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WIGO model
User's Manual

Input files	Switches	Parameters	Outputs	Execute
	Technical			
	Model specific			

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Institutionen för markvetenskap
Avdelningen för lantbrukets hydroteknik

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Table of Contents

1 Background

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The WIGO model (WIllow GrOwth) considers all biomass and nitrogen flows in a short rotation forest which are of major importance for growth. The time step is one day and simulations can be made over several years and include different types of management (harvest, fertilization, defoliation etc.). Several studies are related to earlier versions of this model (see the section on References). The basic concept of the model has been described by Eckersten & Slapokas (1990).

The aim of this manual is to give a complete technical description of all inputs and outputs of the model so that the model can be used in all its context by the person running the model. The manual is available in the program under the help option. Just press [F1]! The sections om Switches, Parameters and Outputs are placed at the end of the manual because they are so often read. For the theoretical description of the model is referred to Eckersten (1991). The link to that report is through the symbols given in the parameter and variable description. Observe that the units may differ between the manual and the model description.

The source code of the model is written in FORTRAN 77 and the exe-file is created making use of a special program package for creating simulation models on PC (PSIM made by Per-Erik Jansson and Jan Clareus, Uppsala). Multiple runs with the model with different parameter values can be made with the MR-program. The input variables as well as the outputs from the model are aimed to be created and presented and further evaluated using the PGraph-program. This program (or PGDEMO which is free of charge) also enables the conversion between WIGO-GROWTH specific files and ordinary DOS-files with ASCII-format.

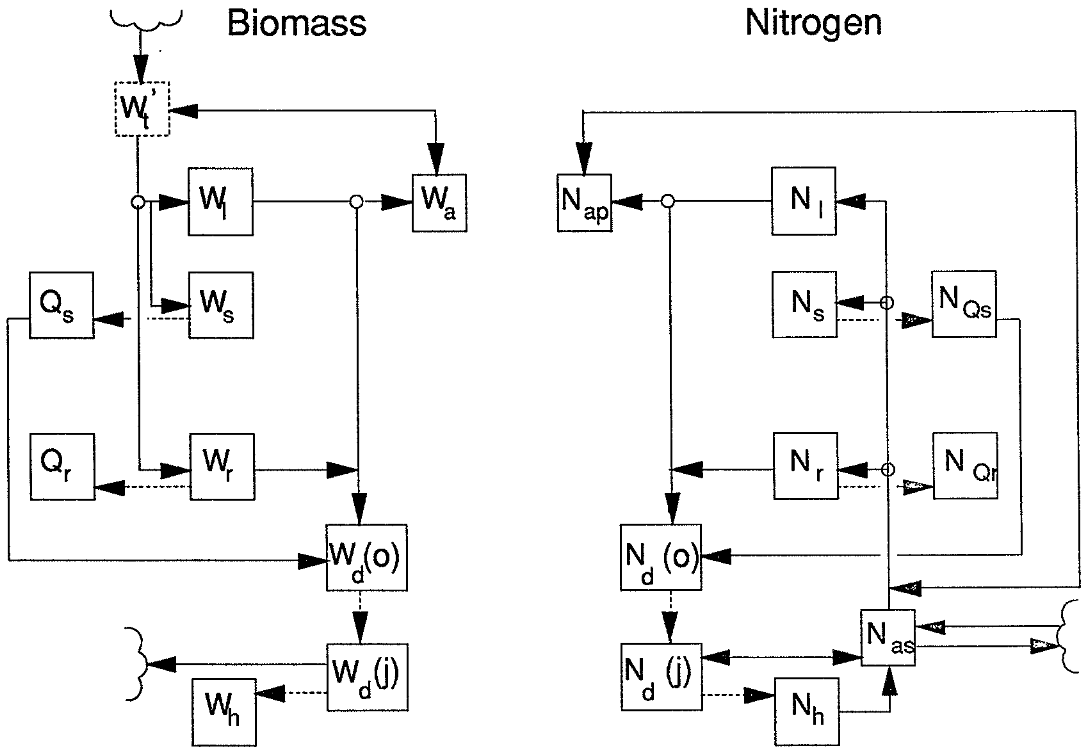

Figure 1: Schematic description of the WIGO model consisting of two "submodels": the production submodel and the nitrogen turnover submodel. W and N are biomass and nitrogen respectively. Indices are as follows: a=available pool; ap= available pool in plant; as= available pool in soil; d=litter; h=humus; l=leaf; r=roots; s=stems; and t=total. j is the age. The prime sign denotes a daily change. Solid lines are daily flows whilst dotted lines are annual flows. All major flows of the model are represented in the graph. Those lacking are maintain respiration, leaching of N from falling leaves and harvest.

2 Getting started

2.1 Installation

The model is normally distributed on a floppy diskette for IBM PC together with a demonstration example (see below). You just put all files in the same directory. However, keep a copy somewhere else.

2.2 Files

If you want to distribute the files among different directories the following is suggested (PATH should be available to directories other than the working (application) directory. Setting this PATH most conveniently is done in the AUTOEXEC.BAT file. See also the special for the WIGO.TRA file):

Directory	Files	Description
GENERAL PROGRAMS	PG.EXE	Executable file, PGraph program. A special version that is freely available is named PGDEMO.EXE
	PREP.EXE	Executable file, PREP program
	PG.HLP	Help file, PGraph program
MODEL PROGRAMS	WIGO.EXE	Executable file, WIGO model
	WIGO.DEF	Definition file
	WIGO.HLP	Help file
	WIGO.TRA	Variable name translation file. Path to this file must be given in the DEMO.PAR file
WORKING	DEMO.BIN	PG-file with input variables for running the model.
	DEMO.PAR	Parameter file for the WIGO model
	DEMO.INI	Initial values of X-variables
	WIGO.GIN	Initial values of G-variables
	WIGO.AUT	Annual outputs of some variables
	WIGO.CIN	Only used for a special option
	WIGO.CUT	Only used for a special option

2.3 Demonstration example

Usually a demonstration example is delivered together with the model. This example draws pictures of selected inputs and outputs of the model and give a short verbal description. Files belonging to this example are named DEMO..., those named WIGO_.... are outputs, those named WIGO... are model general files and those named P.... are general programs. For further information just type:

DEMO info

2.4 Running the model

For running the program interactively use commands as specified in the section on COMMANDS in the manual. An example is as follows:

PREP WIGO FILE1	This means that PREP-program starts the WIGO model making use of the information in the FILE1.PAR-file. In PREP then, you can modify the prerequisites of the simulation (if you want) and then start the simulation.

2.5 Evaluating your simulation

An successful simulation will result in two different output files numbered as NNN. The presentation of data is made by use the PGraph-program: PG WIGO_NNN. This program can convert the results to ASCCII if wanted. For details on how to use Pgraph see the Pgraph manual or use the help utility in the program (F1 key).

WIGO_NNN.SUM	A summary file including a list of output variables are found in the summary file named WIGO_nnn.SUM. The variables to be stored in the output files are selected by the PREP-program.
WIGO_NNN.BIN	A PG-structured file containing all the output variables that were selected in the PREP program.

