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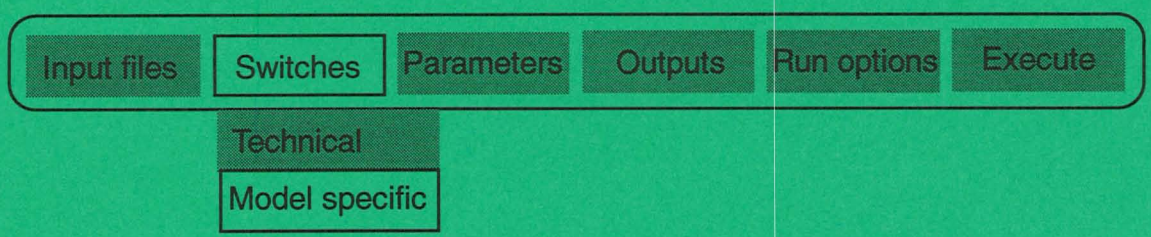
SOILN model

(ver 8.0)

User's manual
2nd edition



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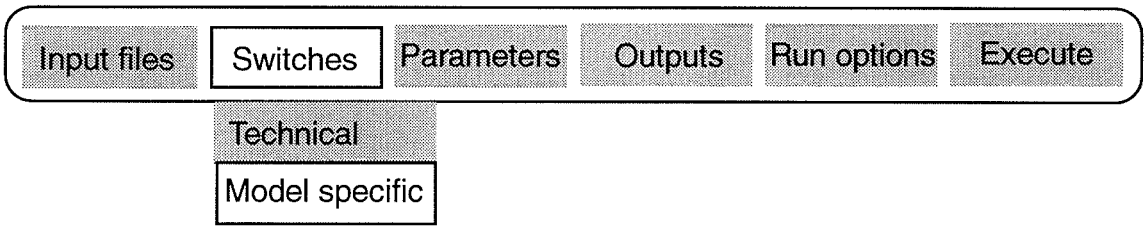

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Table of Contents

1 Background

This manual is applicable to version 8.0 of SOILN and replaces the previous manual for version 6.0 of SOILN (Jansson et al, 1991).

The SOILN model is a model which considers all major N-flows in most agricultural and some forest soils. The model can conceptually be divided into three submodels: the soil submodel, the crop submodel and the forest submodel. The soil submodel (which actually is the core of the model) is described in detail by Johnsson et al. (1987) (Figs. 1a and b). Other papers dealing with applications to different fields are found in the reference list.

The crop growth submodel (named CROP; Eckersten & Jansson, 1991), describes plant growth and nitrogen uptake demand as a function of meteorological variables (Figs. 2a and b).

Furthermore, a growth submodel for short-rotation forests (named FOREST) is available in the same manner as is the crop growth submodel. The submodel originates from another model for willow growth named WIGO which is described by Eckersten (1991a) and Eckersten & Slapokas (1990). The formulas related to the plant in those descriptions are valid also for the FOREST submodel (Figs. 3a and b).

The SOILN model requires driving variables on soil heat and water conditions. These variables are simulated by the associated model named SOIL (Jansson & Halldin, 1979).

This manual is linked with the theoretical descriptions through the symbol given directly after the parameter or variable name or the equation numbers given.

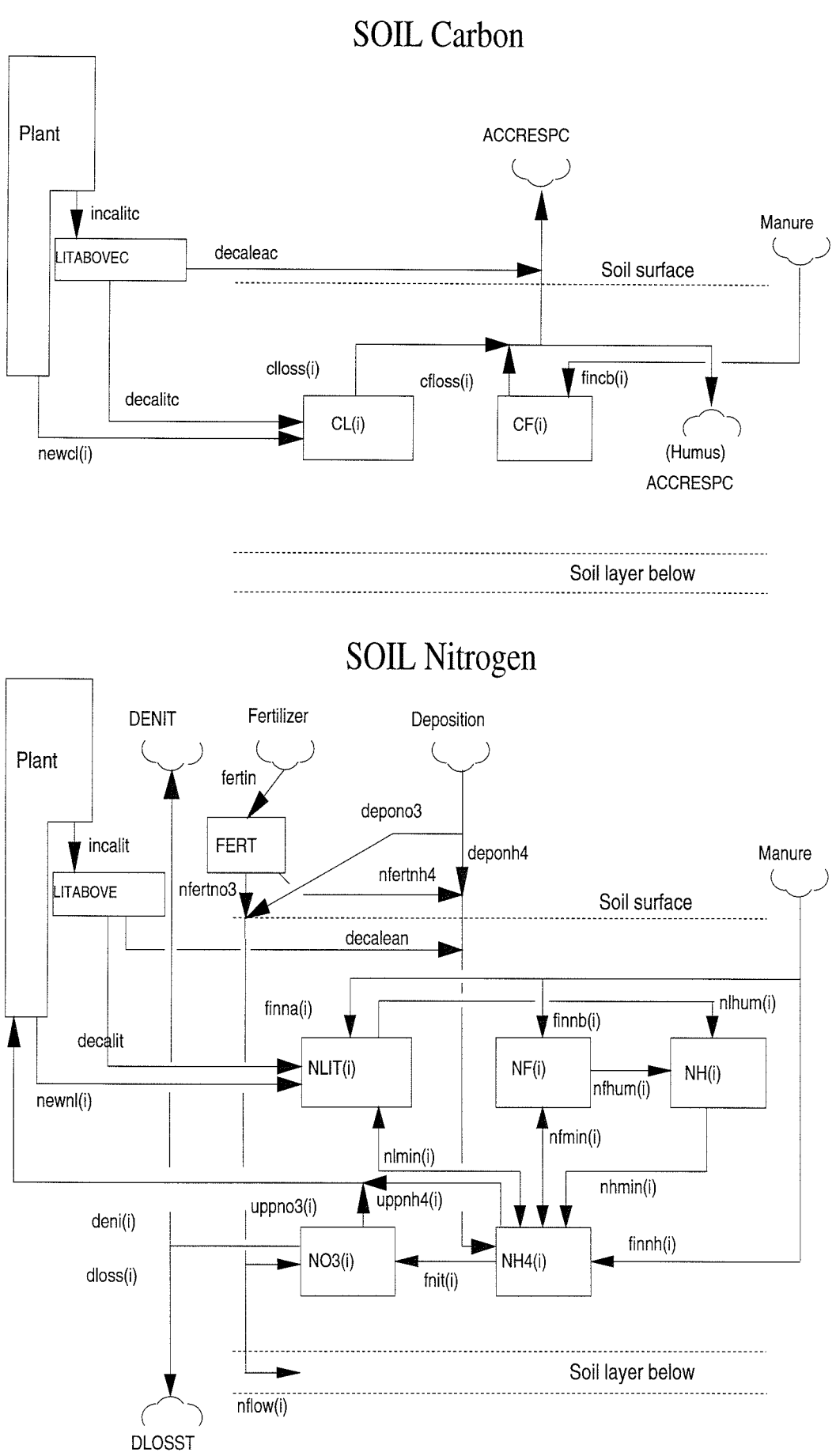
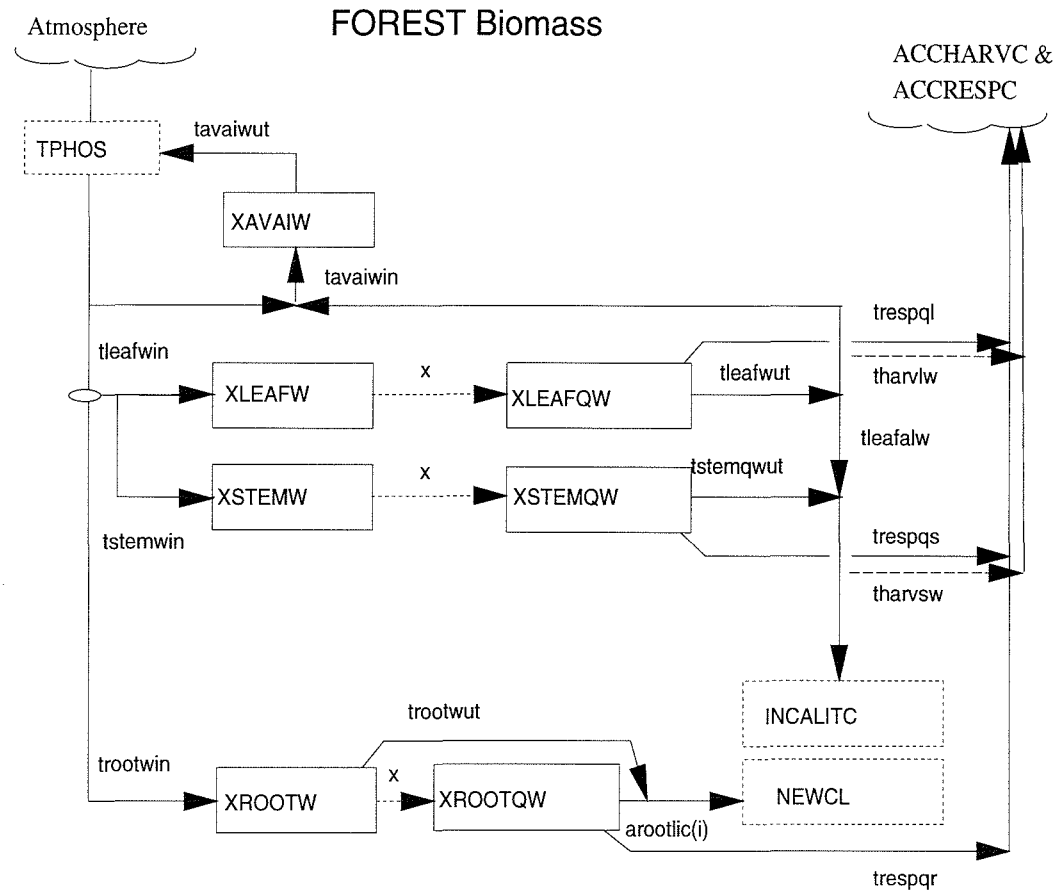
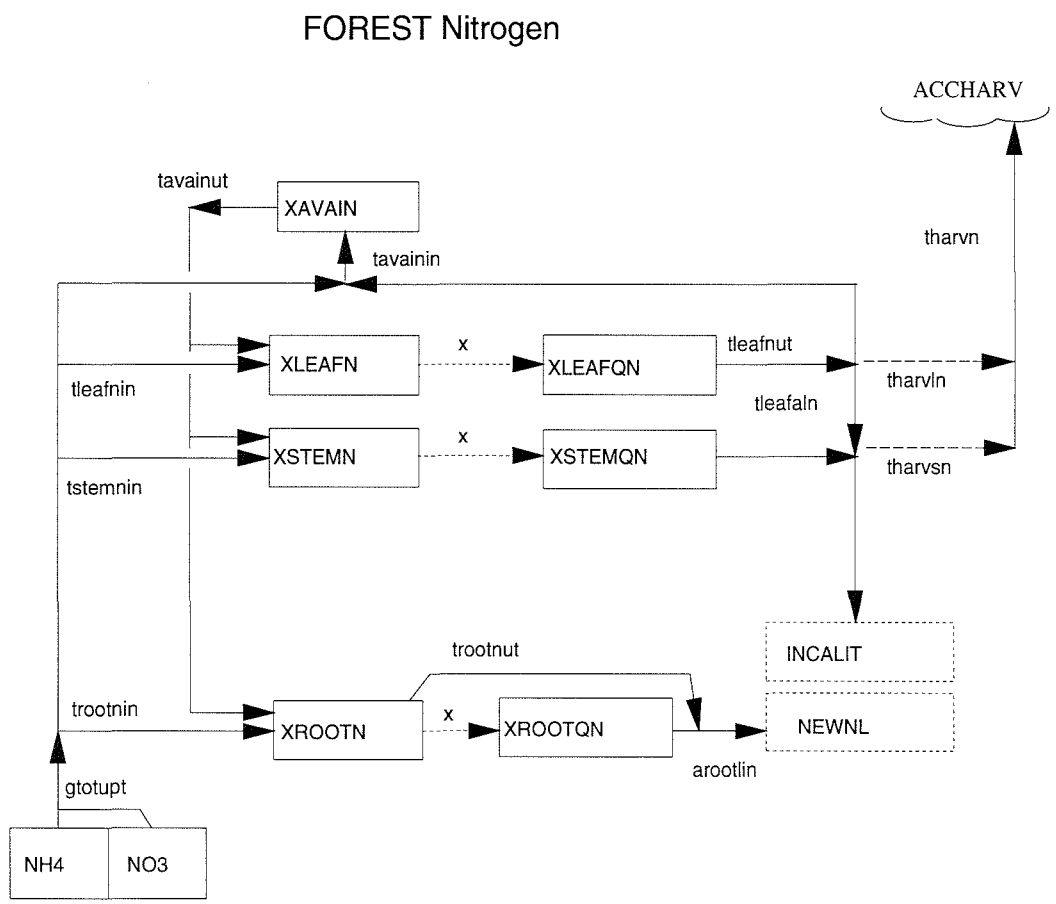
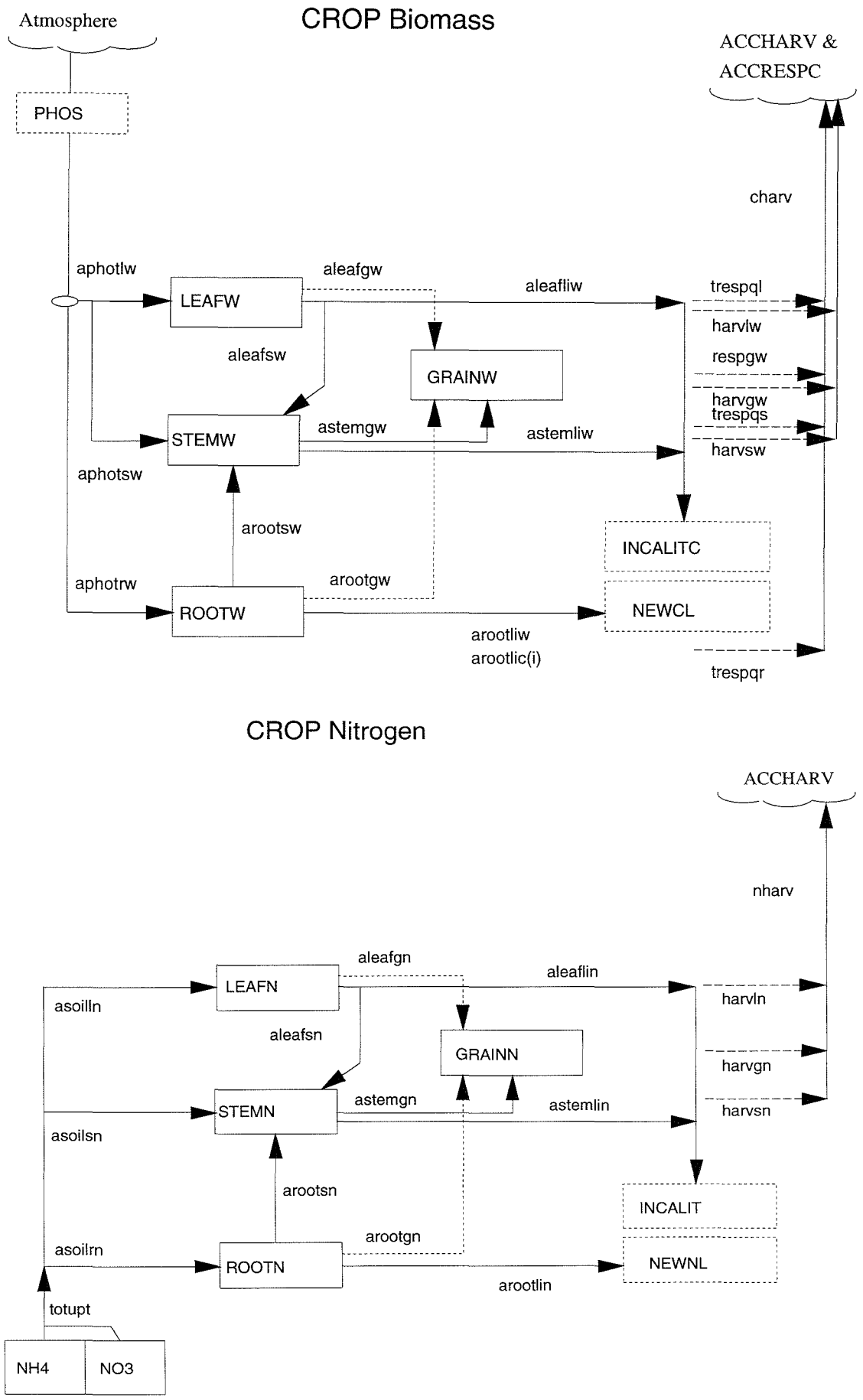


Figure 1a and b. A schematic description of carbon and nitrogen flows and states of the soil part of the SOILN model. Symbols are explained in the section of Output variables.





