HYPE file reference

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

The tables in the sections below contain file names and short descriptions of mandatory and optional input and output files for HYSS/HYPE, grouped by content type. More detailed descriptions on format and requirements for each file are linked from there.

Input files marked *mandatory* in the tables below must exist for a basic HYPE setup. Other files are required only for optional model components 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 "user interface" of HYPE where all options are specified for a model run
- **par.txt**, which holds all calibration parameters
- **HYPE variables**, a listing of variable names used for HYPE inputs and outputs

Setup files

Setup files contain information about a HYPE model domain, model parameters, and model options.

File name	Requirement	Description
filedir.txt	optional	provides location of info.txt
info.txt	mandatory	HYPE user interface, contains model options
pmsf.txt	optional	partial model setup, defines part of model domain to simulate
update.txt	optional	for updating of model variables with observations
GeoClass.txt	mandatory	SLC class definition (HRUs)
GeoData.txt	mandatory	subcatchment characteristics and flow connections between them
BranchData.txt	optional	bifurcations in the flow network
LakeData.txt	optional	properties of specific lakes
DamData.txt	optional	properties of specific regulated lakes, extends LakeData.txt
CropData.txt	optional	information about crops and vegetation
PointSourceData.txt	optional	information about point sources and water abstraction
MgmtData.txt	optional	information about irrigation
AquiferData.txt	optional	regional aquifer definition
FloodData.txt	optional	floodplain definition
GlacierData.txt	optional	glacier definition
par.txt	mandatory	calibrated model parameters
ForcKey.txt	optional	link list between subcatchment IDs and forcing data IDs, as well as temperature observation elevations

File name	Requirement	Description
ForcData.txt	optional	link list between subcatchment IDs and temperature observation IDs, as well as temperature observation elevations
state_save	optional	files containing saved model states for model initialisation
reg_par.txt	optional	file containing regional regression coefficients, for regional parameter estimation method
CatchDes.txt	optional	list of catchment descriptors, for regional parameter estimation method
CatchGroup.txt	optional	list of catchment group membership of all subbasins, for regional parameter estimation method

Observation data files

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

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

File name	Requirement	Description
Pobs.txt	mandatory	precipitation forcing
Tobs.txt	mandatory	air temperature forcing
Qobs.txt	optional	discharge observations
Xobs.txt	optional	observations of other variables, e.g. nutrient concentrations
RHobs.txt	optional	relative humidity forcing
SFobs.txt	optional	snowfall fraction of precipitation forcing
SWobs.txt	optional	shortwave radiation forcing
TMINobs.txt	optional	daily minimum air temperature forcing
TMAXobs.txt	optional	daily maximum air temperature forcing
Uobs.txt	optional	wind speed forcing
XobsXOMn.txt	optional	observations of other variables ?
XobsXOSn.txt	optional	observations of other variables ?

Output files

Output files contain model results, which include time series of simulations and (averaged/summed) observations 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
XXXXXXX.txt (basin output)	optional	basin output file, output variables combined per subbasin
timeXXXX.txt	optional	time output file, output of single variable for all subbasins
mapXXXX.txt	optional	map output file, output of single variable for all subbasins, formatted for GIS

File name	Requirement	Description
subassX.txt	optional	subbasin assessment, performance criteria for subbasins
simass.txt	optional	simulation assessment, summarising performance criteria over model domain
yyyy_ss.txt	optional	result files with annual nutrient transports per subbasin and source
hyss_seqnr_yymmdd_HHMM.log	automatic	log file, created for each model run
Wbf_xxx.txt	optional	water balance: flows per subbasin and day
Wbs_xxx.txt	optional	water balance: storage per subbasin and day
Wbsf_xxx.txt	optional	water balance: irrigation flows per subbasin and day
state_save	optional	files containing saved model states for model initialisation

Calibration files

Calibration files are all files relating to parameter calibration/optimisation routines in HYPE, both setup and results. See also info.txt where the objective function for the optimization is set.

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

File name	Requirement	Description
optpar.txt	optional	calibration routine definition and parameter ranges
qNstartpar.txt	optional	starting values for parameter optimization using Brent method
respar.txt	optional	calibration result parameters
bestsims.txt	optional	best performance results of calibration
allsim.txt	optional	performance results of all runs during calibration
calibration.log	optional	calibration log file

Water balance files

A set of output files relates to the print out of daily subbasin water balance.

