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
AssimInfo.txt	optional/mandatory	settings for data assimilation simulation
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)
ClassData.txt	optional	SLC class definition (HRUs), replaces GeoClass.txt for traveltime soil model
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

File name	Requirement	Description
PointSourceData.txt	optional	information about point sources and water abstraction
PSTIMESeries.txt	optional	daily, monthly or yearly time-series of point sources and water abstractions
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
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 subbasin runoff concentrations
LeakNN_SLCNNN.txt	optional	soil leakage concentrations from root zone
LoadNN_SLCNNN.txt	optional	soil leakage loads for travel time soil model
RiverRatingCurveData.txt	optional	rating curves for main river
AtmdepData.txt	optional	atmospheric deposition
nnnnnn_yyyymmdd[HHMM].bin	optional	files containing an ensemble of saved model states and variables for data assimilation
ensXstates_yyyymmdd[HHMM].bin	optional	files containing an ensemble of saved model states for data assimilation
ensFstates_yyyymmdd[HHMM].bin	optional	files containing an ensemble of saved forcing variables for data assimilation
ensAstates_yyyymmdd[HHMM].bin	optional	files containing an ensemble of saved auxiliary variables for data assimilation

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
Wobs.txt	optional	observations of olake water stage (alternative to Xobs.txt for HYPE variable ID: wstr)
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
UWobs.txt	optional	u-component of wind forcing
VWobs.txt	optional	v-component of wind 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

File name	Requirement	Description
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
reset_state_save.txt	optional	file initial state values of soild nutrient soil states (eg. fastN,humusN).
nnnnnn_yyyymmdd[HHMM].bin	optional	files containing an ensemble of saved model states and variables for data assimilation (one file per variable)
ensXstates_yyyymmdd[HHMM].bin	optional	files containing an ensemble of saved model states for data assimilation
ensFstates_yyyymmdd[HHMM].bin	optional	files containing an ensemble of saved forcing variables for data assimilation
ensAstates_yyyymmdd[HHMM].bin	optional	files containing an ensemble of saved auxiliary variables for data assimilation

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
calibration.log	automatic	calibration log file

Data assimilation files

Data assimilation files are files related to setup and results. Additional data assimilation information is given in info.txt.

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

File name	Requirement	Description
AssimInfo.txt	optional (mandatory for data assimilation)	data assimilation simulation settings
nnnnnn_yyyymmdd[HHMM].bin	optional	files containing an ensemble of saved model states and variables for data assimilation (one file per variable)
ensXstates_yyyymmdd[HHMM].bin	optional	files containing an ensemble of saved model states for data assimilation
ensFstates_yyyymmdd[HHMM].bin	optional	files containing an ensemble of saved forcing variables for data assimilation
ensAstates_yyyymmdd[HHMM].bin	optional	files containing an ensemble of saved auxiliary variables for data assimilation

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 five groups of code-argument combinations:

1. Simulation options, e.g. simulation time period, where to find the model set-up
2. Model options, e.g. specification of time stepping, choice of optional modules, etc.
3. Output options, i.e. type of result files and output variable specification
4. Performance criteria options, i.e. specification of objective functions and criteria computation
5. 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.
`instatecompress`	*Y/N*	defines whether the starting state is an compressed file or not. Y for yes, N for no. No is default. The filename of the compressed file is the same as for the ASCII-text state file, but with different file ending (state_saveyyyymmdd[HHMM].tgz).
`outstatecompress`	*Y/N*	defines whether the created outstate files are to be compressed and the text file then deleted. Y for yes, N for no. No is default. The filename of the compressed file is the same as for the ASCII-text state file, but with different file ending (state_saveyyyymmdd[HHMM].tgz).

Code	Argument	Description
`instateformat`	*0/1*	defines whether the state file is a formatted (0) or unformatted (1) text file. Formatted file is default. The filename is the same for formatted and unformatted text state files.
`outstateformat`	*0/1*	defines whether the state file will be written as a formatted (0) or unformatted (1) text file. Formatted file is default. The filename is the same for formatted and unformatted text state files.
`resetstatedate`	*date-time*	defines that nutrient soil states will be reset to the starting state. The date should be in the format yyyy-mm-dd [HH:MM]. The default is that no reset is done. Maximum 100 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 reset starting state is saved in file reset_state_save.txt.
`indaensstate`	*Y/N*	defines whether a previously saved ensemble of starting state is to be read. *Y* for yes, *N* for no. Default is *N*.
`outdaensstate`	*date-time*	defines that an ensemble of starting states 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 50 dates may be given. The dates may be written on same or different rows. In the latter case, the code first on every row.
`outdaensstate all`		defines that an ensemble of starting states will be output for every timestep of the model simulation. Default is that no output state is written.
`outsaensstate period`	*date-time date-time*	defines that an ensemble of starting states 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.
`substance`	*string*	gives the substances to be simulated. One or several of: *N P C S Si T1 T2*. N - nitrogen, P - phosphorus, C - organic carbon, S - total suspended sediment, Si - silica, 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.
`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 soilcorr.
`assimilation`	*Y/N*	defines whether or not assimilation of data with ensemble Kalman filter is to be done. Default is *N*. Assimilation input is defined in file AssimInfo.txt.
`weightsub`	*Y/N*	defines if the objective function and performance criteria should be weighted by a given trust in each subcatchment (only for criteria that are average of subbasins). Default is no.
`parensemble`	*Y/N*	defines if several simulations with different parameters should be run, default is no. Not to be combined with calibration.

Code	Argument	Description
`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 ForcKey.txt will be used. Give *Y* to read the file (default). Then columns of pobsid/tobsid/etc. present in the file will be used. Set *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`.
`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).
`readpstime`	*Y/N*	defines if pointsources are given as timesseries in files PSTIMESeries.txt. Give *Y* to use the file, or *N* (default).

Code	Argument	Description
`readaddate`	*date-time*	defines which date the atmospheric deposition change. The date should be in the format yyyy-mm-dd [HH:MM]. The atmospheric deposition is read from the file AtmdepData_yyyymmdd[HHMM].txt. The default is to use the file without date-time stamp and this will be used to the first `readaddate` in the simulation period. Maximum 10 dates may be given here. The dates may be written on same or different rows. In the latter case, the code is first on every row.
`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.
`irrunlimited`	*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`	*0-5*	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. 4) Tests will be performed on observation files only, and the simulation will be aborted if errors are found. 5) Tests will be performed on observation files only, and the simulation will be continued regardless if errors are found.
`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
`useicecurves`	*Y/N*	defines if provided ice season river rating curves should be used (default is Y)
`warning`	*Y/N*	can be used to reduce the number of warning messages in hyss.log (default is Y)

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).
diffusesource	*0/1*	defines how rural household diffuse source should be added to the soil. (0) as a flow (the locsoil part) with concentration, (1) as a load. See GeoData.txt
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.
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).
frozensoil	*0/1/2*	defines which frozen soil model to use. Default is none (0), the alternatives calculates frozen volume as a function of temperature with (1) one temperature per soil layer (2) temperature distribution within soil layer. Frozen soil model uses parameters 'logsatmp', 'bcosby' and 'fzsexpand'.
glacierini	*0/1*	defines if initialization from SLC+parameters overrides saved state of glacier volume (1). Default is to use saved state (0).
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).
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.
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).
riverflowmodel	*0/1*	defines which equation for river outflow of attenuation box to use; Default (0) depends on inflow and initial volume, (1) (original) is based on attenuation box current volume.

Code 2	Argument	Description
`sedresuspmodel`	*0/1/2*	defines which model to use for river sedimentation/resuspension. Default is (0) the original HYPE method, the alternatives (1) is flow dependent method with parameter and (2) is a simplified Bagnold Equation.
`siltation`	*0/1/2/3*	defines how lake/reservoir sedimentation affect hydrology. Default is it does not (0). The alternatives are to (1) use a general density, (2) use density based on soil fractions, (3) use density based on soil fractions and compaction, to let the sedimentation reduce the volume of the lake/reservoir.
`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.
`snowfalldist`	*0/1/2*	defines which snowfall distribution model to use. Default is none (0), alternatives are scaling using linear (1) or log-linear (2) Winstrals coefficients (WSF).
`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).
`snowheat`	*0/1*	defines if snow heat shall be calculated and used to limit snow melt. Default is no (0), and alternative is yes (1). Snow heat model uses parameters 'sdnsnew' and 'snkika'.
`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.
`soilleakage`	*0-5*	defines if soil leakage concentrations is to be calculated or read from file. Default (0) is calculation of soil. (1) is reading monthly values for each subbasin. (2) defines that class specific soil leakage typical monthly loads are to be read from files. (3) defines that class specific soil leakage monthly time-series of loads are to be read from files. (4) for combination of classmodel 0,5,6 for land classes. Leak and Load are constant and given per class. (5) for combination of classmodel 0,5,6 for land classes. Leak and Load may be monthly or constant and given per class.
`surfacerunoff`	*0/1/2/3/4*	defines which model to use for diversion of surface runoff and macropore flow from infiltration. Default (0) uses runoff coefficients and soil water threshold, (1) calculates surface runoff from a soil moisture, (2) calculates surface runoff from a soil moisture and rain, (3) is same as (1) but with a discrete formulation of the equation, (4) is same as (2) but with a discrete formulation of the equation.
`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.
`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.

Code 2	Argument	Description
`rivert2model`	*0/1*	defines if water temperature should be reset after rivers being affected by inflow by irrigation, groundwater or water transfer, local rural or point sources, or river wetlands. Default is no (0), and the alternative (1) is the original model used up until 5.19.2.

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.

Output can be given for each time step or aggregated to longer periods. This is specified by the code `meanperiod`. For available aggregation periods see table below. The aggregation works best if it is in alignment with the simulation and output start date, e.g. yearly output that start 1 January.

It is possible to get output for several different aggregation periods for the same type of output (basin- , class-, region- or time-output) by specifying several groups of the same type of output with an 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. Note that the ordinal number need to begin at 1 and go up, no gaps allowed.

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.'.
basinoutput mapoutput timeoutput regionoutput classoutput	signfigures	*integer*	defines the number of significant figures written in the outputs. Allowed values 4-10. 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 be set to 4 to avoid rounding of missing values 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.

Code 1	Code 2	Argument	Description
`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

The table below shows 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 100 criteria are allowed, a complete list of available criteria is available as are equation definitions. Criterion that is the average of criteria for subbasins may be calculated in two variants; arithmetric mean or weighted average. This is set in info.txt by the code `weightsub` (se above). 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 or observations in individual subbasins. Discharge can be updated by discharge or water level observations by various methods. Lake water level can be updated by water level observations.

The updating methods are described in the tutorial. Some updating routines require further settings in an 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	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
update	cuseobs	*none/keyword*	updating of all concentrations. Thereafter may follow one of the two keywords: 'allstation' for updating using all stations in Xobs.txt or 'nostation' for no updating. If no keyword is given stations given in file update.txt is updated.
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.

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 over time. 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, or the value at the end of the period will be used. 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.

Tables of HYPE variables ID

Simulated variables

#	Variable ID	Unit	Description	Agg.	Reference area	Component
1	`ctmp`	*°C*	corrected air temperature	Avg.	subbasin area	Temp. & Precip.
2	`snow`	*mm*	snow water equivalent	Avg.	subbasin land area	Snow

#	Variable ID	Unit	Description	Agg.	Reference area	Component
3	sdep	*cm*	snow depth	Avg.	subbasin land area	Snow
4	soim	*mm*	computed soil moisture (including standing water)	Avg.	subbasin land area	Soil
5	som2	*mm*	soil water of upper two soil layers (including standing water)	Avg.	subbasin land area	Soil
6	sml1	*mm*	soil moisture upper soil layer (not including standing water)	Avg.	area of soil layer	Soil
7	sml2	*mm*	soil moisture second soil layer	Avg.	area of soil layer	Soil
8	sml3	*mm*	soil moisture third soil layer	Avg.	area of soil layer	Soil
9	smrz	*mm*	soil moisture root zone (upper two soil layers) (not including standing water)	Avg.	subbasin land area	Soil
10	sm13	*mm*	soil moisture all soil layers (not including standing water)	Avg.	subbasin land area	Soil
11	stsw	*mm*	standing soil water	Avg.	subbasin land area	Soil
12	srff	-	soil moisture root zone (upper two soil layers) (not including standing water) as fraction of wcfc volume	Avg.	subbasin land area	Soil
13	smfd	-	soil moisture (not including standing water) as fraction of soil depth	Avg.	subbasin land area	Soil
14	srfd	-	soil moisture root zone (upper two soil layers) (not including standing water) as fraction of root depth	Avg.	subbasin land area	Soil
15	smfp	-	soil moisture (not including standing water) as fraction of pore volume	Avg.	subbasin land area	Soil
16	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.

#	Variable ID	Unit	Description	Agg.	Reference area	Component
24	stm1	°C	upper soil layer temperature	Avg.	area of soil layer	Soil Temp.
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	pfN1, pfN2, pfN3	kg/km^2	pools of fastN in soil layers 1 to 3	Avg.	area of soil layer	missing
30	phN1, phN2, phN3	kg/km^2	pool humusN in soil layers 1 to 3	Avg.	area of soil layer	missing
31	pIN1, pIN2, pIN3	kg/km^2	pool of inorg-N in soil layers 1 to 3	Avg.	area of soil layer	missing
32	pfP1, pfP2, pfP3	kg/km^2	pool of fastP in soil layers 1 to 3	Avg.	area of soil layer	missing
33	phP1, phP2, phP3	kg/km^2	pool humusP in soil layers 1 to 3	Avg.	area of soil layer	missing
34	ppP1, ppP2, ppP3	kg/km^2	pool of partP in soil layers 1 to 3	Avg.	area of soil layer	missing
35	pSP1, pSP2, pSP3	kg/km^2	pool of SRP in soil layers 1 to 3	Avg.	area of soil layer	missing
36	phC1, phC2, phC3, pfC1, pfC2, pfC3	kg/km^2	pool humusC/fastC in soil layers 1 to 3	Avg.	area of soil layer	missing
37	pON1, pON2, pON3	kg/km^2	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
40	smax	*mm*	computed snowmax in winter	Avg.	subbasin land area	missing
41	wcom	*m*	water level olake at end of timestep	Avg.	outlet lake area	missing
42	wcav	*m*	water stage olake average over timestep	Avg.	outlet lake area	missing
43	wstr	*m*	observed water level olake, provided in Xobs.txt or Wobs.txt	Avg.	outlet lake area	missing
44	cout	m^3/s	simulated outflow from olake/subbasin, only positive flow (outflow)	Avg.	subbasin upstream area	Flows

#	Variable ID	Unit	Description	Agg.	Reference area	Component
45	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 (can be negative for lakebasins)	Avg.	subbasin upstream area	Flows
53	coub	m^3/s	simulated outflow to branch (can be negative for lakebasins)	Avg.	subbasin upstream area	Flows
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
55	clof	m^3/s	local flow from subbasin (outflow of local river and lake, plus P-E for surface waters)	Avg.	subbasin area	missing
56	cinf	m^3/s	simulated net flow to outlet lake (e.g. including P-E of the lake)	Avg.	subbasin upstream area	Flows
57	clrv	m^3	local watercourse volume	Avg.	local river area	missing
58	cmrv	m^3	main watercourse volume	Avg.	main river area (not including floodplain)	missing
60	qerr	m^3/s	daily error in Q (cobc - rout)	Avg.	subbasin upstream area	missing
61	cobc	m^3/s	'simulated net flow from subbasin prior to updating of Q if updating is made (can be negative for lake basins)	Avg.	subbasin upstream area	Flows