Figures 3a and b. A schematic description of the biomass and nitrogen flows and states of the FOREST-submodel of SOILN model. x = flow once a year (December 31; the flow is equal to the size of state variable). Symbols are explained in the section of Output variables.



Figures 2a and b. A schematic description of the biomass and nitrogen flows and states of the CROP-submodel of SOILN model. Symbols are explained in the section of Output variables.

2 Getting started

2.1 Installation

The model is normally distributed together with the SOIL model on a special floppy diskette for IBM/PC. Two different installation diskettes can be used depending on whether you are a previous user of the PGraph program or not.

SOIL requires that the PGraph program is installed on your computer.

SOILDEMO contains a demo version of PGraph called PGDEMO that can be used for testing and using the SOIL model with the supplied data files.

Independent of which diskette you have got you will use the same command for installation which is found on the diskette:

Type the command:

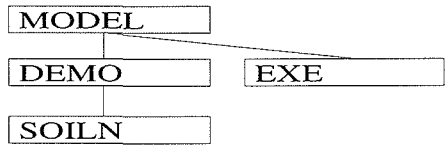
```
A:INSTALL  A:  C:  MODEL
```

This means that you have inserted the diskette into a floppy disk drive named A: and you want to install the model on your hard disk C: in the directory named MODEL. If you already have a directory with that name you should choose another name at the installation.

In addition to the SOILN model also files for running the SOIL model are included on the distribution diskette.

2.2 Files

The installation procedure will create one main directory below which the program files are stored in different subdirectories. The executable files are placed in the subdirectory named EXE and sample files in subdirectory DEMO.



Directory	Files	Description
MODEL\EXE		
	SOILN.EXE	Executable file, SOILN model
	SOILN.DEF	Definition file, SOILN model
	SOILN.HLP	Help file, SOILN model
	SOILN.TRA	Variable name translation file, SOILN
	PREP.EXE	Executable file, PREP program
	PGDEMO.EXE	Executable file, Pgraph program (only if the SOILDEMO diskette is used)
	PG.HLP	Help file, Pgraph program (only if the SOILDEMO diskette is used)
	PLOTPF.EXE	Executable file, PLOTPF program
	PLOTPF.HLP	Help file, PLOTPF program
MODEL\DEMO\SOILN		
	DEMO.BAT	Demo file for running the SOILN model and using the PG program for visualizing some results on the screen.
	AIN_INI.INI	Initial conditions for running the SOILN model

AIN_ORIG.PAR	Parameter file for simulating nitrogen dynamics of and agricultural crop during a growing season.
AIN_CHAN.PAR	An extra parameter file including changes of the original parameter files.
AIN_CLIM.BIN	PG-file with climatic driving variables for running the SOILN model.
AIN_SOIP.DAT	File with soil hydraulic properties.
SOILN.TRA	Variable name translation file, SOILN.
DEMOXXXX.PG	Input files for the PG program used in the DEMO.BAT file for showing results from the simulation.
DEMOZXXX.BIN	Files with modified output variables from the simulation examples aimed to be plotted on screen.
SOILNXXX.BIN SOILNXXX.SUM	Files with output variables from the simulation examples.

2.3 Running the model

Before running the model you must make sure that the model and utility programs are correctly installed on your computer. The subdirectory called EXE created by the installation procedure may be renamed or the file may be moved to another directory but it is important that PATH is set to the directory where all the files of the EXE directory is stored. After setting this PATH (most conveniently in the AUTOEXEC.BAT file.

The DEMO.BAT file will be a good test of the installation and it will also show a number of results without any other efforts than running the DEMO.BAT file.

For running the program interactively use commands as specified in the section on Commands.

```
PREP SOILN AIN_ORIG
```

Is an example of how you can make your own simulation based on information in the AIN_ORIG.PAR file.

2.4 Evaluating your simulation

A successful simulation will result in two different output files numbered as nnn :

SOILNnnn.SUM — Contains a summary of simulation results.

SOILNnnn.BIN — A binary file comprising output variables from the simulation. You start the Pgraph program by typing:

```
PG SOILNnnn   or   PGDEMO SOILNnnn
```

For details on how to use Pgraph see the Pgraph manual or use the help utility in the program (F1 key).

Another file created by the PREP program the first time you run the model in a certain directory is:

SOILN.STA — which includes information about your run number. This file could not be listed but the numbering of a run can be modified by the PREP program (see section 8 Run options)

3 Program structure

The preparation of the model prior to a run follows an interactive dialogue where the user has the possibility to design the run according to the present purpose.

The different menus can be reached in any order after moving the cursor to the subject using arrow keys and pressing "return" at the chosen subject. "Return" takes the cursor down in the menus and "Esc" moves the cursor up one level. Normally a user will start with the subjects to

the left in the main menu and move to the right. It is a good rule to modify the settings of switches and input files before moving to the other menus since the content of the other menus are influenced by the setting of the two first sub menus.

4 Files

When running the model two output files are always created:

SOILNnnn.SUM: Contains a summary of all instructions used for the simulation and a summary of simulated results. The first part of this file corresponds with a parameter file. This means that you can always rename or copy this file to a file named, for example, MYRUN.PAR which could be used as parameter file for future simulations. If you do not modify the instruction by editing this file or modifying anything by using the PREP program you will reproduce your old run.

SOILNnnn.BIN: A binary file to be used by the Pgraph program for plotting results from the simulation. The file contains all the outputs that where selected in the PREP program.

Input files and output files depending on the use of the model are given below:

4.1 Driving variable file

FILE(1) XXXXXX.BIN: A driving variable file is always a PG-file. The variables in the PG-file can be organized in different ways depending on how different parameters are specified. The driving variables for the SOILN model is generated by the SOIL model using the default SOIL.TRA-file. The variables are identified by SOILN according to the names given below (see Driving variables to get the description). They can also be identified with the model description given by the SOIL model. Layers must be given in order, from the top to the bottom. In the output file SOILNxxx.SUM you can check that your driving variables have been correctly identified.

Name in the SOIL model	Number of variables	Optional	Unit
WFLOW	[N-1]	No	(mm/day)
INFIL	[1]	No	(mm/day)
INFBYPASS	[1]	Yes	(mm/day)
DFLOW	[N]	Yes	(mm/day)
SURR	[1]	No	(mm/day)
TEMP	[N]	No	(°C)
THETA	[N]	No	(vol %)
ETR	[1]	No	(-)
PERC	[1]	Yes	(mm/day)
TA	[1]	No	(°C)
RIS	[1]	No	(Jm2/day)
MEACONC	[1]	Yes	(mg/l)

N is the number of layers in your simulation and this number must correspond to the value of the NUMLAY paramater (See soil profile).

4.2 Parameter file

FILE(2) XXXXXX.PAR: The parameter file is an ordinary DOS-file with ASCII- characters. All parameters with actual numerical values should be included in the file. If any parameter is missing in the file an message is displayed on the screen and a default value of zero is selected. New parameter files may be created prior the execution of the model using the WRITE command (see EXECUTION WRITE).

4.3 Translation file

FILE(3) SOILN.TRA: A translation file have to exist if the variables in the output PG-file should get their correct identifications. Only when the OUTFORN switch is ON this file is not necessary.

4.4 Initial states file

FILE(4) XXXXXX.INI: The file contains the initial values of all state variables. If INISTATE-switch = 0: Not used.

4.5 Final states file

FILE(5) XXXXXX.FIN: This file contains the final values of all state variables (ASCCI). If OUTSTATE = 0: Not used.

4.6 Output file

FILE(6) SOILNnnn.BIN: If the ADDSIM-switch = 1 then the results of the simulation are added to results of this file.

4.7 Validation file

FILE(7) XXXXXX.BIN: A validation file is a file with variables that should be compared with simulated variables. The result of the comparison will be found in the SOILNnnn.SUM file. The first variable in the validation file will be compared with the first variable in the output PG-file, the second with the second and so on. If VALIDPG-switch = 0: Not used.

4.8 Soil physical properties

FILE(8) XXXXXX.DAT: A file containing soil physical properties of the soil profile which are used for the soil water and heat simulation with the SOIL model (ASCCI). The file is created by the PLOTPF program and must exist on the directory where the simulation will be done. The table below include all the parameters in the file. Only the porosity (PORO) and the water content at wilting point (WILT) are used in the nitrogen simulation. A complete description of the file is found in the SOIL manual (Jansson, 1991b).

In the SOIL model, the thickness given for each layer in the SOILP.DAT file can be adjusted in the simulation (Parameters in the SOIL model: UDEP and LDEP, in case UTHICK = 0, otherwise see UTHICK). Check your actual layer thickness used in the sum file of your SOIL simulation. If necessary adjust the layer thickness in the SOILP.DAT file used for the SOILN simulation. The result of these adjustments can be seen in the SOILNnnn.SUM file.

4.9 External inputs - driving variable file

FILE(9) XXXXXX.BIN: Depending on the value of the switch DRIVEXT different parameters concerning fertiliser application are expected to be find in this file (at time 12:00).

Value on DRIVEXT	Variable (#)	Parameter name in model	Unit
1	1	FERN	gN m^{-2}
2	2	MANNH	gN m^{-2}
2	3	MANLN	gN m^{-2}
2	4	CNBED	(-)
2	5	MANFN	gN m^{-2}
2	6	CNFEC	(-)
2	7	MANDEPTH	(m)
3	8	DEPWC	(mgN l^{-1})
3	9	DEPDRY	(gN $m^{-2}day^{-1}$)

4.10 Crop - driving variable file

FILE(10) XXXXXX.BIN: Parameters related plant N uptake. Only used if the GROWTH-switch = 0.

Value on DRIVCROP	Variable (#)	Parameter name in model	Unit
1	1	ROOTDEP	(m)
2	2	UPA,UPB...	(gN $m^{-2}day^{-1}$)

4.11 Management - driving variable file

FILE(11) XXXXXX.BIN: Depending on the value of the switch DRIVMANA parameters related to harvest and ploughing can be given in this file.

Value on DRIVMANA	Variable (#)	Parameter name in model	Unit
1	1	PLOUGHDEP	(m)
2	2	HARP	(-)
2	3	HARAR	(-)
2	4	HARLR	(-)
2	5	CNARES	(-)
2	6	CNROOT	(-)

5 SWITCHES

The purpose of switches is to choose the simulation mode. Switches can be OFF or ON or have a numerical value. To toggle the status of a switch put the cursor at the switch an press the return key. The switch will then change its value. Switches may be hidden if some other switches make them irrelevant. After you have modified a switch the modification is activated by escaping [ESC] the menu. By entering the menu again, immediately after the escape, you see whether some more switches have become visible because of the previous change.

5.1 Technical

ADDSIM

OFF *Default*	The simulation results will be stored in a separate result file with a name according to the run number.
ON	The simulation results are automatically added to the result file of a previous simulation, run for an earlier time period. Note that the selected output variables must be exactly the same for the present and the previous simulation. The name of the former result file is given by the user as the "output file" name. By default the start date of the present simulation is put identical to the terminate date of the previous simulation. The final values of state variables from the previous simulation must be selected as the initial values of state variables for the present run (see INSTATE and OUTSTATE switches). Note that the OUTSTATE switch must be ON for any simulation to which results of a later simulation will be added. No new result file ".BIN" will be created but a separate summary file ".SUM" will be created just like for an ordinary simulation.

AVERAGED

OFF	All requested driving (=D) variables will be the current simulated values at the end of each output interval. If all switches AVERAGE_ are OFF the date given in the PG-file is also at the end of the interval. Otherwise the date is the middle of each output intervals.
ON *Default*	All requested driving (=D) variables will be mean values representing the whole output interval (see section on Output interval). The output interval is represented with the date in the middle of each period.

AVERAGEG

OFF	All requested auxiliary (=G) variables will be the current simulated values at the end of each output interval. If all switches AVERAGE_ are OFF the date given in the PG-file is also at the end of the interval. Otherwise the date is the middle of each output intervals.
ON *Default*	All requested auxiliary (=G) variables will be mean values representing the whole output interval (see section on Output interval). The output interval is represented with the date in the middle of each period.

AVERAGET

OFF	All requested flow (=T) variables will be the current simulated values at the end of each output interval. If all switches AVERAGE_ are OFF the date given in the PG-file is also at the end of the interval. Otherwise the date is the middle of each output intervals.
ON *Default*	All requested flow (=T) variables will be mean values representing the whole output interval (see section on Output interval). The output interval is represented with the date in the middle of each period.

AVERAGEX

OFF	All requested state (=X) variables will be the current simulated values at the end of each output interval. If all switches AVERAGE_ are OFF the date given in the PG-file is also at the end of the interval. Otherwise the date is the middle of each output intervals.
ON *Default*	All requested state (=X) variables will be mean values representing the whole output interval (see section on Output interval). The output interval is represented with the date in the middle of each period.

CHAPAR

OFF *Default*	Parameter values are constants for the whole simulation period.
ON	Parameter values may be changed at different dates during the simulation period. The new parameter values and the dates from which they should be valid are specified after the other parameter values (which are valid from the start of the simulation). A maximum of 20 dates can be specified.

DRIVPG

0	No function
1 *Default*	Driving variables will be read from a Pgraph file. The name of the file is specified by the user. See Driving Variable File for details.

INSTATE

OFF	No function.
ON *Default*	initial values of state variables will be read from a file. The name of the file is specified by the user, the format should be exactly the same as in the file for final values of state variables, created by the model when the OUTSTATE switch is ON.

LISALLV

OFF	only the subset of output variables selected by the user will be found in the summary file.
ON *Default*	all output variables will be found in the summary file after the simulation.

OUTFORN

OFF *Default*	the variables will be named according to the information stored in the file SOILN.TRA.
ON	all variables in the output Pgraph-file will be named according to their FORTRAN names.

OUTSTATE

OFF *Default*	no action.
ON	final values of state variables will be written on a file at the end of a simulation. The name of the file is specified by the user and the format is the same as used in the file for initial state variables (see the INSTATE switch).

VALIDPG

OFF *Default*	No validation.
ON	Validation variables will be read from a Pgraph file. The name of the file is specified by the user. The values in the validation file will be compared with variables from the output file.

5.2 Model Specific

CROPALLO

OFF *Default*	During grain development reallocation of assimilates occur from leaf to grain, root to grain and stem to grain (see parameters AGRAIN and AGRAINN).
ON	During grain development reallocation of assimilates occur from leaf to stem, root to stem and stem to grain (see parameters AGRAIN and AGRAINN).

CROPEQU

325 *Default*	A combined switch selecting which type of allocation equations that will be used. The first figure is leaf-stem allocation (b_i; parameter ALEAF), the second is the root allocation as function of total plant biomass (b_{rw}; parameter AROOTW) and the third is root allocation as function of leaf nitrogen (b_{rn}; parameter AROOTNI). The figures can range from 0 to 5 and means that different equations are used to estimate the function. 0: function is not active (not allowed for b_i), 1: y=a, 2: y=a+b*x, 3: y=a+b*ln(c*x), 4: y=a+b*exp(c*x), 5 y=other equation. Coefficients a, b and c are the indices 1, 2 and 3 of the parameter. Example: CROPEQU=325 means b_i=ALEAF(1)+ALEAF(2)*ln(ALEAF(3)*W_{ta}); b_{rw}=AROOTW(1)+AROOTW(2)*W_t; b_{rn}= special (see AROOTNI). As regards x and other equations (5), see the parameter name concerned. NOTE! That when changing CROPEQU then the meaning of the parameters change (ALEAF, AROOTW, AROOTNI).

