AMOUNT OF SOLUTE MOVED FROM ROOT TO STEM IN XYLEM (UG/M**2) DRYA  72
C      SLSOLU=AMOUNT OF SOLUTE MOVED FROM STEM TO LEAF IN XYLEM (UG/M**2)DRYA  73
C      RFLUX=AMOUNT OF SOLUTE TRANSPORTED INTO ROOT (UG/M**2)             DRYA  74
C      CONDUC=ROOT CONDUCTIVITY TO SOLUTES (CM/SEC)                       DRYA  75
C      CHCON=ROOT SOLUTE UPTAKE FROM DIFMAS(UG/CM**2 LAND)                DRYA  76
C      ABSPOW=ABSORBING POWER OF ROOTS FOR SOLUTES (CM/SEC)               DRYA  77
C     *PART IS A PARTITION FACTOR TO SPLIT LITTER SOLUTES INTO            DRYA  78
C      L,S,R,F COMPONENTS                                                 DRYA  79
C                                                                         DRYA  80
ISN 0003      IMPLICIT REAL*8 (A-H,O-Z)                                   DRYA  81
ISN 0004      REAL*8 LVOL,LEACH,LSOLU,LSALT,LSOLUM,LINSOL,                DRYA  82
             1LSSALT,LSPHLD,LWANT,KD,LWANA,LPOOL,LMINL                    DRYA  83
             2,LFIX,LHUM,THRD,LPRES,LPART,LLIT,MOIWT,LBCON                DRYA  84
ISN 0005      REAL*4 STOT,ATOT,SINTR,SMD,SSUR,SIMP,SINT,SBAS,SRCH,SRA,SWET,SPET,DRYA  85
             1TOTELH,RES,SRGX,SCEP,REP,XMIN,XMAX                          DRYA  86
ISN 0006      REAL*8 LAI,LSTOR,LSUGAR,LSPHLO,LSTMRT,LSGHRT,LCARB,LDECOM,  DRYA  87
             1LGROW,LTOX,LBIOM,LRESTD,LAIMAX,LABLF                        DRYA  88
ISN 0007      INTEGER Q,HOUR,YEAR                                         DRYA  89
ISN 0008      DIMENSION LEACH(3,9),LSSALT(3,9),SRSALT(3,9),SLSOLU(3,9),   DRYA  90
             1RSSOLU(3,9),SFSALT(3,9),TPAAL(9)                            DRYA  91
ISN 0009      DIMENSION LBCON(9),FBCON(9),SBCONS(9),SBCONH(9),RBCONS(9),  DRYA  92
             1RBCONH(9),TLPOOL(9),TPCONC(9),TMINL(9),TOTM(9),RCONC(9)     DRYA  93
ISN 0010      DIMENSION CANQAW(3,9),DIFSOL(3,9),GASDIF(3,4)               DRYA  94
             1,GASFIX(3,4),ERTREE(3,9),ERLITT(3,9)                        DRYA  95
ISN 0011      COMMON/MISC/STOT,ATOT,SINTR,SMD,SSUR,SIMP,SINT,SBAS,SRCH,SRA,SWET,DRYA  96
             1SPET,TOTELH,RES,SRGX,SCEP,REP                               DRYA  97
ISN 0012      COMMON/SUMDRY/TDIF(3,9),TLEA(3,9),TGAS(3,9),TLSS(3,9),TSFS(3,9),  DRYA  98
             1TSRS(3,9),TRSS(3,9),TSLS(3,9),TLMO(3,9),TSMO(3,9),TFMO(3,9),  DRYA  99
             2TRMO(3,9),TLMI(3,9),TSMI(3,9),TFMI(3,9),TRMI(3,9),TCIN(3,9)   DRYA 100
             3,TPUDDL(3,9)                                                DRYA 101
ISN 0013      DIMENSION TLSSA(3,9),TSSSA(3,9),TRSSA(3,9),TLWA(3,9),TSWA(3,9),  DRYA 102
             1TFWA(3,9),TRWA(3,9),TTWA(3,9),ZERDRY(486)                   DRYA 103
ISN 0014      DIMENSION LPART(3,9),SPART(3,9),RPART(3,9),FPART(3,9)       DRYA 104
ISN 0015      EQUIVALENCE (ZERDRY(1),TDIF(1,1))                           DRYA 105
ISN 0016      COMMON/BLOCKE/RN,GND,TTT,RE,PWP,EV,VEL,JDATE                DRYA 106
ISN 0017      COMMON/CHMGEN/DUMMY(6,25),EMAME(5),Q,ID(25),IPRINT,NELM     DRYA 107
ISN 0018      COMMON/VAL/KD(5,25),SP(5),EQWT(5)                           DRYA 108
ISN 0019      COMMON/DEPO/DEP(5,12),AMT(5),CANAMT(5),STRCPR               DRYA 109
ISN 0020      COMMON/PLANTU/CHCON(3,5),HORS,TRDEP,TRDEPS,R,DL(5),RDEN,LMIN DRYA 110
ISN 0021      COMMON/CERPAR/FSTOR(3),FSUGAR(3),SWOOD(3),RWOOD(3),P1,      DRYA 111
             1P5,B1,B2,FBIOM(3),RBICH(3),LBIOM(3),SBIOM(3),SFPHLO(3),     DRYA 112
             2FRESTD(3),LRESTD(3),RRESTD(3),SRESTD(3),SUGMAX(3),TMPSTD(3), DRYA 113
             3CO2A(3),CO2C(3),CHANGE,SUGCON,                              DRYA 114
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                4T1,T2,T3,T4,CO2X,LAIMAX                                        DRYA 115
ISN 0022         COMMON/TRUNK/LAI(3),LSTOR(3),SSTOR(3),RSTOR(3),LSPHLO(3),SRPHLO(3) DRYA 116
                1,LSUGAR(3),SSUGAR(3),RSUGAR(3),CENTMP                          DRYA 117
ISN 0023         COMMON/TISSUE/RWATER(3),ABSPOW(3,9),SHART(3),RHART(3),         DRYA 118
                1RMESO(3),NSTRAT                                                DRYA 119
ISN 0024         COMMON/CHMMOS/SWFBL(8),CHETA(8),SWRF1,SWRF2,RLAT(8)            DRYA 120
ISN 0025         COMMON/DRYPAR/CFRAC,GASDEN(4),GASCON(4),GASEX(3,4),DIFCO(5),   DRYA 121
                1SWATER(3),PERM(3),FILM(3),WATLAY(3),CONDUC(3),LSOLUM(3,9),     DRYA 122
                2SSOLUM(3,9),RSOLUM(3,9),FSOLUM(3,9),GASNAM(4),MOLWT(4),NMIN,NTOT DRYA 123
ISN 0026         COMMON/INTSOL/LSALT(3,9),SSALT(3,9),RSALT(3,9),FSALT(3,9),     DRYA 124
                1LSOLU(3,9),SSOLU(3,9),RSOLU(3,9),LINSOL(3,9),SINSOL(3,9),      DRYA 125
                2RINSOL(3,9),FINSOL(3,9),GASIN(3,4),DEFCON(9),                  DRYA 126
                3DINCON(9),TOXCON(9),TOXPNT(9),FULCON(9),SDORM(3,9),RDORM(3,9) DRYA 127
ISN 0027         COMMON/HUMID/FOLTYP,PAIR,CPO,RA,RX,SIGMA,XL,GM,GV,HT,ALEAF     DRYA 128
ISN 0028         COMMON/DECAY/IPOOL(3,9),SPOOL(3,9),RPOOL(3,9),FPOOL(3,9),      DRYA 129
                1SHOLD(3,9),TGOODY(3,9)                                         DRYA 130
ISN 0029         COMMON/MORTAL/LSTMRT(3),SSTMRT(3),SSGMRT(3),                   DRYA 131
                1SWDMRT(3),RSTMRT(3),RSGMRT(3),RWDMRT(3),FSTMRT(3),             DRYA 132
                2FSGMRT(3),LSGMRT(3),TMPLIT                                     DRYA 133
ISN 0030         COMMON/REVIVE/LCARB(3),SCARB(3),FCARB(3),RCARB(3),LDECOM(3),   DRYA 134
                1SDECOM(3),FDECOM(3),RDECOM(3),STDMAD(3),SFLOP(3)               DRYA 135
ISN 0031         COMMON/WASH/LMINL(3,9),SMINL(3,9),FMINL(3,9),RMINL(3,9)        DRYA 136
ISN 0032         COMMON/GROWCO/LGROW(3),SGROW(3),FGROW(3),RGROW(3)              DRYA 137
ISN 0033         COMMON/TOXCO/LTOX(3),STOX(3),FTOX(3),RTOX(3)                   DRYA 138
ISN 0034         COMMON/PLTDMY/ PLTDIF(66),PLTGAS(66),PLTLPS(66),PLTSPS(66),    DRYA 139
                1PLTRPS(66),PLTLSS(66),PLTRSS(66),PLTCHC(66),PLTAMT(66),PLTMNS(66) DRYA 140
                2,PLTTWA(66)                                                    DRYA 141
ISN 0035         REAL*4 PLTDIF,PLTGAS,PLTLPS,PLTSPS,PLTRPS,PLTLSS,PLTRSS        DRYA 142
                1,PLTCHC,PLTAMT,PLTMNS,PLTTWA                                   DRYA 143
ISN 0036         COMMON/PITALL/XMIN,XMAX,INC1,ISTRA,NQUES,KS                    DRYA 144
ISN 0037         COMMON/PRSPLC/NPRPLT,NMPLT,NSPLTS,NMSPLT,MONSPL(12),MONPLT(12), DRYA 145
                1PORPLT(36),NBEG(12),NEND(12),MACHIN                            DRYA 146
ISN 0038         INTEGER*2 MONSPL,MONPLT,PORPLT,NBEG,NEND                       DRYA 147
ISN 0039         DATA LPART,SPART/27*0.5,27*0.2/                                DRYA 148
ISN 0040         DATA RPART,FPART/27*0.299,27*0.001/                            DRYA 149
ISN 0041         ZDATE=JDATE                                                    DRYA 150
ISN 0042         STRAT=NSTRAT                                                   DRYA 151
ISN 0043         FTIME=900.D0                                                   DRYA 152
ISN 0044         IF(PRES.LE.0.) FTIME=3600.D0                                   DRYA 153
ISN 0046         TLAI=0.D0                                                      DRYA 154
ISN 0047         TROOT=0.D0                                                     DRYA 155
ISN 0048         DO 100 I=1,NSTRAT                                              DRYA 156
ISN 0049         TLAI=TLAI+LAI(I)                                               DRYA 157
ISN 0050     100 TROOT=TROOT+RSTOR(I)                                           DRYA 158
ISN 0051         SCEPD=SCEP                                                     DRYA 159
ISN 0052         NGAS=NELM+1                                                    DRYA 160
ISN 0053         IF(NGAS.GT.NTOT) GO TO 110                                     DRYA 161
ISN 0055         DO 105 I=NGAS,NTOT                                             DRYA 162
ISN 0056         CAMAMT(I)=0.                                                   DRYA 163
ISN 0057     105 AMT(I)=0.                                                      DRYA 164
ISN 0058     110 TPOOL=0.                                                       DRYA 165
           C *** DETERMINE SOLUTE MOVEMENT IN EACH VEGETATION TYPE              DRYA 166
ISN 0059         DO 375 I=1,NSTRAT                                              DRYA 167
ISN 0060         LSPHLD=LSPHLO(I)*3600.                                         DRYA 168
ISN 0061         SRPHLD=SRPHLO(I)*3600.                                         DRYA 169
ISN 0062         SFPHLD=SFPHLO(I)*3600.                                         DRYA 170
ISN 0063         LVOL=0.                                                        DRYA 171
ISN 0064         IF(TLAI.GT.1.D-10) LVOL=SCEPD*CFRAC*LAI(I)/TLAI                DRYA 172
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ISN 0066          WFLUX=0.                                                    DRYA 173
ISN 0067          IF(TROOT.GT.1.D-10) WFLUX=(SWRF1+SWRF2)*RSTOR(I)/TROOT      DRYA 174
ISN 0069          RCAP=(RSTOR(I)+RSUGAR(I))*RWATER(I)                         DRYA 175
ISN 0070          SCAP=(SSTOR(I)+SSUGAR(I))*SWATER(I)                         DRYA 176
            C *** DETERMINE SOLUTE MOVEMENT FOR EACH CHEMICAL                 DRYA 177
ISN 0071          DO 370 K=NMIN,NTOT                                          DRYA 178
ISN 0072          M=K-NELM                                                    DRYA 179
ISN 0073          LWANA=(LSTOR(I)+LSUGAR(I))*LSOLUM(I,K)                      DRYA 180
ISN 0074          FWANA=(FSTOR(I)+FSUGAR(I))*FSOLUM(I,K)                      DRYA 181
ISN 0075          SWANA=(SSTOR(I)+SSUGAR(I))*SSOLUM(I,K)                      DRYA 182
ISN 0076          RWANA=(RSTOR(I)+RSUGAR(I))*RSOLUM(I,K)                      DRYA 183
ISN 0077          LPRES=(LINSOL(I,K)+LSOLU(I,K)+LSALT(I,K))                   DRYA 184
ISN 0078          LABLE=LWANA-LPRES                                           DRYA 185
ISN 0079          DIFSOL(I,K)=0.                                              DRYA 186
ISN 0080          LEACH(I,K)=0.                                               DRYA 187
ISN 0081          GASFIX(I,K)=0.                                              DRYA 188
ISN 0082          CANQAN(I,K)=0.                                              DRYA 189
ISN 0083          CIN=0.                                                      DRYA 190
ISN 0084          LWANT=0.                                                    DRYA 191
ISN 0085          IF(ZDATE.LT.T1.OR.ZDATE.GT.T4) GO TO 165                    DRYA 192
ISN 0087          IF(LWANA) 120,120,115                                       DRYA 193
ISN 0088      115 LWANT=LABLE/LWANA                                           DRYA 194
ISN 0089          IF(LWANT.GT.1.) LWANT=1.                                    DRYA 195
ISN 0091          GO TO 125                                                   DRYA 196
ISN 0092      120 LWANT=0.                                                    DRYA 197
ISN 0093      125 IF(LWANT.LE.0.) GO TO 165                                   DRYA 198
ISN 0095          IF(M) 130,130,155                                           DRYA 199
ISN 0096      130 IF(TLAI.GT.1.D-10) CANQAN(I,K)=CANAMT(K)*1.D4*LAI(I)/TLAI   DRYA 200
            C                                                                 DRYA 201
            C-----PART ONE - LEAF WASH, LEACHING AND UPTAKE                   DRYA 202
            C                                                                 DRYA 203
ISN 0098          SOLIN=LSALT(I,K)+LSOLU(I,K)                                 DRYA 204
ISN 0099          SOLMAX=LVOL*SP(K)*1.D4                                      DRYA 205
ISN 0100          IF(LVOL.LE.0.) SOLMAX=WATLAY(I)*SP(K)*LAI(I)*1.D4           DRYA 206
ISN 0102          XCESS=CANQAN(I,K)-SOLMAX                                    DRYA 207
ISN 0103          IF(XCESS) 135,135,140                                       DRYA 208
ISN 0104      135 SOLEX=CANQAN(I,K)                                           DRYA 209
ISN 0105          GO TO 145                                                   DRYA 210
ISN 0106      140 SOLEX=SOLMAX                                                DRYA 211
ISN 0107      145 CONTINUE                                                    DRYA 212
ISN 0108          DIFSOL(I,K)=(PERM(I)*(SOLEX-SOLIN)*FTIME)/FILM(I)           DRYA 213
ISN 0109          IF(CANQAN(I,K).LT.DIFSOL(I,K)) DIFSOL(I,K)=CANQAN(I,K)      DRYA 214
ISN 0111          IF(DIFSOL(I,K).GT.LABLE) DIFSOL(I,K)=LABLE                  DRYA 215
ISN 0113          IF(DIFSOL(I,K).LT.0.) GO TO 150                             DRYA 216
ISN 0115          LSALT(I,K)=LSALT(I,K)+DIFSOL(I,K)                           DRYA 217
ISN 0116          CANQAN(I,K)=CANQAN(I,K)-DIFSOL(I,K)                         DRYA 218
ISN 0117          GO TO 160                                                   DRYA 219
ISN 0118      150 LEACH(I,K)=-DIFSOL(I,K)/10.D0                               DRYA 220
ISN 0119          LSALT(I,K)=LSALT(I,K)-LEACH(I,K)                            DRYA 221
ISN 0120          CANQAN(I,K)=CANQAN(I,K)+LEACH(I,K)                          DRYA 222
ISN 0121          GO TO 160                                                   DRYA 223
            C *** UPTAKE OF GASES                                             DRYA 224
ISN 0122      155 TRESIS=(RX+RA)*DIFCO(M)+RHESO(I)                            DRYA 225
ISN 0123          GASDEN(M)=(-4.1D-6*CENTMP)+1.924D-3                         DRYA 226
ISN 0124          GASDEN(M)=GASDEN(M)*MOLWT(M)/44.                            DRYA 227
ISN 0125          GASEX(I,M)=0.2D-7                                           DRYA 228
ISN 0126          IF(JDATE.EQ.238) GASEX(I,M)=0.25D-6                         DRYA 229
ISN 0128          GASDIF(I,M)=((GASEX(I,M)-GASIN(I,M))/TRESIS)*GASDEN(M)*FTIME*1.D+6DRYA 230
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ISN 0129          IF(GASEX(I,M).LE.0.0D0) GASDIF(I,M)=0.0D0                DRYA 231
ISN 0131          GASFIX(I,M)=GASDIF(I,M)*LAI(I)*1.D4                      DRYA 232
ISN 0132          IF(GASFIX(I,M).GT.LABLE) GASFIX(I,M)=LABLE               DRYA 233
ISN 0134          LSALT(I,K)=LSALT(I,K)+GASFIX(I,M)                        DRYA 234
ISN 0135          GASIN(I,M)=GASEX(I,M)*(1.-LWANT)                         DRYA 235
ISN 0136          IF(LWANT.LT.0.) GASIN(I,M)=GASEX(I,M)                    DRYA 236
ISN 0138      160 CONTINUE                                                 DRYA 237
            C *** CONVERT SOLUBLE SALT TO FIXED FORMS IN TISSUE            DRYA 238
ISN 0139          LFIX=LSALT(I,K)*LWANT                                    DRYA 239
ISN 0140          IF(LWANT.LT.0.) LFIX=0.                                  DRYA 240
ISN 0142          LINSOL(I,K)=LINSOL(I,K)+LFIX                             DRYA 241
ISN 0143          LSALT(I,K)=LSALT(I,K)-LFIX                               DRYA 242
            C                                                              DRYA 243
            C-----PART TWO TRANSLOCATION OF SALTS                          DRYA 244
            C                                                              DRYA 245
            C *** CALCULATE PHLOEM SALT MOVEMENT                           DRYA 246
ISN 0144      165 LSSALT(I,K)=0.                                           DRYA 247
ISN 0145          SFSALT(I,K)=0.                                           DRYA 248
ISN 0146          IF(ZDATE.LT.T1.OR.ZDATE.GT.T4) GO TO 170                 DRYA 249
ISN 0148          LSSALT(I,K)=((LSALT(I,K)-SSALT(I,K))/LSPHLD)*FTIME       DRYA 250
ISN 0149          IF(LSALT(I,K).LE.SSALT(I,K)) LSSALT(I,K)=LSSALT(I,K)/10.D0 DRYA 251
ISN 0151          LSALT(I,K)=LSALT(I,K)-LSSALT(I,K)                        DRYA 252
ISN 0152          SSALT(I,K)=SSALT(I,K)+LSSALT(I,K)                        DRYA 253
ISN 0153          SFSALT(I,K)=((SSALT(I,K)-FSALT(I,K))/SFPHLD)*FTIME       DRYA 254
ISN 0154          IF(SSALT(I,K).LE.FSALT(I,K)) SFSALT(I,K)=SFSALT(I,K)/10.D0 DRYA 255
ISN 0156          SSALT(I,K)=SSALT(I,K)-SFSALT(I,K)                        DRYA 256
ISN 0157          FSALT(I,K)=FSALT(I,K)+SFSALT(I,K)                        DRYA 257
ISN 0158      170 SRSALT(I,K)=((SSALT(I,K)-RSALT(I,K))/SRPHLD)*FTIME       DRYA 258
ISN 0159          IF(SSALT(I,K).LE.RSALT(I,K)) SRSALT(I,K)=SRSALT(I,K)/10.D0 DRYA 259
ISN 0161          SSALT(I,K)=SSALT(I,K)-SRSALT(I,K)                        DRYA 260
ISN 0162          RSALT(I,K)=RSALT(I,K)+SRSALT(I,K)                        DRYA 261
            C                                                              DRYA 262
            C-----PART THREE - TRANSPIRATION STREAM SOLUTE MOVEMENT        DRYA 263
            C                                                              DRYA 264
ISN 0163          RSSOLU(I,K)=0.                                           DRYA 265
ISN 0164          SLSOLU(I,K)=0.                                           DRYA 266
ISN 0165          IF(ZDATE.LT.T1.OR.ZDATE.GT.T4) GO TO 175                 DRYA 267
ISN 0167          RSSOLU(I,K)=WFLUX*(RSOLU(I,K)/RCAP)*1.D4                 DRYA 268
ISN 0168          SLSOLU(I,K)=WFLUX*(SSOLU(I,K)/SCAP)*1.D4                 DRYA 269
ISN 0169          RSOLU(I,K)=RSOLU(I,K)-RSSOLU(I,K)                        DRYA 270
ISN 0170          SSOLU(I,K)=SSOLU(I,K)+RSSOLU(I,K)-SLSOLU(I,K)            DRYA 271
ISN 0171          LSOLU(I,K)=LSOLU(I,K)+SLSOLU(I,K)                        DRYA 272
            C                                                              DRYA 273
            C-----PART FOUR - ROOT UPTAKE AND FIXATION                     DRYA 274
            C                                                              DRYA 275
            C *** SUBROUTINE DIFMAS GIVES ROOT UPTAKE OF SOLUTES (CHCON)   DRYA 276
ISN 0172      175 IF(K.GT.NELM) GO TO 180                                  DRYA 277
ISN 0174          IF(TROOT.GT.1.D-10) CIN=(CHCON(I,K)*RSTOR(I)*1.D4/TROOT) DRYA 278
ISN 0176          RSOLU(I,K)=RSOLU(I,K)+CIN                                DRYA 279
            C *** CONVERT SOLUTES TO FIXED FORMS                           DRYA 280
ISN 0177      180 RPRES=(RINSOL(I,K)+RSOLU(I,K)+RSALT(I,K))                DRYA 281
ISN 0178          IF(RWANA) 190,190,185                                    DRYA 282