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 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\'
```

info.txt

General

info.txt files contains HYPE model options and output type specifications and 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 may be omitted. Codes are not case sensitive, except for directory paths given after codes *modeldir* and *resultdir*, and time steps given after code *steplength*. Date-times are always specified as the beginning of the timestep.

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

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

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

Model options

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. Default is the same folder as info.txt.
`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.

Code	Argument	Description
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 starting state is saved in the file state_saveyyyymmdd[HHMM].txt. The default is that no output state is written. Maximum 10 starting states (10 dates) may be written. The dates may be written on same or different rows. In the latter case with this code on every row.
substance	*string*	gives the substances to be simulated. One or several of: *N* (inorganic (IN) and organic nitrogen (ON)), *P* (soluble reactive phosphorus (SP) and particulate phosphorus (PP)), *C* (organic carbon), *T1* (tracers), 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. Substances may be given with either upper- or lower-case letters. 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 type and parameters are defined in file optpar.txt. Note that reading of a model state through *instate* does not work with calibration.
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*.
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.
readformat	*0/1/2*	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, and '2' is a thirty-day-month.
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.

Code	Argument	Description
readdaily	*Y/N*	defines if time series input data should be read every day. The default is to read all data at the beginning of the simulation (*N*). However, for large input data files, memory limitations can preclude this. Set to 'Y' to read input data every day instead.
readobsid	*Y/N*	defines if columns pobsid/tobsid/etc. in GeoData.txt will be used. Give *Y* to use the columns if they exist (default), or *N* to force the use of subid as connection between forcing data columns and and GeoData.
readsfobs	*Y/N*	defines if SFobs.txt with observed snowfall fractions is present and should be used. Give *Y* to use the file, or *N* (default).
readswobs	*Y/N*	defines if SWobs.txt with observed shortwave radiation is present and should be used. Give *Y* to use the file, or *N* (default).
readwind	*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).
readhumid	*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).
readtminmaxobs	*Y/N*	defines if TMINobs.txt and TMAXobs.txt with observed min/max air temperatures are present and should be used. Give *Y* to use the file, or *N* (default).
readxomsfiles	*Y/N*	defines if files XobsXOMn.txt and XobsXOSn.txt are present and should be used (n=0-9). Files hold observations of optional, not predefined variables, XOSn are summed over time in output files while XOMn are averaged. Give *Y* to use the file, or *N* (default).
submodel	*Y/N*	defines if only a part of the model domain is to be simulated. Give *Y* for yes or *N* for no. Default is *N*. The submodel is then defined in the file pmsf.txt.
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.
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.
check indata	*1/2*	defines if model data and set-up files will be checked for formal errors prior to running the model. Default is to perform no checks. Available options are: checks on errors in info.txt, GeoData.txt, GeoClass.txt, and par.txt (1), or checks on forcing data files Pobs.txt/Pobs_nnn.txt, Tobs.txt/Tobs_nnn.txt, RHobs.txt, Qobs.txt, SFobs.txt, SWobs.txt, TMAXobs.txt, TMINobs.txt, UObs.txt, ForcData.txt/ForcData_nnn.txt, and ForcKey.txt/ForcKey_nnn.txt (2). NOTE that these checks are will not necessarily catch any possible error in the checked files. Disable option after successful checks to save model runtime.

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).
`floodplain`	*0/1/2*	defines which model to use for floodplains. Default is none (0), alternative is a simple model (1) and a model with soilroutines (2) (both requires floodplain definition in input file FloodData.txt).
`growthstartmodel`	*0/1*	defines if temperature varying start of the growth season should be used. Default is 0, then CropData.txt constant parameter bd2 is used. The alternative is 1, i.e. to used varying growth season start. Then the season start is calculated based on degreedays (equation defined by parameters in CropData.txt).
`lakeriverice`	*0/1*	defines if simulated ice on lakes and rivers should be used. Default is no (0), alternative is yes (1). The ice calculations require that *substance* T2 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), alternative is temperature dependent (1), modified Jensen-Haise/McGuinness (2), modified Hargreaves-Samani (3), Priestly-Taylor (4), and FAO Penman-Monteith reference crop evapotranspiration (5).
`snowdensity`	*0/1*	defines which snowdensity model to use. Default is snow age dependent snowdensity (0), and alternative is snow compactation snow density model (1).
`snowevaporation`	*0/1*	defines if evaporation (sublimation) from snow and glaciers should be calculated. Default is off (0), and alternative is on (1). Snow and glacier evaporation is governed by the general parameters 'fepotsnow', 'fepotglac', and 'fsceff' in par.txt.
`snowfallmodel`	*0/1*	defines if an alternative snowfall model should be used. Default is threshold temperature (0), alternative is snowfall fraction from SFobs.txt (1).
`snowmeltmodel`	*0/2*	defines which snowmelt model should be used. Default is temperature index (0), the alternative is temperature and radiation index (2). Previous option (1) temperature index with snowcover scaling is no longer used. Snowcover scaling of melt and evaporation is controlled by parameter 'fsceff', see section par.txt.
`swtemperature`	*0/1*	defines if T2 temperature should be used for WQ-processes in surface waters. Default is not (0), alternative is (1). The calculations require that *substance* T2 is simulated.

Output options

HYPE offers three principal output types for standard model runs, all of which are formatted text files with tabular content which is controlled with code combinations in info.txt, as well as two further sets of output 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*).

- **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.
- **annual loads** of nitrogen and phosphorus and **daily water balances**

Outputs are specified with two codes in *info.txt*, first code giving the output type and second specifying content options, followed by arguments. Content option codes are identical for all three output types. All outputs are technically optional.

Code 1	Code 2	Argument	Description

`basinoutput`
`mapoutput`
`timeoutput`
	`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.

`basinoutput`
`mapoutput`
`timeoutput`
	`meanperiod`	*0/1/2/3/4/5*	is given to define the period to which results are aggregated for the output. Only one period can be defined per type of output. The period is given using the codes 0 (sub-daily, only with sub-daily model time steps), 1 (daily), 2 (weekly aggregation), 3 (monthly aggr.), 4 (annual aggr.), 5 (aggregation over model period).
			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. **Note:** Period 5 aggregates are always means of annual aggregates. The type of aggregation is also documented in the list of variables in column 'Value'.

`basinoutput`
`mapoutput`
`timeoutput`
	`decimals`	*integer*	defines the number of decimals written in the outputs. Maximum allowed number of decimals is 9.
			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`
`mapoutput`
`timeoutput`
	`signfigures`	*integer*	defines the number of significant figures written in the outputs.
			Note: *signfigures* applies to all output variables within one output type. Default is zero and then a fixed number of decimals are used. If set, significant figures and mathematical format are used (e.g 9.5451E-03). Maximum allowed number of significant figures is 10.

`basinoutput`	`allbasin`	*NONE*	defines that output is to be written for all subbasins. No further arguments.

Code 1	Code 2	Argument	Description
basinoutput	subbasin	*integer*	defines one or several SUBIDs (subcatchment IDs) for which output is to be written. One or several rows may be given.
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 water balance is to be written. *Y* for yes or *N* for no. Default is *N*.

Performance criteria options

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

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

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

Code_1	Code 2	Argument	Description
crit	meanperiod	*1/2/3/4/5*	defines the period over which the performance criterion will be accumulated, i.e. daily, weekly, monthly or annually. 0-timesteply (for time step less than day), 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 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.

Code_1	Code 2	Argument	Description
crit n	conditional	*numeric*	parameter value. Only used for DEMC-calibration. The parameter value is the threshold for the criterion.

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 discharges lake water levels with observations during model runtime as well as updating of nitrogen and phosphorus concentrations using correction factors in individual subbasins.

Updating routines require further settings in additional input file update.txt.

needs more clarification, e.g. what is AR updating

Code 1	Code 2	Argument	Description
update	quseobs	*none/keyword*	updating of Q. Thereafter may [does one of these have to follow or are these optional?] follow one of the two keywords: 'allstation' for updating using all Q-stations in Qobs.txt or 'nostation' for no updating.
update	qar	*none/keyword*	AR updating of Q on days without observed Q. Uses the switch(1/0) on column ‘qarupd’ in update.txt for on/off on individual stations. Can be followed by keyword 'nostation' for no AR updating.
update	tpcorr	*none*	updating of total phosphorus. No further keywords may be given. Which stations and how much is given in file update.txt.
update	tploccorr	*none*	updating of local phosphorus. No further keywords may be given. Which stations and how much is given in file update.txt.
update	tncorr	*none*	updating of total nitrogen. No further keywords may be given. Which stations and how much is given in file update.txt.
update	tnloccorr	*none*	updating of local nitrogen. No further keywords may be given. Which stations and how much is given in file update.txt.

Code 1	Code 2	Argument	Description
`update`	`wendupd wstr`	*none/keyword*	updating of lake water levels. 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 on W for Q. Uses the switch(1/0) on column ‘warupd’ in update.txt for on/off on individual stations. Can be followed by keyword 'nostation' for no AR updating

HYPE variables

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

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

They appear accordingly in output file headers.

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

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

Column **Value** indicates the type of value of output variables. Variable values represent either averages, weighted averages, or sums over the output interval period defined with code *meanperiod* in info.txt. This is especially relevant for variables representing sums.

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

#	Variable ID	Unit	Description	Value	Reference area	Component
1	`temp`	*°C*	air temperature, provided in Tobs.txt/Tobs_nnn.txt	Avg.	subbasin area	Temp. & Precip.
2	`ctmp`	*°C*	corrected air temperature	Avg.	subbasin area	Temp. & Precip.
3	`snow`	*mm*	snow water equivalent	Avg.	subbasin land area	Snow
4	`sdep`	*cm*	snow depth	Avg.	subbasin land area	Snow
5	`rswe`	*mm*	observed snow water equivalent, provided in Xobs.txt	Avg.	subbasin land area	Snow
6	`rsnw`	*cm*	observed snow depth, provided in Xobs.txt	Avg.	subbasin land area	Snow
7	`soim`	*mm*	computed soil moisture (including standing water)	Avg.	subbasin land area	Soil
8	`som2`	*mm*	soil water of upper two soil layers (including standing water)	Avg.	subbasin land area	Soil
9	`sml1`	*mm*	soil moisture upper soil layer (not including standing water)	Avg.	area of soil layer	Soil
10	`sml2`	*mm*	soil moisture second soil layer	Avg.	area of soil layer	Soil
11	`sml3`	*mm*	soil moisture third soil layer	Avg.	area of soil layer	Soil

#	Variable ID	Unit	Description	Value	Reference area	Component
12	smrz	*mm*	soil moisture root zone (upper two soil layers) (not including standing water)	Avg.	subbasin land area	Soil
13	sm13	*mm*	soil moisture all soil layers (not including standing water)	Avg.	subbasin land area	Soil
14	stsw	*mm*	standing soil water	Avg.	subbasin land area	Soil
15	srff	-	soil moisture root zone (upper two soil layers) (not including standing water) as fraction of wcfc volume	Avg.	subbasin land area	Soil
16	smfd	-	soil moisture (not including standing water) as fraction of soil depth	Avg.	subbasin land area	Soil
17	srfd	-	soil moisture root zone (upper two soil layers) (not including standing water) as fraction of root depth	Avg.	subbasin land area	Soil
18	smfp	-	soil moisture (not including standing water) as fraction of pore volume	Avg.	subbasin land area	Soil
19	srfp	-	soil moisture root zone (upper two soil layers) (not including standing water) as fraction of pore volume	Avg.	subbasin land area	Soil
20	smdf	*mm*	soil moisture deficit to field capacity of upper two soil layers	Avg.	subbasin land area	Soil
21	gwat	*m*	groundwater level	Avg.	subbasin land area	Soil
22	sfst	*cm*	frost depth	Avg.	subbasin land area	Soil
23	stmp	*°C*	soil temperature	Avg.	subbasin land area	Soil Temp.
24	stm1	*°C*	upper soil layer temperature	Avg.	area of soil layer	Soil Temp.
25	stm2	*°C*	middle soil layer temperature	Avg.	area of soil layer	Soil Temp.
26	stm3	*°C*	lowest soil layer temperature	Avg.	area of soil layer	Soil Temp.
27	resf	*cm*	observed frost depth, provided in Xobs.txt	Avg.	subbasin land area	missing
28	regw	*m*	observed groundwater level, provided in Xobs.txt	Avg.	subbasin land area	missing
29	pfN1, pfN2, pfN3	*kg/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

#	Variable ID	Unit	Description	Value	Reference area	Component
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
39	rfsc	-	recorded fractional snow cover area, provided in Xobs.txt	Avg.	subbasin land area	missing
40	smax	*mm*	computed snowmax in winter	Avg.	subbasin land area	missing
41	rfse	-	recorded fractional snow cover area error, provided in Xobs.txt	Avg.	subbasin land area	missing
42	rfsm	-	recorded fractional snow cover multi, provided in Xobs.txt ?	Avg.	subbasin land area	missing
43	rfme	-	recorded fractional snow cover multi error, provided in Xobs.txt	Avg.	subbasin land area	missing
44	wcom	*m*	water level olake (for the last lakebasin this is the whole lake water level)	Avg.	outlet lake area	missing
45	wstr	*m*	observed water level olake, provided in Xobs.txt	Avg.	outlet lake area	missing
46	cout	m^3/s	simulated outflow from olake/subcatchment	Avg.	subbasin upstream area	missing
47	rout	m^3/s	observed outflow from olake/subcatchment, provided in Qobs.txt	Avg.	subbasin upstream area	missing

#	Variable ID	Unit	Description	Value	Reference area	Component
48	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
49	cilv	$10^6 m^3$	computed ilake volume	Avg.	internal lake area	missing
50	clbv	$10^6 m^3$	computed olake volume (volumes for individual basins if any)	Avg.	outlet lake area	missing
51	coum	m^3/s	simulated outflow to main branch	Avg.	subbasin upstream area	missing
52	coub	m^3/s	simulated outflow to branch	Avg.	subbasin upstream area	missing
53	cgwl	m^3/s	simulated outflow from groundwater (losses from catchment)	Avg.	subbasin area	missing
54	cloc	m^3/s	local flow from subbasin to its main river	Avg.	subbasin area without olake and main river (and floodplains)	missing
55	cinf	m^3/s	simulated flow to outlet lake (including P-E of the lake)	Avg.	subbasin upstream area	missing
56	rinf	m^3/s	observed flow to outlet lake (including P-E of the lake), provided in Xobs.txt	Avg.	subbasin upstream area	missing
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
59	qerr	m^3/s	daily error in Q (cout - rout)	Avg.	subbasin upstream area	missing
60	cobc	m^3/s	cout prior to updating of Q if update is made	Avg.	subbasin upstream area	missing
61	wtmp	°C	water temperature in outflow from subbasin	Avg.	subbasin upstream area	missing
62	wtm0	°C	water temperature in outflow from subbasin, limited to above zero	Avg.	subbasin upstream area	missing
63	werr	m	daily error in olake water level (wcom - wstr)	Avg.	subbasin area	missing
64	cwbc	m	computed olake water level prior to updating if update is used	Avg.	outlet lake area	missing
65	coli	cm	computed olake ice depth	Avg.	outlet lake area	missing

#	Variable ID	Unit	Description	Value	Reference area	Component
66	cili	*cm*	computed ilake ice depth	Avg.	internal lake area	missing
67	colb	*cm*	computed olake blackice depth	Avg.	outlet lake area	missing
68	cilb	*cm*	computed ilake blackice depth	Avg.	internal lake area	missing
69	cols	*cm*	computed olake snow depth	Avg.	outlet lake area	missing
70	cils	*cm*	computed ilake snow depth	Avg.	internal lake area	missing
71	roli	*cm*	recorded olake ice depth, provided in Xobs.txt	Avg.	outlet lake area	missing
72	rili	*cm*	recorded ilake ice depth, provided in Xobs.txt	Avg.	internal lake area	missing
73	rolb	*cm*	recorded olake blackice depth, provided in Xobs.txt	Avg.	outlet lake area	missing
74	rilb	*cm*	recorded ilake blackice depth, provided in Xobs.txt	Avg.	internal lake area	missing
75	rols	*cm*	recorded olake snow depth, provided in Xobs.txt	Avg.	outlet lake area	missing
76	rils	*cm*	recorded ilake snow depth, provided in Xobs.txt	Avg.	internal lake area	missing
77	cmri	*cm*	computed main river ice depth	Avg.	main river area	missing
78	clri	*cm*	computed local river ice depth	Avg.	local river area	missing
79	cmrb	*cm*	computed main river blackice depth	Avg.	main river area	missing
80	clrb	*cm*	computed local river blackice depth	Avg.	local river area	missing
81	cmrs	*cm*	computed main river snow depth	Avg.	main river area	missing
82	clrs	*cm*	computed local river snow depth	Avg.	local river area	missing
83	rmri	*cm*	recorded main river ice depth, provided in Xobs.txt	Avg.	main river area	missing
84	rlri	*cm*	recorded local river ice depth, provided in Xobs.txt	Avg.	local river area	missing
85	rmrb	*cm*	recorded main river blackice depth, provided in Xobs.txt	Avg.	main river area	missing
86	rlrb	*cm*	recorded local river blackice depth, provided in Xobs.txt	Avg.	local river area	missing
87	rmrs	*cm*	recorded main river snow depth, provided in Xobs.txt	Avg.	main river area	missing
88	rlrs	*cm*	recorded local river snow depth, provided in Xobs.txt	Avg.	local river area	missing
89	olst	*°C*	computed olake surface temperature	Avg.	outlet lake area	missing
90	olut	*°C*	computed olake upper temperature	Avg.	outlet lake area	missing

#	Variable ID	Unit	Description	Value	Reference area	Component
91	ollt	°C	computed olake lower temperature	Avg.	outlet lake area	missing
92	olwt	°C	computed olake mean temperature	Avg.	outlet lake area	missing
93	ilst	°C	computed ilake surface temperature	Avg.	internal lake area	missing
94	ilwt	°C	computed ilake mean temperature	Avg.	internal lake area	missing
95	lrst	°C	computed local river surface temperature	Avg.	local river area	missing
96	lrwt	°C	computed local river mean temperature	Avg.	local river area	missing
97	mrst	°C	computed main river surface temperature	Avg.	main river area	missing
98	mrwt	°C	computed main river mean temperature	Avg.	main river area	missing
99	rolt	°C	recorded olake surface temperature, provided in Xobs.txt	Avg.	outlet lake area	missing
100	rilt	°C	recorded ilake surface temperature, provided in Xobs.txt	Avg.	internal lake area	missing
101	rmrt	°C	recorded main river surface temperature, provided in Xobs.txt	Avg.	main river area	missing
102	mrto	°C	computed main river temperature (old)	Avg.	main river area	missing
103	lrto	°C	computed local river temperature (old)	Avg.	local river area	missing
104	ilto	°C	computed ilake temperature (old)	Avg.	internal lake area	missing
105	olto	°C	computed olake temperature (old)	Avg.	outlet lake area	missing
106	coic	-	computed olake ice cover	Avg.	outlet lake area	missing
107	ciic	-	computed ilake ice cover	Avg.	internal lake area	missing
108	cmic	-	computed main river ice cover	Avg.	main river area	missing
109	clic	-	computed local stream ice cover	Avg.	local river area	missing
110	glcv	km^3	glacier volume	Avg.	glacier area	missing
111	glca	km^2	glacier area	Avg.	glacier area	missing
112	lrdp	m	local river depth	Avg.	local river area	missing
113	mrdp	m	main river depth	Avg.	main river area	missing

#	Variable ID	Unit	Description	Value	Reference area	Component
114	xom0..9	*depends on variable type*	optional, not predefined variable (averaged over output time interval) provided in Xobs.txt or XobsXOMn.txt	Avg.	depends on variable type	missing
115	aqwl	*m*	aquifer depth to water level	Avg.	subbasin area	missing
116	cgmb	*mm*	computed glacier mass balance	Avg.	specific glacier area	missing
117	rgmb	*mm*	recorded glacier mass balance, provided in Xobs.txt	Avg.	specific glacier area	missing
118	cgma	*km^2*	area used in computed mass balance	Avg.	specific glacier area	missing
119	rgma	*km^2*	area used in recorded mass balance, provided in Xobs.txt	Avg.	specific glacier area	missing
120	rgmp	*days*	recorded mass balance period, provided in Xobs.txt	Avg.	none	missing
121	S105	-	recorded (FSUHSS) snow cover surrounding terrain open (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of non-forest land cover	missing
122	S106	-	recorded (FSUHSS) snow cover course open (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of non-forest land cover	missing
123	S108	*cm*	recorded (FSUHSS) mean depth open, provided in Xobs.txt	Avg.	area of non-forest land cover	missing
124	S111	*g/cm^3*	recorded (FSUHSS) mean density open, provided in Xobs.txt	Avg.	area of non-forest land cover	missing
125	S114	*mm*	recorded (FSUHSS) snow water equivalent open, provided in Xobs.txt	Avg.	area of forest land cover	missing
126	S205	-	recorded (FSUHSS)snow cover surrounding terrain forest (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of forest land cover	missing
127	S206	-	recorded (FSUHSS) snow cover course forest (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of forest land cover	missing
