GSFLOW Input Instructions: A Supplement to Appendix 1 of the GSFLOW manual (USGS TM 6-D1)

Version 1.2.1 GSFLOW release, October 2016

Introduction

Instructions for preparing input files for GSFLOW were provided with the first release of GSFLOW as Appendix 1 in Markstrom and others (2008). Since that time, new functionality has been added to the software; some of the original functionality has been removed; and individual parameters and variables have been added, modified, and deleted. As a result, it has been necessary to update the original input instructions with each new release of GSFLOW. Input instructions for preparing a GSFLOW input dataset are now provided in three formats: This file provides updated information for a few of the tables in Appendix 1 that relate directly to the GSFLOW software. This file is a supplement to Appendix 1 in Markstrom and others (2008; TM 6-D1), which provides a general discussion of the terminology, styles, and formats of GSFLOW inputs and the definitions of each of the GSFLOW input files. This file also replaces the 'Appendix1_Tables.pdf' file that was distributed with previous versions of the software.

Input instructions for the several PRMS modules and MODFLOW packages that are part of the GSFLOW software can be found in separate resources:

PRMS Data and Parameter Files: Up-to-date specifications for PRMS dimensions, parameters, and input and output variables are provided online in several tables on the PRMS-IV software distribution page: *ftp://brrftp.cr.usgs.gov/pub/mows/software/prms/4.0.2/PRMS_tableUpdates_4.0.2.pdf*. In addition, documentation for the `nhru_summary` module can be found in the 'doc\Related reports (PRMS, MODFLOW, CRT)' subdirectory of the GSFLOW distribution folder. [PRMS-IV is documented in Markstrom, S.L., Regan, R.S., Hay, L.E., Viger, R.J., Webb, R.M.T., Payn, R.A., and LaFontaine, J.H., 2015, PRMS-IV, the precipitation-runoff modeling system, version 4: U.S.Geological Survey Techniques and Methods book 6, chap. B7, 158 p. The PRMS-distribution website is *http://wwwbrr.cr.usgs.gov/projects/SW_MoWS/PRMS.html*]

MODFLOW Input Files: Up-to-date descriptions of the input requirements for all MODFLOW-2005 and MODFLOW-NWT Packages and Processes are provided in the *Online Guide to MODFLOW-2005* (*http://water.usgs.gov/ogw/modflow/MODFLOW-2005-Guide/*) and *Online Guide to MODFLOW-NWT* (*http://water.usgs.gov/ogw/modflow-nwt/MODFLOW-NWT-Guide/*). These guides supercede information given on pages 176-226 in TM 6-D1.

Information Related to GSFLOW Input Tables

Tables 1 and 2: Descriptions of PRMS and GSFLOW modules and MODFLOW packages supported in GSFLOW version 1.2.1

Brief descriptions of the modules and packages that are supported in GSFLOW version 1.2.1 are given in table 1; a list of the PRMS modules and MODFLOW packages not implemented in GSFLOW version 1.2.1 is given in table 2. These two tables update tables 1 and 2 provided in TM 6-D1 and TM 6-B7.

Table A1-1: Parameters specified in the GSFLOW Control File

This table supercedes table A1-1 on pages 135-136 of the GSFLOW manual (TM 6-D1) and Table 1-2 in TM6-B7. The GSFLOW Control File is described in detail on pages 134-139 of TM 6-D1. Additional notes follow:

1. Previous versions of GSFLOW required that a PRMS Parameter File be specified in the Control File for a MODFLOW-only simulation. The code has been updated so that the user no longer needs to specify a PRMS Parameter File for a MODFLOW-only simulation. Thus, for a MODFLOW-only simulation, the Control File could be as short as the following example for the Sagehen Creek GSFLOW model distributed with the software:

```
Control File for a MODFLOW-only simulation, Sagehen Creek Watershed
####
model_mode
1
4
MODFLOW
####
modflow_name
1
4
../input/modflow/sagehen.mf.nam
```

Note, however, that for restart simulations, the user also will need to specify control parameters **modflow_time_zero**, **init_vars_from_file**, **save_vars_to_file**, **start_time**, and **end_time**.