3 Program structure

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

The different menus can be reached in any order after moving the cursor to the subject using arrow keys and pressing "return" at the chosen subject. "Return" takes the cursor down in the menus and "Esc" moves the cursor up one level. Normally a user will start with the subjects to the left in the main menu and move to the right. It is a good rule to modify the settings of switches and input files before moving to the other menus since the content of the other menus are influenced by the setting of the two first sub menus. The main menu is as follows:

1 FILES
2 SWITCHES
3 PARAMETERS
4 OUTPUTS
5 RUN OPTIONS
6 EXECUTION.

4 Input files

4.1 Driving variable file

XXXX.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. (See parameters in the group Driving variables)

4.2 Parameter file

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

4.3 Translation file

WIGO.TRA: A translation file which must exist if the variables in the output PG-file should get their correct identification. Only if the switch OUTFORN is ON this file is not necessary.

4.4 Initial states file

XXXX.INI: The file contains the initial values of all state variables.

4.5 Final states file

This file contains the final values of all state variables.

4.6 Output file

WIGO_nnn.BIN: PG-structured file with output variables where nnn is the current run number. The file is a binary file to be used by the PGraph program for plotting results from the simulation. The file contains all the outputs selected in the PREP program. In case of having the ADDSIM switch ON you have to specify the name of the output file since the output file will be the same as used by a previous run with the model.

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

4.7 Validation file

A validation file is a file with variables that should be compared with simulated variables. The result of the comparison will be found in the WIGO_NNN.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 wider.

4.8 Other initial files

Here are two other files including initial values Their names are fixed.

WIGO.GIN: The following auxiliary variables should be initialized:
GCOH1W= Dry weight of the youngest litter cohort
GCOH1N= Nitrogen in the youngest litter cohort
GWSL and XWH are not used

WIGO.CIN: If the COMPETITION-swistch is ON the following variables should be initialized: All X-variables (1-GCOX), XNAS, XNA, GCOH1W and GCOH1N (see the section on Output variables)

4.9 General file description

File	Description	Type
Files used for the simulation (xxxx are names given by the user):		
WIGO.exe	Program	
WIGO.tra	Labels of output variables	ASCII
xxxx.BIN	Input variables (data-file) (the DRIVPGRA switch must be ON)	PGRA
xxxx.PAR	Parameter names and values	ASCII
xxxx.XIN	Initial values (<>0) of state variables (the INSTATE switch must be ON)	ASCII
WIGO.GIN	Initial values of some auxiliary variables, The name is fixed.	ASCII
WIGO.AUT	This file has to exist only. Its name is fixed.	ASCII

WIGO.CIN	Initial values of state and some auxiliary variables. One record for each plant. Only used if CSTTRE>0. OBS! This file is overwritten during the simulation and has to be updated before each simulation. Its name is fixed.	ASCII
WIGO.CUT	Has to exist only. Only used if CSTTRE>0. OBS! This file is overwritten during the simulation. Its name is fixed.	ASCII

Output files:

WIGO_nnn.bin	Output variables (data file), nnn is number of run. OBS! If the competition option is used (i.e. CSTTRE>0) the values are means of all plants.	PGRA
WIGO_nnn.sum	A summary of both inputs and outputs	ASCII
WIGO.sta	Information to WIGO about the current run number. Delete this file if you want to restart from run number 1.	
WIGO.AUT	Annual sums of different flow variables	ASCII
WIGO.CIN & WIGO.CUT	These files contain the variables originally given in WIGO.CIN. The values are those of the two last days simulated. Which is the last and which is the next last depends on the number of days simulated. Only used if CSTTRE>0.	ASCII
xxxx.cmd	Instructions to MR-program about multiple runs with different parameter values. Type: mr xxxx.cmd. (not used)	
WIGO.hlp	File containing help information identical to what is written in this paper (not necessary). This file is created in the following way (by the programmer): (i) >ms WIGO_hlp.doc, make a new section for every symbol name (alt-h for every name and alt-g for the first name of each section), (ii) Retrieve help.set, global settings only (alt-j), (iii) Export ASCII-file (help.txt), unfold the document and write a screen image (alt-k), (iv) DOS> mhelp WIGO.txt (=help.txt).	

Files used for running the model and handling output files:

plotc.bat	Compares two simulations by plotting the variables on the same graph (e.g. Type: plotc xx 8 2)	ASCII
plotc_xx.pg	PG-instruction file in which the variables that shall be compared can be chosen.	ASCII

Files used when making name modifications:

For WIGO.PAR-parameters should be given (for programming):

WIGO.DEF:	Numbers, Names, Groups and Values
PVAL.INC:	Numbers
PNAME.INC:	Names
PNAMENOP.INC:	Names
WIGO.DOC:	Names and Description

For X-, T-, G- and D-variables should be given:

PVAL.INC:	Numbers
WIGO.DEF:	Numbers
WIGO.INI:	Initial X-values <>0
WIGO.TRA:	Names and Description
xxxx.BIN:	Variables
WIGO.GIN:	Check
WIGO.AUT:	Check
WIGO.CIN:	Check
WIGO.DOC:	Names, Description and Numbers (D..)

5 Run options

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

5.1 Run no.:

You can restart from run number 1 by deleting the file: WIGO.STA

5.2 Start date:

The simulation period must be specified with a start and a termination date. The dates will be used when reading the driving variable file and when writing output variables to the PGRA-structured result file. The time is fully represented by a string like f.i. 198711031240 but the hour and minutes may be excluded if they are not needed in the simulation.

5.3 Output interval:

The output interval determines how frequent the output variables will be given to the output file. The requested output variable can either be a mean value of the whole time interval or, the actual value at the time of output (see the switches, AVERAGEX, ..T, ..G and ..D). The output interval is given in units of minutes.

5.4 No of iterations:

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

5.5 Run id:

Any string of characters may be specified as 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 stored in the identification field may be overwritten in some cases.

5.6 Comment:

6 Execute

6.1 Exit

The exit command will terminate the interactive session and quit the program without starting a simulation. By creating a parameter file before exit the program the input will be saved.

6.2 Run

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

6.3 Write a parameter file

This will create a new parameter file which includes all the instructions specified. The new parameter file can be used as an input file to the model.

7 Warnings and Errors of parameter values

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 levels of information: Warnings and Errors.

Normally you will be informed about warning or errors after you have modify a parameter value and moved to the new sub-menu. 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 warning or error 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. The list of messages is found in a window under the execute menu.

In case of errors, the model can not run but in case of only warnings you are allowed to run the model.

8 Commands

You start the preparation of a simulation by pressing
PREP WIGO
on the command line of the DOS system. This will be the starting point for adding any type of new instructions for your simulation. Parameter values from the WIGO.PAR-file will be used if the file is present at the current directory. Otherwise the original (default) values of the model will be used (WIGO.DEF).

You can also start the interactive session with default values taken from another parameter file by entering that parameter file name at the command line:
PREP WIGO FILE1
will result in default values from the parameter file FILE1.PAR.

You can run the WIGO 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. Type:

PREP -b WIGO FILE1

This will result in a run with the model that use information from the FILE1.PAR file. If information is missing in the FILE1.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 (WIGO.DEF). There are also a possibility to specify a number of parameter files on the command line:

PREP -b WIGO FILE1 FILE2 FILE3

This means that the PREP program will first read the instructions of FILE1.PAR then of FILE2.PAR and finally of the FILE3.PAR file. The information read last will be used. But remember that the parameter files not necessarily are complete. They can be organized with only information about for instance harvest in the FILE2.PAR file information about run options like time periods in the FILE3.PAR file.

9 Problems

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

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S-750 07 Uppsala
Sweden

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

10 Help

Help is available (almost) everywhere.

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

In help, typing a single "RETURN" takes you one level down. By pressing "ESC" you move up again.

The <END> key brings you back to WIGO.