DENDIST

0 *Default*	Denitrification rate distribution from parameter values, separate fractions are given for each soil layer (see DFRAC).
1	A linear decrease of denitrification rate from soil surface to the depth specified by the parameter DENDEPTH.
2	A constant denitrification rate from soil surface to the depth specified by the parameter DENDEPTH.
3	A exponential decrease of denitrification rate from soil surface to the depth specified by the parameter DENDEPTH. The deepest depth for denitrification is defined as the depth where a fraction given by the parameter DFRACLOW remains of the§ total denitrification capacity. The remaining fraction DFRACLOW is distributed at layers above the denitrification depth to make the total denitrification capacity to unity.

DRIVCROP

0 *Default*	Plant development is simulated (i.e. the GROWTH-switch > 0) or specified by parameter values.
1	The root depth is read from a driving variable file.
2	Also the potential N-uptake rate is read from the same file.

DRIVEXT

0 *Default*	External inputs of nitrogen to the model is specified by parameter values.
1	N fertilization rate is in a driving variable file.
2	Also the application of manure is specified in the driving variable file.
3	Also variables for wet and dry deposition are specified in the driving variable file.

DRIVMANA

0 *Default*	Management operations are specified by parameter values.
1	Ploughing depth is read from a driving variable file.
2	Also harvest and recirculation of crop residues are specified by variables in a driving variable file.

FERNCALC

0 *Default*	No action.
1	Fertilisation is calculated by the model as the difference between the potential uptake and the actual uptake of the previous day. To this amount could be added a fraction given by the parameter NAVAIL. The amount simulated is included in FERTIN.
2	Fertilisation is calculated by the model as the difference between the wanted soil N mineral amount (given by parameter NAVAIL) and the sum of the mineral pools, the deposition and fertilisation and a preliminary estimated mineralisation from organic matter. The amount simulated is included in FERTIN.

GROWTH

0	Potential N-uptake is given as a function of time and root depth is input (see parameter sections on Nitrogen uptake by roots).
1 *Default*	CROP growth and N-uptake is simulated. The growth and nitrogen uptake of the crop is simulated with the CROP submodel (see the additional parameter sections on Crop Biomass and Crop Nitrogen).
2	FOREST growth and N-uptake is simulated. The growth and nitrogen uptake of forest is simulated with the FOREST submodel (see the additional parameter sections on Forest Growth, Forest Biomass, Forest Nitrogen and Forest Harvest).

GROWDECID

OFF	Leaves are lost from leaves older than one year according to leaf fall functions given by the user. At the end of the year current year old leaves are incorporated in the pool of leaves older than one year.
ON *Default*	All remaining leaves are falling to the ground at the end of the year.

GROWLFALL

OFF *Default*	All remaining leaves are falling to the ground at the end of the year.
ON	Leaves are falling due to the leaffall functions used only. Only used if the GROWTH-switch is > 0 and the SPECIAL-switch = 1.

GROWR

Determining the calculation of the growth response function (f_{Tot}). Only used if GROWTH-switch > 0 and SPECIAL-switch = 1.

0	$f_{Tot} = Min(f_T, f_N, f_W)$
1 *Default*	$f_{Tot} = f_T * f_N * f_W$
2	$f_{Tot} = (f_T + f_N + f_W)/3$

GWFLOW

OFF	The PERC driving variable is considered as deep percolation to ground water. This means that the whole simulated soil profile is unsaturated and that the GWFLOW was OFF when running the SOIL model. This means that DFLOW driving variable is not needed.
ON *Default*	The PERC driving variable is considered as a net horizontal ground water flow. This means that GWFLOW was ON when running the SOIL model.

MANURE

OFF *Default*	Application of manure and transformation of faeces is not considered.
ON	Application of manure and transformation of faeces is considered.

OPTWATER

0 *Default*	Water response functions for soil biological activity and plant growth are active.
1	Soil biological activity are not limited by soil water conditions.
2	Plant growth is not limited by plant water conditions.
3	Both 1 and 2.

ROOTDIST

0 *Default*	Root distribution from parameter values, separate fractions are given for each soil layer.
1	A linear decrease of root density from soil surface to the root depth.
2	A constant root density from soil surface to the root depth.
3	An exponential decrease of the root density from soil surface to the root depth. The root depth is defined as the depth where a fraction given by the parameter RFRACLOW remains of the total uptake capacity. The remaining fraction RFRACLOW is distributed at layers above the root depth to make the total uptake capacity equal to unity.

TEMPR

0 *Default*	The temperature response function for soil biological processes is calculated from the Q_{10} expression in the whole range.
1	The temperature response function for soil biological processes is calculated from the Q_{10} expression when the temperature is above 5 °C. Below that a linear decrease is assumed towards 0 °C where the response diminish.

SPECIAL

OFF *Default*	No action.
ON	Gives access to the parameters in the group named SPECIAL and to certain switches. Then special functions are available. OBS! Be careful, this switch does not influence the calculations. The parameters do. This switch also cancels the FORLEAF switch direct effect on the calculations.

6 PARAMETERS

All parameter values may be modified by pressing the return key when the cursor is located at a certain parameter. A new numerical value may then be specified.

Equation numbers given in the text refers to Johnsson et al. (1987) and symbols given in brackets refer to Eckersten (1991a) and Eckersten & Jansson (1991).

Beneath the unit to the right in the text a default value for each parameter is often given.

6.1 External inputs

Dry and wet deposition to the soil is determined by a dry deposition rate (DEPDRY) and the water infiltration rate (driving variable) combined with a total concentration of nitrogen (DEPWC) in precipitation. The ammonium N fraction (DEPFNH4) enters the ammonium pool of the uppermost soil layer and the rest goes to nitrate pool. Commercial fertilizer N (FERN) can be applied at a day (FERDAY). The ammonium N fraction (FERNFNH4) enters the ammonium pool whereas the rest enters the nitrate pool at a constant rate given by FERK. Under conditions of a water source flow to the soil, this flow can also be a source of nitrogen (see GWCONC).

DEPDRY
Dry deposition of mineral N — ($gN\ m^{-2}\ d^{-1}$)
A value of 0.001 correspond to 3.65 kg N/ha/year. Normal range for an open field in southern Sweden 0.0005 - 0.002 $gN\ m^{-2}\ d^{-1}$. — *0.001*
If DRIVEXT-switch = 3: Not used

DEPFNH4D
Fraction of ammonium N in DEPDRY. The rest (1-DEPFNH4D) is nitrate N — (-) *0*

DEPFNH4W
Fraction of ammonium N in wet deposition given by DEPWC. The rest (1-DEPFNH4W) is nitrate N — (-) *0*

DEPWC
Concentration of mineral N in precipitation. — ($mg\ l^{-1}$)
During a year with 800 mm infiltration a value of 0.8 corresponds to a wet deposition of 6.4 kg N/ha/year. Normal range for southern Sweden 0.8 - 1.8 mg/l and for central Sweden 0.4 - 1.0. — *0.8*
If DRIVEXT-switch = 3: Not used

FERDAY
Fertilization date (commercial fertilizer). — (day number) *140.*

FERK
Specific dissolution rate of solid fertilizer. — (d^{-1})
A value of 0.15 corresponds to half time of 5 days and that 90% of the fertilizer is dissolved within 15 days. A higher value results in faster dissolution. Dependent on fertilizer type and moisture conditions. Normal range 0.05 - 0.5. — *0.15*

FERN
N-fertilization (solid fertilizer) — ($gN\ m^{-2}\ d^{-1}$)
A non solid fertiliser could be applied by setting FERK close to one. — *8*
1 $gN\ m^{-2}$ = 10 kgN/ha. Normal range 0 - 30 $gN\ m^{-2}$.

FERNFNH4
Fraction of ammonium N in FERN. The rest (1-FERNFNH4) is nitrate N — (-) *0*

FERNLAY2
Index 1,2 (-)
Fraction of external mineral N allocated to the second uppermost layer. The rest (1-FERNLAY2) is allocated to the uppermost layer. *0*
Index 1: Solid fertiliser N
Index 2: Atmospheric deposition.

GWCONC
Concentration of nitrate in deeper groundwater ($mgN\ l^{-1}$)
Depends on the local conditions. Normal range 0.1 - 5. *0.3*

NAVAIL
When simulating N fertilisation: (differs)
If FERNCALC-switch=1 then NAVAIL is the fraction to multiply to the estimated supply (unit is -). *1*
If FERNCALC-switch=2 then NAVAIL is the wanted soil mineral N ($gN\ m^{-2}$).

6.2 Manure application

Manure can be applied during three different periods according to day numbers assigned to MANST and MANET. The manure-N is split up between inorganic forms as ammonia (MANNH), organic forms as faeces-N (MANFN) and litter-N (MANLN). The organic forms of manure are described by carbon-nitrogen ratios CNBED and CNFEC for litter and faeces respectively. Applied manure is mixed into the soil down to a depth given by the MANDEPTH parameter.

CNBED
C-N ratio of bedding in manure (-)
(index= application period 1, 2 or 3) *30.*
Only used when the MANURE switch is ON and DRIVEXT < 2
Normal range from 20 to 80. Default value 30.

CNFEC
C-N ratio of faeces in manure (-)
(index= application period 1, 2 or 3) *20.*
Only used when the MANURE switch is ON and DRIVEXT < 2
Depend on type of animals. Normal range 10 - 30. Default value 20.

MANDEPTH
Depth to which the applied manure is uniformly mixed into the soil (m)
(Index= application period 1, 2 or 3). *0.1*
Only used when the MANURE switch is ON and DRIVEXT < 2
Maximum depth = depth of layer 1+2. Normal range 0.5 - 0.25 m. Default value 0.10 m.

MANET
Last date of manure application (day number)
(index= application period 1, 2 or 3) *100.*
Only used when the MANURE switch is ON and DRIVEXT < 2
If MANET is given the same value as MANST the application of manure is made during one day.

MANFN
Nitrogen in faeces in manure ($gN\ m^{-2}$)
(index= application period 1, 2 or 3).
Only used when the MANURE switch is ON and DRIVEXT < 2
Normal range 0 - 30 $gN\ m^{-2}$.

MANLN
Nitrogen in bedding in manure (gN m^{-2})
(index= application period 1, 2 or 3).
Only used when the MANURE switch is ON and DRIVEXT < 2
Normal range 0 - 5 gN m^{-2}.

MANNH
Nitrogen in ammonium in manure (gN m^{-2})
(index= application period 1, 2 or 3).
Only used when the MANURE switch is ON and DRIVEXT < 2
Normal range 0 - 30 gN m^{-2}.

MANST
First date of manure application (day number)
(Index= application period 1, 2 or 3) *100.*
Only used when the MANURE switch is ON and DRIVEXT < 2

6.3 Mineralisation and immobilisation

Leaves and stems fall to a pool for above ground residues (LITABOVE and LITABOVEC). This pool is assumed to be inactive as regards microbial activity. The pool can, however, lose N and C through leaching (ABOVELN and ABOVELC). The transfer of residues to the uppermost litter pool is determined by a rate coefficient (ABOVEK). In the litter microbial activity occurs. The turnover of faeces and litter is treated in a similar way. Rate coefficients for litter and faeces C decomposition are given by the parameters LITK and FECK, respectively. Efficiency constants (FECEFF, LITEFF) determines the fraction of organic C that after respiration remains as organic C. A constant carbon-nitrogen ratio (CNORG) and a humification fraction (FECHF, LITHF) determines the corresponding synthesis of N in faeces, litter and humus pools. Humus N mineralisation is given by the specific rate constant HUMK. Depending on the efficiency constants and the actual carbon-nitrogen ratios, litter and faeces may either demand nitrogen (= immobilization) or release nitrogen as ammonium (= mineralisation). The critical carbon-nitrogen ratio for the shift from immobilization to mineralisation is determined by the ratio between CNORG and FACEFF or LITEFF. Transformation of ammonium to nitrate (=nitrification) will occur if the ratio nitrate-ammonium is lower than NITR, with a rate controlled by NITK. The acidity of the soil (PH) affects the nitrifiers. A multiplicative response ranging between 0 at PHMIN and 1 at PHMAX affects nitrification.

ABOVEK
Fraction of N and C in above ground residues that are transformed to the litter pool every day. (d^{-1})
1

ABOVELC
Fraction of C in above ground residues that are leached out every day. (d^{-1})
0

ABOVELN
Fraction of N in above ground residues that are leached out every day. (d^{-1})
0

CNORG
C-N ratio of microorganisms and humified products (r_0 in eq. 8) (-)
Increasing the value results in larger litter N mineralisation rates and increased C-N ratio of litter at which the shift between mineralisation and immobilization occur. Normal range from 5 to 15. *10.*

CPLANT
C content of biomass when lost as litter. (gC gDW^{-1})
0.4

FECEFF
Efficiency of the internal synthesis of microbial biomass and metabolites in faeces (-) *0.5*
Only used when the MANURE switch is on.
Normal range the same as for LITEFF (0.2 - 0.7).

FECHF
Faeces carbon humification fraction (-) *0.2*
Only used when the MANURE switch is on.
See LITHF for normal range.

FECK
Faeces specific decomposition rate (d^{-1}) *0.035*
Only used when the MANURE switch is on.
Of the same order of magnitude as LITK. Dependent on the type of manure.

HUMK
Humus specific mineralisation rate (k_h in eq. 3) (d^{-1}) *5.0E-5*
A value of 5.0E-5 corresponds to a half time of 38 years under optimum water and temperature conditions. Thus, the effective half time is much longer. Values between 1.0E-5 and 20E-5 have been used. This parameter is also dependent on the definition of the turnover of litter and humus pools according to the assumed humification fraction (see LITHF). If a major part of the residues incorporated into the litter pool is assumed to be remineralised ("fast" litter N mineralisation), it is reasonable to assume a lower value than if the reverse ("slow" litter N mineralisation) is assumed (see LITHF).

LITEFF
Efficiency of the internal synthesis of microbial biomass and metabolites in litter (f_e in eq. 5). (-) *0.5*
Normal range 0.2 - 0.7 based on literature values of microbial growth yield. Increasing the value results in increased litter N mineralisation rates and a decreased C-N ratio at which the shift between litter mineralisation and immobilization occur.

LITHF
Litter carbon humification fraction (f_h in eq. 6). (-) *0.2*
Low values, 0.1 - 0.3 (Defining litter turnover as "fast"), results in that a major part of the residues incorporated into the litter-N pool is remineralised while a minor part is humified. High values 0.6 - 0.9 ("slow" litter turnover), results in the reverse. High values give the humus pool a more active role for the total mineralisation of nitrogen. A fast litter turnover has been assumed in most applications.

LITK
Litter specific decomposition rate (k_l in eq. 4) (d^{-1}) *0.035*
A value of 0.035 corresponds to a half time of 20 days under optimum water and temperature conditions. Thus, the effective half time is much longer. Increasing the value results in an increased litter decomposition rate.

NITK
Specific nitrification rate (k_n in eq. 9). (d^{-1}) *0.2*

NITR
Nitrate-ammonium ratio in nitrification function (n_q in eq. 9) (-) *8.*
Normal range for agricultural soils 1 - 15.

PH
(pH) Acidity in terms of pH in each layer (-)
Index = soil layers (1-10) *0*
If PH(I) = 0 then the pH variable is not considered in any calculations the layer concerned.

PHMAX
(pH_{Max}) pH above which nitrification is not effected by acidity (-)
0

PHMIN
(pH_{Min}) pH below which nitrification is zero (-)
0

6.4 Soil moisture response

A Common soil moisture response function is used for mineralisation, immobilization and nitrification. The activity is zero below the wilting point (defined in the SOILP.DAT file or by parameter WILT) and increases to unity in a soil moisture interval given by MOS(1). Near saturation, the activity decreases down to a saturation activity (MOSSA) in and interval given by MOS(2). Soil porosity (saturation water content) is defined in the SOILP.DAT file or by parameter PORO. The shape of the response curve in the intervals MOS(1) and MOS(2) can be varied according to the MOSM parameter.