#	Variable ID	Unit	Description	Agg.	Reference area	Component
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	ice
67	cili	*cm*	computed ilake ice depth	Avg.	internal lake area	ice
68	colb	*cm*	computed olake blackice depth	Avg.	outlet lake area	ice
69	cilb	*cm*	computed ilake blackice depth	Avg.	internal lake area	ice
70	cols	*cm*	computed olake snow depth	Avg.	outlet lake area	ice
71	cils	*cm*	computed ilake snow depth	Avg.	internal lake area	ice
72	cmri	*cm*	computed main river ice depth	Avg.	main river area	missing
73	clri	*cm*	computed local river ice depth	Avg.	local river area	missing
74	cmrb	*cm*	computed main river blackice depth	Avg.	main river area	missing
75	clrb	*cm*	computed local river blackice depth	Avg.	local river area	missing
76	cmrs	*cm*	computed main river snow depth	Avg.	main river area	missing
77	clrs	*cm*	computed local river snow depth	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

#	Variable ID	Unit	Description	Agg.	Reference area	Component
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	mrto	°C	computed main river temperature (old)	Avg.	main river area	missing
101	lrto	°C	computed local river temperature (old)	Avg.	local river area	missing
102	ilto	°C	computed ilake temperature (old)	Avg.	internal lake area	missing
103	olto	°C	computed olake temperature (old)	Avg.	outlet lake area	missing
104	coic	-	computed olake ice cover	Avg.	outlet lake area	missing
105	ciic	-	computed ilake ice cover	Avg.	internal lake area	missing
106	cmic	-	computed main river ice cover	Avg.	main river area	missing
107	clic	-	computed local stream ice cover	Avg.	local river area	missing
111	glcv	km^3	simulated glacier volume	Avg.	glacier area	missing
112	glca	km^2	simulated glacier area	Avg.	glacier area	missing
113	lrdp	m	simulated local river depth	Avg.	local river area	missing
114	mrdp	m	simulated main river depth	Avg.	main river area	missing
115	aqwl	m	simulated aquifer depth to water level	Avg.	subbasin area	missing
116	cgmb	mm	computed glacier mass balance	Avg.	specific glacier area	missing
117	cgma	km^2	area used in computed mass balance	Avg.	specific glacier area	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

#	Variable ID	Unit	Description	Agg.	Reference area	Component
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	computed 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
142	ceT1	*µU/L*	simulated concentration of tracer T1 in evapotranspiration, unit dependent on substance simulated	W. Avg.	subbasin area	tracer T1
143	csT1	*µU/L*	simulated concentration of tracer T1 in the soil water, unit dependent on substance simulated	W. Avg.	subbasin land area	tracer T1
144	csT2	*°C*	simulated water temperature in the soil	W. Avg.	subbasin land area	missing
145	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

#	Variable ID	Unit	Description	Agg.	Reference area	Component
146	ccT1	*µU/L*	simulated concentration of tracer T1 in outflow from outlet lake/main river, unit dependent on substance simulated (cout) (concentration missing in case of no positive flow)	W. Avg.	subbasin upstream area	tracer T1
147	ccT2	*°C*	simulated water temperature in outflow from outlet lake/subbasin (cout) (concentration missing in case of no positive flow)	W. Avg.	subbasin upstream area	missing
148	ccIN, ccON, ccTN, ccSP, ccPP, ccTP	*µg/L*	simulated concentration of N and P species in outflow from outlet lake/subbasin (cout) (concentration missing in case of no positive flow) (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
149	coOC	*mg/L*	simulated OC concentration in runoff from soil	W. Avg.	subbasin land area	missing
150	csOC	*mg/L*	simulated OC concentration in soil	W. Avg.	subbasin land area	missing
151	ccOC	*mg/L*	simulated OC concentration in outflow from olake/subbasin (cout) (concentration missing in case of no positive flow)	W. Avg.	subbasin upstream area	missing
152	clCO	*mg/L*	simulated OC concentration in local flow from subbasin	W. Avg.	subbasin area without olake and main river (and floodplains)	missing
153	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
160	cprc	*mm/[period]*	corrected precipitation	Sum	subbasin area	Prec.

#	Variable ID	Unit	Description	Agg.	Reference area	Component
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	icpe	*mm/[period]*	losses due to interception (simulated as precipitation corrections)	Sum	subbasin area	missing
166	evsn	*mm/[period]*	computed snow and glacier evaporation (Note that evsn is included in evap, which still is the total evaporation from the subbasin)	Sum	subbasin area	missing
167	levp	*mm/[period]*	simulated land evapotranspiration	Sum	subbasin land area	missing
168	evpt	*mm/[period]*	simulated total evapotranspiration, including “interception losses” icpe	Sum	subbasin area	missing
169	psim	*mm/[period]*	simulated precipitation including water that will be removed as “interception losses” icpe	Sum	subbasin area	missing
170	crun	*mm/[period]*	simulated 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
171	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
172	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
173	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
174	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

#	Variable ID	Unit	Description	Agg.	Reference area	Component
175	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
176	acdf	*mm/[period]*	accumulated volume error	Sum	subbasin upstream area	missing
177	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) (missing in case of no positive flow)	Sum	subbasin upstream area	missing
178	deni	*kg/km^2[period]*	computed denitrification in soil	Sum	subbasin land area	missing
179	crut	*kg/km^2[period]*	computed nitrogen crop uptake	Sum	subbasin land area	missing
180	faIN	*kg/km^2[period]*	computed transformation of fastN pool nitrogen to IN pool	Sum	subbasin land area	missing
181	atmd, atmp	*kg/km^2[period]*	computed atmospheric deposition of IN/TP on land	Sum	subbasin land area	missing
182	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) for irrigation	Sum	none	missing
190	irlr	*m^3/[period]*	abstractions from local river for irrigation	Sum	none	missing
191	irrg	*m^3/[period]*	abstractions from local groundwater for irrigation	Sum	none	missing
192	irrs	*m^3/[period]*	surface water abstractions sent to other connected subbasins from this subbasin and used for irrigation	Sum	none	missing
193	irel	*m^3/[period]*	evaporation losses due to irrigation	Sum	area of irrigated SLCs	missing

#	Variable ID	Unit	Description	Agg.	Reference area	Component
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
197	speq	*mm/[period]*	specific discharge (replaces upro), based on cout thus only positive flow (outflow)	Sum	subbasin upstream area	missing
198	clwc	*m*	olake water stage (wcom) cleaned fromw0ref 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

#	Variable ID	Unit	Description	Agg.	Reference area	Component
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
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

#	Variable ID	Unit	Description	Agg.	Reference area	Component
236	den3	*kg*	computed denitrification soil layer 3	Sum	subbasin area	missing
237	denz	*kg*	computed 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
245	olfg	*%*	outlet lake floodplain degree of flooded area (% of floodplain area)	Avg.	floodplain area	Floodplain
246	sden	g/cm^3	computed snow density	Avg.	subbasin land area	Snow
247	melt	*mm/[period]*	computed snow melt	Sum	subbasin land area	Snow
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

#	Variable ID	Unit	Description	Agg.	Reference area	Component
259	clT1	*µU/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	*µU/L*	simulated concentration of T1 in runoff from soil layer 1	W. Avg.	subbasin land area	tracer T1
261	Tcr2	*µU/L*	simulated concentration of T1 in runoff from soil layer 2	W. Avg.	area of soil layer	tracer T1
262	Tcr3	*µU/L*	simulated concentration of T1 in runoff from soil layer 3	W. Avg.	area of soil layer	tracer T1
263	Tcrd	*µU/L*	simulated concentration of T1 in tile runoff	W. Avg.	subbasin land area	tracer T1
264	Tcrs	*µU/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
266	ccSS	*mg/L*	computed suspended sediment (SS) concentration in outflow from outlet lake/subbasin (cout) (concentration missing in case of no positive flow)	W. Avg.	subbasin upstream area	missing
267	ccAE	*mg-N/L*	computed algae concentration in outflow from outlet lake/subbasin (cout) (concentration missing in case of no positive flow)	W. Avg.	subbasin upstream area	missing
268	ccTS	*mg/L*	computed total suspended sediment (TS) concentration in outflow from outlet lake/subbasin (cout) (concentration missing in case of no positive flow)	W. Avg.	subbasin upstream area	missing
269	rpwl	*m*	computed main river floodplain water level	Avg.	floodplain area	Floodplain
270	lpwl	*m*	computed outlet lake floodplain water level	Avg.	floodplain area	Floodplain
271	gmlt	*mm/[period]*	computed glacier melt	Sum	glacier slc area	missing
272	loff	$L/km^2/s$	computed 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
273	lrfa	-	local river fractional area	Avg.	local river area	Evaporation

#	Variable ID	Unit	Description	Agg.	Reference area	Component
274	mrfa	-	main river fractional area	Avg.	main river area	Evaporation
275	lred	*m*	local river effective depth when area is reduced	Avg.	local river area	missing
276	mred	*m*	main river effective depth when area is reduced	Avg.	main river area	missing
277	cSSl, cTSl	*kg/[period]*	simulated sediment load out from subbasin (SS=suspended sediments, TS=total suspended sediments) (missing in case of no positive flow)	Sum	subbasin upstream area	missing
278	infi	*mm/[period]*	infiltration to soil, including macropore flow and water staying standing on the surface of the soil	Sum	subbasin land area	infiltration
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	P Sed. & Resusp.
292	Pslr	*kg*	local river PP storage in sediments	Avg.	local river area	P Sed. & Resusp.
293	Ssmr	*kg*	main river SS storage in sediments	Avg.	main river area	S Sed. & Resusp.

#	Variable ID	Unit	Description	Agg.	Reference area	Component
294	Sslr	*kg*	local river SS storage in sediments	Avg.	local river area	S Sed. & Resusp.
295	ssmx	*mg L^{-1}*	SS maximum transport concentration in main river flow	Avg.	subbasin upstream area except olake area	S Sed. & Resusp.
296	sdrs	*kg ts^{-1}*	SS sedimentation/resuspension in main river (positive values indicate sedimentation and negative values indicate resuspension)	Avg.	subbasin upstream area except olake area	S Sed. & Resusp.
297	wilk	*m*	ilake water stage above threshold	Avg.	local lake area	Local lakes
298	craw	*m*	runoff including wetland class (iwet)	Sum	subbasin land area plus iwet area	Wetlands
299	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
300	wcSS	*mg/L*	simulated concentration of suspended sediment (SS) in outflow of iwet	W.Avg.	subbasin land area plus iwet area	missing
301	wcAE	*mg-N/L*	simulated concentration of algae (AE) in outflow of iwet	W.Avg.	subbasin land area plus iwet area	missing
302	wcOC	*mg/L*	simulated concentration of organic carbon (OC) in outflow of iwet	W.Avg.	subbasin land area plus iwet area	missing
303	wcT2	*°C*	simulated water temperature in outflow of iwet	W.Avg.	subbasin land area plus iwet area	missing
304	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
305	wiSS	*mg/L*	simulated concentration of suspended sediment (SS) in inflow to iwet	W.Avg.	subbasin land area	missing

#	Variable ID	Unit	Description	Agg.	Reference area	Component
306	wiAE	*mg-N/L*	simulated concentration of algae (AE) in inflow to iwet	W.Avg.	subbasin land area	missing
307	wiOC	*mg/L*	simulated concentration of organic carbon (OC) in inflow to iwet	W.Avg.	subbasin land area	missing
308	wiT2	*°C*	simulated water temperature in inflow to iwet	W.Avg.	subbasin land area	missing
309	iwin	m^3/s	computed inflow of iwet	Avg.	internal wetland (iwet) area	missing
310	iwut	m^3/s	computed ouflow of iwet	Avg.	internal wetland (iwet) area	Wetlands
311	ciwv	m^3	computed iwet volume	Avg.	internal wetland (iwet) area	Wetlands
312	wiwt	*m*	iwet water depth above threshold (-w0 if soil is dry)	Avg.	internal wetland (iwet) area	Wetlands
313	cowv	m^3	computed owet volume	Avg.	outlet wetland (owet) area	Wetlands
314	wowt	*m*	owet water depth above threshold (-w0 if soil is dry)	Avg.	outlet wetland (owet) area	Wetlands
315	hged	*m*	main river water depth calculated by hydraulic geometry	Avg.	subbasin upstream area	Main river
316	hgeu	*m/s*	main river velocity calculated by hydraulic geometry	Avg.	subbasin upstream area	Main river
317	corl	*m*	computed water level of main river (calculated from river rating curve)	Avg.	main river area	Main river
318	crrl	*?*	main river water level in local reference system and in unit of local reference system	Avg.	main river area	Main river
319	snwc	*mm*	computed snow liquid water content	Avg.	subbasin land area	Snow
320	snht	*MJ*	computed snow heat content	Avg.	subbasin land area	Snow
321	snte	*°C*	computed snow temperature	Avg.	subbasin land area	Snow
322	snts	*°C*	computed snow surface temperature	Avg.	subbasin land area	Snow
323	dtmp	*°C*	computed deep soil temperature	Avg.	subbasin land area	Soil temp.
324	cmrp	-	main river ice porosity	Avg.	main river area	missing

#	Variable ID	Unit	Description	Agg.	Reference area	Component
325	colp	-	olake ice porosity	Avg.	outlet lake area	missing
326	c1IN, c1ON, c1TN, c1SP, c1PP, c1TP, c1OC, c1SS, c1AE, c1TS, c1T1, c1T2	-	simulated concentration of substance in main outflow (coum)	W. Avg.	subbasin upstream area	missing
327	c2IN, c2ON, c2TN, c2SP, c2PP, c2TP, c2OC, c2SS, c2AE, c2TS, c2T1, c2T2	-	simulated concentration of substance in branch outflow (coub)	W. Avg.	subbasin upstream area	missing
328	c3IN, c3ON, c3TN, c3SP, c3PP, c3TP, c3OC, c3SS, c3AE, c3TS, c3T1, c3T2	-	simulated concentration of substance in main outflow (coum)	Avg.	subbasin upstream area	missing
329	c4IN, c4ON, c4TN, c4SP, c4PP, c4TP, c4OC, c4SS, c4AE, c4TS, c4T1, c4T2	-	simulated concentration of substance in branch outflow (coub)	Avg.	subbasin upstream area	missing
330	c5IN, c5ON, c5TN, c5SP, c5PP, c5TP, c5OC, c5SS, c5AE, c5TS, c5T1, c5T2	-	simulated concentration of substance in internal lake (ilake)	W. Avg.	ilake area	missing
331	c6IN, c6ON, c6TN, c6SP, c6PP, c6TP, c6OC, c6SS, c6AE, c6TS, c6T1, c6T2	-	simulated concentration of substance in outlet lake	W. Avg.	olake area	missing
332	c7IN, c7ON, c7TN, c7SP, c7PP, c7TP, c7OC, c7SS, c7AE, c7TS, c7T1, c7T2	-	simulated concentration of substance in total outflow of lake (coul)	W. Avg.	subbasin upstream area	missing
333	c8IN, c8ON, c8TN, c8SP, c8PP, c8TP, c8OC, c8SS, c8AE, c8TS, c8T1, c8T2	-	simulated concentration of substance in total outflow of lake (coul)	Avg.	subbasin upstream area	missing