11 References

Papers and reports published with relevance for the WIGO model and publications referred to in the text.

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12 SWITCHES

The purpose of switches is to chose the simulation mode. Most switches could either be OFF or ON. Others can achieve different values.

12.1 Technical

■ *ADDSIM*

OFF	The simulation results will be stored in a separate result file with a name according to the run number.
ON	The simulation results are automatically added to the result file of a previous simulation, run for an earlier time period. Note that the selected output variables must be exactly the same for the present and the previous simulation. The name of the former result file is given by the user as "output file" name. By default the start date of the present simulation is put identical as 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 the result of a later simulation will be added. No new outpu data file ".BIN" will be created but a separate summary file ".SUM" will be created just like for an ordinary simulation.

■ *AVERAGED*

OFF	the actual value at each time point is stored in the output file.
ON	all requested driving (=D) variables will be mean values representing the whole time period between adjacent time points in the output file. The time period is represented with the date in the middle of each period.

■ *AVERAGEG*

OFF	the actual value at each time point is stored in the output file.
ON	all requested auxiliary (=G) variables will be mean values representing the whole time period between adjacent time points in the output file. The time period is represented with the date in the middle of each period.

■ *AVERAGET*

OFF	the actual value at each time point is stored in the output file.
ON	all requested flow (=T) variables will be mean values representing the whole time period between adjacent time points in the output file. The time period is represented with the date in the middle of each period.

■ *AVERAGEX*

OFF	the actual value at each time point is stored in the output file.
ON	all requested state (=X) variables will be mean values representing the whole time period between adjacent time points in the output file. The time period is represented with the date in the middle of each period.

■ *CHAPAR*

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

■ *DRIVPG*

0	No function
1	Driving variables will be read from a Pgraph file. The name of the file is specified by the user. Model parameters are used to define the arrangement of variables in the file (see the DRIVANA-switch and the variables under the heading DRIVING VARIABLES)

■ *INSTATE*

OFF	initial state variables will be put to zero if not otherwise specified by model parameters.
ON	initial values of state variables will be read from a file. The name of the file is specified by the user, the format should be exactly the same as in the file for final values of state variables, created by the model when the OUTSTATE switch is on.

■ *LISALLV*

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

■ *OUTFORN*

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

■ ***OUTSTATE***

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

■ ***VALIDPG***

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

12.2 Model Specific

SWITCH-TREE

HARVEST	
DRIVRAD	
DRIVANA -------------	ANALEAF
	ANAFERT
	ANAWATERP
	ANAWATERS
	ANATEMPS
SPECIAL -------------	COMPET

■ ***HARVEST***

OFF	No action
ON	It is possible to harvest at a certain day. The daynumber is given by the ZSTHAR parameter (Start group).

■ ***DRIVRAD***

1	The daily radiation driving variable DRAD is: the relative duration of sunshine (D).
2	the duration of sunshine (t_{Sun} (h d^{-1})).
3	the ratio between actual and clear sky global radiation (S_s/S_{Cls}).
4	the actual global radiation (S_s (MJ m^{-2} d^{-1})).
5	the fractional cloudiness during daytime (O_v).

■ *DRIVANA*

OFF	All driving variables are available in the input file.
ON	Some of the driving variables in the input file are not available or wanted to be modified. This option gives access to simple substitution functions of driving variables. OBS! Be careful, this switch does not influence the calculations.

■ *ANAFERT*

OFF	The fertilization rate is a driving variable in the input file.
ON	The fertilization rate equals maximum plant demand in terms of the daily growth.

■ *ANALEAF*

OFF	The areal leaf weight is a driving variable in the input file.
ON	The areal leaf wight (leaf "thickness") can be put constant.

■ *ANAWATERP*

OFF	The plant water factor is a driving variable in the input file.
ON	The plant water factor is equal to one.

■ *ANAWATERS*

OFF	The soil water factor is a driving variable in the input file.
ON	The soil water conditions are optimal (i.e. $v_d = 1$).

■ *ANATEMPS*

OFF	The soil temperature is a driving variable.
ON	The soil temperature given as a driving variable can be multiplied with a function that varies sinusoidally over time and exponentially over depth.

■ *SPECIAL*

OFF	No action.
ON	Special functions are available. OBS! Be careful, this switch does not influence the calculations. The parameters do. This switch also cancels some other switches direct effect on the calculations. These are: ANALEAF, ANAFERT, ANAWATERP and ANAWATERS.

■ *COMPETITION*

OFF	No action.
ON	A special option is activated that simulates the growth of single trees (see parameter CSTTRE). OBS! Be careful, this switch does not influence the calculations. CSTTRE acts as a switch in the calculations (not used)

13 PARAMETERS

General rules for parameter names are as follows:

.ST..	= Start parameter
.S..	= Sensitivity parameter
P..	= Photosynthesis
Z..	= Growth
Q..	= Nitrogen turnover
V..	= Water
C..	= Competition

13.1 Start

These parameters are of special concern prior each simulation. Some special options can be selected using these parameters:

(i) The areal leaf weight ("leaf thickness") can be given as a driving variable or put constant (ZSTBAD and ZSTBAC; see ANALEAF-switch).

(ii) The water response function for growth can be given as a driving variable or estimated by the program (however no function is used in the program so it is put equal to 1) (VSTPLD and VSTPLE; see ANAWATERP-switch).

(iii) The litter pool consists of several litter cohorts. However, initial values are only given for the one year old litter cohort (in the WIGO.GIN-file). The initial values of the older cohorts are calculated assuming decomposition to have been going on for several decomposition periods of length QSTDAY days and with a constant air temperature of 10°C at optimal water conditions.

(iv) Harvest of plant can take place at day ZSTHAR (see HARVEST-switch). If you simulate over several years the program harvest every year at this day. However by using the CHAPAR-switch you can change the value of ZSTHAR to zero after a harvest and then no more harvest will be done. In this way new harvest days can be chosen as well. The degree of harvest can range between 0 and 100%. You can choose the fraction of tissues that are taken out of growth ("destroyed") with ZSTHDL, ZSTHDS and ZSTHDQ. Of this amount a certain fraction can be taken out of the forest (ZSTHHL, ZSTHHS and ZSTHHQ) whereas the rest is incorporated in the litter pool.

(v) A special option named Competition is activated by setting CSTTRE > 0 (see COMPETITION-switch). Then initial values of state variables for each plant should be given in WIGO.CIN. Results of the "mean plant" is found among the normal output variables while the final values of the single plants are found in either WIGO.CIN or WIGO.CUT. The plants can compete for light and nitrogen. Technically this option works by making the "ordinary simulations" several times each day (once for each plant). The input and output of state variables for the single plants are read/write from WIGO.CIN and WIGO.CUT. The light and nitrogen availability is however a function of all the other plants. The "mean plant" is the mean value of each state variable.

[] are values normally used.

