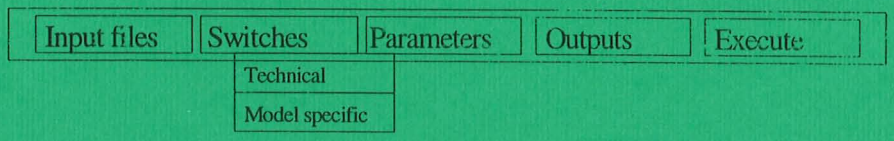
SOILN model
User's Manual



Version 9.2

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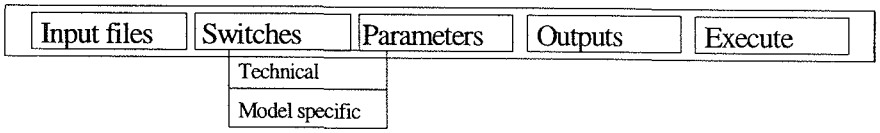

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Table of Contents

1 Background

Version 9.2; Uppsala 98-06-29

This manual is adapted to the SOILN model version 9.2 and is a development from Eckersten et al. (1994, 1996). The model presentation is divided into one part which describes a basic and/or original part of the model and one part including special/new options which you can get access to by setting the SPECIAL switch ON. By this switch the model can be used as a tool for testing alternative theories selected by the user, and to get access to special options useful for application of the model. This report can not be used as a reference for the validity of those theories. In that context is referred to the reference list below (see f.i. Jansson & Persson 1998). The model is developed in close collaboration with several research scientists. The contribution of different persons is given in Acknowledgement.

1.1 Model description

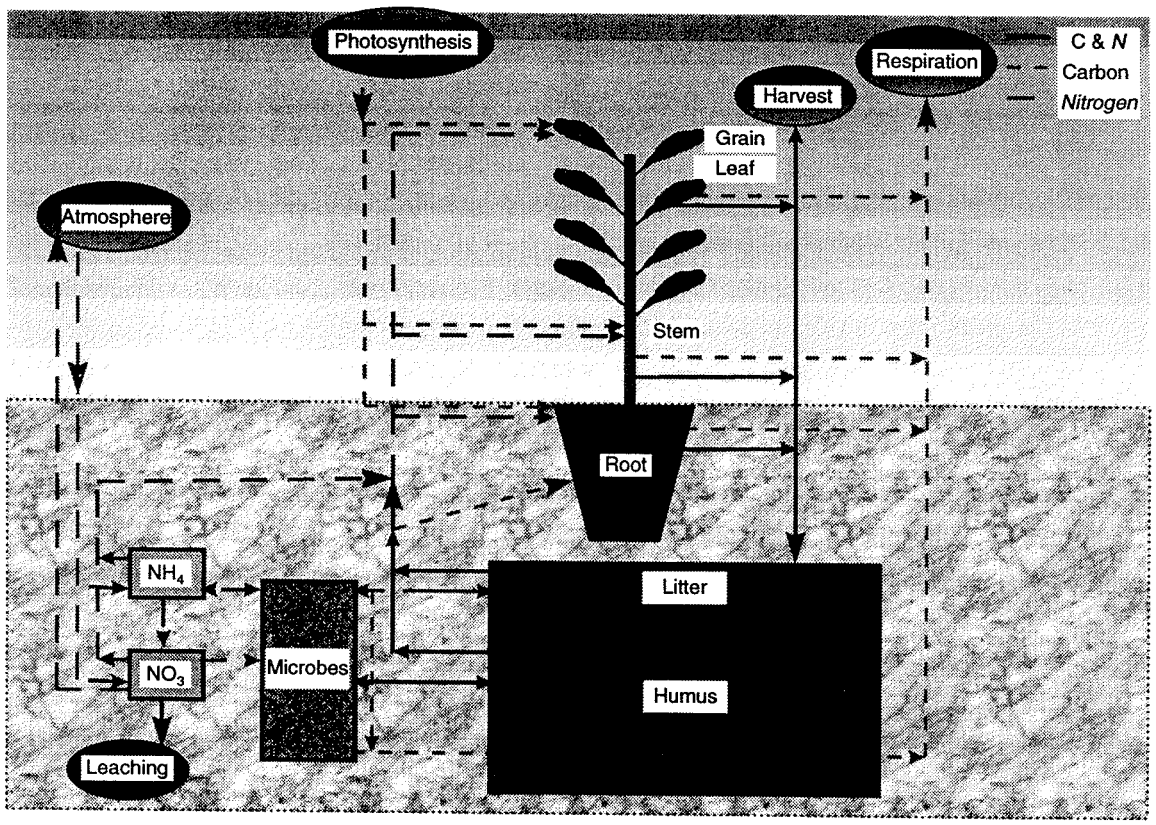


Figure 1. A schematic scheme of carbon, nitrogen and biomass flows and storage in the SOILN model. The soil is divided into layers and plant biomass can be separated into pools of annual and perennial tissues.

The SOILN model simulates major C and N-flows in agricultural and forest soils and plants. The model has a daily time step and simulates flow and state variables explicitly in one spatial dimension (vertical) on a field level. Input variables are daily data on air temperature and solar radiation, management data and variables on soil heat and water conditions which are simulated by an associated model named SOIL (Jansson & Halldin, 1979). The model can conceptually be divided into two submodels: the soil submodel and the plant submodel. The soil part is described in detail by Johnsson et al. (1987) (Figs. 2a and b) and the plant model description is divided into one part for the current year dynamics (Figs. 3a and b; Eckersten & Jansson, 1991) and one for the perennial part (Figs. 4a and b; Eckersten, 1994). Note that the flow schemes in Figs 2-4 describe possible flows whereas the flows used depend on the model application, i.e. the choice of switches and parameter values. Papers dealing with applications of the model are found in the reference list.

The soil is divided into layers. In each layer mineral N is represented by one pool for ammonium N and one for nitrate N. Ammonium is immobile whereas nitrate is transported with the water fluxes (a special option can make ammonium mobile). The ammonium pool is increased by nitrogen supplied from, manure application, mineralisation of organic material and by atmospheric deposition, and it is decreased by immobilization to organic material, nitrification to the nitrate pool, and plant uptake. The nitrate pool is increased through nitrification of the ammonium pool, fertilization, atmospheric deposition and by capillary rise of water from subsoil. It is decreased by leaching, denitrification and plant uptake. Water flows bringing nitrate between layers, is the process finally responsible for N leaching. The daily output of N from the mineral pools might in case of low mineral N contents be higher than available N plus input, especially as concerns nitrate.

The dead soil organic matter is normally represented by two pools, however, there are options to alter the number of pools used and to choose if microbe dynamics should be simulated or not. The rate of decomposition of organic matter depends on soil water and temperature conditions. Nitrogen dynamics of the organic matter is governed by those C flows and mineralisation or immobilisation depend on the C/N ratio of the decomposed material and availability of mineral N.

The plant biomass and N dynamics are based on a strong relationship between carbon and nitrogen as used by Eckersten & Slapokas (1990), Eckersten (1991a), Eckersten (1994) for willow and (Eckersten & Jansson, 1991) for wheat. The model concept has its origin in two basic model concepts; first that carbon input is strongly related to the energy input (de Wit 1965) and second, the nitrogen input is governing growth (Ingestad et al. 1981).

The plant is divided into one pool for biomass and one for nitrogen for each type of function simulated by the model. Leaves take up carbon from the atmosphere and roots take up nitrogen from the soil. Stem is used for storage. During grain development the grain pool is an additional storage organ supplied with assimilates from the stem. The maximum photosynthesis is related to the radiation intercepted by the canopy leaf area. The actual photosynthesis is then reduced by low air temperature, low leaf nitrogen concentrations and water deficit. N uptake is either limited by the sum of the demands by different plant tissues or the availability of N in soil. The demand depends on the plant growth and wanted N concentration of tissues. The available soil N is a fraction of the total mineral N in the root zone.

The partitioning of daily growth to root, leaf and stem is governed by two functions. The fraction partitioned to roots decreases as the total plant biomass increases or in case of nitrogen or water shortage. The partitioning between leaves and stems depends on the leaf area development which is determined by the leaf area to shoot biomass ratio. During grain development biomass and nitrogen are allocated from different plant tissues to grain. Litter formation occurs continuously and tissues may redraw some of their biomass and N before they die. There are different functions for governing the mortality of plant tissues. Dates of emergence, start and stop of grain filling and maturity are calculated as functions of temperature, daylength and a maximum harvest index.

In case of perennial plant there are additional pools for old plant biomass and a pool of easily available assimilates. The old tissues have a smaller influence on growth than the younger ones. They affect the C and N dynamics by consuming assimilates for the maintenance respiration, by increasing available assimilates for growth and by increasing root depth. They also affect the input to the litter pools by the contribution of material with relatively low nitrogen concentration. The biomass of the young pools are transferred to the old biomass pools at a certain age (normally one year) given by the user.

A more precise model description is given in the section on Parameters where the most essential equations for different processes are found. The parameters are given with their names whereas other variables are given by normal mathematic symbols, the explanation of which is found within the section on Outputs.

1.2 Model application

The model needs a large amount of input to be applied. This put practical limits to its applicability. However, the objectives of applications differ and thereby also the constraints on the input. For instance, if the objective is to make hypothetical predictions of changing fertilisation regimes at a site for which the model already has been calibrated, then the management driving variables are the only input needed extra for this application. On the other hand, if the theories of the model should be evaluated against measurements, on for instance N content in different part of the system, the accuracy of individual parameter values become more important. High accuracy on those values might require extensive measurements.

To enable a robust application procedure of the model, certain developments have been made. A special program SIMVB (see Appendix 2) allows the user a good overview when checking that all variables simulated by the model are reasonable. It also allows a handy way of comparison between simulations and measurements. In addition a special option is introduced (see BOUNDARY-switch) that enables simulated values to be replaced by measurements or values calculated by another model. This option is meant to be used if only parts of the SOILN model is wanted to be studied, for instance when making step-wise calibration. In Appendix 2 an example of a procedure of how to calibrate the SOILN model is shown.

1.3 Flow schemes

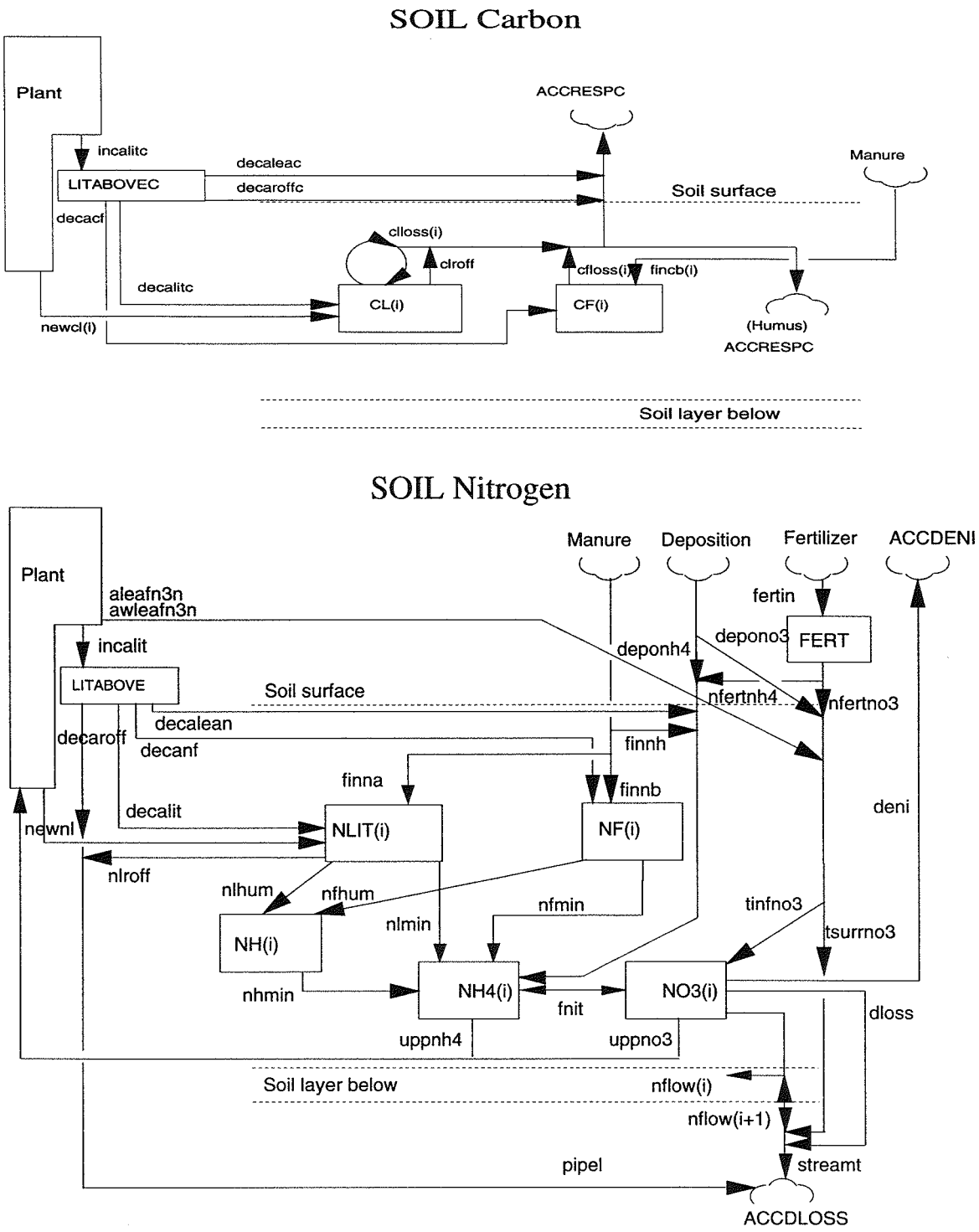
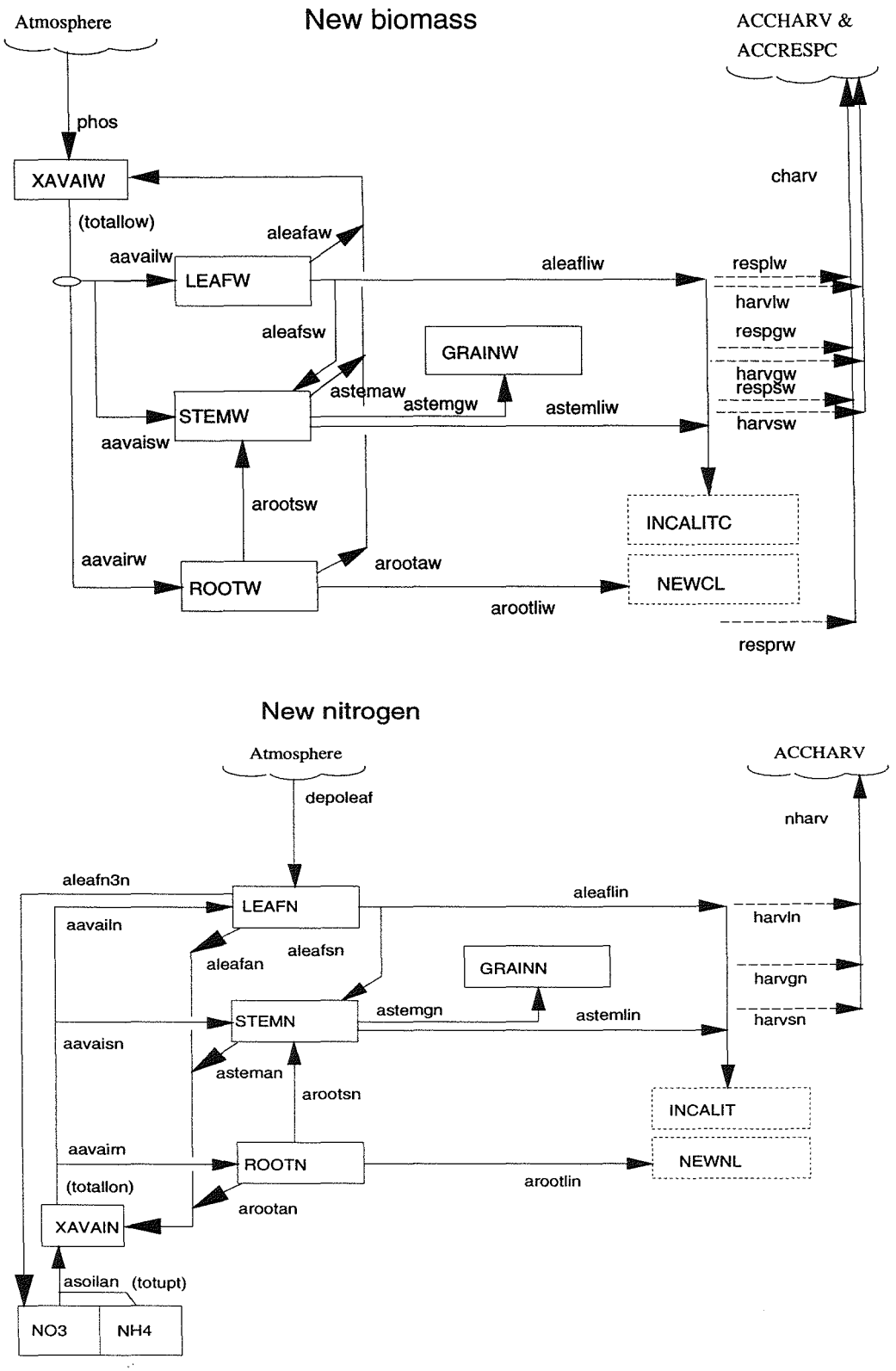
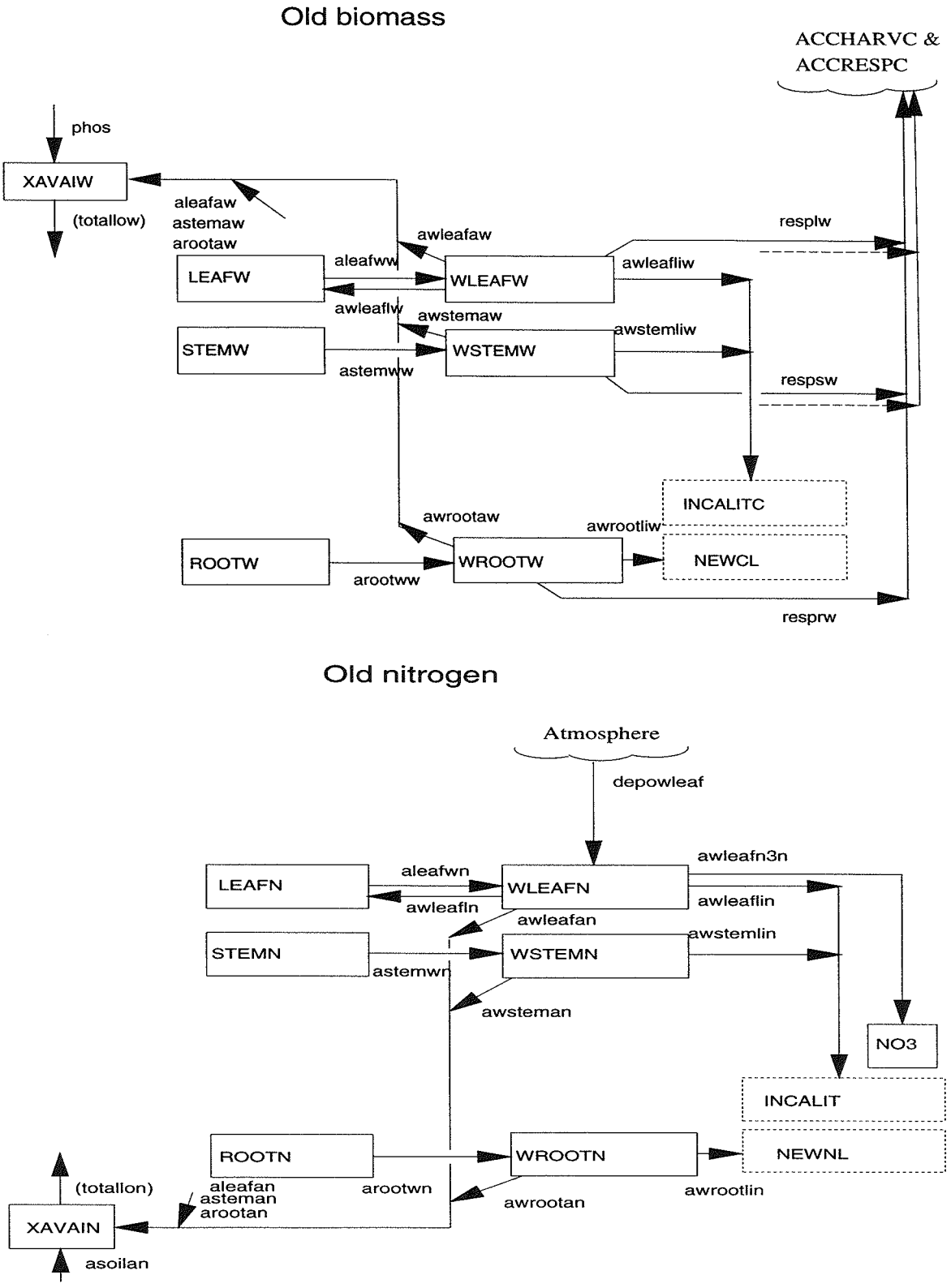


Figure 2a and b. A schematic description of carbon and nitrogen flows and states of the soil part of the SOILN model. Symbols are explained in the section of Output variables. Microbial biomass, extra litter pool and organic N uptake are not included in the scheme.



Figures 3a and b. A schematic description of the biomass and nitrogen flows and states of the PLANT-submodel of SOILN model. The part concerning the current year growth. Symbols are explained in the section of Output variables.



Figures 4a and b. A schematic description of the biomass and nitrogen flows and states of the PLANT-submodel of SOILN model. The part concerning perennial growth. 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.

Type the command: `A:INSTALL A: C: XXX`

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 XXX. Normally XXX is substituted by SIM or SIMVB. If you already have a directory with that name you should choose another name at the installation.

2.2 Files

The installation procedure will create one main directory (C:\SIMVB\) below which the program files are stored in different subdirectories. The excitable files are placed in the subdirectory named EXE and sample files in the subdirectory named DEMO.

Table 1: Description of files in the different directories.

Files	Description
Directory: C:\SIMVB\EXE	
SOILN.EXE	Execute file, SOILN model
SOILN.DEF	Definition file, SOILN model
SOILN.HLP	Help file, SOILN model
PREP.EXE	Execute file, PREP program
PG.EXE	Execute file, Pgraph program
PG.HLP	Help file, Pgraph program
PLOTPF.EXE	Execute file, PLOTPF program
PLOTPF.HLP	Help file, PLOTPF program
Directory: C:\SIMVB\DEMO\N	
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_ONE.PAR	Parameter file for simulating nitrogen dynamics of an arable land with an agricultural crop during a growing season.
AIN_CLIM.BIN	PG-file with climatic driving variables for running the SOILN model.
AIN_SOIP.DAT	File with soil hydraulic properties.
SOILN.TRA	Translation files for variable names, SOILN
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. There must be a path to files store in directory C:\SIMVB\EXE (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_ONE
```

Is an example of how you can make your own simulation based on information in the AIN_ONE.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 in ASCII.

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

```
PG 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. The numbering of a run within this file 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 lower menus is influenced by the setting of those above.

4 Files

4.1 Input

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. 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 were correctly identified.

Table 2: Variables in drivingvariable file (FILE(1)) to SOILN.

Name in the SOIL model	Number of variables	Optional	Unit
WFLOW	[N-1]	No	(mm/day)
INF	[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 parameter (See soil profile).

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. Parameters missing in the file receives the default value found in SOILN.DEF. New parameter files may be created prior the execution of the model using the WRITE command (see EXECUTION WRITE). Several parameter files could be used. The information from the last incorporated file gets the highest priority, it "overwrites information from earlier parameter files and the SOILN.DEF file.

Translation file

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

Initial states file

FILE(4) XXXXXX.INI: An ASCII file containing the initial values of all state variables that should start from a value > 0. The state variables denoted ACC... should normally be zero. Note that GROWINI-switch regulates if plant states should be read from this file.

Rules to write the file: (Note, first column must be empty)
1. The most simple and safe way is to write only one variable name at each row followed by a space and the value, for instance: LITABOVE 1.2
2. Up to 3 variables could be put on each row with the following format: variable 1-3 should be in columns 2 to 27, 29 to 54 and 56 to 81, respectively. 3. Layers is denoted within brackets, for instance: NO3(3) 1.35
4. If different layers have the same value you could write for instance: NO3(1-3) 1.35
5. The name of the state variable file must be defined in the xxx.PAR-file or be given in PREP under Input files.

If INSTATE-switch = 0: All initial states are zero.

Output file

FILE(6) SOILNnnn.BIN: Only used if ADDSIM-switch = 1. The results of the current simulation are added to this file which contains output data from a previous simulation.

Validation file

FILE(7) XXXXXX.BIN: A file with variables (measured) 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.

Soil physical properties

FILE(8) XXXXXX.DAT: An ASCII file containing soil physical properties of the soil profile which are used for the soil water and heat simulation with the SOIL model. The file is created by the PLOTPF program and must exist on the working directory. 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.

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). Date of application is taken from the date record in the file. If the first variable (FERN) is missing for a date, no other variables are read. If it is -99 then the other variables are read. If a variable value is -99 then it is treated as missing in the calculations. All values are reset to zero for intermediate time points. Only used if DRIVEXT-switch>0.

Table 3: Variables in FILE(9) for different values on the DRIVEXT-switch.

DRIVEXT-switch	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 $m^{-2}day^{-1}$)

Crop - driving variable file

FILE(10) XXXXXX.BIN: Parameters related to plant N uptake. Same roles for reading values as for FILE(9) except that values are not reset for intermediate time points. The values are kept constant until a new value is read. Only used if the GROWTH-switch=0, BOUNDARY-switch=0 and DRIVCROP-switch>0.

Table 4: Variables in FILE(10) for different values on the DRIVCROP-switch.

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

Boundary - driving variable file

FILE(10) XXXXXX.BIN: Measured values of states, flows and auxiliaries to which the model should be fixed during simulation. Maximum 40 variables with their errors could be given. Variable that should be fixed to the value in the file is defined by parameter BOUNVNUM(nn). The parameter defines the number in X, T or G array of the model (see Appendix 2). Total number of variables in the files (including the error variables) is given by parameter BOUNFTOT. If the BOUNDARY-switch=3 the error variables should be omitted. The roles for reading values are the same as for FILE(10) in the previous section. Only used if BOUNDARY-switch>0.

Table 5: Variables in FILE(10) for different values on the BOUNDARY-switch.

BOUNDARY-switch	Variable (#)	Value	Unit
1	1	Mean value var1	(differ)
1	2	Relative error var1	(-)
1	3	Mean value var2	(differ)
1	4	Relative error var2	(-)
1	...	....	....
1	40	Relative error var20	(-)

Management - driving variable file

FILE(11) XXXXXX.BIN: Parameters related to harvest and ploughing can be given in this file. Same roles for reading values as for FILE(10). Only used if DRIVMANA-switch>0.

Table 6: Variables in FILE(10) for different values on the DRIVMANA-switch.

DRIVMANA-switch	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	(-)

4.2 Output

Simulated data

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

Simulation summary

SOILNnnn.SUM: An ASCII file containing a summary of all instructions used for the simulation, a summary of simulated results and identification of model version used. 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 with the extension .PAR, for example MYRUN.PAR, and use it as a parameter file in future simulations. If you have exactly the same input variables and initial states this file should exactly reproduce your old run.