#	Variable ID	Unit	Description	Agg.	Reference area	Component
334	coul	m^3/s	simulated total outflow from lake (including branched outflow from upstream lakebasins of multi-basin lakes)	Avg.	subbasin upstream area	Flows
335	crgl	*MJ/d*	calculated global radiation	Avg.	subbasin area	missing
336	crnt	*MJ/d*	calculated net radiation	Avg.	subbasin area	missing
337	cmrr	*MJ/d*	calculated main river radiation when simulating T2 or if main river area is positive	Avg.	main river area	missing
338	crpt	*MJ/d*	calculated potential short-wave radiation	Avg.	subbasin area	missing
339	crex	*MJ/d*	calculated extraterrestrial radiation	Avg.	subbasin area	missing
340	fnca	-	fraction of non-contribution area of the ilake catchment area	Avg.	ilake catchment area	Local lakes
341	fcon	-	fraction of ilake connectivity	Avg.	ilake area	Local lakes
342	acIN	*ug/L*	concentration of IN in aquifer below the subbasin	Avg.	subbasin area	missing
343	acON	*ug/L*	concentration of ON in aquifer below the subbasin	Avg.	subbasin area	missing
344	acSP	*ug/L*	concentration of SP in aquifer below the subbasin	Avg.	subbasin area	missing
345	acPP	*ug/L*	concentration of PP in aquifer below the subbasin	Avg.	subbasin area	missing
346	acOC	*mg/L*	concentration of OC in aquifer below the subbasin	Avg.	subbasin area	missing
347	acSS	*mg/L*	concentration of SS in aquifer below the subbasin	Avg.	subbasin area	missing
348	acT1	*µU/L* ?	concentration of T1 in aquifer below the subbasin	Avg.	subbasin area	missing
349	absr	m^3*/[period]*	abstraction from main river	Sum	none	missing
350	absl	m^3*/[period]*	abstraction from outlet lake	Sum	none	missing
351	ccDS, ccAS, ccSI	*mg/L*	simulated concentration of dissolved silica (DS), algae silica (AS) and total silica (SI) in outflow from outlet lake/subbasin	W.Avg.	subbasin upstream area	missing
352	reSI	*mg/L*	recorded concentration of silica in outflow from outlet lake/subbasin	W.Avg.	subbasin upstream area	missing
353	csSI	*mg/L*	simulated concentration of dissolved silica (DS) in soil water	W.Avg.	subbasin land area	missing

#	Variable ID	Unit	Description	Agg.	Reference area	Component
354	coSI	*mg/L*	simulated concentration of dissolved silica (DS) in local runoff from soil	W.Avg.	subbasin land area	missing
355	clDS, clAS	*mg/L*	simulated concentration of dissolved silica (DS) and algae silica (AS) in local flow from subbasin	W.Avg.	subbasin area	missing
356	pSI1,pSI2,pSI3	kg/m^2	pool of dissolved silica (DS) in soil layers 1 to 3	Avg.	subbasin land area	missing
357	dPP1,dPP2,dPP3	kg/m^2	pool of suspended PP in soil water in layers 1 to 3	Avg.	subbasin land area	missing
358	psub	*mm/[period]*	simulated precipitation above vegetation (before vegetation interception effect simulated as pcluse)	Sum	subbasin area	Prec.
359	esub	*mm/[period]*	simulated total evapotranspiration including vegetation interception effect (simulated as pcluse)	Sum	subbasin area	Prec.
360	isub	*mm/[period]*	simulated vegetation interception effect (simulated as pcluse)	Sum	subbasin area	Prec.
361	cmrq	m^3/s	simulated main river flow	Avg.	subbasin upstream area except olake area	Flows
362	c9IN, c9ON, c9TN, c9SP, c9PP, c9TP, c9OC, c9SS, c9AE, c9TS, c9T1, c9T2 ,c9DS, c9AS, c9SI	-	simulated concentration of substance in main river flow (cmrq)	W. Avg.	subbasin upstream area except olake area	missing
363	olsp	$kg\ m^{-2}$	olake sediment SS pool	Avg.	outlet lake area	missing
364	olsa	*days*	olake sediment pool age	Avg.	outlet lake area	missing
365	olsd	$kg\ m^{-3}$	olake sediment pool density	Avg.	outlet lake area	missing
366	olss	*m*	olake sediment thickness, includes SS and AE	Avg.	outlet lake area	missing
367	olld	*m*	olake current lake depth below threshold	Avg.	outlet lake area	missing
368	olsf	-	flag for olake sediment flushing, 0 indicates sediment is accumulating, 1 indicates sediment is being removed from reservoir pool	Avg.	outlet lake area	missing
369	olas	*kg / [period]*	outlet lake sedimentation of TS (total sediment)	Sum	outlet lake area	missing

#	Variable ID	Unit	Description	Agg.	Reference area	Component
370	olan	*kg / [period]*	outlet lake sedimentation of TN (total nitrogen)	Sum	outlet lake area	missing
371	olap	*kg / [period]*	outlet lake sedimentation of TP (total phosphorus)	Sum	outlet lake area	missing
372	olac	*kg / [period]*	outlet lake sedimentation of OC (organic carbon)	Sum	outlet lake area	missing
373	olai	*kg / [period]*	outlet lake sedimentation of Si (total silica)	Sum	outlet lake area	missing
374	ola1	*U / [period]*	outlet lake sedimentation of T1	Sum	outlet lake area	missing
375	olns	*kg / [period]*	outlet lake net change in sediment pool of TS	Sum	outlet lake area	missing
376	csON	*µg/L*	simulated concentration of organic nitrogen (ON) in soil water	W.Avg.	subbasin land area	missing
377	csSP	*µg/L*	simulated concentration of soluble reactive phosphorus (SP) in soil water	W.Avg.	subbasin land area	missing
378	csPP	*µg/L*	simulated concentration of suspended particulata phosphorus (PP) in soil water	W.Avg.	subbasin land area	missing

Observed variables and a few other related variables

This table contain HYPE variable ID:s for variables provided in Tobs.txt, Pobs.txt, Qobs.txt, Wobs.txt, Xobs.txt and “XobsXOMn/XobsXOSn.txt”. In addition it includes a few variables that is calculated from the former.

Variable ID	Unit	Description	Agg.	Reference area	Component
temp	*°C*	air temperature, provided in Tobs.txt/Tobs_nnn.txt	Avg.	subbasin area	Temp. & Precip.
prec	*mm/[period]*	precipitation as provided in Pobs.txt/Pobs_nnn.txt	Sum	subbasin area	Prec.
rswe	*mm*	observed snow water equivalent, provided in Xobs.txt	Avg.	subbasin land area	Snow
rsnw	*cm*	observed snow depth, provided in Xobs.txt	Avg.	subbasin land area	Snow
rfsc	-	recorded fractional snow cover area, provided in Xobs.txt	Avg.	subbasin land area	missing
rfse	-	recorded fractional snow cover area error, provided in Xobs.txt	Avg.	subbasin land area	missing
rfsm	-	recorded fractional snow cover multi, provided in Xobs.txt	Avg.	subbasin land area	missing
rfme	-	recorded fractional snow cover multi error, provided in Xobs.txt	Avg.	subbasin land area	missing
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

Variable ID	Unit	Description	Agg.	Reference area	Component
S106	-	recorded (FSUHSS) snow cover course open (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of non-forest land cover	missing
S108	*cm*	recorded (FSUHSS) mean depth open, provided in Xobs.txt	Avg.	area of non-forest land cover	missing
S111	g/cm^3	recorded (FSUHSS) mean density open, provided in Xobs.txt	Avg.	area of non-forest land cover	missing
S114	*mm*	recorded (FSUHSS) snow water equivalent open, provided in Xobs.txt	Avg.	area of forest land cover	missing
S205	-	recorded (FSUHSS)snow cover surrounding terrain forest (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of forest land cover	missing
S206	-	recorded (FSUHSS) snow cover course forest (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of forest land cover	missing
S208	*cm*	recorded (FSUHSS) mean depth forest, provided in Xobs.txt	Avg.	area of forest land cover	missing
S211	g/cm^3	recorded (FSUHSS) mean density forest, provided in Xobs.txt	Avg.	area of forest land cover	missing
S214	*mm*	recorded (FSUHSS) snow water equivalent forest, provided in Xobs.txt	Avg.	area of forest land cover	missing
repo	*mm/[period]*	observed potential evapotranspiration, provided in Xobs.txt	Sum	subbasin area	pot evap
eobs	*mm/[period]*	observed evapotranspiration, provided in Xobs.txt	Sum	subbasin area	missing
resf	*cm*	observed frost depth, provided in Xobs.txt	Avg.	subbasin land area	missing
regw	*m*	observed groundwater level, provided in Xobs.txt	Avg.	subbasin land area	missing
rrun	*mm/[period]*	observed local runoff from land area (corresponds to crun), provided in Xobs.txt	Sum	subbasin land area	missing
rerl	*m*	recorded water level of main river, provided in Xobs.txt	Avg.	main river area	Main river
rinf	m^3/s	observed net flow to outlet lake (corresponding to cinf), provided in Xobs.txt	Avg.	subbasin upstream area	missing
wstr	*m*	observed water level olake, provided in Xobs.txt or Wobs.txt	Avg.	outlet lake area	missing
clws	*m*	observed water stage (wstr) cleaned from w0ref reference level	Avg.	outlet lake area	missing
rout	m^3/s	observed outflow from olake/subbasin, provided in Qobs.txt	Avg.	subbasin upstream area	missing
roum	m^3/s	observed outflow from olake outlet 1, provided in Xobs.txt	Avg.	subbasin upstream area	missing

Variable ID	Unit	Description	Agg.	Reference area	Component
roub	m^3/s	observed outflow from olake outlet 2, provided in Xobs.txt	Avg.	subbasin upstream area	missing
roli	*cm*	recorded olake ice depth, provided in Xobs.txt	Avg.	outlet lake area	ice
rolb	*cm*	recorded olake blackice depth, provided in Xobs.txt	Avg.	outlet lake area	ice
rols	*cm*	recorded olake snow depth, provided in Xobs.txt	Avg.	outlet lake area	ice
rolt	*°C*	recorded olake surface temperature, provided in Xobs.txt	Avg.	outlet lake area	missing
rili	*cm*	recorded ilake ice depth, provided in Xobs.txt	Avg.	internal lake area	ice
rilb	*cm*	recorded ilake blackice depth, provided in Xobs.txt	Avg.	internal lake area	ice
rils	*cm*	recorded ilake snow depth, provided in Xobs.txt	Avg.	internal lake area	ice
rilt	*°C*	recorded ilake surface temperature, provided in Xobs.txt	Avg.	internal lake area	missing
rmri	*cm*	recorded main river ice depth, provided in Xobs.txt	Avg.	main river area	ice
rmrb	*cm*	recorded main river blackice depth, provided in Xobs.txt	Avg.	main river area	ice
rmrs	*cm*	recorded main river snow depth, provided in Xobs.txt	Avg.	main river area	ice
rmrt	*°C*	recorded main river surface temperature, provided in Xobs.txt	Avg.	main river area	missing
rlri	*cm*	recorded local river ice depth, provided in Xobs.txt	Avg.	local river area	ice
rlrb	*cm*	recorded local river blackice depth, provided in Xobs.txt	Avg.	local river area	ice
rlrs	*cm*	recorded local river snow depth, provided in Xobs.txt	Avg.	local river area	missing
rgmb	*mm*	recorded glacier mass balance, provided in Xobs.txt	Avg.	specific glacier area	missing
rgma	km^2	area used in recorded mass balance, provided in Xobs.txt	Avg.	specific glacier area	missing
rgmp	*days*	recorded mass balance period, provided in Xobs.txt	Avg.	none	missing
cpT1	*µU/L*	observed concentration of tracer T1 in precipitation, unit user-provided, values provided in Xobs.txt	W. Avg.	subbasin area	tracer T1 atm dep
cpIN	*µg/L*	observed concentration of inorganic nitrogen (IN) in precipitation, provided in Xobs.txt	W. Avg.	subbasin area	atm dep
cpSP	*µg/L*	observed concentration of soluble phosphorus (SP) in precipitation, provided in Xobs.txt	W. Avg.	subbasin area	atm dep

Variable ID	Unit	Description	Agg.	Reference area	Component
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
reT2	*°C*	observed water temperature in outflow from olake/subbasin, provided in Xobs.txt (period average based on recorded flow, if present)	W. Avg.	subbasin upstream area	missing
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 (period average based on recorded flow, if present)	W. Avg.	subbasin upstream area	missing
reOC	*mg/L*	observed OC concentration in outflow from olake/subbasin, provided in Xobs.txt	W. Avg.	subbasin upstream area	missing
reSS	*mg/L*	recorded suspended sediment (SS) concentration in outflow from outlet lake/subbasin, provided in Xobs.txt	W. Avg.	subbasin upstream area	missing
reTS	*mg/L*	recorded total suspended sediment (TS) concentration in outflow from lake/subbasin, provided in Xobs.txt	W. Avg.	subbasin upstream area	missing
reSI	*mg/L*	recorded total silica (SI) concentration in outflow from lake/subbasin, provided in Xobs.txt	W. Avg.	subbasin upstream area	missing
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
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
dwtr	m^3/s	demanded water transfer flow, provided in Xobs.txt	Avg.	-	missing
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

Variable ID	Unit	Description	Agg.	Reference area	Component
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

Upstream variables

Upstream variables are given as the average over the upstream area. For variables which represent another area than the subbasin, eg. the land area, this means that they are rescaled to the subbasin area before the average of upstream area is calculated.

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.	$10^6 m^3$
upcilv	*mm*	lake volume of ilakes spread over upstream area	Avg.	$10^6 m^3$
upclbv	*mm*	lake volume of olakes and individual lake basins spread over upstream area	Avg.	$10^6 m^3$
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]*
upaqin	*mm/[period]*	aquifer recharge over upstream area	Sum	m^3/*[period]*
upaqut	*mm/[period]*	aquifer return flow over upstream area	Sum	m^3/*[period]*
upabsr	*mm/[period]*	abstraction from main river over upstream area	Sum	m^3/*[period]*
upabsl	*mm/[period]*	abstraction from olakes 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.

Old ID	New variable ID	Unit	Description	Value
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. Four 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
- **weighted average:** criteria calculated in subbasins individually, and then combined as an weighted average with different weight (based on trust) to each station. The use of weighted average instead of arithmetic average is decided by a flag in info.txt (`weightsub`).

Available performance criteria for domain-wide model evaluation are listed in the table below. The following criteria will use weighted average in case of flag set for weighted subbasins; MR2, MRA, MRE, MRS, MCC, AKG, MNW, ASK, TAU, and MAR. Equation definitions for criteria calculation are described here.

Note: As described in info.txt, up to 100 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*
ASK	average of rescaled Kling-Gupta efficiency for all subbasins with observations.	*ASCKGE*
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*

Criterion ID	Description	Equation ID
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*
SNR	Spatial RMSE.	*SPATRMSE*
SMB	Spatial mean absolute scaled bias on log transformed values.	*SPATASB*
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*
Average KGE	AKG	*AVKGE*
Aver scalKGE	ASK	*ASCKGE*

Name	Code	Equation ID
Spatial NSE	SR2	*SPATNSE*
Spatial RA	RRA	*SPATRA*
Spatial RE	-	*SPATRB*
Spatial Bias	SMB	*SPATASB*
Spatial RMSE	SNR	*SPATRMSE*
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 efficiency 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*
akg	average of Kling-Gupta efficiency for subbasins	*AVKGE*
asckg	average of Kling-Gupta efficiency rescaled to interval [-1,1] (C2M criteria applied to KGE, Mathevet et al. 2006)	*ASCKGE*
mare	average of absolute relative bias for subbasins (Note: fraction. not %) (MAR in info.txt)	*AVARB*
mdnr	median of normalised RMSE for subbasins	*MEDNE*
mnw	average of Nash-Sutcliffe efficiencies adjusted for bias for subbasins	*AVNSEW*
snr	spatial root mean square error	*SPATRMSE*

Heading	Description	Equation ID
smb	spatial mean absolute scaled bias on natural log transformed values	*SPATASB*

Equation IDs for performance criteria set in info.txt are tabled here.

