HYPE file reference

This part of the HYPE documentation is a reference guide to all mandatory and optional HYPE files. HYPE works with plain text files for model setup, data input/output, and calibration.

The tables in the following sections contain file names and short descriptions of mandatory and optional input and output files for HYPE, grouped by content type. More detailed descriptions on file content, format and requirements are found in the section of each file.

Input files marked *mandatory* in the tables below must exist for a basic HYPE setup. Other files are required only for optional model components, e.g. glaciers, or for specific model tasks, e.g. parameter calibration.

As a shortcut, here are three links to frequently used references when running an existing HYPE setup:

- **info.txt**, which is the main instruction file of HYPE where all options are specified for a model simulation
- **par.txt**, which holds the values of model parameters
- **HYPE variables**, a list of variable names used for HYPE inputs and outputs

Setup files

Setup files contain information about a HYPE model domain, model parameters, model options (model choice and simulation settings).

File name	Requirement	Description
filedir.txt	optional	provides location of info.txt
info.txt	mandatory	model options and simulation settings
pmsf.txt	optional	partial model setup, defines part of model domain to simulate
update.txt	optional	for updating of model variables with observations
GeoClass.txt	mandatory	SLC class definition (HRUs)
GeoData.txt	mandatory	subcatchment characteristics and flow connections between them
BranchData.txt	optional	bifurcations in the flow network
LakeData.txt	optional	properties of specific lakes (including regulated dams)
DamData.txt	optional	properties of specific regulated lakes, extends LakeData.txt
CropData.txt	optional	information about crops and vegetation
PointSourceData.txt	optional	information about point sources and water abstraction
PSMonthlySeries.txt	optional	information about time-varying monthly point sources and water abstractions (in development, not released yet)
MgmtData.txt	optional	information about irrigation and water transfer
AquiferData.txt	optional	information about regional aquifers
FloodData.txt	optional	information about floodplain
GlacierData.txt	optional	information about glaciers

File name	Requirement	Description
par.txt	mandatory	model parameters, some is calibrated
state_save	optional	files containing saved model states for model initialisation
reg_par.txt	optional	file containing regional regression coefficients, for parameter regionalization method
CatchDes.txt	optional	list of catchment descriptors, for parameter regionalization method
CatchGroup.txt	optional	list of catchment group membership of all subbasins, for parameter regionalization method
Outregions.txt	optional	information about output regions
ForcKey.txt	optional	link list between subcatchment IDs and forcing data IDs, as well as temperature observation elevations
LeakageData.txt	optional	soil leakage concentrations to replace runoff concentrations

Observation data files

Observation data files are HYPE input files which contain time series, both forcing data and evaluation data.

All HYPE variable IDs are described in the **complete HYPE variable list**, while HYPE variable IDs useable in Xobs.txt are also described in the Xobs.txt section.

File name	Requirement	Description
Pobs.txt	mandatory	precipitation forcing (HYPE variable ID: prec)
Tobs.txt	mandatory	air temperature forcing (HYPE variable ID: temp)
Qobs.txt	optional	discharge observations (HYPE variable ID: rout)
Xobs.txt	optional	observations of evaluation variables for subbasins, e.g. nutrient concentrations, lake water stage
Xoregobs.txt	optional	observations of evaluation variables for output regions, e.g. snow
RHobs.txt	optional	relative humidity forcing
SFobs.txt	optional	snowfall fraction of precipitation forcing
SWobs.txt	optional	shortwave radiation forcing
TMINobs.txt	optional	daily minimum air temperature forcing
TMAXobs.txt	optional	daily maximum air temperature forcing
Uobs.txt	optional	wind speed forcing
XobsXOMn.txt	optional	observations of evaluation variables, one per file (HYPE variable ID: xom0-xom9)
XobsXOSn.txt	optional	observations of evaluation variables, one per file (HYPE variable ID: xos0-xos9)

Output files

Output files contain model results. This includes time series of simulations and observations (for each time step or averaged/summed over a longer period) as well as model performance results.

All HYPE variable IDs used in HYPE output files are described in the **complete HYPE variable list**.

File name	Requirement	Description
hyss_seqnr_yymmdd_HHMM.log	automatic	log file, created for each model run
tests_seqnr_yymmdd_HHMM.log	automatic	log file, created for model tests
XXXXXXX.txt	optional	basin output file, several output variables for one subbasin (subid=XXXXXXX)
XXXXXXX.txt (regional)	optional	region output file, several output variables for one output region (outregid=XXXXXXX)
timeXXXX.txt	optional	time output file, output of single variable (HYPE variable ID=XXXX) for all subbasins
mapXXXX.txt	optional	map output file, output of single variable (HYPE variable ID=XXXX) for all subbasins, formatted for GIS
XXXXXXX.txt or timeXXXX.txt (class)	optional	class output files, several output variables for a single subbasin or output of single variable for all subbasins, both file variants for a single class or class group
subassX.txt	optional	subbasin assessment, performance criteria for subbasins
simass.txt	optional	simulation assessment, summarising performance criteria over model domain
yyyy_ss.txt	optional	result files with annual nutrient transports per subbasin and source
Wbf_xxx.txt	optional	water balance: flows per subbasin and day
Wbff_xxx.txt	optional	water balance: floodplain related flows per subbasin and day
Wbfs_xxx.txt	optional	water balance: irrigation flows per subbasin and day
Wbs_xxx.txt	optional	water balance: storage per subbasin and day
state_saveyyyymmdd[HHMM]	optional	files containing saved model states for model initialisation

Calibration files

Calibration files are files related to the parameter calibration model option in HYPE, both for setup and results. Additional calibration information is given in info.txt where the objective function for the optimization (see performance criteria) is set and calibration turned on.

All HYPE variable IDs used in HYPE calibration files are described in the **complete HYPE variable list**.

File name	Requirement	Description
optpar.txt	optional (mandatory for calibration)	calibration simulation settings including parameter ranges
qNstartpar.txt	optional	starting values for parameter optimization using quasiNewton methods (including Brent)
respar.txt	optional	optimal parameter values of calibration
bestsims.txt	optional	best performance criteria and parameter values of calibration
allsim.txt	optional	performance results (criteria and parameter values) of all runs during calibration

File name	Requirement	Description
calibration.log	automatic	calibration log file

Water balance files

A set of output files giving subbasin water balance. The water balance is calculated for each time step and subbasin, and one file holds one flow or store.

File prefix	Type	Unit	Description
WBs	store	m^3	water volume in each store for each time step for all subbasins or for selected subbasins (irrigation, floodplains) or for aquifers
WBf	flow	$m^3\ ts^{-1}$	horizontal flows between subbasins and regional groundwater flows
WBf	flow	$m^3\ ts^{-1}$	vertical or horizontal flows within subbasin
WBfs/WBf	flow	$m^3\ ts^{-1}$	water management flows; irrigation (WBfs) for selected subbasins, water transfer flow (WBf) and point sources (WBf) for all subbasins
WBff	flow	$m^3\ ts^{-1}$	floodplain related flows

A description of these will come (HYPE water balance).

filedir.txt

If HYPE is run without argument, the program tries to find a file filedir.txt in the starting folder and read the path to info.txt there. It is possible to give the path as the only content of filedir.txt (and without the flag). Alternatively the arguments are given in filedir in the same way as on the command line:

HYPE takes two arguments: The search path to the folder where the info.txt file is stored which has to be given, and a sequence number which is optional.

flag	argument
-infodir *or* -i	path
-sequence *or* -s	seqnr

The path can either be given as an absolute address or relative from the folder in which the program is started. The path may have a maximum of 200 characters and need surrounding apostrophes 'path' if blanks are included in the path. The search path should end with a slash. The sequence number is an integer between 0 and 999. The sequence number determines which forcing files to use. Seqnr 0 uses forcing files without sequence number.

Example of a filedir.txt file content:

```
'D:\modelsetups\model1\'
```

Example of a filedir.txt file in Linux (to run files in the same folder as the program):

```
./
```

info.txt

General

The *info.txt* file contain model options and simulation settings. The purpose of the file is to govern the simulation. It works as the user interface for a HYPE model run. The basic format in the info file is simply a row-wise code-argument(s) combination:

```
!! <comment>
<code 1.1> [<code 1.2>] <argument 1> [<argument 2>] ... [<argument n>]
<code 2.1> [<code 2.2>] <argument 1> [<argument 2>] ... [<argument m>]
...
```

Comment rows can be added anywhere and are marked with double exclamation marks, i.e. !!, or '!!' followed by a space. For other rows, the first (and sometimes second) code string decides what information is to be read. The code can be written within or without apostrophes ('...'). Most codes are optional and can be omitted if not required in a model run. Codes are not case sensitive, except for directory paths given after codes *modeldir*, *forcingdir* and *resultdir*, and time steps given after code *steplength*. Date-times are always specified as the beginning of the timestep. Maximum 18000 characters can be read on a single line.

A typical info file contains four groups of code-argument combinations:

1. Model options, e.g. specification of time stepping, choice of optional modules, etc.
2. Output options, i.e. type of result files and output variable specification
3. Performance criteria options, i.e. specification of objective functions and criteria computation
4. Updating options, specification of optional updating of subcatchment output variables with measurements

Conventionally, info files are sorted according to this order. The following tables describe all possible codes, grouped in the above order.

In order to write output files of results for other than daily time steps or the whole simulation period, `bdate`, `cdate`, and `edate` must agree with the period chosen for output, e.g. for monthly output, *cdate* should be the first day of a calendar month and *edate* the last day of a month. This is true also for shorter time steps, e.g. `edate` should be the last timestep of the date ending the period.

Mandatory codes denoted in bold face.

Code	Argument	Description
modeldir	*directory path*	Gives the search path to all model input files, with exception of forcing data and initial state if `forcingdir` is set. Default is the same folder as info.txt. Relative path starts from the info-file folder.
forcingdir	*directory path*	Gives the search path to forcing files (Pobs, Qobs etc. and ForcKey) and initial state file. Default is `modeldir`. Relative path starts from the info-file folder.

Code	Argument	Description
resultdir	*directory path*	Gives the search path to the result files (except for hyss.log which is written in the folder of [info.txt](). The folder must exist. Default is same folder as [info.txt](). Relative path starts from the info-file folder.
bdate	*date-time*	Gives the start date for simulation. Format: yyyy-mm-dd [HH:MM].
cdate	*date-time*	Gives the start date for the output of results and calculations of criteria. Format: yyyy-mm-dd [HH:MM]. Defaults to `bdate`.
edate	*date-time*	Gives the last date for the simulation (including this date). Format: yyyy-mm-dd [HH:MM].
steplength	*string*	defines the length of the time step used in calculations. It consists of an integer followed directly by d, h or min. For example a daily time step is defined as *1d*, while a time step of six hours is defined as *6h*. The code has so far been tested with step lengths *1h*, *6h* and *1d*. Default is 1d. Time steps of a simulation with shorter time step than a day use hour and minute to denote their time. The hour is between 00 and 23. The date-time is the beginning of the time step. For example with 12h time step is the 2 times during a 1 January denoted 2010-01-01 00:00 and 2010-01-01 12:00.
instate	*Y/N*	defines whether a starting state is to be read. *Y* for yes, *N* for no. Default is *N*. For yes, the file with a previously saved model state must exist (state_saveyyyymmdd[HHMM].txt) date in file name must be the same as `bdate`.
outstatedate	*date-time*	defines that a starting state will be output for the given date. The date should be in the format yyyy-mm-dd [HH:MM]. The default is that no output state is written. Maximum 10 dates may be given. The dates may be written on same or different rows. In the latter case, the code first on every row. The starting state is saved in file state_saveyyyymmdd[HHMM].txt.
outstatedate all		defines that a starting state will be output for every timestep of the model simulation. Default is that no output state is written. The starting states are saved in files state_saveyyyymmdd[HHMM].txt.
outstatedate period	*date-time date-time*	defines that starting state will be output for all time steps within the period between the given dates. The dates should be in the format yyyy-mm-dd [HH:MM]. Default is that no output state is written. The starting states are saved in files state_saveyyyymmdd[HHMM].txt.
substance	*string*	gives the substances to be simulated. One or several of: *N P C S T1 T2*. N - nitrogen, P - phosphorus, C - organic carbon, S - total suspended sediment, T1 - tracer, and T2 - water temperature. Substances may be defined on one or several rows (with the code preceding the substance on each row) with one or several substances per row (separated by space). The default is to simulate no substances, only water.

Code	Argument	Description
calibration	*Y/N*	defines whether or not automatic calibration is to be done. *Y* for calibration. Default is *N*. Calibration method and parameters are defined in file [optpar.txt](). Note that reading of initial state does not work with automatic calibration of parameters rivvel and damp, or with the `soilstretch` functionality.
regestimate	*Y/N*	defines if regional estimated parameters calculated by regression is used. This option requires the files [reg_par.txt](), [CatchDes.txt]() and [CatchGroup.txt](). *Y* for yes or *N* for no. Default is *N*.
readformat	*0/1*	handles several different formats of input data. The default (0) is ASCII-files with dates in the format yyyy-mm-dd and normal months. '1' is ASCII-files with date in MATLAB format
writeformat	*0/1*	Set to 1 to write output in a format suitable for MATLAB (i.e. date without '-', '%' in front of the column headings). Default is 0.
readoutregion	*Y/N*	defines if [Outregions.txt]() is present and should be used. Give Y to use the file, or N (default).
resseqnr	*Y/N*	determines if result files have the sequence number as a suffix to their name, if HYPE is run with flag '-sequence', see [How to run HYPE](). Default is yes. Give No to remove the number from result file names.
readdaily	*Y/N*	defines if time series input data should be read every day. The default is to read all data at the beginning of the simulation (*N*). However, for large input data files, memory limitations can preclude this. Set to 'Y' to read input data every day instead.
readobsid	*Y/N*	defines if columns pobsid/tobsid/etc. in [ForcKey.txt]() will be used. Give *Y* to use the columns if they exist (default), or *N* to force the use of subid as connection between forcing data columns and and GeoData.
readsfobs	*Y/N*	defines if [SFobs.txt]() with observed snowfall fractions is present and should be used. Give *Y* to use the file, or *N* (default).
readswobs	*Y/N*	defines if [SWobs.txt]() with observed shortwave radiation is present and should be used. Give *Y* to use the file, or *N* (default).
readuobs	*Y/N*	defines if [Uobs.txt]() with observed wind speeds is present and should be used. Give *Y* to use the file, or *N* (default). Replaces `readwind`.
readrhobs	*Y/N*	defines if [RHobs.txt]() with observed relative humidity is present and should be used. Give *Y* to use the file, or *N* (default). Replaces `readhumid`.
readtminobs	*Y/N*	defines if [TMINobs.txt]() with observed min air temperatures are present and should be used. Give *Y* to use the file, or *N* (default). Replaces `readtminmaxobs`.
readtmaxobs	*Y/N*	defines if [TMAXobs.txt]() with observed max air temperatures are present and should be used. Give *Y* to use the file, or *N* (default). Replaces `readtminmaxobs`.

Code	Argument	Description
readxomsfiles	*Y/N*	defines if files XobsXOMn.txt and XobsXOSn.txt are present and should be used (n=0-9). Files hold observations of optional, not predefined variables, XOSn are summed over time in output files while XOMn are averaged. Give *Y* to use the file, or *N* (default).
submodel	*Y/N*	defines if only a part of the model domain is to be simulated. Give *Y* for yes or *N* for no. Default is *N*. The submodel is then defined in the file pmsf.txt.
irrrunlimited	*Y/N*	defines if irrigation withdrawals should be taken from within the model domain (*N*, default) or from an unlimited outside source (*Y*). For further irrigation details, see MgmtData.txt
soiliniwet	*Y/N*	initiates soil water to porosity instead of field capacity which is default (*N*). Set *Y* to use porosity.
soilstretch	*Y/N*	define if parameter *soilcorr* shall be used to stretch the soil depths given by GeoClass.txt.
modeloption	*processmodel #*	takes two arguments and defines if an alternative processmodel should be used. Default is 0, alternative processmodels correspond to higher integers. For available processmodels, see below.
indatacheckonoff	*0-3*	defines if setup- and observation files as well as hydrological processes and model options will be checked for formal errors prior to running the model. Default is to not perform any checks (0). 1) Tests will be performed and the simulation will be aborted if errors are found. 2) Tests will be performed and the simulation will be continued regardless if errors are found. 3) Tests will be performed and simulation will be aborted regardless if errors are found or not.
indatachecklevel	*0-2*	Printout level for verification and validation checks: 0) only passed/failed, 1) also show which tests were performed, 2) also show parameters/inputs
usestop84	*Y/N*	flag to use the old return code 84 for a successful run

Model options

The following process models are available as modeloptions. The second code and argument are given after the `modeloption` code word.

Code 2	Argument	Description
deepground	*0/1/2*	defines which model to use for regional groundwater flow and aquifers. Default is none (0), alternative is a regional groundwater flow model without dedicated aquifer volumes (subsurface transfer between subcatchments) (1) and an aquifer model with dedicated regional aquifer volumes (2) (requires aquifer definition in input file AquiferData.txt).
floodmodel	*0/1/2/3*	defines which model to use for floodplains. Default is none (0), alternatives are a simple model (1) and a model with soilroutines (2). A fourth option (3) is to use the model with soil routines and connecting floodplains. All requires floodplain information in input file FloodData.txt).

Code 2	Argument	Description
growthstartmodel	0/1	defines if temperature varying start of the growth season should be used. Default is 0, then CropData.txt constant parameter bd2 is used. The alternative is 1, i.e. to used varying growth season start. Then the season start is calculated based on degreedays (equation defined by parameters in CropData.txt).
lakeriverice	0/1/2	defines if ice on lakes and rivers should be simulated. Default is no (0), while a positive number means yes. The alternative models are (1) with temperature transfer between air and water and (2) with water surface heat balance. The ice calculations require that *substance* T2 (water temperature) is simulated.
petmodel	0/1/2/3/4/5	defines if an alternative potential evapotranspiration model should be used. Default is temperature dependence or use of observations (0), alternatives are temperature dependent (1), modified Jensen-Haise/McGuinness (2), modified Hargreaves-Samani (3), Priestly-Taylor (4), and FAO Penman-Monteith reference crop evapotranspiration (5).
snowdensity	0/1	defines which snowdensity model to use. Default is snow age dependent snowdensity (0), and alternative is snow compactation snow density model (1).
snowevaporation	0/1	defines if evaporation (sublimation) from snow and glaciers should be calculated. Default is off (0), and alternative is on (1). Snow and glacier evaporation is governed by the general parameters 'fepotsnow', 'fepotglac', and 'fsceff' in par.txt.
snowfallmodel	0/1	defines if an alternative snowfall model should be used. Default is threshold temperature (0), alternative is snowfall fraction from SFobs.txt (1).
snowmeltmodel	0/2	defines which snowmelt model should be used. Default is temperature index (0), the alternative is temperature and radiation index (2). Previous option (1) temperature index with snowcover scaling is no longer used. Snowcover scaling of melt and evaporation is controlled by parameter 'fsceff', see section par.txt.
swtemperature	0/1	defines if T2 temperature should be used for WQ-processes in surface waters. Default is not (0), alternative is (1). The calculations require that *substance* T2 is simulated.
glacierini	0/1	defines if initialization from SLC+parameters overrides saved state of glacier volume (1). Default is to use saved state (0).
infiltration	0/1/2/3	defines which infiltration model should be used. Default is the basic infiltration model of HYPE. For infiltration model 1 infiltration is limited by frozen soils. Infiltration model 2 is an alternative model where infiltration and percolation is added after runoff and evaporation is calculated. Model 3 is a combination of model 2 and 1.
erosionmodel	0/1	defines which soil erosion model to be used for simulation of suspended sediments. Default (0) is similar to erosion of PP (uses CropData), alternative (1) is based on HBV-sed.
wetlandmodel	0/1/2	defines if wetland model is to be simulated. Default (0) is no wetland model, (1) is river wetland nutrient model, (2) wetlands as classes with water regulation capabilities.
soilleakage	0/1	defines if soil leakage concentrations is to be calculated or read from file. Default (0) is calculation, (1) is reading monthly values for each subbasin.

Output options

HYPE offers three principal output types for standard model runs, as well as two variants, all of which are formatted text files with tabular content which is controlled with code combinations in info.txt. Additional output are two types of files which are activated by single codes:

- **basin outputs**, which return multiple variables for a single subcatchment in one file XXXXXXX.txt per subcatchment, where 'XXXXXXX' is the ID of the subcatchment, a number with maximum 7 digits (filled with leading zeros in case of shorter ID, e.g. *0001234.txt*).
- **region outputs**, similar to basin outputs (return multiple variables for a single region in one file) XXXXXXX.txt, where 'XXXXXXX' is the ID of the output region (must not overlap subids).
- **time outputs**, which return single variables for all sub-catchments in one file timeXXXX.txt per variable, where 'XXXX' is the four-letter variable ID, e.g. *timeCOUT.txt*.
- **map outputs**, which also return single variables for all sub-catchments in one file, mapXXXX.txt per variable, similar to time outputs but transposed, which makes it easier to connect the results to sub-catchment maps/GIS layers.
- **class outout**, which return multiple variables for a single subcatchment in one file or single variables for all sub-catchments in one file. The class output are thus similar to basin- and timeoutput, but the variables are for a specified group of classes. The file names has an extra suffix with the classgroup name.
- **annual loads** of nitrogen and phosphorus
- **water balances** of subbasin water stores for each time step

The principal outputs are specified with two codes in *info.txt*, first code giving the output type and second specifying content options. After the codes follow the arguments. Content option codes are identical for all basic output types. All outputs are technically optional.

It is possible to get output for several different aggregation periods for the same type of output (basin- , region- or time-output) by specifying several groups of the same type of output with a ordinal number between **Code 1** and **Code 2**. See example below the table. The files will then have a suffix to their name to separate them, e.g. *timeCRUN_DD.txt*. If only one non-numbered group is used no meanperiod suffix will be added to the file(s). The number between **Code 1** and **Code 2** is also used to hold together classoutput information for different variables/groups/meanperiods.

Code 1	Code 2	Argument	Description
basinoutput mapoutput timeoutput regionoutput classoutput	variable	ID string(s)	defines variables to be written. Multiple variables are separated by blanks or tabs. The order of the variables defines the order in basin output files. For time output files and map output files the order is irrelevant (one file per variable returned). Both internal and output variables are available, see Complete list of variables. One or several rows may be given.
basinoutput mapoutput timeoutput regionoutput classoutput	meanperiod	0/1/2/3/4/5	is given to define the period to which results are aggregated for the output. The period is given using codes, e.g. 1 for daily (see table below). The type of aggregation depends on variable and chosen period: Fluxes are given as sums, storages and states as averages, and concentrations as flow-weighted averages. It is documented in the list of variables in column 'Agg.'.

Code 1	Code 2	Argument	Description
`basinoutput` `mapoutput` `timeoutput` `regionoutput` `classoutput`	`signfigures`	*integer*	defines the number of significant figures written in the outputs. Allowed values 2-10. Default is to use a fixed number of decimals. If set, significant figures and mathematical format are used (e.g 9.5451E-03) instead. **Note:** *signfigures* applies to all output variables within one output type. **Note:** *signfigures* less than 4 will round missing value to -1E4.
`basinoutput` `mapoutput` `timeoutput` `regionoutput` `classoutput`	`decimals`	*integer*	defines a fixed number of decimals written in the outputs, alternative to *signfigures*. Maximum allowed number of decimals is 9. Consider using *signfigures* instead, which is more flexible. **Note:** *decimals* applies to all output variables within one output type. Output variables which contain small numbers and ones which contain large numbers can be impossible to combine in a single `basinoutput` combination, because a small number *variable* can require such a large number of *decimals* to give meaningful precision that the total number of digits of the large number variable exceeds HYPE's maximum output width, resulting in the printing of '****************' strings. A typical example is a combination of substance loads (kg/year) and discharge (m^3/s).
`basinoutput` `classoutput`	`allbasin`	*NONE*	defines that output is to be written for all subbasins. No further arguments.
`basinoutput` `classoutput`	`subbasin`	*integer*	defines one or several SUBIDs (subcatchment IDs) for which output is to be written. One or several rows may be given.
`regionoutput`	`outregion`	*integer*	defines one or several OUTREGIDs for which output is to be written. One or several rows may be given. If no row with outregions is defined all outregions will be written.
`classoutput`	`group`	*name string(s)*	defines which class groups are to be printed for this output. Leave out if default class groups are used.
`classoutput`	`definegroup`	*name string, integer(s)*	defines which slc-classes are included in the classgroup with this name. The name may be up to 6 letters.
`classoutput`	`definegroup`	*allclass*	define default groups should be used for all classoutput. This means one class per classgroup.
`printload`		*Y/N*	defines if output of annual loads is to be written. *Y* for load output. Default is *N*.
`printwaterbal`		*Y/N*	defines if output of daily (time steply) water balance is to be written. *Y* for yes or *N* for no. Default is *N*.

Aggregation period codes

Aggregation period codes (used for `meanperiod`) and corresponding file name suffix. Simulation period (5) aggregates are means of annual aggregates.

Code	Suffix	Description
0	TS / HR / DD	*The code give timesteply output, the suffix varies depending on time step length*
1	DD	*daily*
2	WK	*weekly*
3	MO	*monthly*
4	YR	*yearly*
5	SP	*simulation period*
	TS	*timesteply*
	HR	*hourly*

The following example snippet gives daily discharge simulated and observed for two subbasins in the files 0000025.txt and 0000073.txt. It gives monthly time series of precipitation, evaporation, local runoff and discharge and daily time series of runoff. The additional file, in this case for daily runoff, is called *timeCRUN_DD.txt*, while the runoff file from the first group is called *timeCRUN_MO.txt*:

```
basinoutput variable cout rout
basinoutput meanperiod 1
basinoutput subbasins 25 73
timeoutput 1 variable prec evap crun cout
timeoutput 1 meanperiod 3
timeoutput 1 decimals 3
timeoutput 2 variable crun
timeoutput 2 meanperiod 1
timeoutput 2 decimals 1
```

Performance criteria options

HYPE can calculate several performance criteria over the model domain. HYPE allows to set several criteria which evaluate the whole model domain, e.g. an average Nash-Sutcliffe efficiency over all stations. If several of these domain-wide criteria are set in the performance criteria options they will be added, optionally with weights, to give an overall performance measure. This measure will be used as objective function in the calibration routines. Performance measure and domain-wide criteria are written to output file simass.txt. Users can also access all criteria values for each subbasin (observation site at catchment outlet) seperately in output file subassX.txt. Criteria are calculated for all subbasins where observation data are available. Criteria are always based on the model evaluation period as defined with codes `cdate` and `edate`, see Model options.

Performance criteria are specified in *info.txt* with code `crit` or `crit n`, followed by a second code. n is used to number individual domain-wide performance criteria which are combined to the overall performance measure as described above. Up to 20 criteria are allowed, a complete list of available criteria is available as are equation definitions. Calibration routines require further settings in additional input files, see Calibration files.

For the calculation of criterion for lake water stage, the combination of variables `wcom` and `wstr` are exchanged for the internal variables `clwc` and `clws` by the program. These variables are the water stages cleaned from `w0ref` reference level ($clwc=$ `wcom-w0ref`, $clws=$`wstr-w0ref`). This makes the criterion calculation more accurate, but note that relative criteria, e.g. relative bias, are now relative to the smaller cleaned water stage level.

Code_1	Code 2	Argument	Description
crit	meanperiod	*1/2/3/4*	defines the period over which the data will be accumulated (i.e. no weighting on volume for concentrations) before calculating the performance criterion, i.e. criterion will be calculated from daily, weekly, monthly or annual values. 1-daily, 2-weekly, 3-monthly, 4-annually. Default is daily.
crit	datalimit	*integer*	defines smallest amount of observations required for the performance criteria to be calculated. Default is 3.
crit	subbasin	*integer(s)*	defines one or several SUBIDs which subbasins should be included in criteria calculations (optional). If not set all are used. One or several rows may be given.
crit n	criterion	*ID string*	a performance criterion to be calculated. See List of available performance criteria.
crit n	cvariable	*ID string*	simulated variable to calculate criterion with. See List of output variables.
crit n	rvariable	*ID string*	observed variable to calculate criterion with. See List of output variables.
crit n	weight	*numeric*	weighting factor for the criteria if a combined criterion is to be calculated (should be a positive number)
crit n	parameter	*numeric*	parameter value used for RA-criteria coefficient value. See coefficient a in RA equation definition.
crit n	conditional	*numeric*	parameter value. Only used for DEMC-calibration. The parameter value is the threshold for the criterion.
crit n	cgroup	*name*	name of the classgroup for which the simulated variable to calculate criterion with is to be taken. Note observed variables can not be specified on classgroup level. Suitable variable can be defined as e.g. xom1.

The following example snippet combines a median Kling-Gupta performance measure for daily discharges and a mean relative bias for daily total nitrogen concentration observations at stations where at least 50 observations are available during the model period:

```
crit    meanperiod 1
crit    datalimit  50
crit 1 criterion  MKG
crit 1 cvariable  cout
crit 1 rvariable  rout
crit 1 weight     0.5
crit 2 criterion  MRE
crit 2 cvariable  cctn
crit 2 rvariable  retn
crit 2 weight     0.5
```

Updating options

HYPE allows updating of simulated discharge and lake water level with observations during model run as well as updating of nitrogen and phosphorus concentrations using correction factors in individual subbasins. Discharge can be updated directly by discharge observations, by previously saved errors of simulated discharge, or previously saved errors of simulated lake water level. An auto-regressive

(AR) model is used to model the errors for the last two methods. Lake water level can be updated by water level observations, or by previously saved errors of simulated lake water level.

The updating methods are described in detail in the tutorial. Some updating routines require further settings in additional input file update.txt.

Code 1	Code 2	Argument	Description
update	quseobs	*none/keyword*	updating of Q. Thereafter may follow one of the two keywords: 'allstation' for updating using all Q-stations in Qobs.txt or 'nostation' for no updating. If no keyword is given stations given in file update.txt is updated.
update	qar	*none/keyword*	AR updating of Q on days without observed Q. Uses the switch(1/0) on column 'qarupd' in update.txt for on/off on individual stations. Can be followed by keyword 'nostation' for no AR updating.
update	tpcorr	*none*	updating of total phosphorus. No further keywords may be given. Which stations and how much is given in file update.txt.
update	tploccorr	*none*	updating of local phosphorus. No further keywords may be given. Which stations and how much is given in file update.txt.
update	tncorr	*none*	updating of total nitrogen. No further keywords may be given. Which stations and how much is given in file update.txt.
update	tnloccorr	*none*	updating of local nitrogen. No further keywords may be given. Which stations and how much is given in file update.txt.
update	wendupd wstr	*none/keyword*	updating of lake water levels from W observations. Thereafter there may follow one of the two keywords: 'allstation' for updating using all W-stations in Xobs.txt or 'nostation' for no updating.
update	war wstr	*none/keyword*	AR updating of lake water level used to calculate Q. The lake water state variable is not updated. Uses the switch(1/0) on column 'warupd' in update.txt for on/off on individual stations. Can be followed by keyword 'nostation' for no AR updating

HYPE variables

Variable IDs given in the table below are used in info.txt files to specify variables which are written in any of the possible output files, e.g.:

```
!! basinfile output of measured and simulated discharge
basinoutput variable rout cout
```

They appear accordingly in output file headers.

The variable IDs are also used in HYPE's observation data files, Xobs.txt. For a complete list of input files, see here. Input data from the files Pobs.txt, Tobs.txt and Qobs.txt has also variable IDs to be used in output and performance criteria determination.

As a general rule, observation variable IDs begin with an 'r' for *recorded*, and corresponding simulated variables with a 'c' for *computed*, Cf. rout and cout, the IDs for measured and simulated discharge. There are exceptions to the rule, though.

All variables in the table relates to a subbasin, either to the local subbasin or a part of it, or to the upstream area (e.g. outflow of a subbasin, cout). Additional output variables can be created for output regions or upstream areas by extending the name of the variable with 'rg' in the beginning (e.g. rgsnow) for regional values or with 'up' for upstream average value (e.g. upsnow). This method does not work on all variables, partly because the result would be nonsense (e.g. upcout or rgwcom) and partly because they are not yet defined for that area (i.e. variables refering to the area of soil layer 2 or 3 or water surface areas are not handled).

Column **Agg.** indicates the type of aggregation of the variables. The type determines how the variable is treated when asked for as an output variable or in a criterion calculation. The meanperiod of the output/criterion determines the period over which the variables values will be aggregated. They will be averaged, weight-averaged or summed according to the type of aggregation. Similarly single time step values represent either averages, weighted averages, or sums over the timestep.

Column **Component** links result variables to model components in HYPE model description.

The general unit (U) is used in tables of parameters and input data where the unit is not defined.