Final states file

FILE(5) XXXXXX.FIN: Only used if OUTSTATE-switch = 1. An ASCII file containing the final values of all state variables. This file could be used as an initial states file.

5 SWITCHES

The purpose of switches is to choose the subroutines valid for you application. Switches can be OFF, ON or have a numerical value. You change value of a switch by putting the cursor at the switch and press the return key. 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. Note that also new parameter settings might appear. (Group names given within brackets (S, P, M or O) refer to Soil, Plant, Management and Others)

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. (Group O)
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 current and the previous simulation. The name of the former result file is given by the user as the "output file" name (see FILE(6)). 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 values at the end of each output interval. See also AVERAGEX-switch. (Group O)
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. See also AVERAGEX-switch. (Group O)
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. See also AVERAGEX-switch. (Group O)
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-output file is also the date of the end of the interval. Otherwise the date is the middle of each output intervals. (Group O)
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. (Group M)
ON	Parameter values may be changed at different dates during the simulation period. If you edit the parameter file then all parameter values given after a definition of a new time point will be activated when the simulation has reach that point in time. A maximum of 20 dates can be specified.

DRIVPG

0	No function (Group M)
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	All initial state values are zero (Group S)
1 *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.
2	The same as for INSTATE=1 except that soil states are given in units of m^3 (instead of m^2).

LISALLV

OFF	only the subset of output variables selected by the user will be found in the summary file. (Group S)
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. (Group O)
ON	all variables in the output Pgraph-file will be named according to their FORTRAN names.

OUTSTATE

OFF *Default*	no action. (Group O)
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. (Group O)
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

Switches denoted GROW.... are only used if GROWTH-switch = 1.

DENDIST

0 *Default*	Denitrification rate distribution from parameter values, separate fractions are given for each soil layer (see DFRAC) (Group S).
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	An exponential decrease of denitrification rate from soil surface to the depth specified by the parameter DENDEPTH.

DRIVCROP

0 *Default*	Plant development is simulated (i.e. the GROWTH-switch > 0) or specified by parameter values in parameter file. (Group S)
1	The root depth is read from a driving variable file (FILE(10)). Only used if BOUNDARY-switch=0.
2	As for 1 but also the potential N-uptake rate is read from the same file.

DRIVEXT

0 *Default*	Parameter values for external inputs of nitrogen to the model are specified in parameter files. (Group M)
1	N fertilization rate is taken from a driving variable file (FILE(9)).
2	As for 1 but also parameters for application of manure are taken from the same file.
3	As for 2 but also parameters for wet and dry deposition are taken from the same file.

DRIVMANA

0 *Default*	Parameters of management operations are taken from parameter file. (Group M)
1	Ploughing depth is read from a driving variable file (FILE(11)).
2	Also harvest and re-circulation of crop residues are taken from the same file.

GROWDECID

OFF *Default*	Current year old leaves are transferred (at the end of the year, normally) to old leaves according to leaf fall functions given by the user. Only used if GROWPREN-switch=1. (Group P)
ON	All remaining leaves are falling to the ground at the end of the year.

GROWGRAIN

0 *Default*	No grain development. (Group P)
1	Grain development may occur (see related parameters GRAINI, AGRAIN, AGRAINN). Only used if GROWPHEN-switch > 0.

GROWINI

OFF	Plant initial values (annual biomass pools only) are calculated from parameter (TOTW(1)). N plant values are set assuming maximum N concentrations. (Group P)
ON *Default*	Plant initial values for the first growing period are taken from initial file (FILE(4)). TOTW(1) is not used. For the second growing period TOTW(2) should be used.

GROWPEREN

0 *Default*	No perennial pools are used. (Group P)
1	Perennial (wood) pools are used. Perennial pools are pools older than DAYPEREN days. See related parameters APEREN, DAYPEREN. Nitrogen and assimilates can be stored in an available pool in plant (see related parameters AVA...).

GROWSTART

0 *Default*	Day for start of growth is given by parameter UPST and GROWPHEN switch. (Group P)
1	Day for start of growth is a function of temperature (see parameters DAYTAACC, TAACCG. Only used for GROWTH-switch = 1.

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). (GROWTH=0 not properly tested) (Group P)
1 *Default*	Plant growth, N-uptake, allocation and litter fall are simulated by the SOILN/PLANT growth model (see the additional parameter sections denoted (P) and switches denoted GROW....).

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. (Group S)
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. (Group M)
ON	Application of manure and transformation of faeces is considered.

ROOTDIST

0 *Default*	Root distribution from parameter values (ROOTF), separate fractions are given for each soil layer. (Group S)
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.

SPECIAL

OFF *Default*	No special functions are active. (Group M)
ON	Special functions are available. Gives access to the switches and parameters in the groups named SPECIAL. Note, that now the control of the special functions are made with these switches and parameters.

5.3 Special

These switches activates special options of the model and are only available if the SPECIAL-switch is ON (=1).

BOUNDARY

0 *Default*	No corrections of simulated values during simulation. Parameter BOUNFTOT = 0 sets BOUNDARY-switch = 0 (Group M)
1	Values in a driving variable file (see FILE(10)) are used for correction, during simulation, of simulated states, flows or auxiliaries (see parameter BOUNVNUM(nn) and Appendix 1). For each time point given in the file, correction is made to the given value, in case the simulated value is outside the error limits. States are corrected prior each timestep. Errors given in the file are relative errors. Total number of variables in the file is set by parameter BOUNFTOT. Boundary corrections are not made for days of harvest or ploughing. Corrections of flows or auxilaries could only be done with special care, contact the authors of the program on this matter. Examples are given in Appendix1. Only used if DRIVCROP-switch=0.
2	The same as for 1 but errors given in the file are absolute values.
3	The same as for 1 but no error variables are given in the file. Relative error is given by parameter BOUNRERR.
4	The same as for 3 but no external file is used (i.e. FILE(10)). Instead the values to which variables should be corrected should be given in parameters BOUNVALU(1-40). The correction is made every timestep (day).

CHAPARSW

0 *Default*	No action (Group M)
1	Possible to change Switch values during simulation by using the CHAPAR-switch. All switches has a corresponding parameter with the similar name but X in front of the name (i.e. X....). If the X...parameter value <> -1 then the Switch will get its value from the parameter.

FERNCALC

0 *Default*	No action. (Group M)
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 AVAILN. The amount simulated by the model (FERNSIM) is added as ammonium and is incorporated in FERTNH4.
2	Fertilisation is calculated by the model as the difference between the wanted soil N mineral amount (given by parameter AVAILN) and the sum of the mineral pools, the deposition and fertilisation and a preliminary estimation of mineralisation from organic matter. The amount simulated (FERNSIM) is added as solid fertilisers and is incorporated in FERTNO3.

GROWAEQ

11000 *Default*	A combined switch selecting which type of allocation equations that will be used. (Note should be >10000) The first figure is the way different root allocation sub functions (b_{rw}, b_{rn}, b_{re}) should be combined. 1: $b_r = \max(b_{rw}, b_{rn}, b_{re})$ 2: $b_r = b_{rw}*b_{rn}*b_{re}$ and 3: $b_r = (b_{rw}+b_{rn}+b_{re})/3$. The second figure is leaf-stem allocation (b_i; parameter ALEAF). The third is the root allocation as function of total plant biomass (b_{rw}; parameter AROOTW). The forth is root allocation as function of leaf nitrogen (b_{rn}; parameter AROOTNI). The fifth is root allocation as function of transpiration ratio (b_{re}; parameters AROOTE and AROOTETR). 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: GROWAEQ=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! When changing GROWAEQ, the meaning of the parameters changes (ALEAF, AROOTW, AROOTNI). (Group P)

GROWALLO

0	During grain development, reallocation of assimilates occur from leaf to grain (flows ALEAFGW and ALEAFGN), root to grain and stem to grain (flows AROOTGW and AROOTGN). (see parameters AGRAIN and AGRAINN). Flows AROOTSW and AROOTSN = 0 (Group P)
1 *Default*	During grain development, reallocation of assimilates occur from leaf to stem, root to stem and stem to grain (see parameters AGRAIN, AGRAINN, ADRAWLW, ADRAWLN).

GROWAVAN

0 *Default*	Root N uptake is allocated to the available pool of N in plant. The same amount is transfered to structural growth in the same time step. (Group P)
1	The same as for switch=0 but retranslocation of N from plant structural pools could be added to the structural growth.
2	The same as for switch=1 but the N retranslocated from plant pools is incorporated in the plant available pool and not emptied in the same time step.
3	The same as for switch=2 but both root N uptake and N retranslocated within plant are incorporated in the plant available pool.
4	The root N uptake is reduced by the amount released from the available pool in plant.
14,24,34	Combinations of switch = 1,2,3,4.

GROWAVAW

0 *Default*	Daily photosynthesis is allocated to the available pool of biomass in plant. The same amount is transfered to structural growth the same time step. (Group P)
1	The same as for switch=0 but retranslocation of biomass from plant structural pools could be added to the structural growth.
2	The same as for switch=1 but the biomass retranslocated from plant pools is incorporated in the plant available pool and not emptied in the same time step.
3	The same as for switch=2 but both photosynthesis and the biomass retranslocated within plant are incorporated in the plant available pool.
4	The photosynthesis is reduced by the amount released from the available pool.
14,24,34	Combinations of switch = 1,2,3,4.

GROWCAT

0 *Default*	No action (Group P)
1	Used for special options related to catch crops
2	The same as for GROWCAT = 1 also for TOTW(1) = 0.

GROWMYCO

0 *Default*	No action (Group S)
1	Plant roots can take up organic N (see parameter PMY...).

GROWNCON

0 *Default*	Maximum and minimum N concentrations of plant tissues are constant. (Group P)
1	Maximum and minimum leaf N concentrations change with time. See parameters NCONTIME and NCONCHAN.
2	Maximum stem N concentration changes with time.
3	Maximum root N concentration changes with time.
4	Leaf N demand concentration changes with time.
12,13,14,123,123,1234,124,134,23,234,34	Combinations of switch = 1,2,3,4.

GROWGEQ

Determining the calculation of the growth response function (f_{Tot}). If GROWPHOS = 1 then f_T is not included in the functions. (Group P)

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

GROWPHEN

0	No phenologic functions are active. Day of emergency is given by parameter UPST and day of harvest is given by parameter UPET. (Group P)
1 *Default*	Start of grain development is an accumulated function of air temperature and daylength. Otherwise as for GROWPHEN = 0.
2	Day of emergency is a function of accumulated temperature since sowing. Day of sowing is given by the UPST parameter. Day of start of grain filling is calculated as for GROWPHEN = 1 except that accumulation of the index starts at day of emergency and not UPST. Day of end of grain filling is a function of accumulated temperature since start of grain filling. Day of harvest is a function of accumulated temperature since day for end of grain filling. The routine is taken from AFRCWHEAT model (Porter, 1984).
3	Only vegetative growth (GROWSTAG is fixed to 2)
4	The same as for GROWPHEN = 2, except that the day for ploughing is estimated as a fixed number of days (HARPLOUGH) after harvest.

GROWPHOS

0 *Default*	Leaf assimilation is calculated using the radiation use efficiency concept. (Group P)
1	Leaf assimilation is calculated using a light response curve for photosynthesis taking account of growth respiration (France and Thornley, 1984) using the additional parameters PPMAX20, PTRANSM, and PGRESP.
2	The same as for (0) but the nitrogen response for photosynthesis is a linear function of total (annual) plant N concentration. This means that parameters NLEAFXG and NLEAFN are used to represent the total N concentration at which photosynthesis is at maximum and minimum.

LITTKCN

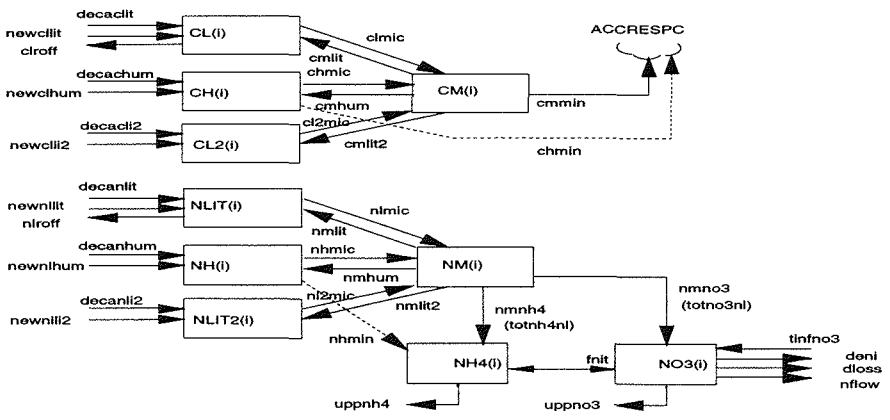
0 *Default*	The specific decomposition rate of litter (LITK) and faeces (FECK) are independent of C/N ratio. (Group S)
1	The specific decomposition rate of litter (LITK) can be set a linear function of the C/N ratio. If MICROB-switch>0 then MICK(1-3) is a function of C/N ratio.
2	As for 1 but for faeces (FECK).
3	Both 1 and 2 above.

MICABIO

Only used if MICROB-switch>0

0	Neither microbial mortality rate or maintenance respiration are directly dependent on soil temperature and moisture conditions. (Group M)
1	Microbial mortality rate is dependent on soil temperature conditions.
2	Microbial mortality rate is dependent on soil moisture conditions.
3 *Default*	Microbial maintenance respiration is dependent on soil temperature conditions.
4	Microbial maintenance respiration is dependent on soil moisture conditions.
12,13,14,12 3,...etc	Combinations of the above alternatives. Note give figures in increasing order.

MICROB

0 *Default*	Microbial biomass is not explicitly simulated. Instead it is implicitly included in the litter (CL, NLIT) and faeces (CF, NF) pools (Group M)
1	Microbial biomass (CM, NM) dynamics are simulated. CM and NM receive mass from the litter pool (CL,NLIT) and looses mass to the same pool. The litter pool receives organic material from roots and above ground residues. Note that the meaning of variables related to normal pools are cancelled or modified: flows: NLHUM=NLMIN=NEWNL=NEWCL=NHMIN=0 auxiliaries: RATCNL= C/N meaning may differ, see parameter OUTRATCN Flow scheme is as follows: Microbes 
2	Same as for 1, except that an additional organic pool is included, humus (CH, NH). The microbial dynamics are in analogy with that of the litter pool. Specific coefficients for the humus pool should be given.
3	Same as for 2, except that one more organic pool is included, litter2 (CL2, NLIT2).

4	Same as for 2, except that the humus pool is included in the way it is used in the original model, i.e. mineralisation occurs directly from humus, proportional to the humus N and independent of the simulated microbial activity. In addition to the original model, respiration from humus (CH) is calculated. (The flows CHMIC=NHMIC=0, NHMIN>0, CHMIN>0)
91,92,93,94	Same as for 1-4, except that microbial gross consumption rate is proportional to substrate amount instead of microbial biomass.
101,102,103,104,191,192,193,194	Same as for 1-4 and 91-94 except that seperate microbial parameters are used for each soil layer. The parameters MICK(1-3) are replaced by the parameters MICKLI(), MICKH(), MICKLI2() and the parameters MICMORT(1-3) are replaced by MICMORLI(), MICMORH(), MICMORLI2.

NH4MOBIL

0 *Default*	Ammonium in soil profile is immobile. (Group M)
1	A fraction of ammonium is adsorbed to solid particles and the rest is in soil water and is mobile between layers, in analogy with nitrate flow.

NMINCOMP

0 *Default*	No action (Group S)
1	A deficit of mineral N is allocated between flows consuming mineral N (see parameters NH4COMP and NO3COMP).

OPTWATER

0 *Default*	Water response functions for soil biological activity and plant growth are active. (Group M)
1	Soil NH_4 mineralisation or immobilisation is not limited by soil water conditions.
2	Plant growth is not limited by plant water conditions. Only used for GROWTH-switch = 1.
3	Optimum water conditions are assumed for the allocation of assimilates to root function. Only used for GROWTH-switch = 1.
12,13,123,23	Combinations of the above alternatives.

TEMPREQ

0 *Default*	The temperature response function for soil biological processes is calculated from the Q_{10} expression in the whole range. (Group S)
1	The temperature response function is calculated from the Q_{10} expression when the temperature is above TEMLIN. Below that a linear decrease is assumed towards 0 °C where the response diminish.
2	The temperature response function is calculated from a quadratic response function (Ratkowsky function). Note that the TEMBAS parameter change meaning.
3	The temperature response function is calculated from a second order polynomial.
4	Separate parameters may be used for mineralisation, nitrification and denitrification.
14,24	Combinations of the above alternatives.

6 PARAMETERS

Parameters are grouped in accordance to the processes they belong to. The most important equations are given at the top of each section. The basic ideas behind the equations are given, as concerns soil by Johnsson et al. (1987), and as concerns plant by Eckersten & Slapokas (1990) and Eckersten & Jansson (1991).

All parameter values may be modified in the PREP-program by pressing the return key when the cursor is located at a certain parameter. A new numerical value may then be specified and is loaded when you go back to the top menu again [Esc].

Beneath the unit in the parameter description a value is sometimes given. This is a default value given by SOILN.DEF file. In the head of each parameter group is given (S), (P) or (M) denoting Soil, Plant and Management, respectively.

6.1 External inputs (M)

Dry and wet deposition to the soil surface is determined by a dry deposition rate (DEPDRY) and the water supply rate (the driving variables infiltration and surface run off) multiplied by the concentration of total nitrogen in precipitation (DEPWC). The ammonium N fraction (DEPFNH4) enters the ammonium pool of the uppermost soil layer whereas the nitrate is separated between surface runoff and infiltration. Commercial fertilizer N (FERN) is applied at a certain day (FERDAY). The fertiliser is dissolved at a constant rate (FERK) and a certain fraction (FERNFNH4) enters the ammonium pool whereas the rest enters the nitrate pool. Under conditions of a water source flow to the soil, this flow can also be a source of nitrogen (see GWCONC). Dry deposition can also be directly taken up by leaves (DEPDRYA).

$N_{Dep\rightarrow NH4}$ = DEPDRY*DEPFNH4D + DEPWC*(q_{Inf}+q_{Surr})*DEPFNH4W
$N_{Dep\rightarrow Inf+Surr}$ = DEPDRY*(1-DEPFNH4D) + DEPWC*(q_{Inf}+q_{Surr})*(1-DEPFNH4W)

$N_{Dep\rightarrow l}$ = DEPDRYA*A_l

$N_{Fert\rightarrow NH4}$ = FERNFNH4*FERK*N_{Fert}
$N_{Fert\rightarrow Inf+Surr}$ = (1-FERNFNH4)*FERK*N_{Fert}

$N_{l\rightarrow Inf}$ = *see N allocation*
$N_{lw\rightarrow Inf}$ = *see N allocation*

$N_{Inf\rightarrow NO3}$ = x*q_{Inf}/(q_{Inf}+q_{Surr}) ; *if* q_{Surr} = 0 *then* $N_{Inf\rightarrow NO3}$ = x
$N_{Surr\rightarrow Stream}$ = x*q_{Surr}/(q_{Inf}+q_{Surr})
where:
x = $N_{Dep\rightarrow Inf+Surr}$ + $N_{Fert\rightarrow Inf+Surr}$ + $N_{l\rightarrow Inf}$ + $N_{lw\rightarrow Inf}$

DEPDRY
Dry deposition of mineral N to soil nitrate and/or ammonium. (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:
Then DEPDRY is read from FILE(9)

DEPDRYA
Dry deposition of mineral N on canopy per unit of leaf area and which is taken up by leaves. (gN m^{-2} d^{-1})
Only used if GROWTH-switch = 1 *0*

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

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

DEPWC
Concentration of mineral N in infiltration and surface runoff. (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:
Then DEPWC is read from FILE(9)

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

FERK
Specific dissolution rate of commercial fertilizer (not the ammonium N, if any). (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 (commercial fertilizer) (gN m^{-2})
1 gN m^{-2} = 10 kgN/ha. Normal range 0 - 30 gN m^{-2}. *8*
If DRIVEXT-switch >= 1:
Then FERN is read from FILE(9)

FERNFNH4
Fraction of dissolved solid N fertiliser that is ammonium. The rest is nitrate N (-)
0

GWCONC
Concentration of nitrate in deeper groundwater. Input of N to profile from below is visible by DFLOW (driving variable) at the lower boundary being < 0. The negative value is added to the flow DLOSS. (mgN l^{-1})
Depends on the local conditions. Normal range 0.1 - 5. *0.3*

6.2 Manure application (M)

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 Soil and Plant management (M)

At start of growth 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).

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 in the horizon in accordance to the root depth distribution (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. The deepest layer involved in ploughing is included as a whole, also when PLOUGHDEP defines less than the whole to be involved. Note, it is not possible to harvest at the same day as ploughing is made and it should be three days between ploughing and sowing.

If GROWTH-switch = 0 then plant N is in focus. The plant is split into a harvested 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 N. The dead root N is included into the litter-N pool and split between different soil horizons according to the depth distribution of roots (see parameter ROOT). The dead root C content is set 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 (-)
(index= growth period 1, 2 or 3) *0*
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. If DRIVMANA-switch = 2: Not used. *0.*

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 alive after harvest. (-)
(index= growth period 1, 2 or 3) *0*
If GROWTH-switch = 0: Not used

HARLR
Fraction of roots alive after harvest (-)
(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 alive after harvest. (-)
(index= growth period 1, 2 or 3) *0*
If GROWTH-switch = 0: Not used.

HARP
Harvested fraction of plant N (-)
(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.

PLOUGHDAY
Date of ploughing or soil cultivation. Note, must differ from harvest day UPET. (day number)
If GROWPHEN-switch = 2 then ploughday is shifted forward to be after harvest, in case the simulated harvest date is earlier. By settting PLOUGHDAY < 0 this forward shifting is cancelled.

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

TOTN
($N_t(t_o)/W_t(t_o)$) Total plant N conc at start of growth. (-)
(index= growth period 1, 2 or 3).
If TOTN = 0 then maximum N-concentrations are assumed at the start.
If TOTN > 0 then TOTN/TOTW concentration is applied in all tissues.
GROWINI-switch=1 implies TOTN(1) is not used.

TOTW
($W_t(t_o)$) Total plant biomass at start of growth. (gDW m^{-2})
(index= growth period 1, 2 or 3).
Maximum N-concentrations are assumed at the start.
GROWINI-switch=1 implies TOTW(1) is 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=1:
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 stopped 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_o) 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 (OBS! This parameter is related to UPET (this parameter group) and TOTW (Crop Biomass group)).

6.4 Soil Profile and Site Description (S)

The soil profile is divided into a number of layers (NUMLAY) with different thickness (THICK). The division of layers is strictly linked to which layers the driving variables represent. The driving variables are usually taken from the SOIL model. Then the borders of layers should coincide with those used in the SOIL simulations. However, number of layers may differ. For instance two layers in SOIL could be represented by one layer in SOILN. Then weighted means of outputs from SOIL should then be used as input to SOILN.

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)
Note that those should correspond to those used in 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

6.5 Mineralisation and immobilisation (M)

The microbial activity determines the decomposition rate of litter. The microbial biomass is not explicitly represented but instead lumped into the litter pool. In this way it is assumed that the microbial biomass is constant. Rate coefficient for litter C decomposition is given by the parameter LITK. Efficiency constant (LITEFF) determines the fraction of organic C that after respiration remains as organic C. An assumed constant carbon-nitrogen ratio of microbes (CNORG) and a humification fraction (LITHF) determines the corresponding synthesis of N in litter and humus pools. Depending on the efficiency constants and the actual carbon-nitrogen ratios, litter may either demand nitrogen as ammonium or nitrate (= immobilization) or release nitrogen as ammonium (= mineralisation). The critical carbon-nitrogen ratio of litter for the shift from immobilization to mineralisation is determined by the ratio between CNORG and LITEFF.

The turnover of faeces and litter is treated in a similar way. What differs is the C/N ratio of the decomposing material. For faeces FECK corresponds to LITK, FECEFF to LITEFF and FECHF to LITHF.

Humus N mineralisation is given by the specific rate constant HUMK. Humus C is not represented.

Transformation of ammonium to nitrate (=nitrification) will occur if the ratio nitrate-ammonium is lower than NITR. The rate is controlled by NITK and response functions to temperature, soil water and pH.

If the MICROB-switch = 1 then dynamics of microbial biomass is simulated and C humus is represented explicitly. See section on Special parameters.

$C_{Li \rightarrow Decomp} = LITK * e_t e_m C_{Li}$
$C_{Li \rightarrow Atm} = (1\text{-}LITEFF) * C_{Li \rightarrow Decomp}$
$C_{Li \rightarrow h} = LITEFF * LITHF * C_{Li \rightarrow Decomp}$
$C_{Decomp \rightarrow Li} = LITEFF * (1\text{-}LITHF) * C_{Li \rightarrow Decomp}$

$N_{Li \rightarrow h} = C_{Li \rightarrow h} / CNORG$
$N_{Li \rightarrow Decomp} = C_{Li \rightarrow Decomp} N_{Li} / C_{Li}$
assumption: $C_{Decomp \rightarrow Li} / (N_{Li \rightarrow Decomp} - N_{Li \rightarrow h} - N_{Li \rightarrow NH4}) = CNORG$ *implies:*
$N_{Li \rightarrow NH4} = C_{Li \rightarrow Decomp} (N_{Li} / C_{Li} - LITEFF / CNORG)$

$N_{h \rightarrow NH4} = HUMK * e_t e_m N_h$

$N_{NH4 \rightarrow NO3} = NITK * e_t e_m e_p (N_{NH4} - N_{NO3} / NITR)$; >=0

CNORG
C-N ratio of microorganisms and humified products (-)
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.*
If MICROB-switch=1: C/N ratio of microbes.

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 (-)
Only used when the MANURE switch is on. *0.5*
Normal range the same as for LITEFF (0.2 - 0.7).

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

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

HUMK
Humus specific mineralisation rate (d^{-1})
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 re-mineralised *5.0E-5*

("fast" litter N mineralisation), it is reasonable to assume a lower value than if the reverse ("slow" litter N mineralisation) is assumed (see LITHF). Only used if MICROB-switch=0.

LITEFF

Efficiency of the internal synthesis of microbial biomass and metabolites in litter. (-) *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.
Only used if MICROB-switch=0.

LITHF

Litter carbon humification fraction. (-) *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 re-mineralised 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.
Only used if MICROB-switch=0.

LITK

Litter specific decomposition rate. (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. (d^{-1}) *0.2*

NITR

Nitrate-ammonium ratio in nitrification function. (-) *8.*

Normal range for agricultural soils 1 - 15.

6.6 Soil abiotic response (S)

A common soil temperature response function is used for mineralisation, immobilization and nitrification. The activity increases exponentially with temperature having the Q_{10}-value as a base. Different values of parameters in the response function for mineralisation, immobilization and nitrification, respectively, could be given, see the Special parameter group.

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 an 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.

The acidity of the soil (PH) affects the nitrifiers. A multiplicative response ranging between 0 at PHMIN and 1 at PHMAX affects nitrification.

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.

e_t = TEMQ10**((T_s-TEMBAS)/10)
e_m = MOSSA + (1-MOSSA)*x**MOSM ; *when* θ_s-MOS(2)<θ<θ_s
where
x = (θ_s - θ)/MOS(2)
e_m = ((θ - θ_w)/MOS(1))**MOSM ; *when* θ_w<θ<θ_w+MOS(2) , 0<= e_m <= 1

e_p = (PH(I) - PHMIN)/(PHMAX-PHMIN) , 0<= e_p <= 1

e_{md} = ((θ - (θ_s - MOSDEN))/MOSDEN)**DEND , 0<= e_{md} <= 1

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

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

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. *8*

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.