MOS
Water content intervals in the soil moisture response function defining ranges for increasing and decreasing biological activity ($d0_1$ and $d0_2$ in eq. 12). (%)

MOS(1): Water content interval defining increasing activity from 0 (no activity) at wilting point to unity (optimum activity) at MOS(1) + wilting point. Normal range 8 - 15 vol %, depending on soil type. *13*

MOS(2): Water content interval defining decreasing activity from 1 (optimum activity) at porosity - MOS(2) to the activity given by parameter MOSSA at porosity. Normal range 1 - 10 vol %, depending on soil type. Default value 8 % *8*

MOSM
Coefficient in soil moisture function (m in eq. 11) (-)
A linear response correspond to the value 1.0. Values between 0 and 1 results in a convex response and values larger than 1 in a concave response. *1*

MOSSA
Saturation activity in soil moisture response function (e_s in eq. 11). (-)
A value of 1 corresponds to optimum activity at saturation and 0 no activity. *0.6*
Normal range 0 - 1.

6.5 Soil temperature response

Separate temperature response functions are used for mineralisation-immobilization, denitrification and nitrification. The function is based on a Q10 relation (TEMQ10, TEMQ10D, TEMQ10N), with a temperature base (TEMBAS, TEMBASD, TEMBASN) at which the value of the function is one. Below a certain temperature (TEMLIN, TEMLIND, TEMLINN) the response is linear. This linear function equals the other function at temperature equal to TEMLIN and is zero at 0°C.

OUTLAY
(i) Layer. The response function is calculated for each layer but is stored as output only for this layer. A value outside 1-10 will give you the average response function for all layers as output. (-)
1

TEMBAS
(T_{bm}) For the mineralisation-immobilisation process; Base temperature at which temperature effect = 1 (see eq. 10). (°C) *20*

TEMBASD
(T_{bd}) For the denitrification process; Base temperature at which temperature effect = 1. If TEMBASD = 0 then TEMBASD is set equal TEMBAS. (°C) *20*

TEMBASN
(T_{bn}) For the nitrification process; Base temperature at which temperature effect = 1. If TEMBASN = 0 then TEMBASN is set equal TEMBAS. (°C) *20*

TEMLIN
(T_{ml}) For the mineralisation-immobilisation process. Threshold temperature below which the temperature response is a linear function of temperature. (°C) *5*

TEMLIND
(T_{dl}) For the denitrification process. Threshold temperature below which the temperature response is a linear function of temperature. If TEMLIND = 0 then TEMLIND is set equal TEMLIN. (°C) *5*

TEMLINN
(T_{dl}) For the nitrification process. Threshold temperature below which the temperature response is a linear function of temperature. If TEMLINN = 0 then TEMLINN is set equal TEMLIN. (°C) *5*

TEMQ10
(Q_{m10}) For the mineralisation-immobilisation process. Response to a 10 °C soil temperature change (see eq. 10) (-) *3*
A value of 2 results in a doubled activity with a 10 °C increase in temperature. Normal range between 1.5 and 4.

TEMQ10D
(Q_{d10}) For the denitrification process. Response to a 10 °C soil temperature change. If TEMQ10D = 0 then TEMQ10D is set equal TEMQ10. (-) *3*

TEMQ10N
(Q_{n10}) For the nitrification process. Response to a 10 °C soil temperature change. If TEMQ10N = 0 then TEMQ10N is set equal TEMQ10. (-) *3*

6.6 Denitrification

Denitrification (=loss of nitrate from soil to the atmosphere) is calculated according to a potential rate (DENPOT), the nitrate concentration in soil solution and response functions for temperature and moisture. The temperature response is the same as for the other biological processes. The distribution of the potential rate of denitrification in the soil profile can be given separately for each layer (DFRAC) or according to distribution functions (see switch DENDIST). Denitrification increases with increasing water content in an interval MOSDEN below saturation water content (PORO). The shape of the response curve may be varied according to DEND. Denitrification is reduced when the nitrate concentration decreases in soil water solution according to a michaelis-menten type function (DENHS).

DEND
Coefficient in function for soil moisture/aeration effect on denitrification (d in eq. 15) (-) *2*
A linear response correspond to a value of 1 whereas higher values results in a concave non-linear response.

DENDEPTH
The depth where the denitrification capacity ceases. (m)
Only used when the DENDIST switch is set to 1,2 or 3.

DENHS
Half saturation constant in function for nitrate concentration effect on denitrification (c_s in eq. 16) (mgN l^{-1})
10
Nitrate concentration at which the activity is half of the activity at optimum nitrate concentrations. Normal range 5 - 15.

DENPOT
Potential rate of denitrification (k_d in eq. 16) (gN m^{-2} d^{-1})
0.04
Dependent on type of cropping system and soil. Typical value for a barley crop on a loam soil 0.04 and for a grass ley 0.2.

DFRAC
Fraction of potential denitrification in layers (-)
(Index= layer. 1 to minimum of 10 and NUMLAY)
Only used when the DENDIST switch is set to 0
The vertical distribution is dependent on soil organic matter content as source for the activity of denitrifiers in the different layers. A first assumption may be to assume similar distribution as the root distribution or the distribution of soil organic matter.

DFRACLOW
Fraction of the exponential function remaining below the depth where the denitrification activity ceases (DENDEPTH), used when the DENDIST switch is set to 3 (-)
0.05

The activity (f_r) that are found above a depth z is given by:

$$f_r = \frac{(1-\exp(-kextd(z/z_r))}{(1-DFRACLOW)}$$

where (z_r) is the root depth and kextd is an extinction coefficient.
DFRACLOW=exp(-kextd)
and
kextd=-ln(DFRACLOW)

Normal range of kextd 2.5 - 4.5 corresponds to values from 0.08 to 0.01 of DFRACLOW.

MOSDEN
Water content range in function for soil moisture/aeration effect on denitrification (vol %)
17.
Water content interval defining increasing activity from 0 (no activity) at saturation water content - MOSDEN, to 1 (optimum activity) at saturation water content.

6.7 Soil Profile and Site Description

The division of the soil profile into a number of layers (NUMLAY) with different thickness (THICK) should be done in a way which corresponds to the driving variables simulated with the SOIL model.

LATID
Latitude of the field. (°)

NUMLAY
Number of layers (maximum 22) in the soil profile used in the simulation

THICK
Thickness of soil layers (m)
Use values from the soil water and heat simulation.

UNUM
Replicate number of soil parameters in SOILP.DAT. The replicate number is also used in the PLOTPF program.

UPROF
Profile number as specified in SOILP.DAT. The profile number is also used in the PLOTPF program

6.8 Stream water

These parameters are used to account for the consumption of nitrogen in a stream.

CONCRI
Half saturation constant in calculation of nitrate consumption in stream water (-)

CONPOT
Potential rate of nitrate consumption in stream water. ($gN\ m^{-2}\ d^{-1}$)
Note that the area correspond to the total watershed area simulated. Value dependent on the total stream length in the watershed as well as on the biological factors in the stream. Default value 0, i.e. no consumption assumed.

CONTEM
Lower temperature limit for nitrate consumption in stream water (°C)

6.9 Soil management

PLOUGHDAY
Date of ploughing or soil cultivation (day number)

PLOUGHDEP
Depth of ploughing or soil cultivation (m)
Normal range 0.05 - 0.30 m. *0.25*

6.10 Crop management

The plant N is handled in different ways at harvest depending on how the plant N uptake is simulated. When the GROWTH-switch = 0, the total plant N is splitted up to a harvested fraction (HARP), residues (HARAR) and roots remaining and living (HARLR). When the GROWTH-switch = 1, root, stem, leaf and grain are simulated explicitly and harvest can be made of the different tissues separately (HARS, HARL, HARG) and the fractions reamaining and living can be given (HARLR, HARLS, HARLL).

Harvest of plant can take place at three different dates (UPET). At these dates a fraction of leaves (HARL) and a fraction of stems (HARS) are harvested. Another fraction remains alive: HARLL for leaves and HARLS for stems. The rest is included in the pool for above ground residuals (see output variables INCALIT and INCALITC). Concerning the roots a fraction remain alive (HARLR) and the rest is included in the litter pools (see output variables NEWNL and NEWCL). At the day of ploughing (PLODAY) all remaining living leaves and stems, and roots down to a depth given by PLOUGHDEP, all above ground residues are evenly included in the litter pools down to a depth of PLOUGHDEP. The living roots below PLOUGHDEP are incorporated in the corresponding litter pools. Note! It is not possible to harvest at the same day as ploughing is made.

At harvest dates the total plant biomass-N is split into a harvest fraction (HARS), a fraction of plant residues above ground (HARLR) and a fraction of remaining living biomass-N (HARL). The residual (1-HARS-HARLR-HARL) is considered as dead root biomass-N. The dead root biomass-N is included into the litter-N pool at the day of harvest and split between different soil horizons according to the depth distribution of roots (see ROOT). The dead root biomass-C is included into the litter-C pool according to a carbon-nitrogen ratio of roots (CNROOT).

CNARES
C-N ratio of above ground residues (-)
Normal range 20-100. Default value represents a grain crop. *50.*
If GROWTH-switch > 0: Not used.
If DRIVMANA-switch = 2: Not used.

CNROOT
C-N ratio of roots (-)
Normal range 20-30. *25.*
If GROWTH-switch > 0: Not used.
If DRIVMANA-switch = 2: Not used.

HARAR
Above ground residue fraction of plant N at harvest (f_{ar} (-)
in eq.1) *0*
(index= growth period 1, 2 or 3)
If GROWTH-switch > 0: Not used.
If DRIVMANA-switch = 2: Not used.

HARG
The fraction of grains that is harvested. (-)
If GROWTH-switch = 0: Not used. *0.*
If DRIVMANA-switch = 2: Not used.

HARL
The fraction of leaves that is harvested. (-)
(index= growth period 1, 2 or 3) *0.*
If GROWTH-switch = 0: Not used.
If DRIVMANA-switch = 2: Not used.

HARLL
Fraction of leaves remaining and living after harvest. (-)
(index= growth period 1, 2 or 3) *0*
If GROWTH-switch = 0: Not used

HARLR
Fraction of roots remaining and living after harvest (f_{lr} in eq. 1) (-)
(index= growth period 1, 2 or 3) *0.*
If GROWTH-switch = 0: The fraction refers to plant N (PLANT)
If GROWTH-switch = 1: The fraction refers to root (ROOTN and ROOTW)
If DRIVMANA-switch = 2: Not used.

HARLS
Fraction of stems remaining living after harvest. (-)
(index= growth period 1, 2 or 3) *0*
If GROWTH-switch = 0: Not used.

HARP
Harvested fraction of total plant N (f_{hp} in eq. 1) (-)
(index = growth period 1-3) *0.5*
If GROWTH-switch > 0: Not used.
If DRIVMANA-switch = 2: Not used.

HARS
Fraction of stems that is harvested. (-)
(index = growth period 1-3) *0.5*
If GROWTH-switch = 0: Not used.
If DRIVMANA-switch = 2: Not used.

UPET
(t_e) End of plant uptake period and harvest date (day number)
(index= growth period 1, 2, or 3) *240.*

(CROP): If the GROWTH-switch is 1, 3, or 4:
UPET(i)=367 implies the current growth period is not ended until the simulation is ended.
UPET(i)>367 implies that the growing period (i) is stoped at day UPET(i)-365.
Should be: UPST(i)<UPET(i)<UPST(i+1)
If UPET is given a negative value then: t_e=-UPET and the root biomass remains unchanged.

UPST
(t_0) Start of plant uptake period (day number)
(index= growth period 1, 2 or 3) *120*
(CROP): If the GROWTH-switch is 1, 3 or 4: The parameter equals the earliest day for start of plant development. The temperature may delay the start of growth from this date.
Should be UPST(1)<UPST(2)<UPST(3)<366.
UPST(i)=0 implies the period (i) is cancelled (Note! This parameter is related to UPET (this parameter group) and TOTW (Crop Biomass group)).

6.11 Nitrogen uptake by roots

The development of the root depth is given by parameters ROOTT and ROOTDEP. The distribution of plant N uptake demand and root biomass in the soil profile can be given separately for each layer (ROOTF) or according to distribution functions (see switch ROOTDIST).

If GROWTH-switch = 0: Plant uptake of inorganic nitrogen from the soil (both nitrate and ammonium) is controlled by a logistic uptake function defining the potential demand (UPA, UPB and UPC).

RFRACLOW
(Δa_r) Fraction of the exponential function remaining below the root depth, used when the ROOTDIST switch is set to 3 (-) *0.05*

The fraction of roots (a_r) that are found above a depth z is given by:

$$a_r = \frac{(1-\exp(-k_r(z/z_r)))}{(1-\Delta a_r)}$$

where (z_r) is the root depth and (k_r) is an root extinction coefficient.

$$\Delta a_r = \exp(-k_r)$$

and

$$k_r = -\ln(\Delta a_r)$$

Normal range of k_r 2.5 - 4.5 corresponds to values from 0.08 to 0.01 of RFRACLOW.

ROOTDEP
Root depth at days given of ROOTT(I) (m)
(Index= 1 to 5)
Only used when the DRIVCROP-switch = 0 and GROWTH-switch = 0.

ROOTF
Fraction of roots in layers (when fully developed) (-)
(Index= layer 1 to min(10, NUMLAY))
Only used when the ROOTDIST switch is set to 0.

ROOTT
Day number for deepest root depth given of ROOTDEP(I) (day number)
(Index = 1 to 5)
Day number for deepest root depth given of ROOTDEP(1) (Index=6)
Only used when the DRIVCROP-switch = 0 and GROWTH-switch = 0.

UPA
Potential nitrogen uptake (u_c in eq. 13) ($gN\ m^{-2}\ yr^{-1}$)
(index= growth period 1, 2 or 3) *20.*
Typical values may be around 20 $gN\ m^{-2}\ yr^{-1}$ for a grain crop and 40 $gN\ m^{-2}\ yr^{-1}$ for a grass ley in south and central Sweden.
If GROWTH-switch > 0: Not used.

UPB
Coefficient in plant uptake function (u_b in eq. 13) (-)
In case of an annual crop, UPB is the initial plant N content ($gN\ m^{-2}\ yr^{-1}$) at *1.*
the start of the plant uptake period, i.e., the N-content of seed. A normal variation of UPB is 0.1 - 1.5. n.b! In older versions of the SOILN model the UPB parameter was defined slightly different, corresponding to $(UPA-u_b)/u_b$. Thus, a value of UPB of 0.95 and UPA of 20 in the present version of the model corresponds to a value of 20 in older simulations.
If GROWTH-switch > 0: Not used.

UPC
Coefficient in plant uptake function (u_c in eq. 13) (d^{-1})
Determines the plant development rate. Increasing UPC results in that the *0.12*
peek uptake occurs faster and at a higher rate. Typical values for rapid developing grain crops is around 0.12 and for slower developing crops like sugarbeets 0.04. Normal values 0.02 - 0.14.
If GROWTH-switch > 0: Not used.

UPMA
(f_{ma}, c_u) Fraction of mineral N available for immobilization and plant uptake (d^{-1})
(f_{ma} in eq. 14). For the lowest soil layer with roots, c_u for roots is decreased *0.08*
in proportion to how large fraction of the layer that is not penetrated by roots. A value of 0.1 is equivalent to that 10% of the total mineral-N pool is available at one time-step. Normal range 0.05 - 0.12.

UPMOV
(c_{um}) Compensatory N uptake from layers with access of N. (-)
A value of 1 results in the most efficient compensation (i.e., all differences *1*
between potential and actual uptake occuring in layers with mineral N deficiency is added to the uptake demand in layers with no deficiency). A value of 0 represents a case where the uptake demand is strictly partitioned between different soil layers according to the soil root distribution.

6.12 Crop biomass

These parameters are activated when the GROWTH-switch is 1

At start of growth (see Crop management parameters) or simulation a certain amount of plant biomass exists on the field (TOTW(i); i=1-3 depending on which cultivation of the year is concerned). The solar radiation is absorbed by the canopy according to the radiation extinction coefficient (EXTCOEFF) and converted into potential growth (PHOEFF). The potential growth is reduced according to temperature (PHOTEMP) and nitrogen (see Crop nitrogen parameters NLEAFN and NLEAFX). ROOTDINC, ROOTDMAX and ROOTDMIN determine the root depth development.