ISN 0179      185 RWANT=(RWANA-RPRES)/RWANA                                DRYA 283
ISN 0180          IF(RWANT.GT.1.) RWANT=1.                                 DRYA 284
ISN 0182          GO TO 195                                                DRYA 285
ISN 0183      190 RWANT=0.                                                 DRYA 286
ISN 0184      195 RFIX=RSOLU(I,K)*RWANT                                    DRYA 287
ISN 0185          IF(RWANT.LT.0.) RFIX=0.                                  DRYA 288
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ISN 0187          RINSOL(I,K)=RINSOL(I,K)+RFIX                                  DRYA 289
ISN 0188          RSOLU(I,K)=RSOLU(I,K)-RFIX                                    DRYA 290
ISN 0189          RDEAD=0.                                                      DRYA 291
ISN 0190          IF(RSTOR(I).GT.1.D-10) RDEAD=RINSOL(I,K)*RHART(I)/RSTOR(I)    DRYA 292
ISN 0192          RDORM(I,K)=RDORM(I,K)+RDEAD                                   DRYA 293
ISN 0193          RINSOL(I,K)=RINSOL(I,K)-RDEAD                                 DRYA 294
                C                                                               DRYA 295
                C-----PART FIVE - STEM AND FRUIT SOLUTE FIXATION AND DORMANT FIXATION  DRYA 296
                C                                                               DRYA 297
ISN 0194          SPRES=(SINSOL(I,K)+SSOLU(I,K)+SSALT(I,K))                     DRYA 298
ISN 0195          IF(SWANA) 205,205,200                                         DRYA 299
ISN 0196      200 SWANT=(SWANA-SPRES)/SWANA                                     DRYA 300
ISN 0197          IF(SWANT.GT.1.) SWANT=1.                                      DRYA 301
ISN 0199          GO TO 210                                                     DRYA 302
ISN 0200      205 SWANT=0.                                                      DRYA 303
ISN 0201      210 SFIX=SSALT(I,K)*SWANT                                         DRYA 304
ISN 0202          IF(SWANT.LT.0.) SFIX=0.                                       DRYA 305
ISN 0204          SINSOL(I,K)=SINSOL(I,K)+SFIX                                  DRYA 306
ISN 0205          SSALT(I,K)=SSALT(I,K)-SFIX                                    DRYA 307
ISN 0206          SDEAD=0.                                                      DRYA 308
ISN 0207          IF(SSTOR(I).GT.1.D-10) SDEAD=SINSOL(I,K)*SHART(I)/SSTOR(I)    DRYA 309
ISN 0209          SDORM(I,K)=SDORM(I,K)+SDEAD                                   DRYA 310
ISN 0210          SINSOL(I,K)=SINSOL(I,K)-SDEAD                                 DRYA 311
ISN 0211          FPRES=(FINSOL(I,K)+FSALT(I,K))                                DRYA 312
ISN 0212          FWANT=0.                                                      DRYA 313
ISN 0213          IF(ZDATE.LT.T1.OR.ZDATE.GT.T4) GO TO 230                      DRYA 314
ISN 0215          IF(FWANA) 220,220,215                                         DRYA 315
ISN 0216      215 FWANT=(FWANA-FPRES)/FWANA                                     DRYA 316
ISN 0217          IF(FWANT.GT.1.) FWANT=1.                                      DRYA 317
ISN 0219          GO TO 225                                                     DRYA 318
ISN 0220      220 FWANT=0.                                                      DRYA 319
ISN 0221      225 FFIX=FSALT(I,K)*FWANT                                         DRYA 320
ISN 0222          IF(FWANT.LT.0.) FFIX=0.                                       DRYA 321
ISN 0224          FINSOL(I,K)=FINSOL(I,K)+FFIX                                  DRYA 322
ISN 0225          FSALT(I,K)=FSALT(I,K)-FFIX                                    DRYA 323
                C                                                               DRYA 324
                C-----PART SIX - WHOLE PLANT ADJUSTMENTS                        DRYA 325
                C                                                               DRYA 326
                C *** EQUILIBRATE XYLEM AND PHLOEM SOLUTES                      DRYA 327
ISN 0226      230 LSALT(I,K)=(LSALT(I,K)+LSOLU(I,K))/2.D0                       DRYA 328
ISN 0227          LSOLU(I,K)=LSALT(I,K)                                         DRYA 329
ISN 0228          SSALT(I,K)=(SSALT(I,K)+SSOLU(I,K))/2.D0                       DRYA 330
ISN 0229          SSOLU(I,K)=SSALT(I,K)                                         DRYA 331
ISN 0230          RSALT(I,K)=(RSALT(I,K)+RSOLU(I,K))/2.D0                       DRYA 332
ISN 0231          RSOLU(I,K)=RSALT(I,K)                                         DRYA 333
                C *** DETERMINE ROOT ABSORBING POWER FOR DIFMAS                 DRYA 334
ISN 0232          TWANA=LWANA+SWANA+RWANA+FWANA                                 DRYA 335
ISN 0233          TPRES=(LINSOL(I,K)+SINSOL(I,K)+RINSOL(I,K)+(LSOLU(I,K)+SSOLU(I,K)+DRYA 336
                 1RSOLU(I,K))*2.D0)+FSALT(I,K)+FINSOL(I,K)                      DRYA 337
ISN 0234          TWANT=(TWANA-TPRES)/TWANA                                     DRYA 338
ISN 0235          IF(TWANT.GT.1.) TWANT=1.                                      DRYA 339
                C      NOTE IF ROOT UPTAKE IS CONTROLLED BY SOLUTE LEVELS IN THE ROOT  DRYA 340
                C       THEN 'RWANT' SHOULD BE USED RATHER THAN 'TWANT' IN 'ABSPOW'.  DRYA 341
ISN 0237          ABSPOW(I,K)=TWANT*CONDUC(I)                                   DRYA 342
ISN 0238          IF(TWANT.LT.0.) ABSPOW(I,K)=0.                                DRYA 343
ISN 0240          IF(ZDATE.LT.T1.OR.ZDATE.GT.T4) ABSPOW(I,K)=0.                 DRYA 344
                C                                                               DRYA 345
                C-----PART SEVEN - SOLUTE EFFECTS ON NEW GROWTH                 DRYA 346
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ISN 0242            IF(K.NE.KS) GO TO 270                                   DRYA 347
ISN 0244            LGROW(I)=1.                                             DRYA 348
ISN 0245            IF(LBIOM(I).LT.1.D-10) GO TO 240                        DRYA 349
ISN 0247            DEFLEV=DEFCON(K)*(LSUGAR(I)+LSTOR(I))                   DRYA 350
ISN 0248            DIMLEV=DIMCON(K)*(LSUGAR(I)+LSTOR(I))                   DRYA 351
ISN 0249            IF(DEFLEV.EQ.0.) GO TO 235                              DRYA 352
ISN 0251            IF(LPRES.LT.DEFLEV) LGROW(I)=LPRES/DEFLEV               DRYA 353
ISN 0253        235 IF(LPRES.GT.DIMLEV) LGROW(I)=1.-(LPRES-DIMLEV)/(LWANA-DIMLEV)  DRYA 354
ISN 0255            IF(LGROW(I).LT.0.) LGROW(I)=0.                          DRYA 355
ISN 0257        240 SGROW(I)=1.                                             DRYA 356
ISN 0258            IF(SBIOM(I).LT.1.D-10) GO TO 250                        DRYA 357
ISN 0260            DEFLEV=DEFCON(K)*(SSUGAR(I)+SSTOR(I))                   DRYA 358
ISN 0261            DIMLEV=DIMCON(K)*(SSUGAR(I)+SSTOR(I))                   DRYA 359
ISN 0262            IF(DEFLEV.EQ.0.) GO TO 245                              DRYA 360
ISN 0264            IF(SPRES.LT.DEFLEV) SGROW(I)=SPRES/DEFLEV               DRYA 361
ISN 0266        245 IF(SPRES.GT.DIMLEV) SGROW(I)=1.-(SPRES-DIMLEV)/(SWANA-DIMLEV)  DRYA 362
ISN 0268            IF(SGROW(I).LT.0.) SGROW(I)=0.                          DRYA 363
ISN 0270        250 FGROW(I)=1.                                             DRYA 364
ISN 0271            IF(FBIOM(I).LT.1.D-10) GO TO 260                        DRYA 365
ISN 0273            DEFLEV=DEFCON(K)*(FSUGAR(I)+FSTOR(I))                   DRYA 366
ISN 0274            DIMLEV=DIMCON(K)*(FSUGAR(I)+FSTOR(I))                   DRYA 367
ISN 0275            IF(DEFLEV.EQ.0.) GO TO 255                              DRYA 368
ISN 0277            IF(FPRES.LT.DEFLEV) FGROW(I)=FPRES/DEFLEV               DRYA 369
ISN 0279        255 IF(FPRES.GT.DIMLEV) FGROW(I)=1.-(FPRES-DIMLEV)/(FWANA-DIMLEV)  DRYA 370
ISN 0281            IF(FGROW(I).LT.0.) FGROW(I)=0.                          DRYA 371
ISN 0283        260 RGROW(I)=1.                                             DRYA 372
ISN 0284            IF(RBIOM(I).LT.1.D-10) GO TO 270                        DRYA 373
ISN 0286            DEFLEV=DEFCON(K)*(RSUGAR(I)+RSTOR(I))                   DRYA 374
ISN 0287            DIMLEV=DIMCON(K)*(RSUGAR(I)+RSTOR(I))                   DRYA 375
ISN 0288            IF(DEFLEV.EQ.0.) GO TO 265                              DRYA 376
ISN 0290            IF(RPRES.LT.DEFLEV) RGROW(I)=RPRES/DEFLEV               DRYA 377
ISN 0292        265 IF(RPRES.GT.DIMLEV) RGROW(I)=1.-(RPRES-DIMLEV)/(RWANA-DIMLEV)  DRYA 378
ISN 0294            IF(RGROW(I).LT.0.) RGROW(I)=0.                          DRYA 379
ISN 0296        270 CONTINUE                                                DRYA 380
ISN 0297            IF(MONTH.GT.1) GO TO 275                                DRYA 381
ISN 0299            IF(IHR.NE.23.OR.MIN.NE.45) GO TO 275                    DRYA 382
ISN 0301            IF(LGROW(I).LT.1.) WRITE(6,8000) LGROW(I),LPRES,DEFLEV,DIMLEV,  DRYA 383
                   1LWANA,K,I                                               DRYA 384
ISN 0303       8000 FORMAT('0*****LEAF GROWTH AFFECTED*****',LGROW,LPRES,DEFLEV,'  DRYA 385
                   1,'DIMLEV,LWANA,CHEMICAL,PLANT'/1X,5E10.3,25X,I2,10X,I2)  DRYA 386
ISN 0304            IF(SGROW(I).LT.1.) WRITE(6,8005) SGROW(I),SPRES,DEFLEV,DIMLEV,  DRYA 387
                   1SWANA,K,I                                               DRYA 388
ISN 0306       8005 FORMAT('0*****STEM GROWTH AFFECTED*****',SGROW,SPRES,DEFLEV,'  DRYA 389
                   1,'DIMLEV,SWANA,CHEMICAL,PLANT'/1X,5E10.3,25X,I2,10X,I2)  DRYA 390
ISN 0307            IF(RGROW(I).LT.1) WRITE(6,8010) RGROW(I),RPRES,DEFLEV,DIMLEV,  DRYA 391
                   1RWANA,K,I                                               DRYA 392
ISN 0309       8010 FORMAT('0*****ROOT GROWTH AFFECTED*****',RGROW,RPRES,DEFLEV,'  DRYA 393
                   1,'DIMLEV,RWANA,CHEMICAL,PLANT'/1X,5E10.3,25X,I2,10X,I2)  DRYA 394
ISN 0310            IF(FGROW(I).LT.1) WRITE(6,8015) FGROW(I),FPRES,DEFLEV,DIMLEV,  DRYA 395
                   1FWANA,K,I                                               DRYA 396
ISN 0312       8015 FORMAT('0*****FRUIT GROWTH AFFECTED*****',FGROW,FPRES,DEFLEV,'  DRYA 397
                   1,'DIMLEV,FWANA,CHEMICAL,PLANT'/1X,5E10.3,25X,I2,10X,I2)  DRYA 398
ISN 0313        275 CONTINUE                                               DRYA 399
                C                                                          DRYA 400
                C-----PART EIGHT - CHEMICAL LOSSES FROM PLANT BY MORTALITY DRYA 401
                C                                                          DRYA 402
                C     PARTITION LITTER CHEMICALS INTO COMPONENTS           DRYA 403
                                                                           DRYA 404
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ISN 0314          LPOOL(I,K)=AMT(K)*LPART(I,K)*1.D4                          DRYA 405
ISN 0315          SPOOL(I,K)=AMT(K)*SPART(I,K)*1.D4                          DRYA 406
ISN 0316          RPOOL(I,K)=AMT(K)*RPART(I,K)*1.D4                          DRYA 407
ISN 0317          FPOOL(I,K)=AMT(K)*FPART(I,K)*1.D4                          DRYA 408
ISN 0318          TPUDDL(I,K)=TPUDDL(I,K)-(LPOOL(I,K)+SPOOL(I,K)+RPOOL(I,K)  DRYA 409
                 1+FPOOL(I,K)+SHOLD(I,K))                                    DRYA 410
ISN 0319          LHUM=0.0                                                   DRYA 411
ISN 0320          LLIT=0.0                                                   DRYA 412
ISN 0321          IF(ZDATE.LT.T1.OR.ZDATE.GT.T4) GO TO 285                   DRYA 413
ISN 0323          IF(LSTOR(I).LT.1.D-10) GO TO 280                           DRYA 414
ISN 0325          LLIT=LINSOL(I,K)*LSTMRT(I)/LSTOR(I)                        DRYA 415
ISN 0326          LINSOL(I,K)=LINSOL(I,K)-LLIT                               DRYA 416
ISN 0327      280 IF(LSUGAR(I).LT.1.D-10)  GO TO 285                         DRYA 417
ISN 0329          LHUM=LSOLU(I,K)*2.D0*LSGMRT(I)/LSUGAR(I)                   DRYA 418
ISN 0330          LSOLU(I,K)=LSOLU(I,K)-LHUM/2.D0                            DRYA 419
ISN 0331          LSALT(I,K)=LSOLU(I,K)                                      DRYA 420
ISN 0332      285 LPOOL(I,K)=LPOOL(I,K)+LHUM+LLIT                            DRYA 421
ISN 0333          IF(LPOOL(I,K).LT.0.) CALL ERROR                            DRYA 422
ISN 0335          SLIT=0.                                                    DRYA 423
ISN 0336          SHUM=0.                                                    DRYA 424
ISN 0337          SFALL=0.                                                   DRYA 425
ISN 0338          SINC=0.                                                    DRYA 426
ISN 0339          IF(SSTOR(I).LT.1.D-10) GO TO 290                           DRYA 427
ISN 0341          SLIT=SINSOL(I,K)*SSTMRT(I)/SSTOR(I)                        DRYA 428
ISN 0342          SINSOL(I,K)=SINSOL(I,K)-SLIT                               DRYA 429
ISN 0343      290 IF(SSUGAR(I).LT.1.D-10) GO TO 295                          DRYA 430
ISN 0345          SHUM=SSOLU(I,K)*2.D0*SSGMRT(I)/SSUGAR(I)                   DRYA 431
ISN 0346          SSOLU(I,K)=SSOLU(I,K)-SHUM/2.D0                            DRYA 432
ISN 0347          SSALT(I,K)=SSOLU(I,K)                                      DRYA 433
ISN 0348      295 IF(SWOOD(I).LT.1.D-10) GO TO 300                           DRYA 434
ISN 0350          SFALL=SDORM(I,K)*SWDMRT(I)/SWOOD(I)                        DRYA 435
ISN 0351          SDORM(I,K)=SDORM(I,K)-SFALL                                DRYA 436
ISN 0352      300 IF(STDEAD(I).LT.1.D-10) GO TO 305                          DRYA 437
ISN 0354          SINC=SHOLD(I,K)*SFLOP(I)/STDEAD(I)                         DRYA 438
ISN 0355          SPOOL(I,K)=SPOOL(I,K)+SINC                                 DRYA 439
ISN 0356      305 SHOLD(I,K)=SHOLD(I,K)+SLIT+SHUM+SFALL-SINC                 DRYA 440
ISN 0357          IF(SHOLD(I,K).LT.0.0) CALL ERROR                           DRYA 441
ISN 0359          RLIT=0.                                                    DRYA 442
ISN 0360          RHUM=0.                                                    DRYA 443
ISN 0361          RFALL=0.                                                   DRYA 444
ISN 0362          IF(RSTOR(I).LT.1.D-10) GO TO 310                           DRYA 445
ISN 0364          RLIT=RINSOL(I,K)*RSTMRT(I)/RSTOR(I)                        DRYA 446
ISN 0365          RINSOL(I,K)=RINSOL(I,K)-RLIT                               DRYA 447
ISN 0366      310 IF(RSUGAR(I).LT.1.D-10) GO TO 315                          DRYA 448
ISN 0368          RHUM=RSOLU(I,K)*2.D0*RSGMRT(I)/RSUGAR(I)                   DRYA 449
ISN 0369          RSOLU(I,K)=RSOLU(I,K)-RHUM/2.D0                            DRYA 450
ISN 0370          RSALT(I,K)=RSOLU(I,K)                                      DRYA 451
ISN 0371      315 IF(RWOOD(I).LT.1.D-10) GO TO 320                           DRYA 452
ISN 0373          RFALL=RDORM(I,K)*RWDMRT(I)/RWOOD(I)                        DRYA 453
ISN 0374          RDORM(I,K)=RDORM(I,K)-RFALL                                DRYA 454
ISN 0375      320 RPOOL(I,K)=RPOOL(I,K)+RLIT+RHUM+RFALL                      DRYA 455
ISN 0376          IF(RPOOL(I,K).LT.0.0) CALL ERROR                           DRYA 456
ISN 0378          FLIT=0.                                                    DRYA 457
ISN 0379          FHUM=0.                                                    DRYA 458
ISN 0380          IF(ZDATE.LT.T1.OR.ZDATE.GT.T4) GO TO 330                   DRYA 459
ISN 0382          IF(FSTOR(I).LT.1.D-10) GO TO 325                           DRYA 460
ISN 0384          FLIT=FINSOL(I,K)*FSTMRT(I)/FSTOR(I)                        DRYA 461
ISN 0385          FINSOL(I,K)=FINSOL(I,K)-FLIT                               DRYA 462
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ISN 0366        325 IF(FSUGAR(I).LT.1.D-10) GO TO 330                          DRYA 463
ISN 0388            FHUM=FSALT(I,K)*FSGMRT(I)/FSUGAR(I)                        DRYA 464
ISN 0389            FSALT(I,K)=FSALT(I,K)-FHUM                                 DRYA 465
ISN 0390        330 FPOOL(I,K)=FPOOL(I,K)+FLIT+FHUM                            DRYA 466
ISN 0391            IF(FPOOL(I,K).LT.0.0) CALL ERROR                           DRYA 467
ISN 0393            IF(K.LE.5) AMT(K)=AMT(K)+(LHUM+LLIT+SINC+RHUM+             DRYA 468
                   1RLIT+RFALL+FHUM+FLIT)*1.D-4                                DRYA 469
                C                                                              DRYA 470
                C-----PART NINE - SOLUTE DYNAMICS IN LITTER AND EFFECTS        DRYA 471
                C                                                              DRYA 472
ISN 0395            LMINL(I,K)=0.                                              DRYA 473
ISN 0396            IF(K.EQ.KS) LTOX(I)=1.                                     DRYA 474
ISN 0398            IF(LCARB(I).LT.1.D-10) GO TO 335                           DRYA 475
ISN 0400            LMINL(I,K)=LPOOL(I,K)*LDECCM(I)/LCARB(I)                   DRYA 476
ISN 0401            LPOOL(I,K)=LPOOL(I,K)-LMINL(I,K)                           DRYA 477
ISN 0402            IF(LPOOL(I,K).LT.0.0) CALL ERROR                           DRYA 478
ISN 0404            IF(K.NE.KS) GO TO 335                                      DRYA 479
ISN 0406            IF(LPOOL(I,K).LE.0.0) GO TO 335                            DRYA 480
ISN 0408            TOXAMT=LCARB(I)*TOXCON(K)                                  DRYA 481
ISN 0409            TOXLEV=LCARB(I)*TOXPNT(K)                                  DRYA 482
ISN 0410            FULLEV=LCARB(I)*FULCON(K)                                  DRYA 483
ISN 0411            IF(LPOOL(I,K).LT.FULLEV) LTOX(I)=LPOOL(I,K)/FULLEV         DRYA 484
ISN 0413            IF(LPOOL(I,K).GT.TOXLEV) LTOX(I)=1.-(LPOOL(I,K)-TOXLEV)/(TOXAMT  DRYA 485
                   1-TOXLEV)                                                   DRYA 486
ISN 0415            IF(LPOOL(I,K).GT.TOXAMT) LTOX(I)=0.                        DRYA 487
ISN 0417        335 SMINL(I,K)=0.                                              DRYA 488
ISN 0418            IF(K.EQ.KS) STOX(I)=1.                                     DRYA 489