MOSM
Coefficient in soil moisture function. (-)
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. (-)
A value of 1 corresponds to optimum activity at saturation and 0 no activity. *0.6*
Normal range 0 - 1.

OUTLAY
(i) Layer. Only for presentation of outputs. For different soil response functions which are calculated for each layer but only have one output variable for presentation. OUTLAY is the soil layer for which the response function will be stored. A value outside 1-10 will give you the average response function for all layers. (-) *1*

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 of the layer concerned.

PHMAX
pH above which nitrification is not affected by acidity (-) *0*

PHMIN
pH below which nitrification is zero (-) *0*

TEMBAS
For the mineralisation-immobilisation process; Base temperature at which temperature effect = 1. (°C) *20*

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

6.7 Denitrification (S)

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 is reduced when the nitrate concentration decreases in soil water solution according to a Micahelis-Menten type function (DENHS).

$N_{NO3 \rightarrow atm} = f_r * DENPOT * e_t e_{md} x/(x + DENHS)$
where:
$x = N_{NO3}/\theta/\Delta z$
f_r = *fraction of total denitrification activity occurring in the layer concerned*

If DENDIST-switch=0:
$f_r(i) = DFRAC$
If DENDIST-switch=3:
$f_r(i) = (1 - \exp(-k_d z(i)/DENDEPTH))/(1 - DFRACLOW)$
where:
$k_d = -\ln(DFRACLOW)$

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. Nitrate concentration at which the activity is half of the activity at optimum nitrate concentrations. Normal range 5 - 15. (mgN l^{-1})
10

DENPOT
Potential rate of denitrification. 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. (gN m^{-2} d^{-1})
0.04

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
A first assumption may be to assume similar distribution as the root distribution or the distribution of soil organic matter since the activity of denitrifiers is known to depend on carbon availability.

DFRACLOW
Fraction of the exponential function remaining below the depth where the denitrification activity ceases (DENDEPTH). The remaining fraction DFRACLOW is equally distributed among layers above the denitrification depth. (-)
0.05

Normal range of k_d 2.5 - 4.5 corresponds to values from 0.08 to 0.01 of DFRACLOW.
Only used if DENDIST-switch = 3

6.8 Stream water (S)

Litter in uppermost layer and above ground residues is lost to stream by surface runoff.

Nitrate N is lost by consumption of nitrogen in a stream.

$N_{Li \rightarrow Stream} = LITTROFF * q_{Surr} N_{Li}$
$C_{Li \rightarrow Stream} = LITTROFF * q_{Surr} C_{Li}$

$N_{ab \rightarrow Stream} = ABOVROFF * q_{Surr} N_{ab}$
$C_{ab \rightarrow Stream} = ABOVROFF * q_{Surr} C_{ab}$

$N_{Surr \rightarrow Stream}$ = *see External inputs*

$N_{Stream \rightarrow Consum} = CONPOT * e_t N_{Stream} / (N_{Stream} + CONCRI)$; if $T_s > CONTEM$

ABOVROFF
Fraction of above ground residue lost per unit (mm) runoff. (mm^{-1})

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. *0*

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

LITTROFF
Fraction of litter in uppermost layer lost per unit (mm) runoff. (mm^{-1})

6.9 N root uptake (S)

Root depth: If GROWTH-switch = 1 then ROOTDINC and ROOTDMIN determine the root depth development. If GROWTH-switch = 0 then the development of the root depth is given by parameters ROOTT and ROOTDEP.

Distribution of plant N uptake capacity: Root biomass/area distribution in the soil profile can be given separately for each layer (ROOTF) or according to distribution functions (see switch ROOTDIST).

Plant N demand: If Growth-switch = 1: Plant demand for inorganic nitrogen from the soil (both nitrate and ammonium) is controlled by the growth of the plant (see the plant growth model: If the GROWTH-switch = 0 the plant demand is determined by a logistic uptake function defining the potential demand (UPA, UPB and UPC).

Soil N availability: 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, re-allocation of the uptake demand to other layers occurs to a degree given by UPMOV.

$N_{Soil\rightarrow a}(i) = N_{NO3\rightarrow a}(i) + N_{NH4\rightarrow a}(i)$
$N_{NO3\rightarrow a}(i) = \min (UPMA*N_{NO3}(i), x_{fra}N_{Demand}(i))$
$N_{NH4\rightarrow a}(i) = \min (UPMA*N_{NH4}(i), (1 - x_{fra})N_{Demand}(i))$
where:
$N_{Demand}(i) = a_r(i)N_{Demand} + N_{Deficit}$
$N_{Deficit} = \Sigma\ UPMOV*(N_{Demand}(i) - N_{Soil\rightarrow a}(i))$
$x_{fra} = N_{NO3}(i)/(N_{NO3}(i)+N_{NH4}(i))$

If GROWTH-switch=1:
$N_{Demand} = N_{lDemand} + N_{sDemand} + N_{rDemand} - N_{a\rightarrow r,s,l}$; *see N allocation*

If ROOTDIST-switch=3:
The fraction of roots (ar) that are found above a depth z:
$a_r(i) = (1 - \exp(-k_r z(i)/z_r))/(1 - RFRACLOW)$
where:
$k_r = -\ln(RFRACLOW)$
If GROWTH-switch=1:
$z_r = ROOTDMIN*W_r/(W_r+ROOTDMIN/ROOTDINC)$; $z_r \geq ROOTDMIN$

RFRACLOW
Fraction of the exponential function remaining below the root depth. This fraction is distributed equally among layers above the root depth. Normal range of k_r 2.5 - 4.5 corresponds to values from 0.08 to 0.01 of RFRACLOW. Only Used when the ROOTDIST-switch=3. (-) *0.05*

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

ROOTDINC
Parameter determining root depth as function of root biomass; (OBS! <0). (m)

ROOTDMIN
Lowest level for roots (OBS! <0) (-largest root depth). (m)

ROOTF
(a_r) 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) ($gN\ m^{-2}\ yr^{-1}$)
(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 case of an annual crop, UPB is the initial plant N content ($gN\ m^{-2}\ yr^{-1}$) at 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. *1.*
If GROWTH-switch > 0: Not used.

UPC
Coefficient in plant uptake function (u_c) (d^{-1})
Determines the plant development rate. Increasing UPC results in that the 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 sugar-beets 0.04. Normal values 0.02 - 0.14. *0.12*
If GROWTH-switch > 0: Not used.

UPMA
Fraction of mineral N available for immobilization and plant uptake. For the lowest soil layer with roots, UPMA for roots is decreased in proportion to how large fraction of the layer that is not penetrated by roots. (d^{-1})
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. If MICROB-switch > 0 only used for plant uptake. *0.08*

UPMOV
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 occurring 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*

6.10 Leaf assimilation (P)

The potential total assimilation rate is basically proportional (PHOEFF) to the amount of solar radiation intercepted by the canopy (EXTCOEFF). The radiation use efficiency is decreased in case of grain development (PHOREDUC). The actual radiation use is finally determined by the reduction factors for low (or too high) temperature (PHOTEMP), low leaf nitrogen concentration (NLEAFN and NLEAFXG) or plant water stress.

$W_{Atm \rightarrow a} = \alpha\ I_i\ f_T\ f_N\ f_W$
where:
α = PHOEFF-PHOREDUC*W_g
$I_i = I(1 - \exp(-EXTCOEFF * A_l))$
$f_T = (T_a$ - PHOTEMP(1))/(PHOTEMP(2)-PHOTEMP(1)); $0 <= f_T <= 1$; T<PHOTEMP(3)
$f_T = 1 - (T_a$-PHOTEMP(3))/(PHOTEMP(4)-PHOTEMP(3)); $0 <= f_T <= 1$; T>PHOTEMP(3)
$f_N = (n_l$ - NLEAFN)/(NLEAFXG - NLEAFN)
$f_W = E_t/E_{tp}$ *(input variable; see also special parameters)*

EXTCOEF
Radiation extinction coefficient for the canopy. (-)

NLEAFN
Leaf nitrogen concentration in leaf at which minimum growth occurs. (-)
If GROWPHOS-switch=2: Total plant N concentration at which minimum photosynthesis occurs.

NLEAFXG
Leaf nitrogen concentration in leaf at which maximum photosynthesis. (-)
If GROWPHOS-switch=2: Total plant N concentration at which maximum photosynthesis occurs.

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

PHOREDUC
Radiation use efficiency decreased due to grain development. Only used if GROWGRAIN-switch=1 (MJ^{-1})

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

PHOTEMP(1): Minimum daily mean air temperature for growth. (°C)

PHOTEMP(2): Minimum daily mean air temperature for optimum growth. (°C)

PHOTEMP(3): Maximum daily mean air temperature for optimum growth. (°C)

PHOTEMP(4): Maximum daily mean air temperature for growth. (°C)

6.11 Biomass allocation (P)

The plant biomass is divided into four compartments: root (W_r), stem (W_s), leaf (W_l) and grain (W_g). The daily new assimilates are partitioned between root, stem and leaf whereas grain receives assimilates from the other tissues. The root development is stimulated by low plant nitrogen (AROOTNI) or water status (AROOTE) but decreases with plant size (AROOTW). When grain development occurs allocation to roots is at a minimum (AROOTN). The allocation between stem and leaf depends on specific leaf area (WLAI) and the leaf area expansion. The latter in turn depends on above ground growth and biomass. The leaf area expansion increases with growth but decreases as the shoots become larger (ALEAF). When the above ground biomass has reached a high level no further development occurs. In this way the plant size strongly influences the partitioning between different organs. The grain development starts when a function of air temperature and day-length exceeds over a certain limit. Then a fraction of the assimilates in the stem tissues are translocated to grain (AGRAIN(2)). The stem receives assimilates from leaves (ADRAWLW) and roots (AGRAIN(3)). The vegetative growth goes on also after this time, although considerably reduced by the grain development. A certain fraction of the leaf biomass is withdrawn to stem (ADRAWLW) before abscission and a certain fraction of root litter is withdrawn to living roots (ADRAWRW).

In case of perennial plant accumulated current year growth is allocated to old biomass at a certain day (age) DAYPEREN. Assimilates can be released from biomass to an available pool both from young (AVACUR) and old (AVAWOOD) tissues. The available pool is then added to the daily total photosynthesis and allocated between leaf, stem and root.

$W_a' = W_{Atm\to a} + W_{r\to a}+W_{s\to a}+W_{l\to a}+W_{rw\to a}+W_{rs\to a}+W_{rl\to a} - W_{a\to r,s,l}$
$W_{a\to r,s,l} = W_{Atm\to a} + W_{r\to a}+W_{s\to a}+W_{l\to a}+W_{rw\to a}+W_{rs\to a}+W_{rl\to a}$
where:
$W_{Atm\to a}$ = *see Leaf assimilation*
If GROWAVAN > 0:
$W_{r\to a} = f_{Tas}*AVACUR*W_r$
$W_{rw\to a} = f_{Tas}*AVAWOOD*W_{rw}$
$W_{s\to a} = f_{Tap}*AVACUR*W_s$
$W_{sw\to a} = f_{Tap}*AVAWOOD*W_{sw}$
$W_{l\to a} = f_{Tap}*AVACUR*W_l$
$W_{lw\to a} = f_{Tap}*AVAWOOD*W_{lw}$
where:
$f_{Tas} = (T_s - AVATEM(1))/(AVATEM(2)-AVATEM(1));\ 0<=f_{Tas}<=1;\ T_s=max(T_s(z))$
$f_{Tap} = (T_a - AVATEM(1))/(AVATEM(2)-AVATEM(1));\ 0<=f_{Tap}<=1$

If GROWAVAN = 2:
$W_{a\to r,s,l} = W_{Atm\to a} + AVAK*W_a$
If GROWAVAN = 3:
$W_{a\to r,s,l} = AVAK*W_a$

$W_r' = W_{a\rightarrow r} - W_{r\rightarrow Li} - W_{r\rightarrow g} - W_{r\rightarrow Atm} - W_{r\rightarrow a}$
where:
$W_{a\rightarrow r} = b_r W_{a\rightarrow r,s,l}$
$W_{r\rightarrow Li}$ = *see Litter*
$W_{r\rightarrow g} = AGRAIN(3)*W_r$; = 0 if $i_g < 1$ *or GROWALLO-switch=1*
$W_{r\rightarrow s} = AGRAIN(3)*W_r$; = 0 if $i_g < 1$ *or GROWALLO-switch=0*
$W_{r\rightarrow Atm}$ = *see Respiration*
$W_{r\rightarrow a}$ = *see above*
where:
$b_r = \max(b_{rn}, b_{rw}, b_{re}, AROOTN)$; b_r= AROOTN if $i_g > 1$; b_r= 1 if $f_T <= 0$
$b_{rw} = AROOTW(1) + AROOTW(2)*W_t$ *(Note can differ, see Special parameters)*
$b_{rn} = AROOTNI(1) + AROOTNI(2)*(n_l' - NLEAFN)/(NLEAFXG - NLEAFN)$ *(Note can differ, see Special parameters)*
$b_{re} = AROOTE(1) + AROOTE(2)*(1 - AROOTETR*E_t/E_{tp})$ *(Note can differ, see Special parameters)*
$n_l' = N_{Soil\rightarrow l}/W_{p\rightarrow l}$

$A_l'(in) = W_{Ta}'(ALEAF(1) - ALEAF(2)*(1 + \ln(W_{Ta})))$; $A_l'(in) \geq 0$; $A_l'(in) \leq WLAI*W_{Ta}'$ *(Note can differ)*
where:
$W_{Ta} = W_l + W_s + W_g$

$W_l' = W_{a\rightarrow l} - W_{l\rightarrow Ab} - W_{l\rightarrow g} - W_{l\rightarrow Atm} - W_{l\rightarrow a}$
where:
$W_{a\rightarrow l} = A_l'(in)/WLAI$
$W_{l\rightarrow Ab}$ = *see Litter*
$W_{l\rightarrow g} = AGRAIN(1)*W_l$; = 0 if $i_g < 1$ *or GROWALLO-switch=1*
$W_{l\rightarrow Atm}$ = *see Respiration*
$W_{l\rightarrow a}$ = *see above*

$W_s' = W_{a\rightarrow s} + W_{l\rightarrow s} + W_{r\rightarrow s} - W_{s\rightarrow Ab} - W_{s\rightarrow g} - W_{s\rightarrow Atm} - W_{s\rightarrow a}$
where:
$W_{a\rightarrow s} = W_{a\rightarrow r,s,l} - W_{a\rightarrow r} - W_{a\rightarrow l}$
$W_{l\rightarrow s} = ADRAWLW*W_{l\rightarrow Ab}$
$W_{s\rightarrow Ab}$ = *see Litter*
$W_{s\rightarrow g} = AGRAIN(2)*W_s$; = 0 if $i_g < 1$
$W_{s\rightarrow Atm}$ = *see Respiration*
$W_{s\rightarrow a}$ = *see above*

$W_g' = W_{s\rightarrow g} + W_{l\rightarrow g} + W_{r\rightarrow g} - W_{g\rightarrow Atm}$
where:
$W_{g\rightarrow Atm}$ = *see Respiration*

If GROWPEREN-switch=1:

If t = DAYPEREN:
$W_{r\rightarrow rw}$ = APEREN*(W_r - $W_{r\rightarrow a}$)
$W_{s\rightarrow sw}$ = APEREN*(W_s - $W_{s\rightarrow a}$)
$W_{l\rightarrow lw}$ = APEREN*(W_l - $W_{l\rightarrow a}$) ; = 0 *If GROWDECID-switch=1*

$W_{rw}' = W_{r\rightarrow rw} - W_{rw\rightarrow a} - W_{rw\rightarrow Li} - W_{rw\rightarrow Atm}$
$W_{sw}' = W_{s\rightarrow sw} - W_{sw\rightarrow a} - W_{sw\rightarrow Li} - W_{sw\rightarrow Atm}$
$W_{lw}' = W_{l\rightarrow rw} - W_{lw\rightarrow a} - W_{lw\rightarrow Li} - W_{lw\rightarrow Atm} - W_{lw\rightarrow l}$
where:
$W_{rw\rightarrow Li}$ = (ALITTERR(1)-ADRAWRW)*$W_{p\rightarrow r}(t_l)$ + ALITTERR(2)*W_{rw}
t_l = t-AROOTAGE
$W_{sw\rightarrow Li}$ = ALITTERS*W_{sw} ; then $W_{s\rightarrow Li} = 0$
$W_{lw\rightarrow L}$ = ADRAWLW*ALITTERL*W_{lw} ; = 0 *If GROWDECID-switch = 1*
$W_{lw\rightarrow Li}$ = (1-ADRAWLW)*ALITTERL*W_{lw} ; = 0 *If GROWDECID-switch = 1*
$W_{rw\rightarrow Atm}$ = *dito* $W_{r\rightarrow Atm}$ *but* W_r *replaced by* W_{rw} ; $W_{r\rightarrow Atm} = 0$; *see Respiration*
$W_{sw\rightarrow Atm}$ = *dito* $W_{s\rightarrow Atm}$ *but* W_s *replaced by* W_{sw} ; $W_{s\rightarrow Atm} = 0$; *see Respiration*
$W_{lw\rightarrow Atm}$ = *dito* $W_{l\rightarrow Atm}$ *but* W_r *replaced by* W_{lw} ; $W_{l\rightarrow Atm} = 0$; *see Respiration*

ADRAWLW
Fractional withdrawal of dry weight in leaf litter to stem before abscission. If GROWPEREN = 1 withdrawal is from old leaves to new leaves. (-)

ADRAWRW
Fractional withdrawal of dry weight in current year old root litter fall to the same pool before abscission. (-)

AGRAIN
Fraction of biomass in tissues re-allocated to other tissues during grain development.

AGRAIN(1): (d^{-1})
If GROWALLO-switch=0: From leaves to grain.
If GROWALLO-switch=1: Not used (see ADRAWLW)

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

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

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

ALEAF(1): Coefficient a (m^2 gDW^{-1})

ALEAF(2): Coefficient b (differ)

ALEAF(3): Coefficient c (differ)

AROOTN
Minimum fraction of daily total growth allocated to roots. (-)

APEREN
() Fraction of annual growth allocated to woody pools. (-)

AVACUR
(w_a) Fraction of accumulated current year growth allocated to the available pool, daily. (d^{-1})

AVAK
Fraction of the available pool released daily (both biomass and N). (d^{-1})

AVATEM
Coefficients for the response of the release of assimilates from biomass, to temperature.

AVATEM(1): Minimum daily mean soil temperature for release of assimilates. (°C)

AVATEM(2): Minimum daily mean soil temperature for maximum release of assimilates. (°C)

AVAWOOD
(w_{aw}) Fraction of old biomass allocated to the available pool, daily. (d^{-1})

AVAWOODF
Fraction of old biomass and nitrogen in stem and roots allocated to leaf growth at flushing. Only used if GROWDECID-switch=1 (-)

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

6.12 N allocation (P)

Allocation of the daily total nitrogen uptake to root, stem and leaf is based on the idea that the roots receive nitrogen first, until they reach their maximum concentrations (NROOTX). Then the stem (NSTEMX) and finally the leaf (NLEAFXD). Leaves can take up nitrogen from deposition (see parameter DEPDRYA).

The allocation of plant nitrogen as well as allocation to litter basically follows the allocation of biomass in accordance with the N concentrations. However parameters allow you to change those proportions.

The amount N leached from canopy is a fraction (ALEACHLN) of the amount N in leaves times the throughfall rate up to a certain value PRECLEAC.

N dynamics of perennial pools follows the dynamics of the corresponding biomass pools (see Biomass allocation parameters). Concerning the available assimilates N is released from structural biomass in proportion to the biomass flows, and delivered to the uptake flow of nitrogen, thereby allocated in relation to demand by different organs.

$N_a' = N_{Soil\to a} + N_{r\to a}+N_{s\to a}+N_{l\to a}+N_{rw\to a}+N_{rs\to a}+N_{rl\to a} - N_{a\to r,s,l}$
where:
$N_{a\to r,s,l} = N_{a\to r} + N_{a\to s} + N_{a\to l}$
others in analogy with biomass except that AVACURN *and* AVAWOODN *are used instead of AVACUR and AVAWOOD*
If GROWAVAN = 3:
$N_{a\to r,s,l} = AVAK*N_a$

$N_{a\to r} = \min(N_{a\to r,s,l}, N_{rDemand})\ ;\geq 0$
$N_{a\to s} = \min(N_{a\to r,s,l}-N_{a\to r}, N_{sDemand})\ ;\geq 0$
$N_{a\to l} = \min(N_{a\to r,l,s}-N_{a\to r}-N_{a\to s}, N_{lDemand})\ ;\geq 0$
where:
$N_{rDemand} = NROOTX*W_{a\to r}$
$N_{sDemand} = NSTEMX*W_{a\to s}$
$N_{lDemand} = NLEAFXD*W_{a\to l}$

$N_r' = N_{a\to r} - N_{r\to Li} - x_1 - x_2$
$N_s' = N_{a\to s} + x_1 + x_3 - N_{s\to Ab} - n_sW_{s\to g}*AGRAINN(2)/AGRAIN(2)$
$N_l' = N_{a\to l} + N_{Dep\to l} - N_{l\to Ab} - x_3 - x_4 - + N_{l\to NO3}$
$N_g' = n_sW_{s\to g}*AGRAINN(2)/AGRAIN(2) + x_2 + x_4$
where:
$x_1 = n_rW_{r\to s}*AGRAINN(3)/AGRAIN(3)$ *if GROWALLO-switch=1*
$x_2 = n_rW_{r\to g}*AGRAINN(3)/AGRAIN(3)$ *if GROWALLO-switch=0*
$x_3 = n_lW_{l\to s}*AGRAINN(1)/AGRAIN(1)$ *if GROWALLO-switch=1*
$x_4 = n_lW_{l\to g}*AGRAINN(1)/AGRAIN(1)$ *if GROWALLO-switch=0*
$N_{r\to Li} = n_rW_{r\to Li}*ADRAWRN/ADRAWRW$
$N_{s\to Ab} = n_sW_{s\to Ab}$
$N_{l\to Ab} = n_lW_{l\to Ab}*ADRAWLN/ADRAWLW$
$N_{Dep\to l}$ = *see External inputs*
$N_{l\to Inf+Surr} = N_l*ALEACHLN*(q_{Inf}+q_{Surr})/PRECLEAC$

ADRAWLN
Fractional withdrawal of nitrogen in leaves before abscission. From leaf litter to stem. (-)

ADRAWRN
Fractional withdrawal of nitrogen in roots before abscission. From root litter to roots. (-)

AGRAINN
Fraction of N in tissues re-allocated to other tissues during grain development.

AGRAINN(1): (d^{-1})
If GROWALLO-switch = 0: From leaves to grain.
If GROWALLO-switch = 1: Not used (see ADRAWLN)

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

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

ALEACHLN
Fraction of N in leaves and old leaves that are leached to soil nitrate each day in case of water throughfall more or equal to PRECLEAC mm. (d^{-1})

AVACURN
Fraction of accumulated current year N allocated to the available pool, daily. (d^{-1})

AVAWOODN
Fraction of N in old tissues allocated to the available pool, daily. (d^{-1})

NLEAFXD
Leaf nitrogen concentration corresponding to maximum demand. (-)

NROOTX
Maximum nitrogen concentration of root biomass. (-)

NSTEMX
Maximum nitrogen concentration of stem biomass. (-)

PRECLEAC
Throughfall limit above which no further increasing of leaching from canopy occurs. (mm)

6.13 Respiration & Litter (P)

Maintenance respiration is a function of biomass content (WRESP) and temperature. The temperature response follows a Q_{10} function in a similar way as decomposition of organic matter, however with its own parameters (TEMQ10P and TEMBASP). Above ground respiration depends on air temperature whereas root respiration depends soil temperature.

Leaf litter fall is a fraction of leaf biomass (ALITTERL) and depends on leaf age (ALEAFAGE). Stem litter fall is a fraction of stem biomass (ALITTERS). Root litter fall is a fraction of root biomass (ALITTERR(2)) and depends on age of roots (AROOTAGE). All plant litter is assumed to have the same C/biomass ratio (CPLANT). In case of perennial plant maintenance respiration occurs only from old biomass.

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 lose N and C either through leaching (ABOVELN and ABOVELC) or transfer of residues to the uppermost litter pool determined by a rate coefficient (ABOVEK) or to faeces (ABOVEFEC).

A comment on the relation between carbon and dry weight (biomass) of plant. When plant grow it gains biomass. The plant is assumed to have C/dry_weight ratio equal to CPLANT. That means that the fraction (1-CPLANT) comes from somewhere not specified. When plant lose carbon through respiration or litter fall, the analogy is used. The carbon losses causes a biomass loss and it is assumed that the carbon ratio of that loss i CPLANT. The rest (1-CPLANT) goes to an unspecified place. In case of organic uptake the amount of carbon transferred from litter or humus to roots is converted to biomass by division with the parameter CPLANT.

$W_{r\rightarrow Atm} = WRESP*e_{tr}*W_r$
where:
$e_{tr} = T_s/TEMLINP*TEMQ10P**((TEMLINP-TEMBASP)/10)$; *if* T_s<*TEMLINP*
$e_{tr} = TEMQ10P**((T_s-TEMBASP)/10)$; *if* T_s>=*TEMLINP*

$W_{s\rightarrow Atm} = WRESP*e_{tp}*W_s$
$W_{l\rightarrow Atm} = WRESP*e_{tp}*W_l$
where:
$e_{tp} = T_a/TEMLINP*TEMQ10P**((TEMLINP-TEMBASP)/10)$; *if* T_a<*TEMLINP*
$e_{tp} = TEMQ10P**((T_a-TEMBASP)/10)$; *if* T_a>=*TEMLINP*
If GROWPEREN-switch=1:
$W_{r\rightarrow Atm} = W_{s\rightarrow Atm} = W_{l\rightarrow Atm} = 0$
$Q_{r\rightarrow Atm} = WRESP*e_{tr}*Q_r$
$Q_{s\rightarrow Atm} = WRESP*e_{tp}*Q_s$
$Q_{l\rightarrow Atm} = WRESP*e_{tp}*Q_l$

$W_{l\rightarrow Ab} = W_{p\rightarrow l}(t_l) + ALITTERL*W_l - W_{l\rightarrow s}$; t_l = t-ALEAFAGE
$W_{s\rightarrow Ab} = ALITTERS*W_s$

$C_{Ab\rightarrow Out} = ABOVELC*C_{Ab}$; if q_{Inf}>0
$C_{Ab\rightarrow Li} = ABOVEK*C_{Ab}$; if $T_s(1)$>0

$W_{r\rightarrow Li}(i) = a_r(i)W_{r\rightarrow Li}$
where:
$W_{r\rightarrow Li} = (ALITTERR(1)-ADRAWRW)*W_{p\rightarrow r}(t_l) + ALITTERR(2)*W_r$; t_l = t-AROOTAGE
$W_{l\rightarrow Ab}$, $W_{s\rightarrow Ab}$ and $W_{r\rightarrow Li}$ *are converted to C with* CPLANT

If GROWDECID-switch = 1 and t = DAYPEREN
$W_{l\rightarrow Ab} = W_l*APEREN$

$N_{Ab\rightarrow NH4} = ABOVELN*N_{Ab}$; if q_{Inf}>0
$N_{Ab\rightarrow Li} = ABOVEK*N_{Ab}$; if $T_s(1)$>0
$N_{r\rightarrow Li}$, $N_{s\rightarrow Ab}$, $N_{l\rightarrow Ab}$ *see N allocation*

ABOVEFEC
Fraction of N and C in above ground residues that are transformed to faeces. (d^{-1})
Only used if MANURE-switch=1. *1*

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

ALEAFAGE
Lifetime of leaves (d)

ALEAFINI
For the leaf litter pools. Loss of leaf is related to leaf age. Then the age of leaves are registrated. ALEAFINI is the amount of leaf biomass that should be distributed among these pools at start of simulation. Only used if parameter ALEAFAGE>0. (gDW m^{-2})

ALEAFTA
The relative change of ALEAFAGE with temperature. = 1 at 10°C. Only used if parameter ALEAFAGE>0. ($°C^{-1}$)

ALITTERL
Fraction of leaf biomass lost to litter. (d^{-1})

ALITTERR
Parameters for root mortality.