2. If default values shown for any input parameter are acceptable, the user does not need to enter those parameter blocks.

Table A1-3: Time-series data that can be specified in the PRMS Data File (supercedes table A1-3 in TM 6-D1, page 141)

1. This table is provided online (PRMS-IV table 1.4, Time-series input variables that may be included in the Data File for the Precipitation-Runoff Modeling System). Refer to that table for the current list of variables that can be specified in PRMS Data Files.

2. The Data File must have at least one column of input values ("data") in addition to the 6 values that specify the date and time for the time series. Variables that do not have values do not need to be specified. For example form_data, solrad, and pan_evap as shown in figure A1-1 in TM D6-1 page 140 could be removed.

Table A1-4: Dimensions defined in PRMS Parameter Files (supercedes table A1-4 in TM 6-D1, page 145 and table 1-1 in TM 6-B7)

1. Dimensions defined in this table are only needed for the GSFLOW and PRMS-only simulation modes, and are not needed for MODFLOW-only simulation mode because Parameter Files are not needed for a MODFLOW-only simulation.

Tables A1-5 and A1-6 through A1-22: Parameters in the PRMS Parameter File and input parameters for each of the PRMS modules (pages 147-172 in TM 6-D1)

1. These tables have been superceded and are provided online (PRMS-IV table 1.3, Parameters listed by usage with the associated modules in which they are used for the Precipitation-Runoff Modeling System). Refer to

that table for the current list of parameters that can be specified in PRMS Parameter Files. Also note that not all of the parameters listed in online table 1.3 are available in GSFLOW; those that are available are based on the PRMS modules available in GSFLOW (see table 1 below).

Table A1-23: Parameters specified for GSFLOW modules (supercedes tables 3 and 4, page 27, and tables A1-23 through A1-27, pages 173-175 in TM 6-D1)

1. This table replaces the seven tables previously used to define input parameters for each of the GSFLOW modules. In keeping with the new structure of the table used to define PRMS-IV input parameters, the parameters for all of the GSFLOW modules are now combined into a single table.

Table 1-5: Selected GSFLOW output variables for which values can be written to the PRMS Statistic Variables File and PRMS Animation Variables File(s) (supercedes Table A1-2 (p. 138-139) in TM 6-D1).

1. The variables shown in this table relate to GSFLOW simulation mode only; additional variables can be written for PRMS-only simulations depending on values in the Data File and active modules (see online PRMS-IV tables 2, 1-2, 1-3, and 1.4 and 1.5).

Table 1-6: GSFLOW output variables written to the GSFLOW Comma-Separated Values File (supercedes Table 12 (p. 88-89) in TM 6-D1).

1. The variables shown in this table have been substantially revised from previous versions of the software.

Table 1. Description of PRMS and GSFLOW modules and MODFLOW packages implemented in GSFLOW version 1.2.1. [Module or package name: Users select only one of the modules or packages in each group indicated by a number from 1 to 8. Fortran or C programming language file: C programming language file designated with a ".c" at end of file name. Version: Shows the GSFLOW release version number when the module or package was first added to GSFLOW. Model mode: G is GSFLOW coupled simulation, P is PRMS-only simulation, M is MODFLOW-only simulation; HRU: hydrologic response unit]