ISN 0420            IF(SCARB(I).LT.1.D-10) GO TO 340                           DRYA 490
ISN 0422            SMINL(I,K)=SPOOL(I,K)*SDECOM(I)/SCARB(I)                   DRYA 491
ISN 0423            SPOOL(I,K)=SPOOL(I,K)-SMINL(I,K)                           DRYA 492
ISN 0424            IF(SPOOL(I,K).LT.0.0) CALL ERROR                           DRYA 493
ISN 0426            IF(K.NE.KS) GO TO 340                                      DRYA 494
ISN 0428            IF(SPOOL(I,K).LE.0.0) GO TO 340                            DRYA 495
ISN 0430            TOXAMT=SCARB(I)*TOXCON(K)                                  DRYA 496
ISN 0431            TOXLEV=SCARB(I)*TOXPNT(K)                                  DRYA 497
ISN 0432            FULLEV=SCARB(I)*FULCON(K)                                  DRYA 498
ISN 0433            IF(SPOOL(I,K).LT.FULLEV) STOX(I)=SPOOL(I,K)/FULLEV         DRYA 499
ISN 0435            IF(SPOOL(I,K).GT.TOXLEV) STOX(I)=1.-(SPOOL(I,K)-TOXLEV)/(TOXAMT  DRYA 500
                   1-TOXLEV)                                                   DRYA 501
ISN 0437            IF(SPOOL(I,K).GT.TOXAMT) STOX(I)=0.                        DRYA 502
ISN 0439        340 FMINL(I,K)=0.                                              DRYA 503
ISN 0440            IF(K.EQ.KS) FTOX(I)=1.                                     DRYA 504
ISN 0442            IF(FCARB(I).LT.1.D-10) GO TO 345                           DRYA 505
ISN 0444            FMINL(I,K)=FPOOL(I,K)*FDECOM(I)/FCARB(I)                   DRYA 506
ISN 0445            FPOOL(I,K)=FPOOL(I,K)-FMINL(I,K)                           DRYA 507
ISN 0446            IF(FPOOL(I,K).LT.0.0) CALL ERROR                           DRYA 508
ISN 0448            IF(K.NE.KS) GO TO 345                                      DRYA 509
ISN 0450            IF(FPOOL(I,K).LE.0.0) GO TO 345                            DRYA 510
ISN 0452            TOXAMT=FCARB(I)*TOXCON(K)                                  DRYA 511
ISN 0453            TOXLEV=FCARB(I)*TOXPNT(K)                                  DRYA 512
ISN 0454            FULLEV=FCARB(I)*FULCON(K)                                  DRYA 513
ISN 0455            IF(FPOOL(I,K).LT.FULLEV) FTOX(I)=FPOOL(I,K)/FULLEV         DRYA 514
ISN 0457            IF(FPOOL(I,K).GT.TOXLEV) FTOX(I)=1.-(FPOOL(I,K)-TOXLEV)/(TOXAMT  DRYA 515
                   1-TOXLEV)                                                   DRYA 516
ISN 0459            IF(FPOOL(I,K).GT.TOXAMT) FTOX(I)=0.                        DRYA 517
ISN 0461        345 RMINL(I,K)=0.                                              DRYA 518
ISN 0462            IF(K.EQ.KS) RTOX(I)=1.                                     DRYA 519
ISN 0464            IF(RCARB(I).LT.1.D-10) GO TO 350                           DRYA 520
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ISN 0466          RMINL(I,K)=RPOOL(I,K)*RDECOM(I)/RCARB(I)                          DRYA 521
ISN 0467          RPOOL(I,K)=RPOOL(I,K)-RMINL(I,K)                                  DRYA 522
ISN 0468          IF(RPOOL(I,K).LT.0.0) CALL ERROR                                  DRYA 523
ISN 0470          IF(K.NE.KS) GO TO 350                                             DRYA 524
ISN 0472          IF(RPOOL(I,K).LE.0.0) GO TO 350                                   DRYA 525
ISN 0474          TOXAMT=RCARB(I)*TOXCON(K)                                         DRYA 526
ISN 0475          TOXLEV=RCARB(I)*TOXPNT(K)                                         DRYA 527
ISN 0476          FULLEV=RCARB(I)*FULCON(K)                                         DRYA 528
ISN 0477          IF(RPOOL(I,K).LT.FULLEV) RTOX(I)=RPOOL(I,K)/FULLEV                DRYA 529
ISN 0479          IF(RPOOL(I,K).GT.TOXLEV) RTOX(I)=1.-(RPOOL(I,K)-TOXLEV)/(TOXAMT   DRYA 530
                 1-TOXLEV)                                                          DRYA 531
ISN 0481          IF(RPOOL(I,K).GT.TOXAMT) RTOX(I)=0.                               DRYA 532
ISN 0483      350 CONTINUE                                                          DRYA 533
ISN 0484          IF(MONTH.GT.1) GO TO 355                                          DRYA 534
ISN 0486          IF(IHR.NE.23.OR.MIN.NE.45) GO TO 355                              DRYA 535
ISN 0488          IF(LTOX(I).LT.1) WRITE(6,8020) LTOX(I),LPOOL(I,K),FULLEV,TOXLEV,  DRYA 536
                 1TOXAMT,K,I                                                        DRYA 537
ISN 0490     8020 FORMAT('0*****LEAF LITTER TOXIC EFFECTS*****',                    DRYA 538
                 1'LTOX,LPOOL,FLLEV,TXLEV,TXAMT,CHEM,PLANT'/1X,5E10.3,15X,I2,6X,I2) DRYA 539
ISN 0491          IF(RTOX(I).LT.1.) WRITE(6,8025) RTOX(I),RPOOL(I,K),FULLEV,TOXLEV ,DRYA 540
                 1TOXAMT,K,I                                                        DRYA 541
ISN 0493     8025 FORMAT('0*****ROOT LITTER TOXIC EFFECTS*****',                    DRYA 542
                 1'RTOX,RPOOL,FLLEV,TXLEV,TXAMT,CHEM,PLANT'/1X,5E10.3,15X,I2,6X,I2) DRYA 543
ISN 0494          IF(STOX(I).LT.1) WRITE(6,8030) STOX(I),SPOOL(I,K),FULLEV,TOXLEV,  DRYA 544
                 1TOXAMT,K,I                                                        DRYA 545
ISN 0496     8030 FORMAT('0*****STEM LITTER TOXIC EFFECTS*****',                    DRYA 546
                 1'STOX,SPOOL,FLLEV,TXLEV,TXAMT,CHEM,PLANT'/1X,5E10.3,15X,I2,6X,I2) DRYA 547
ISN 0497          IF(FTOX(I).LT.1) WRITE(6,8035) FTOX(I),FPOOL(I,K),FULLEV,TOXLEV,  DRYA 548
                 1TOXAMT,K,I                                                        DRYA 549
ISN 0499     8035 FORMAT('0*****FRUIT LITTER TOXIC EFFECTS*****',                   DRYA 550
                 1'FTOX,FPOOL,FLLEV,TXLEV,TXAMT,CHEM,PLANT'/1X,5E10.3,15X,I2,6X,I2) DRYA 551
ISN 0500      355 CONTINUE                                                          DRYA 552
ISN 0501          IF(K.LE.5) AMT(K)=AMT(K)-(LMINL(I,K)+SMINL(I,K)+FMINL(I,K)+       DRYA 553
                 1RMINL(I,K))*1.D-4                                                 DRYA 554
ISN 0503          IF(AMT(K).LT.0.0) CALL ERROR                                      DRYA 555
ISN 0505          TPAAL(K)=LPOOL(I,K)+SPOOL(I,K)+FPOOL(I,K)+RPOOL(I,K)              DRYA 556
ISN 0506          TPOOL=TPOOL+TPAAL(K)                                              DRYA 557
ISN 0507          TPUDDL(I,K)=TPUDDL(I,K)+TPAAL(K)+SHOLD(I,K)                       DRYA 558
ISN 0508          IF(K.GT.NELM) GO TO 360                                           DRYA 559
ISN 0510          IF(DIFSOL(I,K).GT.0.0D0)TDIF(I,K)=TDIF(I,K)+DIFSOL(I,K)           DRYA 560
ISN 0512          TLEA(I,K)=TLEA(I,K)+LEACH(I,K)                                    DRYA 561
ISN 0513          TCIN(I,K)=TCIN(I,K)+CIN                                           DRYA 562
ISN 0514          GO TO 365                                                         DRYA 563
ISN 0515      360 TGAS(I,K)=TGAS(I,K)+GASFIX(I,M)                                   DRYA 564
ISN 0516          TCIN(I,K)=TCIN(I,K)+CIN                                           DRYA 565
ISN 0517      365 TLSS(I,K)=TLSS(I,K)+LSSALT(I,K)                                   DRYA 566
ISN 0518          TSFS(I,K)=TSFS(I,K)+SFSALT(I,K)                                   DRYA 567
ISN 0519          TSRS(I,K)=TSRS(I,K)+SRSALT(I,K)                                   DRYA 568
ISN 0520          TRSS(I,K)=TRSS(I,K)+RSSOLU(I,K)                                   DRYA 569
ISN 0521          TSLS(I,K)=TSLS(I,K)+SLSOLU(I,K)                                   DRYA 570
ISN 0522          TLMO(I,K)=TLMO(I,K)+LLIT+LHUM                                     DRYA 571
ISN 0523          TSMO(I,K)=TSMO(I,K)+SLIT+SHUM+SFALL                               DRYA 572
ISN 0524          TFMO(I,K)=TFMO(I,K)+FLIT+FHUM                                     DRYA 573
ISN 0525          TRMO(I,K)=TRMO(I,K)+RLIT+RHUM+RFALL                               DRYA 574
ISN 0526          TLMI(I,K)=TLMI(I,K)+LMINL(I,K)                                    DRYA 575
ISN 0527          TSMI(I,K)=TSMI(I,K)+SMINL(I,K)                                    DRYA 576
ISN 0528          TFMI(I,K)=TFMI(I,K)+FMINL(I,K)                                    DRYA 577
ISN 0529          TRMI(I,K)=TRMI(I,K)+RMINL(I,K)                                    DRYA 578
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ISN 0530          TLWA(I,K)=LWANT                                          DRYA 579
ISN 0531          TSWA(I,K)=SWANT                                          DRYA 580
ISN 0532          TFWA(I,K)=FWANT                                          DRYA 581
ISN 0533          TRWA(I,K)=RWANT                                          DRYA 582
ISN 0534          TTWA(I,K)=TWANT                                          DRYA 583
ISN 0535      370 CONTINUE                                                 DRYA 584
            C      DRYADS OUTPUT                                           DRYA 585
            C      HEADING                                                 DRYA 586
            C     GIVE SOME HOURLY INFO                                    DRYA 587
ISN 0536      375 CONTINUE                                                 DRYA 588
            C *** DETERMINE TOTAL CANOPY DEPOSITION                        DRYA 589
ISN 0537          DO 385 K=NMIN,NTOT                                       DRYA 590
ISN 0538          CANAMT(K)=0.D0                                           DRYA 591
ISN 0539          DO 385 I=1,NSTRAT                                        DRYA 592
ISN 0540          IF(TPAAL(K).LE.0.) GO TO 380                             DRYA 593
ISN 0542          LPART(I,K)=LPOOL(I,K)/TPAAL(K)                           DRYA 594
ISN 0543          IF(LPART(I,K).LE.0.) GO TO 380                           DRYA 595
ISN 0545          SPART(I,K)=SPCOL(I,K)/TPAAL(K)                           DRYA 596
ISN 0546          IF(SPART(I,K).LE.0.) GO TO 380                           DRYA 597
ISN 0548          FPART(I,K)=FPOOL(I,K)/TPAAL(K)                           DRYA 598
ISN 0549          IF(FPART(I,K).LE.0.) GO TO 380                           DRYA 599
ISN 0551          RPART(I,K)=RPOOL(I,K)/TPAAL(K)                           DRYA 600
ISN 0552          IF(RPART(I,K).LE.0.) GO TO 380                           DRYA 601
ISN 0554          GO TO 385                                                DRYA 602
ISN 0555      380 LPART(I,K)=0.5                                           DRYA 603
ISN 0556          SPART(I,K)=0.3                                           DRYA 604
ISN 0557          FPART(I,K)=0.001                                         DRYA 605
ISN 0558          RPART(I,K)=0.199                                         DRYA 606
ISN 0559      385 CANAMT(K)=CANAMT(K)+CANQAN(I,K)*1.D-4                    DRYA 607
ISN 0560          IF(INC1.EQ.0) GO TO 405                                  DRYA 608
ISN 0562          IF(NPRPLT.EQ.0) GO TO 405                                DRYA 609
ISN 0564          DO 390 J=1,NMPLT                                         DRYA 610
ISN 0565          IF(MONTH.NE.MONPLT(J)) GO TO 390                         DRYA 611
ISN 0567          GO TO 395                                                DRYA 612
ISN 0568      390 CONTINUE                                                 DRYA 613
ISN 0569          GO TO 405                                                DRYA 614
ISN 0570      395 CONTINUE                                                 DRYA 615
ISN 0571          IF(KS.LE.NELM) PLTDIF(INC1)=TDIF(ISTRA,KS)               DRYA 616
ISN 0573          IF(KS.GT.NELM) PLTGAS(INC1)=TGAS(ISTRA,KS)               DRYA 617
ISN 0575          PLTLPS(INC1)=LINSOL(ISTRA,KS)+LSALT(ISTRA,KS)+           DRYA 618
                 1LSOLU(ISTRA,KS)                                          DRYA 619
ISN 0576          PLTSPS(INC1)=SINSOL(ISTRA,KS)+SSALT(ISTRA,KS)+SSOLU(ISTRA,KS)  DRYA 620
ISN 0577          PLTRPS(INC1)=RINSOL(ISTRA,KS)+RSALT(ISTRA,KS)+RSOLU(ISTRA,KS)  DRYA 621
ISN 0578          PLTLSS(INC1)=LSSALT(ISTRA,KS)+PLTLSS(INC1)               DRYA 622
ISN 0579          PLTRSS(INC1)=RSSOLU(ISTRA,KS)+PLTRSS(INC1)               DRYA 623
ISN 0580          PLTCHC(INC1)=PLTCHC(INC1)+CHCON(ISTRA,KS)*1.D4           DRYA 624
ISN 0581          PLTAMT(INC1)=AMT(KS)*1.D4                                DRYA 625
ISN 0582          PLTMNS(INC1)=LMINL(ISTRA,KS)+PLTMNS(INC1)                DRYA 626
ISN 0583          PLTTWA(INC1)=PLTTWA(KS)                                  DRYA 627
ISN 0584          IF(NQUES.NE.1) GO TO 405                                 DRYA 628
ISN 0586          CALL DRYPLT(INC1,XMIN,XMAX,MONTH)                        DRYA 629
ISN 0587          NQUES=0                                                  DRYA 630
ISN 0588          DO 400 J=1,66                                            DRYA 631
ISN 0589          PLTLSS(J)=0.0                                            DRYA 632
ISN 0590          PLTRSS(J)=0.0                                            DRYA 633
ISN 0591          PLTCHC(J)=0.0                                            DRYA 634
ISN 0592          PLTMNS(J)=0.0                                            DRYA 635
ISN 0593      400 CONTINUE                                                 DRYA 636
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ISN 0594        405 CONTINUE                                                    DRYA 637
ISN 0595            IF(KDAY.NE.LASDAY(YEAR,MONTH)) RETURN                       DRYA 638
ISN 0597            IF(IHR.NE.23.OR.MIN.NE.45) RETURN                           DRYA 639
ISN 0599            WRITE(6,8040)                                               DRYA 640
ISN 0600       8040 FORMAT('1DRYADS OUTPUT'///)                                 DRYA 641
ISN 0601            DO 455 I=1,NSTRAT                                           DRYA 642
ISN 0602            WRITE(6,8045) I                                             DRYA 643
ISN 0603       8045 FORMAT('0VEGETATION LAYER',I3)                              DRYA 644
ISN 0604            IFG=NELM+1                                                  DRYA 645
ISN 0605            M1=NTOT-NELM                                                DRYA 646
ISN 0606            WRITE(6,8050)  (ENAME(K),K=1,NELM),(GASNAM(K),K=1,M1)       DRYA 647
ISN 0607       8050 FORMAT(' CONTAMINANTS',8X,9(3X,A8)//)                       DRYA 648
ISN 0608            WRITE(6,8055) (TDIF(I,K),K=NMIN,NELM)                       DRYA 649
ISN 0609            WRITE(6,8060)  (TLEA(I,K),K=NMIN,NELM)                      DRYA 650
ISN 0610            WRITE(6,8065) (TGAS(I,K),K=IFG,NTOT)                        DRYA 651
ISN 0611       8055 FORMAT('0**FLUXES IN **'/                                   DRYA 652
                   1' DIFSOL(UG/M**2/MO)',2X,9E11.3)                            DRYA 653
ISN 0612       8060 FORMAT(' LEACH(UG/M**2/MO)',3X,9E11.3)                      DRYA 654
ISN 0613       8065 FORMAT(' GASFIX(UG/M**2/MO)',46X,4E11.3)                    DRYA 655
ISN 0614            WRITE(6,8070) (TLSS(I,K),K=NMIN,NTOT)                       DRYA 656
ISN 0615            WRITE(6,8075) (TSFS(I,K),K=NMIN,NTOT)                       DRYA 657
ISN 0616            WRITE(6,8080) (TSRS(I,K),K=NMIN,NTOT)                       DRYA 658
ISN 0617            WRITE(6,8085) (TRSS(I,K),K=NMIN,NTOT)                       DRYA 659
ISN 0618            WRITE(6,8090) (TSLS(I,K),K=NMIN,NTOT)                       DRYA 660
ISN 0619       8070 FORMAT('0**FLUXES WITHIN**'/                                DRYA 661
                   1' LSSALT(UG/M**2/MO)',2X,9E11.3)                            DRYA 662
ISN 0620       8075 FORMAT(' SFSALT(UG/M**2/MO)',2X,9E11.3)                     DRYA 663
ISN 0621       8080 FORMAT(' SRSALT(UG/M**2/MO)',2X,9E11.3)                     DRYA 664
ISN 0622       8085 FORMAT(' RSSOLU(UG/M**2/MO)',2X,9E11.3)                     DRYA 665
ISN 0623       8090 FORMAT(' SLSOLU(UG/M**2/MO)',2X,9E11.3)                     DRYA 666
ISN 0624            DO 420 K=NMIN,NTOT                                          DRYA 667
                C    MONTHLY MASS BALANCE                                       DRYA 668
ISN 0625            TOTHER=(TLMO(I,K)+TSMO(I,K)+TFMO(I,K)+TRMO(I,K))-TGOODY(I,K) DRYA 669
                   1+(LINSOL(I,K)+LSOLU(I,K)+LSALT(I,K)+FSALT(I,K)+FINSOL(I,K)  DRYA 670
                   2+SINSOL(I,K)+SSOLU(I,K)+SSALT(I,K)+RINSOL(I,K)+RSALT(I,K)   DRYA 671
                   3+RSOLU(I,K)+SDORM(I,K)+RDORM(I,K))-TCIN(I,K)                DRYA 672
ISN 0626            IF(K.GT.NELM) GO TO 410                                     DRYA 673
ISN 0628            ERTREE(I,K)=TDIF(I,K)-TLEA(I,K)-TOTHER                      DRYA 674
ISN 0629            GO TO 415                                                   DRYA 675
ISN 0630        410 ERTREE(I,K)=TGAS(I,K)-TOTHER                                DRYA 676
ISN 0631        415 ERLITT(I,K)=TLMO(I,K)+TSMO(I,K)+TRMO(I,K)+TFMO(I,K)         DRYA 677
                   1-TLMI(I,K)-TSMI(I,K)-TRMI(I,K)-TFMI(I,K)-TPUDDL(I,K)        DRYA 678
ISN 0632            TLSSA(I,K)=LSOLU(I,K)+LSALT(I,K)                            DRYA 679
ISN 0633            TSSSA(I,K)=SSOLU(I,K)+SSALT(I,K)                            DRYA 680
ISN 0634            TRSSA(I,K)=RSOLU(I,K)+RSALT(I,K)                            DRYA 681
ISN 0635            TGOODY(I,K)=LINSOL(I,K)+SINSOL(I,K)+SDORM(I,K)+RINSOL(I,K)  DRYA 682
                   1+RDORM(I,K)+FINSOL(I,K)+FSALT(I,K)+LSALT(I,K)+SSALT(I,K)    DRYA 683
                   2+RSALT(I,K)+LSOLU(I,K)+SSOLU(I,K)+RSOLU(I,K)                DRYA 684
ISN 0636            LBCON(K)=0.                                                 DRYA 685
ISN 0637            FBCON(K)=0.                                                 DRYA 686
ISN 0638        420 CONTINUE                                                    DRYA 687
ISN 0639            WRITE(6,8125) (LINSOL(I,K),K=NMIN,NTOT)                     DRYA 688
ISN 0640            WRITE(6,8130) (TLSSA(I,K),K=NMIN,NTOT)                      DRYA 689
ISN 0641            WRITE(6,8135) (FSALT(I,K),K=NMIN,NTOT)                      DRYA 690
ISN 0642            WRITE(6,8140) (FINSOL(I,K),K=NMIN,NTOT)                     DRYA 691
ISN 0643            WRITE(6,8145) (SINSOL(I,K),K=NMIN,NTOT)                     DRYA 692
ISN 0644            WRITE(6,8150) (TSSSA(I,K),K=NMIN,NTOT)                      DRYA 693
ISN 0645            WRITE(6,8155) (SDORM(I,K),K=NMIN,NTOT)                      DRYA 694
```