#	Variable ID	Unit	Description	Agg.	Reference area	Component
1	temp	°C	air temperature, provided in Tobs.txt/Tobs_nnn.txt	Avg.	subbasin area	Temp. & Precip.
2	ctmp	°C	corrected air temperature	Avg.	subbasin area	Temp. & Precip.
3	snow	mm	snow water equivalent	Avg.	subbasin land area	Snow
4	sdep	cm	snow depth	Avg.	subbasin land area	Snow
5	rswe	mm	observed snow water equivalent, provided in Xobs.txt	Avg.	subbasin land area	Snow

#	Variable ID	Unit	Description	Agg.	Reference area	Component
6	rsnw	*cm*	observed snow depth, provided in Xobs.txt	Avg.	subbasin land area	Snow
7	soim	*mm*	computed soil moisture (including standing water)	Avg.	subbasin land area	Soil
8	som2	*mm*	soil water of upper two soil layers (including standing water)	Avg.	subbasin land area	Soil
9	sml1	*mm*	soil moisture upper soil layer (not including standing water)	Avg.	area of soil layer	Soil
10	sml2	*mm*	soil moisture second soil layer	Avg.	area of soil layer	Soil
11	sml3	*mm*	soil moisture third soil layer	Avg.	area of soil layer	Soil
12	smrz	*mm*	soil moisture root zone (upper two soil layers) (not including standing water)	Avg.	subbasin land area	Soil
13	sm13	*mm*	soil moisture all soil layers (not including standing water)	Avg.	subbasin land area	Soil
14	stsw	*mm*	standing soil water	Avg.	subbasin land area	Soil
15	srff	-	soil moisture root zone (upper two soil layers) (not including standing water) as fraction of wcfc volume	Avg.	subbasin land area	Soil
16	smfd	-	soil moisture (not including standing water) as fraction of soil depth	Avg.	subbasin land area	Soil
17	srfd	-	soil moisture root zone (upper two soil layers) (not including standing water) as fraction of root depth	Avg.	subbasin land area	Soil
18	smfp	-	soil moisture (not including standing water) as fraction of pore volume	Avg.	subbasin land area	Soil
19	srfp	-	soil moisture root zone (upper two soil layers) (not including standing water) as fraction of pore volume	Avg.	subbasin land area	Soil
20	smdf	*mm*	soil moisture deficit to field capacity of upper two soil layers	Avg.	subbasin land area	Soil
21	gwat	*m*	groundwater level	Avg.	subbasin land area	Soil
22	sfst	*cm*	frost depth	Avg.	subbasin land area	Soil
23	stmp	*°C*	soil temperature	Avg.	subbasin land area	Soil Temp.
24	stm1	*°C*	upper soil layer temperature	Avg.	area of soil layer	Soil Temp.

#	Variable ID	Unit	Description	Agg.	Reference area	Component
25	stm2	*°C*	middle soil layer temperature	Avg.	area of soil layer	Soil Temp.
26	stm3	*°C*	lowest soil layer temperature	Avg.	area of soil layer	Soil Temp.
27	resf	*cm*	observed frost depth, provided in Xobs.txt	Avg.	subbasin land area	missing
28	regw	*m*	observed groundwater level, provided in Xobs.txt	Avg.	subbasin land area	missing
29	pfN1, pfN2, pfN3	*kg/km²*	pools of fastN in soil layers 1 to 3	Avg.	area of soil layer	missing
30	phN1, phN2, phN3	*kg/km²*	pool humusN in soil layers 1 to 3	Avg.	area of soil layer	missing
31	pIN1, pIN2, pIN3	*kg/km²*	pool of inorg-N in soil layers 1 to 3	Avg.	area of soil layer	missing
32	pfP1, pfP2, pfP3	*kg/km²*	pool of fastP in soil layers 1 to 3	Avg.	area of soil layer	missing
33	phP1, phP2, phP3	*kg/km²*	pool humusP in soil layers 1 to 3	Avg.	area of soil layer	missing
34	ppP1, ppP2, ppP3	*kg/km²*	pool of partP in soil layers 1 to 3	Avg.	area of soil layer	missing
35	pSP1, pSP2, pSP3	*kg/km²*	pool of SRP in soil layers 1 to 3	Avg.	area of soil layer	missing
36	phC1, phC2, phC3, pfC1, pfC2, pfC3	*kg/km²*	pool humusC/fastC in soil layers 1 to 3	Avg.	area of soil layer	missing
37	pON1, pON2, pON3	*kg/km²*	pool ON in soil layers 1 to 3	Avg.	area of soil layer	missing
38	cfsc	-	computed fractional snow cover area	Avg.	subbasin land area	missing
39	rfsc	-	recorded fractional snow cover area, provided in Xobs.txt	Avg.	subbasin land area	missing
40	smax	*mm*	computed snowmax in winter	Avg.	subbasin land area	missing
41	rfse	-	recorded fractional snow cover area error, provided in Xobs.txt	Avg.	subbasin land area	missing
42	rfsm	-	recorded fractional snow cover multi, provided in Xobs.txt ❓	Avg.	subbasin land area	missing

#	Variable ID	Unit	Description	Agg.	Reference area	Component
43	rfme	-	recorded fractional snow cover multi error, provided in Xobs.txt	Avg.	subbasin land area	missing
44	wcom	m	water level olake (for the last lakebasin this is the whole lake water level) at end of timestep	Avg.	outlet lake area	missing
45	wcav	m	water stage olake (for the last lakebasin this is the whole lake water level) average over timestep	Avg.	outlet lake area	missing
46	wstr	m	observed water level olake, provided in Xobs.txt	Avg.	outlet lake area	missing
47	cout	m^3/s	simulated outflow from olake/subcatchment	Avg.	subbasin upstream area	missing
48	rout	m^3/s	observed outflow from olake/subcatchment, provided in Qobs.txt	Avg.	subbasin upstream area	missing
49	colv	$10^6 m^3$	computed lake volume of simple olakes and outlets of basin lakes, where upstream lake basin volumes are included (zero for basin lakes which are not lake outlets, use clbv for volumes of those)	Avg.	outlet lake area, incl. upstream lake area for outlets of basin lakes	missing
50	cilv	$10^6 m^3$	computed ilake volume	Avg.	internal lake area	missing
51	clbv	$10^6 m^3$	computed olake volume (volumes for individual basins if any)	Avg.	outlet lake area	missing
52	coum	m^3/s	simulated outflow to main branch	Avg.	subbasin upstream area	missing
53	coub	m^3/s	simulated outflow to branch	Avg.	subbasin upstream area	missing
54	cgwl	m^3/s	simulated outflow from soil groundwater to regional groundwater (losses from subbasin)	Avg.	subbasin area	missing
55	cloc	m^3/s	local flow from subbasin to its main river	Avg.	subbasin area without olake and main river (and floodplains)	missing
56	cinf	m^3/s	simulated flow to outlet lake (including P-E of the lake)	Avg.	subbasin upstream area	missing
57	rinf	m^3/s	observed flow to outlet lake (including P-E of the lake), provided in Xobs.txt	Avg.	subbasin upstream area	missing
58	clrv	m^3	local watercourse volume	Avg.	local river area	missing

#	Variable ID	Unit	Description	Agg.	Reference area	Component
59	cmrv	m^3	main watercourse volume	Avg.	main river area (not including floodplain)	missing
60	qerr	m^3/s	daily error in Q (cout - rout)	Avg.	subbasin upstream area	missing
61	cobc	m^3/s	cout prior to updating of Q if update is made	Avg.	subbasin upstream area	missing
62	wtmp	$°C$	water temperature in outflow from subbasin	Avg.	subbasin upstream area	missing
63	wtm0	$°C$	water temperature in outflow from subbasin, limited to above zero	Avg.	subbasin upstream area	missing
64	werr	m	daily error in olake water stage (cwbc - wstr)	Avg.	subbasin area	missing
65	cwbc	m	computed olake water stage at the end of time step prior to updating, if update is used, and wamp adjustment	Avg.	outlet lake area	missing
66	coli	cm	computed olake ice depth	Avg.	outlet lake area	missing
67	cili	cm	computed ilake ice depth	Avg.	internal lake area	missing
68	colb	cm	computed olake blackice depth	Avg.	outlet lake area	missing
69	cilb	cm	computed ilake blackice depth	Avg.	internal lake area	missing
70	cols	cm	computed olake snow depth	Avg.	outlet lake area	missing
71	cils	cm	computed ilake snow depth	Avg.	internal lake area	missing
72	roli	cm	recorded olake ice depth, provided in Xobs.txt	Avg.	outlet lake area	missing
73	rili	cm	recorded ilake ice depth, provided in Xobs.txt	Avg.	internal lake area	missing
74	rolb	cm	recorded olake blackice depth, provided in Xobs.txt	Avg.	outlet lake area	missing
75	rilb	cm	recorded ilake blackice depth, provided in Xobs.txt	Avg.	internal lake area	missing
76	rols	cm	recorded olake snow depth, provided in Xobs.txt	Avg.	outlet lake area	missing
77	rils	cm	recorded ilake snow depth, provided in Xobs.txt	Avg.	internal lake area	missing
78	cmri	cm	computed main river ice depth	Avg.	main river area	missing
79	clri	cm	computed local river ice depth	Avg.	local river area	missing
80	cmrb	cm	computed main river blackice depth	Avg.	main river area	missing

#	Variable ID	Unit	Description	Agg.	Reference area	Component
81	clrb	*cm*	computed local river blackice depth	Avg.	local river area	missing
82	cmrs	*cm*	computed main river snow depth	Avg.	main river area	missing
83	clrs	*cm*	computed local river snow depth	Avg.	local river area	missing
84	rmri	*cm*	recorded main river ice depth, provided in Xobs.txt	Avg.	main river area	missing
85	rlri	*cm*	recorded local river ice depth, provided in Xobs.txt	Avg.	local river area	missing
86	rmrb	*cm*	recorded main river blackice depth, provided in Xobs.txt	Avg.	main river area	missing
87	rlrb	*cm*	recorded local river blackice depth, provided in Xobs.txt	Avg.	local river area	missing
88	rmrs	*cm*	recorded main river snow depth, provided in Xobs.txt	Avg.	main river area	missing
89	rlrs	*cm*	recorded local river snow depth, provided in Xobs.txt	Avg.	local river area	missing
90	olst	$°C$	computed olake surface temperature	Avg.	outlet lake area	missing
91	olut	$°C$	computed olake upper temperature	Avg.	outlet lake area	missing
92	ollt	$°C$	computed olake lower temperature	Avg.	outlet lake area	missing
93	olwt	$°C$	computed olake mean temperature	Avg.	outlet lake area	missing
94	ilst	$°C$	computed ilake surface temperature	Avg.	internal lake area	missing
95	ilwt	$°C$	computed ilake mean temperature	Avg.	internal lake area	missing
96	lrst	$°C$	computed local river surface temperature	Avg.	local river area	missing
97	lrwt	$°C$	computed local river mean temperature	Avg.	local river area	missing
98	mrst	$°C$	computed main river surface temperature	Avg.	main river area	missing
99	mrwt	$°C$	computed main river mean temperature	Avg.	main river area	missing
100	rolt	$°C$	recorded olake surface temperature, provided in Xobs.txt	Avg.	outlet lake area	missing
101	rilt	$°C$	recorded ilake surface temperature, provided in Xobs.txt	Avg.	internal lake area	missing
102	rmrt	$°C$	recorded main river surface temperature, provided in Xobs.txt	Avg.	main river area	missing
103	mrto	$°C$	computed main river temperature (old)	Avg.	main river area	missing

#	Variable ID	Unit	Description	Agg.	Reference area	Component
104	lrto	°C	computed local river temperature (old)	Avg.	local river area	missing
105	ilto	°C	computed ilake temperature (old)	Avg.	internal lake area	missing
106	olto	°C	computed olake temperature (old)	Avg.	outlet lake area	missing
107	coic	-	computed olake ice cover	Avg.	outlet lake area	missing
108	ciic	-	computed ilake ice cover	Avg.	internal lake area	missing
109	cmic	-	computed main river ice cover	Avg.	main river area	missing
110	clic	-	computed local stream ice cover	Avg.	local river area	missing
111	glcv	km^3	glacier volume	Avg.	glacier area	missing
112	glca	km^2	glacier area	Avg.	glacier area	missing
113	lrdp	m	local river depth	Avg.	local river area	missing
114	mrdp	m	main river depth	Avg.	main river area	missing
115	aqwl	m	aquifer depth to water level	Avg.	subbasin area	missing
116	cgmb	mm	computed glacier mass balance	Avg.	specific glacier area	missing
117	rgmb	mm	recorded glacier mass balance, provided in Xobs.txt	Avg.	specific glacier area	missing
118	cgma	km^2	area used in computed mass balance	Avg.	specific glacier area	missing
119	rgma	km^2	area used in recorded mass balance, provided in Xobs.txt	Avg.	specific glacier area	missing
120	rgmp	$days$	recorded mass balance period, provided in Xobs.txt	Avg.	none	missing
121	S105	-	recorded (FSUHSS) snow cover surrounding terrain open (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of non-forest land cover	missing
122	S106	-	recorded (FSUHSS) snow cover course open (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of non-forest land cover	missing
123	S108	cm	recorded (FSUHSS) mean depth open, provided in Xobs.txt	Avg.	area of non-forest land cover	missing
124	S111	g/cm^3	recorded (FSUHSS) mean density open, provided in Xobs.txt	Avg.	area of non-forest land cover	missing
125	S114	mm	recorded (FSUHSS) snow water equivalent open, provided in Xobs.txt	Avg.	area of forest land cover	missing

#	Variable ID	Unit	Description	Agg.	Reference area	Component
126	S205	-	recorded (FSUHSS)snow cover surrounding terrain forest (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of forest land cover	missing
127	S206	-	recorded (FSUHSS) snow cover course forest (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of forest land cover	missing
128	S208	*cm*	recorded (FSUHSS) mean depth forest, provided in Xobs.txt	Avg.	area of forest land cover	missing
129	S211	*g/cm^3*	recorded (FSUHSS) mean density forest, provided in Xobs.txt	Avg.	area of forest land cover	missing
130	S214	*mm*	recorded (FSUHSS) snow water equivalent forest, provided in Xobs.txt	Avg.	area of forest land cover	missing
131	C106	-	computed snow cover open (fraction from 0 to 10)	Avg.	area of non-forest land cover	missing
132	C108	*cm*	computed mean snow depth open	Avg.	area of non-forest land cover	missing
133	C111	*g/cm^3*	computed mean snow density open	Avg.	area of non-forest land cover	missing
134	C114	*mm*	computed snow water equivalent open	Avg.	area of non-forest land cover	missing
135	C206	-	computed snow cover forest (fraction from 0 to 10)	Avg.	area of forest land cover	missing
136	C208	*cm*	computed mean snow depth forest	Avg.	area of forest land cover	missing
137	C211	*g/cm^3*	comp. mean snow density forest	Avg.	area of forest land cover	missing
138	C214	*mm*	computed snow water equivalent forest	Avg.	area of forest land cover	missing
139	coT1	*µU/L*	simulated concentration of tracer T1 in local runoff from soil, unit dependent on substance simulated	W. Avg.	subbasin land area	tracer T1
140	coT2	*°C*	simulated water temperature of local runoff from soil	W. Avg.	subbasin land area	missing
141	coIN, coON, coTN, coSP, coPP, coTP	*µg/L*	simulated concentration of N and P species in local runoff from soil (IN=inorganic nitrogen, ON=organic nitrogen, SP=soluble reactive phosphorus, PP=particulate phosphorus, TN=total nitrogen and TP=total phosphorus concentration)	W. Avg.	subbasin land area	missing

#	Variable ID	Unit	Description	Agg.	Reference area	Component
142	reT1	*µU/L*	observed concentration of tracer T1 in outflow from olake/subbasin, unit dependent on substance simulated, values provided in [Xobs.txt](#)	W. Avg.	subbasin upstream area	[tracer T1](#)
143	reT2	*°C*	observed water temperature in outflow from olake/subbasin, provided in [Xobs.txt](#) (average based on recorded flow if present)	W. Avg.	subbasin upstream area	[missing](#)
144	reIN, reON, reSP, rePP, reTN, reTP	*µg/L*	observed concentration of N and P species in outflow from olake/subbasin (IN=inorganic nitrogen, ON=organic nitrogen, SP=soluble reactive phosphorus, PP=particulate phosphorus, TN=total nitrogen and TP=total phosphorus concentration), provided in [Xobs.txt](#) (average based on recorded flow if present)	W. Avg.	subbasin upstream area	[missing](#)
145	cpT1	*µU/L*	observed concentration of tracer T1 in precipitation, unit user-provided, values provided in [Xobs.txt](#)	W. Avg.	subbasin area	[tracer T1](#)
146	ceT1	*µU/L*	simulated concentration of tracer T1 in evapotranspiration, unit dependent on substance simulated	W. Avg.	subbasin area	[tracer T1](#)
147	csT1	*µU/L*	simulated concentration of tracer T1 in the soil water, unit dependent on substance simulated	W. Avg.	subbasin land area	[tracer T1](#)
148	csT2	*°C*	simulated water temperature in the soil	W. Avg.	subbasin land area	[missing](#)
149	csIN	*µg/L*	simulated concentration of IN in the soil, this differs from coXX variables in that the weights are different for soil water concentration averages and runoff concentration averages	W. Avg.	subbasin land area	[missing](#)
150	ccT1	*µU/L*	simulated concentration of tracer T1 in outflow from outlet lake/main river, unit dependent on substance simulated	W. Avg.	subbasin upstream area	[tracer T1](#)
151	ccT2	*°C*	simulated water temperature in outflow from outlet lake/subbasin	W. Avg.	subbasin upstream area	[missing](#)

#	Variable ID	Unit	Description	Agg.	Reference area	Component
152	ccIN, ccON, ccTN, ccSP, ccPP, ccTP	*µg/L*	simulated concentration of N and P species in outflow from outlet lake/subbasin (IN=inorganic nitrogen, ON=organic nitrogen, SP=soluble reactive phosphorus, PP=particulate phosphorus, TN=total nitrogen and TP=total phosphorus concentration)	W. Avg.	subbasin upstream area	missing
153	coOC	*mg/L*	simulated OC concentration in runoff from soil	W. Avg.	subbasin land area	missing
154	csOC	*mg/L*	simulated OC concentration in soil	W. Avg.	subbasin land area	missing
155	ccOC	*mg/L*	simulated OC concentration in outflow from olake/subbasin	W. Avg.	subbasin upstream area	missing
156	reOC	*mg/L*	observed OC concentration in outflow from olake/subbasin, provided in Xobs.txt	W. Avg.	subbasin upstream area	missing
157	clCO	*mg/L*	simulated OC concentration in local flow from subbasin	W. Avg.	subbasin area without olake and main river (and floodplains)	missing
158	clIN, clON, clTN, clSP, clPP, clTP	*µg/L*	simulated concentration in local flow from subbasin (IN=inorganic nitrogen, ON=organic nitrogen, SP=soluble reactive phosphorus, PP=particulate phosphorus, TN=total nitrogen and TP=total phosphorus concentration)	W. Avg.	subbasin area without olake and main river (and floodplains)	missing
159	prec	*mm/[period]*	precipitation as provided in Pobs.txt/Pobs_nnn.txt	Sum	subbasin area	missing
160	cprc	*mm/[period]*	corrected precipitation	Sum	subbasin area	missing
161	cpSF	*mm/[period]*	corrected precipitation that falls as snow	Sum	subbasin area	missing
162	cpRF	*mm/[period]*	corrected precipitation that falls as rain	Sum	subbasin area	missing
163	evap	*mm/[period]*	evapotranspiration	Sum	subbasin area	missing
164	epot	*mm/[period]*	potential evapotranspiration	Sum	subbasin area	missing
165	repo	*mm/[period]*	observed potential evapotranspiration, provided in Xobs.txt	Sum	subbasin area	missing
166	eobs	*mm/[period]*	observed evapotranspiration, provided in Xobs.txt	Sum	subbasin area	missing
167	icpe	*mm/[period]*	losses due to interception (simulated as precipitation corrections)	Sum	subbasin area	missing

#	Variable ID	Unit	Description	Agg.	Reference area	Component
168	evsn	*mm/[period]*	snow and glacier evaporation (Note that evsn is included in evap, which still is the total evaporation from the subbasin)	Sum	subbasin area	[missing](#)
169	levp	*mm/[period]*	land evapotranspiration	Sum	subbasin land area	[missing](#)
170	evpt	*mm/[period]*	total evapotranspiration, including "interception losses"	Sum	subbasin area	[missing](#)
171	psim	*mm/[period]*	precipitation including water that will be removed as "interception losses"	Sum	subbasin area	[missing](#)
172	cpIN	*µg/L*	observed concentration of inorganic nitrogen (IN) in precipitation, provided in [Xobs.txt](#)	W. Avg.	subbasin area	[missing](#)
173	cpSP	*µg/L*	observed concentration of soluble phosphorus (SP) in precipitation, provided in [Xobs.txt](#)	W. Avg.	subbasin area	[missing](#)
174	crun	*mm/[period]*	calculated local runoff from land area. Note that this is not the same as the flow to the local stream if floodplains are used.	Sum	subbasin land area	[missing](#)
175	rrun	*mm/[period]*	observed local runoff from land area, provided in [Xobs.txt](#)	Sum	subbasin land area	[missing](#)
176	cro1, cro2, cro3	*mm/[period]*	simulated runoff from soil layers 1 to 3. Note that this is not the same as the flow to the local stream if floodplains are used.	Sum	area of soil layer	[missing](#)
177	crod	*mm/[period]*	simulated runoff from tile drains. Note that this is not the same as the flow to the local stream if floodplains are used.	Sum	subbasin land area	[missing](#)
178	cros	*mm/[period]*	simulated surface runoff ($ros1+ros2$). Note that this is not the same as the flow to the local stream if floodplains are used.	Sum	subbasin land area	[missing](#)
179	ros1	*mm/[period]*	simulated saturated surface runoff. Note that this is not the same as the flow to the local stream if floodplains are used.	Sum	subbasin land area	[missing](#)
180	ros2	*mm/[period]*	simulated surface runoff due to excess infiltration. Note that this is not the same as the flow to the local stream if floodplains are used.	Sum	subbasin land area	[missing](#)

#	Variable ID	Unit	Description	Agg.	Reference area	Component
181	acdf	*mm/[period]*	accumulated volume error	Sum	subbasin upstream area	missing
182	cINl, cONl, cTNl, cSPl, cPPl, cTPl, cOCl	*kg/[period]*	total simulated nutrient or organic carbon load out from subbasin (IN=inorganic nitrogen, ON=organic nitrogen, SP=soluble reactive phosphorus, PP=particulate phosphorus, TN=total nitrogen and TP=total phosphorus)	Sum	subbasin upstream area	missing
183	deni	*kg/km^2[period]*	denitrification in soil	Sum	subbasin land area	missing
184	crut	*kg/km^2[period]*	N crop uptake	Sum	subbasin land area	missing
185	faIN	*kg/km^2[period]*	flow of fastN to IN pool	Sum	subbasin land area	missing
186	atmd, atmp	*kg/km^2[period]*	atmospheric deposition of IN/TP on land	Sum	subbasin land area	missing
187	rtoN, rtoP	*kg/[period]*	recorded nutrient load out from subbasin (calculated from recorded flow rout and concentration reTN/reTP) (TN=total nitrogen and TP=total phosphorus)	Sum	subbasin upstream area	missing
188	irra	*m^3/[period]*	applied irrigation water to the soil	Sum	area of irrigated SLCs	missing
189	irld	*m^3/[period]*	abstractions from local dam(s)	Sum	none	missing
190	irlr	*m^3/[period]*	abstractions from local river	Sum	none	missing
191	irrg	*m^3/[period]*	abstractions from local groundwater	Sum	none	missing
192	irrs	*m^3/[period]*	surface water abstractions sent to other connected subbasins from this subbasin	Sum	none	missing
193	irel	*m^3/[period]*	evaporation losses due to irrigation	Sum	area of irrigated SLCs	missing
194	rlIN, rlON, rlSP, rlPP, rlTN, rlTP, rlOC	*kg/[period]*	recorded load out from subbasin (calculated from computed flow cout and recorded concentration reIN etc) (IN=inorganic nitrogen, ON=organic nitrogen, SP=soluble reactive phosphorus, PP=particulate phosphorus, TN=total nitrogen, TP=total phosphorus concentration and OC=organic carbon)	Sum	subbasin upstream area	missing
195	aqin	*m^3/[period]*	aquifer recharge	Sum	subbasin area	missing
196	aqut	*m^3/[period]*	aquifer outflow	Sum	main river area	missing

#	Variable ID	Unit	Description	Agg.	Reference area	Component
197	speq	*mm/[period]*	specific discharge (replaces `upro`)	Sum	subbasin upstream area	missing
198	clwc	*m*	olake water stage (`wcom`) cleaned from `w0ref` reference level	Avg.	outlet lake area	missing
199	clws	*m*	observed water stage (`wstr`) cleaned from `w0ref` reference level	Avg.	outlet lake area	missing
200	sl01	*kg*	gross load of soil layer 1 and 2 of inorganic nitrogen	Sum	subbasin area	Soil load
201	sl02	*kg*	net load of soil layer 1 and 2 of inorganic nitrogen	Sum	subbasin area	Soil load
202	sl03	*kg*	gross load of soil layer 1 and 2 of organic nitrogen	Sum	subbasin area	Soil load
203	sl04	*kg*	net load of soil layer 1 and 2 of organic nitrogen	Sum	subbasin area	Soil load
204	sl05	*kg*	gross load of soil layer 1 and 2 of total nitrogen	Sum	subbasin area	Soil load
205	sl06	*kg*	net load of soil layer 1 and 2 of total nitrogen	Sum	subbasin area	Soil load
206	sl07	*kg*	gross load of soil layer 1 and 2 of SRP	Sum	subbasin area	Soil load
207	sl08	*kg*	net load of soil layer 1 and 2 of SRP	Sum	subbasin area	Soil load
208	sl09	*kg*	gross load of soil layer 1 and 2 of particulate phosphorus	Sum	subbasin area	Soil load
209	sl10	*kg*	net load of soil layer 1 and 2 of particulate phosphorus	Sum	subbasin area	Soil load
210	sl11	*kg*	gross load of soil layer 1 and 2 of total phosphorus	Sum	subbasin area	Soil load
211	sl12	*kg*	net load of soil layer 1 and 2 of total phosphorus	Sum	subbasin area	Soil load
212	sl13	*kg*	gross load of soil layer 3 of inorganic nitrogen	Sum	subbasin area	Soil load
213	sl14	*kg*	net load of soil layer 3 of inorganic nitrogen	Sum	subbasin area	Soil load
214	sl15	*kg*	gross load of soil layer 3 of organic nitrogen	Sum	subbasin area	Soil load
215	sl16	*kg*	net load of soil layer 3 of organic nitrogen	Sum	subbasin area	Soil load
216	sl17	*kg*	gross load of soil layer 3 of total nitrogen	Sum	subbasin area	Soil load
217	sl18	*kg*	net load of soil layer 3 of total nitrogen	Sum	subbasin area	Soil load
218	sl19	*kg*	gross load of soil layer 3 of SRP	Sum	subbasin area	Soil load
219	sl20	*kg*	net load of soil layer 3 of SRP	Sum	subbasin area	Soil load
220	sl21	*kg*	gross load of soil layer 3 of particulate phosphorus	Sum	subbasin area	Soil load

#	Variable ID	Unit	Description	Agg.	Reference area	Component
221	sl22	*kg*	net load of soil layer 3 of particulate phosphorus	Sum	subbasin area	Soil load
222	sl23	*kg*	gross load of soil layer 3 of total phosphorus	Sum	subbasin area	Soil load
223	sl24	*kg*	net load of soil layer 3 of total phosphorus	Sum	subbasin area	Soil load
224	sl25	*kg*	gross load of soil layer 3 + tile of inorganic nitrogen	Sum	subbasin area	Soil load
225	sl26	*kg*	net load of soil layer 3 + tile of inorganic nitrogen	Sum	subbasin area	Soil load
226	sl27	*kg*	gross load of soil layer 3 + tile of organic nitrogen	Sum	subbasin area	Soil load
227	sl28	*kg*	net load of soil layer 3 + tile of organic nitrogen	Sum	subbasin area	Soil load
228	sl29	*kg*	gross load of soil layer 3 + tile of total nitrogen	Sum	subbasin area	Soil load
229	sl30	*kg*	net load of soil layer 3 + tile of total nitrogen	Sum	subbasin area	Soil load
230	sl31	*kg*	gross load of soil layer 3 + tile of SRP	Sum	subbasin area	Soil load
231	sl32	*kg*	net load of soil layer 3 + tile of SRP	Sum	subbasin area	Soil load
232	sl33	*kg*	gross load of soil layer 3 + tile of particulate phosphorus	Sum	subbasin area	Soil load
233	sl34	*kg*	net load of soil layer 3 + tile of particulate phosphorus	Sum	subbasin area	Soil load
234	sl35	*kg*	gross load of soil layer 3 + tile of total phosphorus	Sum	subbasin area	Soil load
235	sl36	*kg*	net load of soil layer 3 + tile of total phosphorus	Sum	subbasin area	Soil load
236	den3	*kg*	denitrification soil layer 3	Sum	subbasin area	missing
237	denz	*kg*	denitrification soil layer 1 and 2	Sum	subbasin area	missing
238	cIN1	*µg/L*	simulated concentration of IN in soil layer 1	W. Avg.	area of soil layer	missing
239	cIN2	*µg/L*	simulated concentration of IN in soil layer 2	W. Avg.	area of soil layer	missing
240	cIN3	*µg/L*	simulated concentration of IN in soil layer 3	W. Avg.	area of soil layer	missing
241	sml9	*mm*	soil moisture upper soil layer (including standing water)	Avg.	area of soil layer	missing
242	mrfp	*m*	main river floodplain water depth	Avg.	floodplain area	Floodplain
243	olfp	*m*	outlet lake floodplain water depth	Avg.	floodplain area	Floodplain
244	mrfg	*%*	main river floodplain degree of flooded area (% of floodplain area)	Avg.	floodplain area	Floodplain

#	Variable ID	Unit	Description	Agg.	Reference area	Component
245	olfg	%	outlet lake floodplain degree of flooded area (% of floodplain area)	Avg.	floodplain area	Floodplain
246	sden	g/cm^3	snow density	Avg.	subbasin land area	Snow
247	melt	mm/[period]	snow melt	Sum	subbasin land area	Snow
248	roum	m^3/s	observed outflow from olake outlet 1	Avg.	subbasin upstream area	missing
249	roub	m^3/s	observed outflow from olake outlet 2	Avg.	subbasin upstream area	missing
250	aT11	$\mu U/km^2$	simulated pool of adsorbed T1 in soil layer 1	Avg.	subbasin land area	tracer T1
251	aT12	$\mu U/km^2$	simulated pool of adsorbed T1 in soil layer 2	Avg.	area of soil layer	tracer T1
252	aT13	$\mu U/km^2$	simulated pool of adsorbed T1 in soil layer 3	Avg.	area of soil layer	tracer T1
253	sT11	$\mu U/km^2$	simulated pool of T1 in soil water in soil layer 1	Avg.	subbasin land area	tracer T1
254	sT12	$\mu U/km^2$	simulated pool of T1 in soil water in soil layer 2	Avg.	area of soil layer	tracer T1
255	sT13	$\mu U/km^2$	simulated pool of T1 in soil water in soil layer 3	Avg.	area of soil layer	tracer T1
256	Tsmr	U	simulated pool of T1 in main river sediment	Avg.	main river area (not including floodplain)	tracer T1
257	Tslr	U	simulated pool of T1 in local river sediment	Avg.	local river area	tracer T1
258	T1sf	$\mu U/km^2$	simulated pool of T1 above soil	Avg.	subbasin land area	tracer T1
259	clT1	$\mu U/L$	simulated concentration of T1 in flow of local river	W. Avg.	subbasin area without olake and main river (and floodplains)	tracer T1
260	Tcr1	$\mu U/L$	simulated concentration of T1 in runoff from soil layer 1	W. Avg.	subbasin land area	tracer T1
261	Tcr2	$\mu U/L$	simulated concentration of T1 in runoff from soil layer 2	W. Avg.	area of soil layer	tracer T1
262	Tcr3	$\mu U/L$	simulated concentration of T1 in runoff from soil layer 3	W. Avg.	area of soil layer	tracer T1
263	Tcrd	$\mu U/L$	simulated concentration of T1 in tile runoff	W. Avg.	subbasin land area	tracer T1
264	Tcrs	$\mu U/L$	simulated concentration of T1 in surface runoff	W. Avg.	subbasin land area	tracer T1
265	coSS	mg/L	computed suspended sediment (SS) concentration in runoff	W. Avg.	subbasin land area	missing