Process	Fortran or C programming language file	Description	Version	Model mode
		PRMS Modules		
Basin Definition	basin	Defines shared watershed-wide and hydrologic response unit (HRU) physical parameters and variables	1.0.00	G,P
Cascading Flow	cascade	Determines computational order of the HRUs and groundwater reservoirs for routing flow downslope	1.0.00	G,P
Climate and Flow Parameter and Variable Definition	climateflow	Defines shared watershed-wide and hydrologic response unit (HRU) climate and flow parameters and variables	1.1.5	G,P
Potential Solar Radiation	soltab	Computes potential solar radiation and sunlight hours for each HRU for each day of year	1.0.00	G,P
Daily Time Step Definition	prms_time	Computes time related variables within the daily time step	1.2.0	G,P
Observed Data	obs	Reads and stores observed data from all specified measurement stations	1.0.00	G,P
Temperature Distribution (1)	temp_1sta	Distributes maximum and minimum temperatures to each HRU by using temperature data measured at one station and an estimated monthly lapse rate	1.0.00	G,P
	temp_laps	Distributes maximum and minimum temperatures to each HRU by computing a daily lapse rate with temperature data measured at a base station and lapse station with differing altitudes	1.0.00	G,P
	xyz_dist	Determines the form of precipitation and distributes precipitation and temperatures to each HRU by using a multiple linear regression of measured data from a group of measurement stations or from atmospheric model simulation; selection requires this module also be selected for precipitation	1.0.00	G,P
	temp_dist2	Distributes maximum and minimum temperatures to each HRU by using a basin-wide lapse rate applied to the temperature data, adjusted for distance, measured at each station	1.0.00	G,P
	climate_hru	Reads distributed temperature values directly from files	1.1.5	G,P
	ide_dist	Determines the form of precipitation and distributes precipitation and temperatures to each HRU on the basis of measurements at stations with closest elevation or shortest distance to the respective HRU; selection requires this module also be selected for precipitation	1.2.0	G,P
Precipitation Distribution (2)	precip_1sta	Determines the form of precipitation and distributes it from one or more stations to each HRU by using monthly correction factors to account for differences in altitude, spatial variation, topography,	1.0.00	G,P

		and measurement gage efficiency.		
	precip_laps	Determines the form of precipitation and distributes it to each HRU by using monthly lapse rates	1.0.00	G,P
	xyz_dist	Distributes precipitation and maximum and minimum temperatures to each HRU using a multiple linear regression of measured data from a group of measurement stations or from atmospheric model results; selection requires this module also be selected for temperature	1.0.00	G,P
	precip_dist2	Determines the form of precipitation and distributs it to each HRU by using an inverse distance weighting scheme	1.0.00	G,P
	climate_hru	Reads distributed precipitation values directly from files	1.1.5	G,P
	ide_dist	Determines the form of precipitation and distributes precipitation and temperatures to each HRU on the basis of measurements at stations with closest elevation or shortest distance to the respective HRU; selection requires this module also be selected for temperature	1.2.0	G,P
Solar Radiation (3)	ddsolrad	Distributes solar radiation to each HRU and estimates missing solar radiation data using a maximum temperature per degree-day relation	1.0.00	G,P
	ccsolrad	Distributes solar radiation to each HRU and estimates missing solar radiation data using a relation between solar radiation and cloud cover	1.0.00	G,P
	climate_hru	Reads distributed solar radiation values directly from files	1.1.5	G,P
Potential Evapotranspiration (4)	potet_jh	Computes the potential evapotranspiration by using the Jensen-Haise formulation (Jensen and Haise, 1963)	1.0.00	G,P
	potet_hamon	Computes the potential evapotranspiration by using the Hamon formulation (Hamon, 1961)	1.0.00	G,P
	potet_pan	Computes the potential evapotranspiration for each HRU by using pan-evaporation data	1.0.00	G,P
	potet_hs	Computes the potential evapotranspiration by using the Hargreaves-Samani formulation (Hargreaves and Samani, 1982)	1.2.0	G,P
	potet_pm	Computes the potential evapotranspiration by using the Penman-Monteith formulation (Penman, 1948; Monteith, 1965) using specified windspeed and humidity in CBH files	1.2.0	G,P
	potet_pm_sta	Computes the potential evapotranspiration by using the Penman-Monteith formulation (Penman, 1948; Monteith, 1965) using specified windspeed and humidity in the PRMS Data File	1.2.1	G,P
	potet_pt	Computes the potential evapotranspiration by using the Priestley-Taylor formulation (Priestley and Taylor, 1972)	1.2.0	G,P
	climate_hru	Reads distributed potential evapotranspiration values directly from files	1.1.5	G,P
Transpiration Period (8)	transp_frost	Determines whether the current time step is in a period of active transpiration by the killing frost method	1.2.0	G,P