```
ISN 0646          WRITE(6,8160) (RINSOL(I,K),K=NMIN,NTOT)                DRYA 695
ISN 0647          WRITE(6,8165) (TRSSA(I,K),K=NMIN,NTOT)                 DRYA 696
ISN 0648          WRITE(6,8170) (RDORM(I,K),K=NMIN,NTOT)                 DRYA 697
ISN 0649          AMTL=LSTOR(I)+LSUGAR(I)                                DRYA 698
ISN 0650          AMTF=FSTOR(I)+FSUGAR(I)                                DRYA 699
ISN 0651          DO 435 K=NMIN,NTOT                                     DRYA 700
ISN 0652          IF(AMTL.LT.1.D-12) GO TO 425                           DRYA 701
ISN 0654          LBCON(K)=(LINSOL(I,K)+TLSSA(I,K))/AMTL                 DRYA 702
ISN 0655      425 IF(AMTF.LT.1.D-12) GO TO 430                           DRYA 703
ISN 0657          FBCON(K)=(FSALT(I,K)+FINSOL(I,K))/AMTF                 DRYA 704
ISN 0658      430 SBCONS(K)=(SINSOL(I,K)+TSSSA(I,K))/(SSTOR(I)+SSUGAR(I)) DRYA 705
ISN 0659          SBCONH(K)=SDORM(I,K)/SWOOD(I)                          DRYA 706
ISN 0660          RBCONS(K)=(RINSOL(I,K)+TRSSA(I,K))/(RSTOR(I)+RSUGAR(I)) DRYA 707
ISN 0661          RBCONH(K)=RDORM(I,K)/RWOOD(I)                          DRYA 708
ISN 0662      435 CONTINUE                                               DRYA 709
ISN 0663          WRITE(6,8095)  (LBCON(K),K=NMIN,NTOT)                  DRYA 710
ISN 0664          WRITE(6,8100)  (FBCON(K),K=NMIN,NTOT)                  DRYA 711
ISN 0665          WRITE(6,8105)  (SBCONS(K),K=NMIN,NTOT)                 DRYA 712
ISN 0666          WRITE(6,8110)  (SBCONH(K),K=NMIN,NTOT)                 DRYA 713
ISN 0667          WRITE(6,8115)  (RBCONS(K),K=NMIN,NTOT)                 DRYA 714
ISN 0668          WRITE(6,8120)  (RBCONH(K),K=NMIN,NTOT)                 DRYA 715
ISN 0669     8095 FORMAT(' BIOMASS CONCENTRATION'/' LBCON(UG/G)',9X,9E11.3) DRYA 716
ISN 0670     8100 FORMAT(' FBCON(UG/G)',9X,9E11.3)                       DRYA 717
ISN 0671     8105 FORMAT(' SBCONS(UG/G)',8X,9E11.3)                      DRYA 719
ISN 0672     8110 FORMAT(' SBCONH(UG/G)',8X,9E11.3)                      DRYA 720
ISN 0673     8115 FORMAT(' RBCONS(UG/G)',8X,9E11.3)                      DRYA 721
ISN 0674     8120 FORMAT(' RBCONH(UG/G)',8X,9E11.3)                      DRYA 722
ISN 0675     8125 FORMAT('0**STANDING POOLS**'/,                         DRYA 723
                 1' LINSOL(UG/M**2)',5X,9E11.3)                          DRYA 724
ISN 0676     8130 FORMAT(' LSOL-SAL(UG/M**2)',3X,9E11.3)                 DRYA 725
ISN 0677     8135 FORMAT(' FSALT(UG/M**2)',6X,9E11.3)                    DRYA 726
ISN 0678     8140 FORMAT(' FINSOL(UG/M**2)',5X,9E11.3)                   DRYA 727
ISN 0679     8145 FORMAT(' SINSOL(UG/M**2)',5X,9E11.3)                   DRYA 728
ISN 0680     8150 FORMAT(' SSOL-SAL(UG/M**2)',3X,9E11.3)                 DRYA 729
ISN 0681     8155 FORMAT(' SDORM(UG/M**2)',6X,9E11.3)                    DRYA 730
ISN 0682     8160 FORMAT(' RINSOL(UG/M**2)',5X,9E11.3)                   DRYA 731
ISN 0683     8165 FORMAT(' RSOL-SAL(UG/M**2)',3X,9E11.3)                 DRYA 732
ISN 0684     8170 FORMAT(' RDORM(UG/M**2)',6X,9E11.3)                    DRYA 733
ISN 0685          WRITE(6,8190)  (LPOOL(I,K),K=NMIN,NTOT)                DRYA 734
ISN 0686          WRITE(6,8195) (SPOOL(I,K),K=NMIN,NTOT)                 DRYA 735
ISN 0687          WRITE(6,8200) (FPOOL(I,K),K=NMIN,NTOT)                 DRYA 736
ISN 0688          WRITE(6,8205) (RPOOL(I,K),K=NMIN,NTOT)                 DRYA 737
ISN 0689          DO 440 K=NMIN,NTOT                                     DRYA 738
ISN 0690          TLPOOL(K)=SPOOL(I,K)+FPOOL(I,K)+LPOOL(I,K)             DRYA 739
ISN 0691          TPCONC(K)=TLPOOL(K)/(LCARB(I)+SCARB(I)+FCARB(I))       DRYA 740
ISN 0692          RCONC(K)=RPOOL(I,K)/RCARB(I)                           DRYA 741
ISN 0693      440 CONTINUE                                               DRYA 742
ISN 0694          WRITE(6,8180)  (TLPOOL(K),K=NMIN,NTOT)                 DRYA 743
ISN 0695          WRITE(6,8185)  (TPCONC(K),K=NMIN,NTOT)                 DRYA 744
ISN 0696          WRITE(6,8175)  (RCONC(K),K=NMIN,NTOT)                  DRYA 745
ISN 0697     8175 FORMAT(' RCONC(UG/G)',9X,9E11.3)                       DRYA 746
ISN 0698     8180 FORMAT(' TLPOOL(UG/M**2)',5X,9E11.3)                   DRYA 747
ISN 0699     8185 FORMAT(' TPCONC(UG/G)',8X,9E11.3)                      DRYA 748
ISN 0700     8190 FORMAT('0**LITTER POOLS**'/                            DRYA 749
                 1' LPOOL(UG/M**2)',6X,9E11.3)                           DRYA 750
ISN 0701     8195 FORMAT(' SPOOL(UG/M**2)',6X,9E11.3)                    DRYA 751
ISN 0702     8200 FORMAT(' FPOOL(UG/M**2)',6X,9E11.3)                    DRYA 752
ISN 0703     8205 FORMAT(' RPOOL(UG/M**2)',6X,9E11.3)                    DRYA 753
```

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ISN 0704          WRITE(6,8215)  (TLMI(I,K),K=NMIN,NTOT)                DRYA 754
ISN 0705          WRITE(6,8220) (TSMI(I,K),K=NMIN,NTOT)                DRYA 755
ISN 0706          WRITE(6 8225) (TFMI(I,K),K=NMIN,NTOT)                DRYA 756
ISN 0707          WRITE(6,8230) (TRMI(I,K),K=NMIN,NTOT)                DRYA 757
ISN 0708          DO 445 K=NMIN,NTOT                                   DRYA 758
ISN 0709      445 TMINL(K)=TLMI(I,K)+TSMI(I,K)+TFMI(I,K)+TRMI(I,K)     DRYA 759
ISN 0710          WRITE(6,8210)  (TMINL(K),K=NMIN,NTOT)                DRYA 760
ISN 0711     8210 FORMAT(' TMINL(UG/M**2/MO)',3X,9E11.3)               DRYA 761
ISN 0712     8215 FORMAT('0**MINERALIZATION**'/                        DRYA 762
                 1' LMINL(UG/M**2/MO)',3X,9E11.3)                      DRYA 763
ISN 0713     8220 FORMAT(' SMINL(UG/M**2/MO)',3X,9E11.3)               DRYA 764
ISN 0714     8225 FORMAT(' FMINL(UG/M**2/MO)',3X,9E11.3)               DRYA 765
ISN 0715     8230 FORMAT(' RMINL(UG/M**2/MO)',3X,9E11.3)               DRYA 766
ISN 0716          WRITE(6,8235)  I,(ERTREE(I,K),K=NMIN,NTOT)           DRYA 767
ISN 0717     8235 FORMAT('0**PLANT POOL ERROR**'/' (UG/M**2/MO)'/      DRYA 768
                 1' PLANT',I2,13X,9E11.3)                              DRYA 768
ISN 0718          WRITE(6,8240)  I,(ERLITT(I,K),K=NMIN,NTOT)           DRYA 769
ISN 0719     8240 FORMAT('0**LITTER POOL ERROR**'/' (UG/M**2/MO)'/     DRYA 770
                 1'  LITTER',I2,12X,9D11.3)                            DRYA 770
ISN 0720          WRITE(6,8245) (TLWA(I,K),K=NMIN,NTOT)                DRYA 771
ISN 0721          WRITE(6,8250) (TSWA(I,K),K=NMIN,NTOT)                DRYA 772
ISN 0722          WRITE(6,8255) (TFWA(I,K),K=NMIN,NTOT)                DRYA 773
ISN 0723          WRITE(6,8260) (TRWA(I,K),K=NMIN,NTOT)                DRYA 774
ISN 0724          WRITE(6,8265) (TTWA(I,K),K=NMIN,NTOT)                DRYA 775
ISN 0725          WRITE(6,8270) (ABSPOW(NSTRAT,K),K=NMIN,NTOT)         DRYA 776
ISN 0726     8245 FORMAT('0**PLANT DEMAND**'/                          DRYA 777
                 1' LWANT',15X,9E11.3)                                 DRYA 778
ISN 0727     8250 FORMAT(' SWANT',15X,9E11.3)                          DRYA 779
ISN 0728     8255 FORMAT(' FWANT',15X,9E11.3)                          DRYA 780
ISN 0729     8260 FORMAT(' RWANT',15X,9E11.3)                          DRYA 781
ISN 0730     8265 FORMAT(' TWANT',15X,9E11.3)                          DRYA 782
ISN 0731     8270 FORMAT(' ABSPOW',14X,9E11.3)                         DRYA 783
ISN 0732          WRITE(6,8280) (TLMO(I,K),K=NMIN,NTOT)                DRYA 784
ISN 0733          WRITE(6,8285) (TSMO(I,K),K=NMIN,NTOT)                DRYA 785
ISN 0734          WRITE(6,8290) (TFMO(I,K),K=NMIN,NTOT)                DRYA 786
ISN 0735          WRITE(6,8295) (TRMO(I,K),K=NMIN,NTOT)                DRYA 787
ISN 0736          DO 450 K=NMIN,NTOT                                   DRYA 788
ISN 0737          TOTM(K)=TLMO(I,K)+TSMO(I,K)+TRMO(I,K)+TFMO(I,K)      DRYA 789
ISN 0738      450 CONTINUE                                             DRYA 790
ISN 0739          WRITE(6,8275)  (TOTM(K),K=NMIN,NTOT)                 DRYA 791
ISN 0740     8275 FORMAT(' TOTAL(UG/M**2/MO)',3X,9E11.3)               DRYA 792
ISN 0741     8280 FORMAT('0**MORTALITY  (UG/M**2/MO)**'/               DRYA 793
                 1' L(LIT-HUM)'10X,9E11.3)                             DRYA 794
ISN 0742     8285 FORMAT(' S(LIT-HUM-FALL)',5X,9E11.3)                 DRYA 795
ISN 0743     8290 FORMAT(' F(LIT-HUM)',10X,9E11.3)                     DRYA 796
ISN 0744     8295 FORMAT(' R(LIT-HUM-FALL)',5X,9E11.3)                 DRYA 797
ISN 0745      455 CONTINUE                                             DRYA 798
ISN 0746          DO 460 I=1,486                                       DRYA 799
ISN 0747      460 ZERDRY(I)=0.0D0                                      DRYA 800
ISN 0748          RETURN                                               DRYA 801
ISN 0749          END                                                  DRYA 802
```