#	Variable ID	Unit	Description	Agg.	Reference area	Component
266	ccSS	*mg/L*	computed suspended sediment (SS) concentration in lake outflow	W. Avg.	subbasin upstream area	missing
267	reSS	*mg/L*	recorded suspended sediment (SS) concentration in lake outflow	W. Avg.	subbasin upstream area	missing
268	ccAE	*mg-N/L*	computed algae concentration in lake outflow	W. Avg.	subbasin upstream area	missing
269	ccTS	*mg/L*	computed total suspended sediment (TS) concentration in lake outflow	W. Avg.	subbasin upstream area	missing
270	xom0..9	*depends on variable type*	observations of not predefined variable (to be averaged over output time interval) provided in Xobs.txt or XobsXOMn.txt	Avg.	depends on variable type	missing
271	xos0..9	*depends on variable type*	observations of not predefined variable (to be summed over output time interval) provided in Xobs.txt or XobsXOSn.txt	Sum	depends on variable type	missing
272	dwtr	m^3/s	demanded water transfer flow	Avg.	-	missing
273	rpwl	*m*	main river floodplain water level	Avg.	floodplain area	Floodplain
274	lpwl	*m*	outlet lake floodplain water level	Avg.	floodplain area	Floodplain
275	gmlt	*mm/[period]*	glacier melt	Sum	glacier slc area	missing
276	loff	$L/km^2/s$	calculated local runoff from land area. Note that this is not the same as the flow to the local stream if floodplains are used.	Sum	subbasin land area	missing
277	lrfa	-	local river fractional area	Avg.	local river area	Evaporation
278	mrfa	-	main river fractional area	Avg.	main river area	Evaporation
279	lred	*m*	local river effective depth when area is reduced	Avg.	local river area	missing
280	mred	*m*	main river effective depth when area is reduced	Avg.	main river area	missing
281	cSSl, cTSl	*kg/[period]*	simulated sediment load out from subbasin (SS=suspended sediments, TS=total suspended sediments)	Sum	subbasin upstream area	missing
282	infi	*mm/[period]*	infiltration to soil, including macropore flow and water staying standing on the surface of the soil	Sum	subbasin land area	infiltration
283	reTS	*mg/L*	recorded total suspended sediment (TS) concentration in lake outflow	W. Avg.	subbasin upstream area	missing

#	Variable ID	Unit	Description	Agg.	Reference area	Component
284	clTS	*mg/L*	computed total suspended sediment (TS) concentration in local flow from subbasin	W. Avg.	subbasin area without olake and main river (and floodplains)	missing
285	clSS	*mg/L*	computed suspended sediment (SS) concentration in local flow from subbasin	W. Avg.	subbasin area without olake and main river (and floodplains)	missing
286	nlTS	*kg/[period]*	computed total suspended sediment (TS) net load of main river and outlet lake	Sum	subbasin main river and olake area	missing
287	nlSS	*kg/[period]*	computed suspended sediment (SS) net load of main river and outlet lake	Sum	subbasin main river and olake area	missing
288	wilk	*m*	internal lake water stage above threshold	Avg.	internal lake area	missing
289	isps	*kg/km^2*	intermediate storage pool SS	Avg.	subbasin land area	Soil erosion
290	ispp	*kg/km^2*	intermediate storage pool PP	Avg.	subbasin land area	Soil Erosion
291	Psmr	*kg*	main river PP storage in sediments	Avg.	main river area	Sed. & Resusp.
292	Pslr	*kg*	local river PP storage in sediments	Avg.	local river area	Sed. & Resusp.
293	Ssmr	*kg*	main river SS storage in sediments	Avg.	main river area	Sed. & Resusp.
294	Sslr	*kg*	local river SS storage in sediments	Avg.	local river area	
295	wilk	*m*	ilake water stage above threshold	Avg.	local lake area	Local lakes
296	craw	*m*	runoff including wetland classes (iwet and owet)	Sum	subbasin land area plus wetland areas	Wetlands
297	wcIN, wcON, wcSP, wcPP	*ug/L*	simulated concentration of N and P species in outflow of iwet (IN=inorganic nitrogen, ON=organic nitrogen, SP=soluble reactive phosphorus, and PP=particulate phosphorus)	W.Avg.	subbasin land area plus iwet area	missing
298	wcSS	*mg/L*	simulated concentration of suspended sediment (SS) in outflow of iwet	W.Avg.	subbasin land area plus iwet area	missing
299	wcAE	*mg-N/L*	simulated concentration of algae (AE) in outflow of iwet	W.Avg.	subbasin land area plus iwet area	missing

#	Variable ID	Unit	Description	Agg.	Reference area	Component
300	wcOC	*mg/L*	simulated concentration of organic carbon (OC) in outflow of iwet	W.Avg.	subbasin land area plus iwet area	[missing](#)
301	wcT2	*°C*	simulated water temperature in outflow of iwet	W.Avg.	subbasin land area plus iwet area	[missing](#)
302	wiIN, wiON, wiSP, wiPP	*ug/L*	simulated concentration of N and P species in inflow to iwet (IN=inorganic nitrogen, ON=organic nitrogen, SP=soluble reactive phosphorus, and PP=particulate phosphorus)	W.Avg.	subbasin land area	[missing](#)
303	wiSS	*mg/L*	simulated concentration of suspended sediment (SS) in inflow to iwet	W.Avg.	subbasin land area	[missing](#)
304	wiAE	*mg-N/L*	simulated concentration of algae (AE) in inflow to iwet	W.Avg.	subbasin land area	[missing](#)
305	wiOC	*mg/L*	simulated concentration of organic carbon (OC) in inflow to iwet	W.Avg.	subbasin land area	[missing](#)
306	wiT2	*°C*	simulated water temperature in inflow to iwet	W.Avg.	subbasin land area	[missing](#)
307	iwin	*m³/s*	computed inflow of iwet	Avg.	internal wetland (iwet) area	[missing](#)
308	iwut	*m³/s*	computed ouflow of iwet	Avg.	internal wetland (iwet) area	[Wetlands](#)
309	ciwv	*m³*	computed iwet volume	Avg.	internal wetland (iwet) area	[Wetlands](#)
310	wiwt	*m*	iwet water depth above threshold (-w0 if soil is dry)	Avg.	internal wetland (iwet) area	[Wetlands](#)
311	cowv	*m³*	computed owet volume	Avg.	outlet wetland (owet) area	[Wetlands](#)
312	wowt	*m*	owet water depth above threshold (-w0 if soil is dry)	Avg.	outlet wetland (owet) area	[Wetlands](#)
313	hged	*m*	main river water depth calculated by hydraulic geometry	Avg.	subbasin upstream area	
314	hgeu	*m/s*	main river velocity calculated by hydraulic geometry	Avg.	subbasin upstream area	

Table of upstream variables that have different unit compared to the subbasin variable.

New variable ID	Unit	Description	Value	Subbasin unit
upcolv	mm	lake volume of simple olakes and basin lakes spread over upstream area	Avg.	10^6m^3
upcilv	mm	lake volume of ilakes spread over upstream area	Avg.	10^6m^3
upclbv	mm	lake volume of olakes and individual lake basins spread over upstream area	Avg.	10^6m^3
upclrv	mm	local watercourse volume spread over upstream area	Avg.	m^3
upcmrv	mm	main watercourse volume spread over upstream area	Avg.	m^3
upglcv	mm	glacier volume spread over upstream area	Avg.	km^3
upglca	-	glacier area, fraction of upstream area	Avg.	km^2
upirra	mm/[period]	applied irrigation water to the soil	Sum	m^3/[period]
upirld	mm/[period]	abstractions from local dam(s) spread over upstream area	Sum	m^3/[period]
upirlr	mm/[period]	abstractions from local river spread over upstream area	Sum	m^3/[period]
upirrg	mm/[period]	abstractions from local groundwater spread over upstream area	Sum	m^3/[period]
upirrs	mm/[period]	abstractions from surface water spread over upstream area	Sum	m^3/[period]
upirel	mm/[period]	evaporation losses due to irrigation spread over upstream area	Sum	m^3/[period]

Table of removed HYPE variables IDs, and what variable is replacing them.

Old ID	New variable ID	Unit	Description	Value
upsn	upsnow	mm	upstream catchment average snow water	Avg.
upso	upsoim	mm	upstream catchment average soil water	Avg.
uppr	upcprc	mm/[period]	upstream catchment average precipitation, corrected precipitation if correction is used	Sum
upev	upevap	mm/[period]	upstream catchment average evaporation	Sum
uppe	upepot	mm/[period]	upstream catchment average potential evaporation	Sum
upro	speq	mm/[period]	specific discharge	Sum
upsf	upcpsf	mm/[period]	upstream catchment average snowfall, corrected snowfall if correction is used	Sum
uprf	upcprf	mm/[period]	upstream catchment average rainfall, corrected rainfall if correction is used	Sum
upsd	upsmdf	mm/[period]	upstream average soil deficit to field capacity for upper two soil layers	Sum
upfp	upsmfp	-	upstream soil moisture as fraction of pore volume (not including standing water)	Avg.
upme	upmelt	mm/[period]	average upstream snow melt	Sum
upte	upctmp	°C	average upstream corrected air temperature	Avg.

Available performance criteria

Performance criteria that can be chosen as objective function for calibration in info.txt. The criteria are calculated for the model domain, based on performances at individual subbasins where observations exists. Three kinds of combination of the individual subbasins are used:

- **average/median:** criteria calculated in subbasins individually, and then combined (equal weight to each station, irrespective of time series length)
- **regional:** criteria calculated on a combined long time series over all subbasins (thus weighted by data lengths)
- **spatial:** time series att each subbasin is collapsed to a single long-term average, these averages are then combined to a "spatial series" over all subbasins, and the criteria calculated over those

Available performance criteria for domain-wide model evaluation are listed in the table below. Equation definitions for criteria calculation are described here.

Note: As described in info.txt, up to 20 performance criteria can be combined for model evaluation. However, for HYPE-internal computational reasons, **criteria TAU, MRA, RRA, and SRA criteria must be defined as one of the first four criteria in info.txt** (e.g. as `crit 1 criterion MRA`).

Criterion ID	Description	Equation ID
MR2	average of Nash-Sutcliffe efficiency for all subbasins with observations.	*AVNSE*
MRE	average of the relative bias for all subbasins (Note: fraction, not %).	*AVRB*
MRA	average value of subbasin values of efficiency (RA) similar to Nash-Sutcliffe with coefficient *a* instead of a square.	*AVRA*
MCC	Pearson correlation coefficient, average of all subbasins with observations.	*AVCC*
MRS	error in standard deviation, average of all subbasins with observations.	*AVRSB*
MAR	average of absolute relative bias for all subbasins (Note: fraction, not %).	*AVARB*
MNW	average of Nash-Sutcliffe efficiency adjusted for bias for all subbasins with observations.	*AVNSEW*
AKG	average of Kling-Gupta efficiency for all subbasins with observations.	*AVKGE*
RR2	regional Nash-Sutcliffe efficiency (all data combined in one long time series).	*REGNSE*
RRE	regional relative bias (all data combined in one long time series).	*REGRB*
RRA	regional efficiency similar to Nash-Sutcliffe with coefficient *a* instead of a square.	*REGRA*
MD2	median of Nash-Sutcliffe efficiency for all subbasins with observations.	*MEDNSE*
MDA	median of all subbasins' RA (efficiency similar to Nash-Sutcliffe with coefficient *a* instead of a square).	*MEDRA*
MKG	median of all subbasins' Kling-Gupta efficiency.	*MEDKGE*
MNR	median of all subbasins' normalised RMSE.	*MEDNE*
SR2	spatial Nash-Sutcliffe efficiency calculated using annual means for all subbasins (requires at least 5 years and 5 subbasins with data) to calculate the Nash-Sutcliffe efficiency.	*SPATNSE*
SRA	Spatial efficiency similar to Nash-Sutcliffe with coefficient *a* instead of a square.	*SPATRA*

Criterion ID	Description	Equation ID
TAU	average of Kendall's rank correlation coefficient (Tau) value for all subbasins.	*AVTAU*

Criteria equations

Performance criteria are used in several files. Different criterion is given in subass.txt and simass.txt files. In addition criteria can be selected in info.txt. Below is listed the code/heading used in each file together with the equation identificator. Further down all the equations are defined.

Code to equation coupling

Equation IDs for subbasin assessment criteria (subassX.txt):

Heading	Description	Equation ID
NSE	Nash-Sutcliffe efficiency	NSE
CC	Pearson correlation coefficient (Kling-Gupta efficiency, part 1)	CC
RE(%)	relative bias in percent	RE%
RSDE(%)	relative error in standard deviation in percent	RS%
Sim	average of simulated variable	cm
Rec	average of observed variable	rm
SDSim	standard deviation of simulated variable	cd
SDRec	standard deviation of observed variable	rd
MAE	mean absolute error	MAE
RMSE	root mean square error	RMSE
Bias	bias	Bias
SDE	Error of standard deviation	ES
KGE	Kling-Gupta efficiency	KGE
KGESD	Kling-Gupta efficiency, part 2	KGESD
KGEM	Kling-Gupta efficiency, part 3	KGEM
NRMSE	normalised root mean square error	NE
NSEW	Nash-Sutcliffe efficiency adjusted for bias	NSEW

Equation IDs for simulation assessment criteria (simass.txt):

Name	Code	Equation ID
Regional NSE	RR2	REGNSE
Regional RA	RRA	REGRA
Regional RE	RRE	REGRB
Regional MAE	-	REGMAE
Average NSE	MR2	AVNSE
Average RA	MRA	AVRA
Average RE	MRE	AVRB
Average RSDE	MRS	AVRSB
Average CC	MCC	AVCC
Average ARE	MAR	AVARB
Spatial NSE	SR2	SPATNSE
Spatial RA	RRA	SPATRA

Name	Code	Equation ID
Spatial RE	-	*SPATRB*
Kendalls Tau	TAU	*AVTAU*
Median NSE	MD2	*MEDNSE*
Median RA	MDA	*MEDRA*
Median KGE	MKG	*MEDKGE*
Median NRMSE	MNR	*MEDNE*
Mean NSEW	MNW	*AVNSEW*

Equation IDs for calibration simulation assessment criteria ([bestsims.txt](#) and [allsim.txt](#)):

Heading	Description	Equation ID
`rr2`	regional Nash-Sutcliffe efficiency (data from all subbasins combined in one data series)	*REGNSE*
`sr2`	spatial Nash-Sutcliffe efficiency, calculated using annual means for all subbasins (requires at least 5 years and 5 subbasins with data) to form one data series to calculate the Nash-Sutcliffe efficiency on	*SPATNSE*
`mr2`	average of Nash-Sutcliffe efficiencies for subbasins	*AVNSE*
`rmae`	regional mean absolute error (data from all subbasins combined in one data series)	*REGMAE*
`sre`	spatial relative bias (calculated on annual means for all subbasins)	*SPATRB*
`rre`	regional relative bias (data from all subbasins combined in one data series)	*REGRB*
`mre`	average of the relative bias for all subbasins (Note: fraction, not %)	*AVRB*
`rra`	regional RA, similar to regional NSE, RA is a Nash-Sutcliffe like criterion where the square in the Nash-Sutcliffe formula is exchanged with a coefficient value	*REGRA*
`sra`	spatial RA, similar to spatial NSE, RA is a Nash-Sutcliffe like criterion where the square in the Nash-Sutcliffe formula is exchanged for a coefficient value	*SPATRA*
`mra`	average value of RA for subbasins, RA is a Nash-Sutcliffe like criterion where the square in the Nash-Sutcliffe formula is exchanged with a coefficient value	*AVRA*
`tau`	average of Kendall's Tau value for subbasins	*AVTAU*
`md2`	median of Nash-Sutcliffe efficiency for subbasins	*MEDNSE*
`mda`	median of all subbasins' RA (Nash-Sutcliffe like criteria where the square is exchanged with a coefficient value)	*MEDRA*
`mrs`	average of error in standard deviation for subbasins	*AVRSB*
`mcc`	Pearson correlation coefficient, average of all subbasins with observations	*AVCC*
`mdkg`	median of Kling-Gupta efficiency (MKG in [info.txt](#)) for subbasins	*MEDKGE*
`mare`	average of absolute relative bias for subbasins (Note: fraction. not %) (MAR in [info.txt](#))	*AVARB*
`mnr`	median of normalised RMSE for subbasins	*MEDNE*
`mnw`	average of Nash-Sutcliffe efficiencies adjusted for bias for subbasins	*AVNSEW*

Equation IDs for performance criteria set in info.txt are tabled [here](#).

Equation definitions

Denotations

c	computed value
r	recorded value
i	index for time steps with observations in a time series of a station
mi	number of values in a time series of a station
j	index of stations
mj	number of stations
ij	index over time steps with observations for all stations
mij	number of time steps with obsevations for all stations
cm	average value of $c_i, i=1, mi$ for a station
rm	average value of $r_i, i=1, mi$ for a station
cd	standard deviation of $c_i, i=1, mi$ for a station
rd	standard deviation of $r_i, i=1, mi$ for a station

Basic equations

Average value for a time series of a station:

$$xm = \frac{1}{mi} \sum_{i=1}^{mi} x_i \qquad x=r \text{ or } c$$

Standard deviation of a time series of a station:

$$xd = \sqrt{\frac{1}{mi} \sum_{i=1}^{mi} x_i^2 - xm^2} \qquad x=r \text{ or } c$$

Criteria equations for a time series of a station

Nash-Sutcliffe Efficiency (*NSE* or R2):

$$NSE = 1 - \frac{\sum_{i=1}^{mi} \left(c_i - r_i\right)^2}{\sum_{i=1}^{mi} \left(r_i - rm\right)^2}$$

Efficiency with coefficient a (*RA*):

$$RA = 1 - \frac{\sum_{i=1}^{mi} \left| c_i - r_i \right|^a}{\sum_{i=1}^{mi} \left| r_i - rm \right|^a}$$

Bias:

$$Bias = \frac{\sum_{i=1}^{mi} \left(c_i - r_i \right)}{mi}$$

Relative bias (*RB* or RE):

$$RB = \frac{\sum_{i=1}^{mi} \left(c_i - r_i \right)}{\left| \sum_{i=1}^{mi} r_i \right|}$$

Relative bias in percent (*RE%*):

$$RE\% = RB \times 100 = \frac{\sum_{i=1}^{mi} \left(c_i - r_i \right)}{\left| \sum_{i=1}^{mi} r_i \right|} \times 100$$

Error of standard deviation (*ES*):

$$ES = cd - rd$$

Relative error of standard deviation (*RS*):

$$RS = \frac{cd - rd}{rd}$$

Relative error of standard deviation in percent (*RS%*):

$$RS\% = RS \times 100 = \frac{cd - rd}{rd} \times 100$$

Mean absolute error (*MAE*):

$$MAE = \frac{\sum_{i=1}^{mi} \left| c_i - r_i \right|}{mi}$$

Kling-Gupta efficiency (*KGE*):

$$KGE = 1 - \sqrt{\left(CC - 1\right)^2 + \left(\frac{cd}{rd} - 1\right)^2 + \left(\frac{cm}{rm} - 1\right)^2}$$

Pearson correlation coefficient, Kling-Gupta efficiency part 1 (*CC*):

$$CC = \frac{\frac{1}{mi} \sum_{i=1}^{mi} \left(r_i \times c_i\right) - cm \times rm}{cd \times rd}$$

Kling-Gupta efficiency part 2 (*KGESD*):

$$KGESD = \frac{cd}{rd}$$

Kling-Gupta efficiency part 3 (*KGEM*):

$$KGEM = \frac{cm}{rm}$$

Root mean square error (*RMSE*):

$$RMSE = \sqrt{\frac{1}{mi} \sum_{i=1}^{mi} \left(c_i - r_i\right)^2}$$

Normalised root mean square error (*NE*):

$$NE = \frac{\sqrt{\frac{1}{mi} \sum_{i=1}^{mi} \left(c_i - r_i\right)^2}}{\max\left(r_i\right)}$$

Kendalls rank correlation coefficient, tau-b, with adjustments for ties (*TAU*):

$$TAU = \frac{n_c - n_d}{\sqrt{\left(n_0 - n_1\right)\left(n_0 - n_2\right)}}$$

Nash-Sutcliffe Efficiency adjusted for bias (*NSEW*). Introduced in Lindström (2016):

$$NSEW = NSE - \frac{Bias^2}{rd^2}$$

where

n_c = number of concordant pairs ($c_i < c_k \, and \, r_i < r_k \, or \, c_i > c_k \, and \, r_i > r_k, i=1, mi \, k=1, mi$)

n_d = number of discordant pairs ($c_i < c_k \, and \, r_i > r_k \, or \, c_i > c_k \, and \, r_i < r_k, i=1, mi \, k=1, mi$)

n_0 = number of compared pairs

n_1 = number of compared pairs that ties in the computed values

n_2 = number of compared pairs that ties in the recorded values

Criteria equations for a model domain (several stations)

Average Nash-Sutcliffe efficiency (*AVNSE*):

$$AVNSE = \frac{1}{mj} \sum_{j=1}^{mj} NSE_j$$

Median Nash-Sutcliffe efficiency (*MEDNSE*):

$$MEDNSE = median \left\{ NSE_j, j=1..mj \right\}$$

Spatial Nash-Sutcliffe efficiency (*SPATNSE*):

$$SPATNSE = 1 - \frac{\displaystyle\sum_{j=1}^{mj} \left(cm_j - rm_j \right)^2}{\displaystyle\sum_{j=1}^{mj} \left(rm_j - \frac{1}{mj} \sum_{j=1}^{mj} rm_j \right)^2}$$

Regional Nash-Sutcliffe efficiency (*REGNSE*):

$$REGNSE = 1 - \frac{\sum_{ij=1}^{mij} \left(c_{ij} - r_{ij} \right)^2}{\sum_{ij=1}^{mij} \left(r_{ij} - \frac{1}{mij} \sum_{ij=1}^{mij} r_{ij} \right)^2}$$

Average efficiency with coefficient a (AVRA):

$$AVRA = \frac{1}{mj} \sum_{j=1}^{mj} RA_j$$

Median efficiency with coefficient a (MEDRA):

$$MEDRA = median \left\{ RA_j, j = 1..mj \right\}$$

Spatial efficiency with coefficient a (SPATRA):

$$SPATRA = 1 - \frac{\sum_{j=1}^{mj} \left| cm_j - rm_j \right|^a}{\sum_{j=1}^{mj} \left| rm_j - \frac{1}{mj} \sum_{j=1}^{mj} rm_j \right|^a}$$

Regional efficiency with coefficient a (REGRA):

$$REGRA = 1 - \frac{\sum_{ij=1}^{mij} \left| c_{ij} - r_{ij} \right|^a}{\sum_{ij=1}^{mij} \left| r_{ij} - \frac{1}{mij} \sum_{ij=1}^{mij} r_{ij} \right|^a}$$

Average relative bias (AVRB):

$$AVRB = \frac{1}{mj} \sum_{j=1}^{mj} RB_j$$

Regional relative bias (REGRB):

$$REGRB = \frac{\sum_{ij=1}^{mij} \left(c_{ij} - r_{ij} \right)}{\left| \sum_{ij=1}^{mij} r_{ij} \right|}$$

Spatial relative bias (*SPATRB*):

$$SPATRB = \frac{\sum_{j=1}^{mj} \left(cm_j - rm_j \right)}{\left| \sum_{j=1}^{mj} rm_j \right|}$$

Average Kling-Gupta efficiency (*AVKGE*):

$$AVKGE = \frac{1}{mj} \sum_{j=1}^{mj} KGE_j$$

Median Kling-Gupta efficiency (*MEDKGE*):

$$MEDKGE = median \left\{ KGE_j, j=1..mj \right\}$$

Median of Normalised root mean square error (*MEDNE*):

$$MEDNE = median \left\{ NE_j, j=1..mj \right\}$$

Average of absolute relative bias (*AVARB*):

$$AVARB = \frac{1}{mj} \sum_{j=1}^{mj} \left| RB_j \right|$$

Average Pearson correlation coefficient (*AVCC*):

$$AVCC = \frac{1}{mj} \sum_{j=1}^{mj} CC_j$$

Average relative error of standard deviation (*AVRSB*):

$$AVRSB = \frac{1}{mj} \sum_{j=1}^{mj} RS_j$$

Average Kendalls rank correlation coefficient (*AVTAU*):

$$AVTAU = \frac{1}{mj} \sum_{j=1}^{mj} TAU_j$$

Regional mean absolute error (*REGMAE*):

$$REGMAE = \frac{\sum_{ij=1}^{mij} |c_{ij} - r_{ij}|}{mij}$$

Average Nash-Sutcliffe efficiency adjusted for bias (*AVNSEW*):

$$AVNSEW = \frac{1}{mj} \sum_{j=1}^{mj} NSEW_j$$

References

Lindström, G., 2016. Lake water levels for calibration of the S-HYPE model. Hydrology Research 47.4:672-682. doi: 10.2166/nh.2016.019.

pmsf.txt

The pmsf-file is used to simulate a selection of a larger HYPE model setup, while still keeping the files for the larger model intact. The file defines the selection of subbasins to simulate as a submodel. To run a subset of a model with *pmsf.txt*, use the code `submodel` in *info.txt*. The name "pmsf" is short for "partial model setup file".

The file is placed in the same folder as info.txt. Subbasins provided in the file must represent "complete basins", i.e. include all upstream subbasins and also all basins linked through irrigation sources in MgmtData.txt or through regional aquifers in AquiferData.txt.

pmsf.txt are simple text files with the total number of subbasins in the selected submodel written in the first line, and whitespace-separated subids listed from row 2. There is no limit in number of rows with subids (line breaks are treated as whitespace). The given subids can be listed in any order. Subids listed must be a selection of those provided in GeoData.txt).

Example for a *pmsf.txt* file structure with 8 sub-basins:

```
8
345  456  464  579  204
496   56  654
```

update.txt

The file is located in the [modeldir](#) folder and contains information on updating of modeled fluxes using observations. This means that the values (e.g of flow or water stage) are changed for the rest of the simulation. The file holds the subbasins that will be updated (the order is irrelevant). Only subbasins which are to be updated have to be listed here. Updating is activated through [codes in info.txt](#).

update.txt is a tab-separated text file. The first row contains column headings, following rows hold data. Comment columns are allowed and ignored by HYPE, but the total number of columns must not exceed 20. A text column may contain at most 100 characters.

The following columns are read by HYPE:

Column ID	Format	Description
`arfact`	*0-1*	AR-factor for updating method `qar` for discharge and `war` for discharge
`subid`	*integer*	subbasin ID (mandatory)
`quseobs`	*0/1*	status for discharge updating with the quseobs method
`qarupd`	*0/1*	status for discharge AR-updating with the qar method
`tpcorr`	*fraction*	change in SP and PP concentration out of subbasin, e.g. -0.1 for 10% reduction
`tncorr`	*fraction*	change in IN and ON concentration out of subbasin
`tploccorr`	*fraction*	change in SP and PP concentration out of local river
`tnloccorr`	*fraction*	change in IN and ON concentration out of local river
`warupd`	*0/1*	status for discharge updating with waterstage AR-method
`wendupd`	*0/1*	status for waterstage updating with the wendupd method

GeoClass.txt

SLC classes divide the subbasins of the model based on land use etc. The *GeoClass.txt* file describes the characteristics of all classes. The SLC classes are defined as combinations of soil type and land use/land cover, but can also have other properties that separates them. SLC stands for Soil type - Land use Combination. The classes as defined in HYPE act as Hydrological Response Units (HRU).

Lakes, rivers and glaciers make up special classes. There can be only one of each special class in a model. All other classes are land classes made up by combinations of land use and soil type. Two land classes can have the same land use and soil type, but differ in other aspects, e.g. soil depth or crop/vegetation. Additional information for land classes are tile drainage depth and stream drainage depth.

File content

The *GeoClass.txt* file is located in the modeldir folder. Information for a SLC is given on a single row in the file. The information is given with a predefined order of columns. The column values are separated by blanks or tabs. Comment rows can be added and are denoted with a '!' in the first position. A maximum of 999 classes can be defined. The order of SLC:s in *GeoClass.txt* is the same order that is used in GeoData.txt (slc_nn).

Example snippet of a *GeoClass.txt* file structure:

```
! Three classes in this set up:
! grass on sand, forest on sand, forest on till soil.
! Two landuses: 1=grass, 2=forest and two soil types: 1=sand, 2=till
! No Lu  St  Cl ...
1    1   1   1  ...
2    2   1   2  ...
3    2   2   2  ...
```

Description of class characteristics provided in *GeoClass.txt* columns:

Column	Unit	Data	Description
1	-	SLC	Soil type-land use combination. Should be 1,2,3... in order. The number is the same used for the class's area fraction (slc_nn) in GeoData.txt.
2	-	Land use/Land cover code	An integer 1,2,3,.. The land use code is determined by the modeller, e.g. 1 could be water, 2 grass, 3 forest. Used for land use dependent model parameters.
3	-	Soil type code	An integer 1,2,3,.. The soil type code is determined by the modeller, e.g. 1 could be peat, 2 till soil, 3 sand. Used for soil type dependent model parameters.
4	-	Main crop cropid	An integer 1,2,3,.. The cropid is determined by the modeller, and couples the class to a vegetation/crop in CropData.txt. Used for nutrient simulation and irrigation classes. If not relevant, e.g. for water classes, set to 0.

Column	Unit	Data	Description
5	-	Second crop cropid	An integer 1,2,3,... Some agriculture land has a secondary crop, e.g. a catch crop. If not relevant set to 0.
6	-	Crop rotation group	An integer 0,1,2,... Determines which crops/classes are inter-changed on a piece of land. 0=no crop rotation for this class, 1=class belong to crop rotation group 1, etc. The classes within the same crop rotation group will exchange soil nutrients. The crop rotation is only used for NP-simulations.
7	-	Vegetation type	The vegetation types are pre-defined in HYPE: 1=open, 2=forest, 3=water. The vegetation type is only used for NP-simulations (atmospheric deposition) and snow output (C106-C214). If not set (0) vegetation type 1 will be used.
8	-	Special class code	Some classes are special and separated by this code. Use 0 for all others. The following classes are pre-defined in HYPE: 1=outlet lake, 2=internal lake, 3=glacier, 11=local stream, 12=main river, 13=internal wetland (iwet), 14=outlet wetland (owet).
9	*m*	Tile depth	Distance from soil surface to (average) tile drainage system level. Set to 0 to not use tile drainage routine. Tiledepth should be zero for special wetlands classes.
10	*m*	Stream depth	Distance from soil surface to local stream depth. The depth may not be larger than the total soil profile depth for the class (last column). Streamdepth are set to zero for special wetland classes, or a negative streamdepth can be used to set the outflow threshold above land surface.
11	-	Number of soil layers	May be 1 to 3. For water classes set 1 layer with depth 1 m (the values are not used).
12	*m*	Soil layer depth	Distance from the soil surface to the bottom of the uppermost soil layer.
13	*m*	Soil layer depth	Distance from the soil surface to the bottom of the second soil layer. Must be larger than (or equal) to previous depth. If less than two layers set value equal to soil layer one.
14	*m*	Soil layer depth	Distance from the soil surface to the bottom of the third soil layer. Must be larger than (or equal) to previous depth. If less than three layers set value equal to soil layer two.

GeoData.txt

This file contains characteristics of the spatially delineated sub-basins in a HYPE model domain. This includes e.g. SUBIDs (sub-basin IDs) and SUBIDs of downstream sub-basins, fractions of SLC classes (hydrological response units) within each sub-basin, different model region (sub-domain) identifiers. As a general rule, information included in *GeoData.txt* is time-invariant within HYPE.

GeoData.txt is a tab-separated file located in the modeldir folder. Sub-basins are listed row-wise. The first row contains a column header with variable names. Variable names are not case-sensitive (max. 10 characters, no spaces). Columns with headings unknown to HYPE are skipped while reading the file, but must not longer than ten characters. Columns containing character strings, e.g. descriptive meta-data, must not exceed a length of 100 characters. The columns may be in any order. A value must exist for every column and row, i.e. empty cells are not allowed.

Sub-basins have to be ordered in down-stream sequence in *GeoData.txt*, starting at headwaters and ending at outlet basins. This is because HYPE requires upstream contributions whe computing fluxes at each sub-basin and sub-basin the computation sequence follows *GeoData.txt* rows. Note that bifurcations as given in input file BranchData.txt will create additional upstream areas and the row order in *GeoData.txt* must also take those contributions into account.

Example for a *GeoData.txt* file structure:

```
subid maindown area parreg lakedataid rivlen slc_1 slc_2 slc_3 slc_4 scr_1
...
1     3        5000 1      1          0      0.54  0.23  0.1   0.13  0.1
...
2     3        3000 1      0          0      0.45  0.5   0.05  0
...
3     0        6000 2      2          500    0.45  0     0.25  0.3   0.2
...
...   ...      ...  ...    ...        ...    ...   ...   ...   ...   ...
...
```

All *GeoData.txt* variables are described in the table below. Point source can no longer be given in this file, use input file PointSourceData.txt instead.

Variable ID	Unit	Requirement	Description
area	m^2	mandatory	subbasin area
subid	-	mandatory	id number for subbasins, matched against Qobs.txt and Xobs.txt column headings, integer $< 10^7$
maindown	-	mandatory	subid of downstream sub-basin, i.e. the one to which the subbasin flows (integer, use 0 for subbasins that don't run to another subbasin, e.g. coastal areas)
latitude	°	optional	latitude in degrees N (-90,90), used for calculation of extraterrestrial radiation in Hargreaves-Samani evapotranspiration model
region	-	optional/mandatory	production region for crops in CropData.txt. All sub-basins must have a non-zero region defined if CropData.txt is used.