Equation definitions

Denotations

c	computed value
r	recorded value
cl	log transform of computed value, natural logarithm
rl	log transform of recorded value, natural logarithm
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
w	weight of station

Basic equations

Average value for a time series of a station:

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

Standard deviation of a time series of a station:

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

Natural logaritm of value:

$$xl = LN\left(x\right)$$ *x=r* or *c* or *rm* or *cm* if *x>0*

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

Scaled bias (*ScBias*):

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

Scaled KGE (*SCKGE*):

$$SCKGE = \frac{KGE}{2 - KGE}$$

Criteria equations for a model domain (several stations)

Average Nash-Sutcliffe efficiency (*AVNSE*):

AVNSE arithmetic mean

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

or *AVNSE* weighted average

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

Median Nash-Sutcliffe efficiency (*MEDNSE*):

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

Spatial Nash-Sutcliffe efficiency (*SPATNSE*):

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

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

AVNSEW arithmetic mean

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

or *AVNSEW* weighted average

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

Average efficiency with coefficient a (*AVRA*):

AVRA arithmetric mean

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

or *AVRA* weighted average

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

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 arithmetric mean

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

or *AVRB* weighted average

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

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 arithmetric mean

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

or *AVKGE* weighted average

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

Median Kling-Gupta efficiency (*MEDKGE*):

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

Average scaled Kling-Gupta efficiency (*ASCKGE*):

ASCKGE arithmetric mean

$$ASCKGE = \frac{1}{mj} \sum_{j=1}^{mj} SCKGE_j$$

or *ASCKGE* weighted average

$$ASCKGE = \frac{\sum_{j=1}^{mj} w_j \times SCKGE_j}{\sum_{j=1}^{mj} w_j}$$

Spatial root mean square error (*SPATRMSE*):

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

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

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

Average of absolute relative bias (*AVARB*):

AVARB arithmetric mean

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

or *AVARB* weighted average

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

Average Pearson correlation coefficient (*AVCC*):

AVCC arithmetric mean

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

or *AVCC* weighted average

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

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

AVRSB arithmetric mean

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

or *AVRSB* weighted average

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

Average Kendalls rank correlation coefficient (*AVTAU*):

AVTAU arithmetric mean

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

or *AVTAU* weighted average

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

Regional mean absolute error (*REGMAE*):

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

Spatial mean absolute scaled bias on log transformed values (*SPATASB*):

$$SPATASB = \frac{\sum_{j=1}^{mj} \left| \frac{cml_j - rml_j}{cml_j + rml_j} \right|}{mj}$$

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.

Mathevet et al. 2006. A bounded version of the Nash-Sutcliffe criterion for better model assessment on large sets of basins. In: Large Sample Basin Experiments for Hydrological Model Parameterization: Results of the Model Parameter Experiment–MOPEX. IAHS Publ. 307, 2006, p. 211-219.

AssimInfo.txt

General

The *AssimInfo.txt* file contains additional model settings to info.txt and is therefore located in the same folder as info.txt. The AssimInfo-file is used to define what kind of data assimilation to be done if assimilation is turned on in info.txt. The file information is divided into four groups:

1. general settings,
2. setting of control variables,
3. observation settings, and
4. meteorological forcing data settings.

The settings are usually kept in their four groups, but that is not necessary. The general settings all start with the letters G_, while the control variable settings start with A_, observations settings with O_ and forcing settings with F_. The control variable settings determine which group of HYPE states the filtering will be applied to.

File format

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 code string decides what information is to be read. The code can be written within or without apostrophes ('...'). Codes are not case sensitive. Maximum 18000 characters can be read on a single line.

General settings

Code	Argument	Description
G_NE	*Integer*	Ensemble size, number of ensemble members (default=100)
G_MV	*Real*	Missing value for the assimilation routine (default=-9999) (not useful for HYPE, must be -9999?)
G_MEANOUT	*0/1*	mean(1) or median(0) value printed in ordinary output files (default=mean)
G_STATOUT	*0/1/2/3/4/5/..*	Extra output files for statistics (0-5) and ensemble members (6-). 1 give minimum as _002, 2 give min and max (as _003), 6 and up give ensemble members 1 and up to maximum 5+NE (as _007 and up). Note: 3-5 is not implemented. They should in the future give: 3 give previous and 0.025-perc (as _004), 4 give previous and median (as _005), 5 give previous and 0.975-perc (as _006) (default=0)

Code	Argument	Description
G_XYLOC	*Real*	Horizontal length scale [m] for covariance localization (distance with ~90% covariance reduction) (default=1000000)
G_ZLOC	*Real*	Vertical length scale [m] for covariance localization (default=100000)
G_USEBINX	*0/1/2*	Use bin-files to hold state ensembles (0=no, 1=one bin-file, 2=several bin-files) (default is no)
G_USEBINFA	*0/1/2*	Use bin-files to hold forcing and auxiliary ensembles (0=no, 1=one bin-file, 2=several bin-files) (default is no)
G_STOP	*0/1*	Stop simulation when cholesky factorisation fails (0/1) (default=0=not stop)
G_CNC	*0/1*	Collapse non-controlled states to ensemble mean(or median) (0==no, 1=yes) (default=0)
G_TRANSTAT	*0/1*	Transform state variables (and some outvar) before the EnKF analysis (0=no, 1=yes) (default=0). If yes, then statevariables with physical range [0,+inf] will be log-transformed, and variables with range [0,1] will be logit transformed. Once implemented, Yeo-Johnson transform will be used on variables with unbounded physical limits (such as temperatres)
G_TRANEPS	*Real*	epsilon = minimum value used for log and logit transforms (used for state variables with physical range [0,+inf] and [0,1], respectively) (default=0.000001)

Control variable settings

These are the variables controlled by assimilation. They are set as a group by category or separate by name. The categories and names are specific to the HYPE model. If they are turned off, the analysis is NOT applied to variables in this category. Instead, they are re-initialized to the ensemble mean (or median depending on G_MEANOUT) after each time step. If they are turned on, the analysis IS APPLIED whenever there are observations available. No re-initialization.

Format of control variable lines: They start with A_ followed by include_ or exclude_ followed by bycategory or byname followed by [category] or [name]. To identify the variable by name, the category of the variable need to be set on a line directly before the variable. Example:

```
A_INCLUDE_BYCATEGORY SNOW
A_INCLUDE_BYCATEGORY SOIL
A_EXCLUDE_BYCATEGORY GLACIER
```

Code	Argument	Description
A_INCLUDE_BYCATEGORY	*Category*	Category is defined in the HYPE code (see table below)
A_EXCLUDE_BYCATEGORY	*Category*	Category as above
A_INCLUDE_BYNAME	*Name*	Name is state variable name in HYPE code (see table below).
A_EXCLUDE_BYNAME	*Name*	Name as above

Category	Names
SNOW	snow csnow snowage snowdepth snowcov snowmax snowheat snowliq
GLACIER	glacvol
LAKEICE	lakesnow lakesnowage lakesnowdepth lakeice lakebice lakeicecov lakeicepor
RIVERICE	riversnow riversnowage riversnowdepth riverice riverbice rivericecov rivericepor

Category	Names
SOIL	water temp deeptemp conc humusN fastN partP fastP humusP fastC humusC PPrelpool Srelpool oldgrw partT1 surface icelens
AQUIFER	water conc lastrecharge clastrecharge nextoutflow cnextoutflow
RIVERWT	water temp conc TPmean temp10 temp20 Psed qqueue cqueue cwetland Qdayacc Q365 Qmean T1sed Ssed
LAKEWT	water temp conc TPmean temp10 temp20 uppertemp lowertemp volfrac
MISC	temp5 temp30 temp10 temp20 gdd gsbegin nextirrigation cnextirrigation updatestationsarcorr floodwater cfloodwater partT1sf nexttransfer cnexttransfer

Observation settings

The observation settings determine which observations should be assimilated. The observations settings are given as a table with one observation variable per line. The settings include which HYPE outvar variables to compare, the ensemble generation model, minimum and maximum values allowed, standard deviation parameters, and parameters for generation of spatially correlated perturbations. The columns are in the order given in the table below.

Column number	Column name	Type	Value range	Description
1	Observation	Character	0_nnn	Beginning with the code for observation setting (“O_”), the following characters (nnn) are a description for the user
2	IDobs	4 characters	HYPE variable ID	The 4 letter code for the observation as used by HYPE
3	IDmod	4 characters	HYPE variable ID	The 4 letter code for the corresponding simulated variable as used by HYPE for output
4	EnsType	Integer	0-4	Ensemble generation model (following Turner et al). EnsType definition: 0=not used, 1=unrestricted, 2=semi-restricted(minimum), 3=semi-restricted(maximum), 4=constrained (max and min)
5	Min	Real	-	Minimum value allowed (EnsType 2,3,4). Perturbations outside this range will be truncated to the min value.
6	Max	Real	-	Maximum value allowed (EnsType 2,3,4). Perturbations outside this range will be truncated to the max value.
7	Minsigma	Real	-	Standard deviation parameter. Minsigma is minimum allowed standard deviation
8	Sigma	Real	-	Standard deviation parameter. Sigma is constant standard deviation used for EnsType = 1, also used as minimum allowed standard deviation for EnsType = 2-4
9	SemiMeta	Real	-	Standard deviation parameter. SemiMeta is relative standard deviation used for EnsType = 2 & 3
10	RestMeta	Real	-	Standard deviation parameter. RestMeta is relative standard deviation for EnsType = 4

Column number	Column name	Type	Value range	Description
11	Lscale	Real	-	correlation length (horizontal)
12	GridSize	Real	-	cellsize (x and y dir) in the 2D grid used for the 2D spatially correlated random fields (interpolated to the model coordinates)
13	CorrType	Integer	1-3	correlation function: 0 none 1 Gaussian, 2 Compact 5th degree polynomial, 3 Power law
14	Coordid	Integer	1-4	spatial domain of observation (1=subbasin, 2=upstream area (ie. COUT), 3=aquifer, 4=outregions)
15	Transform	Integer	0-3	kind of transformation to be applied to the variable before filtering (0=none, 1=log, 2=Yeo-Johnson (not implemented yet), 3=logit
16	epsilon	Real	-	minimum value used to avoid 0 in log or logit transform
17	ClassGroup	Character	-	Optional. If a class group variable is used, the class group name (as defined in info.txt) is given.

Forcing data settings

The meterological forcing data settings determine which forcing data should be perturbed and included in assimilation. The settings are given as a table with one forcing variable per line. The settings include the ensemble generation model, minimum and maximum values allowed, standard deviation parameters, and parameters for generation of spatially correlated perturbations. The columns are in the order given in the table below.

Column number	Column name	Type	Value range	Description
1	Forcing	Character	F_nnn	Beginning with a code for forcing data setting (F_), the following characters (nnn) are a description for the user
2	IDobs	4 characters	-	A letter code for the forcing as used by HYPE. It is the filename without the file ending, e.g. Pobs
3	EnsType	Integer	0-4	Ensemble generation model (following Turner et al). EnsType definition: 0=not used, 1=unrestricted, 2=semi-restricted(minimum), 3=semi-restricted(maximum), 4=constrained (max and min)
4	Min	Real	-	Minimum value allowed (EnsType 2,3,4). Perturbations outside this range will be truncated to the min value. Note: TMIN and TMAX is handled as deviations from Tobs in the DA, thus their range is the range of the deviation (negative for TMIN, positive for TMAX).
5	Max	Real	-	Maximum value allowed (EnsType 2,3,4). Perturbations outside this range will be truncated to the max value. Note: TMIN and TMAX is handled as deviations from Tobs in the DA, thus their range is the range of the deviation (negative for TMIN, positive for TMAX).
6	Minsigma	Real	-	Standard deviation parameter. Minsigma is minimum allowed standard deviation

Column number	Column name	Type	Value range	Description
7	Sigma	Real	-	Standard deviation parameter. Sigma is constant standard deviation used for EnsType = 1, also used as minimum allowed standard deviation for EnsType = 2-4
8	SemiMeta	Real	-	Standard deviation parameter. SemiMeta is relative standard deviation used for EnsType = 2 & 3
9	RestMeta	Real	-	Standard deviation parameter. RestMeta is relative standard deviation for EnsType = 4
10	Lscale	Real	-	correlation length (horizontal)
11	GridSize	Real	-	cellsize (x and y dir) in the 2D grid used for the 2D spatially correlated random fields (interpolated to the model coordinates)
12	CorrType	Integer	1-3	correlation function: 0 none 1 Gaussian, 2 Compact 5th degree polynomial, 3 Power law
13	Tau	Real	-	perturbation memory coefficient (fraction of perturbation propagated from previous timestep)

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 must be listed in downstream 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 which subbasins should be have their modelled variables updated. Flow and waterstage are updated based on observations and concentrations can be updated with a relative change of the value. This means that the values changed (e.g flow or water stage) influence the downstream areas and the rest of the simulation period. The updating function is activated through codes in info.txt, and the update.txt file is read only if asked for by the settings in info.txt. The update.txt file holds the subbasins that will be updated (the order is irrelevant). Only subbasins which are to be updated have to be listed here. For subbasins listed here that lack observations time series, the updating will have no effect.

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
`subid`	*integer*	subbasin ID (mandatory)
`arfact`	*0-1*	AR-factor for updating method `qar` for discharge or `war` for discharge
`quseobs`	*0/1*	status for discharge updating with the quseobs method
`qarupd`	*0/1*	status for discharge updating with the qar method
`warupd`	*0/1*	status for discharge updating with waterstage AR-method
`wendupd`	*0/1*	status for waterstage updating with the wendupd method
`cuseobs`	*0/1*	status for concentration updating with the cuseobs 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

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  C1 ...
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 have special caclulations and are 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, 5=traveltime soilmodel (used together with modeloption soilleakage 2-5), 6=rootzone leakage soilmodel (used together with modeloption soilleakage 4 or 5), 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.

ClassData.txt

SLC classes divide the subbasins of the model based on land use etc. The *ClassData.txt* file (alternative file to GeoClass.txt) 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, wetlands and glaciers make up special classes, while all other classes are land classes and combinations of land use and soil type. Two SLC 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 e.g. tile drainage depth, stream drainage depth and time of travel.

File content

The *ClassData.txt* file is located in the `modeldir` folder. Information for a SLC is given on a single row in the file. The data is tab-separated and information is defined by a header row with variable names. Variable names are not case-sensitive (max. 11 characters, no spaces). Columns with headings unknown to HYPE are skipped while reading the file, but must not longer than eleven characters. A maximum of 15 columns can be read. Columns containing character strings are not allowed. The columns may be in any order. A value must exist for every column and row, i.e. empty cells are not allowed.

Comment rows can be added in the beginning of the file and are denoted with a '!' in the first position. A maximum of 999 classes can be defined. The data of SLC:s in GeoData.txt is not necessary to be in slc order.