128	S208	*cm*	recorded (FSUHSS) mean depth forest, provided in Xobs.txt	Avg.	area of forest land cover	missing
129	S211	*g/cm^3*	recorded (FSUHSS) mean density forest, provided in Xobs.txt	Avg.	area of forest land cover	missing
130	S214	*mm*	recorded (FSUHSS) snow water equivalent forest, provided in Xobs.txt	Avg.	area of forest land cover	missing
131	C106	-	computed snow cover open (fraction from 0 to 10)	Avg.	area of non-forest land cover	missing

#	Variable ID	Unit	Description	Value	Reference area	Component
132	C108	*cm*	computed mean depth open	Avg.	area of non-forest land cover	missing
133	C111	*g/cm^3*	computed mean density open	Avg.	area of non-forest land cover	missing
134	C114	*mm*	computed snow water equivalent open	Avg.	area of non-forest land cover	missing
135	C206	-	computed snow cover forest (fraction from 0 to 10)	Avg.	area of forest land cover	missing
136	C208	*cm*	computed mean depth forest	Avg.	area of forest land cover	missing
137	C211	*g/cm^3*	comp. mean 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	upsn	*mm*	upstream catchment accumulated snow water	Avg.	subbasin upstream area	missing
140	upso	*mm*	upstream catchment accumulated soil water	Avg.	subbasin upstream area	missing
141	coT1	*undefined*	simulated concentration of stable water isotope tracer in local runoff from soil, unit dependent on unit in user-provided precipitation concentration of cpT1, typically ‰ deviation from V-SMOW	W. Avg.	subbasin land area	missing
142	coT2	*°C*	simulated water temperature of local runoff from soil	W. Avg.	subbasin land area	missing
144	coIN, coON, coTN, coSP, coPP, coTP	*µg/L*	simulated concentration of N and P species in local runoff from soil	W. Avg.	subbasin land area	missing
145	reT1	*undefined*	observed concentration of stable water isotope tracer in outflow from olake/subbasin, unit dependent on unit in user-provided precipitation concentration of cpT1, typically ‰ deviation from V-SMOW, provided in Xobs.txt	W. Avg.	subbasin upstream area	missing
146	reT2	*°C*	observed water temperature in outflow from olake/subbasin, provided in Xobs.txt	W. Avg.	subbasin upstream area	missing

#	Variable ID	Unit	Description	Value	Reference area	Component
148	reIN, reON, reSP, rePP, reTN, reTP	*μg/L*	observed concentration of N and P species in outflow from olake/subbasin, provided in Xobs.txt	W. Avg.	subbasin upstream area	missing
149	cpT1	*undefined*	observed concentration of stable water isotopes in precipitation, unit user-provided, typically ‰ deviation from V-SMOW, provided in Xobs.txt	W. Avg.	subbasin area	missing
150	ceT1	*undefined*	simulated concentration of stable water isotopes in evapotranspiration, unit dependent on unit in user-provided precipitation concentration of cpT1, typically ‰ deviation from V-SMOW	W. Avg.	subbasin area	missing
151	csT1	*undefined*	simulated concentration of stable water isotopes in the soil, unit dependent on unit in user-provided precipitation concentration of cpT1, typically ‰ deviation from V-SMOW	W. Avg.	subbasin land area	missing
152	csT2	*°C*	simulated water temperature in the soil	W. Avg.	subbasin land area	missing
154	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
155	ccT1	*undefined*	simulated concentration of stable isotope tracer in outflow from outlet lake/subbasin, unit dependent on unit in user-provided precipitation concentration of cpT1, typically ‰ deviation from V-SMOW	W. Avg.	subbasin upstream area	missing
156	ccT2	*°C*	simulated water temperature in outflow from outlet lake/subbasin	W. Avg.	subbasin upstream area	missing

#	Variable ID	Unit	Description	Value	Reference area	Component
158	ccIN, ccON, ccTN, ccSP, ccPP, ccTP	*µg/L*	simulated concentration of N and P species in outflow from outlet lake/subbasin	W. Avg.	subbasin upstream area	missing
159	coOC	*mg/L*	simulated OC concentration in runoff from soil	W. Avg.	subbasin land area	missing
160	csOC	*mg/L*	simulated OC concentration in soil	W. Avg.	subbasin land area	missing
161	ccOC	*mg/L*	simulated OC concentration in outflow from olake/subbasin	W. Avg.	subbasin upstream area	missing
162	reOC	*mg/L*	observed OC concentration in outflow from olake/subbasin, provided in Xobs.txt	W. Avg.	subbasin upstream area	missing
163	clCO	*mg/L*	simulated OC concentration in local flow from subbasin	W. Avg.	subbasin area without olake and main river (and floodplains)	missing
164	clIN, clON, clTN, clSP, clPP, clTP	*µg/L*	simulated concentration in local flow from subbasin	W. Avg.	subbasin area without olake and main river (and floodplains)	missing
165	prec	*mm/[period]*	precipitation as provided in Pobs.txt/Pobs_nnn.txt	Sum	subbasin area	missing
166	cprc	*mm/[period]*	corrected precipitation	Sum	subbasin area	missing
167	cpSF	*mm/[period]*	corrected precipitation that falls as snow	Sum	subbasin area	missing
168	cpRF	*mm/[period]*	corrected precipitation that falls as rain	Sum	subbasin area	missing
169	evap	*mm/[period]*	evapotranspiration	Sum	subbasin area	missing
170	epot	*mm/[period]*	potential evapotranspiration	Sum	subbasin area	missing
171	repo	*mm/[period]*	observed potential evapotranspiration, provided in Xobs.txt	Sum	subbasin area	missing
172	eobs	*mm/[period]*	observed evapotranspiration, provided in Xobs.txt	Sum	subbasin area	missing
173	icpe	*mm/[period]*	losses due to interception (simulated as precipitation corrections)	Sum	subbasin area	missing
174	evsn	*mm/[period]*	snow and glacier evaporation (Note that evsn is included in evap, which still is the total evaporation from the subbasin)	Sum	subbasin area	missing
175	levp	*mm/[period]*	land evapotranspiration	Sum	subbasin land area	missing

#	Variable ID	Unit	Description	Value	Reference area	Component
176	`crun`	*mm/[period]*	calculated local runoff from land area. Note that this is not the same as the flow to the local stream if floodplains are used.	Sum	subbasin land area	missing
177	`rrun`	*mm/[period]*	observed local runoff from land area, provided in Xobs.txt	Sum	subbasin land area	missing
178	`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
179	`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
180	`cros`	*mm/[period]*	simulated 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
181	`acdf`	*mm/[period]*	accumulated volume error	Sum	subbasin upstream area	missing
182	`totN`, `totP`, `totC`	*kg/[period]*	total simulated nutrient or organic carbon load out from subbasin	Sum	subbasin upstream area	missing
183	`deni`	*kg/km^2[period]*	denitrification in soil	Sum	subbasin land area	missing
184	`crut`	*kg/km^2[period]*	N crop uptake	Sum	subbasin land area	missing
185	`faIN`	*kg/km^2[period]*	flow of fastN to IN pool	Sum	subbasin land area	missing
186	`atmd`, `atmp`	*kg/km^2[period]*	atmospheric deposition of IN/TP on land	Sum	subbasin land area	missing
187	`rtoN`, `rtoP`	*kg/[period]*	total recorded nutrient load out from subbasin (based on recorded flow)	Sum	subbasin upstream area	missing
188	`irra`	*m^3/[period]*	applied irrigation water to the soil	Sum	area of irrigated SLCs	missing
189	`irld`	*m^3/[period]*	abstractions from local dam(s)	Sum	none	missing
190	`irlr`	*m^3/[period]*	abstractions from local river	Sum	none	missing
191	`irrg`	*m^3/[period]*	abstractions from local groundwater	Sum	none	missing
192	`irrs`	*m^3/[period]*	surface water abstractions sent to other connected subbasins from this subbasin	Sum	none	missing
193	`irel`	*m^3/[period]*	evaporation losses due to irrigation	Sum	area of irrigated SLCs	missing

#	Variable ID	Unit	Description	Value	Reference area	Component
194	rlIN, rlON, rlSP, rlPP, rlTN, rlTP, rlOC	*kg/[period]*	recorded load calculated on computed flow out from subbasin	Sum	subbasin upstream area	missing
195	xos0..9	*depends on variable type*	optional, not predefined variable (summed over output time interval) provided in Xobs.txt or XobsXOSn.txt	Sum	depends on variable type	missing
196	aqin	*m^3/[period]*	aquifer recharge	Sum	subbasin area	missing
197	aqut	*m^3/[period]*	aquifer outflow	Sum	main river area	missing
198	uppr	*mm/[period]*	upstream catchment average precipitation, corrected precipitation if correction is used	Sum	subbasin upstream area	missing
199	upev	*mm/[period]*	upstream catchment average evaporation	Sum	subbasin upstream area	missing
200	uppe	*mm/[period]*	upstream catchment average potential evaporation	Sum	subbasin upstream area	missing
201	upro	*mm/[period]*	specific discharge	Sum	subbasin upstream area	missing
202	upsf	*mm/[period]*	upstream catchment average snowfall, corrected snowfall if correction is used	Sum	subbasin upstream area	missing
203	uprf	*mm/[period]*	upstream catchment average rainfall, corrected rainfall if correction is used	Sum	subbasin upstream area	missing
204	cpIN	*µg/L*	observed concentration of inorganic nitrogen in precipitation, provided in Xobs.txt	W. Avg.	subbasin area	missing
205	cpSP	*µg/L*	observed concentration of soluble phosphorus in precipitation, provided in Xobs.txt	W. Avg.	subbasin area	missing
206	clwc	*m*	olake water stage (wcom) cleaned fromw0ref reference level	Avg.	outlet lake area	missing
207	clws	*m*	observed water stage (wstr) cleaned from w0ref reference level	Avg.	outlet lake area	missing
208	evpt	*mm/[period]*	total evapotranspiration, including “interception losses”	Sum	subbasin area	missing
209	upsd	*mm/[period]*	upstream average soil deficit to field capacity for upper two soil layers	Sum	subbasin upstream area	missing

#	Variable ID	Unit	Description	Value	Reference area	Component
210	upfp	-	upstream soil moisture as fraction of pore volume (not including standing water)	Avg.	subbasin upstream area	missing
211	psim	*mm/[period]*	precipitation including water that will be removed as “interception losses”	Sum	subbasin area	missing
212	sl01	*kg*	gross load of soil layer 1 and 2 of inorganic nitrogen	Sum	subbasin area	missing
213	sl02	*kg*	net load of soil layer 1 and 2 of inorganic nitrogen	Sum	subbasin area	missing
214	sl03	*kg*	gross load of soil layer 1 and 2 of organic nitrogen	Sum	subbasin area	missing
215	sl04	*kg*	net load of soil layer 1 and 2 of organic nitrogen	Sum	subbasin area	missing
216	sl05	*kg*	gross load of soil layer 1 and 2 of total nitrogen	Sum	subbasin area	missing
217	sl06	*kg*	net load of soil layer 1 and 2 of total nitrogen	Sum	subbasin area	missing
218	sl07	*kg*	gross load of soil layer 1 and 2 of SRP	Sum	subbasin area	missing
219	sl08	*kg*	net load of soil layer 1 and 2 of SRP	Sum	subbasin area	missing
220	sl09	*kg*	gross load of soil layer 1 and 2 of particulate phosphorus	Sum	subbasin area	missing
221	sl10	*kg*	net load of soil layer 1 and 2 of particulate phosphorus	Sum	subbasin area	missing
222	sl11	*kg*	gross load of soil layer 1 and 2 of total phosphorus	Sum	subbasin area	missing
223	sl12	*kg*	net load of soil layer 1 and 2 of total phosphorus	Sum	subbasin area	missing
224	sl13	*kg*	gross load of soil layer 3 of inorganic nitrogen	Sum	subbasin area	missing
225	sl14	*kg*	net load of soil layer 3 of inorganic nitrogen	Sum	subbasin area	missing
226	sl15	*kg*	gross load of soil layer 3 of organic nitrogen	Sum	subbasin area	missing
227	sl16	*kg*	net load of soil layer 3 of organic nitrogen	Sum	subbasin area	missing
228	sl17	*kg*	gross load of soil layer 3 of total nitrogen	Sum	subbasin area	missing
229	sl18	*kg*	net load of soil layer 3 of total nitrogen	Sum	subbasin area	missing
230	sl19	*kg*	gross load of soil layer 3 of SRP	Sum	subbasin area	missing
231	sl20	*kg*	net load of soil layer 3 of SRP	Sum	subbasin area	missing
232	sl21	*kg*	gross load of soil layer 3 of particulate phosphorus	Sum	subbasin area	missing
233	sl22	*kg*	net load of soil layer 3 of particulate phosphorus	Sum	subbasin area	missing

#	Variable ID	Unit	Description	Value	Reference area	Component
234	sl23	*kg*	gross load of soil layer 3 of total phosphorus	Sum	subbasin area	missing
235	sl24	*kg*	net load of soil layer 3 of total phosphorus	Sum	subbasin area	missing
236	sl25	*kg*	gross load of soil layer 3 + tile of inorganic nitrogen	Sum	subbasin area	missing
237	sl26	*kg*	net load of soil layer 3 + tile of inorganic nitrogen	Sum	subbasin area	missing
238	sl27	*kg*	gross load of soil layer 3 + tile of organic nitrogen	Sum	subbasin area	missing
239	sl28	*kg*	net load of soil layer 3 + tile of organic nitrogen	Sum	subbasin area	missing
240	sl29	*kg*	gross load of soil layer 3 + tile of total nitrogen	Sum	subbasin area	missing
241	sl30	*kg*	net load of soil layer 3 + tile of total nitrogen	Sum	subbasin area	missing
242	sl31	*kg*	gross load of soil layer 3 + tile of SRP	Sum	subbasin area	missing
243	sl32	*kg*	net load of soil layer 3 + tile of SRP	Sum	subbasin area	missing
244	sl33	*kg*	gross load of soil layer 3 + tile of particulate phosphorus	Sum	subbasin area	missing
245	sl34	*kg*	net load of soil layer 3 + tile of particulate phosphorus	Sum	subbasin area	missing
246	sl35	*kg*	gross load of soil layer 3 + tile of total phosphorus	Sum	subbasin area	missing
247	sl36	*kg*	net load of soil layer 3 + tile of total phosphorus	Sum	subbasin area	missing
248	den3	*kg*	denitrification soil layer 3	Sum	subbasin area	missing
249	denz	*kg*	denitrification soil layer 1 and 2	Sum	subbasin area	missing
250	cIN1	*µg/L*	simulated concentration of IN in soil layer 1	W. Avg.	area of soil layer	missing
251	cIN2	*µg/L*	simulated concentration of IN in soil layer 2	W. Avg.	area of soil layer	missing
252	cIN3	*µg/L*	simulated concentration of IN in soil layer 3	W. Avg.	area of soil layer	missing
253	sml9	*mm*	soil moisture upper soil layer (including standing water)	Avg.	area of soil layer	missing
254	mrfp	*m*	main river floodplain water depth	Avg.	floodplain area	Floodplain
255	olfp	*m*	outlet lake floodplain water depth	Avg.	floodplain area	Floodplain
256	mrfg	*%*	main river floodplain degree of flooded area (% of floodplain area)	Avg.	floodplain area	Floodplain
257	olfg	*%*	outlet lake floodplain degree of flooded area (% of floodplain area)	Avg.	floodplain area	Floodplain

Available performance criteria

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

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

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

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

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

Criteria equations

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

Code to equation coupling

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

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

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

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

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

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

Equation definitions

Denotations

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

Basic equations

Average value for a time series of a station:

$$xm = \frac{1}{mi}\sum_{i=1}^{mi} x_i$$ *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*

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:

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

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*):

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

where

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

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

n_0 = number of compared pairs

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

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

Criteria equations for a model domain (several stations)

Average Nash-Sutcliffe efficiency (*AVNSE*):

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

Median Nash-Sutcliffe efficiency (*MEDNSE*):

$$MEDNSE = median \, j = 1 mj \, NSE_j$$

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 efficiency with coefficient a (*AVRA*):

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

Median efficiency with coefficient a (*MEDRA*):

$$MEDRA = median\, j = 1\, mj\, RA_j$$

Spatial efficiency with coefficient a (*SPATRA*):

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

Regional efficiency with coefficient a (*REGRA*):

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

Average relative bias (*AVRB*):

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

Regional relative bias (*REGRB*):

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

Spatial relative bias (*SPATRB*):

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

Median Kling-Gupta efficiency (*MEDKGE*):

$$MEDKGE = median\, j = 1\, mj\, KGE_{j}$$

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

$$MEDNE = median\, j = 1\, mj\, NE_{j}$$

Average of absolute relative bias (*AVARB*):

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

Average Pearson correlation coefficient (*AVCC*):

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

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

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

Average Kendalls rank correlation coefficient (*AVTAU*):

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

Regional mean absolute error (*REGMAE*):

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

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

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

pmsf.txt

The file is located in the same folder as info.txt. This file includes the subbasins to be calculated if only part of the model domain is required. Note that all subbasins upstream also must be included in the file.

In the first row should be given how many subbasins to be calculated (i.e. how many subid to be read from file). In, the second and following rows give the subid for the subbasins to be calculated (a selection of those in GeoData.txt).

optpar.txt

The file is 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 parameters to calibrate and with which boundaries are information also given in *optpar.txt*.

Maximum 100 parameters may be optimised simultaneously. To optimise more parameters, the code needs to be changed (set *maxoptpar* to a higher value). Parameters are listed in description of par.txt. The objective function is defined in info.txt as the combination of criteria chosen.

There are eight methods of optimisation implemented in HYPE as detailed in the table below. 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 routines only, see table below. Task WS

Task	Description
MC	Monte Carlo simulation with parameter values randomly distributed over the intervals
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 steepest descent method
SC	organised scanning of two parameters
WA	write performance result for all simulations (MC, SM or DE)
WS	write simulation results (basin-, time- or map-files) for all ensembles in MonteCarlo simulation (MC, BP, or DE) (maximum 9999999 ensembles total)

File format

The first row is for comments. It is ignored by the program. Second to 21st row are used to define tasks and calibration settings. Parameters to be calibrated are defined from row 22 and onward.

A row starts with a code indicating task or other settings. Argument of the code is listed from character 12 on each row. The following options are available:

Code	Argument	Description
`task`	*two letter word*	define what kind of optimisation to do (see methods above), and if all results are to be written afterwords for the MC methods
`scan_numx`	*integer*	number of steps taken for the first parameter (SC method)
`scan_numy`	*integer*	number of steps taken for the second parameter (SC method)
`num_mc`	*integer*	number of Monte Carlo simulations (per centre point and stage for progressive MC)

Code	Argument	Description
num_ens	*integer*	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*	number of simulations per reduced parameter space which the best simulations shall be selected from (MC-method)
num_bpmax	*integer*	number of reductions of the parameter space for MC simulation (MC-method)
num_stages	*integer*	number of stages for progressive Monte Carlo
num_zoom	*real*	reduction of parameter space (0-1) for each stage of progressive MC
DEMC_ngen	*integer*	number of generations for DE method
DEMC_npop	*integer*	number of populations for DE method
DEMC_gammascale	*real*	scaling of the mutation strength for DE 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*	crossover probability for DE method. Probability that the proposed candidate is chosen instead of the parent parameter. Large DEMC_crossover values mean larger probability that the proposal is chosen. Set to 1, all proposals are accepted. This makes it harder to find an acceptable overall proposal because all parameters are changed in every generation. Set to 0.5, each parameter candidate has only a 50% chance to be accepted into the next proposal.
DEMC_sigma	*real*	sample error standard deviation for DE 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 below).
DEMC_accprob	*integer*	scaling factor for probabilistic acceptance for DE method (0 = off (default); >0 = on). If set to off, parameter proposals will only (and always) be accepted if the likelyhood score decreases (= better performance). Values close to 0 will increase the probability of acceptance within the probabilistic framework, a value of 1 means no scaling.
BR_diagStp	*Y/N*	flag for taking a diagonal step at the end of each iteration (BN method)
BR_latOffs	*real*	lateral offset from original value for line search delimitation (BN method) (not in use)
num_maxItr	*integer*	max amount of iterations (interrupt non-MonteCarlo methods)
num_maxTim	*integer*	max calibration time (hours) (interrupt non-MonteCarlo methods)
num_parItr	*integer*	number of iterations taken into account for parameter change tolerance (interrupt non-MonteCarlo methods)
num_criItr	*integer*	number of iterations taken into account for criterium change tolerance (interrupt non-MonteCarlo methods)
num_criTol	*real*	tolerance for criteria relative change over last iterations (interrupt non-MonteCarlo methods)

Code	Argument	Description
`lnS_maxItr`	*integer*	max amount of line search iterations (per line)
`lnS_tol`	*real*	general relative tolerance for line search
`lnS_log`	*Y/N*	line search write progression in calibration.log (alternative is own file)
`QN_nrmTol`	*real*	tolerance for gradient norm to be considered zero (QN methods)
`QN_pctDerv`	*real*	factor to offset current parameter value for numerical derivative (QN methods)
`QN_stencil`	*integer*	numerical derivative stencil type (QN methods)
`QN_lambMax`	*real*	factor to contain lambda prior to line search (QN methods)
`QN_lambAcc`	*real*	factor increasing the step length (QN methods)

From row 22 and onward, parameters to calibrate are defined (no quotation marks). For class- or land use-dependent parameters, values for all soil-types/land-uses/subbasin/parameterregion/lakeregions or one value for general parameter 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 additional factor to scale the random noise added to the proposed next-generation parameter, see description of DEMC settings code `DEMC_accprob` in table above.

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

Example of parameter rows:

```
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  2.0   0.0
ttmp  0.0   2.0
ttmp  0.01  0.01
```

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 temperatures for 2 land-uses.

update.txt

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

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

The following columns are read by HYPE:

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

GeoClass.txt

The file describes the characteristics of all classes that make up the model subbasins. The classes, called SLC classes, are defined as combinations of soil type and land use/land cover, but also have other properties that separates them. SLC stands for Soil type - Land use Combination. The classes defined here act as Hydrological Response Units (HRU).

Lakes, rivers and glaciers make up special classes, while all other classes are combinations of land cover and soil type. Information for each SLC class is given on one row with a predefined order of columns. A SLC class can have the same land use and soil type, but differ in other aspects, e.g. soil depth or crop (on agricultural land). The columns are separated by blanks or tabs. Comment rows can be added and are denoted with a '!' in the first position. A maximum of 99 SLC classes can be defined. The file is located in the modeldir folder.

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	Name	Description
1	-	SLC class number	That is 1,2,3,.. in order. The number is the same used for the classes 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
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
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. If no nutrient uptake is to occur, e.g. for water-classes and sealed layers (i.e. concrete) or no nutrient simulation, use 0. If irrigation routines are used, irrigated classes require a crop (cropid>0), because irrigation characteristics are also defined in CropData.txt
5	-	Second crop cropid	An integer 1,2,3,... Some agriculture land has a second crop of the year, e.g. a catch crop. Use 0 if no secondary crop are simulated.
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	An integer 1,2 or 3. The vegetation types are pre-determined: 1=open, 2=forest, 3=water. The vegetation type is only used for NP-simulations. If not set (0) vegtype 1 vill be used.

Column	Unit	Name	Description
8	-	Special class code	An integer. Some classes that are treated special is denoted here. These are pre-defined: 1=outlet lake, 2=internal lake, 3=glacier, 11=local stream, 12=main river, 0=others.
9	*m*	Tile depth	The distance from soil surface to (average) tile drainage system level. Set to 0 to not use tile drainage.
10	*m*	Stream depth	The 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).
11	-	Number of soil layers	An integer 1,2 or 3. For water classes give 1 layer with depth 1 (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. 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. If less than three layers set value equal to soil layer two.

GeoData.txt

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

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

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

Example for a *GeoData.txt* file structure:

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

All *GeoData.txt* variables are described in the table below. For point source variables (beginning with *ps*) it is recommended to use input file PointSourceData.txt instead, because this allows to define unlimited point sources per sub-basin, whereas in *GeoData.txt* only three can be defined. Observation IDs (all **obsid* variables), which link columns in forcing data files to sub-basins, are not necessary if observation IDs are identical with SUBIDs. They can also be linked to sub-basin SUBIDs in file ForcKey.txt or ForcData.txt.

#	Variable ID	Unit	Requirement	Description
1	area	m^2	mandatory	sub-basin area
2	subid	-	mandatory	id number for subbasins, matched against * Qobs.txt and Xobs.txt column headings, integer < 10^8
3	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 basin, e.g. coastal areas).

#	Variable ID	Unit	Requirement	Description
4	pobsid	-	optional	observation ID, matched against Pobs.txt column heading, integer < 10^8
5	tobsid	-	optional	observation ID, matched against Tobs.txt column heading, integer < 10^8
6	sfobsid	-	optional	observation ID, matched against SFobs.txt column heading, integer < 10^8
7	swobsid	-	optional	observation ID, matched against SWobs.txt column heading, integer < 10^8
8	tminobsid	-	optional	observation ID, matched against TMINobs.txt column heading, integer < 10^8
9	tmaxobsid	-	optional	observation ID, matched against TMAXobs.txt column heading, integer < 10^8
10	latitude	°	optional	latitude in degrees N (-90,90), used for calculation of extraterrestrial radiation in Hargreaves-Samani evapotranspiration model
11	region	-	optional	production region (or other region number system) for crops in CropData.txt, optional for nutrient modelling
12	lakeregion	-	optional/mandatory	lake region for watercourse parameters, mandatory for nutrient simulation, integer > 0
13	parreg	-	optional	region for correction parameters (e.g. evapcorr), integer > 0
14	wqparreg	-	optional	region for water quality correction parameters (e.g. incorr), integer > 0
15	elev_mean	*m*	optional	mean elevation of sub-basin
16	elev_std	*m*	optional	variation (standard deviation) in elevation in a subbasin
17	slope_mean	%	optional/mandatory	slope (>= 0%), mandatory for nutrient modelling
18	slope_std	%	optional	variation (standard deviation) of slope in a subbasin
19	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. Definition there takes precedence. Must be > 0
20	lakedataid	-	optional	lake or lake basin ID, coupled to *lakedataid* in LakeData.txt, 0 if no such coupling exists
21	icatch	-	mandatory	Fraction of local runoff which runs through the local lake (ilake), the rests runs directly into the main watercourse
22	rivlen	*m*	mandatory	length of main watercourse within subbasin
23	slc_nn	-	mandatory	soil-type/land-use class number *nn* (soil-landuse-combination class, hydrological response units in HYPE), fraction of the subbasin's area belonging to this class (between 0 and 1). A maximum of 99 SLCs can be defined *nn* matches the first column in GeoClass.txt
24	scr_nn	-	optional	fraction of SLC class nn's area that is sown with secondary crop (between 0 and 1)
25	dhslc_nn	*m*	optional	deviation for each class from mean elevation of subbasin (defaults to 0)

#	Variable ID	Unit	Requirement	Description
26	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.
27	grwolake	-	optional	fraction of groundwater flow from this subbasin that flows to this subbasins olake instead of to subbasin given in grwdown
28	loc_tp	*mg/l*	optional	concentration of Tot-P from rural households outflow
29	loc_tn	*mg/l*	optional	concentration of Tot-N from rural households outflow
30	loc_vol	m^3/d	optional	outflow from rural households
31	loc_sp	-	optional	fraction of rural household P outlet that is in soluble form
32	loc_in	-	optional	fraction of rural household N outlet that is in soluble form
33	wetdep_n	*µg/l*	optional	wet deposition of inorganic nitrogen, concentration of precipitation
34	drydep_n1	$kg/(km^2 d)$	optional	dry deposition of inorganic nitrogen on land-use group 1
35	drydep_n2	$kg/(km^2 d)$	optional	dry deposition of inorganic nitrogen on land-use group 2
36	drydep_n3	$kg/(km^2 d)$	optional	dry deposition of inorganic nitrogen on land-use group 3
37	lrwet_area	m^2	optional	area of local river wetland
38	mrwet_area	m^2	optional	area of main river wetland
39	lrwet_dep	*m*	optional	mean depth of local river wetland
40	mrwet_dep	*m*	optional	mean depth of main river wetland
41	lrwet_part	-	optional	part of local river flow through wetland
42	mrwet_part	-	optional	part of main river flow through wetland
43	buffer	-	optional	fraction of watercourse through agricultural land that has a buffer zone (between 0 and 1), mandatory for phosphorus simulation
44	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
45	ps1_tp	*mg/l*	optional	concentration of Tot-P in point source 1 outflow
46	ps1_tn	*mg/l*	optional	concentration of Tot-N in point source 1 outflow
47	ps1_vol	m^3/d	optional	outflow from point source 1
48	ps1_sp	-	optional	fraction of point source 1 P that is in soluble form
49	ps1_in	-	optional	fraction of point source 1 N that is in inorganic form
50	ps2_tp	*mg/l*	optional	concentration of Tot-P in point source 2 outflow
51	ps2_tn	*mg/l*	optional	concentration of Tot-N in point source 2 outflow
52	ps2_vol	m^3/d	optional	outflow from point source 2
53	ps2_sp	-	optional	fraction of point source 2 P that is in soluble form
54	ps2_in	-	optional	fraction of point source 2 N that is in inorganic form
55	ps3_tp	*mg/l*	optional	concentration of Tot-P in point source 3 outflow
56	ps3_tn	*mg/l*	optional	concentration of Tot-N in point source 3 outflow

#	Variable ID	Unit	Requirement	Description
57	`ps3_vol`	*m^3/d*	optional	outflow from point source 3
58	`ps3_sp`	-	optional	fraction of point source 3 P that is in soluble form
59	`ps3_in`	-	optional	fraction of point source 3 N that is in inorganic form

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 and additionally to define minimum and maximum flow limits.

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.

LakeData.txt

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

Outlet lakes in HYPE can cover a fraction of a sub-basin or the whole sub-basin. Large lake systems can be split into several sub-basins themselves (lake basins), which allows for different properties in different lake basins. Outlet flows for such lakes are then defined in an additional entry in *LakeData.txt*, see variable and column `LdType` in table below.

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 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 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 REGAMP
RATE EXP ...
         1      0      1        3.6  5000  7.67      0      0      0      0
40   2 ...
         0      1      2        7.2 34000 21.94   13.5    401    200    0.4
155 0.3 ...
         2      1      3        6.9  4000     0      0      0      0      0
0   0 ...
         3      1      4          5 30000     0      0      0      0      0
0   0 ...
       ...    ...    ...        ...   ...   ...    ...    ...    ...    ...
... ... ...
```