Variable ID	Unit	Requirement	Description
parreg	-	optional	region for correction parameters (e.g. evapcorr), integer > 0, default is 1
wqparreg	-	optional	region for water quality correction parameters (e.g. incorr), integer > 0, default is 1
lakeregion	-	optional	lake region for watercourse parameter, integer > 0, default is 1
ilregion	-	optional	lake region for ilake parameters, integer > 0, default is 1
olregion	-	optional	lake region for olake parameters, integer > 0, default is 1
elev_mean	*m*	optional	mean elevation of sub-basin
elev_std	*m*	optional	variation (standard deviation) in elevation in a subbasin
slope_mean	%	optional/mandatory	slope (>= 0%), mandatory for nutrient modelling
slope_std	%	optional	variation (standard deviation) of slope in a subbasin
lake_depth	*m*	optional	water depth from outflow threshold, below which outlet flow ceases, down to mean depth for outlet lake, used for general lake discharge curve. Can also be defined in LakeData.txt or par.txt. Definition in LakeData takes precedence. Must be > 0, or set to -9999 to use general or region parameter value from par.txt.
lakedataid	-	optional	lake or lake basin ID, coupled to *lakedataid* in LakeData.txt, 0 if no such coupling exists
icatch	-	optional	fraction of local runoff that goes through the local lake (ilake), the rests runs directly into the main watercourse. To instead use parameter values (gicatch, ilicatch in par.txt) for a single simulation set value to -9999 in GeoData or remove the column completely.
rivlen	*m*	mandatory	length of main watercourse within subbasin
loc_rivlen	*m*	optional	length of local watercourse within subbasin, default is square root of land area
slc_nn	-	mandatory	soil-type/land-use class number *nn* (soil-landuse-combination class, hydrological response units in HYPE), fraction of the subbasin's area belonging to this class (between 0 and 1). A maximum of 999 SLCs can be defined *nn* matches the first column in GeoClass.txt. Smallest slc fraction allowed is 10^{-7}, i.e. 7 decimals.
scr_nn	-	optional	fraction of SLC class nn's area that is sown with secondary crop (between 0 and 1)
dhslc_nn	*m*	optional	deviation for each class from mean elevation of subbasin (defaults to 0)
grwdown	-	optional	subid for the subbasin to which this subbasin's lateral/regional groundwater flow runs (use 0 for subbasins whose groundwater flow disappears). If column is missing or all zeros it is assumed that the groundwater flows via maindown.

Variable ID	Unit	Requirement	Description
grwolake	-	optional	fraction of groundwater flow from this subbasin that flows to this subbasins olake instead of to subbasin given in grwdown
loc_tp	*mg/l*	optional	concentration of Tot-P from rural households outflow
loc_tn	*mg/l*	optional	concentration of Tot-N from rural households outflow
loc_ts	*mg/l*	optional	concentration of total suspended material from rural households outflow
loc_vol	m^3/d	optional	outflow from rural households
loc_sp	-	optional	fraction of rural household P outlet that is in soluble form
loc_in	-	optional	fraction of rural household N outlet that is inorganic
loc_ss	-	optional	fraction of rural total suspended material outlet that is is suspended material
loc_t1	*µU/L*	optional	concentration of tracer T1 from rural households outflow
loc_t2	*°C*	optional	temperature of rural households outflow (used for T2 simulation)
wetdep_n	*µg/l*	optional	wet deposition of inorganic nitrogen, concentration of precipitation
drydep_n1	$kg/(km^2 d)$	optional	dry deposition of inorganic nitrogen on vegetation type 1 (open)
drydep_n2	$kg/(km^2 d)$	optional	dry deposition of inorganic nitrogen on vegetation type 2 (forest)
drydep_n3	$kg/(km^2 d)$	optional	dry deposition of inorganic nitrogen on "vegetation" type 3 (water)
deploadn1 - deploadn12	$kg/(km^2 d)$	optional	total deposition of inorganic nitrogen on water, January - December
lrwet_area	m^2	optional	area of local river wetland
mrwet_area	m^2	optional	area of main river wetland
lrwet_dep	*m*	optional	mean depth of local river wetland
mrwet_dep	*m*	optional	mean depth of main river wetland
lrwet_part	-	optional	part of local river flow through river wetland
mrwet_part	-	optional	part of main river flow through river wetland
iwetcatch	-	optional	fraction of subbasin area that are catchment area of the internal wetland (iwet)
buffer	-	optional	fraction of watercourse through agricultural land that has a buffer zone (between 0 and 1), mandatory for phosphorus simulation
close_w	-	optional	fraction of agricultural land that lies near watercourse and which leakage therefore is affected by the buffer zone (between 0 and 1), mandatory for phosphorus simulation

Variable ID	Unit	Requirement	Description
petmodel	-	optional	defines with alternative potential evapotranspiration model should be used for each subbasin. Default is temperature dependence or use of observations (0), alternatives are temperature dependent (1), modified Jensen-Haise/McGuinness (2), modified Hargreaves-Samani (3), Priestly-Taylor (4), and FAO Penman-Monteith reference crop evapotranspiration (5). Note: will override petmodel given in info.txt
eroindex	-	optional	erosion index given per subbasin, used for erosion model 1 (defaults to 1)

BranchData.txt

This file contains all bifurcations within a HYPE model domain. Bifurcations are stream splits in downstream direction. They can occur naturally, but are often used in HYPE to describe inter-catchment water transfers for e.g. hydropower production. HYPE allows to split water flows by fixed fractions (`mainpart`) and optionally to define minimum and maximum flow limits. Another way to determine branch flow is through lakes with two outlets defined in LakeData.txt. Then only the path of the branch is necessary to give in BranchData.txt, but `mainpart` can also be given. It is used to calculate the upstream area of the subbasin, which in turn is used for calculating initial volume of main river, general rating curve parameters, upstream-area-output variables etc. A third way to define branch flow is by prescribing a constant or a time series of the wanted flow.

BranchData.txt is a tab-separated file located in the modeldir folder. Sub-basins with bifurcations are listed row-wise. The first row contains a column header with variable names. Variable names are not case-sensitive (max. 10 characters, no spaces). Columns with headings unknown to HYPE are skipped while reading the file, but must not longer than ten characters. Columns containing character strings, e.g. descriptive meta-data, must not exceed a length of 100 characters. The columns may be in any order. A value must exist for every column and row, i.e. empty cells are not allowed.

Example for a *BranchData.txt* file structure with two bifurcations:

```
name          sourceid branchid mainpart maxqmain minqmain maxqbranch
bifurcation1 43        576      0.9      5000     350      1
bifurcation2 3955      2301     0.5      0        0        500
```

The table below describes all *BranchData.txt* columns read by HYPE.

Variable ID	Unit	Description
sourceid	-	SUBID of sub-basin with bifurcation, i.e. with two downstream sub-basins
branchid	-	SUBID of sub-basin receiving the second branch flow, must be located in a row below the sub-basin with bifurcation in GeoData.txt
mainpart	-	fraction of flow from subbasin sourceid that flows in the main branch (as given in column *maindown* in GeoData.txt) (between 0 and 1). Default is 1.
maxQmain	m^3/s	maximum flow that is allowed in the main branch. Use 0 for no limitation or exclude column completely.
minQmain	m^3/s	minimum flow that is required in the main branch before water is routed into branch. Use 0 for no limitation or exclude column completely.
maxQbranch	m^3/s	maximum flow that is allowed in the branch. Use 0 for no limitation or exclude column completely.
Qbranch	-	the flow of the branch is prescribed; 0 (default) not use, 1 read flow from Xobs.txt (dwtr)

LakeData.txt

This file contains lake properties for **outlet lakes** with specific data available. Properties defined here override the properties and generic parameters given in GeoData.txt and par.txt. If you want to use a generic parameter from par.txt for a particular lake in *LakeData.txt*, use -9999 as parameter value for that lake in *LakeData.txt*. Lake depth from GeoData.txt may also be kept by using -9999 for the value in *LakeData.txt*. Lake properties include physical characteristics, e.g. depth, and outlet rating curve, regulation routine parameters, and parameters concerning nutrient cycling within the lake. In *LakeData.txt*, two regulation regimes can be defined; constant flow and seasonally varying sinus-wave shaped flow. For more regulation options, use DamData.txt, which extends the regulation options provided here.

Outlet lakes in HYPE can cover a fraction of a sub-basin or the whole sub-basin. Large lake systems can be split into several sub-basins themselves (lake basins), which allows for different properties in different lake basins. Outlet flows for such lakes are then defined in an additional entry in *LakeData.txt*, see variable and column LdType in table below. Smaller lakes that are not divided into lakebasins may have two outlets defined in LakeData.txt (see model description. These outlets are defined by `ldtype` 5 and 6 for the main outlet and the branch outlet. For these lakes only the downstream subid of the branch need to be given in BranchData.txt.

LakeData.txt is a tab-separated file located in the modeldir folder. Lakes and lake basins are listed row-wise. The first row contains a column header with variable names. Variable names are not case-sensitive (max. 10 characters, no spaces). Columns with headings unknown to HYPE are skipped while reading the file, but the column heading must not be longer than ten characters. Columns containing character strings, e.g. descriptive data, must not exceed a length of 100 characters. The columns may be in any order. A value must exist for all columns which cannot be alternatively defined in par.txt, see column description in table below.

Example snippet of a *LakeData.txt* file structure, showing an unregulated single basin lake, and a regulated lake with two lake basins:

```
LAKEDATAID LAKEID LDTYPE LAKE_DEPTH   AREA W0REF QPROD1 DATUM1 REGVOL RATE
EXP ...
         1      0      1         3.6   5000  7.67      0      0      0   40
2 ...
         0      1      2         7.2  34000 21.94   13.5    401    200  155
0.3 ...
         2      1      3         6.9   4000     0      0      0      0    0
0 ...
         3      1      4           5  30000     0      0      0      0    0
0 ...
       ...    ...    ...         ...    ...   ...    ...    ...    ...  ...
... ...
```

The table below describes all *LakeData.txt* columns read by HYPE.

Variable ID	Unit	Type	LdType	Description
lakedataid	-	*general*	*1/3/4/5*	lake/lake basin ID (integer), used to connect lakes/lake basins to subbasins in GeoData.txt (mandatory). Only main outlet of lake with two outlets have lakedataid. The second outlet should have lakedataid=0. Otherwise the lakedataid must be a unique positive integer.
lakeid	-	*general*	*2/3/4/5/6*	lake ID (integer), used to connect lake basins to multi-basin lakes and and outlets to same lake with two outlets. Unique positive integer, 0 for simple outlet lakes (ldtype = 1)
ldtype	-	*general*	*all*	code for lake data type, integer (mandatory): **1** - simple outlet lake **2** - multi-basin lake, i.e. covering several HYPE sub-basins, generic lake/outflow properties **3** - upstream lake basin of a multi-basin lake **4** - last/outlet lake basin of a multi-basin lake **5** - lake with two outlets, main outlet **6** - lake with two outlets, second outlet
lake_depth	*m*	*physical property*	*1/3/4/5*	water depth below threshold for outlet lake (mean depth), can also be defined in GeoData.txt (must be > 0). Not used for outlet 2 of lake with two outlets.
area	m^2	*physical property*	*1-5*	lake or lake basin area, used for multi-basin lakes and to check which fraction of the sub-basin is covered by the outlet lake for simple outlet lakes (compared with SLC class fraction in GeoData.txt), mandatory for ldtype = 2
w0ref	*m*	*general*	*1/2/5/6*	reference water level to be added to simulated water level before print out, for lake outflow threshold. This column has a different meaning for ldtype=6, where it is used as the relative difference to the threshold (w0ref) of outlet 1.
rate	-	*general/regulation*	*1/2/5/6*	parameter for specific rating curve of unregulated lakes or for spillway flow of regulated lakes above threshold (w0ref), equation $q = rate\ (w - w0)^{exp}$.
exp	-	*general/regulation*	*1/2/5/6*	parameter for specific rating curve of unregulated lakes or for spillway flow of regulated lakes above threshold (w0ref), equation $q = rate\ (w - w0)^{exp}$
deltaw0	*m*	*regulation*	*1/2/5/6*	difference in lake threshold for regulation with two rating curves (m). Determines the lake threshold for regulation period 2 (w0=w0ref + deltaw0), see datum1 and datum2
qprod1	m^3/s	*regulation*	*1/2/5/6*	parameter for regulated olake, constant production flow down to lowest allowed waterstage for regulation period 1
qprod2	m^3/s	*regulation*	*1/2/5/6*	parameter for regulated olake, constant production flow down to lowest allowed waterstage for regulation period 2
datum1	-	*regulation*	*1/2/5/6*	parameter for regulated olake, start of regulation period 1 (if not defined only one period is used) (4 character month-day string *mmdd*)

Variable ID	Unit	Type	LdType	Description
datum2	-	*regulation*	*1/2/5/6*	parameter for regulated olake, start of regulation period 2 (4 character month-day string *mmdd*)
qamp	-	*regulation*	*1/2/5/6*	parameter for regulated olake, seasonally varying flow in regulated volume. Variation defined in form of a sinus wave with this amplitude (as fraction of current qprod: 0-1), where the minimum of the sinus wave occurs for day number qpha
qpha	-	*regulation*	*1/2/5/6*	parameter for regulated olake, seasonally varying flow below the threshold. Default is qpha = 102.
regvol	$10^6\ m^3$	*regulation*	*1/2/5/6*	regulation volume for general regulation routine. Determines lowest water stage for production flow (*wmin*). (must be less than lake depth * lake area)
wamp	m	*regulation*	*1/2/5/6*	regulation amplitude. Usually larger than water depth given by regvol. Used for scaling computed water stage variation (below threshold) similar to variation of observations. Set to -9999 for not to use.
maxQprod	m^3/s	*regulation*	*5/6*	maximum allowed production flow. Usually larger than daily production flow. Will reduce the number of spill occations and the spill flow. Only used for lakes with 2 outlets.
minflow	-	*regulation*	*5/6*	flag for minimum allowed flow. If set to one, the actual minimum flow will be determined by production flow parameters. Only used for lakes with 2 outlets.
obsflow	-	*regulation*	*6*	flag for using wanted water transfer flow for second outlet, 0=no (default), 1=yes. Only used for lakes with 2 outlets.
limqprod	-	*regulation*	*1/3/4/5*	water level below which there is reduced production flow from a dam (fraction of regulating volume), the flow reduction is linear to *wmin* (lowest water stage for production flow). Can also be defined in [par.txt](par.txt)
prodpp	m/d	*nutrient cycling*	*1/3/4/5*	parameter for internal load of Part-P
prodsp	m/d	*nutrient cycling*	*1/3/4/5*	parameter for internal load of SRP (m/d)
Qmean	mm/y	*physical property*	*1/3/4/5*	initial value for calculation of mean flow, can also be defined in [par.txt](par.txt)
tpmean	mg/l	*nutrient cycling*	*1/3/4/5*	mean concentration of total P, used for production if P is not simulated. Also used as initial value of particulate P concentration in lakes. Can also be defined in [par.txt](par.txt)
tnmean	mg/l	*nutrient cycling*	*1/3/4/5*	mean concentration of total N (mg/l), used as initial value N concentration in lakes. Can also be defined in [par.txt](par.txt)
tocmean	mg/l	*nutrient cycling*	*1/3/4/5*	mean concentration of TOC (mg/l), used as initial value of TOC concentration in lakes. Can also be defined in [par.txt](par.txt)
sedon	m/d	*nutrient cycling*	*1/3/4/5*	sedimentation rate for ON in lakes. Can also be defined in [par.txt](par.txt)
sedpp	m/d	*nutrient cycling*	*1/3/4/5*	sedimentation rate for PP in lakes. Can also be defined in [par.txt](par.txt)

Variable ID	Unit	Type	LdType	Description
sedoc	m/d	nutrient cycling	1/3/4/5	sedimentation rate for OC in lakes. Can also be defined in par.txt
wprodn	kg/(m³ d)	nutrient cycling	1/3/4/5	production/degradation in water for N. Can also be defined in par.txt
wprodp	kg/(m³ d)	nutrient cycling	1/3/4/5	production/degradation in water for P. Can also be defined in par.txt
wprodc	kg/(m³ d)	nutrient cycling	1/3/4/5	production/degradation in water for C. Can also be defined in par.txt.
denitwl	kg/(m² d)	nutrient cycling	1/3/4/5	parameter for denitrification in lakes. Can also be defined in par.txt
deeplake	-	physical property	1/3/4/5	fraction of the lake's initial volume which is considered as slow (SLP), between 0 and 1. 0 means that the lake is not divided into a slow and a fast part. Can also be defined in par.txt
fastlake	-	physical property	1/3/4/5	parameter determining the fraction of lake outflow from the different lake parts (FLP, SLP). Varies between 0 (default, no outflow from FLP) to 1 (outflow fractions proportional to FLP and SLP volumes). Can also be defined in par.txt
t2mix	-	physical property	1/3/4/5	switch for using mixed lake T2 temperature on outflow of lake (0/1). Can also be defined in par.txt

DamData.txt

This file contains dam properties for **outlet lakes** that operate as reservoirs (i.e. dams) and which do not use general parameters (so the term olake below refers to those olakes that are reservoirs/dams). Properties defined here override the properties and generic parameters given in GeoData.txt and par.txt. Lake depth from GeoData.txt may also be kept by using -9999 for the value in *DamData.txt*. Dams defined in *DamData.txt* can not be included in LakeData.txt (with the exception of a LakeData.txt with only nutrient model parameters). Dam properties include physical characteristics, e.g. depth, and regulation routine parameters. In *DamData.txt*, four different dam types with different purposes may be used. These are irrigation dam, water supply dam, flood control dam and hydropower dam. Each typ has its own rules for regulation. Hydropower dams are regulated similar to the routines in LakeData.txt, but not totally.

DamData.txt can only be used for standard olakes (ldtype 1, see `ldtype` definition in LakeData.txt), no lakebasins are allowed.

DamData.txt is a tab-separated file located in the modeldir folder. Lakes are listed row-wise. The first row contains a column header with variable names. Variable names are not case-sensitive (max. 10 characters, no spaces). Columns with headings unknown to HYPE are skipped while reading the file. Columns containing character strings, e.g. descriptive meta-data, must not exceed a length of 100 characters. The columns may be in any order. A value must exist for every column and row, i.e. empty cells are not allowed, with the exception of column `lake_depth`, see first paragraph. Maximum 50 columns allowed.

Example snippet of a *DamData.txt* file structure:

```
PURPOSE SUBID LAKE_DEPTH REGVOL RATE EXP  W0REF SNOWFRAC QINFJAN QINFFEB
QINFMAR ...
4       25    16.7       189    100  1.5  104   0.27     18.8    16.3
16.5    ...
4       34    55.7       85     75   1.5  0     0.61     5.3     5.1     4.1
...
...     ...   ...        ...    ...  ...  ...   ...      ...     ...     ...
...
```

The table below describes all *DamData.txt* columns read by HYPE.

Variable ID	Unit	Purpose	Description
subid	-	*all*	subbasin ID (integer), used to connect lake basins to lakes (mandatory)
purpose	-	*all*	the main purpose of the reservoir, 1= irrigation, 2=water supply, 3=flood control, 4=hydropower (mandatory)
lake_depth	*m*	*all*	water depth below threshold for outlet lake (mean depth), can also be defined in GeoData.txt (must be > 0)
w0ref	*m*	*all*	reference water level to be added to simulated water level before print out, for lake outflow threshold
qprod1	m^3/s	*1/2/4*	parameter for regulated olake, constant production flow down to lowest allowed waterstage for regulation period 1

Variable ID	Unit	Purpose	Description
qprod2	m^3/s	1/2/4	parameter for regulated olake, constant production flow down to lowest allowed waterstage for regulation period 2
datum1	-	1/2/4	parameter for regulated olake, start of regulation period 1 (if not defined only one period is used) (4 character month-day string *mmdd*)
datum2	-	1/2/4	parameter for regulated olake, start of regulation period 2 (4 character month-day string *mmdd*)
qamp	-	4	parameter for regulated olake, seasonally varying flow in regulated volume. Variation defined in form of a sinus wave with this amplitude (as fraction of current qprod: 0-1), where the minimum of the sinus wave occurs for day number qpha
qpha	-	4	parameter for regulated olake, seasonally varying flow below the threshold. Default is qpha = 102.
snowfrac	-	4	fraction of the precipitation in the dam's catchment that falls as snow (can be taken from a model run with this as output), used to give default seasonal varying production flow for high latitude dams (for snowfrac>0.35: qamp=0.71, qpha must be set)
rate	-	all	parameter for specific rating curve of unregulated lakes or for spillway flow of regulated olakes above threshold (w0ref), equation $q = rate\ (w - w0)^{\wedge}exp$
exp	-	all	parameter for specific rating curve or for spillway flow of regulated olake above threshold (w0ref), equation $q = rate\ (w - w0)^{\wedge}exp$
regvol	10^6 m^3	all	regulation volume for general regulation routine. Determines lowest water stage for production flow. (must be less than lake depth * lake area) (suggest 85% of dam volume if data can't be found)
wamp	m	all	regulation amplitude. Usually larger than water depth given by regvol. Used for scaling computed water stage variation (below threshold) similar to variation of observations. Set to -9999 for not to use.
qinfjan	m^3/s	all	mean January inflow to reservoir (can be taken from a model run without reservoirs for example)
qinffeb	m^3/s	all	mean Fabruary inflow to reservoir (can be taken from a model run without reservoirs for example)
qinfmar	m^3/s	all	mean March inflow to reservoir (can be taken from a model run without reservoirs for example)
qinfapr	m^3/s	all	mean April inflow to reservoir (can be taken from a model run without reservoirs for example)
qinfmay	m^3/s	all	mean May inflow to reservoir (can be taken from a model run without reservoirs for example)
qinfjun	m^3/s	all	mean June inflow to reservoir (can be taken from a model run without reservoirs for example)
qinfjul	m^3/s	all	mean July inflow to reservoir (can be taken from a model run without reservoirs for example)
qinfaug	m^3/s	all	mean August inflow to reservoir (can be taken from a model run without reservoirs for example)
qinfsep	m^3/s	all	mean September inflow to reservoir (can be taken from a model run without reservoirs for example)
qinfoct	m^3/s	all	mean October inflow to reservoir (can be taken from a model run without reservoirs for example)
qinfnov	m^3/s	all	mean November inflow to reservoir (can be taken from a model run without reservoirs for example)

Variable ID	Unit	Purpose	Description
qinfdec	m^3/s	all	mean December inflow to reservoir (can be taken from a model run without reservoirs for example)

CropData.txt

This file includes variables relating to crops, including irrigation characteristics, and other vegetation. All vegetation is called crops in the text below, e.g. also forest. *CropData.txt* is **only needed for nutrient or irrigation modelling**, but can be used for water and tracer simulations. Crops in HYPE have a number of static properties, e.g. sowing and harvesting dates, which are read from *CropData.txt*. The handling of these properties assume the catchment is on the Northern hemisphere, i.e. that summer is the growing season. Crops are part of the unique combination making up an SLC class, as defined in GeoClass.txt. To allow for modifying properties of a certain crop within the model domain, e.g. to reflect climate gradients, several crop regions can be defined with corresponding variables `region` in GeoData.txt and `reg` in *CropData.txt*.

CropData.txt is a tab-separated text file located in the modeldir folder. The first row contains a column header with variable names. Variable names are not case-sensitive (max. 10 characters, no spaces). The following rows contain variable values for each crop. Columns with headings unknown to HYPE are skipped while reading the file. A text column may contain at most 100 characters. The first column is often used for a descriptive name of the crop, and not read by HYPE. The columns may be in any order. A value must exist for every column and row, i.e. empty cells are not allowed.

Example for *CropData.txt* file structure:

```
name     nr  cropid reg fn1 fp1 fday1 fdown1 ...
grains  1   1      1   80  5   100   0.1    ...
grains  2   1      2   80  5   120   0.1    ...
grasses 3   2      1   0   0   100   0.1    ...
...     ... ...    ... ... ... ...   ...    ...
```

All crop characteristics are described in the table below. Column **Type** groups variables according to:

- **General**: IDs to connect crop properties to other indata.
- **Fertiliser**: Variables for fertiliser and manure application. ***NOTE:*** parameter `fertdays` in par.txt needs to be set to a value larger than zero for fertiliser and manure to be applied.
- **Turnover**: Crop growth and biomass turnover properties.
- **Irrigation**: Crop irrigation properties.
- **T1 source**: Tracer T1 application.

The general unit (U) is used in tables of parameters and input data where the unit is not defined.

1	nr	-	General	This column with row numbers is usually given to see the order of the crops, but is not read by the program.
2	cropid	-	General	crop ID number (used in GeoClass.txt)
3	reg	-	General	integer, agricultural region number (e.g. production region from agricultural statistics) (corresponds to region in GeoData.txt). Note, all regions defined in GeoData.txt must also be defined in CropData.txt
4	fn1	*kg/(ha yr)*	Fertiliser	amount of N in fertiliser (1st application) (100% IN)
5	fp1	*kg/(ha yr)*	Fertiliser	amount of P in fertiliser (1st application) (100% SP)
6	mn1	*kg/(ha yr)*	Fertiliser	amount of N in manure (1st application) (50% IN)
7	mp1	*kg/(ha yr)*	Fertiliser	amount of P in manure (1st application) (50% SP)

8	fday1	*julian day*	Fertiliser	day number for application of fertiliser (1st application)
9	mday1	*julian day*	Fertiliser	day number for application of manure (1st application)
10	fdown1	-	Fertiliser	fraction of fertiliser that is tilled down to second soil layer (1st application)
11	mdown1	-	Fertiliser	fraction of manure that is tilled down to second soil layer (1st application)
12	fn2	*kg/(ha yr)*	Fertiliser	amount of N in fertiliser (2nd application) (100% IN)
13	fp2	*kg/(ha yr)*	Fertiliser	amount of P in fertiliser (2nd application) (100% SP)
14	mn2	*kg/(ha yr)*	Fertiliser	amount of N manure (2nd application) (50% IN)
15	mp2	*kg/(ha yr)*	Fertiliser	amount of P manure (2nd application) (50% SP)
16	fday2	*julian day*	Fertiliser	day number for application of fertiliser (2nd application)
17	mday2	*julian day*	Fertiliser	day number for application of manure (2nd application)
18	fdown2	-	Fertiliser	fraction of fertiliser that is tilled down to second soil layer (2nd application)
19	mdown2	-	Fertiliser	fraction of manure that is tilled down to second soil layer (2nd application)
20	resn	*kg/(ha yr)*	Turnover	amount of N that is added to the pool stored in the soil from decaying plants
21	resp	*kg/(ha yr)*	Turnover	amount of P that is added to the pool stored in the soil from decaying plants
22	resc	*kg/(ha yr)*	Turnover	amount of organic C that is added to the pool stored in the soil from decaying plants
23	resday	*julian day*	Turnover	day number for application of decaying plants, if set to 0, a uniform application all year round is assumed
24	resdown	-	Turnover	fraction of decaying plants that are tilled down to the second soil layer
25	resfast	-	Turnover	fraction of decaying plants that are added to the fast turnover pool, used for N and P
26	up1	$g/(m^2\ y)$	Turnover	parameter for the crop's potential uptake function (logistic growth) - typically 20 g N/m2/year for grains, 40 g N/m2/year for grasses. Note: must be larger than or equal to up2. A value equal to up2 indicates no uptake of nutrients.
27	up2	-	Turnover	parameter for the crop's potential uptake function (logistic growth) - typically 1
28	up3	*1/day*	Turnover	parameter for the crop's potential uptake function (logistic growth) - typically 0.12 1/day
29	upupper	-	Turnover	fraction of nutrient uptake in uppermost soil layer
30	pnupr	-	Turnover	P-N relationship for nutrient uptake
31	bd1	*julian day*	Turnover	day number for spring ploughing, give 0 if no spring ploughing.
32	bd2	*julian day*	Turnover	day number for start of growth season in spring (typically sow date or a few days later). Default method for start of growth season, but also needed for ground cover/crop cover calculations.
33	bd3	*julian day*	Turnover	day number for harvest (end of growing season)
34	bd4	*julian day*	Turnover	day number for autumn ploughing, 0 if no autumn ploughing
35	bd5	*julian day*	Turnover	day number for autumn crop's grown season start (typically sow date or some days later), 0 if not used

36	ccmax1	-	Turnover	Maximum crop cover fraction (between 0 and 1) for harvested crops during the spring-summer growth period. **OR** Maximum crop cover fraction for permanent vegetation (e.g. forest).
37	ccmax2	-	Turnover	Maximum crop cover fraction (between 0 and 1) for harvested crops during the autumn-winter growth period (e.g. set to 0 for spring-sown crops, and to > 0 for autumn-sown crops). Always 0 for permanent vegetation.
38	gcmax1	-	Turnover	Maximum ground cover fraction (between 0 and 1) for harvested crops during the spring-summer growth period. **OR** Maximum ground cover fraction for permanent vegetation (e.g. forest).
39	gcmax2	-	Turnover	Maximum ground cover fraction (between 0 and 1) for harvested crops during the autumn-winter growth period. Always 0 for permanent vegetation.
40	plantday	julian day	Irrigation	day number for planting
41	lengthini	days	Irrigation	number of days for initial crop growth period
42	kcbini	-	Irrigation	basal crop coefficient for initial crop growth period
43	lengthdev	days	Irrigation	number of days for development crop growth period
44	lengthmid	days	Irrigation	number of days for middle crop growth period
45	kcbmid	-	Irrigation	basal crop coefficient for middle crop growth period
46	lengthlate	days	Irrigation	number of days for late crop growth period
47	kcbend	-	Irrigation	basal crop coefficient for end of late crop growth period
48	dlref	-	Irrigation	reference depletion level
49	imm_start	julian day	Irrigation	day number for start of immersion period. Zero (default) for non-immersed crops.
50	imm_end	julian day	Irrigation	day number for end of immersion period (immersion period must be contained in irrigation period). Zero (default) for non-immersed crops.
51	daylength	hours	Turnover	length of day needed to start accumulate GDD (alternative method for start of growth season)
52	gddsow	degreedays	Turnover	GDD needed to start growth season (alternative method for start of growth season)
53	basetemp	degree Celsius	Turnover	temperature deducted from airtemp when calculating GDD (typical value 0-10) (alternative method for start of growth season)
54	firstday	julian day	Turnover	first day when GDD accumulation can start. Usually set to 1 (alternative method for start of growth season)
55	tamount	U/ha	T1 source	amount of T1 to be applied per year and ha
56	tyear	-	T1 source	year to apply T1, if zero T1 will be applied every year
57	tday	julian day	T1 source	day to start T1 application
58	tnumdays	days	T1 source	number of days with T1 application (with start at tday)
59	tdaydown	julian day	T1 source	day number for T1 to be tilled down
60	tdown1	-	T1 source	fraction of T1 above soil pool that are tilled down to the first soil layer
61	tdown2	-	T1 source	fraction of T1 above soil pool that are tilled down to the second soil layer

PointSourceData.txt

This file contains points source concentrations and discharges. HYPE allows to separate three types of point sources, e.g. wastewater treatment plants, industries, and urban stormwater. Conceptually, all three are treated the same by HYPE (see description), but HYPE will separate them in the annual load result files if these are requested in output options of info.txt. Point source loads are added to main rivers as a constant flux.

Tracers (substance T1) can be added as point sources to the main river with the method above. An alternative use of point sources for tracers is possible though. Tracers can be added to the local river, internal lake, main river or outlet lake. These point sources are not separated into different types of point sources (they are signified by using type zero). These point sources can not be used together with info.txt output options `printload` or `printwaterbal`.

The point sources file can also be used for water abstraction sinks, if point source discharges volume are set to values < 0. Abstraction can be made from the main river or an outlet lake. Only one row with abstraction per subbasin is allowed.

PointSourceData.txt is a tab-separated file located in the modeldir folder. Point sources are listed row-wise, multiple point sources for each sub-basin are allowed (but not multiple abstractions). The first row contains a column header with variable names. Variable names are not case-sensitive (max. 10 characters, no spaces). Columns with headings unknown to HYPE are skipped while reading the file, but are not allowed to be longer than ten characters. Columns containing character strings, e.g. descriptive meta-data, must not exceed a length of 100 characters. The columns may be in any order. A value must exist for every column and row, i.e. empty cells are not allowed.

The table below describes all *PointSourceData.txt* columns read by HYPE. The general unit (U) is used in tables of parameters and input data where the unit is not defined.

Variable ID	Unit	Description
`subid`	-	id number for subbasin in which point source is located, integer $< 10^8$
`ps_type`	-	**For point source**: integer signifying type of point source, between 1 and 3. Irrelevant if water abstraction. **For alternative tracer point source**: zero.
`ps_vol`	m^3/d	point source discharge or, if negative, abstracted water volume
`ps_tpconc`	mg/l	concentration of Tot-P in point source (irrelevant if water abstraction)
`ps_spfrac`	-	fraction of Tot-P in point source that is in soluble form (irrelevant if water abstraction)
`ps_tnconc`	mg/l	concentration of Tot-N in point source (irrelevant if water abstraction)
`ps_infrac`	-	fraction of Tot-N in point source that is in inorganic form (irrelevant if water abstraction)
`ps_tsconc`	mg/l	concentration of total suspended material in point source (irrelevant if water abstraction)
`ps_ssfrac`	-	fraction of total suspended material in point source that is suspended material (irrelevant if water abstraction)
`ps_t1`	$\mu U/L$	concentration of tracer T1 in point source (irrelevant if water abstraction)
`ps_t2`	$°C$	temperature of point source water (used for T2 simulation) (irrelevant if water abstraction)

Variable ID	Unit	Description
fromdate	*date-time*	Gives the start date for the point source. Format: yyyy-mm-dd [HH:MM]. Set to 0 if the source is from before the simulation start. (optional, default is 0, i.e. constant source for the simulation period)
todate	*date-time*	Gives the end date for the point source. Format: yyyy-mm-dd [HH:MM]. Set to 0 if the source is continuing after the simulation end. (optional, default is 0, i.e. constant source for the simulation period)
ps_source	-	**For abstraction**: integer code for location of abstraction; from main river volume (1), outlet lake volume (2) or main river volume and inflow (3), default is 1. **For alternative tracer point source**: integer code for location of source local river (1), local lake (2), main river (3) or outlet lake (4). For other point source: not used.