Variable	Symbol ; Explanation	(Unit)
PSTRLA	latitude for the radiation data ; Only used when DRIVRAD-switch = 2.	(°)
PSTSLA	latitude for the growth simulation site ; OBS! Latitudes are given in degree units with minutes converted to decimals.	(°)
QSTDAY	t_{Dec} ; Length of decomposition period prior the simulation start. During these earlier decomposition periods is assumed a constant air temperature of 10°C and optimal water conditions.	(d)
QSTTS	t_{Soil} ; Number of days determining the periodicity in the sinusoidal variation of soil temperature over time. T_s=exp(-z/z_d)*[sin(365*(t+t_{Soil})*2π-z/z_d)-sin(365*(t+t_{Soil})*2π)]. Only used if ANATEMPS-switch is ON.	(d)
STTRAC	trace switch [0] ; Switch activating a trace option (=0 implies no tracing)	(-)
VSTPLD	Switch 0 or 1 [0] ; =1 implies that the water response factor for growth is given as a driving variable (DVP). OBS! Then VSTPLE should be 0.	(-)
VSTPLE	V_p/V_p(estimated) [1] ; The relative change of the water response function estimated by the program (however equal to one at present). OBS! Then VSTPLD should be 0.	(-)
VSTSOD	Switch 0 or 1 [0] ; =1 implies that the water response factor for decomposition is given as a driving variable (DVS). OBS! Then VSTSOE should be 0.	(-)
VSTSOE	V_s/V_s(estimated) [1] ; The relative change of the soil water response function estimated by the program (however equal to one at present). OBS! Then VSTSOD should be 0.	(-)
ZSTBAC	b_A [x] ; =x implies that the areal leaf weight is constant equal to x during the season. OBS! Then ZSTBAD should be 0. ANALEAF-switch must be ON.	(gDW m^{-2})
ZSTBAD	Switch 0 or 1 [0] ; =1 implies that the areal leaf weight is given as a driving variable (DBA). OBS! Then ZSTBAC should be 0. ANALEAF-switch must be ON.	(-)
ZSTHAR	t_h [0] ; Day-number for harvest counted from Jan 1; =0 --> no harvest. HARVEST-switch must be ON.	(d)
ZSTHDL	d_l [0.999] ; Fraction of the leaf biomass that is destroyed. OBS! Must be <1. HARVEST-switch must be ON.	(-)
ZSTHDQ	d_Q [0.999] ; Fraction of the old stem biomass that is destroyed. If you are giving the fraction a negative value the old root biomass is destroyed in the same proportion as the stem. HARVEST-switch must be ON.	(-)
ZSTHDS	d_s [0.999] ; Fraction of the stem biomass of the current year that is destroyed. If you are giving the fraction a negative value the old root biomass is destroyed in the same proportion as the stem. OBS! Must be >-1 and <1. HARVEST-switch must be ON.	(-)
ZSTHHL	h_l [0] ; Fraction of the destroyed leaf biomass that is harvested (the rest goes to litter). HARVEST-switch must be ON.	(-)

ZSTHHQ	h_Q [1] ; Fraction of the destroyed old stem biomass that is harvested (the rest goes to litter). HARVEST-switch must be ON.	(-)
ZSTHHS	h_s [1] ; Fraction of the destroyed young stem biomass that is harvested (the rest goes to litter). HARVEST-switch must be ON.	(-)
	********* Competition ***********	(-)
CSTI	A_{li}(min) [2] ; Minimum value of the leaf area index of the largest plant (A_{li}(l)(max)) before competition for light starts. High value --> No competition for light.	(-)
CSTSW	Switch-setter [0] ; This parameter is used for, choosing between two simulations: (a): 0=simulation from start (b): 1= sim. starts within veg.per. and sw2=2. "Add"-simulations are made as follows: (i) WIGO.CIN should be the latest of WIGO.CIN and WIGO.CUT and the previous simulation (ii) In WIGO.INI, X1 should be the mean of XWR in WIGO.CIN and X9 should be the mean of XNA of the single plants. (iii) Start the simulation the day before the last day of the previous sim. (iv) CSTTRE should be >=1	(-)
CSTTRE	l_{Max} [0] ; Number of plants that wants to be used in the simulation. The WIGO.CIN file should contain at least l_{Max} records with initial values. =0 implies that the competition option is not active. Should be $\leq$ 10.	(number)

13.2 Photosynthesis

Parameters used for the calculation of daily canopy photosynthesis.

PCLOU1	a in: $D=a+bO_v$; see PCLOU2 below	(-)
PCLOU2	b in: $D=a+bO_v$; Coefficients for determining the radiation factor (D is the relative duration of sunshine) as function of the fractional cloudiness (O_v)). (only used if DRIVRAD-switch = 5)	(-)
PGH	g_h ; Daily time fraction for which suntrack is not obscured by horizon. Only used if DRIVRAD-switch = 2	(-)
PGI	g_I ; PAR-quanta incident above canopy devided by the corresponding global radiation (=Icl/Scl)	(μE J^{-1})
PGO	g_o ; PAR-quanta incident above canopy during an overcast day devided by the corresponding value for clear sky conditions (=Iov/Icl)	(-)
PGS	g_s ; Parameter related to air turbidity. Used for calculating global radiation	(-)
PK0	a in: $k=a+b*A_i+c*A_i^2$, see PK2 below	(-)
PK1	b in: $k=a+b*A_i+c*A_i^2$, see PK2 below	(-)

PK2	c in: $k=a+b*A_i+c*A_i^2$	(-)
	Coefficients for estimating the light extinction coefficient (k) as a function of the accumulated leaf area index from the canopy top (A_i).	
PM0	a in: $M=a+b*t_{Sun}+c*t_{Sun}^2$, see PM2 below	(-)
PM1	b in: $M=a+b*t_{Sun}+c*t_{Sun}^2$, see PM2 below	(-)
PM2	c in: $M=a+b*t_{Sun}+c*t_{Sun}^2$	(-)
	Actual photosynthesis as a function (M) of photosynthesis at overcast and clear sky conditions. t_{Sun} is the relative duration of bright sunshine.	
PPI	p_I ; Parameter for the photosynthetic light response (equal to the light (PAR) that gives $P=P_m/2$)	($\mu E\ m^{-2}\ s^{-1}$)
PPM0	p_1 in: $P_m=p_1+p_2n_l$, see PPM1 below	($mgCO_2\ gDW^{-1}\ h^{-1}$)
PPM1	p_2 in: $P_m=p_1+p_2n_l$	($mgCO_2\ gDW^{-1}\ h^{-1}$)
	Photosynthesis per unit leaf weight at optimal light (PAR), temperature and water conditions as a function of leaf nitrogen concentration (n_l)	
ZDALI	δ_A ; A_{li} of internal canopy layers used for calculating the light (PAR) interception.	(-)
ZID	I_d ; Light (PAR) level below which leaf-shedding starts.	($\mu E\ m^{-2}\ s^{-1}$)
ZRG	r_g ; Fractional respiration of total daily growth (W_t').	(-)

13.3 C_allocation

Parameters related to the allocation of biomass within the plant and litter fall.

QMR	m_r ; Mortality of roots as a fraction of the daily root growth.	()
QMS	m_s ; Daily relative mortality rate for stems older than one year.	(d^{-1})
ZBI0	b_{io} ; The leaf area to shoot biomass ratio at unity shoot biomass.	($ha\ ton^{-1}$)
ZBI1	b_{i1} ; Parameter related to the decrease in the leaf area to shoot biomass ratio as the shoot biomass increases.	($ha\ ton^{-1}$)
ZBR0	b_{ro} ; Minimum fraction of the total daily growth that is allocated to roots.	(-)
ZDWAX	δW_{aMax} ; Maximum daily release rate of assimilates in the available pool.	($kgDW\ ha^{-1}\ d^{-1}$)
ZKM0	k_{mo} ; Coefficient for the leaf abscission function (m_A)	(-)
ZKM1	k_{m1} ; Coefficient for the leaf abscission function (m_A)	(d^{-1})
ZTDA	d_a ; Length of the day (after midsummer) when leaf abscission starts.	(h)
ZWAI	w_{ai} ; Fraction of the daily growth allocated to the plant available assimilates.	(-)
ZWSL	w_{as} ; Stem biomass for which δW_{aMax} is doubled.	($kgDW\ ha^{-1}$)

13.4 N_allocation

Parameters related to the allocation of nitrogen within the plant.