Example snippet of a ClassData.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
class landuse  soiltype  cropid ...
1    1   1   1  ...
2    2   1   2  ...
3    2   2   2  ...
```

Description of class characteristics provided in *ClassData.txt* columns. Mandatory headings in bold:

Header	Unit	Data	Description
class	-	Soil type-land use combination (slc)	Should be 1,2,3.... The number is the same used for the class's area fraction (slc_nn) in GeoData.txt.
landuse	-	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.
soiltype	-	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.

Header	Unit	Data	Description
cropid	-	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.
2ndcropid	-	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.
rotgroup	-	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.
atmdepveg	-	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. If not set (0) vegetation type 1 will be used.
classmodel	-	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, 5=traveltime soilmodel, 6=rootzone leakage soilmodel, 11=local stream, 12=main river, 13=internal wetland, 14=outlet wetland.
tiledepth	*m*	Tile depth	Distance from soil surface to (average) tile drainage system level. Set to 0 to not use tile drainage routine for a class.
streamdepth	*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.
numlayers	-	Number of soil layers	May be 1-3. For water classes set to 1 layer with depth 1 m (the values are not used).
depthsl1	*m*	Soil layer depth	Distance from the soil surface to the bottom of the uppermost soil layer.
depthsl2	*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 (or zero).
depthsl3	*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 (or zero).
traveltime	-	time of travel	Scaling factor for the class toime of travel in relation to the reference time of travel
tilegroup	-	tile type group	An integer 0,1,2,..., 10. Determines which classes are to have reduced tile drainage based on fraction of drained area. 0=no reductions, 1=reduction based on fraction for tile group 1, etc.

GeoData.txt

This file contains characteristics of the spatially delineated subbasins in a HYPE model domain. This includes e.g. SUBIDs (subbasin IDs) and SUBIDs of downstream subbasins, fractions of SLC classes (hydrological response units) within each subbasin, 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. Subbasins are listed row-wise. The first row contains a column header with variable names. Variable names are not case-sensitive (max. 11 characters, no spaces). Columns with headings unknown to HYPE are skipped while reading the file, but must not longer than eleven 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.

Subbasins 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 when computing fluxes at each subbasin and subbasin 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. Note that multibasin lakes are calculated at the last lake basin, and thus all downstream basins of the multibasin lakes outlets (main outlet and possible branched outflow from other lake basins) must be taken located after the last lakebasin in the subbasin order.

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. Atmospheric deposition should no longer be given in this file, use input file AtmdepData.txt instead, see Deprecated variables table below.

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)

Variable ID	Unit	Requirement	Description
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.
parreg	-	optional	region for correction parameters (e.g. evapcorr). An integer 1,2,3,.., default is 1.
wqparreg	-	optional	region for water quality correction parameters (e.g. incorr). An integer 1,2,3,.., default is 1.
lakeregion	-	optional	lake region for watercourse parameter. An integer 1,2,3,.., default is 1.
ilregion	-	optional	lake region for internal lake (ilake) parameters. An integer 1,2,3,.. , default is 1.
olregion	-	optional	lake region for outlet lake (olake) parameters. An integer 1,2,3,.. , default is 1.
elev_mean	*m*	optional	mean elevation of subbasin
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	olake 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_nnn	-	mandatory	soil-type/land-use class number *nnn* (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_nnn	-	optional	fraction of SLC class nn's area that is sown with secondary crop (between 0 and 1)
dhslc_nnn	*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_vol	m^3/d	optional	outflow from rural households (modeloption diffusesource 0)
loc_tp	*mg/l*	optional	concentration of Tot-P from rural households outflow (loc_vol)
loc_sp	-	optional	fraction of rural household P outlet that is in soluble form
loc_tn	*mg/l*	optional	concentration of Tot-N from rural households outflow (loc_vol)
loc_in	-	optional	fraction of rural household N outlet that is inorganic
loc_ts	*mg/l*	optional	concentration of total suspended material from rural households outflow (loc_vol)
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_vol)
loc_t2	*°C*	optional	temperature of rural households outflow (used for T2 simulation)
loc_si	*mg/l*	optional	concentration of silica from rural households diffuse source (loc_vol)
loc_ds	-	optional	fraction of rural hoursehold silica outlet that is is dissolved silica
loc_oc	*mg/l*	optional	concentration of organic carbon from rural households diffuse source (loc_vol)
loc_soil	-	optional	fraction of emission from rural waste water (loc_vol) that is emitted directly to the lowest soil layer (rest goes to the local river). If no column found, the parameter locsoil is used.
locltp	*kg/yr*	optional	rural household diffuse source in the form of a load added to soil water (used for modeloption diffusesource 1)
loclsp	-	optional	fraction of locltp that is SP
locltn	*kg/yr*	optional	rural household diffuse source in the form of a load added to soil water (used for modeloption diffusesource 1)
loclin	-	optional	fraction of locltn that is IN
loclts	*kg/yr*	optional	rural household diffuse source in the form of a load added to soil water (used for modeloption diffusesource 1)
loclss	-	optional	fraction of loclts that is SS
loclt1	*U/yr*	optional	rural household diffuse source in the form of a load added to soil water (used for modeloption diffusesource 1)
loclt2	*k°C m3/yr*	optional	rural household diffuse source in the form of a load added to soil water (used for modeloption diffusesource 1)
loclsi	*kg/yr*	optional	rural household diffuse source in the form of a load added to soil water (used for modeloption diffusesource 1)
loclds	-	optional	fraction of loclsi that is dissolved silica (DS)
locloc	*kg/yr*	optional	rural household diffuse source in the form of a load added to soil water (used for modeloption diffusesource 1)
lrwet_area	m^2	optional	area of local river wetland
mrwet_area	m^2	optional	area of main river wetland

Variable ID	Unit	Requirement	Description
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
eroindex	-	optional	erosion index given per subbasin, used for erosion model 1 (defaults to 1)
suspchannel	-	optional	river channel erodability/vegetation cover modification factor of resuspension (0-1), used for sedresusp model 2
sand	-	optional	sand soil fraction, used for siltation model
silt	-	optional	silt soil fraction, used for siltation model
clay	-	optional	clay soil fraction, used for siltation model
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
ws_nn_d		optional	Winstral coefficient for each class number *nn* and direction *d*
cloud_nnn	-	optional	monthly cloudiness climatology (fraction). *nnn* is the first three letters of the month.
weight_sub	-	optional	weight of (trust in) subbasin in calculation of average model performace criteria and objective function
lks_num	-	optional	number of lake section of ilake (maximum 99)
lks_dp_N	*m*	optional	lake section N threshold above lake depth at outlet, N=1,2,..
lks_fi_N	-	optional	lake section N fraction of icatch, N=1,2,..
lks_fa_N	-	optional	lake section N fraction of ilake area, N=1,2,..
tilefrac_n	-	optional	optional fraction of tile drained area for the classes of this tile group, n=1-10

Table. Deprecated variables from HYPE version 5.17.0

Variable ID	Unit	Description	Replacement
wetdep_n	*µg/l*	wet deposition of inorganic nitrogen, concentration of precipitation	Replaced by column IN_WD in AtmdepData.txt. Note the unit change to *mg/L*.
drydep_n1	*kg/(km^2 d)*	dry deposition of inorganic nitrogen on vegetation type 1 (open)	Replaced by column IN_DD_V1 in AtmdepData.txt

Variable ID	Unit	Description	Replacement
drydep_n2	*kg/(km^2 d)*	dry deposition of inorganic nitrogen on vegetation type 2 (forest)	Replaced by column IN_DD_V2 in AtmdepData.txt
drydep_n3	*kg/(km^2 d)*	dry deposition of inorganic nitrogen on “vegetation” type 3 (water)	Replaced by column IN_DD_V3 in AtmdepData.txt.
deploadn1 - deploadn12	*kg/(km^2 d)*	total deposition of inorganic nitrogen on water, January - December	Replaced by adding as dry deposition in AtmdepData.txt; columns IN_DD_M1_V3 ... IN_DD_M12_V3.

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, sediment management, 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 subbasin or the whole subbasin. Large lake systems can be split into several subbasins themselves. Each such subbasin's olake is then a lake basins of the **multi-basin lake**. This allows for different properties in different lake basins (e.g. depth). Flow between lakebasins of such a multi-basin lake is not defined in LakeData (outflow parameters should be zero). Outflow parameters for a multi-basin lake are defined only for lake basin which has an outlet to the outside of the multi-basin lake. The main outlet leaves by the last lakebasin, while additional outlets leaves through branches of upstream lakebasins. Maximum five outflows of a multi-basin lake is allowed.

Lakes that are not multi-basin lakes 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 lakes with two outlets defined in *LakeData.txt* 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. A row with data is skipped if ldtype is zero and the lakedataid is not found in GeoData (e.g. is zero). This can be used to temporary not use the specific lake properties on a row.

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 ...
         2      1      7        6.9  4000     0      0      0      0    0
0 ...
         3      1      7          5 30000 21.94   13.5    401    200  155
0.3 ...
       ...    ...    ...        ...   ...   ...    ...    ...    ...  ...
... ...
```

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

Variable ID	Unit	Type	LdType	Description
`lakedataid`	-	*general*	*1/5/7*	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*	*5/6/7*	lake ID (integer), used to connect lake basins to its multi-basin lake and outlets of a lake with two outlets to that lake. Use unique positive integer for these lakes, but for simple outlet lakes (`ldtype` = 1) an arbitrary number can be used, e.g. 0.
`ldtype`	-	*general*	*all*	code for lake data type, integer (mandatory): **1** - simple outlet lake **2**, **3**, **4** - not used anymore **5** - lake with two outlets, main outlet **6** - lake with two outlets, second outlet **7** - lake basin of multibasin lake that will have a equal water level
`lake_depth`	*m*	*physical property*	*1/5/7*	water depth below threshold for outlet lake (mean depth), can also be defined in GeoData.txt (must be > 0). Not used for second outlet of lake with two outlets.
`area`	m^2	*physical property*	*1/5/7*	lake or lake basin area, optional, used for check the fraction of the subbasin covered by the outlet lake for simple outlet lakes (compared with SLC class fraction in GeoData.txt)
`w0ref`	*m*	*general*	*1/5/6/7*	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. Only for the last lakebasin of multi-basin lake, the other use the same reference.
`rate`	-	*general/regulation*	*1/5/6/7*	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*	*1/5/6/7*	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*	*1/5/6/7*	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*	*1/5/6/7*	parameter for regulated olake, constant production flow down to lowest allowed waterstage for regulation period 1

Variable ID	Unit	Type	LdType	Description
qprod2	m^3/s	*regulation*	*1/5/6/7*	parameter for regulated olake, constant production flow down to lowest allowed waterstage for regulation period 2
datum1	-	*regulation*	*1/5/6/7*	parameter for regulated olake, start of regulation period 1 (if not defined only one period is used) (4 character month-day string *mmdd*)
datum2	-	*regulation*	*1/5/6/7*	parameter for regulated olake, start of regulation period 2 (4 character month-day string *mmdd*)
qamp	-	*regulation*	*1/5/6/7*	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*	*1/5/6/7*	parameter for regulated olake, seasonally varying flow below the threshold. Default is qpha = 102.
regvol	10^6 m^3	*regulation*	*1/5/6/7*	regulation volume for general regulation routine. Determines lowest water stage for production flow (*wmin*). (must be less than lake depth * lake area). Value for multi-basin lake is set on last lakebasin row.
wamp	*m*	*regulation*	*1/5/6/7*	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. Only for last lakebasin of multi-basin lake.
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*	*1/5/7*	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
w0adjdays	*days*	*regulation*	*1/5/6/7*	number of days over which a change in seasonal threshold for number of days over which a change in seasonal threshold for regulation with two rating curves (deltaw0) is to take place. Can also be defined in par.txt

Variable ID	Unit	Type	LdType	Description
builddam	-	*regulation*	*1/5/6/7*	date (yyyy-mm-dd) when the dam with regvol was built, before this date only the rating curve will be used for calculating outflow and at this date the lake threshold will be increased
removedam	-	*regulation*	*1/5/6/7*	date (yyyy-mm-dd) when the dam with regvol will be removed, after this date the lake threshold will be lowered (lake depth will be reduced) and only the rating curve will be used for calculating outflow
Qmean	*mm/y*	*physical property*	*1/5/7*	initial value for calculation of mean flow, can also be defined in par.txt
prodpp	*m/d*	*nutrient cycling*	*1/5/7*	parameter for internal load of Part-P
prodsp	*m/d*	*nutrient cycling*	*1/5/7*	parameter for internal load of SRP
tpmean	*mg/l*	*nutrient cycling*	*1/5/7*	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
tnmean	*mg/l*	*nutrient cycling*	*1/5/7*	mean concentration of total N (mg/l), used as initial value N concentration in lakes. Can also be defined in par.txt
tocmean	*mg/l*	*nutrient cycling*	*1/5/7*	mean concentration of OC (mg/l), used as initial value of OC concentration in lakes. Can also be defined in par.txt
sedon	*m/d*	*nutrient cycling*	*1/5/7*	sedimentation rate for ON in lakes. Can also be defined in par.txt
sedpp	*m/d*	*nutrient cycling*	*1/5/7*	sedimentation rate for PP in lakes. Can also be defined in par.txt
sedoc	*m/d*	*nutrient cycling*	*1/5/7*	sedimentation rate for OC in lakes. Can also be defined in par.txt
sedss	*m/ts*	*nutrient cycling*	*1/5/7*	sedimentation rate for SS in lakes. Can also be defined in par.txt
sedsi	*m/ts*	*nutrient cycling*	*1/5/7*	sedimentation rate for algae silica (AS) in lakes. Can also be defined in par.txt
wprodn	*kg/(m^3 d)*	*nutrient cycling*	*1/5/7*	production/degradation in water for N. Can also be defined in par.txt
wprodp	*kg/(m^3 d)*	*nutrient cycling*	*1/5/7*	production/degradation in water for P. Can also be defined in par.txt
wprodc	*kg/(m^3 d)*	*nutrient cycling*	*1/5/7*	production/degradation in water for OC. Can also be defined in par.txt.
wprodsi	*kg/(m^3 d)*	*nutrient cycling*	*1/5/7*	production/degradation of algae silica in water. Can also be defined in par.txt.
denitwl	*kg/(m^2 d)*	*nutrient cycling*	*1/5/7*	parameter for denitrification in lakes. Can also be defined in par.txt
muptn	*kg/(m^2 d)*	*nutrient cycling*	*1/5/7*	macrophyte uptake of IN in lake water. Can also be defined in par.txt
muptp	*kg/(m^2 d)*	*nutrient cycling*	*1/5/7*	macrophyte uptake of SP in lake water. Can also be defined in par.txt
t2mix	-	*physical property*	*1/5/7*	switch for using mixed lake T2 temperature on outflow of lake (0/1). Can also be defined in par.txt

Variable ID	Unit	Type	LdType	Description
sm_resop	*0-4*	*sediment management*	*1/5/7*	reservoir operation mode, used for sediment density; 1=sediment always submerged or nearly submerged, 2=normally moderate to considerable reservoir drawdown, 3=reservoir normally empty, 4=riverbed sediments
sm_mode	*0-2*	*sediment management*	*1/5/7*	reservoir sediment management methods; 0=no flush, 1=flush based on reservoir fill up, 2=flushing based on day of year
sm_dest	*0-1*	*sediment management*	*1/5/7*	reservoir sediment management methods; 0=flushed material is removed, 1=flushed material added to flow going downstream
sm_start	*-/days*	*sediment management*	*1/5/7*	threshold to start sediment flushing. For sm_mode=1 fraction of initial storage volume. For sm_mode=2 day of year.
sm_duradays	*days*	*sediment management*	*1/5/7*	parameter to regulate the rate of flushing, number of days over which to flush. For sm_mode=1 and 2.
sm_caprest	*-*	*sediment management*	*1/5/7*	parameter to regulate the rate of flushing, the fraction of the reservoir storage capacity that will be restored. For sm_mode=1 and 2.
sm_yfreq	*years*	*sediment management*	*1/5/7*	number of years between flushing. For sm_mode=2 only.

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, regulation routine parameters, and sediment management. 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)^exp*
exp	-	*all*	parameter for specific rating curve or for spillway flow of regulated olake above threshold (w0ref), equation*q = rate (w - w0)^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.
builddam	-	*all*	date (yyyy-mm-dd) when the dam with regvol was built, before this date only the rating curve will be used for calculating outflow and at this date the lake threshold will be increased
removedam	-	*all*	date (yyyy-mm-dd) when the dam with regvol will be removed, after this date the lake threshold will be lowered and only the rating curve will be used for calculating outflow
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)

Variable ID	Unit	Purpose	Description
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)
qinfdec	*m^3/s*	*all*	mean December inflow to reservoir (can be taken from a model run without reservoirs for example)
sm_resop	*0-4*	*all*	reservoir operation mode, used for sediment density; 1=sediment always submerged or nearly submerged, 2=normally moderate to considerable reservoir drawdown, 3=reservoir normally empty, 4=riverbed sediments
sm_mode	*0-2*	*all*	reservoir sediment management methods; 0=no flush, 1=flush based on reservoir fill up, 2=flushing based on day of year
sm_dest	*0-1*	*all*	reservoir sediment management methods; 0=flushed material is removed, 1=flushed material added to flow going downstream
sm_start	*-/days*	*all*	threshold to start sediment flushing. For sm_mode=1 fraction of initial storage volume. For sm_mode=2 day of year.
sm_duradays	*days*	*all*	parameter to regulate the rate of flushing, number of days over which to flush. For sm_mode=1 and 2.
sm_caprest	*-*	*all*	parameter to regulate the rate of flushing, the fraction of the reservoir storage capacity that will be restored. For sm_mode=1 and 2.
sm_yfreq	*years*	*all*	number of years between flushing. For sm_mode=2 only.