Examples of use of *PointSourceData.txt* and of the file structure:

First example: first row: a constant point source of type 1, e.g. waste water, with nutrients; second row: a larger constant point source of type 2, e.g. industrial effluents; third row: abstraction of water from outlet lake.

```
subid ps_type ps_vol ps_tpconc ps_tnconc ps_spfrac ps_infraq ps_source
456   1       10     0.5       40        0.3       0.9       0
765   2       2301   2         100       0.3       0.9       0
4050  3       -100   0         0         0         0         2
```

Second example: A constant point source of nitrogen and T2 increased 10-fold from March 21 2004.

```
subid ps_type ps_vol ps_tnconc ps_infraq ps_t2 fromdate   todate
456   1       10     40        0.7       4     1990-01-01 2004-03-20
456   1       100    40        0.7       4     2004-03-21 0
```

Third example: A general tracer point source to local lake at 1999-08-05.

```
subid ps_type ps_source ps_vol ps_t1 fromdate   todate
456   0       2         10     4     1999-08-05 1999-08-05
```

MgmtData.txt

This file may hold information about irrigation and water transfer.

The first row contains column headings. These may be maximum 10 characters long and may not include white space. They are read in by the program which then matches the column's data with the correct variable. The column headings may be large or small letters. Columns may be in any order. Unknown column names are skipped while reading. Such text column may contain at most 100 characters.

One row is required for each irrigated subbasin, as well as for each subbasin acting as a regional source. One row is required for each water transfer flow. Maximum one water transfer per subbasin is allowed if demanded flow water transfer time serie is used, otherwise several water transfers may originate in the same lake or end in the same subbasin.

Columns:

Column	Format	Description
mgmttype	1/2	code for type of water managment information on this row; 1=irrigation, 2=water transfer (optional if only irrigation is included in file)
subid	integer	subbasin ID (mandatory)
gw_part	fraction	fraction of irrigation water withdrawn from groundwater
irrdam	0/1	a dam in this subbasin may be used for irrigation only if irrdam is set to 1. Irrdam regulates olake and ilake for local withdrawals, but only olake for regional source withdrawals.
regsrcid	integer	the subid of the subbasin that is a regional source of irrigation water for this subbasin
local_eff	fraction	efficiency of the local irrigation network (within the subbasin). local_eff is the fraction that infiltrates the soil (must be >0, default is 1)
region_eff	fraction	efficiency of the regional irrigation network (withdrawals from another subbasin), fraction reaching the local irrigation network (must be >0, default is 1)
demandtype	integer	type of equation for irrigation water demand (1=constant, 2=soil water deficit, 3=threshold dependent).
receiver	integer	subid of subbasin receiving the water transfer (not dependent on subbasin order in GeoData)
flow	m^3/s	demanded constant flow water transfer (if negative, flow in Xobs.txt from output variable dwtr will be used)

AquiferData.txt

This file contains definitions for HYPE's regional aquifer module, see code `deepground` (option *2*) in the model options of info.txt and the corresponding process description in the aquifer section of the HYPE model description. Regional aquifers are linear reservoirs which connected to a group of sub-basins. These can add water, with IN and SP fluxes, to the aquifer through percolation from the deepest soil layer, and receive return flow into their main river volume. *AquiferData.txt* contains connection properties for sub-basins contributing to regional aquifers and generic properties for the aquifers themselves.

AquiferData.txt is a tab-separated file located in the modeldir folder. Sub-basins are listed row-wise. The first row contains a column header with variable names. Variable names are not case-sensitive (max. 10 characters, no spaces). Columns with headings unknown to HYPE are skipped while reading the file, but must not longer than ten characters. Columns containing character strings, e.g. descriptive meta-data, must not exceed a length of 100 characters. The columns may be in any order. A value must exist for every column and row, i.e. empty cells are not allowed. This means that in the current form, zeros have to be filled in for all aquifer-related variables in sub-basin rows and vice-versa.

Example for an *AquiferData.txt* file with two aquifers and each two contributing sub-basins (no water quality parameters):

```
NAME AREA SUBID POROSITY BASEDEPTH TOPDEPTH INIDEPTH RECHARGE AQUID RETFRAC
RETRATE DELAY PARREG
none 1500    1        0         0        0        0        1      1        0
0      0     0
none 2000    2        0         0        0        0        1      1        1
0      0     0
Aqu1 3500    0     0.15       -55       -5       -7        0      1        0
3.5E-08   10       1
none 4000    3        0         0        0        0        1      2      0.3
0      0     0
none 3200    4        0         0        0        0        1      2      0.7
0      0     0
Aqu2 7200    0     0.09       -20       -2       -4        0      2        0
1.5E-05    4       2
```

All *AquiferData.txt* variables are described in the table below.

Variable ID	Unit	Requirement	Description
`aquid`	-	All	unique aquifer ID (integer), used to connect subbasins to aquifers. A subbasin can be connected to maximum one aquifer. (mandatory)
`subid`	-	All	subbasin ID (integer). Zero is used for row which defines aquifer characteristics. (mandatory)
`recharge`	-	sub-basin	subbasin contributes to aquifer recharge (0 = no, 1 = yes)
`retfrac`	-	sub-basin	subbasin receive this fraction of the return flow from the aquifer (between 0 and 1)
`topdepth`		aquifer	depth below surface of top of aquifer (negative m) (needed for nitrogen simulation)

Variable ID	Unit	Requirement	Description
basedepth	*m*	aquifer	depth below surface of base of aquifer (negative)
inidepth	*m*	aquifer	initial/average water table depth (below surface) of aquifer (negative)
porosity	-	aquifer	average porosity of aquifer
area	*m2*	aquifer	aquifer horizontal area, used together with inidepth to calculate initial aquifer volume
retrate	-	aquifer	recession coefficient for aquifer return flow (between 0 and 1)
delay	*days*	aquifer	parameter for deep percolation delay (days until 63% ($1-e^{-1}$) of the flow has gotten through)
parreg	-	aquifer	parameter region for aquifer, separate from parreg in GeoData.txt (mandatory)
temp	*°C*	aquifer	temperature of aquifer (constant), also initial value of aquifer T2-temperature
conc_IN	*μg/L*	aquifer	initial concentration of inorganic nitrogen
conc_SP	*μg/L*	aquifer	initial concentration of soluble reactive phosphorus

FloodData.txt

This file contains definitions for HYPE's floodplain module, see process descriptions in the floodplain section of the HYPE model description. Floodplains can be simulated for main river class and outlet lake class, and can vary in size within its class area fraction. The file holds characteristics of each floodplain. It is possible to override the floodplain information in FloodData.txt and instead use general parameters (same for all floodplains). This is done by setting parameters in par.txt (see optonoff).

FloodData.txt is a tab-separated file located in the modeldir folder. Subbasins with floodplains are listed row-wise. The first row contains a column header with variable names. Variable names are not case-sensitive (max. 10 characters, no spaces). Columns with headings unknown to HYPE are skipped while reading the file, but must not longer than ten characters. Columns containing character strings, e.g. descriptive meta-data, must not exceed a length of 100 characters. The columns may be in any order. A value must exist for every column and row, i.e. empty cells are not allowed. Maximum 50 columns is allowed in the file.

Example for a *FloodData.txt* file with a main river floodplain in subbasin 37:

```
SUBID  FPFMR  FYMMR  FLMRR  FLMRP  RCRFP  RCFPR
37     0.95   1.8    0.32   2.25   0.82   0.60
```

All *FloodData.txt* variables are described in the table below.

Variable ID	Unit	Description
subid	-	subbasin ID (integer) (mandatory)
fpfol	-	fraction of outlet lake slc-area that is floodplain (0-1)
fpfmr	-	fraction of main river slc-area that is floodplain (0-1)
floll	m	flooding threshold level for outlet lake to floodplain flow
flolp	m	flooding threshold level for floodplain to outlet lake flow
flmrr	m	flooding threshold level for main river to floodplain flow
flmrp	m	flooding threshold level for floodplain to main river flow
rclfp	-	recession coefficient for outlet lake to floodplain flow (0-1)
rcfpl	-	recession coefficient for floodplain to outlet lake flow (0-1)
rcrfp	-	recession coefficient for main river to floodplain flow (0-1)
rcfpr	-	recession coefficient for floodplain to main river flow (0-1)
fymol	m	water level at maximum areal extent of outlet lake floodplain
fymmr	m	water level at maximum areal extent of main river floodplain
hrefr	m	main river floodplain threshold in flooddata reference system (optional)
hrefl	m	outlet lake floodplain threshold in flooddata reference system (optional)

GlacierData.txt

This file contains definitions for HYPE's glacier module, see process descriptions in the glaciers section of the HYPE model description. Glaciers are a special class, and can vary in size within its class area fraction.

GlacierData.txt is a tab-separated file located in the modeldir folder. Sub-basins with glaciers are listed row-wise. The first row contains a column header with variable names. Variable names are not case-sensitive (max. 10 characters, no spaces). Columns with headings unknown to HYPE are skipped while reading the file, but must not longer than ten characters. Columns containing character strings, e.g. descriptive meta-data, must not exceed a length of 100 characters. The columns may be in any order. A value must exist for every column and row, i.e. empty cells are not allowed.

Example for a *GlacierData.txt* file with two glaciers:

```
NAME SUBID GLACTYPE LOGVOLCORR
Glac1 157    0        0
Glac2 277    1        0
```

All *GlacierData.txt* variables are described in the table below.

Variable ID	Unit	Description
subid	-	subbasin ID (integer) (mandatory)
glactype	0/1/2/3	The default glacier type is mountain glacier (0). The alternatives are; (1) ice cap (same equations different parameters), (2) ice sheet (same as ice cap except that the area is constant), and (3) infinit glacier (glacier melt independent of state).
logvolcorr	-	correction of volume-area relationship coefficient due to combining several glaciers into one class area (no correction=0)
slcdate	*YYYYMMDD*	date for which glacier slc-fraction is representative
annualmb	*mm/yr*	annual mass balance for correction of initial volume
slcvolume	m^3	The initial glacier volume (at slcdate and with annualmb if these are set). Default is not to use slcvolume (-9999). It overrides the glacier state from the state file.

par.txt

Model parameters determine the function of the model. The model parameters are given in the file *par.txt*. A model parameter may have a dependency on some physical property, e.g. soil type, or a spatial division of the model domain or be a general value for the whole model domain. If a parameter is dependent on e.g. a property it will have one value for each code of that property. For instance if a model has two land uses, open and forest land, snow melt rate will have a (different) value for each open and forest land because the HYPE snow melt parameter is land use dependent.

Many model parameters are coefficients in the modelled processes, others define properties of the model domain. For example evapotranspiration depend on model parameters for the potential rate (land use dependent) and on the water holding capacity of the soil (soil type dependent). There are also parameters that set the initial stores or flows to a general value.

Most model parameters can be calibrated. A few parameters are switches for model options. These can't be calibrated. Model parameters, which also can be given in LakeData for specific lakes, cannot be calibrated.

There are also model parameters specially designed to be calibrated. They are correction parameters (sometimes called super parameters), often dependent on a larger region, that adjust the model in some general way. Some of them can simultanouely adjust several processes (this is e.g. the case for nutrients). Others correct input data (precipitation and temperature).

The following dependencies exist for HYPE model parameters;

- general, i.e. no dependency
- land use (land cover), a code given for each SLC class
- soil type, a code given for each SLC class
- month
- parameter region (parreg), a user defined grouping of subbasins into larger regions
- water quality parameter region (wqparreg), a user defined grouping of subbasins into larger regions, used for some WQ parameters
- lake region, a user defined grouping of subbasins into larger regions, used for some lake and river parameters
- ilake region, a user defined grouping of subbasins into larger regions, used for some ilake parameters
- olake region, a user defined grouping of subbasins into larger regions, used for some olake parameters

File content

The file is located in the modeldir folder. One parameter is given per row with parameter name first and then values for all dependencies or one value for a general parameter. A single value may not take up more than 10 positions. Comment rows are allowed anywhere in the file and start with a double exclamation mark !! followed by a blank (no empty lines allowed). In-line comments may crash the simulation. **Note**: If you import (and later export) a *par.txt* file into R using the HYPEtools package, in-line comments are moved to separate rows. The parameter names are not case sensitive, but some are written partly with capital letters to ease the interpretation. The default value is zero for all parameters except five glacier parameters for density and area-volume relationship.

Example snippet of a *par.txt* file structure:

```
!! water content for 11 soil types (defined in GeoClass.txt)
wcfc  0.100 0.120 0.120 0.050 0.250 0.250 0.150 0.050 0.500 0.500 0.050
!! threshold temperature for 2 land uses (defined in GeoClass.txt)
ttmp  0.0   0.0
!! potential evaporation limit, a general parameter
lp    0.8
...
```

The table below describes all available model parameters. Unit '-' mean the parameter is dimensionless. Unit *ts* means time step, which can be day or hour or of some other length. The general unit (U) is used in case of parameters and input data where the unit is not defined.

Name	Unit	Dependency	Description	Link
wcfc	-	soil type	fraction of soil available for evapotranspiration but not for runoff, same for all soil layers (used if wcfc1 not given)	water content
wcwp	-	soil type	wilting point as a fraction, same for all soil layers (used if wcwp1 not given)	water content
wcep	-	soil type	effective porosity as a fraction, same for all soil layers (used if wcep1 not given)	water content
wcfc1	-	soil type	fraction of soil available for evapotranspiration but not for runoff, for uppermost soil layer	water content
wcwp1	-	soil type	wilting point as a fraction, for uppermost soil layer	water content
wcep1	-	soil type	effective porosity as a fraction, for uppermost soil layer	water content
wcfc2	-	soil type	fraction of soil available for evapotranspiration but not for runoff, for second soil layer	water content
wcwp2	-	soil type	wilting point as a fraction, for second soil layer	water content
wcep2	-	soil type	effective porosity as a fraction, for second soil layer	water content
wcfc3	-	soil type	fraction of soil available for evapotranspiration but not for runoff, for lowest soil layer	water content
wcwp3	-	soil type	wilting point as a fraction, for lowest soil layer	water content
wcep3	-	soil type	effective porosity as a fraction, for lowest soil layer	water content
mperc1	$mm\ ts^{-1}$	soil type	maximum percolation capacity from soil layer 1 to soil layer 2	perc
mperc2	$mm\ ts^{-1}$	soil type	maximum percolation capacity from soil layer 2 to soil layer 3	perc
cmlt	$mm\ °C^{-1}\ ts^{-1}$	land use	melting parameter for snow	snow melt
ttmp	°C	land use	threshold temperature for snow melt, snow density and evapotranspiration	snow melt snow or rain PET

Name	Unit	Dependency	Description	Link
ttpd	$°C$	general	deviation from ttmp for threshold temperature for snow-/rainfall	snow or rain
ttpi	$°C$	general	half of temperature interval with mixed snow- and rainfall. Interval is (ttmp+ttpd) +/- ttpi.	snow melt snow or rain
cevp	$mm\ °C^{-1}$ ts^{-1}	land use	evapotranspiration parameter	PET
t1evap	-	general	evaporation factor for substance T1 (0-1), default is 0, if 1 the substance evaporates with the water	tracer T1
frost	$cm\ °C^{-1}\ or\ -$	land use	frost depth parameter (both frost and sfrost must be >0 for simulation to occur)	frost
sfrost	$-\ or\ cm\ °C^{-1}$	soil type	frost depth parameter (both frost and sfrost must be >0 for simulation to occur)	frost
deepmem	d	general	deep soil temperature memory	soil temp
surfmem	d	land use	upper soil layer soil temperature memory	soil temp
depthrel	m^{-1}	land use	depth relation for soil temperature memory	soil temp
rrcs1	ts^{-1}	soil type	recession coefficient for uppermost soil layer	runoff
rrcs2	ts^{-1}	soil type	recession coefficient for lowest soil layer	runoff
rrcs3	$ts^{-1}\ \%^{-1}$	general	recession coefficient for slope dependence (upper layer)	runoff
srrcs	ts^{-1}	land use	recession coefficient for surface runoff (fraction), should be set to 1 for lake and riverclasses with floodplains	surface runoff
trrcs	ts^{-1}	soil type	recession coefficient for tile drains	tile runoff
rrcscorr	-	parreg	correction factor for recession rrcs=rrcs(1+rrcscorr) for rrcs1,rrcs2,trrcs and srrcs	runoff tile runoff surface runoff
cevpam	-	general	amplitude of sinus function (about 1) that corrects potential evapotranspiration.	PET
cevpph	d	general	phase of sinus function that corrects potential evapotranspiration	PET
cevpcorr	-	parreg	correction factor for evapotranspiration cevap=evap(1+cevpcorr)	PET
lp	-	general	factor for calculating the soil water limit for potential evapotranspiration	evap
gratk	-	general	parameter of rating curve for lake outflow $$Q=gratk\times\left(w\text{-}wo\right)^{gratp}$$	rating curve
gratp	-	general	parameter of rating curve for lake outflow $$Q=gratk\times\left(w\text{-}wo\right)^{gratp}$$	rating curve
grata	-	general	upstream area dependence of discharge curve for lake, if grata>0 and uparea>0 $$Q=\left(gratk\times\left(uparea\right)^{grata}\right)\times\left(w\text{-}wo\right)^{gratp}$$	rating curve

Name	Unit	Dependency	Description	Link
limqprod	-	general	limit for water stage with reduced production flow from dam (fraction of regulating volume) (can also be defined in LakeData.txt)	
krelflood	-	general	factor for increased production flow from flood control dam	
kthrflood	-	general	factor for flow threshold for increased production flow from flood control dam	
klowflood	-	general	factor for water level threshold with production flow from flood control dam equal to inflow	
rivvel	$m\ s^{-1}$	general	celerity of flood in watercourse (rivvel>0)	river
damp	-	general	fraction of delay in the watercourse which also causes damping	river
deadl	$m^2\ km^{-2}$	general	parameter to calculate the dead volume in the local watercourse	river
deadm	$m^2\ km^{-2}$	general	parameter to calculate the dead volume in the main watercourse	river
tcalt	$°C\ (100m)^{-1}$	general	parameter for temperature's elevation dependence, uses SLC's deviation from subbasin mean height (=0.6°C/100m)	temp
tempcorr	$°C$	parreg	correction parameter for temperature	temp
tcelevadd	$°C\ (100m)^{-1}$	general	parameter for temperature's elevation dependence, uses subbasin mean height	temp
tcobselev	$°C\ (100m)^{-1}$	general	parameter for temperature correction due to observation elevation deviation from subbasin elevation	temp
monthlapse	$°C\ (100m)^{-1}$	month	alternative parameter for temperature correction with elevation, monthly temperature lapse rate (positive when decresasing with elevation, same as `tcalt` and `tcelevadd`)	temp
pcaddg	-	general	correction parameter for precipitation	prec
pcurain	-	general	undercatch correction for rainfall, rainfall = rainfall * (1+pcurain). The correction is applied at the observation level, before using any elevation corrections to basin mean elevation or class specific elevations. Since the snowfall threshold temperature is landuse specific, the correction is weighted depending on the areal fractions of the landuse classes. The same applies to the `pcusnow` parameter	
pcusnow	-	general	undercatch correction for snowfall, snowfall = snowfall*(1+pcusnow). See notes for `pcurain`.	
pcluse	-	land use	correction factor for precipitation prec=prec(1-pcluse)	prec
pcelevadd	$(100m)^{-1}$	general	correction parameter for precipitation (per 100 m elevation > pcelevth)	prec
pcelevth	m	general	elevation above which the precipitation correction pcelevadd is used	prec
pcelevmax	-	general	maximum for height dependent precipitation correction	prec
pcelevstd	$(100m)^{-1}$	general	correction parameter for precipitation (per 100 m of elevation standard deviation)	prec

Name	Unit	Dependency	Description	Link
preccorr	-	parreg	correction factor for precipitation $$prec = prec\left(1+ preccorr\right)$$	prec
gldepi	*m*	general	depth for all ilakes	lake
denitrlu	d^{-1}	land use	parameter for denitrification rate in soil	denitrif
denitrlu3	d^{-1}	land use	denitrification rate in third soil layer, replaces denitrlu if set to >= 0. If only used for some land use classes, set to -1 for all other.	denitrif
degradhp	d^{-1}	land use	decay of humus to fastP	NP soil
degradhn	d^{-1}	land use	decay of humus to fastN	NP soil
minerfn	d^{-1}	land use	mineralisation of fastN to inorganic N	NP soil
minerfp	d^{-1}	land use	mineralisation of fastP to SRP	NP soil
dissolfp	d^{-1}	land use	decay of fastP to dissolved PP	NP soil
dissolfn	d^{-1}	land use	decay of fastN to dissolved organic N	NP soil
dissolhp	d^{-1}	land use	decay of humusP to dissolved PP	NP soil
dissolhn	d^{-1}	land use	decay of humusN to dissolved organic N	NP soil
wprodn	$kg\ m^{-3}\ d^{-1}$	general	production/decay of N in water (can also be defined in LakeData.txt)	NP river lake
wprodp	$kg\ m^{-3}\ d^{-1}$	general	production/decay of P in water (can also be defined in LakeData.txt)	NP river lake
wprodc	$kg\ m^{-3}\ d^{-1}$	general	production/decay of OC in water (can also be defined in LakeData.txt)	C river lake
hsatTP	$mg\ L^{-1}$	general	half saturation concentration of TP for production and mineralisation in surface water	NP river lake C river lake
hsatINs	$mg\ L^{-1}$	general	half saturation concentration of IN for denitrification in soil	denitrif
hsatINw	$mg\ L^{-1}$	general	half saturation concentration of IN for denitrification in surface water	denitrif
denitwrl	$kg\ m^{-2}\ d^{-1}$	general	parameter for denitrification in local watercourse	denitrif
denitwrm	$kg\ m^{-2}\ d^{-1}$	general	parameter for denitrification in main watercourse	denitrif
denitwl	$kg\ m^{-2}\ d^{-1}$	general	parameter for denitrification in lakes (can also be defined in LakeData.txt)	denitrif
sedon	$m\ ts^{-1}$	general	sedimentation rate of ON in lakes (can also be defined in LakeData.txt)	NP lake
sedpp	$m\ ts^{-1}$	general	sedimentation rate of PP in lakes (can also be defined in LakeData.txt)	NP lake
sedexp	-	general	parameter for sedimentation/resuspension in watercourses	P river
limsedON	$mg\ L^{-1}$	general	concentration of ON deducted from conc in water when sedimentation is calculated. This should represent the dissolved organic nitrogen.	NP lake

Name	Unit	Dependency	Description	Link
limsedPP	$mg\ L^{-1}$	general	concentration of PP deducted from concentration in water when sedimentation is calculated. This concentration is also deducted from the mean TP concentration when calculating half-saturation factor in the mineralization/production routine.	NP lake NP lake C river lake
muptn	$kg\ m^{-2}\ d^{-1}$	general	macrophyte uptake of IN in lake water (can also be defined in LakeData.txt)	NP lake
muptp	$kg\ m^{-2}\ d^{-1}$	general	macrophyte uptake of SP in lake water (can also be defined in LakeData.txt)	NP lake
muptdep	m	general	macrophyte uptake production depth	NP lake
humusN0	$mg\ m^{-3}$	land use	starting concentration of humusN soil pool	NP soil
humusP0	$mg\ m^{-3}$	land use	starting concentration of humusP soil pool	NP soil
fastN0	$mg\ m^{-3}$	general	starting concentration of fastN soil pool	NP soil
partP0	$mg\ m^{-3}$	land use	starting concentration of partP soil pool	NP soil
fastP0	$mg\ m^{-3}$	general	starting concentration of fastP soil pool	NP soil
occonc0	$mg\ L^{-1}$	land use	starting value, organic carbon concentration in soil	
onconc0	$mg\ L^{-1}$	land use	starting value, organic nitrogen concentration in soil	NP soil
ppconc0	$mg\ L^{-1}$	land use	starting value, particulate phosphorus concentration in soil	NP soil
onpercred	-	land use	reduction of ON concentration during percolation	NP perc
pppercred	-	land use	reduction of PP concentration during percolation	NP perc
pPhalf	m	land use	half depth for partP soil pool	NP soil
hPhalf	m	land use	half depth for humusP soil pool	NP soil
hNhalf	m	land use	half depth for humusN soil pool	NP soil
iniT1	$\mu U\ L^{-1}$	general	starting value in soil, concentration T1	tracer T1
iniT1sw	$\mu U\ L^{-1}$	general	starting value in surface water, concentration T1	tracer T1
iniT2	$°C$	general	starting value in soil, T2 (temperature)	tracer T2
freuc	kg^{-1}	soil type	parameter in Freundlich equation (coefficient)	P soil
freuexp	-	soil type	parameter in Freundlich equation (exponent)	P soil
freurate	d^{-1}	soil type	parameter that steers adsorption/desorption speed	P soil
locsoil	-	general	fraction of emission from rural waste water that is emitted to directly to the lowest soil layer (rest goes to the local watercourse)	rural
drydeppp	$kg\ km^{-2}\ ts^{-1}$	land use	dry deposition of PP	deposition
wetdepsp	$\mu g\ L^{-1}$	general	wet deposition of SP	deposition
wetdepspl	$kg\ km^{-2}\ ts^{-1}$	general	wet deposition of SP on water surfaces	deposition
aloadconst	-	general	status to keep wet deposition load constant if precipitation is corrected (if set to 1, 0 is default)	deposition
ponatm	-	land use	correction factor for atmospheric deposition of IN, fraction that goes to fastN-pool instead	deposition
srrate	-	soil type	fraction for surface runoff	surface runoff

Name	Unit	Dependency	Description	Link
macrate	-	soil type	fraction for macro-pore flow	macropore
mactrinf	$mm\ ts^{-1}$	soil type	threshold for macro-pore flow	macropore
mactrsm	-	soil type	threshold soil water for macro-pore flow and surface runoff (fraction of wcwp+wcfc i uppermost layer)	macropore and surface runoff
soilcoh	kPa	soil type	characteristic of soil for calculation of soil erosion (cohesion)	erosion
soilerod	$g\ J^{-1}$	soil type	characteristic of soil for calculation of soil erosion (erodibility)	erosion
epotdist	m^{-1}	general	coefficient in exponential function for potential evapotranspiration's depth dependency	PET
qmean	$mm\ yr^{-1}$	general	initial value for calculation of mean flow (can also be defined in LakeData.txt)	
tpmean	$mg\ L^{-1}$	lake region	mean TP level in lakes, used for production if P not simulated, used also as starting value for concentration of particulate P in lakes. Can also be defined in LakeData.txt	NP lake
tnmean	$mg\ L^{-1}$	lake region	mean TN level i lakes, used as starting value for concentration of organic N in lakes. Can also be defined in LakeData.txt	
rivvel1	-	lake region	parameter for calculation of velocity of the water in the watercourse	river
rivvel2	-	lake region	parameter for calculation of velocity of the water in the watercourse	river
rivvel3	-	lake region	parameter for calculation of velocity of the water in the watercourse	river
rivwidth1	-	lake region	parameter for calculation of the width of the watercourse	river
rivwidth2	-	lake region	parameter for calculation of the width of the watercourse	river
rivwidth3	-	lake region	parameter for calculation of the width of the watercourse	river
maxwidth	m	general	parameter for limitation of width of the watercourse	river
sreroexp	-	general	exponent in the equation for calculation of soil erosion caused by surface runoff	erosion
pprelmax	$mm\ ts^{-1}$	general	parameter for delay of SS and PP from surface runoff and tile drains	erosion
pprelexp	-	general	parameter for delay of SS and PP from surface runoff and tile drains	erosion
bufffilt	-	land use	filtration of PartP with surface runoff through the buffer zone (fraction that slips through), 0 for land-uses where this is irrelevant	erosion
innerfilt	-	land use	filtration of PartP with surface runoff from agricultural land far from watercourse (fraction that slips through), 0 for land-uses where this is irrelevant	erosion

Name	Unit	Dependency	Description	Link
`otherfilt`	-	land use	filtration of PartP with surface runoff from other land types than agricultural land (fraction that slips through), 0 for land-uses where this is irrelevant	erosion
`macrofilt`	-	soil type	filtration (retention) of PartP with macropore flow (fraction)	erosion
`sdnsnew`	$g\ cm^{-3}$	general	density of new-fallen snow (former snowdens0)	snow
`snowdensdt`	$g\ cm^{-3}\ ts^{-1}$	general	increase of snow density per day	snow
`sdnsmax`	$g\ cm^{-3}$	general	maximum snow density	snow
`sdnsrate`	ts^{-1}	general	increase of snow density per timestep	snow
`sdnsradd`	ts^{-1}	general	additional increase of snow density per timestep for warm days	snow
`fertdays`	d	general	number of days that fertiliser applications occur counting from application day 1 and forward using the same amount every day	fertilizer
`litterdays`	d	general	number of days that plant residuals are applied counting from application day 1 and forward using the same amount every day	
`humusc1`	$mg\ m^{-3}$	land use	starting concentration for humusC pool in soil's uppermost soil layer	C soil
`fastc1`	$mg\ m^{-3}$	land use	starting concentration for fastC pool in soil's uppermost soil layer	C soil
`humusc2`	$mg\ m^{-3}$	land use	starting concentration for humusC pool in soil's second soil layer	C soil
`fastc2`	$mg\ m^{-3}$	land use	starting concentration for fastC pool in soil's second soil layer	C soil
`humusc3`	$mg\ m^{-3}$	land use	starting concentration for humusC pool in soil lowest soil layer	C soil
`fastc3`	$mg\ m^{-3}$	land use	starting concentration for fastC pool in soil lowest soil layer	C soil
`klh`	d^{-1}	general	parameter for speed of transformation from litter to humus	C soil
`klo`	d^{-1}	general	parameter for speed of transformation from litter to DOC	C soil
`kho`	d^{-1}	general	parameter for speed of transformation from humus to DOC	C soil
`kof`	d^{-1}	general	parameter for speed of transformation from DOC to fastC	C soil
`koflim`	-	general	parameter for threshold for wetness for transformation DOC to fastC	C soil
`koc`	-	general	parameter for DOC-concentrations reduction for percolation	C soil
`kcgwreg`	-	general	parameter for DOC-concentrations reduction with flow out to regional groundwater	C soil
`sedoc`	$m\ ts^{-1}$	general	sedimentation rate OC in lakes. Can also be defined in LakeData.txt.	C lake
`ripz`	-	land use	parameter for OC processes in riparian zone	C riparian

Name	Unit	Dependency	Description	Link
ripe	m^{-1}	general	exponent for groundwater depth dependence of OC processes in riparian zones	C riparian
rips	-	general	seasonal factor for OC processes in riparian zones	C riparian
tocmean	$mg\ L^{-1}$	lake region	mean OC fraction in lakes, used that starting value for concentrations of TOC in lakes (can also be defined in LakeData.txt)	
minc	-	general	fraction of transformation mineralised to DIC	C soil
ocsoimsat	-	land use	saturation in soil moisture function for degradation of soil organic carbon	C soil
ocsoimslp	%	land use	slope in soil moisture function for degradation of soil organic carbon	C soil
deeplake	-	general	part of the lake's initial volume which is considered as slow (SLP). 0 means that the lake is not divided into a slow and a fast part. Value larger than 1 means the initial volume is all slow part, but a fast part may form at high water levels. Can also be defined in LakeData.txt. Use deeplake=0 if floodplains are simulated	lake
fastlake	-	general	parameter determining the fraction of lake outflow from the different lake parts (FLP, SLP). Varies between 0 (default, no outflow from FLP) to 1 (outflow fractions proportional to FLP and SLP volumes). Can also be defined in LakeData.txt.	lake
laketemp	d	general	maximum value for depth dependent lake temperature routine, 0 means that this function is not used.	
snalbmin	-	land use	parameter for snowmelt model 2	
snalbmax	-	land use	parameter for snowmelt model 2	
snalbkexp	ts^{-1}	land use	parameter for snowmelt model 2	
cmrad	$mm\ m^2\ MJ^{-1}$	land use	coefficient for radiation snow melt, parameter for snowmelt model 2	
t2trriver	$J\ m^{-2}\ s^{-1}\ °C^{-1}$	general	heat transfer parameter for water temperature T2 of river	
t2trlake	$J\ m^{-2}\ s^{-1}\ °C^{-1}$	general	heat transfer parameter for water temperature T2 of lake	
upper2deep	$J\ m^{-2}\ s^{-1}\ °C^{-1}$	general	heat transfer parameter for water temperature T2 between lake parts	
tcfriver	$J\ m^{-2}\ s^{-1}\ °C^{-1}$	general	air-riverwater heat flow, temperature difference coefficient	water - atmosphere T2 exchange
scfriver		general	air-riverwater heat flow, solar radiation coefficient	water - atmosphere T2 exchange
ccfriver		general	air-riverwater heat flow, constant coefficient	water - atmosphere T2 exchange
lcfriver		general	air-riverwater heat flow, linear coefficient	water - atmosphere T2 exchange

Name	Unit	Dependency	Description	Link
tcflake	$J\ m^{-2}\ s^{-1}\ °C^{-1}$	general	air-lakewater heat flow, temperature difference coefficient	water - atmosphere T2 exchange
scflake		general	air-lakewater heat flow, solar radiation coefficient	water - atmosphere T2 exchange
ccflake		general	air-lakewater heat flow, constant coefficient	water - atmosphere T2 exchange
lcflake		general	air-lakewater heat flow, linear coefficient	water - atmosphere T2 exchange
stbcorr1		general	parameter for stability correction	
stbcorr2		general	parameter for stability correction	
stbcorr3		general	parameter for stability correction	
licettf	$°C$	general	lake ice model, water temperature threshold for freeze-up	
licetf	$°C$	general	lake ice model, freezing temperature	
licesndens	$g\ cm^{-3}\ ts^{-1}$	general	lake ice model, snow compaction parameter	
licekika	cm	general	lake ice model, ratio between thermal conductivity of ice and heat exchange coefficient in air	
licekexp	-	general	lake ice model, water temperature threshold for freeze-up	
licetmelt	$cm\ °C^{-1}$	general	lake ice model, melt factor for ice	
licewcorr	-	general	lake ice model, snowfall reduction for wind drift	
ricettf	$°C$	general	river ice model, water temperature threshold for freeze-up	
ricetf	$°C$	general	river ice model, freezing temperature	
ricesndens	$g\ cm^{-3}\ ts^{-1}$	general	river ice model, snow compaction parameter	
ricekika	cm	general	river ice model, ratio between thermal conductivity of ice and heat exchange coefficient in air	
ricekexp	-	general	river ice model, water temperature threshold for freeze-up	
ricetmelt	$cm\ °C^{-1}$	general	river ice model, melt factor for ice	
fscmax	-	general	maximum fractional snow cover area	snow cover
fscmin	-	general	minimum fractional snow cover area	snow cover
fsclim	-	general	limit of fractional snow cover area for onset of snowmax	snow cover
fscdistmax	-	land use	maximum snow distribution factor	snow cover
fscdist0	-	land use	minimum snow distribution factor	snow cover
fscdist1	m^{-1}	land use	std coefficient for snow distribution factor	snow cover
fsck1	-	general	parameter for snowmax	snow cover
fsckexp	s^{-1}	general	parameter for snowmax	snow cover
fsceff	-	general	efficiency of snow cover to influence snow melt and snow evaporation, should have values between 0 and 1. A value of 1 means that snow melt will be linearly scaled with snow cover: melt = melt*(1-fsc*(1-snowcov)).	
cmrefr	-	general	refreeze efficiency compared to the degree-day snow melt factor: refreeze=cmrefr*cmlt*(tt-temp) if temp<tt. Used for snow melt model 2.	
fepotsnow	-	general	fraction of snow-free potential evapotranspiration, used for calculation of snow evaporation.	