QNLO	n_{lOpt} ; Optimum canopy nitrogen concentration (for allocation of biomass to roots)	(%gN gDW^{-1})
QNLX	n_{lMax} ; Maximum leaf nitrogen concentration (for N uptake)	(%gN gDW^{-1})
QNRX	n_{rMax} ; Maximum root nitrogen concentration	(%gN gDW^{-1})
QNSX	n_{sMax} ; Maximum stem nitrogen concentration	(%gN gDW^{-1})

13.5 N_availability

Parameters related to the easily available pools of nitrogen both in plant and in soil.

QAD	a_d ; Fractional loss of the nitrogen supplied through fertilizers (N_f').	(-)
QALD	a_{ld} ; Daily fractional loss of nitrogen in the available pool in the soil (N_{as}).	(d^{-1})
QAW	a_w ; Fractional withdrawal of nitrogen in leaves before abscission.	(-)
QBW	b_w ; Fractional withdrawal of dry weight in leaves before abscission (OBS! Must be greater than 0).	(-)
QUPMA1	c_{u1} ; Fraction of soil mineral nitrogen (N_{as}) possible to take up per day as proportional to the root growth (W_r').	($kgDW^{-1}$)
QUPMA2	c_{u2} ; Fraction of soil mineral nitrogen (N_{as}) possible to take up per day as proportional to root biomass of the current year (W_r).	($kgDW^{-1}$ d^{-1})
QUPMA3	c_{u3} ; Fraction of soil mineral nitrogen (N_{as}) possible to take up per day as proportional to root biomass older one year (Q_r).	($kgDW^{-1}$ d^{-1})
QUPMAX	c_{uMax} ; Maximum fraction of the soil mineral nitrogen (N_{as}) possible to be taken up by plant each day. If c_u calculated with QUPMA1-3 <=0, then c_u=QUPMAX.	(d^{-1})

13.6 Decomposition

Parameters used for calculating the decomposition and mineralisation rates from litter and humus.

QALPHA	α ; Coefficient that relates the microbial growth rate and humus mineralisation to soil temperature	($°C^{-1}$)
QBETA	β ; Coefficient that relates microbial growth rate to the litter age.	(-)
QCL	c_l ; The carbon to dry weight ratio in the litter.	(gC gDW^{-1})
QCM	c_m ; The carbon to dry weight ratio in the microbial biomass	(gC gDW^{-1})
QDX	z_d ; The relaxation depth for soil temperature. Only used if ANATEMPS-switch is ON (see parameter QSTTS).	(m)
QE0	e_o ; The microbial efficiency (production/assimilation)	(-)
QKH	k_h ; Daily relative decrease of humus nitrogen.	(d^{-1})
QNDMIN	; Minimum annual mineralization from a litter cohort before it is transferred to the humus compartment.	(kgN ha^{-1} y^{-1})
QNLFL	a_{ln} ; Fraction of nitrogen that is leached from the falling leaves before they enter the litter pool.	(-)
QNM	n_m ; Nitrogen concentration in microbial biomass	(gN gDW^{-1})

QU0	$u_o(1)$; Microbial growth rate of the youngest litter cohort (1-year old) at temperature equal to 10°C and at optimal water conditions.	(d^{-1})
QWLFL	a_l ; Fraction of the dry weight in the leaf fall that is leached before entering the litter pool.	(-)
QZX	z ; Depth of litter cohort. Only used if ANATEMPS-switch is ON (see parameter QSTTS).	(m)

13.7 Temperature_etc

These parameters are related to temperature response, areal leaf weight ("leaf thickness") and respiration.

PT1	T_1 ; Lower temperature limit for growth (see T_f)	(°C)
PT2	T_2 ; Lower temperature limit for optimal growth (see T_f)	(°C)
PT3	T_3 ; Upper temperature limit for optimal growth (see T_f)	(°C)
ZBAX	b_{Ax} ; Maximum areal leaf weight	(gDW m^{-2})
ZBAY	a in: $b_A=b_{Ao}(1+a*shootage)$; Annual relative increase of the areal leaf weight (both if it is given as a driving variable or if it is assumed to be constant (see ZSTBAD and ZSTBAC)).	(-)
ZDAYE	t_e ; Day number at the end of seasonal growth (<365)	(d)
ZDAYTA	t_{Acc} ; Day number at which the calculation of T_{aAcc} starts	(d)
ZRM	r_m ; Daily fractional maintain respiration of root and stem biomass of all ages.	(d^{-1})
ZTAACC	T_5 ; Minimum value of the temperature sum (T_{aAcc}) at which growth starts.	(d °C)

13.8 Water

Parameters related to water response functions for growth and decomposition.

VSOIL1	a_v ; see VSOIL4 below	(-)
VSOIL2	b_v ; see VSOIL4 below	(-)
VSOIL3	c_v ; see VSOIL4 below	(-)
VSOIL4	d_v ;	(-)

a_v, b_v, c_v, d_v are coefficients for calculating the water reduction factor for decomposition as function of the soil water factor ($0 < v_s < 1$):
$v_d = (v_s - a_v)/(b_v - a_v)$; if $v_s < c_v$
$v_d = 1 - (v_s - c_v)/(d_v - c_v)$; if $v_s > c_v$
$0 < v_d < 1$

13.9 Sensitivity

These parameters are used for sensitivity tests and to select some special options. The value for no test is given in brackets []. The subscript ($_o$) denotes the original value.
Where both the relative and the absolute value are possible to change a constant value of the variable concerned can be chosen by setting the relative change to 0.

The special options that can be chosen are as follows:

(i) The N-fertilization rate can be given as a driving variable or taken proportional to the demand by the plant (QSNF, QSNDEM and QSNA).

(ii) The supply of nitrogen to leaves at growth start can be set optimal or taken as a function of the available nitrogen in the soil (QSNLT0).

[] are values normally used.

PSSBD	t_{Sun}-t_{Suno} [0] ; absolute change of sunshine factor	(-)
PSSBR	t_{Sun}/t_{Suno} [1] ; relative change of sunshine factor	(-)
PSTFD	T_f-T_{fo} [0] ; absolute change of temp. function	(-)
PSTFR	T_f/T_{fo} [1] ; relative change of temp. function	(-)
QSBRD	b_r-b_{ro} [0] ; absolute change of root allocation	(-)
QSBRR	b_r/b_{ro} [1] ; relative change of root allocation	(-)
QSNA	N_{aDem} [100] ; The N-fertilization corresponding to the demand by the plant which equals the deficit in the available pool from a certain value (N_{aDem}) that is enough to meet the maximum daily plant demand. Only used if QSNDEM>0. (QSNA works on N_a). OBS! This value is inversely related to c_u (see QUPMAX).	(kgN ha^{-1})
QSNDEM	[0] ; QSNDEM= 1 and QSNF= 0 implies that N_f' is taken equal to the demand by the plant. 0< QSNDEM <1 implies that N_f' is a certain fraction of the demand.	(-)
QSNF	N_f'/N_{fo}' [1] ; relative change of N-fertilization ; QSNF= 1 and QSNDEM= 0 implies that N_f' is given as a driving variable (N_f'=DNF)	(-)
QSNLD	n_l-n_{lo} [0] ; absolute change of leaf N-conc.	(-)
QSNLDE	N_{lDem}'/N_{lDemo}' [1] ; relative change in the demand of N by leaves.	(-)
QSNLR	n_l/n_{lo} [1] ; relative change of leaf N-conc.	(-)
QSNLT0	switch for supply of leaf nitrogen at start [0] ; Determines wether the leaves are supplied by optimal nitrogen content at start of growth (=0 --> $N_l(t_o)=n_{lMax}W_l(t_o)$) or by the nitrogen available in the pool (=1 --> $N_l(t_o)=(N_{lo}$ MIN $N_a)$)	(-)
QSUD	u-u_o [0] ; absolute change in microbial growth rate	(d^{-1})
QSUR	u/u_o [1] ; relative change in microbial growth rate	(-)
ZSALIR	A_{li}'/A_{lio}' [1] ; relative change of leaf area growth	(-)
ZSWLR	W_l'/W_{lo}' [1] ; relative change of leaf growth	(-)