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 information about point sources. It may hold constant point sources' concentrations and discharges or, for time series of point sources, instead identification to find these in the time series files (PSTIMESeries.txt). These two types may not be mixed, which one to use is set in info.txt.

HYPE allows to separate five types of point sources, e.g. wastewater treatment plants, industries, and urban stormwater. Conceptually, all five 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, or the point source type (`ps_type`) is set to minus 1, the point source is interpreted as an abstraction instead. Abstraction can be made from the main river, the outlet lake or the aquifer below the subbasin. There can be only one abstraction from each subbasin (if several the last read will be used).

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
`psid`	-	identification of point source or abstraction given as time series (unique)
`subid`	-	id number for subbasin in which point source is located, integer < 10^8
`ps_type`	-	**For ordinary point source**: integer signifying type of point source, between 1 and 5. **For abstraction**: minus one. **For alternative tracer point source**: not used (set to zero or missing value).
`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_occonc`	*mg/l*	concentration of organic carbon in point source (irrelevant if water abstraction)

Variable ID	Unit	Description
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	*µU/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). Can be set to -9999 to add the flow without changing the temperature of the recieving water.
ps_dsiconc	*mg/l*	concentration of dissolved silica in point source (irrelevant if water abstraction)
ps_asiconc	*mg/l*	concentration of algae silica in point source (irrelevant if water abstraction)
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), main river volume and inflow (3) or aquifer (4). **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 ordinary point source**: not used (set to zero or missing value). **For point source in time series file**: (3)

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  -1      -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
```

Fourth example, time series point source: first row: a waste water point source, second row an abstraction from the main river and its inflow.

```
subid psid ps_type ps_source
```

```
567    1     1        3
668    2     -1       3
```

PSTIMESeries.txt

The time series can be daily, monthly or yearly; PSDailySeries.txt, PSMonthlySeries.txt or PSYearlySeries.txt. The file is used for introducing time series of point sources or abstractions into the model. The point sources and abstractions are defined in the file PointSourceData.txt, while the time series data is given in this file. The file is used when `readpstime` is set in info.txt

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 (-9999) are allowed for concentrations when the flow is zero, but zero concentration works as well.

The first row gives the variable names. For the first column, the date column, the name "date" can be used (may not be omitted). The second row gives which pointsource (psid in PointSourceData.txt) the column's data is given for. The date column may in this case belong to psid 0 (may not be omitted). The first column is date in format yyyy-mm-dd or yyyymmdd (or yyyy-mm, yyyymm, yyyy if monthly or yearly time series). No time is permitted. Second to last columns are data columns.

Variables that can be given are tabled below. Flow is mandatory, while concentrations is optional columns. Missing concentration variables are set to zero. Flow should be larger than or equal to zero. **Note** that the units are not always the same as for constant point sources in PointSourceData.txt.

Variable ID	Unit	Description
`flow`	m^3/s	point source discharge or abstraction
`INconc`	*mg/l*	inorganic nitrogen concentration of point source discharge
`ONconc`	*mg/l*	organic nitrogen concentration of point source discharge
`SPconc`	*mg/l*	soluble phosphorus concentration of point source discharge
`PPconc`	*mg/l*	particulate phosphorus concentration of point source discharge
`OCconc`	*mg/l*	dissolved organic carbon concentration of point source discharge
`SSconc`	*mg/l*	suspended sediment concentration of point source discharge
`AEconc`	*mg/l*	algae nitrogen concentration of point source discharge
`DSconc`	*mg/l*	dissolved silica concentration of point source discharge
`ASconc`	*mg/l*	algae silica concentration of point source discharge
`T1conc`	*uU/l*	tracer concentration of point source discharge
`T2conc`	*degree Celsius*	temperature of point source discharge

Example of PointSourceData.txt for time series point sources: first row: a waste water point source, second row an abstraction from the main river and its inflow.

```
subid psid ps_type ps_source
567   1    1       3
668   2    -1      3
```

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 and aquifers are listed row-wise; one row for each subbasin recharging an aquifer or recieving return flow from an aquifer, and one row for each aquifer. 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 1500000     1        0         0        0        0        1     1
0       0     0      0
none 2000000     2        0         0        0        0        1     1
1       0     0      0
Aqu1 3500000     0     0.15       -55       -5       -7        0     1
0 3.5E-08    10      1
none 4000000     3        0         0        0        0        1     2
0.3       0     0      0
none 3200000     4        0         0        0        0        1     2
0.7       0     0      0
Aqu2 7200000     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 has to be used for row which defines aquifer characteristics. (mandatory)
`recharge`	-	subbasin	subbasin contributes to aquifer recharge (0 = no, 1 = yes)
`retfrac`	-	subbasin	subbasin receive this fraction of the return flow from the aquifer (between 0 and 1)

Variable ID	Unit	Requirement	Description
topdepth		aquifer	depth below surface of top of aquifer (negative m) (needed for nitrogen simulation)
basedepth	*m*	aquifer	depth below surface of base of aquifer where return flow ceases (negative)
passivedep	*m*	aquifer	depth below surface to bottom of aquifer, the aquifer water volume from basedepth to passivedep is passive and do not contribute to return flow (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, can only be calibrated for lakes with the parameter set to missing value in LakeData.txt.

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)	soil water
wcwp	-	soil type	wilting point as a fraction, same for all soil layers (used if wcwp1 not given)	soil water
wcep	-	soil type	effective porosity as a fraction, same for all soil layers (used if wcep1 not given)	soil water
wcfc1	-	soil type	fraction of soil available for evapotranspiration but not for runoff, for uppermost soil layer	soil water
wcwp1	-	soil type	wilting point as a fraction, for uppermost soil layer	soil water
wcep1	-	soil type	effective porosity as a fraction, for uppermost soil layer	soil water
wcfc2	-	soil type	fraction of soil available for evapotranspiration but not for runoff, for second soil layer	soil water
wcwp2	-	soil type	wilting point as a fraction, for second soil layer	soil water
wcep2	-	soil type	effective porosity as a fraction, for second soil layer	soil water
wcfc3	-	soil type	fraction of soil available for evapotranspiration but not for runoff, for lowest soil layer	soil water
wcwp3	-	soil type	wilting point as a fraction, for lowest soil layer	soil water
wcep3	-	soil type	effective porosity as a fraction, for lowest soil layer	soil water
mperc1	$mm\ ts^{-1}$	soil type	maximum percolation capacity from soil layer 1 to soil layer 2	percolation
mperc2	$mm\ ts^{-1}$	soil type	maximum percolation capacity from soil layer 2 to soil layer 3	percolation
cmlt	$mm\ °C^{-1}\ ts^{-1}$	land use	melting parameter for snow	snow melt
cmltcorr	-	parreg	correctionfactor for melting parameter for snow (cmlt=cmlt*(1+cmltcorr))	snow melt

Name	Unit	Dependency	Description	Link
ttmp	*°C*	land use	threshold temperature for snow melt, snow density and evapotranspiration	snow melt snowfall PET
ttpd	*°C*	general	deviation from ttmp for threshold temperature for snow-/rainfall	snowfall
ttpi	*°C*	general	half of temperature interval with mixed snow- and rainfall. Interval is (ttmp+ttpd) +/- ttpi.	snow melt snowfall
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 $Q = gratk \times \left(w - wo \right)^{gratp}$	rating curve
gratp	-	general	parameter of rating curve for lake outflow $Q = gratk \times \left(w - wo \right)^{gratp}$	rating curve
grata	-	general	upstream area dependence of discharge curve for lake, if grata>0 and uparea>0 $Q = \left(gratk \times \left(uparea \right)^{grata} \right) \times \left(w - wo \right)^{gratp}$	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)	dam
w0adjdays	*days*	general	number of days over which a change in seasonal threshold for regulation with two rating curves is to take place (can also be defined in LakeData.txt)	dam
krelflood	-	general	factor for increased production flow from flood control dam	dam
kthrflood	-	general	factor for flow threshold for increased production flow from flood control dam	dam
klowflood	-	general	factor for water level threshold with production flow from flood control dam equal to inflow	dam
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

Name	Unit	Dependency	Description	Link
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
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 (default model)	P river S river
qbank	-	general	factor for sedimentation/resuspension in watercourses (sedresusp model 1)	S river

Name	Unit	Dependency	Description	Link
vpeak	-	general	adjustment factor for peak velocity across channel used in sediment and resuspension model 2	S river
suspconSS	$kg\ L^{-1}\ (m/s)^{-1}$	general	coefficient for maximum suspended concentration of SS in sediment and resuspension model 2	S river
suspexpSS	-	general	exponent for maximum suspended concentration of SS in sediment and resuspension model 2	S river
suspconPP	$kg\ L^{-1}\ (m/s)^{-1}$	general	coefficient for maximum suspended concentration of PP in sediment and resuspension model 2	P river
suspexpPP	-	general	exponent for maximum suspended concentration of PP in sediment and resuspension model 2	P river
suspconT1	$U\ L^{-1}\ (m/s)^{-1}$	general	coefficient for maximum suspended concentration of T1 in sediment and resuspension model 2	T1 river
suspexpT1	-	general	exponent for maximum suspended concentration of SS in sediment and resuspension model 2	T1 river
suspch	-	general	river channel erodability/vegetation cover modification factor (0-1) of resuspension for sediment and resuspension model 2	S river
addsusp	-	general	fraction of sediment in excess of temporary pool that can be resuspended in river for sediment and resuspension model 2	S 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
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 in lake	NP lake
muptnriv	$kg\ m^{-2}\ d^{-1}$	general	macrophyte uptake of IN in river water	NP river
muptpriv	$kg\ m^{-2}\ d^{-1}$	general	macrophyte uptake of SP in river water	NP river
muptdepriv	m	general	macrophyte uptake production depth in river	NP river
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

Name	Unit	Dependency	Description	Link
occonc0	*mg L^{-1}*	land use	starting value, organic carbon concentration in soil	
inconc0	*mg L^{-1}*	land use	starting value, inorganic nitrogen concentration in soil	NP soil
onconc0	*mg L^{-1}*	land use	starting value, organic nitrogen concentration in soil	NP soil
spconc0	*mg L^{-1}*	land use	starting value, soluble reactive phosphorus 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 fastP and humusP soil pool	NP soil
hNhalf	*m*	land use	half depth for fastN and humusN soil pool	NP soil
iniT1	*µU L^{-1}*	general	starting value in soil, concentration T1	tracer T1
iniT1sw	*µU 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). Used if not set in GeoData.txt.	rural
drydeppp	*kg km^{-2} ts^{-1}*	land use	dry deposition of PP. Deprecated, use AtmdepData.txt instead. Use PP_DD_Ln where n is the landuse number.	deposition
wetdepsp	*µg L^{-1}*	general	wet deposition of SP. Deprecated, use AtmdepData.txt instead. Use SP_WD, where the unit is mg/L.	deposition
wetdepspl	*kg km^{-2} ts^{-1}*	general	wet deposition of SP on water surfaces. Deprecated, AtmdepData.txt instead, column SP_DD_V3.	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
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

Name	Unit	Dependency	Description	Link
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
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

Name	Unit	Dependency	Description	Link
sdnsnew	*g cm^{-3}*	general	density of new-fallen snow (former snowdens0)	snow snow melt
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
snkika	*m*	land use	snow heat model, relation between snow thermal conductivity and surface heat exchange coefficient, unit is in meters, values in the range 10-100 approximately.	snow melt
whcsnow	-	general	water holding capacity of snow, typical value 0.08.	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
ocfldelx	$mm\ ts^{-1}$	general	parameter for delay of OC from runoff	C delay
ocfldele	-	general	parameter for delay of OC from runoff	C delay
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
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

Name	Unit	Dependency	Description	Link
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	ice
licetf	*°C*	general	lake ice model, freezing temperature	ice
licesndens	$g\ cm^{-3}\ ts^{-1}$	general	lake ice model, snow compaction parameter	ice
licekika	*cm*	general	lake ice model, ratio between thermal conductivity of ice and heat exchange coefficient in air	ice
licekexp	-	general	lake ice model, water temperature threshold for freeze-up	ice
licetmelt	$cm\ °C^{-1}$	general	lake ice model, melt factor for ice	ice
licewcorr	-	general	lake ice model, snowfall reduction for wind drift	ice
licessmft	-	general	lake ice model, subsurface melt fraction, temperature driven melt	ice
licessmfr	-	general	lake ice model, subsurface melt fraction, radiation driven melt	ice
licermelt	-	general	lake ice model, radiation melt efficiency (fraction of radiation used for melt at T>0)	ice
licebupo	-	general	lake ice model, breakup porosity	ice
liceqhw	W/m^2	general	lake ice model, heat flux from water to ice	ice
ricettf	*°C*	general	river ice model, water temperature threshold for freeze-up	ice
ricetf	*°C*	general	river ice model, freezing temperature	ice
ricesndens	$g\ cm^{-3}\ ts^{-1}$	general	river ice model, snow compaction parameter	ice
ricekika	*cm*	general	river ice model, ratio between thermal conductivity of ice and heat exchange coefficient in air	ice
ricekexp	-	general	river ice model, water temperature threshold for freeze-up	ice
ricetmelt	$cm\ °C^{-1}$	general	river ice model, melt factor for ice	ice
ricermelt	-	general	river ice model, radiation melt efficiency	ice
ricessmft	-	general	river ice model, subsurface melt fraction, temp	ice
ricessmfr	-	general	river ice model, subsurface melt fraction, radiation	ice
ricebupo	-	general	river ice model, breakup porosity	ice
riceqhmn	W/m^2	general	river ice model, (min) heat flux from water to ice at waterflow	ice
riceqhmx	W/m^2	general	river ice model, (max) heat flux from water to ice at waterflow	ice
ricecwi	-	general	river ice model, heat exchange coefficient between stream flow and river ice	ice
fscmax	-	general	maximum fractional snow cover area	snow cover
fscmin	-	general	minimum fractional snow cover area	snow cover

Name	Unit	Dependency	Description	Link
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.	
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

Name	Unit	Dependency	Description	Link
incorr	-	wqparreg	*super-parameter*, regional correction factor for parameter governing inorganic nitrogen: $par = par \times \left(1 + incorr\right)$ for degradhn (except for glaciers) 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 (except for glaciers) 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 (for erosion model 0), dissolhP (except for glaciers), fastP0, humusP0, and partP0	
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

Name	Unit	Dependency	Description	Link
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
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

Name	Unit	Dependency	Description	Link
spdecaq, ppdecaq, ondecaq, ocdecaq, ssdecaq, aedecaq, t1decaq	*days*	general	half time of substance exponential decay in aquifer for substances SP, PP, ON, OC, SS, AE, and T1	aquifer
optonoff	-	general	switch (0/1) for using general parameters opt1-opt8 instead of data from FloodData.txt (0=do not use opt1-opt8, 1=use opt1-opt8, 2=use opt1-opt4, 3=use opt5 and opt8, 4=use opt6-opt7)	
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
T1expdec	*days*	general	half-life of T1 for exponential decay. 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
T1release	mm^{-1}	general	release of T1 from above soil pool. Typically the pool consist of manure.	tracer T1 travel time soil model
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

Name	Unit	Dependency	Description	Link
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
T1decay	*units of totref*	general	half time for exponential decay of tracer for reference time of travel (totref)	travel time soil model
T1timeot	*days*	land use	time of travel of tracer T1 from soil to nearest stream	travel time soil model
t1load1f, t1load2f, t1load3f	-	general	fraction of soil load of tracer T1 that is to be added to soil layer 1-3, default is that all goes to the surface pool	travel time soil model
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.	lake
ilratk	-	ilakeregion	parameter of rating curve for ilake outflow (rate), replaces gratk if above zero	lake
ilratp	-	ilakeregion	parameter of rating curve for ilake outflow (exponent), replaces gratp if above zero	lake
illdepth	*m*	ilakeregion	depth for ilakes	lake
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.	lake
olratk	-	olakeregion	parameter of rating curve for outlet lake outflow (rate), replaces gratk if above zero	lake
olratp	-	olakeregion	parameter of rating curve for outlet lake outflow (exponent), replaces gratp if above zero	lake
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
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

Name	Unit	Dependency	Description	Link
`erodexp`	-	general	erosion model 1 erosion precipitation dependent factor (exponent)	erosion
`erodindex`	-	general	erosion model 1 scaling of subbasin erosion index	erosion
`erodmon`	-	monthly	correction factor for soil erosion by erosion model 1: erosion=(1+erodmon)*erosion	P erosion and S erosion
`eroddecay`	ts^{-1}	general	time constant of removal of eroded sediment (PP and SS)	P erosion and S 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 (can also be defined in LakeData.txt)	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
`wltmpexp`	-	general	exponent in temperature dependence of macrophype nutrient uptake IN,SP for iwet and owet	wetlands

Name	Unit	Dependency	Description	Link
hygeomf	-	general	exponent to calculate river depth with hydraulic geometry	main river
hygeomc	-	general	rate to calculate river depth with hydraulic geometry	main river
hygeomk	-	general	exponent to calculate river velocity with hydraulic geometry	main river
hygeomm	-	general	rate to calculate river velocity with hydraulic geometry	main river
ricew0por, rivew1por	*fraction*	general	ice porosity thresholds for change between summer and winter river rating curve	main river
ricew0ice, ricew1ice	*cm*	general	ice thickness thresholds for change between summer and winter river rating curve	main river
wsfluse	-	land use	Winstral coefficient for snowfall distribution model	snowfall
wsfscale	-	general	Winstral coefficient for snowfall distribution model	snowfall
wsfbias	-	general	Winstral coefficient for snowfall distribution model	snowfall
sfdmax	-	general	maximum allowed snowfall distribution (0-1)	snowfall
sfdlim	-	general	fraction of subbasin area with snowfall for snowfall distribution to be applied	snowfall
numdir	-	general	number of wind directions used for snowfall distribution model (4 or 8)	snowfall
logsatmp	-	soil type	coefficient in unfrozen soil water content function	frozen soil
bcosby	-	soil type	coefficient in unfrozen soil water content function	frozen soil
fzsexpand	-	soil type	frozen soil water volume expansion effect on runoff	frozen soil
inrelease, onrelease, sprelease, pprelease, ocrelease, ssrelease, aerelease. dsrelease, asrelease	mm^{-1}	general	release parameter for pool on soil to dissolved substance (IN=inorganic nitrogen, ON=organic nitrogen, SP=soluble phosphorus, PP=particulate phosphorus, OC=organic carbon, SS=suspended substances, AE=algae nitrogen, DS=dissolved silica, AS=algae silica)	travel time soil model
indecay, ondecay, spdecay, ppdecay, ocdecay, ssdecay, aedecay, dsdecay, asdecay	*days*	general	half time for exponential decay of substance for reference time of travel for model (totref) (IN=inorganic nitrogen, ON=organic nitrogen, SP=soluble phosphorus, PP=particulate phosphorus, OC=organic carbon, SS=suspended substances, AE=algae nitrogen, DS=dissolved silica, AS=algae silica)	travel time soil model
totref	-	general	reference time of travel corresponding to the half life time of travel time soil model. Default is 1.	travel time soil model

Name	Unit	Dependency	Description	Link
intimeot, ontimeot, sptimeot, pptimeot, octimeot, sstimeot, aetimeot, dstimeot, astimeot	-	land use	time of travel relative to reference of substance from soil to nearest stream (IN=inorganic nitrogen, ON=organic nitrogen, SP=soluble phosphorus, PP=particulate phosphorus, OC=organic carbon, SS=suspended substances, AE=algae nitrogen, DS=dissolved silica, AS=algae silica)	travel time soil model
totexp0	-	general	exponent of the time of travel dependence of exponential decay for substances in soil pool on soil	travel time soil model
totexpsl1, totexpsl2, totexpsl3	-	general	exponent of the time of travel dependence of exponential decay for substances in soil layer 1-3	travel time soil model
inload1f, inload2f, inload3f	-	general	fraction of soil load of inorganic nitrogen that is to be added to soil layer 1-3, default is that all goes to the surface pool	travel time soil model
onload1f, onload2f, onload3f	-	general	fraction of soil load of organic nitrogen that is to be added to soil layer 1-3, default is that all goes to the surface pool	travel time soil model
spload1f, spload2f, spload3f	-	general	fraction of soil load of soluble phosphorus that is to be added to soil layer 1-3, default is that all goes to the surface pool	travel time soil model
ppload1f, ppload2f, ppload3f	-	general	fraction of soil load of particulate phosphorus that is to be added to soil layer 1-3, default is that all goes to the surface pool	travel time soil model
ocload1f, ocload2f, ocload3f	-	general	fraction of soil load of organic carbon that is to be added to soil layer 1-3, default is that all goes to the surface pool	travel time soil model
ssload1f, ssload2f, ssload3f	-	general	fraction of soil load of suspended sediment that is to be added to soil layer 1-3, default is that all goes to the surface pool	travel time soil model
aeload1f, aeload2f, aeload3f	-	general	fraction of soil load of algae nitrogen that is to be added to soil layer 1-3, default is that all goes to the surface pool	travel time soil model
dsload1f, dsload2f, dsload3f	-	general	fraction of soil load of dissolved silica that is to be added to soil layer 1-3, default is that all goes to the surface pool	travel time soil model
asload1f, asload2f, asload3f	-	general	fraction of soil load of algae silica that is to be added to soil layer 1-3, default is that all goes to the surface pool	travel time soil model
srbeta	-	general	coefficient in surface runoff optional model	surface runoff
sralpha	-	general	coefficient in surface runoff optional model	surface runoff
srgamma	-	general	coefficient in surface runoff optional model	surface runoff
srnlayer	-	general	number of soillayers to consider in surface runoff optional model	surface runoff
macfrac	-	general	fraction of surface runoff that goes to macro pores in surface runoff optional model	surface runoff
weathrate	$mg\ m^{-3}\ d^{-1}$	soil type	silica weathering rate	silica

Name	Unit	Dependency	Description	Link
weathdep	*m*	general	depth where the weathering activity is half of that at the surface	silica
weathkt	*J mol^{-1}*	general	weathering temperature dependence parameter (rock activation energy)	silica
inisi	*mg L^{-1}*	general	starting value in lakes, concentration of DSi	silica
wprodsi	*kg m^{-3} d^{-1}*	general	production/decay of algae silica in surface water (can also be defined in LakeData.txt)	silica
plimsi	*mg P L^{-1}*	general	concentration of TP deducted from concentration in water when calculating half-saturation factor in the decay/production routine for algae Si production	silica
sitmpexp	-	general	exponent of temperature dependence of the mineralization/production routine for algae Si production	silica
sedsi	*m ts^{-1}*	general	sedimentation velocity of algae silica in lakes (can also be defined in LakeData.txt)	silica
lseddens	*kg m^{-3}*	general	lake sediment density	siltation
remdamdays	*days*	general	number of days before a dam is removed that the threshold will start to decrease	dams

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.

The example below shows entries for regionalizing two parameters (`tcalt` and `cevpcorr`) in a model setup where there are three groups of catchments and ten catchment descriptors. Except for the intercept only catchment descriptors 8, 9 and 10 are used in the equation to calcualte the parameter values.

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 . 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 i^{th} row shows the group number of the i^{th} subbasin in the same order as in GeoData.txt. The file has no heading, and no extra columns are allowed.

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