ALITTERR(1): Fraction of daily root growth lost as litter (if AROOTAGE=0). (-)
If AROOTAGE>0 then, the fraction of daily root growth that is allocated to roots with a lifetime of AROOTAGE days.

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

ALITTERS
Fraction of stem biomass (woody biomass if GROWPEREN-switch=1) lost through litter. (d^{-1})

AROOTAGE
Lifetime of roots (note related to ALITTERR(1). (d)

AROOTINI
For the root litter pools. Loss of leaf is related to leaf age. Then the age of leaves are registrated. AROOTINI is the amount of leaf biomass that should be distributed among these pools at start of simulation. Only used if parameter AROOTAGE>0. (gDW m^{-2})

AROOTTS
The relative change of AROOTAGE with temperature. = 1 at 10°C. Only used if parameter AROOTAGE>0. ($°C^{-1}$)

TEMBASP
For plant respiration; Base temperature at which temperature effect = 1. (°C)
20

TEMLINP
For plant respiration. Threshold temperature below which the temperature response is a linear function of temperature. Only used if TEMLINP>0. (°C)
5

TEMQ10P
For plant respiration. Response to a 10 °C soil temperature change (-)
3

WRESP
Coefficient to multiply the maintenance respiration of root, stem biomass and leaf biomass which is a Q_{10} function of temperature. The product of WRESP and the temperature is the fraction of biomass that is lost through respiration. (d^{-1})
If GROWPEREN-switch = 0: respiration acts on current year biomass.
If GROWPEREN-switch = 1: respiration acts on old biomass.

6.14 Growstage (P)

If GROWSTART-switch=1 then photosynthesis starts at a certain temperature sum (DAYTAACC, TAACC). Otherwise growth starts at day UPST (see Soil and plant management parameter group).

If GROWPHEN-switch>0 then the date for start of grain development is calculated as a function of temperature and daylength (GRAINI). Grain development starts when an index (i_g) becomes unity.

i_v = 11 if: t = UPST i_v = 2 if: UPST <= t <= UPET
If GROWSTART-switch=1: i_v = 10 if: t>=DAYTAACC t_f = t if: $\Sigma(T_a$-PHOTEMP(1); >0) = TAACC i_v = 12 if: t=t_f i_v = 2 if: t>t_f i_v = 13 if: t=DAYPEREN i_v = 0 if: W_l=0 & t>172
If GROWPHEN-switch>0: If i_v = 2 or i_v = 11: $i_g = \Sigma_{Acc}$ GRAINI(1)*(1 - exp(-x))(1 - exp(-y)) *where:* x = GRAINI(4)*(T(t) - GRAINI(5)) y = GRAINI(2)*(D(t) - GRAINI(3))

DAYTAACC
Day number at which the calculation of T_{aAcc} starts (d)

DAYPEREN
Day number at which the transformation of assimilates from young pools (current year) to old pools (wood) occur (d)

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

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

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

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

GRAINI(5): Threshold temperature (°C)

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

6.15 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.

6.16 Special: External input

The Special parameters are available only if the SPECIAL-switch is ON. They activates special routines not used, or kept fixed, in the original model.

Some of the parameters are used for sensitivity tests. The value for no test is the default value, given in italics. In case 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.

Special options for automatic correction of certain simulated values (BOUNDARY-switch and parameters BOUN....) are activated by switches. For description of the options is referred to the description of switches.

NUMLAYWT activates a special routine for drivingvariables (preliminar). If thickness of soil layers of driving variables from SOIL model (water and heat values) missmatch with layer thickness used in the SOILN model. For TEMP (temperature) in the driving variable file temperature is calculated for each cm depth by linear interpolation between the center of each layer(defined by THICKWT()). The temperature used in SOILN is picked out from this profile distribution for the center of each layer defined by parameter THICK(). As the surface boundary is used air temperature. Lower boundary: if the profile defined by NUMLAY is deeper than the one of NUMLAYWT the deepest derived slope is used for extrapolation downwards. If NUMLAYWT=1 then a constant value is used for the whole profile except that the surface boundary could be defined with NUMLAYTA. For THETA a corresponding calculation proceedure is used (see NUMLAYTH). For WFLOW the same calculation proceedure is used except that those values are defined for the limit between layers. If NUMLAY defines a deeper profile than NUMLAYWT then WFLOW deeper down equals PERC. For DFLOW the outflow per cm depth is calculated for the whole profile. One constant value per layer (THICKWT). Using the new soil layers (THICK), the calculated cm-values are summed for each layer. If NUMLAY defines a deeper profile than NUMLAYWT then DFLOW equals the value derived for the lowest THICKWT layer.

BOUNFTOT

Total number of variables (including error variables) in the file used for correction. Only used if BOUNDARY-switch > 0. Setting BOUNFTOT = 0 implies that the BOUNDARY-switch is set = 0. (-) *2*

BOUNRERR

Relative error of variables used for correction. If BOUNRERR<0 then equal to the absolute error. Only used if BOUNDARY-switch=3 (-) *2*

BOUNVALU

Value that simulated variable should be corrected to in each time step. Value = -99 is treated as missing. (differ) *-99*
Index 1-max20. Only used if BOUNDARY-switch=4

BOUNVNUM

Variable number of simulated variable that should be corrected during simulation. Numbers are listed in Appendix 1. (-) *0*
States variables (X-var): X(n) where n=BOUNVNUM
Flow variables (T-var): T(n) where n=BOUNVNUM-1000
Auxiliary variables (G-var): G(n) where n=BOUNVNUM-10000
Index 1-BOUNFTOT/2
Only used if BOUNDARY-switch > 0

NUMLAYTA

Height above soil surface where the soil temperature should become equal to the air temperature (if the soil media would have continued above surface). (m) *0*
If NUMLAYTA=0 then the uppermost vertical slope derived from TEMP(z) is used to calculate surface boundary. Only used if NUMLAYWT parameter>0.

NUMLAYTH
Upper boundary for relative soil water content. It is equal to field capacity in case of infiltration being higher than NUMLAYTH. This boundary option is activated by NUMLAYTH=0. In all other cases the surface boundary is given by the uppermost vertical slope derived from THETA(z). Only used if NUMLAYWT parameter>0.

(mm d^{-1})
0

NUMLAYWF
Acts as a switch. = 1 then the surface boundary for WFLOW is infiltration and lower boundary is defined by PERC. Only used if NUMLAYWT parameter>0.

(-)
1

NUMLAYWT
Activating special routine for drivingvariables: If thickness of soil layers of driving variables from SOIL model (water and heat values) missmatch with layer thickness used in the SOILN model, then use the NUMLAYWT parameter (NUMLAYWT>0 activates the routine). NUMLAYWT is the number of layers in the input file. (see also parameters THICKWT, NUMLAYTA,..TH,..WF). The SOILN layers are defined by NUMLAY and THICK parameters. Be careful, not yet tested properly.

(-)
0

OUTLAY
(i) Layer. The abiotic 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

OUTLITCN
Switch selecting for which pool the specific decomposition rate should be stored in the auxiliary variable LITKCN. 1/2/3: Litter, Humus, Litter2. Layer for which it should be stored is selected with parameter OUTLAY.

(-)
1

OUTRATCN
Switch selecting for which pool the C/N ratio should be stored in the auxiliary variable RATCNL. 1/2/3/4: Litter, Humus, Litter2, Microbes.

(-)
1

OUTSW
Switch selecting which internal model should be stored in the auxiliary variable SWITCHOUT. 1/2/3/4/5: SwFlush, SwStart, SwPlough, SwHarv, SwCatch.

(-)
1

THICKWT
For the input variables on soil water and heat (from SOIL model). Defines the thickness of the soil layers used in those inputs. Not used if NUMLAYWT parameter = 0.

(m)
0

X....
Parameter names equal to switch names except for the X in front of the name. (-)
Used to enable change of switch values during the simulation by using *-1*
CHAPAR-switch. The switch get the value of parameter X... Only used if CHAPARSW-switch=1 an X.... <>-1.

6.17 Special: Soil and plant management

A certain fraction of N deposited and mineral N fertiliser could be directly allocated to the second layer (FERNLAY2).

Special options for automatic fertilisation (FERNCALC-switch).

If FERNCALC-switch=1: $N_{Appl \rightarrow Fert} = N_{Appl \rightarrow Fert} + AVAILN*(N_{Demand} - N_{Soil \rightarrow a} - x)/UPMA$ *where:* $x = N_{Inf \rightarrow NO3} - N_{Dep \rightarrow NH4} - N_{Fert \rightarrow NH4}$
If FERNCALC-switch=2: $N_{Appl \rightarrow Fert} = N_{Appl \rightarrow Fert} + AVAILN - x - y$ *where:* $x = N_{Inf \rightarrow NO3} - N_{Dep \rightarrow NH4} - N_{Fert \rightarrow NH4}$ $y = 0.2*N_{Li} + 7.5*HUMK*N_h + 0.2*N_f + N_{NH4} + N_{NO3}$

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

FERNLAY2
FERNLAY2(1): Fraction of dissolved ammonium N from solid fertiliser that (-)
is allocated directly to the second layer ($N_{Fert \rightarrow NH4}$) *0*

FERNLAY2(2): Fraction of ammonium deposition and infiltrated nitrate that (-)
is allocated directly to the second layer ($N_{Dep \rightarrow NH4}$, $N_{Inf \rightarrow NO3}$) . *0*

6.18 Special: Soil profile

Special options for mobile ammonium (NH4MOBIL-switch) are activated by switch.

If NH4MOBIL-switch=1:
$N_{NH4(i)} \rightarrow_{(i+1)} = q_{w(i)} n_{NH4(i)}/1000$ (i=layer)
where:
$n_{NH4(i)} = N_{NH4Sol(i)}/\theta/THICK(i)$; $\theta >= \theta_w$
where:
$N_{NH4Sol(i)} = N_{NH4(i)} - N_{NH4Ads(i)}$
where:
$N_{NH4Ads(i)} = x + y * N_{NH4(i)}$
where:
N_{NH4Ads}[gN/gSoil] = NH4ADSA + NH4ADSB*n_{NH4}[gN/m^3Water] *implies:*
x = NH4ADSA(i)/(1/BULKDENS(i)/THICK(i)+NH4ADSB(i)/θ/THICK(i))
y = 1/(θ/BULKDENS(i)/NH4ADSB(i)+1)
If NMINCOMP-switch=1: NH4COMP and NO3COMP are activated

BULKDENS

Bulkdensity of soil. Index 1-10: Soil layer. Below layer 10 the value of layer 10 is used.
Only used if NH4MOBIL-switch = 1.

($g\ m^{-3}$)
0.1e+6
1.0e+6

NH4ADSA

Coefficient (a) in the relation between ammonium in soil solution and amount adsorbed on soil particles:
N_{NH4Ads} (gN/gSoil) = a + b * N_{NH4Sol} (gN/m^3Water). Index 1-10: Soil layer. Below layer 10 the value of layer 10 is used.
Only used if NH4MOBIL-switch = 1.

($gN\ gSoil^{-1}$)
0.5e-6

NH4ADSB

Coefficient (b) in the relation between ammonium in soil solution and amount adsorbed on soil particles:
N_{NH4Ads} (gN/gSoil) = a + b * N_{NH4Sol} (gN/m3Water). Index 1-10: Soil layer. Below layer 10 the value of layer 10 is used.
Only used if NH4MOBIL-switch = 1.

(m^3Water $gSoil^{-1}$)
2.0e-6
0.5e-6

NH4COMP

If the difference between output and input (the deficit) of the ammonium pool >0 than it is allocated between output flows from the ammonium pool. The parameter equals the fraction of the deficit that should be allocated to a certain variable. The sum of NH4COMP(1,2,3,4,5,6) should be 1. If not, then the parameter values are adjusted proportionally. The reduction is repeated until the whole deficit is covered. (Only used if NMINCOMP-switch=1)
Indecies 1-6 corresponds to the following output variables:
(1): Plant uptake
(2): Microbial immobilisation
(3): Nitrification
(4): Transport between layers
(5): Ammonium leaching

(-)
0.5
0.25
0.25
0
0

NO3COMP

The difference between output and input (the deficit) of the nitrate pool is allocated between different output variables. See further NH4COMP parameter. (Only used if NMINCOMP-switch=1)	(-)
Indecies (1-5) corresponds to the following variables:	*0.1*
(1): Plant uptake	*0.1*
(2): Microbial immobilisation (not if MICROB-switch=0)	*0.5*
(3): Denitrification	*0*
(4): Transport between layers	
(5): Nitrate leaching	

6.19 Special: Mineralisation and immobilisation

LITTKCN-switch: CNLITN, CNLITX, CNFECN and CNFECX: The specific decomposition rate of litter (LITK) and faeces (FECK) can be set a linear function of the C-N ratio. If the MICROB-switch>0, then this option acts on the microbial gross consumption rate (MICK).

MICROB-switch: A special option of SOILN allows you to simulate microbe dynamics. In that case the microbes decompose dead organic material in proportion (MICK) to the amount of microbial biomass. The microbial gross consumption rate is decreased in case of substrate deficiency. At a certain amount of substrate (MICSUB) MICK is half of its maximum value. The microbes daily decomposition can not be more than a certain maximum fraction of the substrate (MICMAX). Some of the decomposed material is lost by growth respiration (1-MICEFF) whereas the remaining material increases the microbial biomass. The microbes die off in proportion (MICMORT) to their biomass. This is lost to the litter pool and mixed with dead plant material. The microbes also lose carbon due to maintenance respiration (MICMRESP). Both the mortality and the maintenance respiration rates can be set functions of abiotic conditions. The nitrogen dynamics follows the carbon dynamics. Nitrogen consumed by microbes is the N/C ratio of litter multiplied by the C amounts consumed. Then the C/N ratio of this material decreases due to respiration. The microbes lose N in proportion to their C/N ratio when they die. Depending on if the C/N ratio of the assimilated litter is lower or higher than MICCN, the microbes will mineralise N to soil or immobilise N from soil. In case mineral N is low in soil the microbe N uptake might be smaller than their demand and the microbes might get an increased C/N ratio. You can choose up to three different litter pools on which the microbes acts, litter, humus and an extra litter pool. The principals are the same for all pools. What differs are the microbial consumption rates (MICK(1-3) from the different pools, the respiration (1-MICEFF(1-3)) and the fraction of dead microbial biomass delivered to different pools (MICMORT(1-3)). An alternative function is available where the dead microbes can be set to recirculate within the microbial biomass within the time step (see MICMORT(1) below). The litter fall is separated into the different pools by parameters LITFRACA(1-3) (leaves and stems) and LITFRACR(1-3) (roots).

If MICROB-switch>0:	*If MICROB-switch*
$C_{Ab\rightarrow Li} = LITFRACA(1)*C_{Ab\rightarrow LiTot}$	>=1
$C_{r\rightarrow Li} = LITFRACR(1)*C_{r\rightarrow LiTot}$	>=1
D:o for Nitrogen give: $N_{Ab\rightarrow Li}$, $N_{r\rightarrow Li}$	>=1
D:o for Humus give: $C_{Ab\rightarrow h}$, $C_{r\rightarrow h}$, $N_{Ab\rightarrow h}$, $N_{r\rightarrow h}$	=2 or 3
D:o for Litter2 give: $C_{Ab\rightarrow Li2}$, $C_{r\rightarrow Li2}$, $N_{Ab\rightarrow Li2}$, $N_{r\rightarrow Li2}$	=3
$C_{Li\rightarrow m} = MICK(1)*f_{Sub}*e_te_mC_m$; <=$MICMAX*C_{Li}$	>=1
$C_{m\rightarrow Li} = x*MICMORT(1)*C_m$	>=1
where:	
$f_{Sub} = C_{Li}/(C_{Li}+MICSUB(1))$	
x = *abiotic factor, see MICABIO-switch below*	
D:o for Humus give: $C_{h\rightarrow m}$, $C_{m\rightarrow h}$	
D:o for Litter2 give: $C_{Li2\rightarrow m}$, $C_{m\rightarrow Li2}$	=2 or 3
$C_{Li\rightarrow h} = MICCLHUM*C_{Li\rightarrow m}$	=3
D:o for Humus give: $C_{h\rightarrow Li2}$	>=2
	=3
$C_{m\rightarrow Atm} = (1-MICEFF(1))C_{Li\rightarrow m}+(1-MICEFF(2))C_{Li2\rightarrow m}+(1-MICEFF(3))C_{h\rightarrow m} + y*MICMRESP*C_m$	
where:	
y = *abiotic factor, see MICABIO-switch below*	
$N_{Li\rightarrow m} = C_{Li\rightarrow m}N_{Li}/C_{Li}$	>=1
$N_{m\rightarrow Li} = C_{m\rightarrow Li}N_m/C_m$	>=1
D:o for Humus give: $N_{h\rightarrow m}$, $N_{m\rightarrow h}$	=2 or 3
D:o for Litter2 give: $N_{Li2\rightarrow m}$, $N_{m\rightarrow Li2}$	=3
$N_{Li\rightarrow h} = MICCNHUM*C_{Li\rightarrow h}$	>=2
D:o for Humus give: $N_{h\rightarrow Li2}$	=3
$N_m(new) = C_m(new)/MICCN$ *implies:*	
where:	
$C_m(new) = C_m + \Delta C_m$	
$\Delta C_m = C_{Li\rightarrow m}+C_{Li2\rightarrow m}+C_{h\rightarrow m}-(C_{m\rightarrow Li}+C_{m\rightarrow Li2}+C_{m\rightarrow h})-C_{m\rightarrow Atm}$	
$N_m(new) = N_m + \Delta N_{m1} - N_{m\rightarrow NH4}$	
$\Delta N_{m1} = N_{Li\rightarrow m}+N_{Li2\rightarrow m}+N_{h\rightarrow m}-(N_{m\rightarrow Li}+N_{m\rightarrow Li2}+N_{m\rightarrow h})$	
$N_{m\rightarrow NH4} = -((C_m+\Delta C_m)/MICCN - (N_m+\Delta N_{m1}))$; < $MICUPMA*(N_{NO3}+N_{NH4})$	
if $N_{m\rightarrow NH4}<0$ *then also* $N_{m\rightarrow NO3}<0$ *and included in the equation above*	
$N_{h\rightarrow NH4}$ = *see Mineralisation and immobilisation*	=4
$C_{h\rightarrow Atm} = CNORG*N_{h\rightarrow NH4}$	=4

If MICABIO-switch>0:	*If MICABIO-switch:*
mortality abiotic factor x = e_t	=1
mortality abiotic factor x = e_m	=2
maintenance respiration abiotic factor y = e_t	=3
maintenance respiration abiotic factor y = e_m	=4
combinations are multiplication of e_t *and* e_m, *f.i.* x = e_te_m	>=12

If LITTKCN-switch =1 or 3:
$LITK(new) = LITK*(1-(C_{Li}/N_{Li} - CNLITN)/(CNLITX - CNLITN))$
and MICROB-switch >0:
$MICK(new) = MICK(1)*(1-(C_{Li}/N_{Li} - CNLITN)/(CNLITX - CNLITN))$
+D:o for Humus and Litter2 (MICK(2) and MICK(3))

If LITTKCN-switch =2 or 3:
FECK(new) = FECK*(1-(C_f/N_f - CNFECN)/(CNFECX - CNFECN))

CNFECN
Minimum C-N ratio of faeces at which no decomposition occurs. Only used i LITTKCN switch=2 or 3. (-) *0*

CNFECX
Maximum C-N ratio of faeces at which maximum decomposition occurs. Only used i LITTKCN switch=2 or 3. (-) *0*

CNLITN
Minimum C-N ratio of litter at which no decomposition occurs. Only used i LITTKCN switch=1 or 3. (-) *0*

CNLITX
Maximum C-N ratio of litter at which maximum decomposition occurs. Only used i LITTKCN switch=1 or 3. (-) *0*

MICCHLIT2
Fraction of microbial gross assimilation of humus C allocated to litter2 direct. Only used if MICROB-switch>2 (-) *0*

MICCLHUM
Fraction of microbial gross assimilation of litter C allocated to humus direct. Only used if MICROB-switch>1 (-) *0*

MICCN
C-N ratio of microbes. Only used i MICROB switch>0. (-) *5*

MICCNHUM
C/N ratio of litter allocated to humus direct. Only used if MICROB-switch>1 (-) *0*

MICCNLIT2
C/N ratio of humus allocated to litter2 direct. Only used if MICROB-switch>2 (-) *0*

MICEFF
Efficiency of the internal synthesis by microbial biomass of organic material from (index 1-3): Litter, Humus, Litter2
Only used if MICROB-switch>0 (-) *0,0,0*

MICK
Microbial gross consumption rate per unit of microbial biomass, at a reference temperature and optimal soil water condition. The value differ depending of type of substrate. Index 1-3 refers to substrate: Litter, Humus, Litter2.
Only used if MICROB-switch>0

(d^{-1})
0,0,0

MICKH
Microbial gross consumption rate of humus for a certain layer (correspond to MICK(2)). (Index = layer). Only used if MICROB-switch > 100

(d^{-1})
0

MICKLI
Microbial gross consumption rate of litter for a certain layer (correspond to MICK(1)) (Index = layer). Only used if MICROB-switch > 100

(d^{-1})
0

MICKLI2
Microbial gross consumption rate of litter2 for a certain layer (correspond to MICK(3)) (Index = layer). Only used if MICROB-switch > 100

(d^{-1})
0

MICMAX
Maximum fraction of substrate decomposed every day. Only used if MICROB-switch>0.

(d^{-1})
0.1

MICMORH
Microbial relative mortality rate allocated to humus for a certain layer (correspond to MICMORT(2)). Index 1-10 refers to layer. Only used if MICROB-switch > 100

(d^{-1})
0

MICMORLI
Microbial relative mortality rate allocated to the litter pool for a certain layer (correspond to MICMORT(1) also when <0). Index 1-10 refers to layer. Only used if MICROB-switch > 100

(d^{-1})
0

MICMORLI2
Microbial relative mortality rate allocated to the litter2 pool for a certain layer (correspond to MICMORT(3)). Index 1-10 refers to layer. Only used if MICROB-switch > 100

(d^{-1})
0

MICMORT
Microbial relative mortality rate.
Index 1-3: Litter, Humus, Litter2.
If MICMORT(1)<0: the dead microbes are recirculated into microbial biomass within one day. This flow result in a recirculated amount = -MICMORT(1)*x*Cm*MICEFF(1) and the respiration = -MICMORT(1)*x*Cm*(1-MICEFF(1)). (x=abiotic response)
Only used if MICROB-switch>0.

(d^{-1})
0,0,0

MICMRESP
Fraction, at a reference temperature, of microbial biomass lost by maintenance respiration. Only used if MICROB-switch>0. (d^{-1}) *0*

MICSUB
Substrate amount at which MICK is half of its maximum value. Index 1-3: Litter, Humus, Litter2.
If MICSUB(1)<0: $f_{Sub} = C_{Li}/(C_{Li}-MICSUB(1)*C_m)$; the same for index 2 and 3.
Only used if MICROB-switch>0. (-)

MICUPMA
Fraction of mineral N available for immobilization. (d^{-1}) *0.08*

6.20 Special: Soil abiotic response

TEMPREQ-switch: Alternative temperature response functions for microbial activity may be used. Also separate temperature response functions could be used for mineralisation-immobilization, denitrification and nitrification. The function is based on a Q_{10} 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. Microbial utilisation efficiency (MICEFF) could be set a function of soil temperature

If TEMPREQ-switch=1:
e_t = T_s/TEMLIN*TEMQ10**((TEMLIN-TEMBAS)/10) ; *if Ts<TEMLIN*
If TEMPREQ-switch=2:
$e_t = (T_s-TEMMIN)/(TEMBAS-TEMMIN)^2$
If TEMPREQ-switch=3:
$e_t = TEMPOL(1)+TEMPOL(2)*T_s+TEMPOL(3)*T_s^2+TEMPOL(4)*T_s^3+.....$
If MICEFFTS-parameter <> 0 and T_s < MICEFFTS-parameter:
MICEFF= MICEFF*(1+MICEFFTS*(MICEFFT0-T_s(I))

MICEFFT0
Temperature below which MICEFF is a function of temperature. Only used if MICEFFTS <> 0. (°C) *5*

MICEFFTS
Relative change of MICEFF as function of temperature. Only used if MICEFFTS <> 0 and T_s < MICEFFT0. (-) *0*

TEMBASD
For the denitrification process; Base temperature at which temperature effect = 1. Only used if TEMPREQ-switch=4, 14 or 24. (°C) *20*

TEMBASN
For the nitrification process; Base temperature at which temperature effect = 1. If TEMBASN = 0 then TEMBASN is set equal TEMBAS. Only used if TEMPREQ-switch=4, 14 or 24. (°C) *20*

TEMLIN
For the mineralisation-immobilisation process. Threshold temperature below which the temperature response is a linear function of temperature. Only used if TEMPREQ-switch=1. (°C) *5*

TEMLIND
For the denitrification process. Threshold temperature below which the temperature response is a linear function of temperature. Only used if TEMPREQ-switch=4 or 14. (°C) *5*

TEMLINN
For the nitrification process. Threshold temperature below which the temperature response is a linear function of temperature. Only used if TEMPREQ-switch=4 or 14. (°C) *5*

TEMMIN
Minimum temperature for microbial processes in the Ratkowsky function. Only used if TEMPREQ-switch=2 or 24 (°C) *-8*

TEMMIND
The same as for TEMMIN but for the denitrification process. Only used if TEMPREQ-switch=24 (°C) *-8*

TEMMINN
The same as for TEMMIN but for the nitrification process. Only used if TEMPREQ-switch=24 (°C) *-8*

TEMMPOL
Coefficients in a 6-degree polynomial temperature function. Index 1-7. Only used if TEMPREQ-switch=3 (differ)

TEMQ10D
For the denitrification process. Response to a 10 °C soil temperature change. Only used if TEMPREQ-switch=4 or 14. (-) *3*

TEMQ10N
For the nitrification process. Response to a 10 °C soil temperature change. Only used if TEMPREQ-switch=4 or 14. (-) *3*

6.21 Special: N root uptake

If ROOTDENS-parameter>0:
UPMA(new) = UPMA*(W_r(i)/δz(i)/ROOTDENS)**ROOTDENSE
If GROMYCO-switch=1:
$N_{Li \rightarrow Plant} = f_{Def}$*PMYUPPNL*$N_{Li}$
$N_{h \rightarrow Plant} = f_{Def}$*PMYUPPNH*$N_h$
where:
$f_{Def} = (N_{Demand}-N_{mineral \rightarrow Plant})$/PMYUPPNX
$C_{Li \rightarrow Plant}$ = PMYCOCN*$N_{Li \rightarrow Plant}$
$C_{h \rightarrow Plant}$ = PMYCOCN*$N_{h \rightarrow Plant}$

PMYCOCN
C/N ratio of the plant organic N uptake. The amount of carbon transferred from litter or humus to roots is converted to biomass by division with the parameter CPLANT. Only used if GROWMYCO-switch=1. (-) *4*

PMYUPPNH
Maximum fraction of humus N taken up by plant. Only used if GROWMYCO-switch=1. (d^{-1}) *0*

PMYUPPNL
Maximum fraction of litter N taken up by plant. Only used if GROWMYCO-switch=1. (d^{-1}) *0.01*

PMYUPPNX
Plant N deficit at which organic uptake is at maximum. Only used if GROWMYCO-switch=1. ($gN\ m^{-2}$) *0*

ROOTDENS
Parameter making root uptake (UPMA) equal a function of root density. Only used if ROOTDENS > 0. ($gDW\ m^{-3}$) *0*

ROOTDENSE
Parameter making root uptake (UPMA) equal a function of root density, see parameter ROOTDENS. (-) *1*

6.22 Special: Leaf assimilation

The impact of water stress on growth can be modified by parameter PHOETR. CO_2 concentration of the air can be given as input affecting radiation use efficiency (CO2START, PHOCO2).