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

Variable ID	Unit	Type	LdType	Description
`lakedataid`	-	*general*	*1/3/4*	lake/lake basin ID (integer), used to connect lakes/lake basins to subbasins in GeoData.txt (mandatory)
`lakeid`	-	*general*	*2/3/4*	lake ID (integer), used to connect lake basins to multi-basin lakes. Unique integer, 0 for simple outlet lakes (`ldtype` = 1)

Variable ID	Unit	Type	LdType	Description
`ldtype`	-	*general*	*all*	code for lake data type, integer betwen 1 and 4 (mandatory): **1** - simple outlet lake **2** - multi-basin lake, i.e. covering several HYPE sub-basins, generic lake/outflow properties **3** - upstream lake basin of a multi-basin lake **4** - last/outlet lake basin of a multi-basin lake
`lake_depth`	*m*	*physical property*	*all*	water depth below threshold for outlet lake (mean depth), can also be defined in GeoData.txt (must be > 0)
`area`	m^2	*physical property*	*all*	lake or lake basin area, used for multi-basin lakes and to check which fraction of the sub-basin is covered by the outlet lake for simple outlet lakes (compared with SLC class fraction in GeoData.txt), mandatory for `ldtype` = 2
`w0ref`	*m*	*general*	*1/2*	reference water level to be added to simulated water level before print out, for lake outflow threshold
`rate`	m^2/time step	*general/regulation*	*1/2*	parameter for specific rating curve of unregulated lakes or for spillway flow of regulated lakes above threshold (`w0ref`), equation $q = rate\ (w - w0)^{exp}$
`exp`	-	*general/regulation*	*1/2*	parameter for specific rating curve of unregulated lakes or for spillway flow of regulated lakes above threshold (`w0ref`), equation$q = rate\ (w - w0)^{exp}$
`deltaw0`	*m*	*regulation*	*1/2*	difference in lake threshold for regulation with two rating curves (m). Determines the lake threshold for regulation period 2 (w0=`w0ref` + `deltaw0`), see `qprod1` and `qprod2`
`qprod1`	m^3/s	*regulation*	*1/2*	parameter for regulated olake, constant production flow down to lowest allowed waterstage for regulation period 1
`qprod2`	m^3/s	*regulation*	*1/2*	parameter for regulated olake, constant production flow down to lowest allowed waterstage for regulation period 2
`datum1`	-	*regulation*	*1/2*	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*	*1/2*	parameter for regulated olake, start of regulation period 2 (4 character month-day string *mmdd*)
`qamp`	-	*regulation*	*1/2*	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`), where the minimum of the sinus wave occurs for day number qpha
`qpha`	-	*regulation*	*1/2*	parameter for regulated olake, seasonally varying flow below the threshold. day number for the minimum of the sinus wave. Default is qpha = 102.
`regvol`	$10^6\ m^3$	*regulation*	*1/2*	regulation volume for general regulation routine. Determines lowest water stage for production flow. (must be less than lake depth * lake area)

Variable ID	Unit	Type	LdType	Description
wamp	*m*	*regulation*	*1/2*	regulation amplitude. Usually larger than water depth given by regvol. Used for scaling output water stage (wcoa) to larger variation than given by regvol. Set to -9999 for not to use.
prodpp	*m/d*	*nutrient cycling*	*1/3/4*	parameter for internal load of Part-P
prodsp	*m/d*	*nutrient cycling*	*1/3/4*	parameter for internal load of SRP (m/d)
Qmean	*mm/y*	*physical property*	*1/3/4*	initial value for calculation of mean flow, can also be defined in par.txt
tpmean	*mg/l*	*nutrient cycling*	*1/3/4*	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*	*1/3/4*	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*	*1/3/4*	mean concentration of TOC (mg/l), used as initial value of TOC concentration in lakes. Can also be defined in par.txt
limqprod	*-*	*regulation*	*1/3/4*	parameter for water level below which there is reduced production flow from a dam (fraction of regulating volume), the flow reduction is linear to wmin. Can also be defined in par.txt
sedon	*m/d*	*nutrient cycling*	*1/3/4*	sedimentation rate for ON in lakes. Can also be defined in par.txt
sedpp	*m/d*	*nutrient cycling*	*1/3/4*	sedimentation rate for PP in lakes. Can also be defined in par.txt
sedoc	*m/d*	*nutrient cycling*	*1/3/4*	sedimentation rate for OC in lakes. Can also be defined in par.txt
wprodn	*kg/(m^3 d)*	*nutrient cycling*	*1/3/4*	production/degradation in water for N. Can also be defined in par.txt
wprodp	*kg/(m^3 d)*	*nutrient cycling*	*1/3/4*	production/degradation in water for P. Can also be defined in par.txt
wprodc	*kg/(m^3 d)*	*nutrient cycling*	*1/3/4*	production/degradation in water for C. Can also be defined in par.txt.
denitwl	*kg/(m^2 d)*	*nutrient cycling*	*1/3/4*	parameter for denitrification in lakes. Can also be defined in par.txt
deeplake	*-*	*physical property*	*1/3/4*	fraction of the lake's initial volume which is considered as slow (SLP), between 0 and 1. 0 means that the lake is not divided into a slow and a fast part. Can also be defined in par.txt
fastlake	*-*	*physical property*	*1/3/4*	fraction of lake outflow that comes from the fast lake part (FLP), between 0 and 1. Can also be defined in par.txt

DamData.txt

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

DamData.txt can only be used for standard olake (ldtype=1 as defined for 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, 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 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
qprod2	m^3/s	*1/2/4*	parameter for regulated olake, constant production flow down to lowest allowed waterstage for regulation period 2

Variable ID	Unit	Purpose	Description
`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`), where the minimum of the sinus wave occurs for day number `qpha`
`qpha`	-	*4*	parameter for regulated olake, seasonally varying flow below the threshold. day number for the minimum of the sinus wave.
`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`	*m^2/time step*	*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 output water stage (`wcoa`) to larger variation than given by regvol. Set to -9999 for not to use.
`qinfjan`	*m^3/s*	*all*	mean January inflow to reservoir (can be taken from a model run without reservoirs for example)
`qinffeb`	*m^3/s*	*all*	mean Fabruary inflow to reservoir (can be taken from a model run without reservoirs for example)
`qinfmar`	*m^3/s*	*all*	mean March inflow to reservoir (can be taken from a model run without reservoirs for example)
`qinfapr`	*m^3/s*	*all*	mean April inflow to reservoir (can be taken from a model run without reservoirs for example)
`qinfmay`	*m^3/s*	*all*	mean May inflow to reservoir (can be taken from a model run without reservoirs for example)
`qinfjun`	*m^3/s*	*all*	mean June inflow to reservoir (can be taken from a model run without reservoirs for example)
`qinfjul`	*m^3/s*	*all*	mean July inflow to reservoir (can be taken from a model run without reservoirs for example)
`qinfaug`	*m^3/s*	*all*	mean August inflow to reservoir (can be taken from a model run without reservoirs for example)
`qinfsep`	*m^3/s*	*all*	mean September inflow to reservoir (can be taken from a model run without reservoirs for example)
`qinfoct`	*m^3/s*	*all*	mean October inflow to reservoir (can be taken from a model run without reservoirs for example)
`qinfnov`	*m^3/s*	*all*	mean November inflow to reservoir (can be taken from a model run without reservoirs for example)

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

CropData.txt

This file includes variables relating to crops, including irrigation characteristics, and other vegetation. All vegetation is called crops in the text below, e.g. also forest. *CropData.txt* is **only needed for nutrient modelling**. 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.

#	Variable ID	Unit	Type	Description
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)
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)

#	Variable ID	Unit	Type	Description
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 all crops in the summer and for year round crops (e.g. forest)

#	Variable ID	Unit	Type	Description
37	ccmax2	-	Turnover	maximum degree of crop cover for autumn crops in autumn and winter
38	gcmax1	-	Turnover	maximum degree of crop cover for all crops in the summer and for year round crops (e.g. forest) whole year, also degree of crop cover for harvested crops
39	gcmax2	-	Turnover	maximum degree of crop cover for autumn crops in autumn and winter
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
50	imm_end	*julian day*	Irrigation	day number for end of immersion period (immersion period must be contained in irrigation period)
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)

PointSourceData.txt

This file contains points source concentrations and discharges. HYPE allows to separate three types of point sources, e.g. wastewater treatment plants, industries, and urban stormwater. Conceptually, all three are treated the same by HYPE (see here), 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. The point sources file can also be used for water abstraction sinks, if point source discharges volume are set to values < 0.

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. 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.

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

Variable ID	Unit	Description
`subid`	-	id number for subbasin in which point source is located, integer < 10^8
`ps_type`	-	point source type, integer between 1 and 3, default is 1 (irrelevant if water abstraction)
`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_tnconc`	*mg/l*	concentration of Tot-N 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_infrac`	-	fraction of Tot-N in point source that is in inorganic form (irrelevant if water abstraction)
`ps_t1`	-	concentration of tracer T1 in point source (irrelevant if water abstraction)'
`ps_t2`	-	temperature of point source water (used for T2 simulation) (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`	-	integer code for abstraction from main river (1) or outlet lake (2), default is 1 (irrelevant if point source)

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

First example: first row: a constant point source of waste water with nutrients; second row: a larger constant point source of 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       1
```

```
765   2       2301   2         100       0.3       0.9       1
4050  3       -100   0         0         0         0         2
```

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

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

MgmtData.txt

This file hold information about irrigation.

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.

Columns:

Column	Format	Description
`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 water demand (1=constant, 2=soil water deficit, 3=threshold dependent).

AquiferData.txt

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

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

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

```
NAME AREA SUBID POROSITY BASEDEPTH TOPDEPTH INIDEPTH RECHARGE AQUID RETFRAC
RETRATE DELAY PARREG
none 1500     1        0         0        0        0        1     1       0
0     0      0
none 2000     2        0         0        0        0        1     1       1
0     0      0
Aqu1 3500     0     0.15       -55       -5       -7        0     1       0
3.5E-08    10       1
none 4000     3        0         0        0        0        1     1     0.3
0     0      0
none 3200     4        0         0        0        0        1     1     0.7
0     0      0
Aqu2 7200     0     0.09       -20       -2       -4        0     1       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.
`subid`	-	All	subbasin ID (integer). Zero is used for row which defines aquifer characteristics.
`recharge`	-	sub-basin	subbasin contributes to aquifer recharge (0 = no, 1 = yes)
`retfrac`	-	sub-basin	subbasin receive this fraction of the return flow from the aquifer (between 0 and 1)
`topdepth`		aquifer	depth below surface of top of aquifer (negative m) (needed for nitrogen simulation)

Variable ID	Unit	Requirement	Description
`basedepth`	*m*	aquifer	depth below surface of base of aquifer (negative)
`inidepth`	*m*	aquifer	initial/average water table depth (below surface) of aquifer (negative)
`porosity`	-	aquifer	average porosity of aquifer
`area`	*m2*	aquifer	aquifer horizontal area, used together with inidepth to calculate initial aquifer volume
`retrate`	-	aquifer	recession coefficient for aquifer return flow (between 0 and 1)
`delay`	*days*	aquifer	parameter for deep percolation delay (days until 63% ($1-e^{-1}$) of the flow has gotten through)
`parreg`	-	aquifer	parameter region for aquifer
`temp`	*°C*	aquifer	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.

FloodData.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. 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

GlacierData.txt

This file contains definitions for HYPE's glacier module, see process descriptions in the glaciers section of the HYPE model description. Glaciers is 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*	The default type is glacier (0), the alternative type is ice cap (1)
`logvolcorr`	-	correction of volume-area relationship coefficient due to combining several glaciers into one class area (no correction=0)

par.txt

The file *par.txt* holds model parameters, some of which can be calibrated. The parameters 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.

Fix Me! this is a draft only, needs more work Fix Me!

- fill units column in table
- parameters that can be in lakedata need to be marked?
- need additional column linking to model component?
- indicate model time-step dependency
- rework intro text

The file is located in the modeldir folder. A parameter is given per row with parameter name and value for all soil-types/land-uses/subbasins/regions/month or general. A single value may not be larger than 10 letters. Comment rows are allowed anywhere in the file and start with a double exclamation mark `!!`.

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

```
!! field capacity 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 over the whole model
domain
lp    0.8
...
```

The table below describes all available calibration parameters.