Growth and assimilates are allocated between roots (AROOTN, AROOTNI, AROOTW), leaves and stems (ALEAF), grain (AGRAIN) and litter (ALEAFAGE, ALITTERR, ALITTERS). The leaf biomass and leaf area are related through the specific leaf area (WLAI). The grain development starts when a temperature and daylength index becomes unity (GRAINI).

AGRAIN
Fraction of biomass in tissues reallocated to other tissues during grain development.

AGRAIN(1): (b_{gl}) (d^{-1})
If CROPALLO-switch = 0: From leaves to grain.
If CROPALLO-switch = 1: The fraction of assimilates in leaf fall allocated to stem instead of falling to ground.

AGRAIN(2): (b_{gs}) From stem to grain. (d^{-1})

AGRAIN(3): (b_{gr}) (d^{-1})
If CROPALLO-switch = 0: From roots to grain.
If CROPALLO-switch = 1: From roots to stem.

ALEAF
Coefficients for leaf area development as function of shoot biomass.
NOTE! depend on CROPEQU-switch. For explantion of coefficients see CROPEQU. Independent variable is above ground biomass ($x=W_{ta}$). No "other equation" is available.

ALEAF(1): (b_{io}) Coefficient a ($m^2\ gDW^{-1}$)

ALEAF(2): (b_{i1}) Coefficient b (differ)

ALEAF(3): (b_{i2}) Coefficient c (differ)

ALEAFAGE
(d_{Age}) Lifetime of leaves. (d)

ALITTERR
Parameters for root mortality.

ALITTERR(1): (m_{r1}) Fraction of daily root growth lost as litter. (-)

ALITTERR(2): (m_{r2}) Fraction of root biomass lost as litter. (d^{-1})

ALITTERS
(m_s) Fraction of stem biomass lost through litter. (d^{-1})

AROOTN
(b_{rMin}) Minimum fraction of daily total growth allocated to roots. (-)

AROOTNI
Coefficients for root development as function of leaf N concentration.
NOTE! depend on CROPEQU-switch. For explantion of coefficients see CROPEQU. Independent variable is relative leaf N concentration ($x=(n_l'-n_{lMin})/(n_{lMax}-n_{lMin})$), where n_l' is N concentration of newly formed leaves (N_l'/W_l').
"Other equation" is: $1+b_{rMin}-(1-((n_{lMax}-n_l')/n_{lMax})x^2)^{0.5}$.

AROOTNI(1): (c_{no}) Coefficient a (-)

AROOTNI(2): (c_{n1}) Coefficient b (differ)

AROOTNI(3): (c_{n2}) Coefficient c (differ)

AROOTW
Coefficients for root development as function of total plant biomass.
NOTE! depend on CROPEQU-switch. For explantion of coefficients see CROPEQU. Independent variable is total plant biomass ($x=W_t$).
No "other equation" is available.

AROOTW(1): (c_{bo}) Coefficient a (-)

AROOTW(2): (c_{b1}) Coefficient b (differ)

AROOTW(3): (c_{b2}) Coefficient c (differ)

EXTCOEF
(k) Radiation extinction coefficient for the canopy. (-)

GRAINI
Coefficients for the index (i_g) which acts as a switch that starts the grain development.

GRAINI(1): (c_o) The asymptote of the development rate curve. The inverse value gives the shortest possible duration of the phase in days and is therefore related to the basal vegetative period. (d^{-1})

GRAINI(2): (c_3) Regulates the shape of the development-photoperiod (daylength) function. (h^{-1})

GRAINI(3): (c_4) The critical photoperiod (threshold) for the development. (h)

GRAINI(4): (c_1) Regulates the shape of the development - temperature function ($°C^{-1}$)

GRAINI(5): (c_2) Threshold temperature (°C)

PHOEFF
(ε) Radiation use efficiency at optimum temperature, water and nitrogen conditions. (gDW MJ^{-1})

PHOTEMP
Coefficients for the response of the growth (photosynthesis) to temperature.

PHOTEMP(1): (T_{Min}) Minimum daily mean air temperature for growth. (°C)

PHOTEMP(2): (T_{Max}) Daily mean air temperature for optimum growth. (°C)

ROOTDINC
(a_{rz}) Parameter determining root depth as function of root biomass; $z_r=z_{rMin}W_r/(W_r+z_{rMin}/a_{rz})$ (OBS! <0). (m)

ROOTDMIN
(z_{rMin}) Largest root depth (OBS! <0). (m)

TOTW
($W_t(t_o)$) Total plant biomass at start of growth. (gDW m^{-2})
(index= growth period 1, 2 or 3).
Not used if TOTW= 0, then the initial values are given by values in the initialization file on ROOTW,STEMW,LEAFW,ROOTN,STEMN and LEAFN.

WLAI
(a_{ls}) Specific leaf area. (m^2 gDW^{-1})

6.13 Crop nitrogen

These parameters are activated by the GROWTH-switch and related to plant nitrogen uptake and allocation.

The allocation of nitrogen follows the allocation of assimilates however also depending on maximum concentrations of the tissues concerned.
The maximum amount of mineral N available for uptake from a soil layer is controlled by the UPMA parameter. In cases when actual uptake from one layer is below the potential uptake, reallocation of the uptake demand to other layers occurs to a degree given by UPMOV.

AGRAINN
Fraction of N in tissues reallocated to other tissues during grain development.

AGRAINN(1): (b_{gnl}) (d^{-1})
If CROPALLO-switch = 0: From leaves to grain.
If CROPALLO-switch = 1: From leaves to stem

AGRAINN(2): (b_{gns}) From stem to grain. (d^{-1})

AGRAINN(3): (b_{gnr}) (d^{-1})
If CROPALLO-switch = 0: From roots to grain.
If CROPALLO-switch = 1: From roots to stem.

NLEAFN
(n_{lMin}) Minimum nitrogen concentration of leaf biomass. (-)

NLEAFX
(n_{lMax}) Maximum nitrogen concentration in leaf. (-)

NROOTX
(n_{rMax}) Maximum nitrogen concentration of root biomass. (-)

NSTEMX
(n_{sMax}) Maximum nitrogen concentration of stem biomass. (-)

6.14 Forest Biomass

These parameters are activated by the GROWTH-switch and related to the allocation of biomass within the plant and litter fall.

Flushing occurs at a certain temperature sum (ZDAYTA, ZTACC). Growth then depends on temperature (PTEMP). Growth and assimilates are allocated between roots (ZROOTN), leaves and stems (ZLEAF), and the available pool (ZWAI, ZDWAX, ZWSL). The leaf biomass and leaf area are related through the leaf "thickness" (ZBA, ZBAY, ZBAX). Rate of leaf fall depends age of leaf (ZLEAFAGE) and self-shading (ZID) (it can also be a function of time of season; see ZTDA, ZKM in Special group). A certain fraction of the leaf biomass is withdrawn to plant (QBW) before abscission. Of the leaves reaching soil surface a fraction is directly leached (ZWLFL).

PEXTCO
Coefficients for estimating the light extinction coefficient (k) as a function of the accumulated leaf area index from the canopy top (A_i). Coefficients in: $k=a+b*A_i+c*A_i^2$

PEXTCO(1): (a) (-)

PEXTCO(2): (b) (-)

PEXTCO(3): (c) (-)

PTEMP
Coefficients for the relation between growth and temperature (see T_f).

PTEMP(1): (T_1) Lower temperature limit for growth. (°C)

PTEMP(2): (T_2) Lower temperature limit for optimum growth. (°C)

PTEMP(3): (T_3) Upper temperature limit for optimum growth. (°C)

ZALIUTX
() Maximum daily loss of leaf area. (d^{-1})
If GROWLFALL-switch = 0: Not used

ZAW
(b_w) Fractional withdrawal of dry weight in leaves before abscission (OBS! Must be greater than 0). (-)

ZBA
(b_A) [x] ; =x implies that the area leaf weight is constant equal to x during the season. OBS! Then ZSTBAD should be 0. FORLEAF-switch must be ON. (gDW m^{-2})

ZBAX
(b_{Ax}) Maximum area leaf weight (gDW m^{-2})

ZBAY
(a) in: $b_A=b_{Ao}(1+a*shootage)$; Annual relative increase of the area leaf weight (both if it is constant (ZBA) or given as a driving variable (see parameter ZSTBAD Special group). (-)

ZDALI
(δ_A) A_{li} of internal canopy layers used for calculating the light (PAR) interception. (-)
If FORPHOTO-switch <> 1: Not used

ZDAYTA
(t_{Acc}) Day number at which the calculation of T_{aAcc} starts (d)

ZDWAX
(dW_{aMax}) Maximum daily release rate of assimilates in the available pool. (gDW m^{-2} d^{-1})

ZID
(I_d) Light (PAR) at the level in the canopy below which leaf-shedding starts. (μE m^{-2} s^{-1})
The light variable considered is calculated assuming clear sky conditions. OBS! The leaf fall due to this parameter is limited by parameter ZWLUTX (Special group) which by default is put high. OBS! also parameter ZDALI (Forest Growth group) affects this leaf fall routine. The routine is put off by setting ZID=0.
If GROWLFALL-switch < 2: Not used.

ZLEAF
Coefficients for leaf area development as function of shoot biomass.

ZLEAF(1): (b_{io}) The leaf area to shoot biomass ratio at unity shoot biomass. (m^2 gDW^{-1})

ZLEAF(2): (b_{i1}) Parameter related to the decrease in the leaf area to shoot biomass ratio as the shoot biomass increases. (m^2 gDW^{-1})

ZLEAFAGE
(d_{Age}) Lifetime of leaves. (d)
A negative value implies that d_{Age} = -ZLEAFAGE and that the zero-setting of leaf biomass each year is cancelled, i.e. we assume a non-decidous tree.

ZLITTERR
Parameters for root mortality.

ZLITTERR(1): (m_{r1}) Fraction of daily root growth lost as litter. (-)

ZLITTERR(2): (m_{r2}) Fraction of root biomass lost as litter. (d^{-1})

ZLITTERS
(m_s) Daily relative mortality rate for stems older than one year. (d^{-1})

ZPHOEFF
(ε) Radiation use efficiency at optimum temperature, water and nitrogen conditions. (gDW MJ^{-1})
Only used when FORPHOTO-switch is OFF.

ZRFRACLOW
(Δa_r) Fraction of the exponential function remaining below the root depth, used when the ROOTDIST switch is set to 3. (-)

The fraction of roots (a_r) that are found above a depth z is given by:

$$a_r=\frac{(1-\exp(-k_r(z/z_r))}{(1-\Delta a_r)}$$

where (z_r) is the root depth and (k_r) is an root extinction coefficient.

$\Delta a_r = \exp(-k_r)$

and

$k_r = -\ln(\Delta a_r)$

Normal range of kext 2.5 - 4.5 corresponds to values from 0.08 to 0.01 of RFRACLOW.

ZRESPG
(r_g) Fractional respiration of total daily growth (W_t'). (-)
If FORPHOTO-switch <> 1: Not used

ZRESPM
(r_m) Daily fractional maintain respiration of root and stem biomass of all ages. (d^{-1})

ZROOTDINC
(a_{rz}) Parameter determining root depth as function of root biomass; (m)
$z_r = z_{rMin} W_r / (W_r + z_{rMin}/a_{rz})$ (OBS! <0).

ZROOTDMIN
(z_{rMin}) Largest root depth (OBS! <0). (m)

ZROOTN
(b_{ro}) Minimum fraction of the total daily growth that is allocated to roots. (-)

ZTAACC
(T_5) Minimum value of the temperature sum (T_{aAcc}) at which growth starts. (°C)

ZWAI
(w_{ai}) Fraction of daily growth allocated to the available pool. (-)

ZWSL
(w_{as}) Stem biomass for which δW_{aMax} is doubled. (gDW m^{-2})

6.15 Forest Nitrogen

These parameters are activated by the GROWTH-switch and related to plant nitrogen uptake and allocation.

The allocation of nitrogen follows the allocation of assimilates however also depending on maximum concentrations of the tissues concerned.

QAW
(a_w) Fractional withdrawal of nitrogen in leaves before abscission. (-)

QNLEAFN
(n_{lMin}) Minimum leaf nitrogen concentration (for N uptake). (gN gDW^{-1})

QNLEAFO
(n_{lOpt}) Optimum canopy nitrogen concentration (for allocation of biomass to roots). (gN gDW^{-1})

QNLEAFX
(n_{lMax}) Maximum leaf nitrogen concentration (for N uptake). (gN gDW^{-1})

QNROOTX
(n_{rMax}) Maximum root nitrogen concentration. (gN gDW^{-1})

QNSTEMX
(n_{sMax}) Maximum stem nitrogen concentration. (gN gDW^{-1})

QUPMA
(c_u) Fraction of mineral N available for plant uptake. For the lowest soil layer with roots, c_u is decreased in proportion to how large fraction of the layer that is not penetrated by roots. (d^{-1})

QUPMOV
(c_{um}) Compensatory N uptake from layers with access of N. (-)
A value of 1 results in the most efficient compensation (i.e., all differences between potential and actual uptake occuring in layers with mineral N deficiency is added to the uptake demand in layers with no deficiency). A value of 0 represents a case where the uptake demand is strictly partitioned between different soil layers according to the soil root distribution. *1*

6.16 Plotting on line

These parameters activates a display of outputs on the screen during the simulation.

PMAX
The expected maximum value among the variables selected by XTGD. (-)

XTGD
Numbers of output variables to be presented on the screen during the simulation. (-)
For instance, 4200 means 4 X-, 2 T-, zero G- and zero D variables. X= state, T= flow, G= auxiliary and D= driving variables. It is the first variables (of those selected as output) in each array that are plotted.

6.17 Special

These parameters are available only if the SPECIAL-switch is ON (Note! exceptions occur). They activates special routines not used, or kept fixed, in the original model. In brackets () is given the Parameter group the parameter should belong to.

These parameters are used for sensitivity tests and to select some special options. The value for no test is the default value, given in italics. The subscript (o) denotes the symbol for the original value.
Where both the relative and the absolute value are possible to change a constant value of the variable concerned can be chosen by setting the relative change to 0.
The supply of nitrogen to leaves at growth start can be set optimum or taken as a function of the available nitrogen in the soil (QSNLT0).

ROOTDENS
(a_c) Parameter making root uptake (UPMA) equal a function of rootdensity ($c_u = c_{uo}(W_r(i)/\delta z(i)/a_c)^{**}a_{cc}$. Only used if SPECIAL-switch is ON and ROOTDENS > 0. (gDW m^{-3}) *0*

ROOTDENSE
(a_{cc}) Parameter making root uptake (UPMA) equal a function of rootdensity, see parameter ROOTDENS. (-) *1*

PSTFD
(T_f-T_{fo}) Absolute change of temp. function. (Forest Biomass) (-) *0*

PSTFR
(T_f/T_{fo}) Relative change of temp. function. (Forest Biomass) (-) *1*

QSBRR
(b_r/b_{ro}) Relative change of root allocation. (Forest Biomass) (-)
1

QSNLD
(n_l-n_{lo}) Absolute change of leaf N-conc. (Forest Nitrogen) (-)
0

QSNLDE
(N_{lDem}'/N_{lDemo}') Relative change in the demand of N by leaves. (Forest Nitrogen) (-)
1

QSNLR
(n_l/n_{lo}) Relative change of leaf N-conc. (Forest Nitrogen) (-)
1

QSNLT0
switch for supply of leaf nitrogen at start [0] ; Determines wether the leaves are supplied by optimum nitrogen content at start of growth (=0 --> $N_l(t_o)=n_{lMax}W_l(t_o)$) or by the nitrogen available in the pool (=1 --> $N_l(t_o)=(N_{lo}$ MIN $N_a)$). (Forest Nitrogen) (-)
0

RESPK
Respiration coefficient accounts for carbon losses due to maintenance (at 10°C) . (Not active if RESPK=0). (Crop Biomass). Note! Can be activated without SPECIAL-switch ON. (gDW $gDW^{-1}d^{-1}$)
0

ZDAYE
(t_e) Day number at the end of seasonal growth (≤365) (Forest Biomass) (d)
365

ZALIUTX
(A_{li}'(ut)(I)(max)) Maximum loss rate of leaf area index due to self-shading (see parameter ZID in Forest Biomass group). Only used if the GROWTH-switch = 2. (Forest Biomass) (s^{-1})
0.1

ZKM
Coefficients for determining the leaf fall as function of time (m_A). Only used if ZTDA>0. (Forest Biomass)

ZKM(1): (k_{mo}) (-)

ZKM(2): (k_{m1}) (d^{-1})

ZROOTDENS
(a_c) Parameter making root uptake (QUPMA) equal a function of rootdensity (c_u= $c_{uo}(W_r(i)/\delta z(i)/a_c)$**$a_{cc}$. Only used if SPECIAL-switch is ON and ZROOTDENS > 0. (gDW m^{-3})
0

ZSALIR
(A_{li}'/A_{lio}') Relative change of leaf area growth. (Forest Biomass) (-)
1

ZSWLR
(W_l'/W_{lo}') Relative change of leaf growth. (Forest Biomass) (-)
1

ZTDA
(d_a) Length of the day (after midsummer) when leaf abscission starts. =0 implies that this function for leaffall is not active. (Forest Biomass) (h)
0

7 OUTPUTS

Output variables are stored in a PG-structured file named SOILNnnn.BIN where nnn is the current run number. Also, a list of output variables are found in the summary file named SOILNnnn.SUM. The variables to be stored in the summary file can be selected by the switch LISALLV.