```
1
1
2
...
```

Outregions.txt

This file contains information about output regions. Output regions are used to calculate the average for other (larger) areas from subbasin results, e.g. for 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 overlap 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
...
```

LeakNN_SLCNNN.txt

File with rootzone leakage concentration for each land class. The concentration is provided as average daily mean as one constant or as typical monthly values. One file per substance and class which is specified as special class 6 (rootzone leakage soilmodel) is needed, except for T2. NN in the file name stands for the substance code (IN=inorganic nitrogen, ON=organic nitrogen, SP=soluble phosphorus, PP=particulate phosphorus, OC=organic carbon, SS=suspended sediments, AE=algae nitrogen, DS=dissolved silica, AS=algae silica, T1=tracer) and NNN for the slc number. Unit is mg/L for nutrients and other substances except for T1, which has the general unit uU/L.

The rootzone leakage of classes is used when modelling soil substances with the rootzone leakage model. For this model concentration is applied to all water leaving the rootzone. Processes are simulated in the third soil layer, and there concentration can decay with a rate depending on substance.

The file comes in two versions, one for each of modeloption soilleakage 4 and 5. Soilleakage model 4 uses constant leakage concentration, while soilleakage model 5 has typical monthly concentrations for the simulation period. For both file types the first row is headings. The first column is subid, the second to thirteenth column is monthly values or in the case of constant concentration the second column hold these. If T2 is simulated it does not use/need a file. The file is located in the `forcingdir` folder (which is set in info.txt).

Example of file for soilleakage model 5; LeakIN_SLC001.txt:

```
SUBID   1    2    3    4    ...       12
101 0    1    1    0
202 1    1    1    0
203 0    2    2    2
...
```

LoadNN_SLCNNN.txt

File with excess load for each land class. The load is provided as average daily mean load in a monthly time series. One file per substance and class is needed, except for T2 and water classes. NN in the file name stands for the substance code (IN=inorganic nitrogen, ON=organic nitrogen, SP=soluble phosphorus, PP=particulate phosphorus, OC=organic carbon, SS=suspended sediments, AE=algae nitrogen, T1=tracer) and NNN for the slc number. Unit is kg/km2/d for nutrients and OC, SS, AE. T1 has the general unit U/km2/d.

The excess load of classes is used when modelling soil substances with the travel time soil model. For this model load is applied, substances released to water and both load and dissolved substances decay with a rate depending on substance, class, soil layer etc.

The file comes in two versions, one for typical monthly loads and one for time series of monthly loads. The two versions can not be combined in the same model setup. Soilleakage model 2 and 5 uses typical monthly loads, while soilleakage model 3 has time series of monthly load for the simulation period. Soilleakage model 4 uses constant loads, and these are read from a file with the the format of the first version with only one column with values. For both file types the first row is headings. For version 1, the first column is subid, the second to 13th column is monthly values. For version 2, the first column is time (year-month), the second column and onward is subbasins (subid). The data are monthly values, either for the month of this year or for this month every year. If T2 is simulated it does not use/need a load-file. If for soilleakage model 3 data are lacking for year-months in the beginning of the simulation, the first available year of data is used to fill up the space during the upspin period. The file is located in the `forcingdir` folder (which is set in info.txt).

Example of first version of file; LoadIN_SLC001.txt:

```
SUBID   1    2    3    4    ...       12
101 0    1    1    0
202 1    1    1    0
203 0    2    2    2
...
```

Example of second version of file; LoadIN_SLC001.txt:

```
DATE    1    34    195    202    207    322
2002-01 0    1    1    0    3    0
2002-02 0    1    1    0    3    0
2002-03 0    2    2    0    3    0
...
```

RiverRatingCurveData.txt

This file contains data on rating curves used to calculate water level in main river from the flow. Several alternative methods can be used, see River rating curve.

RiverRatingCurveData.txt is a tab-separated file located in the `modeldir` folder. The file hold one rating curve on each row. 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 eleven 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 snippet of a *RiverRatingCurveData.txt* file structure, showing a single rating curve for subbasin 201 and two rating curves for subbasin 202, one for free flow and one for ice-conditions, default ice condition rating curve for subbasin 203 and sectorial rating curve for subbasin 204:

```
SUBID TYPEofRRC W0  K   P   ICESEASON WMIN WMAX
201   1         0.5 2   1.5 0         0    0
202   2         0.5 2   1.5 0         0    0
202   2         0   1.5 1.5 1         0    0
203   2         0   1.5 1.5 0         0    0
204   3         0   1.5 1.5 0         0    10
204   3         0   11. 1.  0         10   100
```

The table below describes the columns of *RiverRatingCurveData.txt* read by HYPE.

Variable ID	Unit	TypeOfRRC	Description
SUBID	-	*all*	Subbasin id for the location of main river with this rating curve.
TYPEofRRC	-	*0-3*	The type of river rating curve. Alternatives are; 1 = a single rating curve, 2 = different curves used for ice- and icefree-conditions, give one for icefree-conditions and one for ice-conditions, or give only one curve for icefree-conditions, then ice-condition curve has k same as icefree and p=1, 3 = sectorial curve; different parameters for different water levels, and 0 = missing, no water level is calculated.
w0ref	*m*	*1,2(only ice-free),3*	level coefficient of rating curve equation; $q=k*(w-w0)^p$, in reference system of river water level
k	-	*all*	rate coefficient in rating curve equation (*k*); $q=k*(w-w0)^p$
p	-	*all*	exponent of rating curve equation (*p*); $q=k*(w-w0)^p$
iceseason	-	*2*	code for season rating curve; 0 = valid for icefree conditions, 1 = valid for ice conditions (optional)
wmin	*m*	*3*	Minimum water level this curve is valid in reference system of river water level (m) (optional)
wmax	*m*	*3*	Maximum water level this curve is valid in reference system of river water level (m) (optional)
unitconv	*?*	*all*	factor for transformation of unit from m to local gauge's unit, e.g. 100 cm/m (optional)

Variable ID	Unit	TypeOfRRC	Description
gaugezero	*m*	*all*	location of zero of local reference system (given in reference system used for w0ref) (optional)

AtmdepData.txt / AtmdepData_yyyymmdd[HHMM].txt

This file contains atmospheric depostion of all substances but T2. The deposition may be given as a dry deposition load or as a wet deposition concentration. The deposition is given for each subbasin, and can be further divided into different values for landuse/vegetation or time. T2 temperature is set from air temperature (T2 of precipitation).

The default is to use the file without date-time stamp and this file will be used up to the first specified date to change the atmospheric deposition. The dates which define when the atmospheric deposition will change is given in info.txt. At these dates, new atmospheric deposition is read from the file with the date-time stamp. The atmospheric deposition may change up to 10 times during a simulation.

AtmdepData.txt is a tab-separated file located in the `modeldir` folder. Subbasins are listed row-wise. The first row contains a column header with variable names. See below how variable names are constructed. Variable names are not case-sensitive. 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. The unit of the deposition values are [mg/l] for wet deposition and [kg/km2/timestep] for dry deposition, with the exception for T1 which may have different units. The corresponding units for T1 in general unit U is [uU/l] and [U/km2/timestep].

The variable named are constructed as a combination of letter codes read consequtively with an underscore in between. The combination has maximum of four components.

1. substance; the substance two letter code (see first part of table below)
2. deposition type; DD for dry deposition, WD for wet deposition
3. time dependence; monthly variation given as MX, where X is month 01-12. Skip for a constant value.
4. landuse/vegetation dependence; vegetation type dependence given as V1-V3, where 1=open,2=forest and 3=water. Alternatively landuse given as LX, where X is the landuse number. Skip for a constant value. The classes' vegetation type and land use are given in GeoClass.txt or ClassData.txt.

Example of headings, a few commonly used columns: **IN_DD_V1** - dry deposition of inorganic nitrogen for open land, **IN_DD_V2** - dry deposition of inorganic nitrogen for forest land, **IN_DD_V3** - dry deposition of inorganic nitrogen for water, **IN_WD** - wet deposition of inorganic nitrogen

Table. Substance two letter code used in HYPE. First part for simulated species, last part for additonal output variabels combinations.

code	simulated substance
IN	inorganic nitrogen
ON	organic nitrogen
SP	soluble reactive phosphorus
PP	particulate phosphorus
OC	organic carbon
SS	suspended sediment
AE	algae
DS	dissolved silica
AS	algae silica

code	simulated substance
T1	tracer
T2	water temperature (not used in AtmdepData.txt)
code	**combined substances**
TN	total nitrogen = IN+ON
TP	total phosphorus = SP+PP
TS	total sediment = SS+20*AE
SI	total silica = DS+AS

state_saveyyyymmdd[HHMM]

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 forcingdir folder. There is one file per time step with saved states: state_saveyyyymmdd[HHMM].txt/tgz. 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.State files can be in text format (state_saveyyyymmdd[HHMM].txt) (formatted or unformatted) or compressed with gzip by the tar archive software (state_saveyyyymmdd[HHMM].tgz). The unformatted or compressed options are set in info.txt, while the formatted text file option is the default. They can be used for Windows10 and Linux.