Name	Unit	Dependency	Description	Link
krs		general	parameter for estimating shortwave radiation, also used in petmodel 3 - Modified Hargreaves-Samani, Hargreaves adjustment factor	PET input data
jhtadd		general	parameter for petmodel 2 - Modified Jensen-Haise/McGuiness	PET
jhtscale		general	parameter for petmodel 2 - Modified Jensen-Haise/McGuiness	PET
alfapt		general	parameter for petmodel 4 - Priestly-Taylor	PET
mwind	$m\ s^{-1}$	general	average wind speed, used for petmodel 5 when no wind forcing is available	wind
zwind	m	general	wind observation height, typical value is 10	wind
zwish	m	general	wanted wind height, typical value is 2	wind
zpdh	m	general	zero plane displacement height	wind
roughness	-	general	surface roughness (for observed wind)	wind
kc	-	land use	crop coefficient for petmodels, default parameter	PET
kc2	-	land use	crop coefficient for petmodel 2, if not set kc is used	PET
kc3	-	land use	crop coefficient for petmodel 3, if not set kc is used	PET
kc4	-	land use	crop coefficient for petmodel 4, if not set kc is used	PET
kc5	-	land use	crop coefficient for petmodel 5, if not set kc is used	PET
alb	-	land use	albedo for petmodels	net downward radiation
incorr	-	wqparreg	*super-parameter*, regional correction factor for parameter governing inorganic nitrogen: $$par = par \times \left(1 + incorr\right)$$ for degradhn and $$par = par \times \left(1 - incorr\right)$$ for denitrlu, denitwl, denitwrm, and denitwrl **Note**: denitwl in LakeData.txt will also be affected by this correction factor	
oncorr	-	wqparreg	*super-parameter*, regional correction factor for parameter governing organic nitrogen: $$par = par \times \left(1 + oncorr\right)$$ for dissolhn and $$par = par \times \left(1 - oncorr\right)$$ for sedon **Note**: sedon in LakeData.txt will also be affected by this correction factor	
phoscorr	-	wqparreg	*super-parameter*, regional correction factor for parameter governing phosphorus: $$par = par \times \left(1 + phoscorr\right)$$ for soilerod, dissolhP, fastP0, humusP0, and partP0	

Name	Unit	Dependency	Description	Link
ratcorr	-	parreg	correction factor for discharge gratk=gratk(1+ratcorr)	rating curve
pirrs	-	parreg	irrigation abstraction fraction from surface water sources. Controls the amount of potentially withdrawable surface water that is in fact abstracted. pirrs=1 implies full withdrawal. pirrs=0 if not set.	irrigation abstraction
pirrg	-	parreg	irrigation abstraction fraction from groundwater. Controls the amount of potentially withdrawable groundwater that is in fact abstracted. pirrg=1 implies full withdrawal. pirrg=0 if not set.	irrigation abstraction
sswcorr	-	general	rescaling factor for the soil water stress irrigation threshold. sswcorr=1 implies no rescaling. sswcorr=0 if not set.	irrigation demand
iwdfrac	-	general	fraction of the irrigation threshold which constitutes irrigation water demand. Note iwdfrac can be >1. Only used if demandtype=3.	irrigation demand
regirr	-	general	connectivity scaling factor for the regional irrigation water abstractions. Regirr=1 implies full connectivity while regirr=0.5 implies that only half of regional demands are taken into account	irrigation abstraction
irrdemand	$mm\ ts^{-1}$	general	the irrigation water demand for subbasins with demandtype=1	irrigation demand
immdepth	mm	general	target submergence depth for submerged irrigated crops	irrigation demand
cirrsink	-	parreg	concentration reduction fraction in settlement tanks at irrigation abstraction points	irrigation abstraction
irrcomp	-	general	irrigation source compensation parameter. Irrcomp defines the fraction of the residual irrigation water demands which can be withdrawn from other local sources. Irrcomp=0 if not set.	irrigation abstraction
glacdens	$m^3\ water$ $(m^3\ ice)^{-1}$	general	density of glacier ice (default value=0.85)	
glac2arlim	m^2	general	area limit for determine glacier type	glacier
glacvcoef	m	general	coefficient of glacier area-volume relationship for glacier of type 0 (default), (default value=0.205)	glacier
glacvexp	-	general	exponent of glacier area-volume relationship for glacier of type 0 (default), (default value=1.375)	glacier
glacvcoef1	m	general	coefficient of glacier area-volume relationship for glacier of type 1, (default value=1.701)	glacier
glacvexp1	-	general	exponent of glacier area-volume relationship for glacier of type 1, (default value=1.25)	glacier
glaccmlt	$mm\ °C^{-1}$ ts^{-1}	general	melting parameter for glacier	glacier
glacttmp	$°C$	general	threshold temperature for glacier melt	glacier

Name	Unit	Dependency	Description	Link
glaccmrad	$mm\ m^2\ MJ^{-1}$	general	coefficient for radiation glacier melt, parameter for snowmelt model 2	glacier
glaccmrefr	-	general	refreeze efficiency compared to the degree-day glacier melt factor, parameter for snow meltmodel 2	glacier
glacalb	-	general	albedo for glacier ice	glacier
fepotglac	-	general	fraction of snow-free potential evapotranspiration, used for calculation of glacier evaporation (snowevaporation model 1).	glacier
rcgrw	-	general	recession coefficient for regional groundwater outflow from soil layers (deepground=1 (and 2))	deep flow or aquifer
rcgrwst	-	soil type	recession coefficient for deep percolation flow out of soil layers (deepground=2)	aquifer
aqretcor	-	parreg (of aquifer)	adjustment of recession coefficients newpar=oldpar(1+aqcor) for aquifer return flow	aquifer
aqdelcor	-	parreg (of aquifer)	adjustment of deep percolation delay to aquifers newpar=oldpar(1+aqcor) for aquifer return flow	aquifer
aqpercor	-	parreg (of subbasin)	adjustment of deep percolation to aquifers newpar=oldpar(1+aqcor) for aquifer return flow	aquifer
optonoff	-	general	switch (0/1) for using general parameters op1-opt8 instead of flooding data of FloodData.txt (1=use opt1-opt8)	
opt1	m	general	parameter replacing FloodData.txt values of floll	floodplain
opt2	m	general	parameter replacing FloodData.txt values of flolp	floodplain
opt3	m	general	parameter replacing FloodData.txt values of flmrr	floodplain
opt4	m	general	parameter replacing FloodData.txt values of flmrp	floodplain
opt5	-	general	parameter replacing FloodData.txt values of rclfp and rcrfp	floodplain
opt6	m	general	parameter replacing FloodData.txt values of fymol	floodplain
opt7	m	general	parameter replacing FloodData.txt values of fymmr	floodplain
opt8	-	general	parameter replacing FloodData.txt values of rcfpl and rcfpr	floodplain
limT2exch	m	general	limit for which deeper river and lakes use surface water heat balance radiation term and other terms (used for modeloption lakeriverice 2)	
t2mix	-	general	switch (0/1) for using mixed lake T2 temperature on outflow of lake (can also be set in LakeData.txt)	lake outflow

Name	Unit	Dependency	Description	Link
T1expdec	*days*	general	half time for exponential decay of T1. Applied to T1 in soil water and surface water (but not in snow). Also applied to T1 in pool above soil, adsorbed to soil and in river sediment.	tracer T1
T1freuc	*L/kg soil or ((U/kg soil)/(U/L))*	general	freundlich adsorption isoterm coefficient for adsorption/desorption of T1 to soil.	tracer T1
T1rel	mm^{-1}	general	release of T1 from above soil pool. Typically the pool consist of manure.	tracer T1
T1sedexp	-	general	parameter for sedimentation/resuspension of T1 in watercourses	tracer T1
T1sedvel	*m/timestep*	general	sedimentation rate of T1 in lakes	tracer T1
T1leakluse	*µU/L or -*	land use	typical leakage concentration of T1 depending on land use or a scaling factor to typical leakage concentration depending on soil type	tracer T1
T1leaksoil	*µU/L or -*	soil type	typical leakage concentration of T1 depending onsoil type or a scaling factor to typical leakage concentration depending on land use	tracer T1
soilcorr	-	land use	factor used to adjust the thicknesses of soil layer 2 and 3 as given in GeoClass. Must be larger than zero if used.	
ttrig	*degree Celsius*	land use	temperature threshold for soil temperature control on soil evapotranspiration	evaporation
treda	-	land use	soil temperature control on soil evapotranspiration	evaporation
tredb	-	land use	soil temperature control on soil evapotranspiration	evaporation
gldepo	*m*	general	depth of olake, used if lake_depth in GeoData/LakeData/DamData is zero or negative	
gicatch	-	general	fraction of local runoff that goes through the local lake (ilake), the rests runs directly into the main watercourse. Replaces icatch in GeoData if that one is negative or column missing and `ilicatch` not set.	
ilratk	-	ilakeregion	parameter of rating curve for ilake outflow (rate), replaces `gratk` if above zero	
ilratp	-	ilakeregion	parameter of rating curve for ilake outflow (exponent), replaces `gratp` if above zero	
illdepth	*m*	ilakeregion	depth for ilakes	
ilicatch	-	ilakeregion	fraction of local runoff that goes through the local lake (ilake), the rests runs directly into the main watercourse. Replaces icatch in GeoData if negative or column missing.	
olratk	-	olakeregion	parameter of rating curve for outlet lake outflow (rate), replaces `gratk` if above zero	
olratp	-	olakeregion	parameter of rating curve for outlet lake outflow (exponent), replaces `gratp` if above zero	
olldepth	*m*	olakeregion	depth for outlet lakes, replaces lake_depth in GeoData if zero or negative	
glacannmb	*mm/yr*	general	annual mass balance for correction of initial glacier volume	glacier

Name	Unit	Dependency	Description	Link
denit3reg	d^{-1}	wqparreg	parameter for denitrification rate in soil layer 3, replaces other denitrification rate parameter (`denitrlu` or `denitrlu3`) in third soil layer if >0	
erodluse	-	land use	erosion model 1 landuse erosion factor	erosion
erodsoil	-	soil type	erosion model 1 soil type erosion factor	erosion
erodslope	-	general	erosion model 1 slope erosion factor (exponent)	erosion
erodexp	-	general	erosion model 1 erosion precipitation dependent factor (exponent)	erosion
erodindex	-	general	erosion model 1 scaling of subbasin erosion index	erosion
ppenrmax	-	soil type	maximum enrichment of PP in transport of soil erosion	erosion
ppenrstab	-	general	minimum enrichment (stable level) of PP in transport of soil erosion	erosion
ppenrflow	$mm\ ts^{-1}$	general	flow at which stable level of enrichment of PP in transport of soil erosion is reached	erosion
sedss	$m\ ts^{-1}$	general	sedimentation velocity of suspended sediments in lakes	sedimentation
limsedss	$mg\ L^{-1}$	general	concentration of SS deducted from concentration in water when sedimentation is calculated	sedimentation
sedae	$m\ ts^{-1}$	general	sedimentation velocity of algae in lakes	sedimentation
fraxe	m	general	mean river depth (m) where fractional river area = 1	evaporation
fraxm	m	general	mean river depth (m) where the slope of the fractional river area has its maximum (must be in the range between 0 and `fraxe`)	evaporation
wetrate	-	general	parameter of rating curve of iwet and owet	wetlands
wetexp	-	general	parameter of rating curve of iwet and owet	wetlands
iwetw0	m	general	outflow threshold for iwet (meter above land surface)	wetlands
owetw0	m	general	outflow threshold for owet (meter above land surface)	wetlands
wlsed	m/d	general	sedimentation velocity ON,PP,SS for iwet and owet	wetlands
wlpartfrac	-	general	fraction of settled PP to partP soil component (the rest to fast) for iwet and owet	wetlands
wlproddep	m	general	production depth for area extent dependence of macrophype nutrient uptake IN,SP for iwet and owet	wetlands
wlmphuptin	-	general	coefficient for macrophype nutrient uptake IN for iwet and owet	wetlands
wlmphuptsp	-	general	coefficient for macrophype nutrient uptake SP for iwet and owet	wetlands
wlfastfrac	-	general	fraction macrophyte residuals to fast soil component (the rest to humus) for iwet and owet	wetlands

Name	Unit	Dependency	Description	Link
wltmpexp	-	general	exponent in temperature dependence of macrophype nutrient uptake IN,SP for iwet and owet	[wetlands](#)
hygeomf	-	general	exponent to calculate river depth with hydraulic geometry	
hygeomc	-	general	rate to calculate river depth with hydraulic geometry	
hygeomk	-	general	exponent to calculate river velocity with hydraulic geometry	
hygeomm	-	general	rate to calculate river velocity with hydraulic geometry	

reg_par.txt

The file is located in the modeldir folder. The file is used in the parameter regionalization method for the calculation of regional parameters as a linear funtion of a set of catchment descriptors. This is used when model option `regestimate` is set in info.txt. The file contains coefficients for the linear estimator for each group. Which catchments belong to which group is given in CatchGroup.txt. The catchment descriptors which are used in the stimator are given in CatchDes.txt.

The first row of the *reg_par.txt* file gives the number of regional parameters. Then follow two rows for each parameter for a given group of catchments. The first row of each parameter contains the coefficients and the second row the corresponding catchment descriptor to apply the coefficient to. Information for all parameters is given first for group one, then group two etc.

The following parameters are possible to estimate with regression: `lp`, `cevpam`, `cevpph`, `rivvel`, `damp`, `tcalt`, `tcelevadd`, `tempcorr`, `pcelevmax`, `pcelevadd`, `pcelevth`, `cevpcorr`, `rrcscorr`, `rrcs3`, `pcurain`, and `pcusnow`. For description of the parameters see [par.txt](par.txt).

The example below shows entries for regionalizing two parameters (`tcalt` and `cevpcorr`) in a model setup where there are three groups of catchments.

Example of a *reg_par.txt* file structure:

```
2
tcalt   0.6
tcalt   1
cevpcorr    0.1    -0.1    -0.2    0.3
cevpcorr    1    8    9    10
tcalt   0.6
tcalt   1
cevpcorr    0.1    0.0    -0.1    0.4
cevpcorr    1    8    9    10
tcalt   0.5
tcalt   1
cevpcorr    -0.1    0.3
cevpcorr    8    10
```

CatchDes.txt

The file is located in the modeldir folder. The file is used in the parameter regionalization method for the calculation of regional parameters as a linear funtion of a set of catchment descriptors. This is used when model option `regestimate` is set in info.txt. This file contains catchment descriptors used for estimation of the regional parameters. The file reg_par.txt contains coefficients for the linear estimator for each group. Which catchments belong to which group is given in CatchGroup.txt.

The first row of the *CatchDes.txt* file gives the number of catchment descriptors (number of columns in the subsequent rows). Then follow one row for each subbasin with the values of the descriptors for the subbasin. The row must be in the same order as in GeoData.txt ✏Fix Me! . No column heading or subid is given. The first column is always 1.0 and serves as an intercept in the linear estimator.

Example snippet of a *CatchDes.txt* file structure:

```
3
1.0 23.3    0.003
1.0 20.9    0.001
...
```

CatchGroup.txt

The file is located in the modeldir folder. The file is used in the parameter regionalization method for the calculation of regional parameters as a linear funtion of a set of catchment descriptors. This is used when model option `regestimate` is set in info.txt. The file reg_par.txt contains coefficients for the linear estimator for each group. The catchment descriptors which are used in the stimator are given in CatchDes.txt.

The file gives the group number to which each subbasin belongs. Groups are numbered 1, 2 and up. The number on the ith row shows the group number of the ith subbasin in the same order as in GeoData.txt (Fix Me!). The file has no heading, and no extra columns are allowed.

Outregions.txt

This file contains information about output regions. Output regions are used to average subbasin results to larger areas, e.g. grid squares. The average is calculated based on subbasin and weights defined in this file *Outregions.txt*. For example if you want to have the average snow over three subbasins you give them weight according to their area fraction of the region. If you want other region, e.g. only part of the subbasin area to be included, you give other weights. The regional average is calculated simply based on given weight and the subbasin value.

Outregions.txt is a tab-separated file located in the modeldir folder. Output regions are listed row-wise. The first row contains a column header with column names. Column names are not case-sensitive (max. 10 characters, no spaces). Columns with headings unknown to HYPE are skipped while reading the file, but must not longer than ten characters. Columns containing character strings, e.g. descriptive meta-data, must not exceed a length of 100 characters. A value must exist for every column and row, i.e. empty cells are not allowed. Set subid and weight to zero if the number of subbasins included are less for one or more regions.

Example of a *Outregions.txt* file:

```
outregid xcoord ycoord subid_1 weight_1 subid_2 weight_2 subid_3 weight_3
1        5.5    4.4    748     0.5      22524   0.5     0       0
2        6.5    3.4    4869    0.4      22538   0.3     4790    0.3
```

Columns of the file is compiled to the table below.

Code	Requirement	Description
outregid	mandatory	output region id, must not over lap with subids
xcoord	optional	coordinate
ycoord	optional	coordinate
zcoord	optional	coordinate, could be elevation above sea level
subid_N	mandatory	subid of included subbasins, N is numbered 1 and up, set zero if not used
weight_N	mandatory	weight of the subid with corresponding N

LeakageData.txt

The file holds the monthly average concentration of local runoff from land area (i.e. HYPE variable ID crun) for each subbasin. The concentration calculated by HYPE soil routines will be replaced by this concentration before the water enters the local stream of the subbasin. There is one file per substance and a file suffix *NN* (*LeakageData_NN.txt*) denote the substance, e.g. IN for inorganic nitrogen, ON for organic nitrogen etc.

Table with substances filesuffix and unit of their concentration in the file.

Suffix	Substance	Unit
IN	inorganic nitrogen	*mg/L*
ON	organic nitrogen	*mg/L*
SP	soluble reactive phosphorus	*mg/L*
PP	particulate phosphorus	*mg/L*
OC	organic carbon	*mg/L*
SS	suspended sediment	*mg/L*
AE	algae	*mg N/L*
T1	tracer	*undefined*
T2	water temperature	*°C*

LeakageData.txt is a tab-separated file located in the modeldir folder. Sub-basins are listed row-wise. The first row contains a column header with months. The rows contain concentrations for January to December for each subbasin. The first column contain subid as an integer. The second to 13th columns contain monthly values of concentration. A value must exist for every column and row, i.e. empty cells are not allowed.

Example snippet of LeakageData.txt file structure:

```
month       1       2       3    ...
1001        35.2    17.9    17.8
1002        37.9    11.2    15.3
...
```

state_saveyyyymmdd[HHMM].txt

State variables can be saved to a file and later used for starting a model simulation from that same point. This can be useful to shorten the simulation time, e.g to skip repeatedly simulating a warm-up period, or to simulate several forecasts after running the model up to date.

State-files are saved for the dates given by `outstatedate` in info.txt. The files are written to the resultdir folder. To use a state-file as a starting state `instate` is set in info.txt. A state-file with the date(time) given by `bdate` is expected and used as starting state. The starting state file is expected to be found in the modeldir folder. There is one file per time step with saved states: state_saveyyyymmdd[HHMM].txt yyyymmdd[HHMM] is the date(time) of the start of simulation (`bdate`). For daily time step only the date is used in the file name.

The first row of the state_save-file hold integer codes for what settings were used when creating the file. The settings are checked against the simulation that is started. Most of the settings must be the same for the simulation to start. For instance number of subbasins and classes are checked, as is some model options and time step length. Number of substances simulated (and their internal order) is checked, but it is possible to use a starting state created from a simulation with substances (e.g. NP) to start a simulation of ony discharge. It is not possible run a model of only discharge starting from a state created with "substance" T2 though. That is an exception because a T2 simulation turn on lake and river ice calculations and related states. Updating with the AR-method is possible to turn on or off between simulations using starting states.

ForcKey.txt/ForcKey_nnn.txt

In the basic case, forcing data time series are given for each subbasin. It is possible to use one time series of forcing to represent the conditions for several subbasins. In this case the forcing data time series are given an identification (obsid) separate from the subid. The ForcKey-file gives the coupling between subbasins and forcing data. It can also hold information about elevation for temperature observations (Tobs.txt) that will be used for temperature corrections with parameter `tcobselev`.

The file is optional and located in the modeldir folder given in info.txt. You can use code `readobsid` in info.txt to use this file, but default is to use the file so it is not necessary to set the flag. Turning off `readobsid` will force HYPE not to read and use an existing ForcKey.txt file.

The file has column headings on first row, and data from second and onward. The number of data rows is assumed to be the same as in GeoData.txt. Missing values are not allow (program won't check!). Columns with unknown column headings are skipped while reading the file and can be used for comments. Such columns must not contain more than 100 characters.

Column	Format	Description
subid	*integer*	id number for subbasins (mandatory)
pobsid	*integer*	id number for precipitation data (<100000000)
tobsid	*integer*	id number for air temperature data (<100000000)
tobselev	*real*	elevation of temperature observation in meter
sfobsid	*integer*	id number for snowfall data (<100000000)
swobsid	*integer*	id number for shortwave radiation data (<100000000)
uobsid	*integer*	id number for wind speed data (<100000000)
rhobsid	*integer*	id number for relative humidity data (<100000000)
tminobsid	*integer*	id number for minimum air temperature data (<100000000)
tmaxobsid	*integer*	id number for maximum air temperature data (<100000000)

ForcKey_nnn.txt holds information on forcing data - subbasin coupling for data of sequence with seqnr nnn. For seqnr 0 is ForcKey.txt used.

Pobs.txt/Pobs_nnn.txt

Pobs.txt files hold precipitation forcing data for HYPE. The file is located in the modeldir folder (set in info.txt). Precipitation (mm/time step) has to be given for all timesteps, but longer time series is allowed. No missing/negative values may exist. Program will read this as negative precipitation. The HYPE variable ID `prec` correspond to the data of the *Pobs.txt* file.

The first row is column headings. It holds a text string (e.g. 'date', no spaces allowed) for the first column, and integers in the form of station or subbasin ID numbers for the rest of the columns.

The first column is date-time. The default format is yyyy-mm-dd [HH:MM], where hour and minutes are necessary if the timestep is shorter than one day. The date-time is the beginning of the timestep. It is possible to use another date-time format: yyyymmdd[HHMM]. It is expected for all forcing files, if `readformat 1` is set in info.txt.

The second to last columns are precipitation for all stations or subbasins. The ID number (first row) may be `pobsid` or `subid`. If `pobsid` is used, several subbasins may use the same precipitation time series. `subid` is defined in GeoData.txt. The order of subbasins in *Pobs.txt* does not have to be same as in GeoData.txt. `pobsid` may be defined in ForcKey.txt.

Example snippet of *Pobs.txt* file:

```
date          1234  1245
1990-01-01    0     0
1990-01-02    1     5.5
...
```

For calibration of small model set-ups running time may be reduced by holding the forcing data in memory instead of reading the files for each time step. This option is set in info.txt (`readdaily N`).

Pobs_nnn.txt holds precipitation forcing data for sequence with seqnr nnn. For seqnr 0 *Pobs.txt* is used.

Tobs.txt/Tobs_nnn.txt

Tobs.txt holds air temperature forcing data for HYPE. The file is located in the modeldir folder (set in info.txt). Air temperature (degree Celsius) has to be given for all timesteps, but longer time series is allowed. No missing values may exist. Program won't handle them. The HYPE variable ID `temp` correspond to the data of the *Tobs.txt* file.

The first row is column headings. It holds a text string (e.g. 'date', no spaces allowed) for the first column, and integers in the form of station or subbasin id numbers for the rest of the columns.

The first column is date-time. The default format is yyyy-mm-dd [HH:MM], where hour and minutes are necessary if the timestep is shorter than one day. The date-time is the beginning of the timestep. It is possible to use another date-time format: yyyymmdd[HHMM]. It is expected for all forcing files, if `readformat 1` is set in info.txt.

The second to last columns are air temperature for all stations or subbasins. The ID number (first row) may be `tobsid` or `subid`. If `tobsid` is used, several subbasins may use the same temperature time series. `subid` is defined in GeoData.txt. The order of subbasins does not have to be same as in GeoData.txt. `tobsid` may be defined in ForcKey.txt.

Example snippet of *Tobs.txt* file:

```
date              1234   1245
1990-01-01 00:00   0      0
1990-01-01 12:00   2.0    3.0
1990-01-02 00:00   -1.5   0.5
...
```

For calibration of small model setups running time may be reduced by holding the forcing data in memory instead of reading the files for each time step. This option is set in info.txt (`readdaily N`).

Tobs_nnn.txt holds air temperature forcing data for sequence with seqnr nnn. For seqnr 0 *Tobs.txt* is used.

Qobs.txt

The *Qobs.txt* file holds observations of discharge for selected points in the model domain. The discharge is assumed to correspond to the outflow from a subbasin. The outflow from a subbasin includes the effect of upstream inflows and lakes in the subbasin. The subbasin id (`subid` from GeoData.txt) is used to couple the observations to the model. When refering to observed flow for output or criterion calculation the HYPE variable ID `rout` correspond to the data of the *Qobs.txt* file.

The file is located in the modeldir folder set in info.txt. Discharge (m^3/s) is given for consecutive timesteps for selected subbasins for a continuous time period which doesn't need to cover the whole simulation time period. Missing values is denoted -9999.

The first row includes a text string (e.g. `date`, no spaces allowed) and then subbasin id(s). The first column is date in the format `yyyy-mm-dd [HH:MM]`. If set in info.txt that matlab-format should be read (`readformat 1`) the date format is `yyyymmdd[HHMM]`. The second to last columns are discharge for selected subbasins (i.e. not all subbasins are required).

Xobs.txt

The file is used for introducing time series of several different variables into the model. The time series can be observations used for evaluation of the model, e.g. `rswe` snow water equivalent. A few of the time series can be used as forcing data, i.e. concentrations of precipitation and observed potential evaporation (`repo`).

The file is located in the `modeldir` folder. File should include a continuous time period of values for each time step, which doesn't need to cover the whole simulation time period. Missing values should be given as -9999.

The first row is a comment row which is skipped when reading the file. The second row gives the variable names. For the first column, the date column, the name "date" can be used (no name may not be omitted). The third row gives which subbasin (`subid` in GeoData.txt) the column's data is given for. The date column may in this case belong to subbasin 0 (may not be omitted). The first column is date in format yyyy-mm-dd [HH:MM]. If set in info.txt that matlab-format should be read (`readformat 1`) the date format is yyyymmdd[HHMM]. Second to last columns are data columns.

Example snippet of *Xobs.txt* file:

```
Comment, this file hold observed snow water equivalent
date        rswe  rswe  ...
0           1234  1245  ...
1990-01-01  0     0     ...
1990-01-02  1     5.5   ...
...
```

Observation variables that can be given in *Xobs.txt* are tabled below. They are a selection of the [HYPE variables](). Column **#** refers to the same column in HYPE variable table.

Column **Agg.** indicates the type of aggregation of the variables. The type determines how the variable is treated when asked for as an output variable or in a criterion calculation. The `meanperiod` of the output/criterion determines the period over which the variables values will be aggregated. They will be averaged, weight-averaged or summed according to the type of aggregation. The weight-averaged variables are weighted with the flow/water volume that they are associated to. For the concentration of precipitation that is `pobs` and for the flow concentrations `rout`. Similarly variable values in *Xobs.txt* represent either averages, weighted averages, or sums over the timestep.