Special options for an alternative function for calculating photosynthesis (GROWPHOS-switch) is activated by switch.

If GROWPHOS-switch=1: $W_{Atm \rightarrow p} = PGRESP*\Sigma(\Delta A_l(xP_{Max}/(x+(1-PTRANSM)*P_{Max})$ *where:* $x = PHOEFF*EXTCOEF*I*\exp(-EXTCOEF*\Sigma\Delta A_l)$ $P_{Max} = PMAX20(1)*(1-PMAX20(2)*(1-\exp(-EXTCOEF*\Sigma\Delta A_l))*f_T*Daylength$
if CO2START>0: CO_{2Atm} = CO2START*(1+CO2INCY*(Year since simulation start)) PHOEFF(new) = x*PHOEFF; *where* x = 1+PHOCO2*(CO_{2Atm}-CO2REF)/CO2REF
$f_W = PHOETR(1)+PHOETR(2)*E_t/E_{tp}$

CO2INCY
Annual relative increment of atmospheric CO_2 concentration. Not used if CO2START= 0 — (y^{-1}) *0.01*

CO2REF
Atmospheric CO_2 concentration at which the radiation use efficiency equals the one given by parameter PHOEFF. — (ppm) *350*

CO2START
Concentration of carbon dioxide in the atmosphere at start of simulation. = 0 implies option is cancelled. Normal value is about 350 — (ppm) *0*

PHOCO2
Relative increase in radiation use efficiency due to doubled atmospheric CO_2 concentration. — (ppm^{-1}) *0.4*

PHOETR
Coefficients modifying the effect of transpiration ratio on plant growth.

PHOETR(1): a in eq. $f_W=a+b*E_t/E_{tp}$ — - *0*

PHOETR(2): b in eq. $f_W=a+b*E_t/E_{tp}$ — - *1*

PPMAX20
Coefficients for maximum photosynthetic rate.
Only used if GROWPHOS-switch = 1.

PPMAX20(1): Maximum leaf photosynthesis rate at optimal temperature, water and nitrogen conditions (note area refers to leaf area). — ($kgCO_2\ ha^{-1}\ h^{-1}$) *43.2*

PPMAX20(2): Rate of decline of maximum leaf photosynthesis with increased leaf area index. — (-) *0.35*

PTRANSM
Leaf transmission coefficient.
Only used if GROWPHOS-switch = 1. — (-) *0.1*

PGRESP
Growth conversion efficiency (reduction coefficient of canopy photosynthesis due to growth respiration). (-)
Only used if GROWPHOS-switch = 1. *0.83*

6.23 Special: Biomass allocation

if GROWAVAI-switch = 1 or 12:
$W_{a \rightarrow r,s,l} = W_a$

if GROWCAT-switch = 1:
If GROWSTAG = 21 then it is reseted to 2 *(grain development is canceled).*
At harvest: Main crop is reduced by y_{Fra}
$y_{Fra} = CATCHINI(1) + CATCHINI(2)*(W_r+W_s+W_l+W_g)$
$W_{r,s,l,g \rightarrow a} = y_{Fra}(W_r+W_s+W_l+W_g)$
$W_r = W_r - W_{r,s,l,g \rightarrow a}W_r/(W_r+W_s+W_l+W_g)$
D:o for leaves, stems and grains

AROOTE
Coefficients for root development as function of transpiration ratio.
NOTE! Depend on GROWAEQ-switch. For explanation of coefficients see GROWAEQ. Independent variable is: $x = 1-AROOTETR*E_t/E_{tp}$.

AROOTE(1): Coefficient a (-)

AROOTE(2): Coefficient b (differ)

AROOTE(3): Coefficient c (differ)

AROOTETR
Relative change of the transpiration ratio in the root allocation function. (-)
1

AROOTNI
Coefficients for root development as function of leaf N concentration.
NOTE! Depend on GROWAEQ-switch. For explanation of coefficients see GROWAEQ. Independent variable is relative leaf N concentration ($x=(n_l-NLEAFN)/(NLEAFXG-NLEAFN)$). "Other equation" is: $1+AROOTN-(1-((NLEAFXG-n_l)/(NLEAFXG-NLEAFN)^2)^{0.5}$.
where n_l is N concentration of leaves (N_l/W_l). If GROWPEREN=1 then n_l is both current year and old leaves.
If SPECIAL-switch=1 then: If AROOTNI(1)<0 then n_l is replaced by N concentration of newly formed leaves ($n_l'=N_l'/W_l'$). If GROWPEREN=1 then n_l is now only the current year old leaves. (The absolute value of AROOTNI(1) is used)

AROOTNI(1): Coefficient a (-)

AROOTNI(2): Coefficient b (differ)

AROOTNI(3): Coefficient c (differ)

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

AROOTW(1): Coefficient a	(-)
AROOTW(2): Coefficient b	(differ)
AROOTW(3): Coefficient c	(differ)

CATCHAVAI
Fraction of the biomass and N at initiation of catch crop at harvest that should be allocated to the available pools in plant. (-) *0.1,0*

CATCHINI
Coefficients to estimate the fraction of total crop (main crop) that is catch crop at harvest (index 1-2). (-) *0.1,0*

6.24 Special: N allocation

if GROWCAT-switch = 1:
At harvest: Main crop is reduced by yfra
$y_{Fra} = CATCHININ(1) + CATCHININ(2)*(N_r+N_s+N_l+N_g)$
$N_{r,s,l,g\rightarrow a} = y_{Fra}(N_r+N_s+N_l+N_g)$
$N_r = N_r - N_{r,s,l,g\rightarrow a}N_r/(N_r+N_s+N_l+N_g)$
D:o for leaves, stems and grains

$n_{lMax} = n_{lMax}(1+NCONCHAN(1)*y_{Day})$
where:
$y_{Day} = (t - NCONTIME(1)/(NCONTIME(2)-NCONTIME(1)$
D:o for stem max, root max, leaf demand and leaf minimum (NCONCHAN(2))

if GROWAVAI-switch = 2 or 12:
$N_{a\rightarrow r,s,l} = N_a$

CATCHININ
Coefficients to estimate the fraction of total crop N (main crop) that is catch crop N at harvest (index 1-2). (-) *0.1,0*

NCONCHAN
NCONCHAN(1): Relative change of the maximum (or demand) N concentration per change in normalised time. (-) *0*

NCONCHAN(2): Relative change of the minimum N concentration per change in normalised time. (-) *0*

NCONTIME

NCONTIME(1): Start day for change in N concentration. (-)
0

NCONTIME(2): Stop day for change in N concentration. (-)
0

SLEAFND

Number of days before the current day of which the leaf N deficit should be added to the leaf N demand. (d)
0

SROOTND

Fraction of the accumulated root N deficit during the current year that should be added to the root N demand. (-)
0

SSTEMND

Fraction of the accumulated stem N deficit during the current year that should be added to the stem N demand. (-)
0

6.25 Special: Respiration & Litter

MICROB-switch: The litter fall is separated into the different pools by parameters LITFRACA(1-3) (leaves and stems) and LITFRACR(1-3) (roots).

If MICROB-switch>0:	*If MICROB-switch*
$C_{Ab\rightarrow Li}$ = LITFRACA(1)*$C_{Ab\rightarrow LiTot}$	>=1
$C_{r\rightarrow Li}$ = LITFRACR(1)*$C_{r\rightarrow LiTot}$	>=1
D:o for Nitrogen give: $N_{Ab\rightarrow Li}$, $N_{r\rightarrow Li}$	>=1
D:o for Humus give: $C_{Ab\rightarrow h}$, $C_{r\rightarrow h}$, $N_{Ab\rightarrow h}$, $N_{r\rightarrow h}$	=2 or 3
D:o for Litter2 give: $C_{Ab\rightarrow Li2}$, $C_{r\rightarrow Li2}$, $N_{Ab\rightarrow Li2}$, $N_{r\rightarrow Li2}$	=3
	>=1
	>=1

ALAGEVDEV

ALEAFAGE for VDEV G-variable > VDEVALAGE parameter. Only used if GROWPHEN-switch>0 (-)
0

LITFRACA

Fractions of leaf and stem litter delivered to (index 1-3) Litter, Humus and Litter2, respectively. (-)
1,0,0
Only used if MICROB-switch>0

LITFRACR

Fractions of root litter delivered to (index 1-3) Litter, Humus and Litter2, respectively. (-)
1,0,0
Only used if MICROB-switch>0

TEMLITTK
The fraction of leaf fall as litter (ALITTERL) is added by a temperature dependent function. This function is exp(TEMLITTK*(TMELITTN-Air temperature))-1.
Only used if TEMLITTK>0 (-) *0*

TEMLITTN
Temperature base (see TEMLITTK-parameter)
Only used if TEMLITTK>0 (°C) *0*

UPMAVDEV
UPMA for VDEV G-variable > VDEVUPMA parameter. Only used if GROWPHEN-switch>0 (-) *0*

VDEVALAGE
Phenologigal stage (value of VDEV) at which the leaf age parameter is resetted back from ALAGEVDEV to the value given by ALEAFAGE. Only used if GROWPHEN-switch>0 (-) *0*

VDEVUPMA
Phenologigal stage (value of VDEV) at which the plant N uptake effeicincy is resetted to UPMAVDEV. Before that stage the value was given by UPMA.
Only used if GROWPHEN-switch>0 (-) *0*

6.26 Special: Growstage

If GROWPHEN-switch=2 then dates for emergency, end of grain filling and harvest are calculated as function of temperature sum (TAPHENOL). If temperature sum is low, then date of harvest is determined by a maximum harvest index being achieved (HARINDEXX).

If GROWPHEN-switch=2:
i_v = 1 if: $0 < i_g < 1$
$i_g = (\Sigma(T_a\text{-TAPHENOL}(1);>0))/\text{TAPHENOL}(2)$
i_v = 11 if: $i_g = 1$
i_v = 2 if: $1 < i_g < 2$
i_v = 21 if: $2 <= i_g < 3$
$i_g = (\Sigma(T_a\text{-TAPHENOL}(3);>0))/\text{TAPHENOL}(4)+2$
i_v = 22 if: $3 <= i_g < 4$
$i_g = (\Sigma(T_a\text{-TAPHENOL}(5);>0))/\text{TAPHENOL}(6)+3$
i_v = 3 if: $i_g = 4$ or $W_g/(W_g+W_l+W_s) >$ HARINDEXX

HARDAYX
Last day of harvest (used when harvest date is simulated) Only used if GROWPHEN-switch = 2 or 4. When GROWPHEN-switch=4 and winter crop then HARDAYX should be < UPST(1)-HARPLOUGH-3 (Julian day) *300*

HARINDEXX

Maximum harvest index ((grain biomass)/(tot above ground biomass)). (-)
Only used if GROWPHEN-switch = 2. *0.6*

HARPLOUGH

Number of days after harvest when ploughing is made. (day)
Only used if GROWPHEN-switch = 4. *6*

TAPHENOL

Temperature limits for phenologic functions. differs
(index= 6)
TAPHENOL(1): Threshold temperature for calculating day of emergency. (°C)
TAPHENOL(2): Accumulated temperature sum since day of sowing to day for emergency. (day°C)
TAPHENOL(3): Threshold temperature for calculating day of end of grain filling. (°C)
TAPHENOL(4): Accumulated temperature sum since day for start of grain filling to day for stop of grain filling. (day°C)
TAPHENOL(5): Threshold temperature for calculating day of harvest. (°C)
TAPHENOL(6): Accumulated temperature sum since day for end of grain filling to harvest. (day°C)
Only used if GROWPHEN-switch = 2.

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 mass balance check of ACC...-variables (Input-Output-Store)	(gN m^{-2})
ACCBALC	Carbon mass balance check of ACC...C-variables (Input-Output-Store)	(gC m^{-2})
ACCDENI	Accumulated denitrification of NO3-N	(gN m^{-2})
ACCDEP	Accumulated N deposition	(gN m^{-2})
ACCDLOSS	Accumulated leaching of NO3-N	(gN m^{-2})
ACCFERT	Accumulated N fertilisation, other than manure and deposition	(gN m^{-2})
ACCHARV	Accumulated N harvested	(gN m^{-2})
ACCHARVC	Accumulated C harvested	(gC m^{-2})
ACCMAN	Accumulated N fertilisation through manure	(gN m^{-2})
ACCPHOSC	Accumulated C uptake by net photosynthesis	(gC m^{-2})
ACCPLANT	Accumulated change in total plant N	(gN m^{-2})
ACCPLANTC	Accumulated change in total plant C	(gC m^{-2})
ACCRESPC	Accumulated C lost by respiration from plant and litter	(gC m^{-2})
ACCSOIL	Accumulated change in soil N	(gN m^{-2})
ACCSOILC	Accumulated change in soil C	(gC m^{-2})
CF	(C_f) Faeces C-pool (Index= layer 1 to 2; two uppermost layers)	(gC m^{-2})

CH	(C_h) Humus C-pool (Index=layer 1 to min(NUMLAY,10))	(gC m^{-2})
CL	(C_{Li}) Litter C-pool (Index=layer 1 to min(NUMLAY,10))	(gC m^{-2})
CL2	(C_{Li2}) Intermediate litter C-pool (litter2) (Index=layer 1 to min(NUMLAY,10))	(gC m^{-2})
CM	(C_m) Microbial C-pool (Index=layer 1 to min(NUMLAY,10)) (if SPECIAL=1)	(gC m^{-2})
FERT	(N_{Fert}) Solid fertilizer N-pool (undissolved)	(gN m^{-2})
GRAINN	(N_g) Grain N-pool (PLANT)	(gN m^{-2})
GRAINW	(W_g) Grain dry weight (PLANT)	(gDW m^{-2})
LEAFN	(N_l) Leaf N-pool (PLANT)	(gN m^{-2})
LEAFW	(W_l) Leaf dry weight (PLANT)	(gDW m^{-2})
LITABOVE	(N_{Ab}) Plant residue N-pool, above ground	(gN m^{-2})
LITABOVEC	(C_{Ab}) Plant residue C-pool, above ground	(gC m^{-2})
NF	(N_f) Faeces N-pool (Index= layer 1 to 2)	(gN m^{-2})
NH	(N_h) Humus N-pool (Index=layer 1 to min(NUMLAY,10))	(gN m^{-2})
NH4	(N_{NH4}) Ammonium NH4-N pool (Index= layer 1 to min(NUMLAY,10))	(gN m^{-2})
NLIT	(N_{Li}) Litter N-pool (Index=layer 1 to min(NUMLAY,10))	(gN m^{-2})
NLIT2	(N_{Li2}) Intermediate litter N-pool (litter2) (Index=layer 1 to min(NUMLAY,10))	(gN m^{-2})
NM	(N_m) Microbial N-pool (Index=layer 1 to min(NUMLAY,10)) (if SPECIAL=1)	(gN m^{-2})
NO3	(N_{NO3}) Nitrate NO3-N pool (Index= layer 1 to NUMLAY)	(gN m^{-2})
ROOTN	(N_r) Root-N (PLANT)	(gN m^{-2})
ROOTW	(W_r) Root dry weight (PLANT)	(gDW m^{-2})
STEMN	(N_s) Stem-N (PLANT)	(gN m^{-2})
STEMW	(W_s) Stem dry weight (PLANT)	(gDW m^{-2})
WLEAFN	(N_{lw}) N in old leaves (if GROWPEREN=1)	(gN m^{-2})

WLEAFW	(W_{lw}) Biomass in old leaves (older than one year, normally) (if GROWPEREN=1)	(gDW m^{-2})
WROOTN	(N_{rw}) N in old roots (if GROWPEREN=1)	(gN m^{-2})
WROOTW	(W_{rw}) Biomass in old roots (if GROWPEREN=1)	(gDW m^{-2})
WSTEMN	(N_{sw}) N in old stems (if GROWPEREN=1)	(gN m^{-2})
WSTEMW	(W_{sw}) Biomass in old stem (if GROWPEREN=1)	(gDW m^{-2})
XAVAIN	(N_a) N in plant available for re-translocation (if GROWPEREN=1)	(gN m^{-2})
XAVAIW	(W_a) Assimilates in plant available for growth (if GROWPEREN=1)	(gDW m^{-2})

7.2 Flows

Variable	(Symbol) Explanation	Unit
AAVAILN	($N_{a\rightarrow l}$) From available pool to leaves (PLANT)	(gN m^{-2} d^{-1})
AAVAIRN	($N_{a\rightarrow r}$) From available pool to root (PLANT)	(gN m^{-2} d^{-1})
AAVAISN	($N_{a\rightarrow s}$) From available pool to stem (PLANT)	(gN m^{-2} d^{-1})
AAVAILW	($W_{a\rightarrow l}$) From available pool to leaf (PLANT)	(gDW m^{-2} d^{-1})
AAVAIRW	($W_{a\rightarrow r}$) From available pool to root (PLANT)	(gDW m^{-2} d^{-1})
AAVAISW	($W_{a\rightarrow s}$) From available pool to stem (PLANT)	(gDW m^{-2} d^{-1})
AGRAINLIN	($N_{g\rightarrow Ab}$) (N_l'(ut)) Grain litter (PLANT)	(gN m^{-2} d^{-1})
AGRAINLIW	($W_{g\rightarrow Ab}$) From grain to above ground residues (PLANT)	(gDW m^{-2} d^{-1})
AHUMMYC	($C_{h\rightarrow r}$) Humus to roots, total profile	(gC m^{-2} d^{-1})
AHUMMYN	($N_{h\rightarrow Plant}$) Humus to Plant, total profile	(gN m^{-2} d^{-1})
ALEAFAN	($N_{l\rightarrow a}$) From leaf to available pool (PLANT)	(gN m^{-2} d^{-1})
ALEAFAW	($W_{l\rightarrow a}$) From leaf to available pool (PLANT)	(gDW m^{-2} d^{-1})
ALEAFGN	($N_{l\rightarrow g}$) From leaves to grains (PLANT)	(gN m^{-2} d^{-1})
ALEAFGW	($W_{l\rightarrow g}$) From leaf to grain (PLANT)	(gDW m^{-2} d^{-1})
ALEAFN3N	($N_{l\rightarrow Inf+Surr}$) Leaches from leaf to nitrate infiltration (PLANT)	(gN m^{-2} d^{-1})
ALEAFLIN	($N_{l\rightarrow Ab}$) Leaf litter (PLANT)	(gN m^{-2} d^{-1})
ALEAFLIW	($W_{l\rightarrow Ab}$) From leaves to above ground residues (PLANT)	(gDW m^{-2} d^{-1})

ALEAFSN	($N_{l\rightarrow s}$) From leaf to stem (PLANT)	(gN m^{-2} d^{-1})
ALEAFSW	($W_{l\rightarrow s}$) From leaf to stem (PLANT)	(gDW m^{-2} d^{-1})
ALEAFWN	($N_{l\rightarrow lw}$) From leaf to old leaves (PLANT)	(gN m^{-2} d^{-1})
ASTEMWN	($N_{s\rightarrow sw}$) From stem to woody stems (PLANT)	(gN m^{-2} d^{-1})
ALEAFWW	($W_{l\rightarrow lw}$) Biomass flow from leaf to old leaves (PLANT)	(gDW m^{-2} d^{-1})
ALITTMYC	($C_{Li\rightarrow r}$) Litter to roots, total profile	(gC m^{-2} d^{-1})
ALITTMYN	($N_{Li\rightarrow Plant}$) Litter to Plant, total profile	(gN m^{-2} d^{-1})
AROOTAN	($N_{r\rightarrow a}$) From root to available pool (PLANT)	(gN m^{-2} d^{-1})
AROOTAW	($W_{r\rightarrow a}$) From root to available pool (PLANT)	(gDW m^{-2} d^{-1})
AROOTGN	($N_{r\rightarrow g}$) From root to grain (PLANT)	(gN m^{-2} d^{-1})
AROOTGW	($W_{r\rightarrow g}$) From root to grain (PLANT)	(gDW m^{-2} d^{-1})
AROOTLIN	($N_{r\rightarrow Li}$) Root litter (PLANT)	(gN m^{-2} d^{-1})
AROOTLIW	($W_{r\rightarrow Li}$) From root to litter (PLANT)	(gDW m^{-2} d^{-1})
AROOTSN	($N_{r\rightarrow s}$) From root to stem (PLANT)	(gN m^{-2} d^{-1})
AROOTSW	($W_{r\rightarrow s}$) From root to stem (PLANT)	(gDW m^{-2} d^{-1})
AROOTWN	($N_{r\rightarrow rw}$) From root to woody roots (PLANT)	(gN m^{-2} d^{-1})
AROOTWW	($W_{r\rightarrow rw}$) From root to woody roots (PLANT)	(gDW m^{-2} d^{-1})
ASOILAN	($N_{Soil\rightarrow a}$) From soil to available pool in plant (PLANT)	(gN m^{-2} d^{-1})
ASTEMAN	($N_{s\rightarrow a}$) From stem to available pool (PLANT)	(gN m^{-2} d^{-1})
ASTEMAW	($W_{s\rightarrow a}$) From stem to available pool (PLANT)	(gDW m^{-2} d^{-1})
ASTEMGN	($N_{s\rightarrow g}$) From stem to grain (PLANT)	(gN m^{-2} d^{-1})
ASTEMGW	($W_{s\rightarrow g}$) From stem to grain (PLANT)	(gDW m^{-2} d^{-1})
ASTEMLIN	($N_{s\rightarrow Ab}$) (N_s'(ut)) Stem litter (PLANT)	(gN m^{-2} d^{-1})
ASTEMLIW	($W_{s\rightarrow Ab}$) From stem to above ground residues (PLANT)	(gDW m^{-2} d^{-1})
ASTEMWW	($W_{s\rightarrow sw}$) From stem to woody stems (PLANT)	(gDW m^{-2} d^{-1})
AWLEAFLIN	($N_{lw\rightarrow Li}$) From old leaf to litter (PLANT)	(gN m^{-2} d^{-1})
AWLEAFLN	($N_{lw\rightarrow l}$) From old leaf to young leaf (PLANT)	(gN m^{-2} d^{-1})
AWLEAFLIW	($W_{lw\rightarrow Li}$) From old leaf to litter (PLANT)	(gDW m^{-2} d^{-1})

AWLEAFLW	($W_{lw\rightarrow l}$) From old leaf to young leaf (PLANT)	(gDW m^{-2} d^{-1})
AWLEAFN3N	($N_{lw\rightarrow Inf+Surr}$) Leaches from old leaf to soil nitrate infiltration (PLANT)	(gN m^{-2} d^{-1})
AWLEAFAN	($N_{lw\rightarrow a}$) From old leaf to available pool (PLANT) (Not amoung outputs yet)	(gN m^{-2} d^{-1})
AWLEAFAW	($W_{lw\rightarrow a}$) From old leaf to available pool (PLANT)	(gDW m^{-2} d^{-1})
AWSTEMAN	($N_{sw\rightarrow a}$) From old stem to available pool (PLANT)	(gN m^{-2} d^{-1})
AWSTEMAW	($W_{sw\rightarrow a}$) From old stem to available pool (PLANT)	(gDW m^{-2} d^{-1})
AWROOTAN	($N_{rw\rightarrow a}$) From old root to available pool (PLANT) (Not amoung outputs yet)	(gN m^{-2} d^{-1})
AWROOTAW	($W_{rw\rightarrow a}$) From old root to available pool (PLANT)	(gDW m^{-2} d^{-1})
AWROOTLIN	($N_{rw\rightarrow Li}$) From woody root to litter (PLANT)	(gN m^{-2} d^{-1})
AWROOTLIW	($W_{rw\rightarrow Li}$) From woody root to litter (PLANT)	(gDW m^{-2} d^{-1})
AWSTEMLIN	($N_{sw\rightarrow Ab}$) From woody stem to litter (PLANT)	(gN m^{-2} d^{-1})
AWSTEMLIW	($W_{sw\rightarrow Ab}$) From woody stem to litter (PLANT)	(gDW m^{-2} d^{-1})
CFLOSS	C flow: Faeces mineralisation + humification (Index= layer 1 to 2)	(gC m^{-2} d^{-1})
CHARV	($C_{Plant\rightarrow Harv}$) C flow: Harvest export of plant-C (PLANT)	(gC m^{-2} d^{-1})
CHMIC	($C_{h\rightarrow m}$) C flow: Microbial gross consumption of humus (Index=layer)	(gC m^{-2} d^{-1})
CHMIN	($C_{h\rightarrow Atm}$) C flow: Loss from humus by respiration (Index=layer). Only used if MICROB-switch=4	(gC m^{-2} d^{-1})
CHLIT2	($C_{h\rightarrow Li2}$) Humus C transferred directly to litter2 without passing microbes (Index=layer). Only used if MICROB-switch>0	(gC m^{-2} d^{-1})
CLITHUM	($C_{Li\rightarrow h}$) Litter C transferred directly to humus without passing microbes (Index=layer). Only used if MICROB-switch>0	(gC m^{-2} d^{-1})
CLLOSS	C flow: Litter mineralisation + humification (CLMIN+CLHUM) (Index= layer 1 to min(NUMLAY,10))	(gC m^{-2} d^{-1})
CLMIC	($C_{Li\rightarrow m}$) C flow: Microbial gross consumption of litter (Index=layer)	(gC m^{-2} d^{-1})
CL2MIC	($C_{Li2\rightarrow m}$) C flow: Microbial gross consumption of litter2 (Index=layer)	(gC m^{-2} d^{-1})