The output variables are divided into four categories:
states (=X), flows (=T), auxiliaries (=G) and drivings (=D).

Symbols given in brackets refer to Eckersten (1991a) and Eckersten & Jansson (1991).

7.1 States

All variables denoted ACC.... are used only to check output and not involved in the model calculations.

Variable	(Symbol) Explanation	Unit
ACCBAL	Nitrogen state: N mass balance check of ACC...-variables	(gN m^{-2})
ACCBALC	Carbon state: C mass balance check of ACC...C-variables	(gC m^{-2})
ACCDEP	Nitrogen state: Accumulated N deposition	(gN m^{-2})
ACCFERT	Nitrogen state: Accumulated N fertilisation, other than manure and deposition	(gN m^{-2})
ACCHARV	Nitrogen state: Accumulated N harvested	(gN m^{-2})
ACCHARVC	Carbon state: Accumulated C harvested	(gC m^{-2})
ACCMAN	Nitrogen state: Accumulated N fertilisation through manure	(gN m^{-2})
ACCPHOSC	Carbon state: Accumulated C uptake by net photosynthesis	(gC m^{-2})
ACCPLANT	Nitrogen state: Accumulated change in total plant N	(gN m^{-2})
ACCPLANTC	Carbon state: Accumulated change in total plant C	(gC m^{-2})
ACCRESPC	Carbon state: Accumulated C lost by resperation from plant and litter	(gC m^{-2})
ACCSOIL	Nitrogen state: Accumulated change in soil N, excluding humus	(gN m^{-2})
ACCSOILC	Carbon state: Accumulated change in soil C, excluding humus	(gC m^{-2})
CF	Carbon state: Faeces-C (Index= layer 1 to 2; two uppermost layers)	(gC m^{-2})
CL	Carbon state: Litter-C (Index=layer 1 to min(NUMLAY,10))	(gC m^{-2})
DENIT	Nitrogen state: Accumulated denitrification of NO3-N	(gN m^{-2})
DLOSST	Nitrogen state: Accumulated leaching of NO3-N	(gN m^{-2})
FERT	Nitrogen state: Solid fertilizer-N (undissolved)	(gN m^{-2})
GRAINN	(N_g) Nitrogen state : Grain-N (CROP)	(gN m^{-2})

GRAINW	(W_g) Biomass state: Grain dry weight (CROP)	(gDW m^{-2})
LEAFN	(N_l) Nitrogen state : Leaf-N (CROP)	(gN m^{-2})
LEAFW	(W_l) Biomass state: Leaf dry weight (CROP)	(gDW m^{-2})
LITABOVE	Nitrogen state: Plant residue-N above ground	(gN m^{-2})
LITABOVEC	Carbon state: Plant residue-C above ground	(gC m^{-2})
NF	Nitrogen state: Faeces-N (Index= layer 1 to 2)	(gN m^{-2})
NH	Nitrogen state: Humus-N (Index=layer 1 to min(NUMLAY,10))	(gN m^{-2})
NH4	Nitrogen state: (N_{NH4}(i)) NH4-N (Index= layer 1 to min(NUMLAY,10))	(gN m^{-2})
NLIT	Nitrogen state: Litter-N (Index=layer 1 to min(NUMLAY,10))	(gN m^{-2})
NO3	Nitrogen state: (N_{NO3}(i)) NO3-N (Index= layer 1 to NUMLAY)	(gN m^{-2})
ROOTN	(N_r) Nitrogen state : Root-N (CROP)	(gN m^{-2})
ROOTW	(W_r) Biomass state: Root dry weight (CROP)	(gDW m^{-2})
STEMN	(N_s) Nitrogen state : Stem-N (CROP)	(gN m^{-2})
STEMW	(W_s) Biomass state: Stem dry weight (CROP)	(gDW m^{-2})
XAVAIN	(N_{ap}) N in plant available for re-translocation (FOREST)	(gN m^{-2})
XAVAIW	(W_a) Assimilates in plant available for flushing (FOREST)	(gDW m^{-2})
XLEAFN	(N_l) N in leaves (FOREST)	(gN m^{-2})
XLEAFQN	(N_{Ql}) N in leaves older than one year (FOREST)	(gN m^{-2})
XLEAFQW	(Q_l) Biomass in leaves older than one year (FOREST)	(gDW m^{-2})
XLEAFW	(W_l) Accumulated leaf growth of the current year (FOREST)	(gDW m^{-2})
XROOTN	(N_r) N in roots (FOREST)	(gN m^{-2})
XROOTQN	(N_{Qr}) N in roots older than one year (FOREST)	(gN m^{-2})
XROOTQW	(Q_r) Biomass in roots older than one year (FOREST)	(gDW m^{-2})
XROOTW	(W_r) Accumulated root growth of the current year (FOREST)	(gDW m^{-2})
XSTEMN	(N_s) N in stem (FOREST)	(gN m^{-2})
XSTEMQN	(N_{Qs}) N in stems older than one year (FOREST)	(gN m^{-2})
XSTEMQW	(Q_s) Biomass in stem older than one year (FOREST)	(gDW m^{-2})
XSTEMW	(W_s) Accumulated stem growth of the current year (FOREST)	(gDW m^{-2})

7.2 Flows

Variable	(Symbol) Explanation	Unit
ALEAFGN	Nitrogen flow : From leaves to grains (CROP)	(gN m^{-2} d^{-1})
ALEAFGW	Biomass flow : From leaf to grain (CROP)	(gDW m^{-2} d^{-1})
ALEAFLIN	Nitrogen flow : (N_l'(ut)) Leaf litter (CROP)	(gN m^{-2} d^{-1})
ALEAFLIW	Biomass flow : from leaves to above ground residues (CROP)	(gDW m^{-2} d^{-1})
ALEAFSN	Nitrogen flow : From leaf to stem (CROP)	(gN m^{-2} d^{-1})
ALEAFSW	Biomass flow : From leaf to stem (CROP)	(gDW m^{-2} d^{-1})
APHOTLW	(W_r') Daily gross leaf growth (CROP)	(gDW m^{-2} d^{-1})
APHOTRW	(W_r'(in)) Daily gross root growth (CROP)	(gDW m^{-2} d^{-1})
APHOTSW	(W_s'(in)) Daily gross stem growth (CROP)	(gDW m^{-2} d^{-1})
AROOTGN	Nitrogen flow : from root to grain (CROP)	(gN m^{-2} d^{-1})
AROOTGW	Biomass flow : from root to grain (CROP)	(gDW m^{-2} d^{-1})
AROOTLIC	Carbon flow : (C_r'(ut)) Root litter (CROP) (Index= layer 1 to min(NUMLAY,10))	(gC m^{-2} d^{-1})
AROOTLIN	Nitrogen flow : (N_r'(ut)) Root litter (CROP)	(gN m^{-2} d^{-1})
AROOTLIW	Biomass flow : from root to litter (CROP)	(gDW m^{-2} d^{-1})
AROOTSN	Nitrogen flow : from root to stem (CROP)	(gN m^{-2} d^{-1})
AROOTSW	Biomass flow : from root to stem (CROP)	(gDW m^{-2} d^{-1})
ASOILGN	Nitrogen flow : From soil to grain (CROP)	(gN m^{-2} d^{-1})
ASOILLN	Nitrogen flow : From soil to leaves (CROP)	(gN m^{-2} d^{-1})
ASOILRN	Nitrogen flow : From soil to root (CROP)	(gN m^{-2} d^{-1})
ASOILSN	Nitrogen flow : From soil to stem (CROP)	(gN m^{-2} d^{-1})
ASTEMGN	Nitogen flow : From stem to grains (CROP)	(gN m^{-2} d^{-1})
ASTEMGW	Biomass flow : From stem to grain (CROP)	(gDW m^{-2} d^{-1})
ASTEMLIN	Nitrogen flow : (N_s'(ut)) Stem litter (CROP)	(gN m^{-2} d^{-1})
ASTEMLIW	Biomass flow : from stem to above ground residues (CROP)	(gDW m^{-2} d^{-1})
CFLOSS	Carbon flow: Faeces-C loss (mineralisation + humification) (Index= layer 1 to 2)	(gC m^{-2} d^{-1})
CHARV	Carbon flow: Harvest export of plant-C (CROP)	(gC m^{-2} d^{-1})
CLLOSS	Carbon flow: Litter-C loss (mineralisation + humification) (Index= layer 1 to min(NUMLAY,10))	(gC m^{-2} d^{-1})

DECALEAC	Carbon flow: Losses of above-ground residue-C to boundary through leaching	(gC m^{-2} d^{-1})
DECALEAN	Nitrogen flow: Leaching of above-ground residue-N to soil ammonium NH4(1)	(gN m^{-2} d^{-1})
DECALIT	Nitrogen flow: Above-ground residue-N to litter NL(1)	(gN m^{-2} d^{-1})
DECALITC	Carbon flow: Above-ground residue-C to litter CL(1)	(gC m^{-2} d^{-1})
DENI	Nitrogen flow: Denitrification of NO3-N (Index= layer 1 to min(NUMLAY,10))	(gN m^{-2} d^{-1})
DEPONH4	Nitrogen flow: Deposition (wet and dry) of ammonium N to soil ammonium NH4(1)	(gN m^{-2} d^{-1})
DEPONO3	Nitrogen flow: Deposition (wet and dry) of nitrate N to soil nitrate NO3(1)	(gN m^{-2} d^{-1})
DLOSS	Nitrogen flow: NO3-N leaching to tiles (Index= layer 1 to NUMLAY)	(gN m^{-2} d^{-1})
FERTIN	Nitrogen flow: Application of soild fertilizer	(gN m^{-2} d^{-1})
FINCB	Carbon flow: Carbon in faeces in manure to faeces-C (Index= layer 1 to 2)	(gC m^{-2} d^{-1})
FINNA	Nitrogen flow: Nitrogen in bedding in manure to litter-N (Index= layer 1 to 2)	(gN m^{-2} d^{-1})
FINNB	Nitrogen flow: Nitrogen in faeces in manure to faeces-N (Index= layer 1 to 2)	(gN m^{-2} d^{-1})
FINNH	Nitrogen flow: Nitrogen in NH4 in manure to NH4-N (Index= layer 1 to 2)	(gN m^{-2} d^{-1})
FNIT	Nitrogen flow: Nitrification of NH4-N to NO3-N (Index= layer 1 to min(NUMLAY,10))	(gN m^{-2} d^{-1})
HARVGN	Nitrogen flow : harvest of grain (CROP)	(gN m^{-2} veg.per.$^{-1}$)
HARVGW	Biomass flow : harvest of grain (CROP)	(gDW m^{-2} veg.per.$^{-1}$)
HARVLN	Nitrogen flow : harvest of leaves (CROP)	(gN m^{-2} veg.per.$^{-1}$)
HARVLW	Biomass flow : harvest of leaves (CROP)	(gDW m^{-2} veg.per.$^{-1}$)
HARVSN	Nitrogen flow : harvest of straw (CROP)	(gN m^{-2} veg.per.$^{-1}$)
HARVSW	Biomass flow : harvest of straw (CROP)	(gDW m^{-2} veg.per.$^{-1}$)
INCALIT	Nitrogen flow: Plant to above-ground residue	(gN m^{-2} d^{-1})
INCALITC	Carbon flow: Plant to above-ground residue	(gC m^{-2} d^{-1})
NEWCL	Carbon flow: Incorporation of plant carbon or above-ground residues to litter-C (Index= layer 1 to min(NUMLAY,10))	(gC m^{-2} d^{-1})
NEWNL	Nitrogen flow: Plant-N to litter-N (Index= layer 1 to min(NUMLAY,10))	(gN m^{-2} d^{-1})

NFERTNH4	Nitrogen flow: Dissolve rate of solid fertiliser to soil ammonium	(gN m^{-2} d^{-1})
NFERTNO3	Nitrogen flow: Dissolve rate of solid fertiliser to soil nitrate	(gN m^{-2} d^{-1})
NFHUM	Nitrogen flow: Humification of faeces-N to humus-N (Index= layer 1 to 2)	(gN m^{-2} d^{-1})
NFLOW	Nitrogen flow: NO3-N flow between layers (Index= layer 1 to NUMLAY-1)	(gN m^{-2} d^{-1})
NFMIN	Nitrogen flow: Mineralisation of faeces-N to NH4-N (Index= layer 1 to 2)	(gN m^{-2} d^{-1})
NHARV	Nitrogen flow: Harvest export of plant-N (CROP)	(gN m^{-2} d^{-1})
NHMIN	Nitrogen flow: Mineralisation of humus-N to NH4-N (Index= layer 1 to min(NUMLAY,10))	(gN m^{-2} d^{-1})
NLHUM	Nitrogen flow: Humification of litter-N to humus-N (Index= layer 1 to min(NUMLAY,10))	(gN m^{-2} d^{-1})
NLMIN	Nitrogen flow: Mineralization/immobilization of litter-N to NH4-N (Index= layer 1 to min(NUMLAY,10))	(gN m^{-2} d^{-1})
PHOS	(W_t') Biomass flow : Assimilation rate (CROP)	(gDW m^{-2} d^{-1})
RESPGW	Biomass flow : respiration rate of grains (CROP)	(gDW m^{-2} d^{-1})
TAVAININ	Nitrogen flow : (N_a'(in)) N input to the pool of available assimilates (FOREST)	(gN m^{-2} d^{-1})
TAVAINUT	Nitrogen flow : (N_a'(ut)) Losses from the pool of available assimilates (FOREST)	(gN m^{-2} d^{-1})
TAVAIWIN	Biomass flow : (W_a'(in)) Input to the pool of available assimilates (FOREST)	(gDW m^{-2} d^{-1})
TAVAIWUT	Biomass flow : (W_a'(ut)) Losses from the pool of available assimilates (FOREST)	(gDW m^{-2} d^{-1})
THARVLN	Nitrogen flow : harvest of leaves (FOREST)	(gN m^{-2} veg.per.$^{-1}$)
THARVLW	Biomass flow : harvest of leaves (FOREST)	(gDW m^{-2} veg.per.$^{-1}$)
THARVN	Nitrogen flow: Harvest export of plant-N (FOREST)	(gN m^{-2} d^{-1})
THARVSN	Nitrogen flow : harvest of stem (FOREST)	(gN m^{-2} veg.per.$^{-1}$)
THARVSW	Biomass flow : harvest of stem (FOREST)	(gDW m^{-2} veg.per.$^{-1}$)
TLEAFALN	Nitrogen flow : () Leaf fallen to ground (FOREST)	(gN m^{-2} d^{-1})
TLEAFALW	Biomass flow : () Leaf fallen to ground (FOREST)	(gDW m^{-2} d^{-1})
TLEAFNIN	Nitrogen flow : (N_l'(in)) N uptake to leaves (FOREST)	(gN m^{-2} d^{-1})
TLEAFNUT	Nitrogen flow : (N_l'(ut)) N losses from leaves (FOREST)	(gN m^{-2} d^{-1})
TLEAFWIN	Biomass flow : (W_l'(in)) Input of assimilates leaves (FOREST)	(gDW m^{-2} d^{-1})