13.10 Plotting_on_line

Variables can be plotted on screen during the simulation by selecting appropriate values of STXTGD and STPMAX. This option consume some time and can be put off by setting STXTGD=0.

STPMAX	plot maximum [1000] ; The expected maximum value among the variables selected by STXTGD.	(differs)
STXTGD	variables plotted on screen [4000] ; Numbers of output variables to be presented on the screen during the simulation (e.g. 4200 means 4 X-, 2 T-, zero G- and zero D variables). =0 implies no plotting.	(numbers)

14 OUTPUTS

The output variables are divided into four categories:
states (=X), flows (=T), auxiliaries (=G) and drivings (=D).
The variables are distributed among the groups not strictly following the meaning of the group name. Some state and flow variables are found among auxiliaries, however named in the proper way. The flow variables are the net flows into the corresponding state variables.

General rules for names of variables are as follows (however not strictly followed):

X.. = State
T.. = Flow
D.. = Driving
G.. = Auxiliary variable used in more than one subroutine
(GC.. sometime means compet. var.)

All units expressed per unit area refers to the ground surface. Note that units of output variables sometimes are multiples of the basic SI-system.

14.1 State variables

Variable	Symbol ; Explanation	(Unit)
XALI	A_{li} ; Leaf area per unit of ground surface (leaf area index)	($m^2\ m^{-2}$)
XNA	N_a ; Sum of N in the plant assimilate pool and the soil mineral pool.	(kgN ha^{-1})
XND0	$N_d(o)$; N in the input litter cohort	(kgN ha^{-1})
XNH	N_h ; N in the humus compartment	(kgN ha^{-1})
XNL	N_l ; N in leaves	(kgN ha^{-1})
XNQR	N_{Qr} ; N in roots older than one year	(kgN ha^{-1})
XNQS	N_{Qs} ; N in stems older than one year	(kgN ha^{-1})
XNR	N_r ; N in roots younger than one year	(kgN ha^{-1})
XNS	N_s ; N in stem younger than one year	(kgN ha^{-1})
XQR	Q ; Accumulated root growth since planting (or harvest) except the growth of the current year	(kgDW ha^{-1})
XQS	Q_s ; Accumulated stem growth since planting (or harvest), except the growth of the current year	(kgDW ha^{-1})
XWA	W_a ; Assimilates in plant available for flushing	(kgDW ha^{-1})
XWD0	$W_d(o)$; Dry weight of input litter cohort	(kgDW ha^{-1})
XWL	W_l ; Accumulated leaf growth of the current year	(kgDW ha^{-1})
XWLF	W_{lf} ; Accumulated leaf fall of the current year	(kgDW ha^{-1})
XWR	W_r ; Accumulated root growth of the current year	(kgDW ha^{-1})
XWS	W_s ; Accumulated stem growth of the current year	(kgDW ha^{-1})
XWSH	W_{sh} ; Accumulated shoot growth of the current year	(kgDW ha^{-1})

14.2 Flow variables

Variable	Symbol ; Explanation	Unit
TALI	A_{li}' ; Leaf area index	(m^2 m^{-2} d^{-1})
TNA	N_a' ; Sum of N in the plant assimilate pool and the soil mineral pool.	(kgN ha^{-1} d^{-1})
TND0	N_d(o)' ; N in the input litter cohort	(kgN ha^{-1} d^{-1})
TNH	N_h' ; N in the humus compartment	(kgN ha^{-1} d^{-1})
TNL	N_l' ; N in leaves	(kgN ha^{-1} d^{-1})
TNQR	N_{Qr}' ; N in roots older than one year	(kgN ha^{-1} y^{-1})
TNQS	N_{Qs}' ; N in stems older than one year	(kgN ha^{-1} y^{-1})
TNR	N_r' ; N in roots	(kgN ha^{-1} d^{-1})
TNS	N_s' ; N in stem	(kgN ha^{-1} d^{-1})
TQR	Q_r' ; Accumulated root growth since planting (or harvest) except the growth of the current year	(kgDW ha^{-1} y^{-1})
TQS	Q_s' ; Accumulated stem growth since planting (or harvest), except the growth of the current year	(kgDW ha^{-1} y^{-1})
TWA	W_a' ; Assimilates in plant available for flushing	(kgDW ha^{-1} d^{-1})
TWD0	W_d(o)' ; Dry weight of input litter cohort	(kgDW ha^{-1} d^{-1})
TWL	W_l' ; Accumulated leaf growth of the current year	(kgDW ha^{-1} d^{-1})
TWLF	W_{lf}' ; Accumulated leaf fall of the current year	(kgDW ha^{-1} d^{-1})
TWR	W_r' ; Accumulated root growth of the current year	(kgDW ha^{-1} d^{-1})
TWS	W_s' ; Accumulated stem growth of the current year	(kgDW ha^{-1} d^{-1})
TWSH	W_{sh}' ; Accumulated shoot growth of the current year	(kgDW ha^{-1} d^{-1})

14.3 Auxiliary variables

Variable	Symbol ; Explanation	(Unit)
	******* Nitrogen turnover ********	
GCOCOH	j ; Number of decomposing litter cohorts (only for information)	(number)
GCOH1N	$N_d(1)$; Nitrogen in decomposition cohort nr:1	(kgN ha^{-1})
GCOH2N	$N_d(2)$; Nitrogen in the second youngest decomposition cohort	(kgN ha^{-1})
GCOH1W	$W_d(1)$; Dry weight of decomposition cohort nr:1	(kgDW ha^{-1})
GDAYI	t ; Day-number (1-366)	(d)
GND1UT	$N_d(1)$'(ut) ; Daily N-mineralisation from the youngest litter cohort	(kgN ha^{-1} d^{-1})
GND2UT	$N_d(2)$'(ut) ; Daily N-mineralisation from the second youngest decomposition cohort	(kgN ha^{-1} d^{-1})