The first data of the state_save-file is 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 where some of them are using starting states.

reset_state_save.txt

File containing the initial state values of solid nutrient soil states (i.e. fastN, humusN, fastP, humusP, partP, fastC, humusC, partT1, partT1sf). It is used to keep these states stable during long simulations.

The file is unformatted to be faster to read and write. The file is written by HYPE by the simulation that will use it. The use of the reset state function is set in info.txt.

nnnnnn_YYYYMMDD[HHMM].bin

These binary files hold an ensemble of states for data assimilation. They are used to restart the data assimilation from a previous saved state. To use the files set `indaensstate` in info.txt. For this version of saved ensemble each file holds one variable (a model state or a forcing or auxiliary variable) and nnnnnn is counted upward currently starting from 100201. Alternatively the states can be saved in three files (ensXstates_yyyymmdd[HHMM].bin, ensFstates_yyyymmdd[HHMM].bin, ensAstates_yyyymmdd[HHMM].bin). Which version of file format to use is set in AssimInfo.txt by `G_USEBINX` and `G_USEBINFA`.

The files to be used as starting states are located in the `forcingdir`. The files written for later use as starting states are found in the `resultdir`.

In addition files of the same format without date-time stamp can be found in the `resultdir`. These files are used during a simulation to temporary hold the ensemble states. There is an option in AssimInfo.txt to save the ensemble states to binary files instead of keeping them in memory.

ensXstates_YYYYMMDD[HHMM].bin

This binary file holds an ensemble of model states for data assimilation. They are used to restart the data assimilation from a previous saved state. To use the files set `indaensstate` in info.txt. For this version of saved ensemble three files are used (ensXstates_yyyymmdd[HHMM].bin, ensFstates_yyyymmdd[HHMM].bin, ensAstates_yyyymmdd[HHMM].bin); one for model states, one for forcing variables and one for auxiliary variables. Alternatively the states can be saved as one file for each variable (nnnnnn_yyyymmdd[HHMM].bin). Which version of file format to use is set in AssimInfo.txt by `G_USEBINX` and `G_USEBINFA`.

The files to be used as starting states are located in the `forcingdir`. The files written for later use as starting states are found in the `resultdir`.

In addition files of the same format without date-time stamp can be found in the `resultdir`. These files are used during a simulation to temporary hold the ensemble states. There is an option in AssimInfo.txt to save the ensemble states to binary files instead of keeping them in memory.

ensFstates_YYYYMMDD[HHMM].bin

This binary file holds an ensemble of forcing variables for data assimilation. They are used to restart the data assimilation from a previous saved state. To use the files set `indaensstate` in info.txt. For this version of saved ensemble three files are used (ensXstates_yyyymmdd[HHMM].bin, ensFstates_yyyymmdd[HHMM].bin, ensAstates_yyyymmdd[HHMM].bin); one for model states, one for forcing variables and one for auxiliary variables. Alternatively the states can be saved as one file for each variable (nnnnnn_yyyymmdd[HHMM].bin). Which version of file format to use is set in AssimInfo.txt by `G_USEBINX` and `G_USEBINFA`.

The files to be used as starting states are located in the `forcingdir`. The files written for later use as starting states are found in the `resultdir`.

In addition files of the same format without date-time stamp can be found in the `resultdir`. These files are used during a simulation to temporary hold the ensemble states. There is an option in AssimInfo.txt to save the ensemble states to binary files instead of keeping them in memory.

ensAstates_YYYYMMDD[HHMM].bin

This binary file holds an ensemble of auxiliary variables for data assimilation. Auxiliary variables are the variables set as output variables from HYPE. The file are used to restart the data assimilation from a previous saved state. To use the files set `indaensstate` in info.txt. For this version of saved ensemble three files are used (ensXstates_yyyymmdd[HHMM].bin, ensFstates_yyyymmdd[HHMM].bin, ensAstates_yyyymmdd[HHMM].bin); one for model states, one for forcing variables and one for auxiliary variables. Alternatively the states can be saved as one file for each variable (nnnnnn_yyyymmdd[HHMM].bin). Which version of file format to use is set in AssimInfo.txt by `G_USEBINX` and `G_USEBINFA`.

The files to be used as starting states are located in the `forcingdir`. The files written for later use as starting states are found in the `resultdir`.

In addition files of the same format without date-time stamp can be found in the `resultdir`. These files are used during a simulation to temporary hold the ensemble states. There is an option in AssimInfo.txt to save the ensemble states to binary files instead of keeping them in memory.

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 forcingdir 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 forcingdir 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 file may have comment rows in the beginning of the file. These rows have to begin with `!!`. The first row read 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 forcingdir 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 file may have comment rows in the beginning of the file. These rows have to begin with `!!`. The first row read 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 forcingdir 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 rows of the file may be comment rows. They begin with '!!' to identify them as comment rows to be skipped when reading the file. The first row after the comment rows gives which subbasin (subid in GeoData.txt) the column's data is given for. This 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 `forcingdir` folder set in info.txt. 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(s) may be commment rows. These rows have to start with !!. At least one comment row is needed. The first row, not a comment 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 **here**. They are a selection of the complete HYPE variables.

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 `prec` and for the flow concentrations `rout`. Similarly variable values in *Xobs.txt* represent either averages, weighted averages, or sums over the timestep.

Wobs.txt

The *Wobs.txt* file may holds observations of outlet lake water stage for selected points in the model domain. The water stage observations may alternatively be given in Xobs, but not in both files. The subbasin id (`subid` from GeoData.txt) is used to couple the observations to the model. When refering to observed water stage for output or criterion calculation the HYPE variable ID `wstr` correspond to the data of the *Wobs.txt* file.

The file is located in the forcingdir folder set in info.txt. Water stage (*m*) 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 rows of the file may be comment rows. They begin with '!!' to identify them as comment rows to be skipped when reading the file. The first row after the comment rows 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 the format `yyyy-mm-dd [HH:MM]`. If set in info.txt that matlab-format should be read (`readformat 1`) the date format is instead `yyyymmdd[HHMM]`. The second to last columns are observations for selected subbasins (i.e. not all subbasins are required).

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 `forcingdir` 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(s) may be comment rows. These rows have to start with !!. At least one comment row is needed. The first row, not a comment 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 **here**. They are a selection of the complete 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 give result that is not meaningful (e.g. `rgwstr`).

Column **Agg.**, in table for Xobs variables, 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 *Xoregobs.txt* represent either averages, weighted averages, or sums over the timestep.

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 `forcingdir` 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 file may have comment rows in the beginning of the file. These rows have to begin with `!!`. The first row read 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 `forcingdir` 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 file may have comment rows in the beginning of the file. These rows have to begin with `!!`. The first row read 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 `forcingdir` 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 file may have comment rows in the beginning of the file. These rows have to begin with `!!`. The first row read 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 forcingdir 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 file may have comment rows in the beginning of the file. These rows have to begin with `!!`. The first row read 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 forcingdir 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 file may have comment rows in the beginning of the file. These rows have to begin with `!!`. The first row read 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 `forcingdir` 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 file may have comment rows in the beginning of the file. These rows have to begin with `!!`. The first row read 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.

UWobs.txt

The u-component of wind is an optional forcing data. It is westerly wind and goes west to east. It can be used for calculation of snowfall distribution.

The file is located in the `forcingdir` folder. U-component of wind speed (*m/s*) is given for all time steps. No missing values may exist (program won't check!). The *UWobs-file* is read only if `readuwobs` is set in info.txt.

The file may have comment rows in the beginning of the file. These rows have to begin with `!!`. The first row read 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 `uwobsid` or `subid`. If `uwobsid` is used, several subbasins may use the same wind time series. `subid` is defined in GeoData.txt. The order of subbasins in *UWobs.txt* does not have to be same as in GeoData.txt. `uwobsid` may be defined in ForcKey.txt.

Example snippet of *UWobs.txt* file:

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

UWobs_nnn.txt holds u-component wind forcing data for sequence with seqnr nnn. For seqnr 0 *UWobs.txt* is used.

VWobs.txt

The v-component of wind is an optional forcing data. It is the southerly wind and goes south to north. It can be used for calculation of snowfall distribution.

The file is located in the `forcingdir` folder. V-component of wind (*m/s*) is given for all time steps. No missing values may exist (program won't check!). The *VWobs-file* is read only if `readvwobs` is set in info.txt.

The file may have comment rows in the beginning of the file. These rows have to begin with `!!`. The first row read 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 `vwobsid` or `subid`. If `vwobsid` is used, several subbasins may use the same wind time series. `subid` is defined in GeoData.txt. The order of subbasins in *VWobs.txt* does not have to be same as in GeoData.txt. `vwobsid` may be defined in ForcKey.txt.

Example snippet of *VWobs.txt* file:

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

VWobs_nnn.txt holds v-component wind forcing data for sequence with seqnr nnn. For seqnr 0 *VWobs.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 `forcingdir` 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(s) may be commment rows. These rows have to start with !!. At least one comment row is needed. The first row, not a comment 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 `forcingdir` 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(s) may be commment rows. These rows have to start with !!. At least one comment row is needed. The first row, not a comment 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.

The observation test can take a long time if the files are big. For a small model (nsub=500) or a big model (nsub=40000) with short forcing data series (a couple of months) the tests took around 4 s, while with 60 years of forcing the big model took 4 min for running the tests.

The test file is divided into the above sections and have in the end 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. A list of tests available can be found under the code description Test list.

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. The date and time of the file name is for the creation of the file.

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. The above mentioned information from the simass-file can also be found in the hyss_yymmddHHMM.log. Both files also give the value of the objective function, but in the simass-file information of the individual criterion is written.

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 %)
`Average KGE`	AKG	average of KGE for all subbasins with observations
`Average scalKGE`	ASK	average of KGE rescaled to the interval [-1,1] by eq. KGE/(2-KGE)
`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

Criterion	Code	Description
Spatial RE	-	spatial relative error calculated using annual means for all subbasins (requires at least 5 years and 5 subbasins with data)
Spatial Bias	SMB	spatial mean absolute scaled bias on log transformed values
Spatial RMSE	SNR	spatial root mean square 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
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 unique combination of simulated and recorded variable among the 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)

Header	Unit	Description
NRMSE	*in first row*	normalised root mean square error
NSEW	-	Nash-Sutcliffe efficiency adjusted for bias
Nrec	-	number of observations

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   Nrec
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   783
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   1052
```

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. In that comment 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 content of 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:

```
!! model=5.13.1; variable=cout; timestep=year; unit=m3/s; comment=Table with
comp outflow subbasi in m3/s for map drawing;
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 content of 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:

```
!! model=5.13.1; variable=cout; timestep=day; unit=m3/s; comment=Timeseries
of comp outflow subbasi 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_001.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
`RzLay3_nn`	*kg/year*	load in runoff from root zone, including soil runoff, tile drainage, surface runoff, and percolation to layer 3, land SLC classes only
`RfLay3_nn`	*kg/year*	load in runoff from third soil layer to local stream, including soil runoff and tile drainage, 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)
`Point1`	*kg/year*	gross load in point source type 1, see description in PointSourceData.txt
`Point2`	*kg/year*	gross load in point source type 2, see description in PointSourceData.txt
`Point3`	*kg/year*	gross load in point source type 3, see description in PointSourceData.txt
`Point4`	*kg/year*	gross load in point source type 4, see description in PointSourceData.txt
`Point5`	*kg/year*	gross load in point source type 5, 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)
`Wtrans`	*kg/year*	load from water transfer (given in MgmtData) into main river
`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

Variable ID	Unit	Description
B	*kg/year*	part of load to local stream from all SLC classes that bypasses the internal wetland
C	*kg/year*	part of load to local stream from all SLC classes that goes into the internal wetland
D	*kg/year*	load in fraction of load to local stream that has passed through internal wetland
E	*kg/year*	load to local stream after internal wetlands
F	*kg/year*	load in local stream after internal wetlands and from rural household source local stream fraction (E + RuralB)
G	*kg/year*	load in local stream (F) after including the effect of local river wetlands (defined in GeoData.txt, see also wetlands in model description)
H	*kg/year*	load after passage of local streams but before internal lakes
I	*kg/year*	load in fraction of local stream discharge that bypasses local lakes (see variable `icatch` in GeoData.txt
J	*kg/year*	load in fraction of local stream discharge that passes through local lakes (see variable `icatch` in GeoData.txt
K	*kg/year*	load in fraction of local stream discharge that has passed through local lakes
L	*kg/year*	net load in local stream after local lake passage (J + K)
MA	*kg/year*	total load to main river, consisting of: net load of local stream, upstream load, point source loads (`Urban1-3`), water transfers (`Wtrans`) and groundwater load (`Rgrwmr`)
M	*kg/year*	total load to main river, consisting of: net load of local stream, upstream load, point source loads (`Urban1-3`), water transfers (`Wtrans`) and groundwater load (`Rgrwmr`), as well as abstractions for irrigation etc.
N	*kg/year*	load to main river after including the effect of main river wetlands (defined in GeoData.txt, see also wetlands in model description)
O	*kg/year*	load in main river, after river passage (river nutrient proesses)
P	*kg/year*	load in main river, after outlet wetland
Q	*kg/year*	load in main river with added inflow from lakebasins and regional ground water sources (`Rgrwmr`)
R	*kg/year*	net load in main river after outlet lake passage
S	*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 settings 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.

The optpar.txt file may also be used for parameter ensemble simulation (`parensemble` in info.txt), to know which model parameters to use. The parameter ensemble may use the parameters earlier found by calibration.

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-, map-, , regional-, or , class-files) for all ensembles in Monte Carlo simulation (`MC`, `BP`, or `DE`)
`AS`	run parameter ensemble simulations with parameters found in allsim.txt
`BS`	run parameter ensemble simulations with parameters found in bestsims.txt

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.

Code	Argument	Default value	Description
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).
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 generation of all populations plus one row (first row in the file) with median values of this last generation. **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
mdkg	median of Kling-Gupta efficiency for subbasins
akg	average of Kling-Gupta efficiency for subbasins
asckg	average of Kling-Gupta Efficiency rescaled to the interval [-1,1]
mar	average of absolute relative bias for subbasins (Note: fraction. not %)
mdnr	median of normalised RMSE for subbasins
mnw	average of Nash-Sutcliffe efficiencies adjusted for bias for subbasins
snr	spatial root mean square error
smb	spatial mean absolute scaled bias on natural log transformed values
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,ak
g,asckg,mar,mdnr,mnw,snr,smb,numrc,nummc,cevp,wcfc,rrcs1,rivvel,damp
1,-0.20237763,0.70495784,-9999,0.20237763,35.02048492,-9999,-0.27154529,-0.2
5385103,-9999,-9999,-9999,-9999,0.18291715,-9999,-0.41173482,0.65588838,0.29
082537,0.32529864,0.21824078,0.29653594,0.12578303,0.37322822,-9999,-9999,87
60,24,0.10426278,0.07934671,0.23716953,1.46884918,0.12412609
```

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
mdkg	median of Kling-Gupta efficiency for subbasins
akg	average of Kling-Gupta efficiency for subbasins
asckg	average of Kling-Gupta Efficiency rescaled to the interval [-1,1]
mar	average of absolute relative bias for subbasins (Note: fraction. not %)
mdnr	median of normalised RMSE for subbasins
mnw	average of Nash-Sutcliffe efficiencies adjusted for bias for subbasins
snr	spatial root mean square error
smb	spatial mean absolute scaled bias on natural log transformed values
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.