TLEAFWUT	Biomass flow : (W_l'(ut)) Loss from leaves (FOREST)	(gDW m^{-2} d^{-1})
TPHOS	(W_t') Biomass flow : Assimilation rate (FOREST)	(gDW m^{-2} d^{-1})
TRESPQL	Biomass flow : respiration of leaves. (CROP and FOREST). For forest resperation of old tissues	(gDWm^{-2} d^{-1})
TRESPQR	Biomass flow : respiration of root (CROP and FOREST). For forest resperation of old tissues	(gDW m^{-2} d^{-1})
TRESPQS	Biomass flow : respiration of stem (CROP and FOREST). For forest resperation of old tissues	(gDWm^{-2} d^{-1})
TROOTNIN	Nitrogen flow : (N_r'(in)) N uptake to root (FOREST)	(gN m^{-2} d^{-1})
TROOTNUT	Nitrogen flow : (N_r'(ut)) Loss of root N (FOREST)	(gN m^{-2} d^{-1})
TROOTWIN	Biomass flow : (W_r'(in)) Input of assimilates to root (FOREST)	(gDW m^{-2} d^{-1})
TROOTWUT	Biomass flow : (W_r'(ut)) Loss of root biomass to litter (FOREST)	(gDW m^{-2} d^{-1})
TSTEMNIN	Nitogen flow : (N_s'(in)) N uptake to stem (FOREST)	(gN m^{-2} d^{-1})
TSTEMQWUT	Biomass flow : (Q_s'(ut)) Loss of stem older than one year (FOREST)	(gDW m^{-2} d^{-1})
TSTEMWIN	Biomass flow : (W_s'(in)) Input of assimilates to stem (FOREST)	(gDW m^{-2} d^{-1})
UPPNH4	(X_{NH4u}(i)) Nitrogen flow: Plant uptake of NH4-N to plant-N (Index= layer 1 to min(NUMLAY,10))	(gN m^{-2} d^{-1})
UPPNO3	(X_{NO3u}(i)) Nitrogen flow: Plant uptake of NO3-N to plant-N (Index= layer 1 to min(NUMLAY,10))	(gN m^{-2} d^{-1})

7.3 Auxiliaries

Variable	(Symbol) Explanation	Unit
AEFF	For the mineralisation process. Combined effect of soil water content and soil temperature (concerning layer see OUTLAY parameter)	(-)
AEFFD	For the denitrification process. Combined effect of soil water content and soil temperature for a layer	(-)
AEFFN	For the nitrification process. Combined effect of soil water content and soil temperature for a layer	(-)
ALI	(A_{li}) Leaf area index (CROP)	(-)
ATEFF	For the mineralisation process. Effect of soil temperature (concerning layer see OUTLAY parameter)	(-)
ATEFFD	For the denitrification process. Effect of soil temperature for a layer	(-)
ATEFFN	For the nitrification process. Effect of soil temperature for a layer	(-)

BI	(b_i) Leaf area to shoot biomass ratio ($=A_{li}/W_{sh}$) (CROP).	(m^2 gDW^{-1})
BR	(b_r) Root allocation function ($=W_r'/W_t'$) (CROP)	(-)
CLTPROF	Litter-C in whole profile	(gC m^{-2})
FERNSIM	N supply simulated by the model. As NH_4 if FERNCALC-switch = 1 and as NO_3 if the switch = 2	(gN m^{-2} d^{-1})
GALI	(A_{li}) Leaf area index (FOREST)	(-)
GALIIN	(A_{li}'(in)) Daily increase of leaf area index (FOREST)	(d^{-1})
GALIUT	(A_{li}'(ut)) Daily decrease of leaf area index (FOREST)	(d^{-1})
GBA	(b_A) Ratio between leaf biomass and leaf area ("leaf thickness") (FOREST)	(gDW m^{-2})
GBI	(b_i) Leaf area to shoot biomass ratio ($=A_{li}/W_{sh}$) (FOREST).	(m^2 gDW^{-1})
GBR	(b_r) Root allocation function ($=W_r'/W_t'$) (FOREST)	(-)
GLEAFDN	Nitrogen flow : leaves nitrogen demand (FOREST)	(gN m^{-2} d^{-1})
GNAVAI	(n_a) The ratio between nitrogen and assimilates of the available pool (FOREST)	(-)
GNLEAF	(n_l) Actual leaf nitrogen concentration (FOREST)	(-)
GNROOT	(n_r) Actual root nitrogen concentration (FOREST)	(-)
GNSTEM	(n_s) Actual stem nitrogen concentration (FOREST)	(-)
GPN	This variable corresponds to W_t', however, not including maintanence respiration and allocation from the available pool (see PHOS for CROP). If the FORPHOTO-switch is ON: ($P_d(1-r_g)/v_d$) Daily net canopy photosynthesis at optimum temperature and water conditions. (FOREST)	(gDW m^{-2} d^{-1})
GPOTUPT	(X_{Nd}) Potential plant uptake of NO_3-N + NH_4-N (FOREST)	(gN m^{-2} d^{-1})
GROOTDEPT	(z_r) Root depth (FOREST)	(m)
GROOTDN	Nitrogen flow : roots nitrogen demand (FOREST)	(gN m^{-2} d^{-1})
GRPTEM	(f_T) Plant growth response function to temperature (FOREST)	(-)
GSTEMDN	Nitrogen flow : stem nitrogen demand (FOREST)	(gN m^{-2} d^{-1})
GTOTUPT	(X_{Nu}) Actual plant uptake of NO_3-N + NH_4-N, total profile (FOREST)	(gN m^{-2} d^{-1})
GUPST	Last day of growing season (FOREST)	(d)
LEAFDN	Nitrogen flow : leaves nitrogen demand (CROP)	(gN m^{-2} d^{-1}
NCONC	Concentration of NO_3-N in soil solution (Index= layer 1 to NUMLAY)	(mgN l^{-1})
NFTPROF	Faeces-N in whole profile	(gN m^{-2})

NGRAIN	(n_g) Actual nitrogen concentration of grain (CROP)	(-)
NH4T	NH4-N in whole profile	(gN m^{-2})
NHTPROF	Humus-N in whole profile	(gN m^{-2})
NLEAF	(n_l) Actual leaf nitrogen concentration (CROP)	(-)
NLEAFNEW	(n_l') Actual nitrogen concentration of newly formed leaves (the ratio between daily uptake of nitrogen and biomass to the leaves) (CROP)	(-)
NLTPROF	Litter-N in whole profile	(gN m^{-2})
NO3T	NO3-N in whole profile	(gN m^{-2})
NROOT	(n_r) Actual root nitrogen concentration (CROP)	(-)
NSTEM	(n_s) Actual stem nitrogen concentration (CROP)	(-)
ODNO3	"Partly measured" leaching of NO3-N to tile drainage system (from all layers) ,i.e., measured NO3 concentration multiplied by simulated water flows from drainage tile system.	(gN $m^{-2}d^{-1}$)
PHEFF	Effect of soil acidity on nitrification (Index= layer 1 to min(NUMLAY,10))	(-)
PIPEL	Leaching of NO3-N to tile drainage system (from all layers)	(gN m^{-2} d^{-1})
PIPENO3C	Concentration of NO3-N in tile drainage	(mgN l^{-1})
PIPEQ	Water flow to drainage tiles (from total profile)	(mmH_2O d^{-1})
POTUPT	(X_{Nd}) Potential plant uptake of NO3-N + NH4-N (CROP)	(gN m^{-2} d^{-1})
QNO3C1	Concentration of NO3 in stream water.	(mgN l^{-1})
QNO3C2	Concentration of NO3 in stream water after N-consumption in stream.	(mgN l^{-1})
RATCNF	C-N ratio of faeces (Index = layer 1 to min(NUMLAY,2))	(-)
RATCNL	C-N ratio of litter (Index = layer 1 to min(NUMLAY,10))	(-)
RISGROUN	(I_g) Radiation reaching the soil surface. Only used if the GROWTH-switch > 0	(W m^{-2})
ROOTDENSI	Root biomass per soil volume (Index = layer 1 to min(NUMLAY,7))	(gDW m^{-1})
ROOTDEPTH	(z_r) Root depth (CROP)	(m)
ROOTDN	Nitrogen flow : roots nitrogen demand (CROP)	(gN m^{-2} d^{-1})
ROOTPROF	Root biomass per soil layer. For FOREST only current year old roots (Index = layer 1 to min(NUMLAY,7))	(gDW m^{-2})

RPN	(f_N) Photosynthesis response function to nitrogen availability (CROP)	(-)
RPTEM	(f_T) Plant growth response function to temperature (CROP)	(-)
RPTOT	(f_{Tot}) Photosynthesis response function, combined effect of soil water stress (ETR), nitrogen availability (RPN) and temperature (RPTEM). (CROP)	(-)
RUSENO3	NO3-N consumption in stream water	(gN m^{-2} d^{-1})
STEMDN	Nitrogen flow : stem nitrogen demand (CROP)	(gN m^{-2} d^{-1})
STREAMQ	Water flow in stream	(mmH_2O d^{-1})
STREAMT	Total leaching of NO3-N to stream flow (including tile drainage, surface runoff and ground water percolation)	(gN m^{-2} d^{-1})
SUMN	An estimated sum of N available for plant uptake. Only used if FERNCALC-switch = 2.	(gN m^{-2})
TOTDEN	Actual denitrification (from total profile)	(gN m^{-2} d^{-1})
TOTFI	Total leaching of NO3-N to stream flow after N-consumption in stream	(gN m^{-2} d^{-1})
TOTMAE	Flow of nitrogen in faeces in manure to faeces-N (in total profile)	(gN m^{-2} d^{-1})
TOTMAL	Flow of nitrogen in bedding in manure to litter-N (in total profile)	(gN m^{-2} d^{-1})
TOTMAN	Flow of nitrogen in NH4 in manure to NH4-N (in total profile)	(gN m^{-2} d^{-1})
TOTNFMIN	Mineralization/immobilization of faeces-N to NH4-N (in total profile)	(gN m^{-2} d^{-1})
TOTNHMIN	Mineralisation of humus-N to NH4-N (in total profile)	(gN m^{-2} d^{-1})
TOTNIT	Nitrification of NH4-N to NO3-N (in total profile)	(gN m^{-2} d^{-1})
TOTNLMIN	Mineralization/immobilization of litter-N to NH4-N (in total profile)	(gN m^{-2} d^{-1})
TOTUPT	(X_{Nu}) Actual plant uptake of NO3-N + NH4-N, total profile (CROP)	(gN m^{-2} d^{-1})
VDEV	(i_g) Index that determines the start of grain development (CROP)	(-)

7.4 Drivings

Variable	Explanation	Unit

DFLOW	Driving variables: Water flow to drainage tiles, ground water flow and surface runoff because of limited hydraulic conductivity in the soil. (Index= layer 1 to NUMLAY). DFLOW in the SOIL model.	($mmH_2O\ d^{-1}$)
ETR	Transpiration ratio (actual/potential)	(-)
INFIL	Driving variable: Infiltration of water into the soil surface (including infiltration from surface pool).	($mmH_2O\ d^{-1}$)
MEACONC	Measured concentration of NO3 in tile drainage.	($mgN\ l^{-1}$)
PERC	Driving variable: Ground water flow. PERC in the SOIL model.	($mmH_2O\ d^{-1}$)
RIS	(I) Solar radiation (300-3000 nm)	($MJm^{-2}\ d^{-1}$)
SURR	Driving variable: Runoff above surface because of limited infiltration capacity in the soil surface. SURR in the SOIL model.	($mmH_2O\ d^{-1}$)
TA	(T) Air temperature	(°C)
TEMP	Driving variables: Soil temperature (Index= layer 1 to NUMLAY) TEMP in the SOIL model.	(°C)
THETA	Driving variables: Volumetric water content (Index= layer 1 to NUMLAY). THETA in the SOIL model.	(%)
WFLOW	Driving variables: Water flow between soil layers (Index= 1 to NUMLAY-1). WFLOW in the SOIL model.	($mmH_2O\ d^{-1}$)

8 Run options

Are used to specify the timestep, the temporal representation of output variables and the period for the simulation.

8.1 Run no.:

8.2 Start date:

8.3 End date:

8.4 Output interval:

The output interval determines how frequent the output variables will be written to the output file. The actual representation of the requested output variables can either be a mean value of the whole time interval or the actual value at time of output (see the switches, AVERAGEX, T.., G.., D..). You can specify the output interval as integers with units of days or minutes.

days:

minutes:

8.5 No of iterations:

The time step of the model is one day. No other values are allowed.

8.6 Run id:

Any string of characters may be specified to facilitates the identification of your simulation in addition to the run number. The identification given will be written in the variable identification field used by the Pgraph-program. Be careful when using long strings of characters since the default information for identification of a field may be overwritten in some cases.

8.7 Comment:

9 Execute

9.1 Exit

The exit command will terminate the interactive session and quit the program without starting a simulation. If a parameter file has been created the input will be saved otherwise all information entered will be lost.

9.2 Run

The run command will terminate the interactive session and start a simulation using the instructions entered. All the instructions are also written to the .SUM-file which may be used as a parameter file if you would like to reproduce the simulation.

9.3 Write parameter file

This will create a new parameter file which includes all the instructions which are specified when the command is given. The new parameter file can be used as an input file if you would like to run the model using instructions from the new parameter file.

10 Warnings and Errors

If you specify your input files or your parameter values in a strange way you may get informations about this before you start executing the model. There are two level: Warnings and Errors.

Normally you will be informed about warning or errors after you have modify a parameter value and moved to the new submenu. Some errors are the results of combinations of different parameters values and they may not occurr before you try to run the model. In this situation a final check of all input files and all relevant parameter values are made. If the final check results in any messages you can always return to the PREP program and continue to modify your instructions so they will be within valid ranges of accepted intervals. If you do so the list of messages are found in an window under the execute menu.

In case of errors, the most servere level, there are no chance to run the model but in case of only warnings you may try to run the model without correcting your instructions.

11 Commands

You start the preparation of a simulation by pressing

```
PREP SOILN
```

on the command line of the DOS system. This will be the starting point for adding any type of new instuctions for your simulation. If a parameter file named SOILN.PAR is present at the current directory default values from that file will be used otherwise original model default values will be used.

You can also start the interactive session with values taken from parameter file by entering the name of the parameter file name on the command line:

```
PREP SOILN DEMO
```

will result in default values from the parameter file DEMO.PAR.

You run the SOILN model in batch mode, which means that you will not make use of the interactive session at all. Instead you will run the model from default values.

```
PREP -b SOILN DEMO
```

which will result in a simulation making use of information from the DEMO.PAR file. If information is missing in the DEMO.PAR file values from the original model definition file will be used. A parameter file does not need to be complete. It may be restricted to only instructions that need to be changed compared to what is found in the original model definition file. There are also a possibility to specify a number of parameter files on the command line:

```
PREP -b SOILN DEMO NEWGROWTH NEWTIME
```

This means that the PREP program will first read the intructions in the DEMO.PAR file, then the NEWGROWTH.PAR file and finally the NEWTIME.PAR file. If information for one parameter is read several times the one read last will be used. Remember that the parameter files may not be complete. They can be organized with only information about evaporation in the NEWGROWTH.PAR file information about run options like time periods in the NEWTIME.PAR file.

12 Additional information

12.1 Help

Just press the F1 key and you are transferred to the help utility.

In some situations you will get simultaneous help as you move between different items in the ordinary menues. In such a case you are fully transferred to the help by using the F2 key which may be necessary if the information from the help library is not fully within the size of the current size of the help window.