GNDEMA	N_{fDem}' ; About equal to the fertilization need to meet the maximum plant N-demand.	(kgN ha^{-1} d^{-1})
GNDT	$\Sigma(N_d(j))$; Total nitrogen in all decomposition cohorts	(kgN ha^{-1})
GNDTUT	$\Sigma(N_d(j)'(ut))$; Total daily N-mineralisation from all litter cohorts	(kgN ha^{-1} d^{-1})
GNHAR	N_h ; Shoot-nitrogen harvested (only for information)	(kgN ha^{-1})
GNL	n_l ; Leaf N-concentration	(%gN gDW^{-1})
GNLFL	N_{lfl} ; Nitrogen leached from the falling leaves	(kgN ha^{-1})
GNLIN	N_l'(in) ; Nitrogen uptake to leaf growth.	(kgN ha^{-1} d^{-1})
GNR	n_r ; Root N-concentration	(%gN gDW^{-1})
GNRIN	N_r'(in) ; Nitrogen uptake to root growth.	(kgN ha^{-1} d^{-1})
GNS	n_s ; Stem N-concentration	(%gN gDW^{-1})
GNSIN	N_s'(in) ; Nitrogen uptake to stem growth.	(kgN ha^{-1} d^{-1})
YNDEM	N_{Dem}' ; Total nitrogen demand by plant	(kgN ha^{-1} d^{-1})
YNLEACH	N_{Leach}'+N_{Den}' ; Nitrogen lost from the soil mineral pool through leaching and denitrification (also a fraction of the fertilizer-N could is included if QAD>0)	(kgN ha^{-1} d^{-1})
YNLUT	N_l'(ut) ; Nitrogen lost from plant through leaf litter	(kgN ha^{-1} d^{-1})
YNRUT	N_r'(ut) ; Nitrogen lost from plant through root litter	(kgN ha^{-1} d^{-1})
YQUPMA	c_u ; Fraction of soil mineral nitrogen that can be taken up each day.	(d^{-1})
	******** Growth *********	(-)
GALIIN	A_{li}'(in) ; Daily increase of leaf area index	(d^{-1})
GALIUI	A_{li}'(I) ; Daily leaf fall due to self shedding	(d^{-1})
GALIUT	A_{li}'(ut): Daily leaf fall	(d^{-1})
GBA	b_A ; Areal leaf weight (=W_l/A_{li})	(gDW m^{-2})
GBI	b_i ; Leaf area to shoot biomass ratio (=A_{li}/W_{sh}) (only for information).	(ha $kgDW^{-1}$)
GBR	b_r ; Root allocation function (=W_r'/W_t') (0-1)	(-)
GPCL	P_{dCl}/v_p ; Gross canopy photosynthesis at optimal temperature and water conditions for clear day	(kgDW ha^{-1} d^{-1})
GPN	$P_d(1-r_g)/v_p$; Daily net canopy photosynthesis at optimal temperature and water conditions	(kgDW ha^{-1} d^{-1})
GPOV	P_{dOv}/v_p ; Gross canopy photosynthesis at optimal temperature and water conditions for overcast day	(kgDW ha^{-1} d^{-1})
GPP	P_d/v_p ; Daily gross canopy photosynthesis at optimal temperature and water conditions	(kgDW ha^{-1} d^{-1})
GTF	T_f ; Temperature function for growth	(-)
GWHAR	W_h ; Shoot-biomass harvested (only for information)	(kgDW ha^{-1})
GWRIN	W_r'(in) ; Daily gross root growth	(kgDW ha^{-1} d^{-1})
GWRUT	W_r'(ut) ; Daily death of roots	(kgDW ha^{-1} d^{-1})

GWSUT	Q_s'(ut) ; Daily death of stems older than one year	($kgDW\ ha^{-1}\ d^{-1}$)
GWT	W_t' ; Total daily growth.	($kgDW\ ha^{-1}\ d^{-1}$)
	*********** Other X-variables **************	(-)
XNAP	N_{ap} ; N in the plant assimilate pool	($kgN\ ha^{-1}$)
XNAS	N_{as} ; Soil mineral N in the whole profile	($kgN\ ha^{-1}$)
XWH	W_h ; Dry weight of the humus compartment (Only for information)	($kgDW\ ha^{-1}$)

14.4 Driving variables

Driving variables should be given at time 00:00 in the input file. No missing data are allowed. The variables should be given in the same order in the input file as in the D-array (see Number below).

Variable	Symbol ; Explanation	(Unit) Number
DRAD	;Radiation factor that can be (see switch DRIVRAD): (i) t_D ; Relative daily duration of sunshine (-). (ii) t_{Sun} ; Duration of sunshine ($h\ d^{-1}$). (iii) ; Ratio between daily values of actual and clear sky global radiation (-). (iv) S_s ; Daily sums of global radiation (300-3000nm) ($MJ\ m^{-2}\ d^{-1}$). (v) O_v ; Mean daytime fraction of cloudiness (-)	(differs) 1
DTA	T_a ; Daily mean air temperature.	(°C) 2
DTS	T_s ; Daily mean soil temperature.	(°C) 3
DVP	v_p ; Plant water factor (0-1) regulating growth. (Actual to potential transpiration ratio).	(-) 4
DVS	v_s ; Soil water factor (0-1) regulating decomposition. (Relative water content)	(-) 5
DNF	N_f' ; Nitrogen fertilization rate (should include atmospheric deposition if any) (OBS! You should set: QSNF=1 and QSNDEM=0)	($kgN\ ha^{-1}\ d^{-1}$) 6
DBA	b_A ; Areal leaf weight (= leaf biomass to leaf area ratio) (OBS! You should set: ZSTBAD=1 and ZSTBAC=0)	($gDW\ m^{-2}$) 7

14.5 Annual sums

In a special output file named WIGO.AUT the annual sums (in case of flow variables) of some variables (mainly those not available in the T-array) are presented in ASCII form. For the explanation of variable names are referred to the other symbol descriptions. (in) and (ut) denote input and output, respectively. The variables are given in the following order in WIGO.AUT:

W_t'(in)	($tonDW\ ha^{-1}\ y^{-1}$)
W_{sh}'(in) & W_{sh}'(ut)	($tonDW\ ha^{-1}\ y^{-1}$)
W_r'(in) & W_r'(ut)	($tonDW\ ha^{-1}\ y^{-1}$)
W_d'(0)(in)	($tonDW\ ha^{-1}\ y^{-1}$)
W_a	($tonDW\ ha^{-1}$)

******* Line break *******

N_l'(in) & N_l'(ut)		($kgN\ ha^{-1}\ y^{-1}$)
N_s'(in)		($kgN\ ha^{-1}\ y^{-1}$)
N_r'(in) & N_r'(ut)		($kgN\ ha^{-1}\ y^{-1}$)
	******* Line break *******	
$N_d(0)$'(in)		($kgN\ ha^{-1}\ y^{-1}$)
$\Sigma N_d(j)$'(ut)	Sum of all age-classes (j)	($kgN\ ha^{-1}\ y^{-1}$)
N_h'(in) & N_h'(ut)		($kgN\ ha^{-1}\ y^{-1}$)
N_f'(in)		($kgN\ ha^{-1}\ y^{-1}$)
N_{ap}'(in) & N_{ap}'(ut)		($kgN\ ha^{-1}\ y^{-1}$)
N_{ap}		($kgN\ ha^{-1}$)
N_{as}		($kgN\ ha^{-1}$)
	******* Line break *******	
N_{lfl}'(in)		($kgN\ ha^{-1}\ y^{-1}$)
W_h'(in)		($kgDW\ ha^{-1}$)
$\Sigma N_d(j)$	Sum of all age classes (j)	($kgN\ ha^{-1}$)
$\Sigma W_d(j)$	Sum of all age classes (j)	($kgDW\ ha^{-1}$)