#	Variable ID	Unit	Description	Agg.	Reference area	Component
5	rswe	*mm*	observed snow water equivalent, provided in Xobs.txt	Avg.	subbasin land area	[Snow]()
6	rsnw	*cm*	observed snow depth, provided in Xobs.txt	Avg.	subbasin land area	[Snow]()
27	resf	*cm*	observed frost depth, provided in Xobs.txt	Avg.	subbasin land area	[missing]()
28	regw	*m*	observed groundwater level, provided in Xobs.txt	Avg.	subbasin land area	[missing]()
39	rfsc	-	recorded fractional snow cover area, provided in Xobs.txt	Avg.	subbasin land area	[missing]()

#	Variable ID	Unit	Description	Agg.	Reference area	Component
41	rfse	-	recorded fractional snow cover area error, provided in Xobs.txt	Avg.	subbasin land area	missing
42	rfsm	-	recorded fractional snow cover multi, provided in Xobs.txt ❓	Avg.	subbasin land area	missing
43	rfme	-	recorded fractional snow cover multi error, provided in Xobs.txt	Avg.	subbasin land area	missing
46	wstr	m	observed water level olake, provided in Xobs.txt	Avg.	outlet lake area	missing
57	rinf	m^3/s	observed flow to outlet lake (including P-E of the lake), provided in Xobs.txt	Avg.	subbasin upstream area	missing
72	roli	cm	recorded olake ice depth, provided in Xobs.txt	Avg.	outlet lake area	missing
73	rili	cm	recorded ilake ice depth, provided in Xobs.txt	Avg.	internal lake area	missing
74	rolb	cm	recorded olake blackice depth, provided in Xobs.txt	Avg.	outlet lake area	missing
75	rilb	cm	recorded ilake blackice depth, provided in Xobs.txt	Avg.	internal lake area	missing
76	rols	cm	recorded olake snow depth, provided in Xobs.txt	Avg.	outlet lake area	missing
77	rils	cm	recorded ilake snow depth, provided in Xobs.txt	Avg.	internal lake area	missing
84	rmri	cm	recorded main river ice depth, provided in Xobs.txt	Avg.	main river area	missing
85	rlri	cm	recorded local river ice depth, provided in Xobs.txt	Avg.	local river area	missing
86	rmrb	cm	recorded main river blackice depth, provided in Xobs.txt	Avg.	main river area	missing
87	rlrb	cm	recorded local river blackice depth, provided in Xobs.txt	Avg.	local river area	missing
88	rmrs	cm	recorded main river snow depth, provided in Xobs.txt	Avg.	main river area	missing
89	rlrs	cm	recorded local river snow depth, provided in Xobs.txt	Avg.	local river area	missing
100	rolt	$°C$	recorded olake surface temperature, provided in Xobs.txt	Avg.	outlet lake area	missing
101	rilt	$°C$	recorded ilake surface temperature, provided in Xobs.txt	Avg.	internal lake area	missing
102	rmrt	$°C$	recorded main river surface temperature, provided in Xobs.txt	Avg.	main river area	missing
117	rgmb	mm	recorded glacier mass balance, provided in Xobs.txt	Avg.	specific glacier area	missing
119	rgma	km^2	area used in recorded mass balance, provided in Xobs.txt	Avg.	specific glacier area	missing
120	rgmp	$days$	recorded mass balance period, provided in Xobs.txt	Avg.	none	missing

#	Variable ID	Unit	Description	Agg.	Reference area	Component
121	S105	-	recorded (FSUHSS) snow cover surrounding terrain open (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of non-forest land cover	missing
122	S106	-	recorded (FSUHSS) snow cover course open (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of non-forest land cover	missing
123	S108	*cm*	recorded (FSUHSS) mean depth open, provided in Xobs.txt	Avg.	area of non-forest land cover	missing
124	S111	*g/cm³*	recorded (FSUHSS) mean density open, provided in Xobs.txt	Avg.	area of non-forest land cover	missing
125	S114	*mm*	recorded (FSUHSS) snow water equivalent open, provided in Xobs.txt	Avg.	area of forest land cover	missing
126	S205	-	recorded (FSUHSS)snow cover surrounding terrain forest (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of forest land cover	missing
127	S206	-	recorded (FSUHSS) snow cover course forest (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of forest land cover	missing
128	S208	*cm*	recorded (FSUHSS) mean depth forest, provided in Xobs.txt	Avg.	area of forest land cover	missing
129	S211	*g/cm³*	recorded (FSUHSS) mean density forest, provided in Xobs.txt	Avg.	area of forest land cover	missing
130	S214	*mm*	recorded (FSUHSS) snow water equivalent forest, provided in Xobs.txt	Avg.	area of forest land cover	missing
142	reT1	*μU/L*	observed concentration of tracer T1 in outflow from olake/subbasin, unit dependent on substance simulated, values provided in Xobs.txt	W. Avg.	subbasin upstream area	tracer T1
143	reT2	*°C*	observed water temperature in outflow from olake/subbasin, provided in Xobs.txt (average based on recorded flow if present)	W. Avg.	subbasin upstream area	missing
144	reIN, reON, reSP, rePP, reTN, reTP	*μg/L*	observed concentration of N and P species in outflow from olake/subbasin, provided in Xobs.txt (average based on recorded flow if present)	W. Avg.	subbasin upstream area	missing
145	cpT1	*μU/L*	observed concentration of tracer T1 in precipitation, unit user-provided, values provided in Xobs.txt	W. Avg.	subbasin area	tracer T1
156	reOC	*mg/L*	observed OC concentration in outflow from olake/subbasin, provided in Xobs.txt	W. Avg.	subbasin upstream area	missing

#	Variable ID	Unit	Description	Agg.	Reference area	Component
165	repo	*mm/[period]*	observed potential evapotranspiration, provided in Xobs.txt	Sum	subbasin area	missing
166	eobs	*mm/[period]*	observed evapotranspiration, provided in Xobs.txt	Sum	subbasin area	missing
171	rrun	*mm/[period]*	observed local runoff from land area, provided in Xobs.txt	Sum	subbasin land area	missing
194	cpIN	*µg/L*	observed concentration of inorganic nitrogen in precipitation, provided in Xobs.txt	W. Avg.	subbasin area	missing
195	cpSP	*µg/L*	observed concentration of soluble phosphorus in precipitation, provided in Xobs.txt	W. Avg.	subbasin area	missing
248	roum	*m³/s*	observed outflow from olake outlet 1	Avg.	subbasin upstream area	missing
249	roub	*m³/s*	observed outflow from olake outlet 2	Avg.	subbasin upstream area	missing
270	xom0..9	*depends on variable type*	observations of not predefined variable (to be averaged over output time interval) provided in Xobs.txt or XobsXOMn.txt	Avg.	depends on variable type	missing
271	xos0..9	*depends on variable type*	observations of not predefined variable (to be summed over output time interval) provided in Xobs.txt or XobsXOSn.txt	Sum	depends on variable type	missing

Xoregobs.txt

The file is used for introducing time series of output region variables into the model. The time series are observations used for evaluation of the model, e.g. `rgrswe` snow water equivalent.

The file is located in the `modeldir` folder. File should include a continuous time period of values for each time step, which doesn't need to cover the whole simulation time period. Missing values should be given as -9999.

The first row is a comment row which is skipped when reading the file. The second row gives the variable names. For the first column, the date column, the name "date" can be used (no name may not be omitted). The third row gives which output region (`outregid` in Outregions.txt) the column's data is given for. The date column may in this case belong to subbasin 0 (may not be omitted). The first column is date in format yyyy-mm-dd [HH:MM]. If set in info.txt that matlab-format should be read (`readformat 1`) the date format is yyyymmdd[HHMM]. Second to last columns are data columns.

Observation variables that can be given in *Xobs.txt* are tabled below. They are a selection of the HYPE variables. The outregion version of the variables can be given in *Xoregobs.txt* by extending the name of the variable with 'rg' in the beginning (e.g. `rswe` correspond to outregion variable `rgrswe`). Some regional variables may give result that is (e.g. `rgwstr`).

Column **#** refers to the column in HYPE variable table for the corresponding subbasin variabel.

Column **Agg.** indicates the type of aggregation of the variables. The type determines how the variable is treated when asked for as an output variable or in a criterion calculation. The `meanperiod` of the output/criterion determines the period over which the variables values will be aggregated. They will be averaged, weight-averaged or summed according to the type of aggregation. Similarly variable values in *Xobs.txt* represent either averages, weighted averages, or sums over the timestep.

#	Variable ID	Unit	Description	Agg.	Reference area
5	rswe	*mm*	observed snow water equivalent, provided in Xobs.txt	Avg.	subbasin land area
6	rsnw	*cm*	observed snow depth, provided in Xobs.txt	Avg.	subbasin land area
27	resf	*cm*	observed frost depth, provided in Xobs.txt	Avg.	subbasin land area
28	regw	*m*	observed groundwater level, provided in Xobs.txt	Avg.	subbasin land area
39	rfsc	-	recorded fractional snow cover area, provided in Xobs.txt	Avg.	subbasin land area
41	rfse	-	recorded fractional snow cover area error, provided in Xobs.txt	Avg.	subbasin land area
42	rfsm	-	recorded fractional snow cover multi, provided in Xobs.txt ❓	Avg.	subbasin land area
43	rfme	-	recorded fractional snow cover multi error, provided in Xobs.txt	Avg.	subbasin land area
45	wstr	*m*	observed water level olake, provided in Xobs.txt	Avg.	outlet lake area

#	Variable ID	Unit	Description	Agg.	Reference area
56	rinf	m^3/s	observed (derived) flow (including P-E) to olake, provided in Xobs.txt	Avg.	subbasin upstream area
69	roli	cm	recorded olake ice depth, provided in Xobs.txt	Avg.	outlet lake area
70	rili	cm	recorded ilake ice depth, provided in Xobs.txt	Avg.	internal lake area
71	rolb	cm	recorded olake blackice depth, provided in Xobs.txt	Avg.	outlet lake area
72	rilb	cm	recorded ilake blackice depth, provided in Xobs.txt	Avg.	internal lake area
73	rols	cm	recorded olake snow depth, provided in Xobs.txt	Avg.	outlet lake area
74	rils	cm	recorded ilake snow depth, provided in Xobs.txt	Avg.	internal lake area
81	rmri	cm	recorded main river ice depth, provided in Xobs.txt	Avg.	main river area
82	rlri	cm	recorded local river ice depth, provided in Xobs.txt	Avg.	local river area
83	rmrb	cm	recorded main river blackice depth, provided in Xobs.txt	Avg.	main river area
84	rlrb	cm	recorded local river blackice depth, provided in Xobs.txt	Avg.	local river area
85	rmrs	cm	recorded main river snow depth, provided in Xobs.txt	Avg.	main river area
86	rlrs	cm	recorded local river snow depth, provided in Xobs.txt	Avg.	local river area
97	rolt	°C	recorded olake surface temperature, provided in Xobs.txt	Avg.	outlet lake area
98	rilt	°C	recorded ilake surface temperature, provided in Xobs.txt	Avg.	internal lake area
99	rmrt	°C	recorded main river surface temperature, provided in Xobs.txt	Avg.	main river area
112	xom0..9	depends on variable type	optional, not predefined variable (averaged over output time interval) provided in Xobs.txt or XobsXOMn.txt	Avg.	depends on variable type
115	rgmb	mm	recorded glacier mass balance, provided in Xobs.txt	Avg.	specific glacier area
117	rgma	km^2	area used in recorded mass balance, provided in Xobs.txt	Avg.	specific glacier area
118	rgmp	days	recorded mass balance period, provided in Xobs.txt	Avg.	none
119	S105	-	recorded (FSUHSS) snow cover surrounding terrain open (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of non-forest land cover
120	S106	-	recorded (FSUHSS) snow cover course open (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of non-forest land cover
121	S108	cm	recorded (FSUHSS) mean depth open, provided in Xobs.txt	Avg.	area of non-forest land cover

#	Variable ID	Unit	Description	Agg.	Reference area
122	S111	g/cm³	recorded (FSUHSS) mean density open, provided in Xobs.txt	Avg.	area of non-forest land cover
123	S114	mm	recorded (FSUHSS) snow water equivalent open, provided in Xobs.txt	Avg.	area of forest land cover
124	S205	-	recorded (FSUHSS)snow cover surrounding terrain forest (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of forest land cover
125	S206	-	recorded (FSUHSS) snow cover course forest (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of forest land cover
126	S208	cm	recorded (FSUHSS) mean depth forest, provided in Xobs.txt	Avg.	area of forest land cover
127	S211	g/cm³	recorded (FSUHSS) mean density forest, provided in Xobs.txt	Avg.	area of forest land cover
128	S214	mm	recorded (FSUHSS) snow water equivalent forest, provided in Xobs.txt	Avg.	area of forest land cover
143	reT1	undefined	observed concentration of stable water isotope tracer in outflow from olake/subbasin, unit dependent on unit in user-provided precipitation concentration of cpT1, typically ‰ deviation from V-SMOW, provided in Xobs.txt	W. Avg.	subbasin upstream area
144	reT2	°C	observed water temperature in outflow from olake/subbasin, provided in Xobs.txt	W. Avg.	subbasin upstream area
146	reIN, reON, reSP, rePP, reTN, reTP	µg/L	observed concentration of N and P species in outflow from olake/subbasin, provided in Xobs.txt	W. Avg.	subbasin upstream area
147	cpT1	undefined	observed concentration of stable water isotopes in precipitation, unit user-provided, typically ‰ deviation from V-SMOW, provided in Xobs.txt	W. Avg.	subbasin area
160	reOC	mg/L	observed OC concentration in outflow from olake/subbasin, provided in Xobs.txt	W. Avg.	subbasin upstream area
169	repo	mm/[timestep]	observed potential evapotranspiration, provided in Xobs.txt	Sum	subbasin area
170	eobs	mm/[timestep]	observed evapotranspiration, provided in Xobs.txt	Sum	subbasin area
175	rrun	mm/[timestep]	observed local runoff from soil, provided in Xobs.txt	Sum	subbasin land area
193	xos0..9	depends on variable	optional, not predefined variable (summed over output time interval) provided in Xobs.txt or XobsXOSn.txt	Sum	depends on variable
202	cpIN	µg/L	observed concentration of inorganic nitrogen in precipitation, provided in Xobs.txt	W. Avg.	subbasin area

#	Variable ID	Unit	Description	Agg.	Reference area
203	cpSP	$\mu g/L$	observed concentration of soluble phosphorus in precipitation, provided in Xobs.txt	W. Avg.	subbasin area
263	roum	m^3/s	observed outflow from olake outlet 1	Avg.	subbasin upstream area
264	roub	m^3/s	observed outflow from olake outlet 2	Avg.	subbasin upstream area

RHobs.txt

Relative humidity is an optional forcing data. It can be used for calculation of potential evaporation. Several of the available model options for potential evaporation depend on vapor pressures and net radiation, which may be calculated with the help of relative humidity data.

The file is located in the `modeldir` folder. Relative humidity (unitless value 0-1) is given for all time steps. The *RHobs-file* is read only if `readhumid` is set in info.txt.

The first row is column headings. It holds a text string (e.g. 'date', no spaces allowed) for the first column, and integers in the form of station or subbasin ID numbers for the rest of the columns.

The first column is date-time. The default format is yyyy-mm-dd [HH:MM], where hour and minutes are necessary if the timestep is shorter than one day. The date-time is the beginning of the timestep. It is possible to use another date-time format: yyyymmdd[HHMM]. It is expected for all forcing files, if `readformat 1` is set in info.txt.

The second to last columns are relative humidity for all stations or subbasins. The ID number (first row) may be `rhobsid` or `subid`. If `rhobsid` is used, several subbasins may use the same relative humidity time series. `subid` is defined in GeoData.txt. The order of subbasins in *RHobs.txt* does not have to be same as in GeoData.txt. `rhobsid` may be defined in ForcKey.txt.

Example snippet of *RHobs.txt* file:

```
date           1234  1245
1990-01-01    0.7      0.75
1990-01-02    0.8      0.65
...
```

RHobs_nnn.txt holds relative humidity forcing data for sequence with seqnr nnn. For seqnr 0 *RHobs.txt* is used.

SFobs.txt

Snowfall fraction is an optional forcing data. It is used for separation of precipitation into snow and rain if `snowfallmodel` is set in info.txt, otherwise air temperature is used to determine the snowfall fraction. The file is located in the `modeldir` folder. Snowfall fraction (unitless value 0-1) is given for all time steps. The *SFobs-file* is read only if `readsfobs` is set in info.txt.

The first row is column headings. It holds a text string (e.g. 'date', no spaces allowed) for the first column, and integers in the form of station or subbasin ID numbers for the rest of the columns.

The first column is date-time. The default format is yyyy-mm-dd [HH:MM], where hour and minutes are necessary if the timestep is shorter than one day. The date-time is the beginning of the timestep. It is possible to use another date-time format: yyyymmdd[HHMM]. It is expected for all forcing files, if `readformat 1` is set in info.txt.

The second to last columns are snowfall fraction for all stations or subbasins. The ID number (first row) may be `sfobsid` or `subid`. If `sfobsid` is used, several subbasins may use the same snowfall fraction time series. `subid` is defined in GeoData.txt. The order of subbasins in *SFobs.txt* does not have to be same as in GeoData.txt. `sfobsid` may be defined in ForcKey.txt.

Example snippet of *SFobs.txt* file:

```
date        1234   1245
1990-01-01  1      1
1990-01-02  0.85   1
...
```

SFobs_nnn.txt holds snowfall fraction forcing data for sequence with seqnr nnn. For seqnr 0 *SFobs.txt* is used.

SWobs.txt

Shortwave radiation is an optional forcing data. It can be used for calculation of snow melt, ice on lake and rivers and potential evaporation. Some of the available model options for these processes depend on shortwave radiation, and use it either from this file or approximated from other input data.

The file is located in the `modeldir` folder. Shortwave radiation ($MJ/m^2/d$) is given for all time steps. The *SWobs-file* is read only if `readswobs` is set in info.txt.

The first row is column headings. It holds a text string (e.g. 'date', no spaces allowed) for the first column, and integers in the form of station or subbasin ID numbers for the rest of the columns.

The first column is date-time. The default format is yyyy-mm-dd [HH:MM], where hour and minutes are necessary if the timestep is shorter than one day. The date-time is the beginning of the timestep. It is possible to use another date-time format: yyyymmdd[HHMM]. It is expected for all forcing files, if `readformat 1` is set in info.txt.

The second to last columns are radiation for all stations or subbasins. The ID number (first row) may be `swobsid` or `subid`. If `swobsid` is used, several subbasins may use the same radiation time series. `subid` is defined in GeoData.txt. The order of subbasins in *SWobs.txt* does not have to be same as in GeoData.txt. `swobsid` may be defined in ForcKey.txt.

Example snippet of *SWobs.txt* file:

```
date            1234   1245
1990-01-01      0.7     0.75
1990-01-02      0.8     0.65
...
```

SWobs_nnn.txt holds shortwave radiation forcing data for sequence with seqnr nnn. For seqnr 0 *SWobs.txt* is used.

TMINobs.txt

TMINobs.txt holds daily minimum air temperature forcing data for HYPE. Minimum and maximum air temperature can only be used for models with daily time step (for now). Several of the available model options for potential evaporation depend on vapor pressures and net radiation, which may be calculated with the help of minimum and maximum air temperature data.

The file is located in the modeldir folder (set in info.txt). Air temperature (degree Celsius) has to be given for all timesteps, but longer time series is allowed. No missing values may exist. Program won't handle them. The *TMINobs-file* is read only if `readtminmaxobs` is set in info.txt.

The first row is column headings. It holds a text string (e.g. 'date', no spaces allowed) for the first column, and integers in the form of station or subbasin id numbers for the rest of the columns.

The first column is date-time. The default format is yyyy-mm-dd. The date-time is the beginning of the timestep. It is possible to use date-time format: yyyymmdd instead. It is expected for all forcing files if `readformat 1` is set in info.txt.

The second to last columns are minimum air temperature for all stations or subbasins. The ID number (first row) may be `tminobsid` or `subid`. If `tminobsid` is used, several subbasins may use the same temperature time series. `subid` is defined in GeoData.txt. The order of subbasins does not have to be same as in GeoData.txt. `tminobsid` may be defined in ForcKey.txt.

Example snippet of *TMINobs.txt* file:

```
date               1234  1245
1990-01-01 00:00   0     0
1990-01-01 12:00   2.0   3.0
1990-01-02 00:00   -1.5  0.5
...
```

TMINobs_nnn.txt holds air temperature forcing data for sequence with seqnr nnn. For seqnr 0 *TMINobs.txt* is used.

TMAXobs.txt

TMAXobs.txt holds daily maximum air temperature forcing data for HYPE. Minimum and maximum air temperature can only be used for models with daily time step (for now). Several of the available model options for potential evaporation depend on vapor pressures and net radiation, which may be calculated with the help of minimum and maximum air temperature data.

The file is located in the modeldir folder (set in [info.txt](#)). Air temperature (degree Celsius) has to be given for all timesteps, but longer time series is allowed. No missing values may exist. Program won't handle them. The *TMAXobs-file* is read only if `readtminmaxobs` is set in [info.txt](#).

The first row is column headings. It holds a text string (e.g. 'date', no spaces allowed) for the first column, and integers in the form of station or subbasin id numbers for the rest of the columns.

The first column is date-time. The default format is yyyy-mm-dd. The date-time is the beginning of the timestep. It is possible to use date-time format: yyyymmdd instead. It is expected for all forcing files if `readformat 1` is set in [info.txt](#).

The second to last columns are maximum air temperature for all stations or subbasins. The ID number (first row) may be `tmaxobsid` or `subid`. If `tmaxobsid` is used, several subbasins may use the same temperature time series. `subid` is defined in [GeoData.txt](#). The order of subbasins does not have to be same as in [GeoData.txt](#). `tmaxobsid` may be defined in [ForcKey.txt](#).

Example snippet of *TMAXobs.txt* file:

```
date              1234  1245
1990-01-01 00:00  0     0
1990-01-01 12:00  2.0   3.0
1990-01-02 00:00  -1.5  0.5
...
```

TMAXobs_nnn.txt holds air temperature forcing data for sequence with seqnr nnn. For seqnr 0 *TMAXobs.txt* is used.

Uobs.txt

Wind speed is an optional forcing data. It can be used for calculation of potential evaporation with the FAO Penman-Monteith medthod (model options petmodel 5). If not given an constant wind speed is assumed.

The file is located in the `modeldir` folder. Wind speed (*m/s*) is given for all time steps. No missing values may exist (program won't check!). The *Uobs-file* is read only if `readwind` is set in info.txt.

The first row is column headings. It holds a text string (e.g. 'date', no spaces allowed) for the first column, and integers in the form of station or subbasin ID numbers for the rest of the columns.

The first column is date-time. The default format is yyyy-mm-dd [HH:MM], where hour and minutes are necessary if the timestep is shorter than one day. The date-time is the beginning of the timestep. It is possible to use another date-time format: yyyymmdd[HHMM]. It is expected for all forcing files, if `readformat 1` is set in info.txt.

The second to last columns are wind for all stations or subbasins. The ID number (first row) may be `uobsid` or `subid`. If `uobsid` is used, several subbasins may use the same wind time series. `subid` is defined in GeoData.txt. The order of subbasins in *Uobs.txt* does not have to be same as in GeoData.txt. `uobsid` may be defined in ForcKey.txt.

Example snippet of *Uobs.txt* file:

```
date         1234  1245
1990-01-01   0.7      0.75
1990-01-02   0.8      0.65
...
```

Uobs_nnn.txt holds wind speed forcing data for sequence with seqnr nnn. For seqnr 0 *Uobs.txt* is used.

XobsXOMn.txt

There are 20 HYPE variable IDs defined to be used for evaluating miscellaneus variables. These variables can be used for different observations that has not a designated HYPE variable ID already defined. There are two types of variables xom and xos, 10 of each numbered 0 to 9. The difference between the two types are that xom is averaged over time when a mean period is asked for (e.g. like soil moisture), while the other xos, is summed over time for the mean period (e.g. like runoff).

The files are located in the `modeldir` folder. A variable of user choice is given for all time steps. Maximum 10 variables/files may be used. One file per variable. The variables are called xom0-xom9. The variable can be used for criterion calculation and is averaged over `meanperiod`. The first row is a comment row. The second row includes a text string (e.g. `date`, no spaces allowed) and then subbasin ids (`subid`). The first column holds date in the format `yyyy-mm-dd`. If set in info that matlab-format should be read (`readformat 1`) the date format is instead `yyyymmdd`. The second to last columns are data values for all or selected subbasins. The order of subbasins does not have to be same as in GeoData.txt. The file is read only if so set in info.txt (`readxomsfiles Y`).

XobsXOSn.txt

There are 20 HYPE variable IDs defined to be used for evaluating miscellaneus variables. These variables can be used for different observations that has not a designated HYPE variable ID already defined. There are two types of variables xom and xos, 10 of each numbered 0 to 9. The difference between the two types are that xom is averaged over time when a mean period is asked for (e.g. like soil moisture), while the other xos, is summed over time for the mean period (e.g. like runoff).

The files are located in the `modeldir` folder. Variable of user choice is given for all time steps. Maximum 10 variables/files may be used. One file per variable. The variables are called `xos0-xos9`. The variable can be used for criterion calculation and is summed over `meanperiod`. The first row is a comment row. The second row includes a text string (e.g. `date`, no spaces allowed) and then subbasin ids (`subid`). The first column holds date in the format `yyyy-mm-dd`. If set in info that matlab-format should be read (`readformat 1`) the date format is instead `yyyymmdd`. The second to last columns hold data values for all or selected subbasins. The order of subbasins does not have to be same as in GeoData.txt. The file is read only if so set in info.txt (`readxomsfiles Y`).

hyss_seqnr_yymmdd_HHMM.log

The file is created in the same folder as info.txt is located. The file is written during simulation with information on progress, warning messages and error messages. In the end, simulation performance is printed (similar to the information in simass.txt).

If a sequence number (*seqnr*) was given when starting the simulation (see How to run HYPE), the *seqnr* is used in the file name. For other simulations the *seqnr* is 000.

tests_seqnr_yymmdd_HHMM.log

The file is created in the same folder as info.txt is located. The file is written during simulation with information on tests performed on setup- and observation files. Choices can be made on what to do if errors occur (e.g. exit on errors or continue regardless of passed or failed tests). The level of printouts to the file is set in the info.txt file.

Tests will be performed on various hydrological processes as well as model options. Passed or failed tests are shown along warning messages and error messages. The tests are divided into sections;

- observations,
- tests during loading of indata files,
- generic tests (often related to a specific indata file),
- processes related tests,

and last a summary of the status and number of failed sections. In the end, after all test results have been summarized, the test during loading may be printed once again to be on the safe side for irregular ending of the program. The process related tests are grouped according to substance and location similar to the wiki, i.e. it starts with water - processes above ground and ends with tracers T1 and T2. Many headings have no tests reported yet. Although all model options and many generic tests have been added already, the work continues to add tests for all processes and substances.

Each test reported in the file starts by giving its status, [Passed] or [Failed], followed by the name of the test. If more information has been asked for;

- a list of parameters, indata or other specifics are given with its status
- the values of data tested, either as a range or each value for model parameters
- tests with no values to report are listed as *incorporated* when performed
- INFO: columns ignored are reported when reading indata files; headings and as *data:* the format of all columns (0=string, 1=integer, 2=real)

If a sequence number (seqnr) was given when starting the simulation (see How to run HYPE), the seqnr is used in the file name. For other simulations the seqnr is 000.

simass.txt

This is a file with simulation assessment, summarising performance criteria over model domain. The file is located in the resultdir folder. The file contains values of most performance criteria of the selected variables in the objective function. Note: If several RA criteria have been selected, only the last of them will be printed to file. Not calculated criterion are indicated by -9999. All information from the simass-files can also be found in the hyss_yymmddHHMM.log.

When ensemble or sequence simulations are made, the results from simulations (I=1 .. *n* or I=sequence number>0) are written to files named simassX_00I.txt. For a Monte Carlo calibration *n* is defined by num_ens in optpar.txt. For a DE calibration *n* is num_ngen plus one, where the first one is a simulation with median of the others parameter values.

For the calculation of criterion for lake water stage, the combination of variables `wcom` and `wstr` are exchanged for the internal variables `clwc` and `clws` by the program. These variables are the water stages cleaned from `w0ref` reference level (clwc=wcom-w0ref, clws=wstr-w0ref). This makes the criterion calculation more accurate, but note that relative criteria, e.g. relative bias, are relative to the smaller cleaned water stage level.

The following performance criteria may be calculated: Code is corresponding code for info.txt. Definitions of equations for calculating the criteria is found here.

Criterion	Code	Description
`Regional NSE`	RR2	regional Nash-Sutcliffe efficiency (all data combined in one long time-series)
`Regional RA`	RRA	regional Nash-Sutcliffe efficiency like criteria where the square is exchanged with a coefficient value
`Regional RE`	RRE	regional relative bias (all data combined in one long time-series)
`Regional MAE`	-	regional absolute error (all data combined in one long time-series)
`Average NSE`	MR2	average of Nash-Sutcliffe efficiencies for all subbasins with observations
`Average RA`	MRA	average value of subbasin values of Nash-Sutcliffe like criteria where the square is exchanged with a coefficient value
`Average RE`	MRE	average of the relative bias for all subbasins (Note: fraction, not %)
`Average RSDE`	MRS	error in standard deviation, average of all subbasins with observations
`Average CC`	MCC	Pearson correlation coefficient, average of all subbasins with observations
`Average ARE`	MAR	mean absolute of relative errors for all subbasins (Note: fraction, not %)
`Spatial NSE`	SR2	spatial R2 calculated using annual means for all subbasins (requires at least 5 years and 5 subbasins with data)
`Spatial RA`	RRA	Spatial Nash-Sutcliffe like criteria where the square in the Nash-Sutcliffe formula is exchanged for a coefficient value
`Spatial RE`	-	spatial relative error calculated using annual means for all subbasins (requires at least 5 years and 5 subbasins with data)
`Kendalls Tau`	TAU	average of Kendall's Tau value for all subbasins
`Median NSE`	MD2	median of Nash-Sutcliffe efficiency for all subbasins with observations

Criterion	Code	Description
Median RA	MDA	median of all subbasins RA (Nash-Sutcliffe like criteria where the square is exchanged with a coefficient value)
Median KGE	MKG	median of all subbasins Kling-Gupta efficiency
Median NRMSE	MNR	median of all subbasins normalised RMSE
Mean NSEW	MNW	average of Nash-Sutcliffe efficiencies adjusted for bias for all subbasins with observations
Number of data for regional criterion	-	number of data points included in calculation of regional criteria
Number of areas in mean/median criterion	-	number of areas (subbasins/outregions) which criteria is included in mean and median criteria calculations

Note: If several RA criteria have been selected, only the last of them will be printed to file.

subassX.txt

This is a file with an assessment of each subbasin's performance, or each output region if regional output variables are used. The file is located in the resultdir folder. One file is printed for each performance criterion included in the objective function given in info.txt. X is the ordinal number of the performance criterion and the subbasin assessment is calculated for the same variables as that performace criterion. If more than nine criteria are included, the following are denoted by capital letters. Definitions of equations for calculating the criteria is found here.

When ensemble or sequence simulations are made, the results from simulations (I=1 .. *n* or I=sequence number>0) are written to files named subassX_00I.txt. For a Monte Carlo calibration *n* is defined by num_ens in optpar.txt. For a DE calibration *n* is num_ngen plus one, where the first one is a simulation with median of the others parameter values.

For the calculation of criterion for lake water stage, the combination of variables `wcom` and `wstr` are exchanged for the internal variables `clwc` and `clws` by the program. These variables are the water stages cleaned from `w0ref` reference level (`clwc=wcom-w0ref`, `clws=wstr-w0ref`). This makes the criterion calculation more accurate, but note that relative criteria, e.g. relative bias, are relative to the smaller cleaned water stage level.

The first row of the file let you know the average period (0=timesteply, 1=daily, 2=weekly, 3=monthly, 4=yearly) used for calculation of the values that are compared in the criteria. This period corresponds to the setting `meanperiod` in info.txt. Variable names and unit are also listed on row one. The second row is column headings. Thereafter follow subbasins which has observations, one on each row. The data limitation for calculating the subbasin criteria is the same as that of the calibration criteria. Missing values are indicated as -9999.

The columns of subassX.txt:

Header	Unit	Description
SUBID / OUTREGID	-	subbasin id (as defined in GeoData.txt) or outregion id (as defined in Outregions.txt)
NSE	-	Nash-Sutcliffe efficiency
CC	-	Pearson correlation coefficient (part 1 of Kling-Gupta efficiency)
RE(%)	%	relative bias in mean
RSDE(%)	%	relative bias in standard deviation
Sim	*in first row*	mean of simulated variable
Rec	*in first row*	mean of observed variable
SDSim	*in first row*	standard deviation of simulated variable
SDRec	*in first row*	standard deviation of observed variable
MAE	*in first row*	mean absolute error
RMSE	*in first row*	root mean square error
Bias	*in first row*	bias
SDE	*in first row*	bias of standard deviation
KGE	-	Kling-Gupta efficiency
KGESD	-	part 2 of Kling-Gupta efficiency (std-quotient)
KGEM	-	part 3 of Kling-Gupta efficiency (mean-quotient)
NRMSE	*in first row*	normalised root mean square error

Header	Unit	Description
NSEW	-	Nash-Sutcliffe efficiency adjusted for bias

Example of subass1.txt:

```
 Subbasin assessment. Criteria is calculated for period 1. Variables: rout,
cout  Unit: m3/s
SUBID   NSE     CC     RE(%)    RSDE(%)    Sim     Rec     SDSim     SDRec      MAE
RMSE     Bias     SDE     KGE     KGESD     KGEM     NRMSE     NSEW
112 0.5071    0.721    22.6492    -68.38    0.058    0.0472    0.0681     0.1
0.0385    0.072    0.0131    -0.0132    0.5182    0.6781    1.2265     0.0662
0.5122
135 0.722     0.8811    -20.802    0.3982    0.3081    0.3887     0.4089
0.4071    0.1464    0.2143    -0.0811    0.0021    0.76    1.004    0.7922
0.0752    0.7223
```

XXXXXXX.txt (basin output)

HYPE basin output files are one of the standard result files for time series output from HYPE, the other are map output files, time output files and region output files.

Basin output files each contain results for multiple variables of a single HYPE subbasin. This makes it different from time and map output files which always contain results for the whole model domain. Basin output files are intended for model analyses at the subbasin scale, and they are arguably the most commonly used HYPE output type. To write basin output files, specify a `basinoutput` for the variables of interest in the info.txt file.

Example snippet of a info.txt file:

```
!! time outputs for measured and simulated discharge
basinoutput variable rout cout prec temp snow evap upcrun
basinoutput subbasin 2452 2353 1244 2424
basinoutput meanperiod 1
basinoutput decimals 3
```

Basin output files are written to the resultdir folder. **XXXXXXX** in the file name is substituted by the subbasin ID (same ID as used in info.txt with leading zeros for SUBID with less than 7 digits), for example *0002452.txt*.

Basin output files contain tab-separated data with column-wise HYPE variables and row-wise time periods. All HYPE variable IDs are described in the **list of HYPE variables**. In addition upstream aggregated variables (e.g. upcrun) may be included in the basin output.

Basin output files are tab-separated and contain two header rows. The first header contains HYPE variable IDs. The second header contains variable units. Below the headers follow the model results. The first column contains a date-time string (format depending on `meanperiod` specified in *info.txt*), following columns contain model results of the given variable for all subbasins in the model set-up. Missing values are given as -9999.