CLROFF	($C_{Li\rightarrow Stream}$) C flow: Loss of litter in uppermost layer to stream due to surface runoff (however included in ACCRESPC).	(gC m^{-2} d^{-1})
CMLIT	($C_{m\rightarrow Li}$) C flow: Microbial loss to litter (Index=layer)	(gC m^{-2} d^{-1})
CMLIT2	($C_{m\rightarrow Li2}$) C flow: Microbial loss to litter2 (Index=layer)	(gC m^{-2} d^{-1})
CMHUM	($C_{m\rightarrow h}$) C flow: Microbial loss to humus (Index=layer)	(gC m^{-2} d^{-1})
CMMIN	($C_{m\rightarrow Atm}$) C flow: Microbial loss due to growth and maintenance respiration (Index=layer)	(gC m^{-2} d^{-1})
DECACF	($C_{Ab\rightarrow f}$) C flow: Above-ground residue to faeces pool CF(1) if $T_s(1) > 0$. Only used if MANURE-switch=1.	(gC m^{-2} d^{-1})
DECACLIT	($C_{Ab\rightarrow Li}$) C flow: Above-ground residue to litter CL(1). Only used if MICROB-switch=1	(gC m^{-2} d^{-1})
DECACLI2	($C_{Ab\rightarrow Li2}$) C flow: Above-ground residue to litter2 CL2(1)	(gC m^{-2} d^{-1})
DECACHUM	($C_{Ab\rightarrow h}$) C flow: Above-ground residue to humus CH(1)	(gC m^{-2} d^{-1})
DECALEAC	($C_{Ab\rightarrow Out}$) C flow: Losses of above-ground residue to boundary through leaching	(gC m^{-2} d^{-1})
DECALEAN	($N_{Ab\rightarrow NH4}$) Leaching of above-ground residue to soil ammonium NH4(1)	(gN m^{-2} d^{-1})
DECALIT	($N_{Ab\rightarrow LiTot}$) Above-ground residue to litter NL(1). If MICROB-switch=1 then DECALIT is split up into flows to different pools. On the day of ploughing: Not used as flow in integration.	(gN m^{-2} d^{-1})
DECALITC	($C_{Ab\rightarrow LiTot}$) C flow: Above-ground residue to litter CL(1). If MICROB-switch=1 then DECALITC is split up into flows to different pools. On the day of ploughing: Not used as flow in integration.	(gC m^{-2} d^{-1})
DECANF	($N_{Ab\rightarrow f}$) Above-ground residue to faeces pool NF(1) if $T_s(1)>0$. Only used if MANURE-switch=1.	(gN m^{-2} d^{-1})
DECANLIT	($N_{Ab\rightarrow Li}$) Above-ground residue to litter NLIT(1). Only used if MICROB-switch=1	(gN m^{-2} d^{-1})
DECANLI2	($N_{Ab\rightarrow Li2}$) Above-ground residue to litter2 NLIT2(1)	(gN m^{-2} d^{-1})
DECANHUM	($N_{Ab\rightarrow h}$) Above-ground residue to humus NH(1)	(gN m^{-2} d^{-1})
DECAROFF	($N_{Ab\rightarrow Stream}$) Loss of above ground residue to stream due to surface runoff	(gN m^{-2} d^{-1})
DECAROFFC	($C_{Ab\rightarrow Out}$) C flow: Loss of above ground residue to stream due to surface runoff (however included in ACCRESPC).	(gC m^{-2} d^{-1})
DENI	($N_{NO3\rightarrow Atm}$) Denitrification of NO3 (Index= layer 1 to min(NUMLAY,10))	(gN m^{-2} d^{-1})

DEPOLEAF	($N_{Dep\rightarrow l}$) Dry deposition absorbed by leaves. (PLANT)	(gN m^{-2} d^{-1})
DEPONH4	($N_{Dep\rightarrow NH4}$) Deposition (wet and dry) to soil ammonium NH4(1)	(gN m^{-2} d^{-1})
DEPONO3	($N_{Dep\rightarrow Inf+Surr}$) Deposition of nitrate to soil (wet and dry)	(gN m^{-2} d^{-1})
DEPOWLEAF	($N_{Dep\rightarrow lw}$) Dry deposition absorbed by old leaves. (PLANT)	(gN m^{-2} d^{-1})
DLOSS	($N_{NO3\rightarrow Stream}$) NO3 leaching to tiles (Index= layer 1 to NUMLAY)	(gN m^{-2} d^{-1})
FERTIN	($N_{Appl\rightarrow Fert}$) Addition of solid fertilizer N	(gN m^{-2} d^{-1})
FINCB	($C_{Appl\rightarrow f}$) C flow: Carbon in faeces in manure to faeces (Index= layer 1 to 2)	(gC m^{-2} d^{-1})
FINNA	($N_{Appl\rightarrow Li}$) Nitrogen in bedding in manure to litter (Index= layer 1 to 2)	(gN m^{-2} d^{-1})
FINNB	($N_{Appl\rightarrow f}$) Nitrogen in faeces in manure to faeces-N (Index= layer 1 to 2)	(gN m^{-2} d^{-1})
FINNH	($N_{Appl\rightarrow NH4}$) Nitrogen in manure to NH4() (Index= layer 1 to 2)	(gN m^{-2} d^{-1})
FNIT	($N_{NH4\rightarrow NO3}$) Nitrification of NH4 to NO3 (Index= layer 1 to min(NUMLAY,10))	(gN m^{-2} d^{-1})
HARVGN	($N_{g\rightarrow Harv}$) Harvest of grain (PLANT)	(gN m^{-2} d^{-1})
HARVGW	($W_{g\rightarrow Harv}$) Harvest of grain (PLANT)	(gDW m^{-2} d^{-1})
HARVLN	($N_{l\rightarrow Harv}$) Harvest of leaves (PLANT)	(gN m^{-2} d^{-1})
HARVLW	($W_{l\rightarrow Harv}$) Harvest of leaves (PLANT)	(gDW m^{-2} d^{-1})
HARVSN	($N_{s\rightarrow Harv}$) Harvest of straw (PLANT)	(gN m^{-2} d^{-1})
HARVSW	($W_{s\rightarrow Harv}$) Harvest of straw (PLANT)	(gDW m^{-2} d^{-1})
INCALIT	($N_{Plant\rightarrow Ab}$) Plant to above-ground residue	(gN m^{-2} d^{-1})
INCALITC	($C_{Plant\rightarrow Ab}$) C flow: Plant to above-ground residue	(gC m^{-2} d^{-1})
NEWCL	($C_{r\rightarrow LiTot}$) C flow: Incorporation of root carbon or above-ground residues to litter-C. (Index=layer). If MICROB-switch=1 then NEWCL is split up into flows to different pools.	(gC m^{-2} d^{-1})
NEWCLLIT	($C_{r\rightarrow Li}$) C flow: Root to litter. (Index=layer). Only used if MICROB-switch=1.	(gC m^{-2} d^{-1})
NEWCLLI2	($C_{r\rightarrow Li2}$) C flow: Root to litter. (Index=layer)	(gC m^{-2} d^{-1})
NEWCLHUM	($C_{r\rightarrow Li}$) C flow: Root to litter. (Index=layer).	(gC m^{-2} d^{-1})

NEWNL	($N_{r\rightarrow LiTot}$) Root to litter (Index=layer). If MICROB-switch=1 then NEWNL is split up into flows to different pools.	(gN m^{-2} d^{-1})
NEWNLLIT	($N_{r\rightarrow Li}$) Root to litter (Index=layer). Only used if MICROB-switch=1.	(gN m^{-2} d^{-1})
NEWNLLI2	($N_{r\rightarrow Li2}$) Root to litter2 (Index=layer)	(gN m^{-2} d^{-1})
NEWNLHUM	($N_{r\rightarrow h}$) Root to humus (Index=layer)	(gN m^{-2} d^{-1})
NFERTNH4	($N_{Fert\rightarrow NH4}$) Solid fertilizer N dissolved to soil ammonium NH4(1)	(gN m^{-2} d^{-1})
NFERTNO3	($N_{Fert\rightarrow Inf+Surr}$) Solid fertilizer N dissolved	(gN m^{-2} d^{-1})
NFHUM	($N_{f\rightarrow h}$) Humification of faeces-N to humus-N (Index= layer 1 to 2)	(gN m^{-2} d^{-1})
NFLOW	($N_{NO3(i)\rightarrow NO3(i+1)}$) NO_3-N flow to the layer below (Index= layer 1 to NUMLAY-1)	(gN m^{-2} d^{-1})
NFMIN	($N_{f\rightarrow NH4}$) Mineralisation of faeces-N to NH_4-N (Index= layer 1 to 2)	(gN m^{-2} d^{-1})
NH4DLOSS	($N_{NH4\rightarrow Stream}$) NH_4 leaching to tiles (Index= layer 1 to NUMLAY)	(gN m^{-2} d^{-1})
NH4FLOW	($N_{NH4(i)\rightarrow NH4(i+1)}$) NH_4-N flow to the layer below (Index= layer 1 to NUMLAY-1)	(gN m^{-2} d^{-1})
NHARV	($N_{Plant\rightarrow Harv}$) Harvest export of plant-N (PLANT)	(gN m^{-2} d^{-1})
NHLIT2	($N_{h\rightarrow Li2}$) Humus N transferred directly to litter2 without passing microbes (Index=layer). Only used if MICROB-switch>0	(gN m^{-2} d^{-1})
NHMIC	($N_{h\rightarrow m}$) Microbial gain from humus	(gN m^{-2} d^{-1})
NHMIN	($N_{h\rightarrow NH4}$) Mineralisation of humus-N to NH4-N (Index= layer 1 to min(NUMLAY,10))	(gN m^{-2} d^{-1})
NLHUM	($N_{Li\rightarrow h}$) Humification of litter-N to humus-N (Index= layer 1 to min(NUMLAY,10))	(gN m^{-2} d^{-1})
NLITHUM	($N_{Li\rightarrow h}$) Litter N transferred directly to humus without passing microbes (Index=layer). Only used if MICROB-switch>0	(gN m^{-2} d^{-1})
NLMIC	($N_{Li\rightarrow m}$) Microbial gain from litter	(gN m^{-2} d^{-1})
NL2MIC	($N_{Li2\rightarrow m}$) Microbial gain from litter2	(gN m^{-2} d^{-1})
NLMIN	($N_{Li\rightarrow NH4}$) Mineralisation(immobilisation) of litter-N to NH4 (Index= layer 1 to min(NUMLAY,10))	(gN m^{-2} d^{-1})

NLROFF	($N_{Li \rightarrow Stream}$) Loss of litter from uppermost layer to stream due to surface runoff	(gN m^{-2} d^{-1})
NMHUM	($N_{m \rightarrow h}$) Microbial-N to humus (Index=layer)	(gN m^{-2} d^{-1})
NMLIT	($N_{m \rightarrow Li}$) Microbial-N to litter (Index=layer)	(gN m^{-2} d^{-1})
NMLIT2	($N_{m \rightarrow Li2}$) Microbial-N to litter2 (Index=layer)	(gN m^{-2} d^{-1})
NMNH4	($N_{m \rightarrow NH4}$) Mineralisation(immobilisation) of microbial-N to NH4 (Index=layer)	(gN m^{-2} d^{-1})
NMNO3	($N_{m \rightarrow NO3}$) -Immobilisation of nitrate-N to microbial-N (Index=layer)	(gN m^{-2} d^{-1})
PHOS	($W_{Atm \rightarrow Phos}$) Assimilation rate (PLANT)	(gDW m^{-2} d^{-1})
RESPGW	($W_{g \rightarrow Atm}$) Loss due to respiration of grains (PLANT)	(gDW m^{-2} d^{-1})
RESPLW	($W_{l \rightarrow Atm}$) Loss due to respiration of old leaves. (PLANT)	(gDWm^{-2} d^{-1})
RESPRW	($W_{r \rightarrow Atm}$) Loss due to respiration of woody root (PLANT)	(gDW m^{-2} d^{-1})
RESPSW	($W_{s \rightarrow Atm}$) Loss due to respiration of woody stem (PLANT)	(gDWm^{-2} d^{-1})
UPPMYCH	($C_{h \rightarrow r}$) Root uptake of organic C in humus (Index= layer 1 to min(NUMLAY,10))	(gC m^{-2} d^{-1})
UPPMYCL	($C_{Li \rightarrow r}$) Root uptake of organic C in litter (Index= layer 1 to min(NUMLAY,10))	(gC m^{-2} d^{-1})
UPPMYNH	($N_{h \rightarrow Plant}$) Plant uptake of organic N in humus (Index= layer 1 to min(NUMLAY,10))	(gN m^{-2} d^{-1})
UPPMYNL	($N_{Li \rightarrow Plant}$) Plant uptake of organic N in litter (Index= layer 1 to min(NUMLAY,10))	(gN m^{-2} d^{-1})
UPPNH4	($N_{NH4 \rightarrow a}$) Plant uptake of NH4-N (Index= layer 1 to min(NUMLAY,10))	(gN m^{-2} d^{-1})
UPPNO3	($N_{NO3 \rightarrow a}$) Plant uptake of NO3-N (Index= layer 1 to min(NUMLAY,10))	(gN m^{-2} d^{-1})

7.3 Auxiliaries

Variable	(Symbol) Explanation	Unit
AEFF	(e_m*e_t) For the mineralisation process. Combined effect of soil water content and soil temperature (concerning layer see OUTLAY parameter)	(-)
AEFFD	(e_m*e_{td})For the denitrification process. Combined effect of soil water content and soil temperature for a layer	(-)

AEFFN	(e_m*e_{tn})For the nitrification process. Combined effect of soil water content and soil temperature for a layer	(-)
ALI	(A_l) Total leaf area (index m^2/m^2) (PLANT)	(-)
ALINEW	(A_{lNew}) Leaf area (index m^2/m^2) of leaves formed the current year (PLANT)	(-)
ALIOLD	(A_{lw}) Leaf area (index m^2/m^2) of old leaves (if GROWPEREN=1) (PLANT)	(-)
ARESPP	(e_{tp}) Respiration function for above ground plant parts (PLANT)	(-)
ARESPR	(e_{tr}) Respiration function for roots, mean of all layers (PLANT)	(-)
ATEFF	(e_t) For the mineralisation process. Effect of soil temperature (concerning layer see OUTLAY parameter)	(-)
ATEFFD	(e_{td}) For the denitrification process. Effect of soil temperature for a layer	(-)
ATEFFN	(e_{tn}) For the nitrification process. Effect of soil temperature for a layer	(-)
ATMEFFUP	Relative change of MICEFF in uppermost soil layer for temperatures below MICEFFT0.	(-)
ATMEFFBO	Relative change of MICEFF in lowest (NUMLAY) soil layer for temperatures below MICEFFT0.	(-)
AVTEMP	(f_{Tap}) Release of above ground available assimilates response function to temperature (PLANT)	(-)
AVTEMS	(f_{Tas}) Release of below ground available assimilates response function to temperature (PLANT)	(-)
BI	(b_i) Leaf area to shoot biomass ratio (tissues formed the current year) (PLANT)	(m^2 gDW^{-1})
BOUNCORR	() Accumulated correction (absolute values) of simulated value (Index=variable to be corrected). Only used if BOUNDARY-switch=1.	(differ)
BOUNVARN	() Variable used for correction of simulated value. Below this value correction is made. (Index=variable to be corrected). Only used if BOUNDARY-switch=1.	(differ)
BOUNVARX	() Variable used for correction of simulated value. Above this value correction is made (Index=variable to be corrected). Only used if BOUNDARY-switch=1.	(differ)
BR	(b_r) Root allocation function (PLANT)	(-)

BRE	(b_{re}) Root allocation, sub function dependent on plant water factor (PLANT)	(-)
BRN	(b_{rn}) Root allocation, sub function dependent on plant nitrogen factor (PLANT)	(-)
BRW	(b_{rw}) Root allocation, sub function dependent on plant biomass (PLANT)	(-)
CFTPROF	(ΣC_f) Feaces-C in whole profile	(gC m^{-2})
CHTPROF	(ΣC_h) Hunus-C in whole profile	(gC m^{-2})
CLMIN	($C_{Li \rightarrow Atm}$) C flow: C Mineralisation from litter (Index=layer 1 to min(NUMLAY,10))	(gC m^{-2})
CLHUM	($C_{Li \rightarrow h}$) C flow: C flow from litter to humus (Index=layer 1 to min(NUMLAY,10))	(gC m^{-2})
CLINT	($C_{Decomp \rightarrow Li}$) C flow: Internal circulation of C within litter (Index=layer 1 to min(NUMLAY,10))	(gC m^{-2})
CLTPROF	(ΣC_{Li}) Litter-C in whole profile	(gC m^{-2})
CL2TPROF	(ΣC_{Li2}) Litter2-C in whole profile	(gC m^{-2})
CMTPROF	(ΣC_m) Microbe-C in whole profile	(gC m^{-2})
CO2CONC	(CO_{2Atm}) Atmospheric CO_2 concentration	(ppm)
DAYSTART	(t_f) Day number at which photosynthesis starts. (PLANT)	(d)
DEFICLN	Deficit in daily N uptake to leaves (PLANT)	(gN m^{-2} d^{-1})
DEPOWC	Total wet N deposition	(gN m^{-2} d^{-1})
FECKCN	(k_f) Faeces specific decomposition rate (parameter FECK). If SPECIAL-switch=1 it can be a function faeces C/N ratio.	(d^{-1})
FERNSIM	($N_{Appl \rightarrow NH4orNO3}$) N external 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})
FRNH4SOL	(N_{NH4Sol}/N_{NH4}) Fraction of toltal ammonium found in soil solution (Index= layer 1 to NUMLAY)	(-)
GHARVDAY	Day of harvest	(Julian day)
GPLOUGHDAY	Day of ploughing	(Julian day)
GROWSTAG	(i_v) Index for stage of growth: sowing-emergence (i_v=1), accumulating temp. sum before growth (10), emergence (11), flushing (12), vegetative growth (2), grain filling (21), end grain filling-mature (22), harvest (3), annual-perennial (13), no photosynthesis (14) (PLANT)	()

GSOWINGD	Day of sowing	(Julian day)
LEAFDN	($N_{lDemand}$)N flow : leaves N demand (PLANT)	(gN m^{-2} d^{-1}
LEAFDNEX	N flow : extra leaf N demand (If SPECIAL-switch=1) (PLANT)	(gN m^{-2} d^{-1})
LITKCN	(k_l) Litter specific decomposition rate (parameter LITK). If SPECIAL-switch=1 it can be a function litter C/N ratio.	(d^{-1})
NAVAI	(n_a) The ratio between N and assimilates of the available pool (PLANT)	(-)
NCONC	(n_{NO3}) Concentration of NO_3-N in soil solution (Index= layer 1 to NUMLAY)	(mgN l^{-1})
NFTPROF	(ΣN_f) Faeces-N in whole profile	(gN m^{-2})
NGRAIN	(n_g) Actual N concentration of grain (PLANT)	(-)
NH4CONC	(n_{NH4}) Concentration of NH_4-N in soil solution (Index= layer 1 to NUMLAY)	(mgN l^{-1})
NH4T	(ΣN_{NH4}) NH4-N in whole profile	(gN m^{-2})
NHTPROF	(ΣN_h) Humus-N in whole profile	(gN m^{-2})
NLEAF	(n_l) Actual leaf N concentration (PLANT)	(-)
NLEAFNEW	(n_l') Actual N concentration of newly formed leaves (the ratio between daily uptake of nitrogen and growth of leaves) (PLANT)	(-)
NLTPROF	(ΣN_{Li}) Litter-N in whole profile	(gN m^{-2})
NL2TPROF	(ΣN_{Li2}) Litter2-N in whole profile	(gN m^{-2})
NMTPROF	(ΣN_m) Microbe-N in whole profile	(gN m^{-2})
NO3T	(ΣN_{NO3}) NO3-N in whole profile	(gN m^{-2})
NROOT	(n_r) Actual root N concentration (PLANT)	(-)
NSTEM	(n_s) Actual stem N concentration (PLANT)	(-)
NWLEAF	(n_{lw}) Actual old leaf N concentration (PLANT)	(-)
NWROOT	(n_{rw}) Actual woody root N concentration (PLANT)	(-)
NWSTEM	(n_{sw}) Actual woody stem N concentration (PLANT)	(-)
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	(e_p) Effect of soil acidity on nitrification (Index= layer 1 to min(NUMLAY,10))	(-)
PHOEFFC	(α) Potential radiation use efficiency only affected by atmospheric CO_2 and reduction due to radiation absorption by grains. (PLANT)	(gDW MJ^{-1})
PIPEL	($\Sigma N_{NO3 \rightarrow Drain}$) Leaching of NO3-N to tile drainage system (from all layers)	(gN m^{-2} d^{-1})
PIPENO3C	(n_{Drain})Concentration of NO3-N in tile drainage	(mgN l^{-1})
PIPEQ	Water flow to drainage tiles (from total profile)	(mmH_2O d^{-1})
POTUPT	(N_{Demand}) Plant N demand.	(gN m^{-2} d^{-1})
QNO3C1	(n_{Stream}) Concentration of NO3 in stream water.	(mgN l^{-1})
QNO3C2	(n_{Out}) Concentration of NO3 in stream water after N-consumption in stream.	(mgN l^{-1})
RATCNF	(c_f) C-N ratio of faeces (Index = layer 1 to min(NUMLAY,2))	(-)
RATCNL	(c_{Li}) C-N ratio of litter (Index=layer). If MICROB-switch=1 RATCNL can be C/N ratio of litter, litter2, humus or microbes depending on parameter OUTRATCN	(-)
RISGROUN	(I_g) Radiation reaching the soil surface. (PLANT)	(W m^{-2})
ROOTDENSI	Root biomass per soil volume (Index = layer 1 to min(NUMLAY,7)) (PLANT)	(gDW m^{-1})
ROOTDEPTH	(z_r) Root depth (PLANT)	(m)
ROOTDN	($N_{rDemand}$)N flow : roots nitrogen demand (PLANT)	(gN m^{-2} d^{-1})
ROOTDNEX	N flow : extra root nitrogen demand (if SPECIAL=1) (PLANT)	(gN m^{-2} d^{-1})
ROOTPROF	($W_r(i)$) Root biomass per soil layer. (Only current year old roots) (Index = layer 1 to min(NUMLAY,7)) (PLANT)	(gDW m^{-2})
RPMOS	(f_W) Plant growth response function to plant water factor (PLANT)	(-)
RPN	(f_N) Plant growth response function to plant nitrogen factor (PLANT)	(-)
RPTEM	(f_T) Plant growth response function to temperature (PLANT)	(-)
RPTOT	(f_{Tot}) Plant growth response function, combined effect of plant water factor (ETR), plant nitrogen factor (RPN) and temperature (RPTEM). (PLANT)	(-)

RROOT	(a_r): Root biomass in a layer as a fraction of total root biomass. (Index=layer 1 to min(NUMLAY,10))	(-)
RUSENO3	($N_{Stream \rightarrow Consum}$) NO3-N consumption in stream water	(gN m^{-2} d^{-1})
STEMDN	($N_{sDemand}$) N flow : stem nitrogen demand (PLANT)	(gN m^{-2} d^{-1})
STEMDNEX	N flow : extra stem nitrogen demand (if SPECIAL=1) (PLANT)	(gN m^{-2} d^{-1})
STREAMQ	Water flow in stream	(mmH_2O d^{-1})
STREAMT	($\Sigma(N_{NO3 \rightarrow Stream})$ 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})
SWITCHOUT	Switch. Different internal model switches can be put into this variable, see parameter OUTSW.	()
TINFNO3	($N_{Inf \rightarrow NO3}$) N flow: Infiltration of NO3 to layer 1 (acts as a flow variable)	(gN m^{-2} d^{-1})
TOTALLON	($N_{a \rightarrow r+s+l}$) Total N allocation to root, stem and leaves (PLANT).	(gN m^{-2} d^{-1})
TOTALLOW	($W_{a \rightarrow r+s+l}$) Total biomass allocation to root, stem and leaves (PLANT).	(gDW m^{-2} d^{-1})
TOTCHLIT2	($\Sigma C_{h \rightarrow Li2}$) Humus C transferred directly to litter2 without passing through microbes (in total profile). Only if MICROB-switch > 0.	(gC m^{-2} d^{-1})
TOTCHMIC	($\Sigma C_{h \rightarrow m}$) Microbial uptake of C from humus (in total profile). Only if MICROB-switch > 0.	(gC m^{-2} d^{-1})
TOTCLHUM	($\Sigma C_{l \rightarrow h}$) Litter C transferred directly to humus without passing through microbes (in total profile). Only if MICROB-switch > 0.	(gC m^{-2} d^{-1})
TOTCLMIC	($\Sigma C_{Li \rightarrow m}$) Microbial uptake of C from litter (in total profile). Only if MICROB-switch > 0.	(gC m^{-2} d^{-1})
TOTCMHUM	($\Sigma C_{m \rightarrow h}$) Humification of C (in total profile). Only if MICROB-switch > 0.	(gC m^{-2} d^{-1})
TOTCMMIN	($\Sigma C_{m \rightarrow CO2}$) Mineralisation of carbon by microbes (in total profile). Only if MICROB-switch>0.	(gC m^{-2} d^{-1})
TOTCMLIT	($\Sigma C_{m \rightarrow Li}$) Mortality of microbial biomass to litter (in total profile). Only if MICROB-switch > 0.	(gC m^{-2} d^{-1})

TOTNHLIT2	($\Sigma N_{h\rightarrow Li2}$) Humus N transferred directly to litter2 without passing through microbes (in total profile). Only if MICROB-switch > 0.	(gN m^{-2} d^{-1})
TOTNLHUM	($\Sigma N_{l\rightarrow h}$) Litter N transferred directly to humus without passing through microbes (in total profile). Only if MICROB-switch > 0.	(gN m^{-2} d^{-1})
TOTDEN	($\Sigma N_{NO3\rightarrow Atm}$) Actual denitrification (from total profile)	(gN m^{-2} d^{-1})
TOTFI	(N_{Stream}-$N_{Stream\rightarrow Consum}$) Total leaching of NO3-N to stream flow after N-consumption in stream	(gN m^{-2} d^{-1})
TOTMAE	($\Sigma N_{Appl\rightarrow f}$) Flow of nitrogen in faeces in manure to faeces-N (in total profile)	(gN m^{-2} d^{-1})
TOTMAL	($\Sigma N_{Appl\rightarrow Li}$) Flow of nitrogen in bedding in manure to litter-N (in total profile)	(gN m^{-2} d^{-1})
TOTMAN	($\Sigma N_{Appl\rightarrow NH4}$) Flow of nitrogen in NH4 in manure to NH4-N (in total profile)	(gN m^{-2} d^{-1})
TOTNFMIN	($\Sigma N_{f\rightarrow NH4}$) Mineralisation/immobilisation of faeces-N to NH4-N (in total profile)	(gN m^{-2} d^{-1})
TOTNH4NF	($\Sigma N_{NH4\rightarrow f}$) N flow from NH4 to faeces (in total profile)	(gN m^{-2} d^{-1})
TOTNH4NL	($\Sigma N_{NH4\rightarrow Li}$) N flow from NH4 to litter (in total profile)	(gN m^{-2} d^{-1})
TOTNHMIC	($\Sigma N_{h\rightarrow m}$) Microbial uptake of N from humus (in total profile). Only if MICROB-switch > 0.	(gN m^{-2} d^{-1})
TOTNHMIN	($\Sigma N_{h\rightarrow NH4}$) Mineralisation of humus-N to NH4-N (in total profile)	(gN m^{-2} d^{-1})
TOTNIT	($\Sigma N_{NH4\rightarrow NO3}$) Nitrification of NH4-N to NO3-N (in total profile)	(gN m^{-2} d^{-1})
TOTNLMIN	($\Sigma N_{Li\rightarrow NH4}$) Mineralisation/immobilisation of litter-N to NH4-N (in total profile). If MICROB-switch=1 then: mineralisation/immobilisation from microbes.	(gN m^{-2} d^{-1})
TOTNLMIC	($\Sigma N_{Li\rightarrow m}$) Microbial uptake of N from litter (in total profile). Only if MICROB-switch > 0.	(gN m^{-2} d^{-1})
TOTNMHUM	($\Sigma N_{m\rightarrow h}$) Humification of N (in total profile). Only if MICROB-switch > 0.	(gN m^{-2} d^{-1})
TOTNMLIT	($\Sigma N_{m\rightarrow Li}$) Mortality of microbial N to litter (in total profile). Only if MICROB-switch > 0.	(gN m^{-2} d^{-1})
TOTNO3NF	($\Sigma N_{NO3\rightarrow f}$) N flow from NO3 to faeces (in total profile)	(gN m^{-2} d^{-1})
TOTNO3NL	($\Sigma N_{NO3\rightarrow Li}$) N flow from NO3 to litter (in total profile)	(gN m^{-2} d^{-1})

TOTUPT	($\Sigma N_{Soil \rightarrow a}$) Actual plant uptake of NO3-N + NH4-N, total profile.	(gN m^{-2} d^{-1})
TSURRNO3	($N_{Surr \rightarrow Stream}$) N flow: Surface runoff of NO3 to STREAMT (acts as a flow variable). = 0 if SURR driving variable < 0.1.	(gN m^{-2} d^{-1})
VDEV	(i_g) Index that determines the start of grain development (PLANT)	(-)

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	(E_t/E_{tp}) Transpiration ratio (actual/potential)	(-)
INF	(q_{Inf}) Infiltration of water into the soil surface (including infiltration from surface pool).	(mmH_2O d^{-1})
INFBYPASS	(q_{Inf2}) Infiltration of water directly to the second soil layer (Not used)	(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	(q_{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_a) Air temperature	(°C)
TEMP	(T_s) Driving variables: Soil temperature (Index= layer 1 to NUMLAY) TEMP in the SOIL model.	(°C)
THETA	(θ) 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. Start date (STARTDAT) and end date (ENDDAT) should be given (for instance "1981-01-01 00:00").