Parameter ID	Unit	Dependency	Description
wcfc	-	soil type	fraction of soil available for evapotranspiration but not for runoff, same for all soil layers (used if wcfc1 not given)
wcwp	-	soil type	wilting point as a fraction, same for all soil layers (used if wcwp1 not given)
wcep		soil type	effective porosity as a fraction, same for all soil layers (used if wcep1 not given)
wcfc1	-	soil type	fraction of soil available for evapotranspiration but not for runoff, for uppermost soil layer
wcwp1	-	soil type	wilting point as a fraction, for uppermost soil layer
wcep1	-	soil type	effective porosity as a fraction, for uppermost soil layer
wcfc2	-	soil type	fraction of soil available for evapotranspiration but not for runoff, for second soil layer
wcwp2	-	soil type	wilting point as a fraction, for second soil layer
wcep2	-	soil type	effective porosity as a fraction, for second soil layer

Parameter ID	Unit	Dependency	Description
`wcfc3`	-	soil type	fraction of soil available for evapotranspiration but not for runoff, for lowest soil layer
`wcwp3`	-	soil type	wilting point as a fraction, for lowest soil layer
`wcep3`	-	soil type	effective porosity as a fraction, for lowest soil layer
`mperc1`	*mm/timestep*	soil type	maximum percolation capacity from soil layer 1 to soil layer 2
`mperc2`	*mm/timestep*	soil type	maximum percolation capacity from soil layer 2 to soil layer 3
`cmlt`		land use	melting parameter for snow (mm/degree/time step)
`ttmp`	*°C*	land use	threshold temperature for snow melt, snow density and evapotranspiration
`ttpd`	*°C*	general	deviation from ttmp for threshold temperature for snow-/rainfall
`ttpi`	*°C*	general	half of temperature interval with mixed snow- and rainfall, (ttmp+ttpd)+/-ttpi
`cevp`		land use	evapotranspiration parameter (mm/degree/d)
`t1evap`	-	general	evaporation factor for substance T1 (0-1), default is 0, if 1 the substance evaporates with the water
`frost`		land use	frost depth parameter (cm/degree Celsius) (both frost and sfrost must be >0 for simulation to occur)
`sfrost`		soil type	frost depth parameter (cm/degree Celsius) (both frost and sfrost must be >0 for simulation to occur)
`deepmem`	*d*	general	deep soil temperature memory
`surfmem`	*d*	land use	upper soil layer soil temperature memory
`depthrel`		land use	depth relation for soil temperature memory (/m)
`rrcs1`		soil type	recession coefficient for uppermost soil layer
`rrcs2`		soil type	recession coefficient for lowest soil layer
`rrcs3`		general	recession coefficient for slope dependence (upper layer)
`srrcs`		land use	recession coefficient for surface runoff (fraction), should be set to 1 for lake and riverclasses with floodplains
`trrcs`		soil type	recession coefficient for tile drains
`rrcscorr`		parreg	correction factor for recession rrcs=rrcs(1+rrcscorr) for rrcs1,rrcs2,trrcs and srrcs
`cevpam`		general	amplitude of sinus function (about 1) that corrects potential evapotranspiration.
`cevpph`		general	phase of sinus function that corrects potential evapotranspiration (days)
`cevpcorr`		parreg	correction factor for evapotranspiration cevap=evap(1+cevpcorr)
`lp`		general	limit for potential evapotranspiration
`gratk`		general	discharge curve for lake $Q = gratk \times \left(w - w0\right)^{gratp}$
`gratp`		general	discharge curve for lake $Q = gratk \times \left(w - w0\right)^{gratp}$

Parameter ID	Unit	Dependency	Description
grata		general	upstream area dependence of discharge curve for lake, if grata>0 and uparea>0 $Q=\left(gratk\times\left(uparea\right)^{grata}\right)\times\left(w-w0\right)^{gratp}$ (default is grata=0)
limqprod		general	limit for water stage with reduced production flow from dam (fraction of regulating volume)
krelflood		general	factor for increased production flow from flood control dam
kthrflood		general	factor for flow threshold for increased production flow from flood control dam
klowflood		general	factor for water level threshold with production flow from flood control dam equal to inflow
rivvel		general	celerity of flood in watercourse (m/s)
damp		general	fraction of delay in the watercourse which also causes damping
deadl	m^2/km^2	general	parameter to calculate the dead volume in the local watercourse
deadm	m^2/km^2	general	parameter to calculate the dead volume in the main watercourse
tcalt	*°C/100m*	general	parameter for temperature's elevation dependence, uses SLC's deviation from subbasin mean height (=0.6°C/100m)
tempcorr	*°C*	parreg	correction parameter for temperature
tcelevadd	*°C/100m*	general	parameter for temperature's elevation dependence, uses subbasin mean height
tcobselev	*°C/100m*	general	parameter for temperature correction due to observation elevation deviation from subbasin elevation
pcaddg		general	correction parameter for precipitation
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+pcurain). See notes for pcurain.
pcluse		land use	correction factor for precipitation prec=prec(1-pcluse)
pcelevadd		general	correction parameter for precipitation (per 100m, elevations > pcelevth)
pcelevth		general	elevation above which the precipitation correction (pcelevadd) is used (m)
pcelevmax		general	maximum for height dependent precipitation correction (part)
pcelevstd		general	correction parameter for precipitation (per 100m elevation standard deviation)

Parameter ID	Unit	Dependency	Description
preccorr		parreg	correction factor for precipitation prec=prec(1+preccorr)
gldepi	*m*	general	depth for all ilakes
denitrlu	d^{-1}	land use	parameter for denitrification i soil
degradhp	d^{-1}	land use	decay of humus to fastP
degradhn	d^{-1}	land use	decay of humus to fastN
minerfn	d^{-1}	land use	mineralisation of fastN to inorganic N
minerfp	d^{-1}	land use	mineralisation of fastP to SRP
dissolfp	d^{-1}	land use	decay of fastP to dissolved PP
dissolfn	d^{-1}	land use	decay of fastN to dissolved organic N
dissolhp	d^{-1}	land use	decay of humusP to dissolved PP
dissolhn	d^{-1}	land use	decay of humusN to dissolved organic N
wprodn		general	production/decay of N in water (kg m-3 d-1) (can also be defined in LakeData.txt)
wprodp		general	production/decay of P in water (kg m-3 d-1) (can also be defined in LakeData.txt)
wprodc		general	production/decay of OC in water (kg m-3 d-1) (can also be defined in LakeData.txt)
sedon		general	sedimentation rate of ON in lakes (m/d) (can also be defined in LakeData.txt)
sedpp		general	sedimentation rate of PP in lakes (m/d) (can also be defined in LakeData.txt)
sedexp		general	parameter for sedimentation/resuspension in watercourses
denitwrl		general	parameter for denitrification in local watercourse (kg m-2 d-1)
denitwrm		general	parameter for denitrification in main watercourse (kg m-2 d-1)
denitwl		general	parameter for denitrification in lakes (kg m-2 d-1)
humusN0		land use	starting value for pool in soil of humusN (mg/m3)
humusP0		land use	starting value for pool in soil of humusP (mg/m3)
fastN0		general	starting value for pool in soil of fastN (mg/m3)
partP0		land use	starting value for pool in soil of partP (mg/m3)
fastP0		general	starting value for pool in soil of fastP (mg/m3)
occonc0		land use	starting value, organic carbon concentration in soil (mg/l)
onconc0		land use	starting value, organic nitrogen concentration in soil (mg/l)
ppconc0		land use	starting value, particulate phosphorus concentration in soil (mg/l)
onpercred		land use	reduction of ON concentration in percolating water
pppercred		land use	reduction of PP concentration in percolating water
pPhalf	*m*	land use	half depth for partP pool
hPhalf	*m*	land use	half depth for humusP pool
hNhalf	*m*	land use	half depth for humusN pool
iniT1		general	starting value in soil, concentration T1
iniT1sw		general	starting value in surface water, concentration T1
iniT2		general	starting value in soil, T2

Parameter ID	Unit	Dependency	Description
freuc	*kg^{-1}*	soil type	parameter in Freundlich equation (coefficient)
freuexp		soil type	parameter in Freundlich equation (exponent)
freurate	*d^{-1}*	soil type	parameter that steers adsorption/desorption speed
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)
drydeppp		land use	dry deposition of PP (kg/km2 d-1)
wetdepsp		general	wet deposition of SP (ug/L)
aloadconst		general	status to keep wet deposition load constant if precipitation is corrected (if set to 1, 0 is default)
srrate	-	soil type	fraction for surface runoff
macrate	-	soil type	fraction for macro-pore flow
mactrinf	*mm/timestep*	soil type	threshold for macro-pore flow
mactrsm	*mm*	soil type	threshold soil water for macro-pore flow and surface runoff
soilcoh	*kPa*	soil type	characteristic of soil for calculation of erosion (cohesion)
soilerod	*g/J*	soil type	characteristic of soil for calculation of erosion (erodibility)
epotdist		general	coefficient in exponential function for potential evapotranspiration's depth dependency
qmean		general	initial value for calculation of mean flow (mm/yr) (can also be defined in LakeData.txt)
tpmean	*mg/L*	lakeregion	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
tnmean	*mg/L*	lakeregion	mean TN level i lakes, used as starting value for concentration of organic N in lakes Can also be defined in LakeData.txt
rivvel1		lakeregion	parameter for calculation of velocity of the water in the watercourse
rivvel2		lakeregion	parameter for calculation of velocity of the water in the watercourse
rivvel3		lakeregion	parameter for calculation of velocity of the water in the watercourse
rivwidth1		lakeregion	parameter for calculation of the width of the watercourse
rivwidth2		lakeregion	parameter for calculation of the width of the watercourse
rivwidth3		lakeregion	parameter for calculation of the width of the watercourse
maxwidth		general	parameter for limitation of width of the watercourse
sreroexp		general	exponent in the equation for calculation of erosion caused by surface runoff
pprelmax		general	parameter for PP from surface runoff and tile drains
pprelexp		general	parameter for PP from surface runoff and tile drains
sdnsnew	*g cm^{-3}*	general	density of new-fallen snow (former snowdens0)
snowdensdt	*g cm^{-3} ts^{-1}*	general	increase of snow density per day
sdnsmax	*g cm^{-3}*	general	maximum snow density
sdnsrate	*ts^{-1}*	general	increase of snow density per timestep
sdnsradd	*ts^{-1}*	general	additional increase of snow density per timestep for warm days

Parameter ID	Unit	Dependency	Description
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
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
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
macrofilt		soil type	filtration (retention) of PartP with macropore flow (fraction)
fertdays		general	number of days that fertiliser applications occur counting from application day 1 and forward using the same amount every day
litterdays		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 value for pool in soil's uppermost soil layer of humus C
fastc1	$mg\ m^{-3}$	land use	starting value for pool in soil's uppermost soil layer of litter C
humusc2	$mg\ m^{-3}$	land use	starting value for pool in soil's second soil layer of humus C
fastc2	$mg\ m^{-3}$	land use	starting value for pool in soil's second soil layer of litter C
humusc3	$mg\ m^{-3}$	land use	starting value for pool in soil lowest soil layer of humus C
fastc3	$mg\ m^{-3}$	land use	starting value for pool in soil lowest soil layer of litter C
klh	d^{-1}	general	parameter for speed of transformation from litter to humus
klo	d^{-1}	general	parameter for speed of transformation from litter to DOC
kho	d^{-1}	general	parameter for speed of transformation from humus to DOC
kof	d^{-1}	general	parameter for speed of transformation from DOC to fastC
koflim	-	general	parameter for threshold for wetness for transformation DOC to fastC
koc	-	general	parameter for DOC-concentrations reduction for percolation
kcgwreg	-	general	parameter for DOC-concentrations reduction with flow out to regional groundwater
sedoc	*m/d*	general	sedimentation rate OC in lakes. Can also be defined in LakeData.txt.
ripz		land use	parameter for OC processes in riparian zone
ripe		general	exponent for groundwater depth dependence of OC processes in riparian zones
rips		general	seasonal factor for OC processes in riparian zones
tocmean		lakeregion	mean OC fraction in lakes (mg/l), used that starting value for concentrations of TOC in lakes (can also be defined in LakeData.txt)
minc	-	general	fraction of decay mineralised to DIC

Parameter ID	Unit	Dependency	Description
ocsoimsat	-	land use	saturation in soil moisture function for degradation of soil organic carbon
ocsoimslp	%	land use	slope in soil moisture function for degradation of soil organic carbon
deeplake		general	part of the lake's initial volume which is considered as slow (SLP), integer 0-1. 0 means that the lake is not divided into a slow and a fast part. Can also be defined in LakeData.txt. Use deeplake=0 if floodplains are simulated
fastlake		general	part of a lake outflow that comes from the fast lake part (FLP), integer 0-1. Can also be defined in LakeData.txt.
laketemp		general	parameter for depth dependent lake temperature (d) 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		land use	parameter for snowmelt model 2 (1/timestep)
cmrad		land use	coefficient for radiation snow melt, parameter for snowmelt model 2
t2trriver		general	heat transfer parameter for water temperature T2 of river
t2trlake		general	heat transfer parameter for water temperature T2 of lake
upper2deep		general	heat transfer parameter for water temperature T2 between lake parts
tcfriver		general	air-riverwater heat flow, temperature difference coefficient
scfriver		general	air-riverwater heat flow, solar radiation coefficient
ccfriver		general	air-riverwater heat flow, constant coefficient
lcfriver		general	air-riverwater heat flow, linear coefficient
tcflake		general	air-lakewater heat flow, temperature difference coefficient
scflake		general	air-lakewater heat flow, solar radiation coefficient
ccflake		general	air-lakewater heat flow, constant coefficient
lcflake		general	air-lakewater heat flow, linear coefficient
stbcorr1		general	parameter for stability correction
stbcorr2		general	parameter for stability correction
stbcorr3		general	parameter for stability correction
licettf	*°C*	general	lake ice model, water temperature threshold for freeze-up
licetf	*°C*	general	lake ice model, freezing temperature
licesndens	$g\ cm^{-3}\ d^{-1}$	general	lake ice model, snow compaction parameter
licekika		general	lake ice model, ratio between thermal conductivity of ice and heat exchange coefficient in air
licekexp		general	lake ice model, water temperature threshold for freeze-up
licetmelt		general	lake ice model, melt factor for ice (cm/C)
licewcorr		general	lake ice model, snowfall reduction for wind drift
ricettf	*°C*	general	river ice model, water temperature threshold for freeze-up
ricetf	*°C*	general	river ice model, freezing temperature