APPENDIX B

Input Data for an Annual Simulation

[Format described in Huff et al. (1976).]

```
BATCH
CROOKED CREEK, MISSOURI                                  1   1
  5
PRECIPITATION-DEPOSITION INPUT
OPEN RAINGAGE INFO
  1  1  CROOKED CREEK, MISSOURI

INPUT RAINGAGE INFORMATION                                   (CALL NEWSTA)
  5  3331SALEM                                   120037 38  00   91 32 00   RECORDING
$
READ HOURLY PRECIPITATION                                    (CALL RDHRLY)
NO
  5       STANFORD MODEL FORMAT
     3331 72 01 03 2                                                  .01        .01  .03  .03
     3331 72 01 04 1  .02        .01  .01                                             .01  .02
     3331 72 01 04 2  .03  .01  .01
     3331 72 01 09 1                                                        .01  .02
     3331 72 01 27 1                                  .05  .05  .05  .05  .05  .05  .05  .05
     3331 72 01 27 2  .05  .05  .05  .05  .05  .05  .05  .05  .05  .05
     3331 72 02 02 2                                                        .02  .01  .02  .02
     3331 72 02 06 1                  .01  .04       .01
     3331 72 02 08 2                                 .01  .01  .05  .02
     3331 72 02 12 1                                 .02  .02  .03  .02       .01
     3331 72 02 12 2  .01  .01
     3331 72 02 14 2                                      .07  .05  .06  .01  .01
     3331 72 02 22 2                                                           .18
     3331 72 02 23 1  .01        .01  .02                 .01  .06  .01
     3331 72 02 23 2  .04  .04  .04  .04  .04  .04  .04  .04  .04  .04  .04  .04
     3331 72 02 24 1  .04  .04  .04  .05  .05  .05  .05  .05  .05  .05  .05  .05
     3331 72 02 24 2  .05  .04  .04  .04  .04  .04
     3331 72 03 12 2                                                           .03
     3331 72 03 13 1  .45  .21  .01  .02
     3331 72 03 15 1                                 .03  .10  .04  .02
     3331 72 03 17 2                                                      .02  .17
     3331 72 03 18 1  .03  .03  .04  .08  .01
     3331 72 03 28 2                  .03  .03  .04  .04  .04  .03  .03  .03  .03
     3331 72 04 03 1                                                           .02
     3331 72 04 03 2  .09  .21  .09  .01
     3331 72 04 07 1                       .20                .02
     3331 72 04 07 2  .01
     3331 72 04 10 1                                          .02  .08  .02
     3331 72 04 13 2                                  .20  .19  .01
     3331 72 04 14 1            .02  .57  .01
     3331 72 04 15 1                                  .72  .20
     3331 72 04 15 2  .10  .88  .29  .01                  .08  .02
     3331 72 04 19 2                  .19  .11  .09  .01                  .22  .10
     3331 72 04 20 1  .08  .01                            .01  .02
     3331 72 04 20 2                                                 .01  .01  .07
     3331 72 04 21 1  .08  .06  .48  .01  .01       .14  .23  .11  .09
     3331 72 04 21 2            .30
     3331 72 04 28 1                                          .27  .21  .02
     3331 72 05 01 1                  .20  .20  .20  .20  .12
     3331 72 05 07 2                                                      .17  .04
     3331 72 05 08 1  .08  .01
     3331 72 05 12 2                       .08  .05  .02  .02
     3331 72 05 15 1            .03
     3331 72 05 23 2                                          .18  .11  .11  .02
     3331 72 05 24 1  .01  .02  .03  .01
     3331 72 05 27 2                                          .06  .01
     3331 72 06 04 1                                  .08
     3331 72 06 06 2                                  .01  .09
     3331 72 06 07 1                                       .04  .15  .01
```