8.1 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 in units of days (OUTINTD). Minutes are not used (OUTINTM 0).

8.2 No of iterations:

The time step of the model is one day. No other values are allowed (NUMITER 1).

8.3 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. (RUNID "xxxxx")

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 occur 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 severe 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 instructions 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 AIN_ONE
```

will result in default values from the parameter file AIN_ONE.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 AIN_ONE
```

which will result in a simulation making use of information from the AIN_ONE.PAR file. If information is missing in the AIN_ONE.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 AIN_ONE AIN_TWO
```

This means that the PREP program will first read the instructions in the AIN_ONE.PAR file and then the AIN_TWO.PAR file. If information for one parameter is read several times the one read the last time will be used. Remember that the parameter files do not need to be complete. They can for instance be organized with only information about time periods.

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 menus. 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 of work. A number of persons have contributed with ideas and suggestions. This could easily be seen from the reference list. Responsible for the present updating of the SOILN model from version 8.0 to 9.2 is Henrik Eckersten. This updating is based on discussions mainly with Karin Blombäck, Annemieke Gärdenäs, Per-Erik Jansson, Thomas Kätterer and Tryggve Persson, all at the Swedish University of Agricultural Sciences (Uppsala), Tor Arvid Breland at the Agricultural University of Norway (Ås, Norway) and also other participants of the NORN project (Jansson & Persson, 1998). Henrik Eckersten made the programming and Hans Johansson, SLU, Uppsala, contributed with help in programming the SIMVB-program. This work was done within the NORN project financed by Nordic authorities SNS/NKJ and national financial boards, mainly SJFR (Skogs- och jordbrukets forskningsråd), Sweden. The work was conducted at the Department of Crop Production Sciences and the Department of Soil Sciences, both at SLU.

Specific contributions were as follows: The special option where the assimilation rate is a function of a light response curve for the single leaf integrated over the canopy (GROWPHOS-switch = 1) was implemented by Lianhai Wu, Beijing Agricultural University, China, currently working at the Soil Department, SAC, Edinburgh, Scotland. Lianhai Wu also contributed with some technical model developments. An option for calculating phenologic stages (GROWPHEN-switch = 2) was introduced from the AFRCWHEAT model (Porter, 1984). The software was delivered by Mikhail Semenov at Long Ashton Research Station, University of Bristol, UK. A special option on estimating N supply to cover deficiency in natural N supply (FERNCALC-switch = 2) was introduced by Peter Botterweg Jordforsk, Ås, Norway and Holger Johnsson SLU, Uppsala. The Ratkowsky temperature function and some other parts of the microbial activity was introduced after discussions with Tor Arvid Breland. The balance between adsorbed and dissolved ammonium was developed with help of Claus Beier, Risö National Laboratory, Roskilde, Denmark and Per Gundersen, Danish Forest and Landscape Research Institute, Lyngby, Denmark. The calibration procedure (Appendix 2) was developed and written together with Thomas Kätterer.

As concerns the SOILN version 8.0 see Eckersten et al. (1994) and for version 9.1 Eckersten et al. (1996). Basic works for previous versions of the model have been made by the three authors of this manual. The PREP-program was made by Per-Erik Jansson and Jan Claréus. If you get problems, find bugs or just want to report an interesting phenomena please let us know about it (remember to send a copy of your input data files and summary-file when you get any problems). Write to:

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12.4 News

Important changes since SOILN v8.0 will be mentioned here. The best overview of new developments is given by the Model specific and special switches description.

February 95

The ZLEAF(2) parameter has got the opposite sign. The harvest routine for the forest growth model has been rebuild, but no changes in input has been made. The CROPPHEN-switch and TAPHENOL-parameters have been introduced.

Mars 95
Date of end of grain filling is also made a function of maximum possible harvest-index given the new parameter HARINDEXX. Additional options have been included for CROPALLO-switch = 2 (N demand by leaves).

August 95
Several changes have been made of which the following are most important: The FOREST submodel has been cancelled. Its options have been build into the CROP submodel which now is named PLANT submodel (the harvest routine remains to build in). Parameter, switch and variable names have been changed in many cases. Extensive error check has been made. The uppermost faeces pool can be used as an additional pool which litter has to path between LITABOVE and NLIT(1). Nitrate and ammonium are both immobilised by litter and faeces in proportion to its abundance. A microbial pool has been introduced in each layer. Deposition nitrogen can be taken up by leaves. Nitrogen can be leached from leaves in case of precipitation. Specific decomposition rate can be set a function of C/N ratio. A new option for calculating leaf assimilation with a photosynthesis response curve is activated with switch GROWPHOS.

July 96
Version 9.1 is ready. The main differences compare to August 95 are: The special option on microbial activity is further developed (MICROB-switch). The alternative use of the faeces pool, as mentioned for August 1995, is cancelled. Alternative temperature functions influencing soil biological processes are added (TEMPREQ-switch). The ammonium is made mobile in the profile (NH4MOBIL-switch). The response of plant biomass allocation to water conditions is included (AROOTE). The response of plant growth to water is given more alternatives (PHOETR) and the response to changing atmospheric CO_2 is included (PHOCO2). The utilisation of available pool in plant is changed (AVAWOOD). A special option on defining boundary conditions for the simulation is included (BOUNDARY-switch).

October 96
Version 9.11. An error in calculation of surface run off of mineral N (TSURRNO3) was corrected. Surface run off of NO3 occured in case of N addition although SURR was =0. The error is found in version 9.0 (dated Aug 95) but not in v 8.0 (dated Dec 94). In the new version input of mineral N to soil surface is sheared among infiltration (TINFNO3) and run off (TSURRNO3) in case run off is larger than zero. If run off is zero all mineral N is incorporated in the uppermost layer (TINFNO3).

December 96
Version 9.12. Parameter SWCATCH (special-group) is added. Is used when running both main crop and catch crop.

January 97
Version 9.12. GROWAVAI-switch is added. All input of N and photosynthates to plant goes through the available pool (some variables have changed there names). Parameter SWCATCH (special-group) also includes that biomass and N is transfered from main crop to catch crop at harvest. Immobilisation of nitrate to microbes has got a seperate variable for each soil layer (NMNO3). Mineralisation of ammonium from microbes is named NMNH4. Organic N uptake is added and activated with the GROWMYCO-switch.

September 97
Preliminar version of Version 9.2.
An error: TSURRNO3 was > 0 even if SURR flow variable was = 0. Corrected 970527 to be: If SURR < 0.1 then TSURRNO3 = 0.
Soil initial states could be given in units per meter depth (INISTATE-switch). Separate microbial parameters for each layers could be used (MICROB-switch > 100). The plant respiration is a function of temperature (TEMLINP parameter). The mycorrhiza option is modified (GROWMYCO switch). Grain litter is included (AGRAINLIW and AGRAINLIN flows). Direct humification introduced (see MICCLHUM parameter). Competition for mineral N introduced (NMINCOMP switch).

November 97
An error: For GROWPHEN-switch= 2 GROWSTAG remained = 11 for several days (Corrected).
An error for 0<AROOTAGE<365 and GROWPEREN ON (Corrected).
Modified the root litter fall routine (see AROOTAGE and ALITTERR(1-2) parameters). Root and leaf age a function temperature (AROOTTS and ALEAFTA parameters).

December 97
Flushing routine is added for deciduous forests (AVAWOODF parameter). Leaf litter fall modified for perennial plants (ALITTERL acts on total needle biomass). Added harvest routine for perennial plants (harvest in middle of season not tested). Added option on changing switches during simulation (CHAPARSW switch).

January 98
Added special routine on using different layer thickness for SOIL and SOILN simulations (NUMLAYWT parameter). Replaced SWITCATCH parameter by GROWCAT switch.
An error for GROWTH-switch=0: More than 100% of plant could go to litter at harvest. (Fraction left as litter is 1-HARP-HARAR-HARLR). (Corrected)
An error: Deep percolation input variable has not been used correctly before. Consequences not evaluated yet. (Corrected)

February 98
An error for NCONC and NH4CONC variables. The mineral N of previous day was used. Corrected to be the mineral N of the current day. Effect of error estimated to range from 0.1% to 0.5% in case of fertilisation.
An error for second and third ploughing during a simulation. Obvious error aroused in ACCBAL variable. (Corrected)
An error, when root depth decrease root distribution remained. (Corrected)

March 98
Corrected BOUNDARY-switch to: Not active for days of harvest or ploughing.
An error for GROWMYCO-switch > 0: The carbon transferred from soil to roots were not converted to biomass. (Corrected).
For GROWPHEN switch > 0: PLOUGHDAY is function harvest day and UPMA and ALEAFAGE a function of phenology. (New parameters introduced)

June 98
Microbial efficiency could be set a function of temperature (MICEFFTS and MICEFFT0 parameters).
SOILN Version 9.2 ready.

Appendix 1: Variable number list for BOUNDARY-switch

Date: 1997-04-29

Exemples of alternative boundary settings:

Numbers below are:
State variables = variable number
Flow variables = variable number + 1000
Auxilary variables = variable number + 10000

########## Boundary = leaf N concentration ##################
bounftot 4
NLEAF, NWLEAF, NLEAFALL, NLEAFDAY
bounvnum(1) 10069
bounvnum(2) 10090
bounvnum(3) 10093
bounvnum(4) 10103

########## Boundary = plant growth ####################
bounftot 9
PHOS,AAVAILW,AAVAISW,AAVAIRW, ALEAFSW, ASTEMGW
bounvnum(1) 1167
bounvnum(2) 1175
bounvnum(3) 1178
bounvnum(4) 1184
bounvnum(5) 1179
bounvnum(6) 1177
ALI,ALINEW
bounvnum(7) 10065
bounvnum(8) 10080
GROWSTAG
bounvnum(9) 10079

########## Boundary = plant growth and litter fall of C and N ##
bounftot 13
PHOS,AAVAILW,AAVAISLW,AAVAIRW
bounvnum(1) 1167
bounvnum(2) 1175
bounvnum(3) 1178
bounvnum(4) 1184
ALI,ALINEW,ALIOLD
bounvnum(5) 10065
bounvnum(6) 10080
bounvnum(7) 10081
INCALITC,AROOTLIW,AWROOTLIW
bounvnum(8) 1228
bounvnum(9) 1236
bounvnum(10) 1198
INCALIT,AROOTLIN,AWROOTLIN
bounvnum(11) 1161
bounvnum(12) 1213
bounvnum(13) 1190

########## Boundary = Plant C and N uptake ############
bounftot 19
UPPNO3(1-7)
bounvnum(1) 1001
bounvnum(2) 1002

```
bounvnum(3) 1003
bounvnum(4) 1004
bounvnum(5) 1005
bounvnum(6) 1006
bounvnum(7) 1007
# UPPNH4(1-7)
bounvnum(8) 1151
bounvnum(9) 1152
bounvnum(10) 1153
bounvnum(11) 1154
bounvnum(12) 1155
bounvnum(13) 1156
bounvnum(14) 1157
# TOTUPT, POTUPT
bounvnum(15) 10034
bounvnum(16) 10032
# LEAFN, LEAFW
bounvnum(17) 77
bounvnum(18) 73
# PHOS
bounvnum(19) 1167
```

```
########### Boundary = soil mineral N ############
bounftot 10
# NO3(1-5)
bounvnum(1) 1
bounvnum(2) 2
bounvnum(3) 3
bounvnum(4) 4
bounvnum(5) 5
# NH4(1-5)
bounvnum(6) 61
bounvnum(7) 62
bounvnum(8) 63
bounvnum(9) 64
bounvnum(10) 65
```

States (X-variables)