12.2 Acknowledgement

The SOILN model is the result of many years work. A number of persons have contributed with ideas and suggestions. This could easily be seen from the reference list. The present updating of the SOILN model to fit the new interface (PREP program of January 1991) was a joint effort by the authors of this report. Per-Erik Jansson has a general responsibility for the model, Henrik Eckersten is responsible for the plant growth parts and Holger Johnsson is responsible for the soil nitrogen processes. For a future successful work with the model you are welcomed with your contribution. The development of the PREP program was made by Per-Erik Jansson and Jan Clareus.

If you get problems, find bugs or just want to report an interesting phenomena please let us know about it. Write to:

Henrik Eckersten/Per-Erik Jansson/Holger Johnsson*
Department of Soil Science
Swedish University of Agricultural Sciences
P.O. Box 7014
S-750 07 Uppsala
Sweden

*) Present P.O. Box for Holger Johnsson is 7072.

Remember to send a copy of your input data files and the commands used when you get any problems.

12.3 References

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12.4 News

Important changes in new versions will be mentioned here.

November 1991
The SOILNFOR.AUT file is cancelled. The information of that file (annual outputs) is instead stored in the SOILNnnn.SUM file.

April 1992
A) Changed parameter names:
Nine parameter names in the "Crop biomass" group, 28 in the "Forest" groups and 2 in the "Plotting on line" group have been changed.
How to update previous version of SOILN:
You have to change names in your parameter files. If you are a user of the CROP-switch or the FORESTSR-switch you have to make several changes. The new names are similar to the old ones. For all other users only STXTGD should be changed to XTGD and STPMAX to PMAX.

B) Added and modified parameters:
The litter fall functions are modified both for the CROP- and FORESTSR-switches. Altogether one parameter is replaced (ALITTER by ALITTERS) and four are added (ALEAFAGE, ALITTERR, ZLEAFAGE, ZALIUTX). In CROP leaves fall when they have reached a certain age (ALEAFAGE). The stem litter is proportional to the stem biomass (ALITTERS) whereas the root litter is proportional to the daily growth (ALITTERR). In FOREST the leaves fall according to the same function as in CROP (ZLEAFAGE). The leaf fall due to self-shading is possible to limit (except with ZID) with a new parameter (ZALIUTX). However, this parameter and the old time dependent function for leaf fall are included in the SPECIAL-option and not normally used (ZKM, ZTDA).
How to update previous version of SOILN:
If you use the CROP-switch or the FORESTSR-switch the new parameter names have to be included in the parameter files.

C) Added output variables:
Some additional output variables have been added for the FORESTSR-switch (7 T- and 6 G-variables). The SOILNFOR.TRA-file is replaced by a new SOILN.TRA-file. How to update previous version of SOILN:
If you use the FORESTSR-switch then replace your old SOILNFOR.TRA-file by the new SOILN.TRA-file.

November 1992
New version of the model: 7.0
The CROP-switch and FOREST-switch are cancelled and included in the GROWTH-switch which now can range between 0 and 8. GROWTH-switch: =0 as before, =1 CROP, =2 FOREST, =3-8 mixed stands. The mixed stand is simulated making use of the same model structure as for the mono-culture stand. The second stand in the mixed structure is simulated by making one loop more within each time step.
Some other minor additions have also been done, f.i. in the crop submodel it is possible to let biomass in different organs remain living after harvest.

March 1993
A number of new state variables was introduced to improve the presentation of the mass balance of nitrogen. They have all the unit gN m-2.
ACCFERT, ACCMAN, ACCDEP, ACCHARV, ACCSTORE, ACCBAL

June 1993
The UPMOV parameter was reintroduced in the model. The parameter value has been fixed to unity during the period from May 1992 to June 1993.

October 1993
Only for the CROP-submodel: Corrected two errors concerning nitrogen litter fall after harvest (previous version did not reset this value after harvest).

November 1993
Only for the CROP-submodel: (i) A new root allocation function is introduced for brw= a-bln(Wt). (ii) A new allocation pattern for assimilates from leaf and root to stem is introduced. This is activated by setting switch GROWALLO ON. Then allocation from leaf or root to grain is cancelled and instead allocated to stem (new output variables are ALEAFSW,AROOTSW,ALEAFSN,AROOTSN). ALEAFSW and ALEAFSN is determined by leaffall ALEAFSW=ALEAFFAL*AGRAIN(1), the rest is going to litter. The nitrogen is treated similar ALEAFSN= ALEAFFAL*NLEAF*AGRAINN(1). Root allocation is determined by AGRAIN(3) and AGRAINN(3) as before. Grain receives assimilates only from stem. (iii) A mass balance check option can be activated by setting parameter xtgd = -97.

February 1994
Only for the CROP-submodel: (i) A new root allocation function is introduced for brn= a+b*exp(-c*(nlx-nl)/(nlx-nln)). a, b and c are given by parameters AROOTNI(1-3). Switch GROWALLO is activating this function. GROWALLO = 1 means: both new leaf,stem and root function (Nov 4 1993) and the new root function are activated; =2: only the first function; =3 only the last function. Three parameters were renamed HARLR to HARL, HARHP to HARS, HARAR to HARLR. They changed there meaning if GROWTH-switch >0, see below. Two parameters were introduced HARLL, HARLS. The meaning of parameters are now: HARL is the fraction of LEAF harvested, HARS is the fraction of stem harvested. HLIVEL is the fraction of non harvested leaves still alive. HARLS is the same for stem. The rest is going to INCALIT. HARLR is the fraction of roots still alive the rest is going to litter. Parameeter CNARES is not active if GROWTH >0. CNARES is given by simulated C/N ratios of biomass.

July 1994
Several changes has been made. New output variables have been introduced, more flexible choise of deposition and fertilisation, new check routines, among others.

This version: 1994-Oct-19

13 Appendix1: Run SOILN under the Windows program

The description below holds for the SOILNVB.EXE program made by H. Eckersten, Swedish University of Agricultural Sciences, and dated 1994-08-03.

Normally the SOILN model is used together with the SOIL model (Jansson 1991a), therefore the link to SOIL will mentioned below.

13.1 How to run SOILN

Run under DOS

Firstly, we make a short summary of which programs and files that are involved when running SOILN under DOS, in an ordinary way.

The SOILN model is executed by the program file SOILN.EXE. There are some associated files to this program. A help-file with variable descriptions etc (SOILN.HLP), a file with standard parameter values and other informations needed by the model (SOILN.DEF) and a file including titles and units of the output variables (SOILN.TRA).

The model is run by using a program file named PREP.EXE. This program helps you preparing the simulation, i.e. you can select parameter values, input files, simulation period etc. The PREP program illustrates well the in- and outputs of the model (type for instance, >prep soiln). All information needed for PREP can be stored in a parameter file (xxxx.PAR-file). You can give instructions to PREP to take the information from that file. PREP is the program that can activate SOILN.EXE, i.e. to start the simulation. Output from the simulation are stored in two files, SOILN001.BIN and SOILN001.SUM. The first file (.BIN) includes the values of the simulated variables. The second file (.SUM) includes both a summary of all outputs (averages, sums, etc.) and the prerequisites for the simulation (i.e. the inputs) which can be used to repeat the simulation if it is renamed to xxxx.PAR.

You can look on the results and make further evaluations of the simulation outputs (SOILN001.BIN) with help of a special program, PG.EXE.

Run under WINDOWS (SOILNVB)

The principal idea for this program (SOILNVB.EXE) is simply to make use of already developed DOS programs and applications. The programming is restricted to this "administration" of the operative programs and routines for running the model, present results etc., programmed under DOS. SOILNVB.EXE is programmed in Windows-VisualBasic and is possible to run under WINDOWS if the VBRUN300.DLL file exists on some directory on your computer, with path to.

You start SOILNVB from the run option of WINDOWS, or by double click on the icon (if installed).

In the program SOILNVB you always start with the bottom denoted "Start here". Note, that in the SOILNVB program you should always use only single click. Then you select application and, in most cases, directory and model. Thereafter you normally continue with "Preparation". (If you already have made a complete "Preparation", and want to have free access to any part of the program, you select "Check off". The Check option only checks the order in which you select options in the program during one and the same run. If you leave the program the Check is reseted.)

The program itself enables a good overview of the principal way of using the model. If a complete run ("Preparation", "Simulation", etc) has been made the different options in the schedule can, in principal, be chosen in any order at any time. However, for the first run you have to choose them in the following order:

(i) PREPARATION of INPUT.
Copies input files to the working directory. Note, that the routines under this option overwrites files at the working directory, without warnings.

(ii) PRESENTATION of INPUT.
Variables in input files named AIN_CLIM.BIN, AIN_SOIP.DAT etc are presented.

(iii) SIMULATION.
The results are stored in files named SOILNCUR.bin and SOILNCUR.sum (CUR denotes the current simulation).

(iv) PRESENTATION of OUTPUT.

Variables in SOILNCUR.bin are presented. Variables that are presented are grouped in accordance to subjects like water, heat etc. You can also compare results with a previous run, or a simulation that has been stored, see below.

(v) STORE FILES.

Here you can store the simulation results (SOILNCUR.*) under a different name. You can also recover a previous stored simulation to the name (SOILNCUR.*), thereby making it available for use in the presentation options etc.

(vi) SOIL-SOILN INTERACTION.

You should use this option if you want the current SOILN simulation to be input to the SOIL model, or vice versa.

13.2 Alternative use of SOILNVB

File list

In the "Preparation" option of SOILNVB files can be selected arbirarily by selecting "file list" in the list menus.

Use PG-program manually

The PG-program can be used in a standard (interactive) way within SOILNVB. SOILNVB brings you only to the proper file.

Use PREP-program manually

The PREP-progam can be run in a standard (interactive) way within SOILNVB. If you have made "Preparation" the prepared AIN_.PAR files are read by PREP. The files are read in the following order: AIN_SOIL.PAR, AIN_PLAN.PAR, AIN_OUT.PAR, AIN_TIME.PAR, AIN_MAN.PAR. If you do not want to load the parameters files you have chosen with "Preparation", then select "Check off" before entering PREP.

Only one parameter file

To run SOILNVB with only one parameter file ONE.PAR.
1) Store a full set up of input files under ...\XXXX\N\NA, as usual, but let all parameter files be empty.
2) Store ONE.PAR at the same directory under the name AIN_MAN.PAR.
3) Start SOILNVB and make "Full Preparation" "Standard".

Multiple runs

Up to 7 multiple simulations can be done.....

Initial states of previous run

Make a simulation using outputs of the previous simulation as initial states in the new simulation.

Alternative applications under directory ... \XXXX\...

Often several versions of the same main application is wanted to be run by SOILNVB. For the "Standard" application one way of running these versions and to store them separately is to do as follows:

1) Store a full set up of input files under ...\XXXX\N\NA, as usual.
2) Store a backup of these files under ...\NA\STANDARD.
3) Store the files changed due the specific version under a separate directory named f.i. VERSION1, i.e. ...\NA\VERSION1. Do not change the name of the files and remember to store the INFON.LIS file in which you give some identification of the application stored in the directory.
4) Copy files from VERSION1 directory to ...\NA by making use of COPYPREN.BAT (i.e. type >COPYPREN XXXX VERSION1).
5) Start SOILNVB and make "Full Preparation" "Standard".

13.3 File preparations for SOILNVB

The description below refers to the "Standard" application.

Directory structure

The directory name given when choosing application should be XXXX in: C\:sim\soilns\XXXX.

Under this directory we find the "working-directory" named ...\XXXX\N. In the "working-directory" all your preparations and simulation results are stored. The meaning is that it is up to the user to delete files within the directory. First time you run the program the directory is empty. When you run the program and make preparation, files are stored on the "working-directory". (For the SOIL model the "working-directory" is named ...\XXXX\S.)

In the sub-directories below the "working-directory" program and data files are stored. They should not be deleted by the user.

When starting the "Preparation" option in SOILNVB files are always copied from ...\XXXX\N\NA\START. These are files related to programs and are common for all applications.

When selecting an option within the "Preparation" option files are copied from ...\XXXX\N\NA. These are files, mostly input data, that can differ between applications.

PG-instruction files used throughout SOILNVB are stored in ...\XXXX\N\NA\PG. Files are copied from this directory to the "working directory" as soon as PG is used. Some files are stored at the "working directory", and not overwritten until a "Soil preparation" is made, to allow the user to make changes in the presentations. There are two standard sets of files of the ...\PG-directory; one to use when the CROP-model is applied and one when the FOREST-model is applied.

No other directories are used by SOILNVB.

Files

Directory ... \XXXX\N; "Working directory"

AIN_CLIM BIN	Driving variables
*AIN_CLIM BPR	Previous version of AIN_CLIM.BIN
AIN_FERT BIN	N input variables
*AIN_FERT BPR	Previous version of AIN_FERT.BIN
AIN_FERT DAT	N input variables as ASCCI
AIN_FERT DDE	Variable description for AIN_FERT.DAT
AIN_INI INI	Initial values of state variables
AIN_MAN PAR	Management parameters. Parameter groups: External Inputs, Soil Managements, Crop Management and related Switches (CHAPAR, DRIVEXT, DRIVMANA, DRIVPG, MANURE). Note that CHAPAR should be used in this file only. (Read by PREP as nr 5)
AIN_OUT PAR	Output variables. Parameter Groups: Plotting on line; Selected Output Variables and related Switches (OUTFORN, OUTSTATE); Files. Note, that OUTFORN must be ON otherwise none of the PG-instruction files will work, then f.i. none of the "PRESENTATION" options will work. (Read by PREP as nr 3)

AIN_PLAN PAR	Plant parameters. Parameter Groups: Nitrogen uptake by roots, Crop Biomass, Crop Nitrogen and related Switches (CROPALLO, CROPEQU, DRIVCROP, GROWLFALL, GROWTH, ROOTDIST). For FOREST the cooresponding groups should be given in this file. (Read by PREP as nr 2)
AIN_SOIL PAR	Soil parameters. All Parameter Groups and Switches not found in the other parameter files. (Read by PREP as nr 1)
AIN_SOIP DAT	Soil physical data (from PLOTPF.EXE)
AIN_THCO DAT	Soil thermal conductivity data
AIN_TIME PAR	Simulation period. (Read by PREP as nr 5)
DEMO_NVB BAT	Program file. Bat-file used to make simulations etc.
DEMOCOMX PG	PG-instruction file
DEMOPCAR PG	PG-instruction file in which variables for plotting "Carbon Other" can be selected
DEMOPCOM PG	PG-instruction file in which variables for comparison "Other" can be selected
DEMOPNIT PG	PG-instruction file in which variables for plotting "Nitrogen Other" can be selected
*DEMOZVAL BIN	Presentation data
DEMZMEAS BIN	Measurements to be compared with in the "Validation" option
SOILN FIN	Output state variables in a form possible to be used as input
*SOILN STA	A counter used by SOILN
SOILN TRA	Data description for Output variables
*SOILNCUR BIN	Output variables from the current simulation
*SOILNCUR SUM	Data description for the bin-file
*SOILNPRE BIN	Output variables from the previous simulation
*SOILNPRE SUM	
*SOILNXXX BIN	Used by the comparison option
*SOILNXXX SUM	

* = Files that can be deleted without needing new preparation

Directory ... \XXXX\N\NA; "Store directory", application specific

AIN_CLIM BIN	see above
AIN_FERT BIN	see above
AIN_FERT DAT	see above
AIN_FERT DDE	see above
AIN_INIP INI	Initial plant state variables
AIN_INIS INI	Initial soil state variables
AIN_MAN PAR	see above
AIN_MR CMD	Multy Run instructions
AIN_MR PAR	Parameters that will be changed in the Multy Run
AIN_OUTM PAR	Output variables for the Multy Run
AIN_PLAN PAR	see above
AIN_SOIL PAR	see above
AIN_SOIP DAT	see above
AIN_THCO DAT	see above
AIN_TIME PAR	see above
COPYPREN BAT	Program file that copies files from other directories to this one. It is used for alternative applications stored on directories below this one. Note it overwrites files.
INFON LIS	Information about the application stored in the directory
MEAS BIN	Identical to DEMZMEAS.BIN, see above

Directory ... \XXXX\N\NA\START; "Store directory", common for all applications

AIN_OUT PAR	see above

DEMO_NVB BAT see above
SOILN TRA see above
Directory ... *\XXXX\N\NA\PG*; Directory with PG-instruction files

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