3331	72	06	14	2					.08	.08	.09	.09	.09	.09	.08	.08
3331	72	06	19	2						.03	.03	.03	.04	.04	.04	.04
3331	72	06	20	1	.04	.04	.04	.04	.04	.04	.03	.03				
3331	72	06	25	1	.01	.01										
3331	72	06	26	1												.01
3331	72	07	01	2												.39
3331	72	07	02	1	.01											
3331	72	07	02	2						.11	.20	.09				
3331	72	07	03	2											.34	.08
3331	72	07	04	1		.02					.01	.03	.04	.02	.01	.02
3331	72	07	15	2							.02	.01	.06	.01	.01	.07
3331	72	07	16	1	.10	.69	.71	.27		.03	.01	.01				
3331	72	08	04	1											.57	.03
3331	72	08	04	2	.02					.03						
3331	72	08	06	1		.11	.01						.01	.04	.03	.10
3331	72	08	15	2			.20									
3331	72	08	19	2				.18	.03							
3331	72	08	21	2	.01	.09	.10	.20	.01							.29
3331	72	08	22	2				.42	.08				.10		.08	.10
3331	72	08	23	1	.10	.04	.28	.10	.02			.02	.02			
3331	72	09	07	2			.12	.68	.10	.40	.39	.02	.01			
3331	72	09	13	2	.03											
3331	72	09	14	1			.22	.16	.01	.01	.02	.18				
3331	72	09	15	1										.25		
3331	72	09	21	1									.02	.05	.01	.01
3331	72	09	22	2		.02	.08	.03	.01							
3331	72	09	23	1		.01	.07				.01	.44	.05			
3331	72	09	25	2	.02											
3331	72	09	26	2												.01
3331	72	09	27	1	.07											
3331	72	09	29	1			.08	.01				.01				.08
3331	72	09	29	2	.30	.22		.10	.02	.07	.01					
3331	72	10	03	1					.03	.18	.12	.01	.01			
3331	72	10	08	2				.06	.03							
3331	72	10	17	1	.09	.01										
3331	72	10	19	2	.20	.03	.02	.05								
3331	72	10	21	1					.02	.08		.10				
3331	72	10	23	1											.07	.01
3331	72	10	23	2					.02	.08						
3331	72	10	27	1		.01										
3331	72	11	01	2										.02	.06	.02
3331	72	11	02	1			.01	.01								
3331	72	11	06	1					.16	.02						
3331	72	11	08	2					.01	.02	.03	.01	.08			
3331	72	11	18	1	.02	.02	.02	.03	.03	.03	.03	.02				
3331	72	11	18	2		.08	.02	.02	.03	.02	.01	.06	.03			
3331	72	11	23	1								.03	.07	.01	.01	.05
3331	72	11	26	1	.03	.04	.03	.04	.03	.04						
3331	72	11	26	2				.01	.01	.01	.07					
3331	72	11	28	2			.20	.10	.08	.02	.21	.07	.03		.01	
3331	72	11	29	1	.03	.03	.02									
3331	72	12	05	2												.02
3331	72	12	06	1	.07	.03	.08	.05	.02							
3331	72	12	06	2								.02	.11	.07	.18	.20
3331	72	12	07	1	.04	.07	.01									
3331	72	12	08	2								.05	.05	.05	.05	.05
3331	72	12	09	1	.05	.05	.05	.05	.05	.05	.05					
3331	72	12	09	2									.20	.20	.20	.20
3331	72	12	10	1	.20	.20	.20	.20	.20	.20	.20					
3331	72	12	13	2									.01	.01	.10	.17
3331	72	12	14	1	.03	.02	.07	.01	.10	.18	.02	.12	.18	.10		
3331	72	12	14	2	.02	.01	.04				.01	.01		.01	.05	.05
3331	72	12	15	1	.05	.05	.05	.05								
3331	72	12	19	1									.18	.04		
3331	72	12	29	1										.01	.01	.05
3331	72	12	29	2	.13			.01	.01		.02	.03	.01	.01	.01	.03

```
     3331 72 12 30 1  .09  .08  .01
$
$
READ MONTHLY DEPOSITION                                    (CALL MODEPS)
NO
  5
  72 1 LEAD          21.0 21.0 21.0 21.0 21.0 21.0 21.0 21.0 21.0 21.0 21.0 21.0
  72 2 CD            .140 .140 .140 .140 .140 .140 .140 .140 .140 .140 .140 .140
  72 3 ZN            1.80 1.80 1.80 1.80 1.80 1.80 1.80 1.80 1.80 1.80 1.80 1.80
  72 4 CU            .800 .800 .800 .800 .800 .800 .800 .800 .800 .800 .800 .800
$
$
$$
ENDRUN
CHOOKEI CREEK, MISSOURI                          1   1
  5
LAND SURFACE SIMULATION
 1 72  1 73  1 73                    START,END,KEY MO-YR, READ BY TIMEWD
  1   5 72 73
 8 SSBF
  .00    9.0    8.90    0.00    3.0
  52.40  179.4     179.4   179.4   179.4
 .2380   .2314   .2314  .2314   .2314
0.304   39.6359  95.56  119.606 142.2   250.588 512.0   0.280   0.302
   0.010      0.175      0.000
06 LANPAR
 1.0 .004 70.10 0.4  0.4
     .1118      .0203       0.0       0.011010
    1 5      3
 4 WINDS
WBW69  71101 6.083 6.167 4.458 4.958 4.583 2.333 2.250 2.500 3.458 2.750 1.583
WBW69  71102 1.167 3.250 8.417 6.792 8.875 4.125 2.750 2.667 5.000 4.333 6.292
WBW69  71103 10.167 3.000 3.292 1.458 2.583 6.708 4.833 3.917 5.542
WBW69  71111 3.458 3.125 6.375 2.750 2.500 2.042 1.917 4.958 5.250 2.708 3.750
WBW69  71112 6.625 1.500 5.833 5.917 2.292 1.917 4.667 8.625 3.208 2.125 4.042
WBW69  71113 4.417 2.458 4.458 2.958 2.167 3.750 3.083 4.458
WBW69  71121 4.000 3.875 6.833 4.500 2.958 3.458 6.750 2.000 1.958 4.292 7.458
WBW69  71122 4.833 3.292 8.417 2.333 1.833 1.167 1.792 3.833 2.958 1.917 2.875
WBW69  71123 6.875 3.792 4.792 5.458 3.875 4.348 2.833 6.000 9.000
WBW70  72 11 1.833 0.667 2.333 2.167 1.542 2.500 3.167 2.875 2.542 1.458 1.167
WBW70  72 12 2.583 2.875 0.958 1.292 1.500 2.500 0.833 2.125 3.833 4.125 1.375
WBW70  72 13 0.917 0.750 1.917 3.208 1.000 1.333 8.750 2.750 1.792
WBW70  72 21 1.208 5.417 2.792 1.250 0.167 1.208 0.917 0.833 1.333 2.125 4.708
WBW70  72 22 4.833 1.500 1.000 3.833 3.625 0.917 7.083 7.250 6.042 1.792 3.083
WBW70  72 23 1.083 2.875 5.042 4.250 3.500 0.792
WBW70  72 31 1.792 3.125 3.542 5.417 1.625 3.667 0.500 1.292 2.042 3.167 2.833
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WBW7C  72 32 3.750 1.333 4.083 4.375 0.958 4.208 2.958 2.250 3.875 3.208 4.417
WBW7C  72 33 4.792 3.042 6.208 8.458 0.583 1.292 4.417 3.792 2.083
WBW70  72 41 4.0001.708 2.042 3.375 6.958 5.792 4.083 4.708 6.250 2.458 3.875
WBW7C  72 42 3.292 6.375 4.083 3.375 2.792 1.208 0.750 6.625 9.292 7.083 5.208
WBW7C  72 43 3.667 4.792 3.500 1.750 1.875 2.292 3.000 4.917
WBW70  72 51 4.875 2.542 4.375 2.333 3.000 4.250 2.708 4.583 4.667 7.042 3.958
WBW70  72 52 5.250 6.042 3.667 3.917 3.458 3.083 2.083 3.042 2.375 2.083 2.042
WBW7C  72 53 2.125 2.375 3.542 3.333 3.333 3.417 3.792 3.250 2.125
WBW7C  72 61 6.792 2.125 0.542 2.250 1.583 1.417 3.667 2.917 1.750 2.625 2.583
WBW70  72 62 3.583 1.875 3.542 3.667 3.667 4.917 8.042 3.208 3.958 6.083 3.000
WBW7C  72 63 2.125 3.500 2.208 8.500 7.250 4.042 3.125 1.417
WBW70  72 71 3.333 3.333 4.583 5.708 2.750 3.000 3.000 3.000 3.000 3.000 3.000
WBW70  72 72 3.000 3.625 4.083 6.792 3.000 1.375 1.542 2.750 5.792 3.042 6.417
WBW7C  72 73 2.083 2.250 3.667 1.875 1.042 0.958 1.042 1.625 2.333
WBW7C  72 81 2.917 2.500 4.208 1.417 1.458 2.458 1.958 3.208 2.083 7.917 3.625
WBW70  72 82 2.208 2.625 1.583 1.708 1.667 3.125 1.667 3.292 1.750 2.167 2.750
WBW70  72 83 4.458 6.167 4.083 2.292 2.583 2.000 1.500 2.708 3.958
WBW70  72 91 1.458 1.625 5.167 2.792 2.417 1.333 1.583 1.083 3.875 3.958 2.542
WBW70  72 92 1.292 1.042 1.667 1.917 1.583 1.625 2.458 1.500 2.667 1.792 1.125
WBW7C  72 93 1.208 1.458 2.375 3.250 4.583 3.917 0.875 3.833
$
 7 READIN
1   DATA AND SIMULATION OF CROOKED CREEK WATERSHED
       30.        60.        60.        6C.        60.
      .233       .257       .283       .317       .330
       .38
   1.0132      .24          10.       100.         0.
    .2         .01        .6         .4         1.0D 6     1.0D 6    5000.
     .001        4.         .0        20.
   300000.      .001       .001
   1C0.     140.       250.       290.
     1.0      7.         2.         1.         .22        .16
     0.60       0.48     5     4
      20.        10.        50.       100.       -.5        -.5
      0.0      315.0      35.0
FORMULA
CROOKED CREEK SOILS A
3.          .2895      146.13     136.5      0.294
1.         .2895      4.995      3.445
CROOKED CREEK SOILS B
3.         .2965      103.05     129.90     .3136
1.         .2965      1.5008D -3 9.7497
CRCOKED CREEK SOILS C
3.         .298       80.26      141.31     .3279
1.         .298       .0040823   8.19124
CBOOKED CREEK SOILS D
3.         .3382      101.06     163.4      .3706
2.         .3382      17.746     4.0        .344097      5.79D- 4
INFILTRATION CURVE FOREST SOIL
  15.        0.0        0.0        25
0.00 1.04 2.08 3.05 4.04 5.05 6.07 7.09 8.03 9.07 10.0811.1012.0913.0814.0715.06
16.0317.0218.0119.0019.9920.9621.9222.8923.80
   0.   5.  10.  15.  20.  25.  30.  35.  40.  45.  50.  55.  60.  65.  70.  75.
  80.  85.  90.  95. 100. 105. 110. 115. 120.
10 RDCER
 CERES PARAMETERS FOLLOW
    1
   0.0  880.      2.0       400.      .0C      0.0      .0       0.       8770.    4084.
   2C0.        5.0     .169       5.365
   2C.        30.          500.0
  0.1  D-31.80    D-4   1.84 D-4   1.88 D-4
 .055          .240
    22.        22.         13.
```

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   .00032
    2.    .648          75.        90.       273.       301.        .00010  5.
    .85         .05        5.7
 800.        700.      50.       600.         440.
  1.          1.         1.       1.
  1.          1.         1.       1.
    2
      100.       420.      1100.       500.       100.
.00035    .00122    .00018    .00013    .0000140  .0000320
   4.08D-3      9.D-8
 4.        14.         4.        8.         6.0
  1.630D-6  1.630D-6   2.60D-6
 9 RDCHM
 KD AND PARAMETERS FOR SOIL MODEL FOLLOW
    4  LEAD  CADMIUM   ZINC   COPPER   PAKE
 5 33.015.30.90.
.1174     .1174     .1174     .1728
    1.D-12     1.D-12     1.D-12     1.D-12     .0564      1.1
    1.D-12     1.D-12     1.D-12     1.D-12     .0317      1.2
    1.D-12     1.D-12     1.D-12     1.D-12     .0194      1.2
    1.D-12     1.D-12     1.D-12     1.D-12     .0479      1.3
      5.D2       1.D1       1.D1      3.5D1       1.0
      6.D2       6.D0       1.D1      2.7D2       1.0
      1.D6       1.D6       1.D6       1.D6       1.0
      1.D6       1.D6       1.D6       1.D6       1.0
       3.0       0.20       2.00       0.60
    189.         1.26      16.2        7.20
    189.         1.26      16.2        7.20
    189.         1.26      16.2        7.20
    189.         1.26      16.2        7.20
    189.         1.26      16.2        7.20
    189.         1.26      16.2        7.20
    189.         1.26      16.2        7.20
    189.         1.26      16.2        7.20
    189.         1.26      16.2        7.20
    189.         1.26      17.2        7.20
    189.         1.26      16.2        7.20
    189.         1.26      16.2        7.20