```
NO3    22   maxindex = 22
**This means that NO3(1-22)= variables 1-22
ACCPLANT    23
ACCDENI    24
ACCDLOSS    25
FERT    26
NLIT    36   maxindex = 10
NF    38   maxindex = 2
NH    48   maxindex = 10
CL    58   maxindex = 10
CF    60   maxindex = 2
NH4    70   maxindex = 10
LITABOVE    71
GRAINW    72
LEAFW    73
STEMW    74
ROOTW    75
GRAINN    76
LEAFN    77
STEMN    78
ROOTN    79
WROOTW    80
WSTEMW    81
WLEAFW    82
WROOTN    83
WSTEMN    84
WLEAFN    85
MYCORC    86
MYCORN    87
XROOTQN    88
XSTEMQN    89
XAVAIN    90
XAVAIW    91
XROOTQW2    92
XSTEMQW2    93
```

XROOTQN2 94
XSTEMQN2 95
XLEAFQW 96
XLEAFQN 97
ACCFERT 98
ACCMAN 99
ACCDEP 100
ACCHARV 101
ACCSOIL 102
ACCBAL 103
ACCSOILC 104
ACCPHOSC 105
ACCHARVC 106
ACCRESPC 107
ACCPLANTC 108
ACCBALC 109
LITABOVEC 110
NM 120 maxindex = 10
CM 130 maxindex = 10
CH 140 maxindex = 10
CL2 150 maxindex = 10
NLIT2 160 maxindex = 10
NHIDD 170 maxindex = 10

Flows (T-variables)

UPPNO3 10 maxindex = 10 (change TOTUPT also)
DENI 20 maxindex = 10
DLOSS 42 maxindex = 22
DEPONO3 43
NFLOW 64 maxindex = 21
FERTIN 65
FINNB 67 maxindex = 2
NHARV 68
NEWNL 78 maxindex = 10
NLMIN 88 maxindex = 10
NLHUM 98 maxindex = 10
FINNA 100 maxindex = 2
NHMIN 110 maxindex = 10
NFHUM 112 maxindex = 2
FINNH 114 maxindex = 2
FNIT 124 maxindex = 10
CLLOSS 134 maxindex = 10
NEWCL 144 maxindex = 10
CFLOSS 146 maxindex = 2
FINCB 148 maxindex = 2
NFMIN 150 maxindex = 2
UPPNH4 160 maxindex = 10 (change TOTUPT also)
INCALIT 161
DECALIT 162
AAVAIRN 163
AAVAISN 164
AAVAILN 165
AAVAIGN 166
PHOS 167
RESPLW 168
RESPSW 169
RESPRW 170
RESPGW 171
HARVGW 172
HARVLW 173
HARVSW 174
AAVAILW 175
ALEAFGW 176
ASTEMGW 177
AAVAISW 178
ALEAFSW 179
AROOTSW 180
ALEAFSN 181
AROOTSN 182
AROOTGN 183
AAVAIRW 184
ASTEMGN 185
ALEAFGN 186
HARVGN 187
HARVLN 188
HARVSN 189
AWROOTLIN 190
ACATCHW 191
AWSTEMAN 192
AWLEAFAW 193
AWSTEMAW 194
AWROOTAW 195
AROOTAW 196
ASTEMAW 197
AWROOTLIW 198
AWSTEMLIW 199
DECALEAC 200
ACATCHN 201
ALEAFWN 202
AWLEAFLIW 203
DECALEAN 204
ALEAFWW 205
ASTEMWW 206
AROOTWW 207
ALEAFFAL 208
ASTEMWN 209
AROOTWN 210
ALEAFAN 211
ASTEMAN 212
AROOTLIN 213
ASTEMLIN 214
ALEAFLIN 215
ALITTMYC 216
TFREE10 217
TFREE11 218
TFREE12 219
TFREE13 220
TFREE14 221
TFREE15 222
CHARV 223

AWLEAFLW 224
AWLEAFLIN 225
AWSTEMLIN 226
ALEAFAW 227
INCALITC 228
DECALITC 229
DEPONH4 230
NFERTNO3 231
NFERTNH4 232
AROOTAN 233
ALEAFLIW 234
ASTEMLIW 235
AROOTLIW 236
AROOTGW 237
AWLEAFLN 238
TINFNO3 239
TSURRNO3 240
DECACF 241
DECANF 242
ALEAFN3N 243
DEPOLEAF 244
NLMIC 254 maxindex = 10
CMMIN 264 maxindex = 10
CMHUM 274 maxindex = 10
CLMIC 284 maxindex = 10
NMNH4 294 maxindex = 10
NMHUM 304 maxindex = 10
DEPOWLEAF 305
AWLEAFN3N 306
NLROFF 307
CLROFF 308
DECAROFF 309
DECAROFFC 310
AROOTMYC 311
AMYCOLIC 312
ASOILMYN 313
AMYCOAN 314
ALITTMYN 315
CHMIC 325 maxindex = 10
CL2MIC 335 maxindex = 10
CMLIT 345 maxindex = 10
CHMIN 355 maxindex = 10
CMLIT2 365 maxindex = 10
NHMIC 375 maxindex = 10
NL2MIC 385 maxindex = 10
NMLIT 395 maxindex = 10
NMLIT2 405 maxindex = 10
NEWCLLIT 415 maxindex = 10
NEWCLLI2 425 maxindex = 10
NEWCLHUM 435 maxindex = 10
NEWNLLIT 445 maxindex = 10
NEWNLLI2 455 maxindex = 10
NEWNLHUM 465 maxindex = 10
DECACLIT 466
DECACLI2 467
DECACHUM 468
DECANLIT 469
DECANLI2 470
DECANHUM 471
NH4DLOSS 493 maxindex = 22
NH4FLOW 514 maxindex = 21
UPPMYNL 524 maxindex = 10
UPPMYCL 534 maxindex = 10
NMNO3 544 maxindex = 10
AWLEAFAN 545
AWROOTAN 546
ASOILAN 547
NH4NHIDD 560 maxindex = 10
NHIDDNH4 570 maxindex = 10

Auxilaries (G-variabler)

NCONC 22 maxindex = 22
PIPEL 23
STREAMT 24
TOTFI 25
NLTPROF 26
NFTPROF 27
NHTPROF 28
NH4T 29
NO3T 30
ROOTDEPTH 31
POTUPT 32
TOTDEN 33
TOTUPT 34 (change UPPNH4 and UPPNO3 also)
PIPEQ 35
STREAMQ 36
TOTMAL 37
TOTMAE 38
TOTMAN 39
TOTNLMIN 40
TOTNFMIN 41
TOTNHMIN 42
TOTNIT 43
CLTPROF 44
RATCNL 54 maxindex = 10
RATCNF 56 maxindex = 2
QNO3C1 57
QNO3C2 58
RUSENO3 59
AEFF 60
ODNO3 61
PIPENO3C 62
ATEFF 63
VDEV 64
ALI 65
NGRAIN 66
BR 67
BI 68
NLEAF 69
RPTEM 70
RPTOT 71
RPN 72

NSTEM 73
NROOT 74
LEAFDN 75
STEMDN 76
ROOTDN 77
ATEFFMY 78
GROWSTAG 79
ALINEW 80
ALIOLD 81
TOTNH4NL 82
TOTNO3NL 83
ARESPP 84
ARESPR 85
LEAFDNEX 86
STEMDNEX 87
ROOTDNEX 88
DEFICLN 89
NWLEAF 90
NWSTEM 91
NWROOT 92
NLEAFALL 93
AVTEMP 94
AVTEMS 95
NAVAI 96
TOTNH4NF 97
TOTNO3NF 98
DAYSTART 99
SWITCHOUT 100
RISBELOW 101
RISGROUN 102
NLEAFDAY 103
LITKCN 104
FECKCN 105
NTOT 106
CO2CONC 107
ROOTPROF 114 maxindex = 7
ROOTDENSI 121 maxindex = 7
AEFFD 122
AEFFN 123
ATEFFD 124
ATEFFN 125
PHEFF 135 maxindex = 10
FERNSIM 136
SUMN 137
CLMIN 147 maxindex = 10
CLHUM 157 maxindex = 10
CLINT 167 maxindex = 10
RROOT 177 maxindex = 10
BOUNVARX 197 maxindex = 20
BOUNVARN 217 maxindex = 20
BOUNCORR 237 maxindex = 20
DEPOWC 238
PHOEFFC 239
BRW 240
BRN 241
BRE 242
RPMOS 243
MYCODN 244
MYCONDEFT 245
NH4CONC 267 maxindex = 22
MYCONDEF 277 maxindex = 10
TOTALLON 278
TOTALLOW 279
TOTAVAIN 280
FRNH4SOL 290 maxindex = 10
NL2TPROF 291
NMTPROF 292
CFTPROF 293
CHTPROF 294
CL2TPROF 295
CMTPROF 296
TOTCLMIC 297
TOTCMMIN 298
TOTCMHUM 299
TOTNLMIC 300
TOTNMHUM 301
TOTNHIDD 302
NHIDDTPR 303
TOTAVAIW 304

Appendix 2: SIMVB; Run SOILN under the Windows program

The description below refers to the program SIMVB.EXE version 1.8 (dated 1998-06-25) made by H. Eckersten, Swedish University of Agricultural Sciences.

The objectives of the SIMVB program are to enable the user of the SOILN model to run the model technically in a simple way, to enable both a strict and flexible presentation of model output, and to enable a simple way of using the model as a tool for evaluation of possible changes in input, calibration, validation and to bring order to input and output files.

Normally, the SOILN model is used together with the SOIL model (Jansson 1991a), therefore the link to SOIL will mentioned below. The SIMVB program is also adapted to the SOIL model and the SPAC model (Eckersten, 1995).

How to run SOILN

Run under DOS

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

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 to prepare and execute the simulation, i.e. you can select parameter values, input files, simulation period etc. The PREP program describes 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 read the information directly from the PAR-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). The file 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 (SIMVB)

The principal idea for this program (SIMVB.EXE) is to make use of already developed DOS programs and applications when running SOILN under WINDOWS. The program is restricted to the "administration" of the operative programs and routines. SIMVB.EXE is programmed in Windows-VisualBasic and used under WINDOWS. The VBRUN300.DLL file should be available.

(i) START the program

You start SIMVB from the run option of WINDOWS, or by double clicking the icon (if installed) or by writing under DOS: >win simvb
In the program SIMVB you always start with the heading denoted *"Start here"*. Note, that in the SIMVB program you should use only single click (except in the file list options). First you select the model to be used *"SOILN"* and second the application *"Standard..."*, for instance. Thereafter you normally continue with *"GIVE INPUT"*.

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

(ii) GIVE INPUT.
Copies input files from "Store directories" to the "Working directory" (on disc). Note, that the routines under this option overwrites files at the "Working directory", without warnings.
Here you can view inputs (figures) and change inputs in "Working directory"

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

(iv) SHOW OUTPUT.
Variables in SOILNCUR.bin are presented. Variables that are presented are grouped in accordance to subjects like litter N, plant N etc. You can also compare results with the previous simulation and/or simulations that have been stored, see below. You can view the summary file of the simulation as well.

(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 SHOW OUTPUT option 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.

(vii) EXIT the program.
You should exit the program by pressing the "EXIT" bottom on the main menu.

(viii) START the program AGAIN
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 checks the order in which you select options in the program during the first run.)

Alternative use of SIMVB

Documentation

You can read the SOILN-manual on screen by selecting *"Help etc, Help&Documentation*, Select item, SOILN users manual"*. In a similar way you can read this SIMVB documentation and the Fortran code of the SOILN model (the model specific code). Selected part of the documentation are available elsewhere, f.i. in SHOW OUTPUT.

Type of User

You can select three type of users (Student, Teacher, Research) under *"Help etc"*. Different users will get access to different parts of the SIMVB program. Some of the options below is only possible to use if *"Research ON"* is chosen (only visible if Reasearch is off).

Give comments

By putting the mouse arrow on space between boxes and by making a click on the right bottom you can give comments, on whatever you want. The comments should be stored or cancelled (MAIN MENU) immediately after the option is closed.

Edit files
You can change a single parameter value or initial states by selecting *"Help etc., Edit files*"*. Be aware of that you must spell the parameter/variable name correct. Note that changes of parameter values preferably are introduced in the AIN_MAN.PAR since values in this file have the highest priority (if you make a change in AIN_PLAN.PAR and the parameter name also appears in AIN_MAN.PAR the latter is the one used). This option is also available from *"GIVE INPUT, Changes*, Edit files*"* or *"GIVE INPUT, Normal*, Change ... par."* or *"SHOW OUTPUT", Blue button "ChangeInput"*.

Make the simulation under DOS
The simulation made by SIMVB can be done from the DOS prompt as well, f.i.: demo_vb sim ain_man. In case the SIMVB-program do not start the simulation properly, you can use this command to make the simulation and then go back to SIMVB for presentation of output.

Use PG-program manually
The PG-program can be used in a standard (interactive) way within SIMVB (see f.i. SHOW OUTPUT). Select *"Help etc, PG ON"* (only visible if PG off).

Use Excel-program manually
The Excel-program can be used in an interactive way within SIMVB, in case Excel is loaded and there is a path to Excel. Select *"Help etc, Excel ON"*. SIMVB converts the PG-binary-file concerned to dbf or lotus123 format and brings you automatically into Excel. With help of the presentation routines of SIMVB you can select variables to be exported to Excel.

Print files
Graphs plotted on screen can also be stored on TEK-files. Press green button *"SCREEN"* which then becomes red *"TEK"*. Drawings are then made on TEK-files instead of on screen.
The files can be printed on screen or paper, or converted to meta files (.CGM-file) that can be imported to documents and graphical programs (*"Help etc, Print files*"....)*. Under this option also ASCII files can be printed.

Using only one parameter file
To run SIMVB with only one parameter file, there are a few alternatives:

(1) Using only one parameter file: In this case the simulation is completely governed with a single file. Store the file under name AIN_ONE.PAR and select *"Help etc, one par-file"*.

(2) Using two parameter files (actually five but three are inactivated): In this case you make use of the parameter file AIN_OUT.PAR selecting proper outputs for the SIMVB presentation routines. The content of the other four parameter files are put together into preferably the AIN_MAN.PAR file (any of the other parameter files AIN_SOIL, AIN_PLAN or AIN_TIME, could be used as well). Note that you should take away (i) the declaration of file names except for FILE(9), which should be named AIN_FERT.BIN if it is used, and (ii) the OUTFORN switch. The three other parameter files have to exist but should be empty except for a ";" (AIN_OUT.PAR is delivered by SIMVB automatically).

(3) Using the SOILNCUR.SUM-file: Principally the same is done as in (1) above. SOILNCUR.SUM is renamed to AIN_MAN.par and all other four parameter files are emptied (;). *("GIVE INPUT, Normal*, "Prep fr sum file")*

Multiple runs
Up to 6 multiple simulations can be done and plotted. (It is the presentation of output that limits the number of simulations.) *("GIVE INPUT, Normal*, Others*, Multiple sim., SIMULATE, Others*, Multiple simulation, SHOW OUTPUT*, Multiple simulation")*

Initial states of previous run
Make a simulation using outputs of the previous simulation as initial states in the new simulation. *("SIMULATE, Others*, Initial values...")*

File list
(1) Selecting single files: In the *"GIVE INPUT, Normal*...file list*"* option of SIMVB files can be selected arbitrary by selecting in the list menus. This is a compliment to the other preparation options.

(2) Selecting directories: All SIMVB files (i.e. named according to the convention used in SIMVB) in the selected directory are copied to "Working directory" *("GIVE INPUT, Normal*, Prep from SubDir, Directory List", select directory, "Preparation").*

Alternative applications under directory ... \XXXX\...
Often several versions of the same main application are used. Then the best way is to store a full set of input files for the reference application in a certain directory:
1) C:\SIMVB\XXXX\N\NA

or directory structure:
2) C:\SIMVB\XXXX\N\NA\A_SITES\SITE_VB \CLIMATE\ain_clim.bin, ain_time.par, ain_ini.ini, ain_inip.ini
\MANAGEM\ain_man.par, ain_fert.bin
\PLANT\ain_plan.par
\SOIL\ain_soil.par, ain_soip.par
\MEAS\meas_1.bin etc.

Alternative applications are then stored in other directories, if for instance a different management file should be used, then store it as:

...\XXXX\N\NA\A_SITES\SITE_NEW\MANAGEM\ain_man.par

Only differences compared to reference application is necessary to store here. In all directories an INFO.LIS file should be present. This file is included in INFO_LOG.LIS in which the preparation could be traced. The files are copied to the "Working directory" by using the second method described in File list (see above) *"GIVE INPUT, Normal*, Prep. from SubDir, Directory list,... Preparation"*

Change instruction files
(1) In SHOW OUTPUT there are a few plot instruction files that could be changed, for instance *"SHOW OUTPUT, Biomass, Edit Others*,...., Others".*

(2) The instruction files used by the PG-program are stored under the directory C:\SIMVB\XXXX\N\NA\PG. If you want the drawing to be made in another way or other variables to be selected you can edit the PG-files. The address to the file you get by selecting *"Help etc, File name"* immediately after making a plot or any other operation (this option is not available for all files).

Adaptation of application to SIMVB

The description below refers to a "Standard" application.

SOILN

If you would like to run the SOILN model under the SIMVB program it is necessary to install the application following the conventions used by SIMVB. Below is given an example of such an installation.

1) Install the CALIBRAT application. The application refers to the Kjettslinge site north of Uppsala grown with barley (Andrén et al. 1990). The application is available on request to Henrik Eckersten or Thomas Kätterer (Thomas.Katterer@mv.slu.se) at SLU.

2) Check that the application works in its original version, on your computer: Start SIMVB, choose SOILN model, Standard. Write CALIBRAT. Make preparation (*"GIVE INPUT, Initial prep., Normal*, Soil(Soil), ...etc."*) and simulation (*"SIMULATE, Normal*"*) and presentation of output *"SHOW OUTPUT*..."*.

3) Replace the files denoted AIN_.... under C:\SIMVB\CALIBRAT\N\NA\A_SITES\SITE_VB\...-directories to those of your application. Information could be added in the INFO.LIS file.

-a) Start by replacing AIN_CLIM.BIN (the driving variable file taken from the SOIL model) with that of yours.
-b) Change in AIN_SOIL.PAR the number of soil layers (NUMLAY) and the thickness of layers (THICK)
-c) Change in AIN_TIME.PAR the time period to be simulated.
-d) Run SIMVB and check that a simulation is done and that you receive results.

-e) Replace AIN_SOIP.DAT (soilp.dat-file) with your file (created with PLOTPF.EXE).
-f) Change in AIN_SOIL.PAR the identification of your profile (UNUM, UPROF)
-g) Run SIMVB and check that a simulation is done and that you receive results.

-h) Change other parameters in the parameter files in accordance with your application
-g) Run SIMVB and check that a simulation is done and that you receive results.

4) Rename your application to standard format: After the two first points above your application set is technically ready, however, named CALIBRAT\S\SA\A_SITES\SITE_VB\.... Your results will not be affected by this. If you, however, want to put your application under standard format with a proper name (for instance Mellby) you just rename the CALIBRAT directory to MELLBY.

5) Restart SIMVB for MELLBY in accordance to 2) above.

Additional information: The description above does not handle the conversion of AIN_BOUN.BIN and MEAS.BIN. Those files are not necessarily needed. AIN_BOUN.BIN is needed if you choose the BOUNDARY-switch > 0, see SOILN user's manual above. MEAS.BIN is used for comparison between simulated and measured data (*"SHOW OUTPUT*, Test..."*). You can use the principal structure of those files to create those of your application. As concerns MEAS.BIN you have to change in the PG-instruction files making the comparison. If you choose *"Help etc, File name"* you get the address of the file used for the presentation. Replace that file(s) with the one(s) you want to apply for the comparison. There are 5 parameter files of which four are application specific. However, you do not necessarily need to have more than one, see the section above on Alternative use of SIMVB, using one parameter file together with an output parameter file.

SOIL

The same procedure could be used for adaptation of a SOIL application to SIMVB as used for SOILN, above. Exceptions are:

Generally: All directories denoted \N\NA\ should be denoted \S\SA\ instead.

-3a) When changing AIN_CLIM.BIN: If you have another type of driving variable file than that of Kjettslinge then change in AIN_MAN.PAR: CNUMD.
-3b) Replace AIN_EXT.BIN so that it is in accordance with your plant and the time period of your application. Note that you can cancel the use of this file by setting DRIV_EXT=0 and choose plant properties with parameters. However, then it is difficult to link to SOILN simulations of leaf area and root depth, later on.

To make the driving variable file for SOILN *"Link SOIL-..."* you need to change the PG-instruction which makes this file (C:\SIMVB\S\SA\PG\DEMODRIN.PG). Change in accordance with the number of layers used in SOILN. The boundary between layers should not differ between SOIL and SOILN. However, thickness of one SOILN-layer may be the same as for several SOIL-layers and you not necessarily need to represent as deep layers as in SOIL. If so, weighted averages of water contents, temperatures etc must be made to fit the SOILN profile structure and only the vertical water flows related to the boundaries between layers of SOILN should be included. Percolation should get the vertical flow at the bottom of the deepest layer of the SOILN application. Concerning relations between layer thickness used in SOIL and SOILN see also the NUMLAYWT-parameter.

Calibration of SOIL-SOILN

The principal steps in the calibration of SOIL-SOILN is illustrated by the interface of the SIMVB program used for administration of SOIL and SOILN applications (Fig. 5).

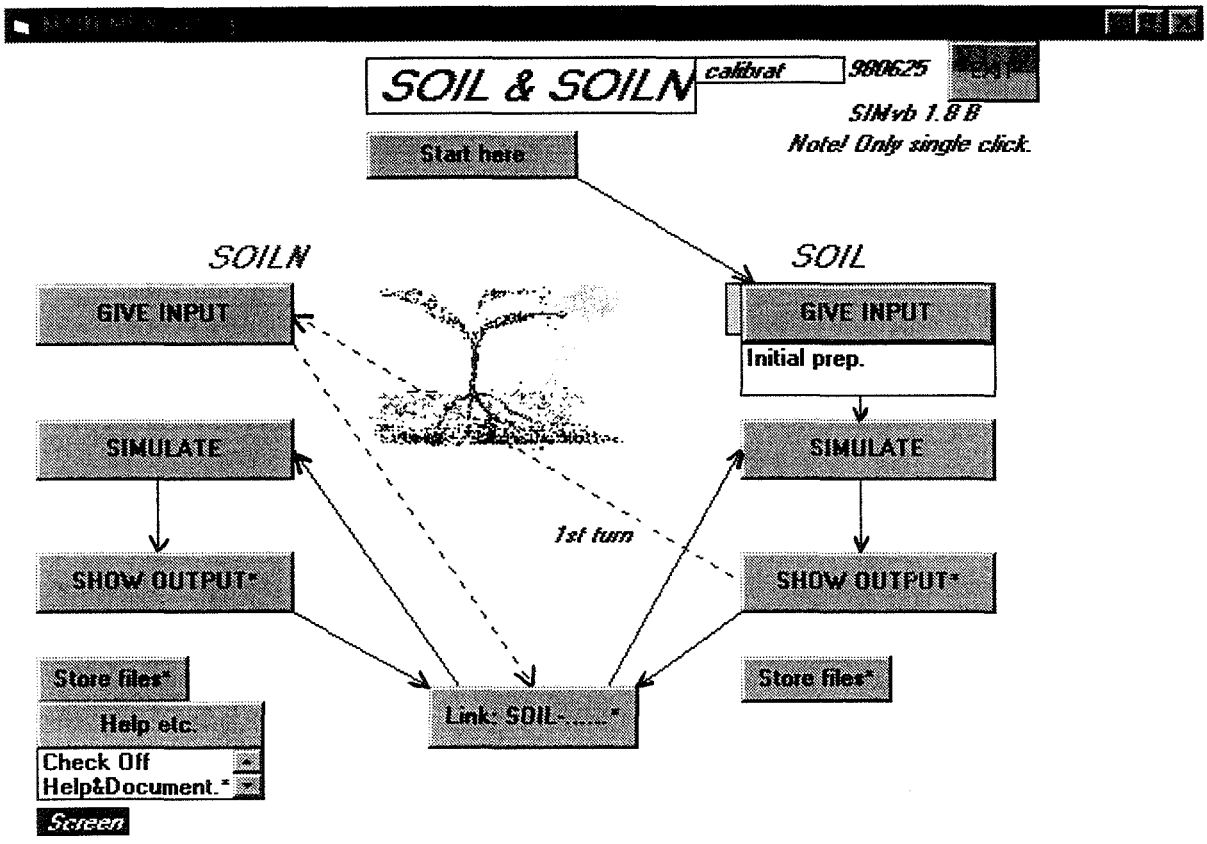

Figure 5. Schematic description of principal steps in SOIL-SOILN applications. The figure shows the SIMVB program written in visual basic and used to administrate the application.

The SOIL-SOILN application starts with the application of the SOIL model. First site properties and driving variables on climate and management are given (GIVE INPUT), then the SOIL simulation is made (SIMULATE) and in the option on SHOW OUTPUT the simulation results are compared with measured data. The calibration of the SOIL model is made by repeating this loop until the fit between simulated and measured values is the best possible.

Thereafter, input to the SOILN model is given in terms of site properties (parameters) and management regimes (GIVE INPUT), and in terms of driving variables related to weather and its effect on soil conditions (Link: SOIL-...). The link option means that soil water flows and storage, temperatures and transpiration ratio as simulated by SOIL, are prepared to be used as driving variables for SOILN. The SOILN model is then calibrated against measured variables in a similar way as was the SOIL model.

The SOILN simulation predicts a leaf area and root depth which probably differ from those used in the SOIL simulation. Therefore the SOIL simulation is repeated with the output from SOILN which is prepared to be used as input for SOIL by the link option (Fig. 1). The loop between SOIL and SOILN is repeated until no further significant changes appears between the last and next last simulations, which normally occurs already after one or two loops.

The methods for estimating parameter values are principally divided into two categories: (i) independent parameterisation where values are received without making simulations and (ii) calibration where the values are estimated by running the model. The independent parameterisation is made first and normally based on a previous application of the model to a similar site. The origin of these values should be checked and replaced if better information is available for the present application. The parameter values not possible to estimate independently have to be estimated by model calibration.

As an example, is shown a procedure of how to calibrate the SOIL-SOILN model to the Kjettslinge barley data set (Andrén et al. 1990). The BOUNDARY-option is used facilitate the calibration procedure by means of decreasing the effect of interactions on the simulated outputs and instead focusing the direct effects of parameter changes. This example is available on request to Henrik Eckersten or Thomas Kätterer at SLU.

Calibration procedure:

Start SIMVB and, *"Start here, SOILN & SOIL, Standard, calibrat".*

SOIL model:

1) Select input (driving) variables and a pre-parameterisation as a starting point for your SOIL calibration (*"GIVE INPUT, initial prep., Normal*, Soil(Soil), Plant(Plant), Weather(Climate), Management(Management), Model test(Measurement)"; you can check your preparation under INFO).*

2) Set initial values of state variables in parameter file (ground water level, soil water potential and temperature; *"GIVE INPUT, Change man. par* ...)* according measurements or reasonable estimates.

3) Make a simulation with the parameter setting and compare with measurements (*"SIMULATE, Normal, SHOW OUTPUT, Test...."*).

4) Change parameter values that could improve model predictions of measured values. (*"GIVE INPUT, Normal*, Change ... par....(follow instructions on line)* (In this way you can change in the input parameter files (ain_soil.par, ain_plan.par, ain_man.par) note that the last one has the highest priority)

5) Redo 3) and 4) until you get reasonable results. When you are satisfied with the SOIL simulation, store the results (*"Store files*, Current to store...").*

SOILN model (plant):

6) Select input (driving) variables and a pre-parameterisation as a starting point for your SOILN calibration *("GIVE INPUT, Initial prep., Normal*, Soil(Soil), Plant(Plant), Weather(Climate), Management(Management), Model test(Measurement)".* (This copies files from "Store directories" to "Working directory").

7) Set initial values of plant state variables in initial file *("GIVE INPUT, Normal*, Change weather, per*, Initial states*, Select file, ain_ini.ini...")*

8) Extract the driving variables for SOILN from the SOIL simulation *("Link SOIL-...*, SOIL to ....").*

9) Calibrate the plant N uptake process. Since plant N uptake usually is the largest N flow in the system, an appropriate calibration of this process is especially important. You should be aware of not introducing errors due to problems in simulating N availability in soil. That problem you intend to solve later. So, in this case, when there are measurement on soil mineral N you should use these values instead of the simulated N, as the source for N uptake. You do this by choosing a new ain_man.par file and the file ain_boun.bin (including the values of NH4 and NO3 for different layers) *("GIVE INPUT, Prep from SubDir, Directory list", choose the directory "..\NNA\A_SITES\SITE_VB\Z_OTHER\BOUNNMIN", "Preparation")* (see further the BOUNDARY-switch).

Suggestion of how to calibrate: The N uptake process could be separated into three different processes that you consider in the following order.
a) The plant growth is one factor that determines the demand for N (i.e. the potential N uptake; see parameter group "Leaf assimilation"). You calibrate this process against measurements on total above ground plant biomass.
b) The actual N uptake is calibrated by adjusting two processes at a time: The second factor determining plant N demand and the availability for nitrogen N. The demand for N is adjusted by changing the maximum N levels of the different tissues (see parameter group "N allocation") and the N availability by changing the fraction of mineral N that can be taken up during one day (see parameter group "N root uptake"). You calibrate these processes against measurements on total above ground plant N.
c) The phenology or/and allocation to grain you calibrate against measurements on grain biomass and N (see parameter groups "Biomass allocation", "N allocation" and "Growstage").
Note, that a), b) and c) are inter dependent and that a correction under b) might cause that you have to modify the calibration under a).
The calibrations you do by making simulation with modified parameter values and compare with measurements *("GIVE INPUT, Normal*, Change man. par, Select file, ain_man.par....,SIMULATE, Normal, SHOW OUTPUT*, Test, Plot5-6..., GIVE INPUT, Normal*,.....and so on).* Note, that a standard preparation of "Management" overwrites the ain_man.par file in which you have introduced the changes.

10) When you are satisfied with the SOILN plant simulation, store the results *("Store files*, Current to store...").*

11) Save the new parameter settings into the soil and plant parameter files. *("GIVE INPUT, Normal*, Change soil par.*, Select file, ain_soil.par...,GIVE INPUT, Normal*, Change plant par.*, Select file, ain_plan.par....").* Note, that a standard preparation of "Soil" overwrites the ain_soil.par file in which you have introduced the changes, and correspondingly for ain_plan.par.

SOILN model (soil):

12) Make boundary file for potential N uptake: When calibrating soil parameters the plant dynamics are fixed to those simulated above, as far as possible. The plant growth and litter fall rates are taken from the last simulation stored above. An input file (ain_boun.bin) with these variables (see Appendix 1) are achieved by choosing: *"GIVE INPUT, Prep from SubDir, Directory list", choose the directory "..\NNA\A_SITES\SITE_VB\Z_OTHER\BOUNPLAN", "Preparation".* (now the files ain_man.par and demopcar.pg has been copied to the "Working directory"), *"SHOW OUTPUT*, Biomass, Others")* (now the ain_boun.bin file has been created).

13) Calibrate the soil processes against measured values on ammonium N and nitrate N by introducing changes in ain_man.par. *("GIVE INPUT, Normal*, Change man. par, Select file, ain_man.par....,SIMULATE, normal, SHOW OUTPUT*, Test, Plot1-3..., GIVE INPUT, Normal*,.....and so on).* Concerning calibration targets see f.i. Eckersten et al. 1998?.

14) When you are satisfied with the SOILN simulation, store the results *("Store files*, Current to store...").*

15) Save the new parameter settings into the soil parameter file. *("GIVE INPUT, Normal*, Change soil par.*, Select file, ain_soil.par...").* Note, that a standard preparation of "Soil" overwrites the ain_soil.par file in which you have introduced the changes.

16) Cancel the boundary option by coping a new ain_man.par file to the working directory. *("GIVE INPUT, Normal*, Management(Management)".*

17) Make a simulation without boundary inputs and compare simulated and measured values, by regression for instance. *("SIMULATE, Normal, SHOW OUTPUT*, Test, Plot1-3 & 5-6).* Probably a slight re-calibration is needed to compensate for interactions between different processes in the model (if so, see f.i. 14) above).

Interactions:

18) Note, there is an inter dependency between 9) and 13) which might require changes of the plant N uptake calibration. You might have to do 9-11) and 13-17) again.

19) When you are satisfied with the SOILN simulation, store the results *("Store files*, Current to store...").*

20) Extract leaf area index and root depth to be used as inputs for a new SOIL simulation *("Link SOIL-...*, ... to SOIL").*

21) Since the leaf area and root depth as simulated by SOILN probably differ from those used in the previous SOIL simulation you might have to do the calibration procedure points 3-4), 8), 9-11) and 13-20) again.

An important part of the calibration is to check the overall performance of the simulation. The SOILN model predicts far more variables than practically can be measured at a site. However, there are often general knowledge about some variables or relation between variables and it could be evaluated whether the predictions are based on unreasonable assumptions or not. To facilitate this evaluation the presentation of different flows and storage in the system have been simplified in the SIMVB program (see Fig. 6).

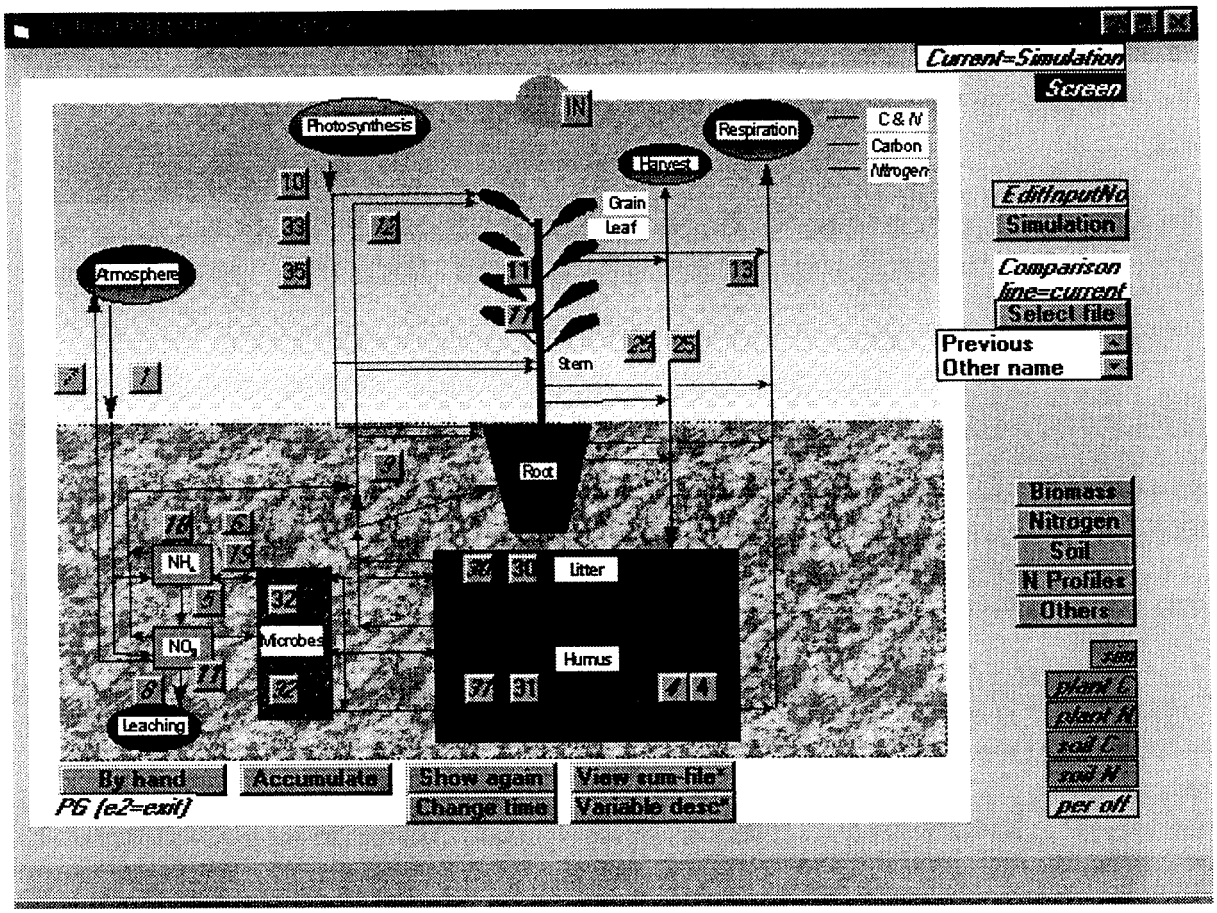

Figure 6. The interface of the SHOW OUTPUT option for the SOILN model in the SIMVB program. In each figure the relevant simulated variables are shown. Bold values means state variables and italics means nitrogen. "*IN*" shows input variables. By pressing "*Select file*" the current simulation can be compared with up to three other simulations. By pressing "*sim*" the parameter descriptions are shown instead of the simulated outputs (figures refer to parameter sections in this issue). In "*Biomass*", "*Nitrogen*" etc further presentations ar available. For options denoted "*Others*" the user can edit PG-instruction files. "*Diff etc*" (not shown) estimate differences between simulations. "*Accumulate*" accumulates the variables in the last presentation. "*Show again*" shows the last presentation again. The "*Screen*" bottom selects between plotting on screen or graphic files. "*View sum-file*" includes an option for exploring differences in parameter values between simulations. "*By hand*" activates the PG-program in an interactive mode. By using "*EditInput*" and "*Simulation*" the whole calibration could be made within the SHOW OUTPUT window.

File description of SIMVB

The description below refers to a *"Standard"* application.

Directory structure

The directory name given when choosing an application should be XXXX in: c:\simvb\XXXX. (c:\simvb\ could be another address, if you specify it under *"DRIVE/DIR?"* just after selected model.)

Under the "Application directory" we find the "WORKING-directory" named ...\XXXX\N. In the "Working-directory" all your preparations and simulation results are stored. It is up to the user to delete files in this directory. Original files can always be recovered from directories below this one. First time you run the program the directory is empty. When you run the program and make preparation, files are copied from the "Store-directories" to the "Working-directory". SIMVB only writes files on this directory (except for comment.txt file under the XXXX-directory). (For the SOIL model the "Working-directory" is named ...\XXXX\S.)

In the "STORE-directories" (...\XXXX\N\NA...) below the "Working-directory", program and data files are stored. Files in this directory as well as below this directory should not be deleted by the user.

First, an initial preparation is made *"GIVE INPUT, Initial preparation"*. This copies files from ...\XXXX\N\NA\START to the "Working directory". These are files related to programs and are in common for all applications.

When making a normal preparation *"GIVE INPUT, Normal*.."* files are copied from the "Store directories" ...\XXXX\N\NA\A_SITES\... These are input files but also validation files for a certain application. Information concerning the application is given in the INFO.LIS file.

PG-instruction files used for presentations etc. 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" to allow the user to make changes in the presentations. They are not overwritten until a new initial preparation is made.

Files

Directory ... \XXXX; "Application directory"

COMMENT LIS	Comments given by the user while running SIMVB.

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

AIN_CLIM BIN	Driving variables
*AIN_CLIM BPR	AIN_CLIM.BIN used in previous run
**AIN_FERT BIN	N input variables
*AIN_FERT BPR	Version of AIN_FERT.BIN used in previous run
**AIN_FERT DAT	N input variables as ASCII
**AIN_FERT DDE	Variable description for AIN_FERT.DAT
AIN_INI INI	Initial values of soil and plant state variables
**AIN_INIP INI	Initial values of plant state variables
AIN_MAN PAR	Management parameters. Parameter Groups and Switches denoted (M) and file specification for files related to management (FILE(9) in SOILN). (Read by PREP as nr 5)
AIN_OUT PAR	Output variables, Parameter Groups and Switches denoted (O), file specifications not related to management and integration and storage interval. Note, that OUTFORN must be ON otherwise none of the PG-instruction files will work in f.i. the "*SHOW OUTPUT*" option. (Read by PREP as nr 3)
AIN_PLAN PAR	Plant parameters. Parameter Groups and Switches denoted (P). (Read by PREP as nr 2)

AIN_SOIL PAR	Soil parameters. All Parameter Groups and Switches denoted (S) or not found elsewhere. (Read by PREP as nr 1)
AIN_SOIP DAT	Soil physical data (from PLOTPF.EXE)
AIN_TIME PAR	Simulation period. (Read by PREP as nr 4)
DEMO_COP BAT	Program file that copies files from different directories to the working directory.
DEMO_VB 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 can be selected *("SHOW OUTPUT*, Biomass, Other")*
**DEMOPCOM PG	PG-instruction file in which variables for comparison can be selected *("SHOW OUTPUT*, Select file, ..., Other")*
**DEMOPNIT PG	PG-instruction file in which variables for plotting can be selected *("SHOW OUTPUT*, Nitrogen, Other")*
*DEMOZVAL BIN	Data of last *"Test"* presentation
INFO LIS	Information about the application loaded on the working directory
**MEAS BIN	Values to be compared with the simulation outputs *("SHOW OUTPUT*, Test...")*
**SOILN FIN	Output state variables (could be used as AIN_INI.INI)
*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

** = Files not always needed

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

Directory ... *\XXXX\N\NA\START\TXT*; "Store directory", documentation files

Directory ... *\XXXX\N\NA\PG*; Directory with PG-instruction files

Directory ... *\XXXX\N\NA\EXCEL*; Directory with EXCEL-instruction files

Directory ... *\XXXX\N\NA\A_SITES\SITE_VB\CLIMATE,* ..*\SOIL,..* etc.; "Store directories", application specific

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