14.6 Other variables calculated

Here are presented some variables that are calculated by the program, however not available as output. They could easily be put among the output variables by replacing some of the old ones. This should be done in the DYNAMIC.FOR file (the EQUIVALENCE statements) and the WIGO.DEF file and then making the corresponding changes in the WIGO.TRA file. (Henrik.for has to be recompiled as well, however not changed)

Variable	Symbol ; Explanation	Unit
GCOX	; Total number of X-variables	(number)
GDAYH	t+h/24 ; Day-number with hourly resolution	(d)
GDAYIA	t_a ; Day-number at start of leaf abscission	(d)
GDAYL	DAYL ; Daylength	(h)
GDEC	DEC ; Sun-declination	(rad)
GPN1	P ; Photosynthesis including the water factor	($kgDW\ ha^{-1}\ d^{-1}$)
GRAD	DRAD ; The radiation input variable (see DRAD)	($h\ d^{-1}$)
GS0	S_o ; total radiation above the atmosphere	($J\ m^{-2}\ s^{-1}$)
GSW2	sw2 ; Switch that is: -1=Ali<0 and t>midsummer ; 0=winter per.; 1 =first day of veg.per. ; 2=veg. per.	(-)
GTAX	DTA ; Air temperature driving variable.	(°C)
GYEARS	Shoot-age	(y)
	******* Nitrogen turnover ******	
GCOCOX	; Maximum numbers of decomposition cohorts	(number)
GCOH(i)	$W_d(j)$; Dry weight of litter cohorts (i=odd values). ; $N_d(j)$; Nitrogen of litter cohorts (i=even values). Index= 1-(GCOCOX+1)	($kgDW\ ha^{-1}$) ($kgN\ ha^{-1}$)
GNAL	N_{al} ; N in N_a that is left for leaves	($kgN\ ha^{-1}$)
GNAPIN	N_{ap}'(in) ; N input to the plant N-pool	($kgN\ ha^{-1}$)

GNAPUT	N_{ap}'(ut) ; N in the plant-pool used for growth	(kgN ha^{-1})
GNDXUT	N_d(YQCOC)'(ut) ; Daily N-mineralisation from the oldest litter cohort	(kgN ha^{-1} d^{-1})
GNHUT	N_h'(ut) ; Daily N-mineralisation from humus	(kgN ha^{-1} d^{-1})
GSW3	sw3 ; Switch that equals zero at the first time step	(-)
GWDT	$\Sigma(W_d(j))$; Total dry weight in all decomposition cohorts	(kgDW ha^{-1})
	******** Growth **********	
GALIUA	A_{li}'(a) ; Daily leaf fall due to winter abscission	(d^{-1})
GALIUS	A_{li}'(ut)(t-1) ; Daily leaf fall of the previous day.	(d^{-1})
GANN(i)	; i=1-GCOANN; Annual sums of daily flows. Printed in WIGO.AUT	(....y^{-1})
GBRN	b_r ; Root allocation as a function of n_l (0-1)	(-)
GCOANN	Number of variables for annual output (OBS! Related to 2010 FORMAT)	(number)
GML	m_A ; Function for daily leaf fall caused by entering winter	(d^{-1})
GTAACC	T_{aAcc} ; accumulated sum of air temperature>0 from day t_{Acc} (=ZDAYTA)	(d °C)
GWSL	$W_s(t_v)$; Stem biomass of the previous year after an eventual harvest	(kgDW ha^{-1})
	******** Competition *********	
GCALI	A_{li}(mean) ; Leaf area index as a mean for all plants	(-)
GCALI1(i)	; The incoming A_{li} values of the single plants that the program reads every day.	(-)
GCALI2(i)	; The outgoing A_{li} values of each days calculations	(-)
GCAMAX	A_{li}(l)(max) ; Maximum leaf area index among all plants	(-)
GCCOT	Plant-number ; (1-CSTTRE)	(number)
GCMAX	W_s(l)(max) ; Maximum stem biomass among all plants	(kgDW ha^{-1})
GCMIN	W_s(l)(min) ; Minimum stem biomass among all plants	(kgDW ha^{-1})
GCNAS	N_{as}(mean) ; The available N-pool as a mean for all plants	(kgN ha^{-1})
GCSW6	sw6 ; Switch: =0 implies 63 is read file and 64 is write file; =1 implies the opposite	
GCTRE	Max number of plants (=10)	(number)
GCWR	W_r(mean plant) ; Root biomass as a mean for all plants.	(kgDW ha^{-1})
GCXMV(i)	MEAN PLANT ; Defined as the mean values of the X-variables (and N_{as}) for single plants. OBS! Initial values should be given in WIGO.INI. Index= 1-(GCOX+1)	(see X-var.)

15 News

Important changes in new versions will be mentioned here.

Förteckning över utgivna häften i publikationsserien fr o m 1989

SVERIGES LANTBRUKSUNIVERSITET, UPPSALA. INSTITUTIONEN FÖR MARKVETENSKAP. AVDELNINGEN FÖR LANTBRUKETS HYDROTEKNIK. AVDELNINGSMEDDELANDE.

89:1 Linnér, H., Persson, R., Berglund, K. & Karlsson, S.-E. Resultat av 1988 års fältförsök avseende detaljavvattning, markvård och markförbättring samt bevattning.

89:2 Persson, L. & Jernlås, R. Apparat för kolonnexperiment under omättade förhållanden. Manuskript.

89:3 Berglund, K. Ytsänkning på mosstorvjord. Sammanställning av material från Lidhult, Jönköpings län. 18 s.

89:4 Messing, I. Saturated hydraulic conductivity as related to macroporosity in clay soils. 21 s.

89:5 Karlsson, I. M. Markbyggnad för bostads- och rekreationsområden. Prioritering av forskningsinsatser. 17 s.

89:6 Håkansson, A. Filtermaterial för dränering. Kommentarer till en serie demonstrationsprover av grus- och sågspånsmaterial. 11 s.

89:7 Persson, R. & Wredin, A. (red.). Vattningsbehov och näringstillförsel. Föredrag presenterade vid NJF-seminarium nr 151, Landskrona 1-3 aug 1989. 275 s.

89:8 Nitare, M. Rotutveckling i majs. Examensarbete i hydroteknik. 39 s.

89:9 Sandsborg, J. & Bjerketorp, A. Kompendium i elementär hydromekanik. 8: Hydraulisk likformighet samt dimensionsanalys. 30 s.

89:10 Karlsson, I. M. Effekten av jordkonditioneringsmedlet ammonium-lauretsulfat på den hydrauliska konduktiviteten i vattenmättat tillstånd i två svenska lerjordar. 16 s.

90:1 Linnér, H., Persson, R., Berglund, K. & Karlsson, S.-E. Resultat av 1989 års fältförsök avseende detaljavvattning, markvård och markförbättring samt bevattning. 73 s.

90:2 Jansson, P.-E. (ed.). The Skogaby Project. Project description. 77 s.

90:3 Berglund, K., Lindberg, K. & Peltomaa, R. Alternativa dräneringsmetoder på jordar med låg genomsläpplighet. 1. Ett nordiskt samarbetsprojekt inom Nordkalottområdet. 20 s.

91:1 Linnér, H., Persson, R., Berglund, K. & Karlsson, S.-E. Resultat av 1990 års fältförsök avseende detaljavvattning, markvård och markförbättring samt bevattning. Manuskript.

91:2 Persson, R. & Wesström, I. Markkemiska effekter av bevattning med Östersjövatten på Öland. 23 s + 5 bil.

91:3 Eckersten, H. WIGO model. User's manual. 30 s.