Parameter ID	Unit	Dependency	Description
ricesndens		general	river ice model, snow compaction parameter (g cm-3 d-1)
ricekika		general	river ice model, ratio between thermal conductivity of ice and heat exchange coefficient in air
ricekexp		general	river ice model, water temperature threshold for freeze-up
ricetmelt	*cm/°C*	general	river ice model, melt factor for ice
fscmax	-	general	maximum fractional snow cover area
fscmin	-	general	minimum fractional snow cover area
fsclim	-	general	limit of fractional snow cover area for onset of snowmax
fscdistmax	-	land use	maximum snow distribution factor
fscdist0	-	land use	minimum snow distribution factor
fscdist1	m^{-1}	land use	std coefficient for snow distribution factor
fsck1	-	general	parameter for snowmax
fsckexp	s^{-1}	general	parameter for snowmax
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 only for the temperature and radiation index snow melt model.
fepotsnow		general	fraction of snow-free potential evapotranspiration, used for calculation of snow evaporation.
krs		general	parameter for radiation, Hargreaves adjustment factor
jhtadd		general	parameter for petmodel 2
jhtscale		general	parameter for petmodel 2
alfapt		general	parameter for petmodel 4
mwind	*m/s*	general	average wind speed, used for petmodel 5 when no wind forcing available
zwind	*m*	general	wind observation height, default is 10
zwish	*m*	general	wanted wind height, default is 2
zpdh	*m*	general	zero plane displacement height
roughness	-	general	surface roughness (for observed wind)
kc		land use	crop coefficient for petmodels
alb		land use	albedo for petmodels
incorr	-	wqparreg	*super-parameter*, regional correction factor for parameter governing inorganic nitrogen: $par = par \times (1 + incorr)$ for degradhn and $par = par \times (1 - incorr)$ for denitrlu, denitwl, denitwrm, and denitwrl **Note**: denitwl in LakeData.txt will also be affected by this correction factor

Parameter ID	Unit	Dependency	Description
oncorr	-	wqparreg	*super-parameter*, regional correction factor for parameter governing organic nitrogen: $par = par \times \left(1 + oncorr\right)$ for dissolhn and $par = par \times \left(1 - oncorr\right)$ for sedon **Note**: sedon in LakeData.txt will also be affected by this correction factor
phoscorr	-	wqparreg	*super-parameter*, regional correction factor for parameter governing phosphorus: $par = par \times \left(1 + phoscorr\right)$ for soilerod, dissolhP, fastP0, humusP0, and partP0
ratcorr	-	parreg	correction factor for discharge gratk=gratk(1+ratcorr)
ponatm	-	land use	correction factor for atmospheric deposition of IN, fraction that goes to fastN-pool instead
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.
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.
sswcorr		general	rescaling factor for the soil water stress irrigation threshold (-). sswcorr=1 implies no rescaling. sswcorr=0 if not set.
iwdfrac		general	fraction of the irrigation threshold which constitutes irrigation water demand. Note iwdfrac can be >1. (-). Only used if demandtype=3.
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 (-)
irrdemand		general	the irrigation water demand for subbasins with demandtype=1 (mm/timestep)
immdepth		general	target submergence depth for submerged irrigated crops (mm)
cirrsink		parreg	concentration reduction fraction in settlement tanks at irrigation abstraction points (-)
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.
glacdens		general	density of glacier ice (default value=0.85)
glacvcoef		general	coefficient of glacier area-volume relationship for glacier of type 0 (default), (default value=0.205)
glacvexp		general	exponent of glacier area-volume relationship for glacier of type 0 (default), (default value=1.375)

Parameter ID	Unit	Dependency	Description
glacvcoef1		general	coefficient of glacier area-volume relationship for glacier of type 1, (default value=1.701)
glacvexp1		general	exponent of glacier area-volume relationship for glacier of type 1, (default value=1.25)
glac2arlim		general	area limit for determine glacier type
glaccmlt		general	melting parameter for glacier (mm/degree/time step)
glacttmp		general	threshold temperature (degree Celsius) for glacier melt
glaccmrad		general	coefficient for radiation glacier melt, parameter for snowmelt model 2
glaccmrefr		general	refreeze efficiency compared to the degree-day glacier melt factor, parameter for snow meltmodel 2
glacalb		general	albedo for glacier ice
fepotglac		general	fraction of snow-free potential evapotranspiration, used for calculation of glacier evaporation.
rcgrw		general	recession coefficient for regional groundwater outflow from soil layers (deepground=1 (and 2))
rcgrwst		soil type	recession coefficient for deep percolation flow out of soil layers (deepground=2) (0-1)
aqretcor		aquid	adjustment of recession coefficients newpar=oldpar(1+aqcor) for aquifer return flow
aqdelcor		aquid	adjustment of deep percolation delay to aquifers newpar=oldpar(1+aqcor) for aquifer return flow
aqpercor		aquid	adjustment of deep percolation to aquifers newpar=oldpar(1+aqcor) for aquifer return flow
monthlapse	*°C/100m*	month	alternative parameter for temperature correction with elevation, monthly temperature lapse rate (positive when decresasing with elevation, same as *tcalt* and *tcelevadd*)
limsedON	*mg L^{-1}*	general	concentration of ON deducted from conc in water when sedimentation is calculated. This should represent the dissolved organic nitrogen.
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.
optonoff	-	general	switch for using general parameters op1-opt8 instead of flooding data of FloodData.txt (0/1, 1=use op1-opt8)
opt1	*m*	general	parameter replacing FloodData.txt values of floll
opt2	*m*	general	parameter replacing FloodData.txt values of flolp
opt3	*m*	general	parameter replacing FloodData.txt values of flmrr
opt4	*m*	general	parameter replacing FloodData.txt values of flmrp
opt5	-	general	parameter replacing FloodData.txt values of rclfp and rcrfp
opt6	*m*	general	parameter replacing FloodData.txt values of fymol
opt7	*m*	general	parameter replacing FloodData.txt values of fymmr
opt8	-	general	parameter replacing FloodData.txt values of rcfpl and rcfpr

qNstartpar.txt

The file is located in the modeldir folder given in info.txt. This 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 value from position 10. The parameters must be given in the same order as in optpar.txt, and only those with interval to vary within.

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
```

reg_par.txt

The file is located in the modeldir folder. The file is used for the calculation of the regional parameters as a linear function 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 three parameters (`tcalt`,`cevpcorr`,and `tcalt`) in a model setup where there are two groups of catchments.

Example of a *reg_par.txt* file structure:

```
3
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 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 first row of the *CatchDes.txt* file gives the number of catchment descriptors (number of columns in the subsequent rows). Then follow one row for each subbasin with the values of the descriptors for the subbasin. The row must be in the same order as in GeoData.txt Fix Me! . No column heading or subid is given. The first column is always 1.0 and serves as an intercept in the linear estimator.

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

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

CatchGroup.txt

The file is located in the modeldir folder. The file is used for the calculation of the regional parameters as a linear function of catchment descriptors. This is used when model option `regestimate` is set in info.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 (Fix Me!). The file has no heading, and no extra columns are allowed.

ForcKey.txt/ForcKey_nnn.txt

The file is optional and located in the modeldir folder given in info.txt. If the file is found its information is used and have priority over the same information found in GeoData.txt. The file holds data on the coupling between subbasins and forcing data. It also hold information about elevation for temperature observations (Tobs.txt) that may be used for temperature corrections with parameter `tcobselev`.

Column heading is on first row, data from second and onward. The number of data rows is assumed to be the same as in GeoData.txt. No missing values may exist (program won't check!). Columns with unknown column heading are skipped while reading the file. Such text column may contain at most 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 of sequence with seqnr nnn. For seqnr 0 is ForcKey.txt used.

ForcData.txt/ForcData_nnn.txt

The file is optional and located in the modeldir folder given in info.txt. If the file is found its information is used and have priority over the same information found in ForcKey.txt. The file holds information about elevation for temperature observations (Tobs.txt) that may be used for temperature corrections with parameter `tcobselev`.

Column heading is on first row, data from second and onward. The number of data rows is assumed to be the same as in GeoData.txt. No missing values may exist (program won't check!). Column with unknown column heading are skipped while reading the file. Such text column may contain at most 100 characters.

Column	Format	Description
`tobsid`	*integer*	id number for air temperature data (<100000000)
`tobselev`	*real*	elevation of temperature observation in meter

ForcData_nnn.txt holds information on forcing data of sequence with seqnr nnn. For seqnr 0 is ForcData.txt used.

Pobs.txt/Pobs_nnn.txt

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

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

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

The second to last columns are precipitation for all stations or subbasins. The id number may be pobsid or subid. If pobsid is used, several subbasins may use the same precipitation. The order of subbasins does not have to be same as in GeoData.txt. subid is defined in GeoData.txt. pobsid may be defined in ForcKey.txt or GeoData.txt.

Example:

```
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. The precipitation is then saved internally in the program as tenth of mm (as an integer). This option is set in info.txt ('readdaily' 'N').

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

Tobs.txt/Tobs_nnn.txt

Tobs.txt holds air temperature forcing data for HYPE. The file is located in the modeldir folder (set in info.txt). Air temperature (degree Celsius) is given for all timesteps, but longer time series is allowed. No missing values may exist. Program won’t handle them.

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

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

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

Example:

```
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 set-ups running time may be reduced by holding the forcing data in memory instead of reading the files for each time step. The temperature is then saved internally in the program as tenth of degree (as an integer). 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 is Tobs.txt used.

Qobs.txt

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

The first row includes a text string (e.g. `date`, no spaces allowed) and then subbasin id (`subid` from GeoData.txt). 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`. The second to last columns are discharge for given subbasins (i.e. not all subbasins required).

Xobs.txt

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

The first row is a comment row which is skipped when reading the file. The second row gives the variable names. For the first column, the date column, the name "x" 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". Second to last columns are data columns.

There is a selection of the HYPE variables that can be put in *Xobs.txt*.

Column **#** refers to the same column in HYPE variable table.

Column **Value** indicates the type of value of output variables. Variable values represent either averages, weighted averages, or sums over timestep.

#	Variable ID	Unit	Description	Value	Reference area
5	rswe	*mm*	observed snow water equivalent, provided in Xobs.txt	Avg.	subbasin land area
6	rsnw	*cm*	observed snow depth, provided in Xobs.txt	Avg.	subbasin land area
27	resf	*cm*	observed frost depth, provided in Xobs.txt	Avg.	subbasin land area
28	regw	*m*	observed groundwater level, provided in Xobs.txt	Avg.	subbasin land area
39	rfsc	-	recorded fractional snow cover area, provided in Xobs.txt	Avg.	subbasin land area
41	rfse	-	recorded fractional snow cover area error, provided in Xobs.txt	Avg.	subbasin land area
42	rfsm	-	recorded fractional snow cover multi, provided in Xobs.txt ?	Avg.	subbasin land area
43	rfme	-	recorded fractional snow cover multi error, provided in Xobs.txt	Avg.	subbasin land area
45	wstr	*m*	observed water level olake, provided in Xobs.txt	Avg.	outlet lake area
56	rinf	*m^3/s*	observed (derived) flow (including P-E) to olake, provided in Xobs.txt	Avg.	subbasin upstream area
69	roli	*cm*	recorded olake ice depth, provided in Xobs.txt	Avg.	outlet lake area
70	rili	*cm*	recorded ilake ice depth, provided in Xobs.txt	Avg.	internal lake area
71	rolb	*cm*	recorded olake blackice depth, provided in Xobs.txt	Avg.	outlet lake area
72	rilb	*cm*	recorded ilake blackice depth, provided in Xobs.txt	Avg.	internal lake area

#	Variable ID	Unit	Description	Value	Reference area
73	`rols`	*cm*	recorded olake snow depth, provided in Xobs.txt	Avg.	outlet lake area
74	`rils`	*cm*	recorded ilake snow depth, provided in Xobs.txt	Avg.	internal lake area
81	`rmri`	*cm*	recorded main river ice depth, provided in Xobs.txt	Avg.	main river area
82	`rlri`	*cm*	recorded local river ice depth, provided in Xobs.txt	Avg.	local river area
83	`rmrb`	*cm*	recorded main river blackice depth, provided in Xobs.txt	Avg.	main river area
84	`rlrb`	*cm*	recorded local river blackice depth, provided in Xobs.txt	Avg.	local river area
85	`rmrs`	*cm*	recorded main river snow depth, provided in Xobs.txt	Avg.	main river area
86	`rlrs`	*cm*	recorded local river snow depth, provided in Xobs.txt	Avg.	local river area
97	`rolt`	*°C*	recorded olake surface temperature, provided in Xobs.txt	Avg.	outlet lake area
98	`rilt`	*°C*	recorded ilake surface temperature, provided in Xobs.txt	Avg.	internal lake area
99	`rmrt`	*°C*	recorded main river surface temperature, provided in Xobs.txt	Avg.	main river area
112	`xom0..9`	*depends on variable type*	optional, not predefined variable (averaged over output time interval) provided in Xobs.txt or XobsXOMn.txt	Avg.	depends on variable type
115	`rgmb`	*mm*	recorded glacier mass balance, provided in Xobs.txt	Avg.	specific glacier area
117	`rgma`	*km^2*	area used in recorded mass balance, provided in Xobs.txt	Avg.	specific glacier area
118	`rgmp`	*days*	recorded mass balance period, provided in Xobs.txt	Avg.	none
119	`S105`	-	recorded (FSUHSS) snow cover surrounding terrain open (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of non-forest land cover
120	`S106`	-	recorded (FSUHSS) snow cover course open (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of non-forest land cover
121	`S108`	*cm*	recorded (FSUHSS) mean depth open, provided in Xobs.txt	Avg.	area of non-forest land cover
122	`S111`	*g/cm^3*	recorded (FSUHSS) mean density open, provided in Xobs.txt	Avg.	area of non-forest land cover
123	`S114`	*mm*	recorded (FSUHSS) snow water equivalent open, provided in Xobs.txt	Avg.	area of forest land cover
124	`S205`	-	recorded (FSUHSS)snow cover surrounding terrain forest (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of forest land cover
125	`S206`	-	recorded (FSUHSS) snow cover course forest (fraction from 0 to 10), provided in Xobs.txt	Avg.	area of forest land cover

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

RHobs.txt

The file is located in the `modeldir` folder. Relative humidity (unitless value 0-1) is given for all time steps. No missing values may exist (program won't check!) The first row includes a text string (e.g. `date`, no spaces allowed) and then a station id. This may be subid or rhobsid from GeoData.txt. The first column is date in the format `yyyy-mm-dd [HH:MM]`. If set in info that matlab-format should be read (`readformat 1`) the date format is `yyyymmdd`. The second to last columns are humidity for all stations/subbasins. The order of subbasins does not have to be same as in GeoData.txt. If `rhobsid` is used, several subbasins may use the same station. The *RHobs-file* is read only if "`readhumid`" is set in info.txt.