    103.65     56.25      32.69      31.75      1.0
     1.D-5     1.D-5      1.D-5      1.D-5      1.D-5
11 RDDRY
.8            1    5    1
 64.
2.8    D-3      1.0       1.0       1.0
 SO2
.118       .239       1.         1.         1.
5.7        1.0   D-11  1.0   D-4  1.0   D-9 1.0    D-8
1000.      1000.      1000.      1000.
100.       100.       100.       100.
7500.      7500.      7500.      7500.
600.       600.       600.       600.
10000.     10000.     10000.     10000.
```

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        0.      900.     25000.      2500.        0.
        0.       90.       600.       500.        0.
        0.     7000.      4000.      1000.        0.
        0.      300.      1000.       200.        0.
        0.     8000.      5000.     10000.        0.
    2.D-8
.9
2 DEW DAILY
      71101   60.   64.   61.   45.   46.   40.   46.   50.   32.   36.   44.
      71102   45.   43.   40.   57.   60.   63.   64.   64.   56.   63.   59.
      71103   60.   54.   57.   57.   48.   48.   55.   56.   31.
      71111   60.   30.   20.   20.   30.   23.   17.    6.   38.   26.   36.
      71112   47.   48.   60.   63.   54.   50.   57.   25.   34.   25.   12.
      71113   29.   32.   31.   38.   28.   34.   30.   20.
      71121   20.   25.   19.   32.   37.   39.   42.   44.   47.   46.   28.
      71122   40.   30.   57.   42.   38.   21.   11.   36.   39.   34.   26.
      71123   43.   41.   54.   48.   55.   17.   43.   28.   19.
      72011   31.   21.   38.    8.   12.   24.   26.   26.   45.   40.   21.
      72012   32.   18.    6.   -6.    7.   23.   41.   36.   54.   36.   36.
      72013   44.   38.    2.   -4.   29.   12.   21.   23.   23.
      72021   20.   20.    3.    5.    6.   38.   -8.   18.   25.   27.   29.
      72022   37.   25.   28.   22.   22.   34.   18.   -4.    9.   47.   17.
      72023   42.   37.   38.   26.   37.   33.   43.
      72031   54.   14.   13.    9.    8.   17.   39.    1.    8.   26.   48.
      72032   54.   40.   31.   50.   32.   32.   29.   35.   40.   43.   28.
      72033   18.   20.   31.   32.   51.   40.   28.   15.   24.
      72041   18.   26.   50.   20.   28.   53.   52.   13.   20.   50.   64.
      72042   63.   60.   64.   53.   44.   35.   45.   59.   61.   58.   45.
      72043   41.   33.   24.   20.   44.   56.   48.   56.
      72051   54.   36.   42.   43.   48.   46.   56.   51.   40.   39.   38.
      72052   56.   43.   49.   45.   50.   44.   46.   48.   52.   48.   52.
      72053   58.   52.   53.   55.   56.   57.   58.   51.   35.
      72061   30.   34.   35.   43.   41.   34.   48.   37.   32.   43.   30.
      72062   45.   47.   71.   41.   46.   45.   43.   43.   65.   47.   43.
      72063   50.   49.   57.   60.   68.   59.   51.   50.
      72071   69.   66.   61.   58.   71.   39.   50.   55.   66.   66.
WBW70  72 72 60.00 61.33 65.46 66.92 61.54 58.17 59.46 63.21 67.67 62.29 64.83
WBW70  72 73 71.08 71.46 70.75 70.21 69.50 69.58 69.04 69.58 70.33
WBW7C  72 81 72.00 71.42 68.83 66.21 64.00 65.08 67.04 69.92 71.08 67.17 66.17
WBW70  72 82 67.54 66.25 65.29 66.46 67.96 67.96 67.71 66.67 69.25 71.13 72.79
WBW7C  72 83 70.13 60.08 60.92 62.88 62.25 65.92 69.50 71.09 67.33
WBW70  72 91 68.08 70.33 67.38 69.00 68.58 67.21 67.08 69.58 68.25 68.04 61.25
WBW7C  72 92 59.75 63.42 65.33 64.42 62.46 65.17 67.83 70.54 68.25 68.42 68.08
WBW7C  72 93 67.29 67.54 66.04 65.71 57.79 44.63 43.71 49.29  0.0
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 1 TEMP
2          THIS IS DCS(13).
 SALEM 71101 87 61 85 60 85 65 73 49 72 48 79 48 71 42 76 52 71 42 57 36 62 46
 SALEM 71102 72 36 78 44 72 42 79 42 78 53 82 62 77 62 74 66 73 56 78 61 72 56
 SALEM 71103 66 58 62 58 61 46 75 51 77 56 77 45 79 53 81 59 80 42
 SALEM 71111 65 46 75 45 66 35 57 32 65 42 68 35 46 19 39 21 41 28 50 24 65 34
 SALEM 71112 69 38 75 44 74 54 74 56 77 45 71 45 69 54 61 31 49 33 66 36 40 17
 SALEM 71113 40 22 35 28 40 25 42 28 44 34 43 31 44 34 35 31
 SALEM 71121 38 20 39 22 39 25 40 31 40 34 41 36 45 40 45 38 51 41 55 46 58 24
 SALEM 71122 49 27 51 24 49 27 66 47 50 32 49 29 49 21 45 20 41 34 54 31 36 31
 SALEM 71123 50 31 54 43 57 42 68 42 70 52 72 19 44 19 57 38 46 20
 SALEM 72011 50 23 43 28 48 29 40 15 15 -2 21 -2 39 18 54 30 49 36 59 33 61 24
 SALEM 72012 48 27 62 24 31  7 19 -6 10 -3 25  0 47 23 58 35 53 37 63 30 47 29
 SALEM 72013 50 36 61 42 66  9 33 10 45 16 30  6 20  6 25 17 32 19
 SALEM 72021 48 28 36 31 36 13 21  6 27  8 47 24 40  7 28  9 37 18 27 18 45 24
 SALEM 72022 43 34 39 31 49 30 67 29 46 24 54 31 55 26 39 21 46 24 59 33 66 21
 SALEM 72023 42 22 48 34 49 33 41 26 46 26 61 33 74 49
 SALEM 72031 81 60 70 19 38 17 48 25 43 19 45 26 66 39 60 25 50 20 63 32 65 36
 SALEM 72032 80 53 77 46 46 33 65 41 65 40 56 39 57 40 57 35 70 45 77 56 62 38
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 SALEM 72033 63 29 55 34 42 32 42 29 52 36 67 42 44 33 39 20 54 29
 SALEM 72041 57 25 43 21 66 33 60 25 57 32 69 48 82 60 65 25 47 28 64 38 63 45
 SALEM 72042 83 60 89 62 84 60 80 59 65 47 65 40 77 51 82 61 80 59 66 56 69 43
 SALEM 72043 76 49 65 40 62 34 61 38 65 49 62 53 62 52 74 55
 SALEM 72051 78 54 70 54 67 46 64 44 72 49 78 55 79 55 74 52 61 45 66 44 70 42
 SALEM 72052 76 56 72 59 74 55 65 50 74 49 81 50 81 48 81 49 83 51 84 54 87 50
 SALEM 72053 89 58 86 56 81 54 81 56 86 57 88 64 85 60 80 57 66 44
 SALEM 72061 68 38 77 48 84 61 89 67 89 67 90 67 91 61 83 62 92 65 92 51 72 42
 SALEM 72062 80 56 87 68 89 71 81 57 84 57 84 56 83 57 85 63 90 66 83 54 75 49
 SALEM 72063 77 47 82 49 87 62 87 63 82 72 90 71 89 68 89 58
 SALEM 72071 93 64 89 70 80 61 80 62 69 51 71 44 76 53 78 58 79 62 88 67 89 67
 SALEM 72072 88 63 88 66 89 67 91 74 87 63 80 65 91 72 89 71 90 71 92 71 90 69
 SALEM 72073 91 70 93 68 91 65 90 69 94 76 90 67 80 65 75 66 80 58
 SALEM 72081 84 62 84 70 89 73 89 65 71 59 80 69 77 59 77 56 84 54 74 51 80 61
 SALEM 72082 89 69 89 65 90 67 93 69 91 62 91 70 91 72 94 71 95 69 96 67 94 68
 SALEM 72083 82 66 81 66 87 66 83 59 71 58 74 55 84 57 86 57 85 61
 BUNKR 72091 88 65 85 65 76 56 71 55 78 52 79 53 89 62 87 68 88 64 81 55 89 63
 BUNKR 72092 89 68 91 68 90 64 80 62 87 67 88 67 90 64 92 68 90 67 87 57 66 50
 BUNKR 72093 70 55 72 65 73 65 78 67 80 62 80 62 80 57 69 36
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 3 RAD DAILY (LANGLEYS / DAY)  COLUMBIA, MISSOURI
COL73  71101 311.8 432.7 315.4 267.9 469.6 103.5 317.8 389.6 397.7 349.8 161.4
COL73  71102 111.2 346.3 425.7 416.2 432.4 409.8 403.4 388.1 395.4 380.9 361.6
COL73  71103 352.8 374.0 375.1 166.3 126.7 100.6  91.6 270.4 318.1
COL73  71111 312.5 254.8 329.2  68.4 342.7 121.7 158.0  60.4 332.9 322.2 104.2
COL73  71112 236.7  61.2 191.1 121.9 292.1 222.6 286.1 104.3  41.6 245.2 261.5
COL73  71113 219.3  41.4 211.4  64.4  96.5 263.6 269.9 235.0
COL73  71121 250.0 262.9 200.1  30.9 108.0 194.1 285.8 212.2 221.9 254.2 219.4
COL73  71122 197.6  44.7  52.2  50.6 209.6 108.6  89.4  51.6 265.7 170.3 254.3
COL73  71123 149.1 100.9  61.3  36.5 111.7 208.0 251.1  55.9 147.9
COL73  72 11 269.8 261.1  31.4  66.6  46.8 225.6  98.1 196.6 299.4 241.3 308.9
COL73  72 12 221.0 285.9 183.9 232.3 267.1  93.0  29.1 244.2 278.1  22.2  22.2
COL73  72 13 298.6 312.2 256.8  84.0 161.5 174.0 244.8 315.6  78.9
COL73  72 21 120.0  75.0 347.8 210.1  72.4  57.2  58.4 401.3 397.0 376.5 301.3
COL73  72 22  83.8 100.8  52.2 196.2 426.5 201.9 138.9 146.8 434.0 390.6 426.3
COL73  72 23 441.6 426.3 359.6  61.3  87.0 426.5
COL73  72 31  40.6  83.8 174.4  63.7 158.5  59.6 482.5 289.0 122.7  85.5  59.2
COL73  72 32 509.5 154.0 505.1 506.8  79.7 382.3 505.4 131.0 151.4 572.8 401.6
COL73  72 33 251.1 150.0 175.6 217.1 382.0 261.7 151.3 464.9 278.0
COL73  72 41  61.7 153.9 114.6 204.8 624.9 611.9 228.7 138.6 284.3 663.8 515.3
COL73  72 42 656.3 656.0 140.5 245.5 380.5 630.5 235.2 281.6 205.6 265.3 615.3
COL73  72 43 408.8 566.7 321.6 389.7 565.5 696.1 413.2 186.6
COL73  72 51 362.2 120.5 729.4 690.7 531.1 220.7 247.3 364.0 502.3 631.8 478.2
COL73  72 52 764.0 675.1 615.3 754.2 711.7 748.5 600.7 582.0 711.1 438.9 413.9
COL73  72 53 369.3 584.2 744.0 421.1 341.2 401.6 496.3 684.4 699.3
COL73  72 61 720.9 419.8 551.6 303.4 315.6 740.3 755.8 750.8 745.7 690.0 671.6
COL73  72 62 575.7 503.0 487.6 554.4 628.1 754.8 573.1 394.3 728.7 744.4 769.3
COL73  72 63 756.0 723.0 547.5 530.7 730.6 720.7 605.1 495.0
COL73  72 71 516.0 652.3 587.3 721.0 651.4 746.8 712.8 685.6 435.3 564.7 730.4
COL73  72 72 724.0 712.8 354.3 672.6 625.6 652.7 523.6 414.1 458.9 415.4 560.2
COL73  72 73 385.2 438.9 448.6 708.5 674.8 642.5 588.0 500.8 609.5
COL73  72 81 602.7 618.0 664.3 652.8 641.8 630.7 634.5 553.6 505.8 659.5 640.9
COL73  72 82 498.0 333.7 602.1 598.4 533.4 602.2 626.1 568.1 618.6 636.5 603.8
COL73  72 83 447.8 578.1 582.9 581.2 513.2 564.7 478.6 498.6 519.1
COL73  72 91 472.5 363.3 243.6 146.0 280.8 550.0 252.8 389.7 350.1 320.8 470.6
COL73  72 92 473.5 196.7 423.6 520.0 219.8 134.4 483.4 192.0 122.2 394.5 331.5
COL73  72 93 326.7 211.9 293.0 345.0 185.0 128.4 445.5 148.4
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15 EVAPO
 100.0      0.24
16 GO
ENDRUN

IHC002I STOP      0
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APPENDIX C

Output Data for One Month

Simulation with Appendix B input data.

The monthly output is divided into sections with results as follows:

1) Daily soil-plant water relations (PROSPER)

DAY	Julian date ($\leq$366)
INFILT	Infiltration (cm/day)
RUNOFF	Surface runoff (cm/day)
DRAINAGE	Soil drainage (cm/day)
ET	Evapotranspiration (cm/day)
FLLAT	Lateral flow from soil layers (cm/day)
FLNET	Vertical flow from root zone to 3rd soil layer (cm/day)
SURF.CON	Surface (leaf) conductance (cm/sec)
THETA1	Water content of first soil layer (ml/ml)
THETA2	Water content of second soil layer (ml/ml)
THETAN	Water content of bottom soil layer (ml/ml)

2) Monthly soil chemistry (SCEHM) and solute uptake (DIFMAS) results

EX	Exchangeable chemical
CON	Solution phase chemical

Results for four chemicals (LEAD, CADMIUM, ZINC, COPPER) given in ug/cm^2 land and ug/g soil (ppm) for 2nd, 3rd, 4th and 5th soil chemistry layer are tabulated.

Values for the amounts of chemical in litter, canopy and components of root uptake and monthly chemical movement in soil water (lateral flow, surface runoff or leaching in drainage water) follow mass balance errors for each chemical in both soil and surface litter layers complete this section.

3) Monthly DRYADS output of solute pools and fluxes.

Solute fluxes and pools using FØRTRAN names as in text. Additional labels have the following meaning:

LBCØN	leaf chemical concentration (ug/g)
FBCØN	fruit chemical concentration (ug/g)
SBCØNS	stem sapwood concentration (ug/g)
SBCØNH	stem heartwood concentration (ug/g)
RBCØNS	root sapwood concentration (ug/g)
RBCØNH	root heartwood concentration (ug/g)
TLPØØL	amount of chemical in leaf, stem and fruit litter (ug/m^2)
TPCØNC	chemical concentration in TLPØØL (ug/g)
RCØNC	root litter chemical concentration (ug/g)
TMINL	total litter mineralization rate (ug/m^2/month)
TØTAL	total plant mortality rate (ug/m^2/month)

4) Monthly CERES output for biomass dynamics of vegetation and litter.

Current biomass status of sugar, storage, heartwood (WØØD), and litter (CARB) compartments and monthly rates of respiration (RESP), mortality (MORT), new growth (FIXD) and decomposition (DECØMP) for the stem root, leaf and fruit components are listed. Totals for compartments also given (TOTALS). Values of leaf area index, monthly net photosynthesis (PHOTGAR, g biomass/m^2land/month), standing dead (g/m^2) and monthly wind fallen material (FALLEN, g/m^2/month), vegetation and litter carbon mass balance errors follow.

5) Monthly water budget

Data from the Terrestrial Ecosystem Hydrology Model (see Huff et al., 1976).

****THE FOLLOWING DATA IS IN CENTIMETERS****

SNOWPACK BALANCE	SNOWFALL IN	INTERCEPTED IN	RAIN ON PACK	MELT RELEASED	SUBLIMATION	STORAGE CHANGE
0.0	0.0	0.0	0.0	0.0	0.0	0.0

INTERCEPTION BALANCE	INTERCEPTION INPUT	CANOPY EVAPORATION	PRIOR STORAGE	CURRENT STORAGE	LOSS TO PACK
0.121116591E-05	1.17455769	1.17455673	0.0	0.0	0.0

LOWER ZONE BALANCE	INFILTRATION	DRAINAGE OUT	TRANSPIRATION	SOIL EVAPORATION	PRIOR STORAGE	CURRENT STORAGE
0.65887440E-03	7.38522	0.439979	7.966962	0.1829832	67.721359	66.515976

SOURCE AREA BALANCE	DRAINAGE IN	DRAINAGE OUT	PRIOR STORAGE	CURRENT STORAGE
0.0	7.38522434	0.0		

DEEP SOIL BALANCE	DRAINAGE IN	DRAINAGE GWS	DRAINAGE CHANL
-.402712758E-04	0.439978719	2.3558846	0.12556202E-10

PRIOR STOR1	PRIOR STOR2	CURRENT STOR1	CURRENT STOR2
97.645966	0.0	95.730118	

GROUNDWATER BALANCE	GW DRAINAGE IN	BASE STREAMFLOW	TRANSPIRATION	PRIOR STORAGE	CURRENT STORAGE
0.225101670E-03	2.3464613	2.4990435	0.0	0.4229807	0.27017367

	DEEP LOSSES
	0.0

INTERFLOW CHECK	LAND T-INTF	SOURCE A - INTF	DEEP SOIL INTF	BALANCE-INTF
	0.00000000	0.0	0.000000000	-.14247098E-14

PA=0.996 RES= 0.0 RES1= 0.0 MONTHLY WATER BALANCE=-0.94756950E-03

BALANCE= -0.947569E-03

**** RUNOFF COMPONENT SUMMARY ****

	IMPERVIOUS	SURFACE	SOURCE AREA 1	SOURCE AREA 2	BASE	TOTAL
CENTIMETERS	0.02954075	0.0	0.0	0.00000000	2.49904346	2.52858353
FRACTION	0.01168272	0.0	0.0	0.00000000	0.98831743	1.00000000

SIMULATION OF JUL. 1972 BEGINS FOR SEGMENT NO. 1. PRECIP FILE KEY = 3331 874
NXTF= 366 TEMPS= 89.0 70.0 MONTH= 7 DAY= 1 RAD= 516.0

DAY	INFILT (CM)	RUNOFF	DRAINAGE	ET	FLLAT	FLNET	SURF.CON (CM/SEC)	SURF.POT (BAR)	THETA1	THETA2	THETAN
			(CM PER DAY)						-(CM PER CM)-		
RAD,SOLAR,SOLNET,AMHR,PMHR			516.00000		516.00000		382.82129		7.1715031		7.1715031
SUNHR											
	0.0		0.0	0.0		0.0		0.0		5.0905323	
	14.744070		22.839874	29.378784		34.360825		37.785965		39.654236	
	39.934448		38.720108	35.917709		31.558426		25.642258		18.169205	
	9.1392765		0.76050532	0.0		0.0		0.0		0.0	
183	0.88D 00	0.0	0.1879D-01	0.1066D 00	0.0	-.3222D-01	0.3576D-01	-.1881D 02	0.1556D	000.1802D	000.3180D 00
184	0.78D 00	0.0	0.1837D-01	0.2674D 00	0.0	-.3040D-01	0.1570D 00	-.1558D 02	0.1791D	000.1799D	000.3179D 00
185	0.94D 00	0.0	0.1796D-01	0.4069D 00	0.0	-.2641D-01	0.3706D 00	-.1328D 02	0.1944D	000.1812D	000.3177D 00
186	0.82D-01	0.0	0.1756D-01	0.3147D 00	0.0	-.1929D-01	0.3398D 00	-.1354D 02	0.2104D	000.1858D	C00.3176D 00
187	0.0	0.0	0.1719D-01	0.3814D 00	0.0	-.1624D-01	0.4687D 00	-.1247D 02	0.1939D	000.1872D	000.3175D 00
188	0.0	0.0	0.1682D-01	0.3823D 00	0.0	-.1570D-01	0.2597D 00	-.1431D 02	0.1813D	000.1870D	000.3173D 00
189	0.0	0.0	0.1647D-01	0.2955D 00	0.0	-.1616D-01	0.1673D 00	-.1543D 02	0.1725D	000.1859D	000.3172D 00
190	0.0	0.0	0.1614D-01	0.2381D 00	0.0	-.1710D-01	0.1220D 00	-.1616D 02	0.1671D	000.1843D	000.3171D 00
191	0.0	0.0	0.1581D-01	0.1751D 00	0.0	-.1792D-01	0.1310D 00	-.1600D 02	0.1639D	000.1830D	000.3170D 00
192	0.0	0.0	0.1550D-01	0.1686D 00	0.0	-.1866D-01	0.6984D-01	-.1739D 02	0.1612D	000.1816D	000.3168D 00
193	0.0	0.0	0.1520D-01	0.1897D 00	0.0	-.1963D-01	0.3063D-01	-.1913D 02	0.1587D	000.1801D	000.3167D 00
194	0.0	0.0	0.1491D-01	0.1309D 00	0.0	-.2034D-01	0.3963D-01	-.1859D 02	0.1568D	000.1788D	000.3166D 00
195	0.0	0.0	0.1463D-01	0.1180D 00	0.0	-.2066D-01	0.3555D-01	-.1882D 02	0.1553D	000.1778D	000.3165D 00
196	0.0	0.0	0.1436D-01	0.1011D 00	0.0	-.2075D-01	0.4131D-01	-.1851D 02	0.1541D	000.1770D	000.3164D 00
197	0.17D 00	0.0	0.1410D-01	0.8150D-01	0.0	-.2075D-01	0.2921D-01	-.1922D 02	0.1529D	000.1762D	000.3163D 00
198	0.45D 01	0.0	0.1385D-01	0.4489D 00	0.0	-.3742D-02	0.2937D 00	-.1397D 02	0.2247D	000.2162D	000.3162D 00
199	0.0	0.0	0.1360D-01	0.5502D 00	0.0	-.1370D-02	0.3230D 00	-.1370D 02	0.2053D	000.2164D	000.3160D 00
200	0.0	0.0	0.1337D-01	0.6032D 00	0.0	-.1763D-02	0.2178D 00	-.1477D 02	0.1929D	000.2129D	000.3159D 00
201	0.0	0.0	0.1314D-01	0.5275D 00	0.0	-.2527D-02	0.2569D 00	-.1434D 02	0.1847D	000.2077D	000.3158D 00
202	0.0	0.0	0.1292D-01	0.4522D 00	0.0	-.3527D-02	0.2441D 00	-.1448D 02	0.1788D	000.2027D	000.3157D 00
203	0.0	0.0	0.1270D-01	0.4411D 00	0.0	-.4833D-02	0.1653D 00	-.1545D 02	0.1735D	000.1976D	000.3156D 00
204	0.0	0.0	0.1250D-01	0.3510D 00	0.0	-.6306D-02	0.1476D 00	-.1572D 02	0.1692D	000.1933D	000.3155D 00
205	0.0	0.0	0.1230D-01	0.2550D 00	0.0	-.7640D-02	0.1362D 00	-.1591D 02	0.1661D	000.1902D	000.3154D 00
206	0.0	0.0	0.1210D-01	0.2244D 00	0.0	-.8855D-02	0.9354D-01	-.1676D 02	0.1635D	000.1875D	000.3153D 00
207	0.0	0.0	0.1191D-01	0.1913D 00	0.0	-.9982D-02	0.8216D-01	-.1704D 02	0.1613D	000.1853D	000.3152D 00
208	0.0	0.0	0.1173D-01	0.1740D 00	0.0	-.1103D-01	0.5654D-01	-.1785D 02	0.1593D	000.1833D	000.3151D 00
209	0.0	0.0	0.1155D-01	0.1624D 00	0.0	-.1206D-01	0.3877D-01	-.1864D 02	0.1575D	000.1815D	000.3150D 00
210	0.0	0.0	0.1138D-01	0.1271D 00	0.0	-.1283D-01	0.4076D-01	-.1853D 02	0.1561D	000.1801D	000.3150D 00
211	0.0	0.0	0.1121D-01	0.1065D 00	0.0	-.1339D-01	0.5384D-01	-.1795D 02	0.1549D	000.1790D	000.3149D 00
212	0.0	0.0	0.1105D-01	0.8763D-01	0.0	-.1376D-01	0.6945D-01	-.1741D 02	0.1539D	000.1780D	000.3148D 00

CONCENTRATIONS

		LEAD EX	LEAD CON	CADMIUM EX	CADMIUM CON	ZINC EX	ZINC CON	COPPER EX	COPPER CON
UG/CM2	2	1.1822D 02	3.2794D-02	9.1056D-01	1.2630D-02	6.5150D 00	9.0366D-02	1.0302D 01	4.0827D-02
PPM	2	3.5823D 01	7.1646D-02	2.7593D-01	2.7593D-02	1.9742D 00	1.9742D-01	3.1219D 00	8.9197D-02
UG/CM2	3	3.7339D-01	7.9125D-05	3.9637D-01	8.3994D-03	4.7475D 00	6.0362D-02	9.8499D-01	4.6384D-04
PPM	3	2.5930D-02	4.3217D-05	2.7526D-02	4.5876D-03	3.2969D-01	3.2969D-02	6.8402D-02	2.5334D-04
UG/CM2	4	1.9931D-04	2.5341D-11	5.0391D-02	6.4070D-09	3.1719D-01	4.0329D-08	1.2213D-03	1.5528D-10
PPM	4	1.1073D-05	1.1073D-11	2.7995D-03	2.7995D-09	1.7622D-02	1.7622D-08	6.7850D-05	6.7850D-11
UG/CM2	5	1.4161D-10	1.9260D-17	1.1092D-08	1.5086D-15	6.8082D-08	9.2597D-15	3.4616D-10	4.7081D-17
PPM	5	1.8155D-12	1.8155D-18	1.4220D-10	1.4220D-16	8.7284D-10	8.7284D-16	4.4380D-12	4.4380D-18
					LEAD	CADMIUM	ZINC		COPPER

AMOUNT IN LITTER (UG/CM**2)	1.0504D 03	9.1173D-01	2.8038D 01	2.2451D 01
AMOUNT IN CANOPY(UG/CM**2)	8.6228D 01	5.4383D-01	7.0253D 00	3.1218D 00
MONTHLY ROOT UPTAKE(UG/CM2/MO))	2.3850D 00	1.9190D 00	2.1032D 01	5.7239D 00
ROOT UPTAKE - DAY FLOW(UG/CM2/MO)	2.2217D 00	1.8410D 00	2.0103D 01	5.4567D 00
ROOT UPTAKE - NIGHT FLOW(UG/CM2/MO)	1.6386D-01	7.8256D-02	9.3206D-01	2.6800D-01
MONTHLY LATERAL FLOW(UG/CM2)	0.0	0.0	0.0	0.0
MONTHLY SURFACE RUNOFF(UG/CM2)	0.0	0.0	0.0	0.0
LEACHED SINCE START OF RUN(UG/CM**2)	3.5174D-14	9.9045D-12	6.1037D-11	2.1694D-13
LEACHED THIS MONTH (UG/CM**2)	0.0	0.0	0.0	0.0
ERROR-SOIL MASS BALANCE(UG/CM**2)	-1.0529D-11	-1.5410D-13	-2.7818D-12	-1.2406D-12
ERROR-SURFACE MASS BALANCE(UG/CM**2)	4.2576D-11	6.7057D-14	2.7882D-12	2.1965D-12

DRYADS OUTPUT

VEGETATION LAYER 1 CONTAMINANTS	LEAD	CADMIUM	ZINC	COPPER	SO2
**FLUXES IN **					
DIFSOL (UG/M**2/MO)	0.181D 05	0.611D 03	0.767D 04	0.297D 04	
LEACH (UG/M**2/MO)	0.520D-03	0.149D-04	0.150D-04	0.275D-04	
GASFIX (UG/M**2/MO)					0.341D 06
FLUXES WITHIN					
LSSALT (UG/M**2/MO)	0.108D 03	-0.105D 03	-0.336D 02	-0.239D 02	0.187D 04
SFSALT (UG/M**2/MO)	0.787D 00	0.419D 02	0.136D 02	0.997D 01	0.373D 01
SBSALT (UG/M**2/MO)	-0.827D 01	-0.738D 03	-0.177D 03	-0.154D 03	0.601D 02
BSSOLU (UG/M**2/MO)	0.304D 03	0.170D 05	0.734D 04	0.532D 04	0.534D 01
SLSOLU (UG/M**2/MO)	0.168D 02	0.117D 04	0.441D 03	0.304D 03	0.287D 00
STANDING POOLS					
LINSOL (UG/M**2)	0.600D 05	0.379D 04	0.261D 05	0.102D 05	0.596D 06
LSOL-SAL (UG/M**2)	0.148D 02	0.416D 00	0.412D 00	0.797D 00	0.329D 02
FSALT (UG/M**2)	0.701D-06	0.659D-03	0.265D-06	0.310D-05	0.153D-06
FINSOL (UG/M**2)	0.326D 01	0.624D 02	0.223D 02	0.129D 02	0.530D 01
SINSOL (UG/M**2)	0.174D 04	0.261D 05	0.115D 05	0.662D 04	0.256D 04
SSOL-SAL (UG/M**2)	0.272D-01	0.248D 01	0.206D 00	0.352D 00	0.143D-02
SDORM (UG/M**2)	0.575D 02	0.272D 03	0.125D 03	0.574D 02	0.228D 02
RINSOL (UG/M**2)	0.482D 05	0.332D 05	0.667D 06	0.123D 06	0.767D 02
RSOL-SAL (UG/M**2)	0.156D 01	0.156D 03	0.134D 02	0.326D 02	0.540D-01
RDORM (UG/M**2)	0.146D 04	0.169D 04	0.261D 05	0.408D 04	0.157D 01
BIOMASS CONCENTRATION					
LBCON (UG/G)	0.139D 03	0.881D 01	0.607D 02	0.237D 02	0.138D 04
FBCON (UG/G)	0.850D 00	0.163D 02	0.583D 01	0.337D 01	0.138D 01
SBCONS (UG/G)	0.199D 01	0.299D 02	0.131D 02	0.757D 01	0.292D 01
SBCONH (UG/G)	0.655D-02	0.310D-01	0.143D-01	0.655D-02	0.260D-02
RBCONS (UG/G)	0.140D 03	0.967D 02	0.193D 04	0.355D 03	0.222D 00
RBCONH (UG/G)	0.358D 00	0.415D 00	0.638D 01	0.999D 00	0.383D-03
LITTER POOLS					
LPOOL (UG/M**2)	0.428D 07	0.526D 00	0.114D 06	0.914D 05	0.324D 00
SPOOL (UG/M**2)	0.250D 07	0.203D 00	0.664D 05	0.534D 05	0.136D-05
FPOOL (UG/M**2)	0.116D 05	0.750D-01	0.307D 03	0.247D 03	0.288D-04
RPOOL (UG/M**2)	0.371D 07	0.912D 04	0.100D 06	0.795D 05	0.129D-03
TLPOOL (UG/M**2)	0.679D 07	0.804D 00	0.180D 06	0.145D 06	0.324D 00
TPCONC (UG/G)	0.528D 04	0.625D-03	0.140D 03	0.113D 03	0.252D-03
RCONC (UG/G)	0.606D 04	0.149D 02	0.163D 03	0.130D 03	0.211D-06
MINERALIZATION					
LMINL (UG/M**2/MO)	0.546D 06	0.271D-01	0.155D 05	0.119D 05	0.109D-01
SMINL (UG/M**2/MO)	0.556D 05	0.537D-02	0.157D 04	0.122D 04	0.388D-07
FMINL (UG/M**2/MO)	0.529D 03	0.841D-03	0.149D 02	0.116D 02	0.331D-06
RMINL (UG/M**2/MO)	0.664D 05	0.202D 03	0.190D 04	0.145D 04	0.144D-05
TMINL (UG/M**2/MO)	0.669D 06	0.202D 03	0.190D 05	0.146D 05	0.109D-01
PLANT POOL ERROR					
(UG/M**2/MO)					
PLANT 1	0.131D-08	0.178D-08	0.137D-07	0.173D-07	0.648D-08