Example structure of a basin output file with daily variables, corresponding to the *info.txt* file example above:

```
DATE        rout   cout   prec   temp snow evap   upcrun
UNITS       m3/s   m3/s   mm     degC mm   mm     mm
2003-01-01 0.51   0.482 0      7.2  1.2  1.543 0.23
2003-01-02 0.40   0.319 1      6.9  0    1.140 0.31
2003-01-03 0.31   0.273 0      5.4  0    0.98  0.08
2003-01-04 0.24   0.247 0.1    5.0  0    0.87  0.1
2003-01-05 0.22   0.226 0      4.5  0    0.75  0.05
...         ...    ...    ...    ...  ...  ...   ...
```

It is possible to print out basinoutput files for several mean periods at the same time. This is controlled from the info-file by numbering the different output information rows for the different types (see info.txt for example). If this option is used the basinoutputs will be separated by adding the mean period as a code in the file name, e.g. 0000748_YR.txt holds yearly average (or sum) of variables specified for subbasin 748.

When ensemble or sequence simulations are made, the results from simulations (I = 1 .. *n* or I = sequence number > 0) are written to files named *XXXXXXX_00I.txt*, where *n* is defined by num_ens in optpar.txt. Alternatively, if a Monte Carlo simulation is done with task set to write all simulations (`task WS` in optpar.txt) files will be named *XXXXXXX_000000I.txt*. In this case up to 9999999 simulations can be saved.

Class output files may also be called XXXXXXX, but they are followed by a suffix naming the class group, e.g. 0000748_DD_past.txt for the past class group's daily data in subid 748. The file has an extra comment row that normal subbasin files do not have. There is specified which classes are included in the group. Otherwise the file is similar to the ordinary basin-files. Only variables with data for the classes will have values in the file.

XXXXXXX.txt (region output)

HYPE region output files are one of the standard result files for time series output from HYPE, the other are basin output files, map output files and time output files.

Region output files each contain results for multiple variables of a single output region (as defined in Outregions.txt). This makes it different from time and map output files which always contain results for the whole model domain. To write region output files, specify a `regionoutput` for the variables of interest in the info.txt file.

Example snippet of a info.txt file:

```
!! region outputs for yearly snow and runoff
regionoutput variable snow crun
regionoutput outregion 1
regionoutput meanperiod 1
regionoutput decimals 3
regionoutput outregion 74
```

Region output files are written to the resultdir folder. **XXXXXXX** in the file name is substituted by the outregion ID (same ID as used in info.txt with leading zeros for OUTREGID with less than 7 digits, for example *0000001.txt*. Note that outregid:s may not overlap subid:s.

Region output files contain tab-separated data with column-wise HYPE variables and row-wise time periods. All HYPE variable IDs are described in the **list of HYPE variables**. Of these the corresponding output regional variables (e.g. `rgcrun`) may be included in the region output.

Region output files are tab-separated and contain two header rows. The first header contains variable IDs. The second header contains variable units. Below the headers follow the model results. The first column contains a date-time string (format depending on `meanperiod` specified in *info.txt*), following columns contain model results of the chosen variables. Missing values are given as -9999.

Example structure of a region output file with daily variables, corresponding to the *info.txt* file example above:

```
DATE        rgsnow  rgcrun
UNITS       mm      mm
2003-01-01 5.511   0.082
2003-01-02 3.403   0.319
2003-01-03 2.31    0.273
2003-01-04 2.244   0.047
2003-01-05 0.22    0.226
...         ...     ...
```

It is possible to print out region output files for several mean periods at the same time. This is controlled from the info-file by numbering the different output information rows for the different types (see info.txt for example). If this option is used the second and following outputs will be separated from the first by adding the mean period as a code in the file name, e.g. 0000748_YR.txt holds yearly average (or sum) of variables specified for output region 748.

When ensemble or sequence simulations are made, the results from simulations (I = 1 .. *n* or I = sequence number > 0) are written to files named *XXXXXXX_00I.txt*, where *n* is defined by num_ens in optpar.txt. Alternatively, if a Monte Carlo simulation is done with task set to write all simulations (task WS in optpar.txt) files will be named *XXXXXXX_000000I.txt*. In this case up to 9999999 simulations can be saved.

mapXXXX.txt

HYPE map output files are one of the standard result files for time series output from HYPE, the other are time output files (like map output files, but transposed), basin output files and region output files.

Map output files each contain results for a single HYPE variable for all modelled sub-basins. They are mainly intended to be joined to a GIS map of sub-basins in order to plot results. All values of map output variables are saved in memory until the end of the simulation, it should therefore not be used to write many periods of aggregated values. If the model and the output are large the available memory may limit the program. If you want output for every time step of the model it is suggested to use time output files instead. To write map output files, specify a mapoutput for the variables of interest in the info.txt file.

Example snippet of a info.txt file:

```
!! map outputs for measured and simulated discharge
mapoutput variable rout cout
mapoutput meanperiod 4
mapoutput decimals 3
```

Map output files are written to the resultdir folder. **XXXX** in the file name is substituted by the variable ID (same ID as used in info.txt, for example *mapCOUT.txt*. All HYPE variable IDs are described in the **list of HYPE variables**.

Map output files contain comma-separated data with column-wise time periods and row-wise sub-basins, corresponding to attribute tables of sub-basin maps. The first row contains a text comment. It briefly describes the HYPE variable which is contained in the file. Row two contains column headings. The first column contains sub-basin IDs (SUBID), following columns contain model results of the given variable for the requested time period. Missing values are given as -9999.

Example structure of a map output file *mapCOUT.txt* with annual discharge averages for a two-year model run:

```
 This is a file with comp outflow olake in m3/s for GIS mapping
SUBID,1999,2000
4472,0.228,0.301
3762,0.364,0.442
3753,0.561,0.641
3361,0.070,0.055
3427,0.100,0.092
 ...,  ...,  ...
```

When ensemble or sequence simulations are made, the results from simulations (I = 1 .. *n* or I = sequence number > 0) are written to files named *mapXXXX_00I.txt*, where *n* is defined by num_ens in optpar.txt. Alternatively, if a Monte Carlo simulation is done with task set to write all simulations (task WS in optpar.txt) files will be named *XXXXXXX_000000I.txt*. In this case up to 9999999 simulations can be saved.

timeXXXX.txt

HYPE time output files are one of the standard result files for time series output from HYPE, the other are map output files (like time output files, but transposed), basin output files and region output files.

Time output files each contain results for a single HYPE variable for all modelled sub-basins or if it is a output regional variable for all modelled output regions. To write time output files, `timeoutput` is specified for the variables of interest in the info.txt file.

Example snippet of a info.txt file:

```
!! time outputs for measured and simulated discharge, regional runoff
timeoutput variable rout cout rgcrun
timeoutput meanperiod 4
timeoutput decimals 4
```

Time output files are written to the resultdir folder. **XXXX** in the file name is substituted by the variable ID (same ID as used in info.txt, for example *timeCOUT.txt*). All HYPE variable IDs are described in the **list of HYPE variables**. In addition upstream aggregated variables and output region variables may be printed, e.g. *timeRGCRUN.txt*.

Time output files contain tab-separated data with column-wise subbasins (or output regions) and row-wise time periods. The first row contains a text comment. It briefly describes the HYPE variable which is contained in the file. Row two contains column headings. The first column contains a date-time string (format depending on `writeformat` specified in *info.txt* and on the length of period for which the value is valid, `meanperiod`), following columns contain model results of the given variable for all sub-basins in the model set-up. Missing values are given as -9999.

Example structure of a map output file *timeCOUT.txt* with daily discharge averages for a model with four sub-catchments:

```
!!This is a file with timeseries of comp outflow olake in m3/s
DATE        4080    4090    4113    4139
2009-07-01  0.0096  0.0096  0.1511  0.1615
2009-07-02  0.0088  0.0089  0.1469  0.1570
2009-07-03  0.0093  0.0093  0.1482  0.1581
2009-07-04  0.0087  0.0088  0.1450  0.1551
2009-07-05  0.0134  0.0134  0.1602  0.2025
2009-07-06  0.0198  0.0200  0.1766  0.2642
      ...     ...     ...     ...     ...
```

It is possible to print out timeoutput files for several mean periods at the same simulation. This is controlled from the info-file by numbering the different output information rows for the different types (see info.txt for example). If this option is used the time outputs will be separated by adding the mean period as a code in the file name, e.g. timeCOUT_YR.txt holds yearly average of *cout*.

When ensemble or sequence simulations are made, the results from simulations (I = 1 .. *n* or I = sequence number > 0) are written to files named timeXXXX_00I.txt, where *n* is defined by num_ens in optpar.txt. Alternatively, if a Monte Carlo simulation is done with task set to write all simulations (`task WS` in optpar.txt) files will be named *XXXXXXX_000000I.txt*. In this case up to 9999999

simulations can be saved.

Class output files may also be called timeXXXX, but they are followed by a suffix naming the class group, e.g. timeCRUN_CG1.txt for the CG1 class group's local runoff. The file comment will contain information on which classes are included in the group. Otherwise the file is similar to the ordinary time-files. All subbasins class group variable data is printed.

Class output

Class output files are a special case of time series output from HYPE. It is similar to basin output files and time output files.

Class output contains values of HYPE variables for a single class or for a group of classes (a `classgroup`). Not all HYPE variables have class values. Class groups are defined for output in the info-file.

Class output files comes in the form of multple variables in a single subbasin similar to basin output files and as a single HYPE variable for all simulated subbasins similar to a time output file. The first are similar to basin output, and are as them named after the subbasin, the second type are named timeXXXX like time output files. To separate them from ordinary basin- and time-files the filename have a suffix consisting of the class group name.

Similar to other output files you specify the variables of interest in the info.txt file. To write class output files of the basin output type, specify a `classoutput` with the wanted subbasins (`subbasin`). To write class output files of the time output type instead specify `allbasin`.

Example snippet of a info.txt file:

```
classoutput definegroup A 1 2 3 4
classoutput definegroup B 5 6 7 8 9
classoutput 1 variables cprc crun
classoutput 1 subbasin 101 105
classoutput 1 group A B
classoutput 2 variables cprc crun
classoutput 2 subbasin 103 105
classoutput 2 group A
```

Class output files are written to the resultdir folder. XXXXXXX in the file name is substituted by the subbasin ID (with leading zeros for SUBID with less than 7 digits), for example 0002452. XXXX in the file name is substituted by the variable ID, for example timeCRUN.

Class output files will always be named with a suffix for the chosen period. It is possible to print out classoutput files for several mean periods at the same time. This is controlled from the info-file by numbering the different output information rows for the different types.

Class output files contain tab-separated data with column-wise HYPE variables or subbasins and row-wise time periods. All HYPE variable IDs are described in the list of HYPE variables. Upstream or regional aggregated variables (e.g. upcrun) may not be included in the class output.

Class output files have a comment on the first row defining the class group. After the first row comes one (time file) or two (subbasin file) header rows. The headers contains subbasins (time file), or HYPE variable IDs and variable units (subbasin file). Below the headers follow the model results. The first column contains a date-time string (format depending on meanperiod specified in info.txt), following columns contain model results of the given variable/subbasins. Missing values are given as -9999.

Example structure of a class output file with daily variables, corresponding to the first classoutput in the info.txt file example above (0000101_DD_A.txt):

```
!!This is a file with variables grouped for classes (  1  2  3  4)
DATE    cprc    crun
UNITS   mm      mm
1961-01-01  0    0
1961-01-02  12.200    0.013
1961-01-03  2.300     0.682
```

When ensemble or sequence simulations are made, the results from simulations (I = 1 .. n or I = sequence number > 0) are written to files with an additional suffix for the sequence/ensemble number, e.g. XXXXXXX_DD_A_00I.txt.

yyyy_ss.txt

These output files hold modelled annual load results. *yyyy* stands for a year during the simulation period and *ss* stands for one of the HYPE-modelled nitrogen (IN, ON) and phosphorus (PP, SP) species (an actual file name would be e.g. *2001_IN.txt*). The files contain modelled annual nutrient loads before and after retention/removal along the modelled nutrient transport pathways.

yyyy_ss.txt are tab-separated files written to the resultdir folder if requested in output options of info.txt. The first row contains a column header with variable names. The following rows contain values for all variables, in one row per sub-basin.

The table below describes all variables written column-wise in *yyyy_ss.txt*. Variables with a *_nn* suffix are calculated for each SLC class separately, with *nn* numbers corresponding to numbers in GeoClass.txt, so that the total number of columns varies depending on the number of SLC classes in the model set-up.

Variable ID	Unit	Description
subid	-	sub-basin identification number
WetAtm_nn	*kg/year*	gross load in wet atmospheric deposition on SLC class area in the sub-basin
DryAtm_nn	*kg/year*	gross load in dry atmospheric deposition on SLC class area in the sub-basin
Fertil_nn	*kg/year*	gross load in fertilizer application on SLC class area in the sub-basin
PDecay_nn	*kg/year*	gross load from plant residues on SLC class area in the sub-basin
RuralA_nn	*kg/year*	gross load from rural household source fraction which is routed into lowest soil layer (see parameter *locsoil* in par.txt), land SLC classes only
GrwSln_nn	*kg/year*	gross load from groundwater flows into lowest soil layer (regional groundwater routine 1, see code `deepground` in info.txt model options, land SLC classes only)
IrrSrc_nn	*kg/year*	gross load in irrigation water, land SLC classes only
Runoff_nn	*kg/year*	total load in runoff to local stream, including soil runoff, tile drainage, and surface runoff, land SLC classes only
RuralB	*kg/year*	gross load from rural household source fraction which is routed into local stream (see parameter *locsoil* in par.txt)
Urban1	*kg/year*	gross load in point source type 1, see description in PointSourceData.txt
Urban2	*kg/year*	gross load in point source type 2, see description in PointSourceData.txt
Urban3	*kg/year*	gross load in point source type 3, see description in PointSourceData.txt
Rgrwmr	*kg/year*	gross load from groundwater flows into main river (regional groundwater routine 2, see code `deepground` in info.txt model options)
Rgrvol	*kg/year*	gross load from groundwater flows into outlet lake if GeoData.txt variable //grwolake// > 0 (regional groundwater routine 1, see code `deepground` in info.txt model options)
A	*kg/year*	load to local stream from all SLC classes
B	*kg/year*	load to local stream from all SLC classes and from rural household source local stream fraction (A + RuralB)
C	*kg/year*	load in local stream (B) after including the effect of local wetlands (defined in GeoData.txt, see also wetlands in model description)
D	*kg/year*	load after passage of local streams but before internal lakes
E	*kg/year*	load in fraction of local stream discharge that bypasses local lakes (see variable `icatch` in GeoData.txt

Variable ID	Unit	Description
F	*kg/year*	load in fraction of local stream discharge that passes through local lakes (see variable `icatch` in GeoData.txt
G	*kg/year*	load in fraction of local stream discharge that has passed through local lakes
H	*kg/year*	net load in local stream after local lake passage (E + G)
I	*kg/year*	total load to main river, consisting of: net load of local stream, upstream load, point source loads (`Urban1-3`), and groundwater load (`Rgrwmr`)
J	*kg/year*	load to main river after including the effect of main river wetlands (defined in GeoData.txt, see also wetlands in model description)
K	*kg/year*	load in main river, after river passage and before outlet lake
L	*kg/year*	load in main river with added regional ground water sources (K + `Rgrwmr`)
M	*kg/year*	net load in main river after outlet lake passage
N	*kg/year*	load in bifurcation branch (see BranchData.txt

HYPE water balance output

There is no wiki description of these files. Download the pdf document to read more: HYPE water balance

Wbf_xxx.txt

These files contain daily water flow for all subbasins (m3/day), one file per flow. The files are located in the resultdir folder given in info.txt. Last part of file name, xxx, is the name of the flow.

See description of flows and files in HYPE water balance.

Wbs_xxx.txt

These files contain daily water storage for all subbasins (m3), one file per store. They also contain the initial store. The files are located in the resultdir folder given in info.txt. Last part of file name, xxx, is the name of the store.

See description of stores and files in HYPE water balance.

Wbfs_xxx.txt

These files contain daily water management flow for all subbasins (m3/day), one file per flow. The files are located in the resultdir folder given in info.txt. Last part of file name, xxx, is the name of the flow.

See description of flows and files in HYPE water balance.

Wbff_xxx.txt

These files contain daily floodplain related flow for all subbasins with floodplain (m3/day), one file per flow. The files are located in the resultdir folder given in info.txt. Last part of file name, xxx, is the name of the flow.

See description of flows and files in HYPE water balance.

optpar.txt

The file holds additional model options to info.txt and is therefore located in the same folder as info.txt. The file is used to define what kind of optimisation to be done if `calibration` is set in info.txt. There are several different methods to chose from, each with their settings. Which model parameters to calibrate and within which boundaries are information also given in *optpar.txt*.

Maximum 100 model parameters may be optimised simultaneously. To optimise more parameters, the code needs to be changed (set *maxoptpar* to a higher value). All parameters are described in the section on par.txt, but not all of them can be calibrated. The objective function of the optimization is defined in info.txt as the combination of criteria chosen, see Performance criteria options.

There are eight methods of optimisation implemented in HYPE as detailed in the table below (read more about them in the tutorial). Additionally, there are two other tasks for output generation, WA and WS, which produce detailed performance and simulation results for all runs performed during optimisation. Tasks WA and WS are compatible with selected optimisation methods only, a denoted in the table. The task of organized scanning SC is a parameter investigation method.

Task	Description
MC	Monte Carlo (MC) simulation with parameter values randomly distributed over the intervals (basic MC-method)
BP	progressive Monte Carlo simulation with parameter space limited by best found so far (alternative MC-method)
SM	progressive Monte Carlo simulation with parameter space reduced in stages (alternative MC-method)
DE	Differential Evolution Markov Chain method (alternative MC-method)
BN	optimisation with Brent method
Q1	optimisation with QuasiNewton DFP gradient-based method
Q2	optimisation with QuasiNewton BFGS gradient-based method
SD	optimisation with QuasiNewton steepest descent method
SC	organised scanning of two parameters
WA	write performance result for all simulations (MC, SM or DE)
WS	write simulation results (basin-, time- or map-files) for all ensembles in Monte Carlo simulation (MC, BP, or DE) (maximum 9999999 ensembles total)

File content

The first row is for general comments. It is ignored by the program when reading the file. Next comes a section with calibration settings. It reaches from second to 21st row, and are used to define tasks and other settings. Last comes a section defining the parameters to be calibrated. These occupy row 22 and onward.

In the calibration setting section a row starts with a code indicating a task or other settings. Argument of the code is listed from position 12 and forward on each row. The following options are available for the calibration setting section:

Code	Argument	Default value	Description
task	two letter word	FALSE	define what kind of optimisation to do (see methods above), and if additional results are to be written for the MC-methods
cal_log	Y/N	YES	flag for writing a calibration.log file
scan_numx	integer	1	number of steps taken for the first parameter (SC method)
scan_numy	integer	1	number of steps taken for the second parameter (SC method)
num_mc	integer	1000	number of Monte Carlo simulations (per centre point and stage for progressive MC)
num_ens	integer	1	number of best Monte Carlo simulations to keep and print results from (and use as centre points for next stage of progressive MC) (maximum 999)
num_bpmc	integer	200	number of simulations per reduced parameter space which the best simulations shall be selected from (BP MC-method)
num_bpmax	integer	100	number of reductions of the parameter space for MC simulation (BP MC-method)
num_stages	integer	1	number of stages for progressive Monte Carlo (SM MC-method)
num_zoom	real	0.9	reduction of parameter space (0-1) for each stage of progressive MC (BP MC-method)
DEMC_ngen	integer	100	number of generations for DEMC method
DEMC_npop	integer	25	number of populations for DEMC method
DEMC_gammascale	real	1	scaling of the mutation strength for DEMC method. A new (next generation) parameter candidate is proposed as a mutation of the parent parameter value based on the difference between two random members of the parent population. DEMC_gammascale is a scaling factor for the resulting parameter jump width. Small values will cause smaller mutations, which potentially stabilises the search through large parameter spaces at the cost of convergence speed. A value of 1 will result in no scaling.
DEMC_crossover	real	1	crossover probability for DEMC method. Probability that the proposed candidate is chosen instead of the parent parameter. Large DEMC_crossover values mean larger probability that the proposal is chosen. Set to 1, all proposals are accepted. This makes it harder to find an acceptable overall proposal because all parameters are changed in every generation. Set to 0.5, each parameter candidate has only a 50% chance to be accepted into the next proposal.
DEMC_sigma	real	0.1	sample error standard deviation for DEMC method. Base for the standard deviation of the random perturbation, which adds random noise to the proposed parameter in addition to the gamma-mutation. This value is multiplied with 3rd-row value for each parameter (see description of parameter rows below).

Code	Argument	Default value	Description
DEMC_accprob	*integer*	0	scaling factor for probabilistic acceptance for DEMC method (0 = off (default); >0 = on). If set to off, parameter proposals will only (and always) be accepted if the objective function decreases (= better performance). If turned on, also proposals with higher value of the objective function can be accepted; better performance will give higher probability of acceptance. High values of the scaling factor will also increase the probability of acceptance.
BR_diagStp	*Y/N*	YES	flag for taking a diagonal step at the end of each iteration (BN method)
num_maxItr	*integer*	500	max amount of iterations (interrupt non-MonteCarlo methods)
num_maxTim	*integer*	72	max calibration time (hours) (interrupt non-MonteCarlo methods)
num_parItr	*integer*	10	number of iterations taken into account for parameter change tolerance (interrupt non-MonteCarlo methods)
num_criItr	*integer*	10	number of iterations taken into account for criterium change tolerance (interrupt non-MonteCarlo methods)
num_criTol	*real*	0.001	tolerance for criteria relative change over last iterations (interrupt non-MonteCarlo methods)
lnS_maxItr	*integer*	500	max amount of line search iterations (per line) (non-Monte Carlo methods)
lnS_tol	*real*	0.001	general relative tolerance for line search (non-Monte Carlo methods)
QN_nrmTol	*real*	0.001	tolerance for gradient norm to be considered zero (QN methods)
QN_pctDerv	*real*	0.02	factor to offset current parameter values for numerical derivative (QN methods)
QN_stencil	*integer*	2	numerical derivative stencil type (2, 4, 6 and 8 allowed) (QN methods)
QN_lambMax	*real*	0.9	factor of parameter interval, used to limit the step length of the line search within given parameter intervals (QN methods)
QN_lambAcc	*real*	1.618	factor increasing the step length of the line search (QN methods)

From row 22 and onward, model parameters to be calibrated are listed. The parameter is given as it is or with single quotation marks (e.g. 'cevp') followed by its values. For non-general parameters, values for all soil types/land uses/subbasins/parameterregions/etc have to be provided.

Each parameter is defined on three rows:

- **Row 1** specifies lower boundaries of the parameter range
- **Row 2** specifies upper boundaries of the parameter range (the model actually accepts lower and upper boundaries in any order)
- **Row 3** specifies either a minimum step width for parameter change *or*, in case of the DE method, a parameter specific factor to scale the random noise added to the proposed next-generation parameter, see description of DEMC settings code DEMC_sigma in table above.

NOTE: If lower and upper boundaries are identical, the parameter is omitted. This allows to calibrate a selection of the values for dependent parameters.

Example of parameter rows in *optpar.txt*:

```
wcfc    0.100 0.020 0.120 0.050 0.250 0.250 0.150 0.050 0.500 0.500 0.050
wcfc    0.100 0.120 0.120 0.050 0.250 0.250 0.150 0.050 0.500 0.500 0.050
wcfc    0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001
ttmp  0.0   0.0
ttmp  2.0   2.0
ttmp  0.01  0.01
```

Explaination of example: The rows starting with wcfc are representing field capacity for 11 soil types, where the second soil type's wcfc is calibrated. Parameter ttmp is threshold temperature for 2 land uses, which are both calibrated.

qNstartpar.txt

The *qNstartpar.txt*/file gives the starting values for the parameters to be optimized with the quasi-Newton methods (including Brent). The parameters are given one on each row with name first and it's value from position 10 and onwards. The parameters must be given in the same order as in optpar.txt, and only those actually calibrated (with non-zero interval) are included. The file is located in the modeldir folder given in info.txt.

The parameter starting values must lie well within the boundaries set in optpar.txt.

Example of *qNstartpar.txt*:

```
cevpcorr   0.000
rrcscorr   0.000
pcaddg     0.000
rivvel     1.500
ttmp       0.500
ttmp       0.500
cmlt       2.400
cmlt       3.600
```

respar.txt

The *respar.txt* file mostly holds the resulting optimal parameter values after an automatic calibration. Generally only calibrated parameters is printed in the file, but if a parameter is only calibrated for one or a few of the parameters dependencies (soil types/land uses/regions/etc) values will still be printed for all of them.

The file is located in the resultdir folder given in info.txt. The first row of the file is a comment row. After that the file contains one parameter per row with name and values for all of the parameter's dependencies. Definition of parameters is found in the section for par.txt.

When Monte Carlo simulation is used for calibration, the parameters from the best (according to the objective function given in info.txt) simulation are printed to *respar.txt*. Parameter values from the rest of the simulations, or the other *N* best simulations depending on settings in optpar.txt, are written to the file bestsims.txt. When the DEMC method is used for calibration, the median parameters of the last generations simulations are printed to *respar.txt*.

Example of a *respar.txt* file:

```
 Optimal value of parameters found during automatic calibration
cevpcorr          -0.2695302
pcaddg            -0.1540260
rivvel             2.9619985
ttmp               0.5000000          6.0000000          0.5000000
0.5000000          1.9998100          0.5000000         -1.6239488
0.5000000          0.5000000          0.5000000
```

bestsims.txt

When performing calibrations that generate several simulations as results (e.g. Monte Carlo simulation) a number of best results (num_ens defined in optpar.txt) are saved to *bestsims.txt*, one row per simulation. The simulation with best objective function value (column CRIT) is first. The file is located in the resultdir folder given in info.txt.

For DEMC calibrations (`task DE` in optpar.txt), *bestsims.txt* contains parameter values of the last generations of all populations plus one row (first row in the file) with median values over all populations. **Note**: These parameter sets are the last ones accepted by the DEMC algorithm (column `iacc == 1` in the allsim.txt result file).

File content

The first row contains column headings. The first column is the ordinal number, and the second is the value of the objective function on which the simulations are sorted. The closest following columns are a set of performance criteria (se table below and equations). When several criteria are given in info.txt to be used together as the objective function, the columns with performance information will be repeated once per such criteria. The last columns contain parameter values.

The value of a performance criterion will be given if it has been calculated during the simulation. Which criterion that is calculated is determined by the choice of objective function. Criterion that can be deduced from the calculations of the objective function are saved, but no additional ones are calculated. Missing values are indicated with -9999. If the objective function is composed of several criteria comparing the same variables, e.g. both NSE and RE of discharge, there will be still be several (two for the example) sets of performance criteria columns in the file, but they will have the same values since they are comparing the same variables. **Note:** If several RA criteria have been selected, only the last of them will be printed to file.

The columns of *bestsims.txt*:

Column	Description
NO	row number
CRIT	value of objective function
rr2	regional Nash-Sutcliffe efficiency (data from all subbasins combined in one data series)
sr2	spatial Nash-Sutcliffe efficiency, calculated using annual means for all subbasins (requires at least 5 years and 5 subbasins with data) to form one data series to calculate the Nash-Sutcliffe efficiency on
mr2	average of Nash-Sutcliffe efficiencies for subbasins
rmae	regional mean absolute error (data from all subbasins combined in one data series)
sre	spatial relative bias (calculated on annual means for all subbasins)
rre	regional relative bias (data from all subbasins combined in one data series)
mre	average of the relative bias for all subbasins (Note: fraction, not %)
rra	regional RA, similar to regional NSE, RA is a Nash-Sutcliffe like criterion where the square in the Nash-Sutcliffe formula is exchanged with a coefficient value
sra	spatial RA, similar to spatial NSE, RA is a Nash-Sutcliffe like criterion where the square in the Nash-Sutcliffe formula is exchanged for a coefficient value

Column	Description
mra	average value of RA for subbasins, RA is a Nash-Sutcliffe like criterion where the square in the Nash-Sutcliffe formula is exchanged with a coefficient value
tau	average of Kendall's Tau value for subbasins
md2	median of Nash-Sutcliffe efficiency for subbasins
mda	median of all subbasins' RA (Nash-Sutcliffe like criteria where the square is exchanged with a coefficient value)
mrs	average of error in standard deviation for subbasins
mcc	Pearson correlation coefficient, average of all subbasins with observations
mkg	median of Kling-Gupta efficiency for subbasins
mar	average of absolute relative bias for subbasins (Note: fraction. not %)
mnr	median of normalised RMSE for subbasins
mnw	average of Nash-Sutcliffe efficiencies adjusted for bias for subbasins
numrc	number of data points included in calculation of regional criteria
nummc	number of areas (subbasins/outregions) which criteria is included in mean and median criteria calculations
parname	parameter(s) that has been calibrated (one or several columns)

Example of *bestsims.txt*:

```
NO,CRIT,rr2,sr2,mr2,rmae,sre,rre,mre,rra,sra,mra,tau,md2,mda,mrs,mcc,mdkg,ma
re,mnr,mnw,numrc,nummc,cevp,wcfc,rrcs1,rivvel,damp
1,-0.15274,0.66997,-9999,0.15274,37.45872,-9999,-0.30995,-0.30442,-9999,-999
9,-9999,-9999,0.21835,-9999,-0.38166,0.63855,0.24106,0.31151,0.12787,0.15274
,20,3,0.26006,0.0856,0.4202,1.97909,0.19939
2,-0.15625,0.66977,-9999,0.15625,37.16421,-9999,-0.3007,-0.283,-9999,-9999,-
9999,-9999,0.21904,-9999,-0.37735,0.63432,0.25736,0.31274,0.1269,0.15625,25,
3,0.14034,0.25485,0.26864,0.74202,0.55459
```

allsim.txt

If a Monte Carlo simulation is chosen and configured so that all performance results will be written to file (task WA defined in optpar.txt), the results are written to *allsim.txt*, one simulation per row. The file is located in the resultdir folder given in info.txt. The format is similar to that of bestsims.txt. Missing values are indicated as -9999.

File content

The first row contains column headings. The first column is the ordinal number, and the second the value of the objective function on which the simulations are sorted. The closest following columns are a set of performance criteria (se table below and equations). When several criteria are given in info.txt to be used together as the objective function, the columns with performance information will be repeated once per such criteria. The last columns contain parameter values.

The criterion value will be given if it has been calculated during the simulation. Which criterion that is calculated is determined by the choice of objective function. Criterion that can be deduced from the calculations of the objective function are saved, but no additional ones are calculated. Missing values are indicated with -9999. **Note:** If several RA criteria have been selected, only the last of them will be printed to file.

The columns of *allsim.txt*:

Column	Description
NO	row number
CRIT	value of objective function
rr2	regional Nash-Sutcliffe efficiency (data from all subbasins combined in one data series)
sr2	spatial Nash-Sutcliffe efficiency, calculated using annual means for all subbasins (requires at least 5 years and 5 subbasins with data) to form one data series to calculate the Nash-Sutcliffe efficiency on
mr2	average of Nash-Sutcliffe efficiencies for subbasins
rmae	regional mean absolute error (data from all subbasins combined in one data series)
sre	spatial relative bias (calculated on annual means for all subbasins)
rre	regional relative bias (data from all subbasins combined in one data series)
mre	average of the relative bias for all subbasins (Note: fraction, not %)
rra	regional RA, similar to regional NSE, RA is a Nash-Sutcliffe like criterion where the square in the Nash-Sutcliffe formula is exchanged with a coefficient value
sra	spatial RA, similar to spatial NSE, RA is a Nash-Sutcliffe like criterion where the square in the Nash-Sutcliffe formula is exchanged for a coefficient value
mra	average value of RA for subbasins, RA is a Nash-Sutcliffe like criterion where the square in the Nash-Sutcliffe formula is exchanged with a coefficient value
tau	average of Kendall's Tau value for subbasins
md2	median of Nash-Sutcliffe efficiency for subbasins
mda	median of all subbasins' RA (Nash-Sutcliffe like criteria where the square is exchanged with a coefficient value)
mrs	average of error in standard deviation for subbasins
mcc	Pearson correlation coefficient, average of all subbasins with observations

Column	Description
mkg	median of Kling-Gupta efficiency for subbasins
mar	average of absolute relative bias for subbasins (Note: fraction. not %)
mnr	median of normalised RMSE for subbasins
mnw	average of Nash-Sutcliffe efficiencies adjusted for bias for subbasins
numrc	number of data points included in calculation of regional criteria
nummc	number of areas (subbasins/outregions) which criteria is included in mean and median criteria calculations
parname	parameter(s) that has been calibrated (one or several columns)
jpop	population index in DEMC-simulation
igen	generation index in DEMC-simulation
iacc	acceptance code in DEMC-simulation (1=accepted)

calibration.log

The file is automatically written during calibration with information on simulation progress unless turned of in optpar.txt. It is not used for all calibration methods though. The file usually begins with some information on the calibration settings to be followed by intermediate parameter and criteria values.

The file is written to the resultdir folder.