SFobs.txt

The file is located in the `modeldir` folder. Snowfall fraction of precipitation is given for all time steps. No missing values may exist (program won't check!) The first row includes a text string (e.g. `date`, no spaces allowed) and then a station id. This may be `subid` or `sfobsid` from GeoData.txt. The first column is date in the format `yyyy-mm-dd [HH:MM]`. If set in info that matlab-format should be read (`readformat 1`) the date format is `yyyymmdd`. The second to last columns are snowfall fraction for all stations/subbasins. The order of subbasins does not have to be same as in GeoData.txt. If `sfobsid` is used, several subbasins may use the same station. The *SFobs-file* is read only if so set in info.txt.

SWobs.txt

The file is located in the “`modeldir`” folder. Shortwave radiation is given for all time steps. No missing values may exist (program won’t check!) The first row includes a text string (e.g. “`date`”, no spaces allowed) and then a station id. This may be “`subid`” or “`swobsid`” from GeoData.txt. The first column is date in the format “`yyyy-mm-dd [HH:MM]`”. If set in info that matlab-format should be read (“`readformat 1`”) the date format is “`yyyymmdd`”. The second to last columns are radiation for all stations/subbasins. The order of subbasins does not have to be same as in GeoData.txt. If `swobsid` is used, several subbasins may use the same station. The *SWobs-file* is read only if so set in info.txt.

TMINobs.txt

The file is located in the “`modeldir`” folder. Minimum temperature is given for all time steps. No missing values may exist (program won’t check!) The first row includes a text string (e.g. “`date`”, no spaces allowed) and then a station id. This may be “`subid`” or “`tminobsid`” from GeoData.txt. The first column is date in the format “`yyyy-mm-dd [HH:MM]`”. If set in info that matlab-format should be read (“`readformat 1`”) the date format is “`yyyymmdd`”. The second to last columns are temperature for all stations/subbasins. The order of subbasins does not have to be same as in GeoData.txt. If tminobsid is used, several subbasins may use the same station. The *TMINobs-file* is read only if so set in info.txt.

TMAXobs.txt

The file is located in the "`modeldir`" folder. Maximum air temperature is given for all time steps. No missing values may exist (program won't check!) The first row includes a text string (e.g. "`date`", no spaces allowed) and then a station id. This may be subid or tmaxobsid from GeoData.txt. The first column is date in the format "`yyyy-mm-dd [HH:MM]`". If set in info that matlab-format should be read ("`readformat 1`") the date format is "`yyyymmdd`". The second to last columns are temperature for all stations/subbasins. The order of subbasins does not have to be same as in GeoData.txt. If "`tmaxobsid`" is used, several subbasins may use the same station. The *TMAXobs-file* is read only if so set in info.txt.

Uobs.txt

The file is located in the "`modeldir`" folder. Wind speed (*m/s*) is given for all time steps. No missing values may exist (program won't check!) The first row includes a text string (e.g. "`date`", no spaces allowed) and then a station id. This may be subid or uobsid from GeoData.txt. The first column is date in the format "`yyyy-mm-dd [HH:MM]`". If set in info that matlab-format should be read ("`readformat 1`") the date format is "`yyyymmdd`". The second to last columns are wind speed for all stations/subbasins. The order of subbasins does not have to be same as in GeoData.txt. If "`uobsid`" is used, several subbasins may use the same station. The *Uobs-file* is read only if "`readwind`" is set in info.txt.

XobsXOMn.txt

The files are located in the “`modeldir`” folder. Variable of user choice is given for all time steps. Maximum 10 variables/files may be used. The variable is called xom0-xom9. The variable can be used for criterion calculation and is averaged over meanperiod. The first row includes a text string (e.g. “`date`”, no spaces allowed) and then subbasin id (“`subid`”). The first column is date in the format “`yyyy-mm-dd`”. If set in info that matlab-format should be read (“`readformat 1`”) the date format is “`yyyymmdd`”. The second to last columns are temperature 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.

XobsXOSn.txt

The files are located in the “`modeldir`” folder. Variable of user choice is given for all time steps. Maximum 10 variables/files may be used. The variable is called “`xos0-xos9`”. The variable can be used for criterion calculation and is summed over meanperiod. The first row includes a text string (e.g. “`date`”, no spaces allowed) and then subbasin id (“`subid`”). The first column is date in the format “`yyyy-mm-dd`”. If set in info that matlab-format should be read (“`readformat 1`”) the date format is “`yyyymmdd`”. The second to last columns are temperature 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.

state_saveyymmdd[HHMM].txt

All state variables can be saved to a file and later used for starting the model from the exact same point. To save state-files the dates are given by `outstatedate` in info.txt. The files written are located in the resultdir folder. To use the starting state-file `instate` is set in info.txt. The starting state files should be located in the modeldir folder. There can be one state-file per time step: state_staveyyyymmdd[HHMM].txt yyyymmdd[HHMM] is the date(time) of the start of simulation. For daily time step only the date is used in the file name.

The first row of the state_save-file hold codes for what settings were used for creating the file. The settings must (with some exceptions) be the same when the simulation is started up again.

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).

When sequence simulations are made, the *seqnr* is set as an argument when starting HYPE (See How to run HYPE) or in filedir.txt. For other simulations the *seqnr* in the file name is 000.

simass.txt

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

When ensemble or sequence simulations are made, the results from simulations (I=1 .. *n* or I=sequence number>0) are written to files named simassX_00I.txt, where *n* is defined by `num_ens` in optpar.txt.

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

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

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

subassX.txt

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

When ensemble or sequence simulations are made, the results from simulations (I=1 .. *n* or I=sequence number>0) are written to files named subassX_00I.txt, where *n* is defined by `num_ens` in optpar.txt.

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.

File content

The first row defines average period (0=timesteply, 1=daily, 2=weekly, 3=monthly, 4=yearly) used for calculation. 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 is the same as that of the calibration criteria. Missing values are indicated as -9999.

The columns:

Header	Unit	Description
`SUBID`	-	subbasin id (as defined in GeoData.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

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
112 0.507    0.721    22.649    -68.38    0.058    0.047    0.068    0.1    0.038    0.07    0.011    -0.032    0.518    0.678    1.226    0.066
135 0.722    0.881    -20.802    0.398    0.308    0.389    0.409    0.407    0.146    0.214    -0.081    0.002    0.76    1.004    0.792    0.075
```

mapXXXX.txt

HYPE map output files are one of the three standard result files for time series output from HYPE, the other two are time output files (like map output files, but transposed) and basin 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 5
```

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

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

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

When ensemble or sequence simulations are made, the results from simulations (I = 1 .. *n* or I = sequence number > 0) are written to files named *mapXXXX_00I.txt*, where *n* is defined by `num_ens` in optpar.txt.

XXXXXXX.txt (basin output)

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

Basin output files each contain results for multiple variables of a single HYPE sub-basin. 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 sub-basin 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
timeoutput variable rout cout prec temp snow evap
basinoutput subbasin 2452 2353 1244 2424
timeoutput meanperiod 4
timeoutput decimals 5
```

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

Time 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**. 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 sub-basins 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
UNITS      m3/s  m3/s  mm    degC mm   mm
2003-01-01 0.51  0.482 0     7.2  1.2  1.543
2003-01-02 0.40  0.319 1     6.9  0    1.140
2003-01-03 0.31  0.273 0     5.4  0    0.98
2003-01-04 0.24  0.247 0.1   5.0  0    0.87
2003-01-05 0.22  0.226 0     4.5  0    0.75
...        ...   ...   ...   ...  ...  ...
```

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_00000I.txt*. In this case up to 9999999 simulations can be saved.

timeXXXX.txt

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

Time output files each contain results for a single HYPE variable for all modelled sub-basins. To write time output files, specify a `timeoutput` for the variables of interest in the info.txt file.

Example snippet of a info.txt file:

```
!! time outputs for measured and simulated discharge
timeoutput variable rout cout
timeoutput meanperiod 4
timeoutput decimals 5
```

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 *mapCOUT.txt*. All HYPE variable IDs are described in the **list of HYPE variables**.

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

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

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

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.

yyyy_ss.txt

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

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

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

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

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

to be filled

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.

The file is located in the resultdir folder given in info.txt. The file gives 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 soil-type/land-use/subbasin it will still be printed for all areas. The first row is a comment row. After that the file contains one parameter per row with name and values for all soil-types/land-uses/subbasins/parameterregions. Definition of parameters is listed in description of 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.

Example snippet 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

The file is located in the resultdir folder given in info.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 (`CRIT`) is first.

For DEMC calibrations (`task DE` in optpar.txt), *bestsims.txt* contains parameter values of the last generations of all populations plus one row (first row in file!) with median values over all populations. **Note**: These parameter sets are the last ones proposed by the DEMC algorithm, and might not have been accepted as improved estimates. For DEMC, therefore, we recommend to evaluate the allsim.txt result file and filter for results with accepted estimates (column `iacc == 1`).

File content

The first row contains column headings. The first column is the ordinal number. Second to eighteenth columns are other criteria (se table below). When several criteria are used in a objective function, the columns with performance information will be repeated once per criteria. The last columns contain parameter values. Note: If several RA criteria have been selected, only the last of them will be printed to file. Missing values are indicated as -9999.

The columns:

Column	Description
`NO`	row number
`CRIT`	value of objective function
`rr2`	regional Nash-Sutcliffe efficiency (all data combined in one long time series)
`sr2`	spatial Nash-Sutcliffe efficiency simulated using annual means for all subbasins (requires at least 5 years and 5 subbasins with data) to calculate the Nash-Sutcliffe efficiency
`mr2`	average of all Nash-Sutcliffe efficiencies for all subbasins with observations
`rmae`	regional mean absolute error
`sre`	spatial relative bias
`rre`	regional relative bias (all data combined in one long time series)
`mre`	average of the relative bias for all subbasins (Note: fraction, not %)
`rra`	regional RA, RA is a Nash-Sutcliffe like criterion where the square is exchanged with a coefficient value
`sra`	Spatial RA, 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 subbasin values of RA, RA is a Nash-Sutcliffe like criterion where the square is exchanged with a coefficient value
`tau`	average of Kendall's Tau value for all subbasins.
`md2`	median of Nash-Sutcliffe efficiency for all subbasins with observations
`mda`	median of all subbasins' RA (Nash-Sutcliffe like criteria where the square is exchanged with a coefficient value)
`mrs`	error in standard deviation, average of all subbasins with observations
`mcc`	Pearson correlation coefficient, average of all subbasins with observations
`mdkg`	median of all subbasins' Kling-Gupta efficiency (MKG in info.txt)

Column	Description
`mare`	average of absolute relative bias for all subbasins (Note: fraction. not %) (MAR in info.txt)
`mnr`	median of all subbasins' normalised RMSE
`mnw`	average of all Nash-Sutcliffe efficiencies adjusted for bias for all subbasins with observations
`parname`	parameter that has been optimised

Example of *bestsims.txt*:

```
NO,CRIT,rr2,sr2,mr2,rmae,sre,rre,mre,rra,sra,mra,tau,md2,mda,mrs,mcc,mdkg,ma
re,mnr,mnw,cevp,wcfc,rrcs1,rivvel,damp
1,-0.15274,0.66997,-9999,0.15274,37.45872,-9999,-0.30995,-0.30442,-9999,-999
9,-9999,-9999,0.21835,-9999,-0.38166,0.63855,0.24106,0.31151,0.12787,0.15274
,0.26006,0.0856,0.4202,1.97909,0.19939
2,-0.15625,0.66977,-9999,0.15625,37.16421,-9999,-0.3007,-0.283,-9999,-9999,-
9999,-9999,0.21904,-9999,-0.37735,0.63432,0.25736,0.31274,0.1269,0.15625,0.1
4034,0.25485,0.26864,0.74202,0.55459
```

allsim.txt

The file is located in the resultdir folder. If a Monte Carlo simulation is made and optpar.txt is configured so that all performance results will be written to file, the results are written to *allsim.txt*, one simulation per row. The format is the same as 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. Second to eighteenth columns are other criteria (se table below). When several criteria are used in a objective function, the columns with performance information will be repeated once per criteria. The last columns contain parameter values. Note: If several RA criteria have been selected, only the last of them will be printed to file. Missing values are indicated as -9999.

The columns:

Column	Description
`NO`	row number
`CRIT`	value of objective function
`rr2`	regional Nash-Sutcliffe efficiency (all data combined in one long time series)
`sr2`	spatial Nash-Sutcliffe efficiency simulated using annual means for all subbasins (requires at least 5 years and 5 subbasins with data) to calculate the Nash-Sutcliffe efficiency
`mr2`	average of all Nash-Sutcliffe efficiencies for all subbasins with observations
`rmae`	regional mean absolute error
`sre`	spatial relative bias
`rre`	regional relative bias (all data combined in one long time series)
`mre`	average of the relative bias for all subbasins (Note: fraction, not %)
`rra`	regional RA, RA is a Nash-Sutcliffe like criterion where the square is exchanged with a coefficient value
`sra`	Spatial RA, 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 subbasin values of RA, RA is a Nash-Sutcliffe like criterion where the square is exchanged with a coefficient value
`tau`	average of Kendall's Tau value for all subbasins.
`md2`	median of Nash-Sutcliffe efficiency for all subbasins with observations
`mda`	median of all subbasins' RA (Nash-Sutcliffe like criteria where the square is exchanged with a coefficient value)
`mrs`	error in standard deviation, average of all subbasins with observations
`mcc`	Pearson correlation coefficient, average of all subbasins with observations
`mdkg`	median of all subbasins' Kling-Gupta efficiency (MKG in info.txt)
`mare`	average of absolute relative bias for all subbasins (Note: fraction. not %) (MAR in info.txt)
`mnr`	median of all subbasins' normalised RMSE
`mnw`	average of all Nash-Sutcliffe efficiencies adjusted for bias for all subbasins with observations
`parname`	parameter that has been optimised

Column	Description
`jpop`	population index in DEMC-simulation
`igen`	generation index in DEMC-simulation
`iacc`	acceptance index in DEMC-simulation

calibration.log

The file is written to the resultdir folder. The file is written during calibration with information on progress.