```
**LITTER POOL ERROR**
(UG/M**2/MO)
 LITTER 1              0.633D-06  0.334D-09  0.384D-07  0.293D-07  0.522D-12

**PLANT DEMAND**
LWANT                 0.861D 00  0.912D 00  0.992D 00  0.961D 00  0.862D 00
SWANT                 0.998D 00  0.701D 00  0.998D 00  0.987D 00  0.100D 01
FWANT                 0.999D 00  0.837D 00  0.999D 00  0.994D 00  0.100D 01
RWANT                 0.860D 00  0.331D-01  0.742D 00  0.408D 00  0.100D 01
TWANT                 0.934D 00  0.617D 00  0.943D 00  0.859D 00  0.964D 00
ABSPOW                0.934D-08  0.617D-08  0.943D-08  0.859D-08  0.964D-08

**MORTALITY (UG/M**2/MO)**
L(LIT-HUM)            0.720D 01  0.460D 00  0.314D 01  0.121D 01  0.697D 02
S(LIT-HUM-FALL)       0.148D 00  0.155D 01  0.677D 00  0.332D 00  0.121D 00
F(LIT-HUM)            0.418D-02  0.761D-01  0.275D-01  0.150D-01  0.562D-02
R(LIT-HUM-FALL)       0.528D 02  0.470D 02  0.837D 03  0.144D 03  0.631D-01
TOTAL(UG/M**2/MO)     0.602D 02  0.491D 02  0.841D 03  0.145D 03  0.699D 02

VEGETATION LAYER      1
```

	SUGAR	RESP	STORAGE	WOOD	MORT	FIXD	CARB	DECOMP
	G/M**2	G/M**2/M	G/M**2	G/M**2	G/M**2/M	G/M**2/M	G/M**2	G/M**2/M
STEM	2.34	110.68	872.01	8764.97	5.65	243.98	703.61	14.74
ROOT	0.27	11.76	345.01	4088.14	8.31	30.91	612.08	10.26
LEAF	10.04	23.83	419.97		0.06	81.88	537.98	64.55
FRUIT	0.00	0.28	3.83		0.00	1.92	43.72	1.88
TOTALS	12.65	146.54	1640.82	12853.11	14.02	358.68	1897.38	91.44

```
          LEAF AREA INDEX        4.30    PHOTGAR          498.01

          STANDING DEAD     4.4658D 02   FALLEN        6.2653D 00  VEG ERROR      8.1218D-10  LIT ERROR      2.4855D-10

 213  0.0       0.0       0.1089D-01 0.9019D-01 0.0       -.1399D-01   0.4031D-01 -.1856D 02   0.1530D 000.1773D 000.3147D 00

MONTHLY WATER BUDGET (CM)

TOTAL INFILTRATION, EVAPOTRANSPIRATION, RUNOFF, DRAINAGE, LATERAL FLOW, SOIL WATER CHANGE AND BALANCE (CM)
       7.385265      8.150624      0.0           0.4400203     0.0           -1.205379     0.9834134D-11
ROOT WATER UPTAKE (CM)  LAYER 1    4.400822     LAYER 2    3.566794
FILE KEY =      874
```

APPENDIX D

Updates to the Soil Chemistry Model SCEHM

In coupling the DRYADS and DIFMAS models to the soil chemistry model, a few minor modifications were incorporated into the documented version of SCEHM (Begovich and Jackson, 1975). These additions were necessary in order to account for canopy solute interception and wash off, to introduce the call to DIFMAS, and to add mass balance error calculations. This new version of the SCEHM model can also be used without DIFMAS and DRYADS, in which case the new coding, described below, is bypassed.

During the periods that foliage is present, a fraction of the atmospheric deposition is retained in the canopy. Thus, the following statements were added to SCEHM:

```
STRC = STRCPR
IF (JDATE.LT.T1 .OR. JDATE.GT.T4) STRC=0.0D0
CANAMT(K)=CANAMT(K)+DEPOS*STRC
AMT(K)=AMT(K)+DEPOS*(1-STRC)
```

where

STRC	fraction of deposition which falls on the canopy for this date,
IF( )	a test to set STRC=0 if no foliage is present,
STRCPR	fraction of the deposition that the foliage retains when it is present,
CANAMT(K)	the amount of cantaminant, K, in the canopy layer (ug/cm^2),
DEPOS	amount of deposition for this time period (ug/cm^2).
AMT(K)	amount of contaminant, K, in the litter layer (ug/cm^2).

To allow for wash off for the canopy, further coding was required:

```
WASH=MOISIN(1)/EPXM
FRAC=1.-1./WASH
WASHOF=FRAC*CANAMT(K)
CANAMT(K)=CANAMT(K)-WASHOF
AMT(K)=AMT(K)+WASHOF
```

where

EPXM	Maximum water interception storage (cm^3/cm^2)
MOISIN(1)	amount of rainfall (cm)
FRAC	fraction of contaminant which is washed off from the canopy layer
WASHOF	amount of contaminant washed off the canopy layer (ug/cm^2)

DIFMAS is called from subroutine FLO of the SCEHM model. The only additional input required is the diffusion coefficient (cm^2/sec) of each solute in free solution (DL). Therefore, subroutine RDCHM now requires, as its last set of input cards, the diffusion coefficients in a 8F10.0 format. Furthermore, since DIFMAS separately sums day and night values of root uptake, these values were added to the quantities output in the monthly summary.

Mass balance error equations were inserted in SCEHM also. Solute mass balances for the litter layer and soil are calculated and printed out in the monthly summary.

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