	transp_tindex	Determines whether the current time step is in a period of active transpiration by the temperature index method	1.0.00	G,P
	climate_hru	Reads distributed transpiration values directly from files	1.1.5	G,P
	frost_date	Computes the last spring frost and first fall frost for each HRU based on the simulation time period and distributed temperature; processes after precipitation distribution are not computed	1.2.0	P
Interception	intcp	Computes volume of intercepted precipitation, evaporation from intercepted precipitation, and throughfall that reaches the soil or snowpack	1.0.00	G,P
Snow	snowcomp	Initiates development of a snowpack and simulates snow accumulation and depletion processes by using an energy-budget approach	1.0.00	G,P
Surface Runoff (5)	srunoff_smidx	Computes surface runoff and infiltration for each HRU by using a nonlinear variable-source-area method allowing for cascading flow	1.0.00	G,P
	srunoff_carea	Computes surface runoff and infiltration for each HRU by using a linear variable-source-area method allowing for cascading flow	1.0.00	G,P
Soil Zone	soilzone	Computes inflows to and outflows from soil zone of each HRU and includes inflows from infiltration, groundwater, and upslope HRUs, and outflows to gravity drainage, interflow, and surface runoff to down-slope HRUs	1.0.00	G,P
Groundwater	gwflow	Sums inflow to and outflow from PRMS groundwater reservoirs; outflow can be routed to downslope groundwater reservoirs and stream segments	1.0.00	P
Streamflow	strmflow	Computes daily streamflow as the sum of surface runoff, shallow-subsurface flow (interflow), detention reservoir flow, and groundwater flow	1.0.00	P
	routing	Computes common segment routing flows for modules strmflow_in_out and muskingum	1.2.0	P
	strmflow_in_out	Routes water between segments in the system by setting the outflow to the inflow	1.2.0	P
	muskingum	Computes basin on-channel reservoir storage and outflows	1.2.0	P
Summary	basin_sum	Sums values for daily, monthly, yearly, and total flow summaries of volumes and flows for all HRUs	1.0.00	P
	map_results	Writes HRU summaries to a user specified target map at weekly, monthly, yearly, and total time steps (initially named grid_report)	1.1.3	G,P
	subbasin	Computes streamflow at internal basin nodes and variables by subbasin	1.1.00	G,P
	nhru_summary	Writes selected user-selected results dimensioned by the value of dimension **nhru** as daily, monthly, and/or mean-monthly time-series as Comma-Separated-Values (CSV) files	1.2.0	G,P
	water_balance	Computes daily HRU and basin-wide water balances for selected hydrologic processes when control parameter **print_debug** is specified equal to 1.	1.2.0	P
	write_climate_hru	Computes user-selected climate values for each	1.1.6	P

		HRU based on the simulation time period and distributed climate; processes after transpiration period are not computed		
		MODFLOW Packages		
Basic	gwf2bas7_NWT	BAS: Handles a number of basic administrative tasks; modification of gwf2bas7	1.0.00	G,M
Block Centered Flow (6)	gwf2bcf7	BCF: Calculates conductance coefficients for groundwater-flow equations using a block-centered flow package	1.0.00	G,M
Layer Property Flow (6)	gwf2lpf7	LPF: Calculates conductance coefficients for groundwater-flow equations using a layer-property flow package	1.0.00	G,M
Hydrogeologic-Unit Flow (6)	gwf2huf7	HUF: Calculates effective hydraulic properties for model layers using hydrostratigraphic units	1.0.00	G,M
Upstream-Weighting Package (6)	gwf2upw1	UPW: Calculates conductance coefficients for groundwater-flow equations using an upstream-weighting package. The package is used with the NWT solver	1.1.5	G,M
Horizontal Flow Barrier	gwf2hfb7_NWT	HFB: Simulates flow barriers by reducing horizontal conductance	1.0.00	G,M
Well	gwf2wel7_NWT	WEL: Adds terms to flow equation to represent wells	1.0.00	G,M
Multi-Node Well	gwf2mnw17_NWT	MNW, version 1: Adds terms to flow equation for wells that extract or inject water in more than one cell	1.0.00	G,M
	gwf2mnw27_NWT	MNW, version 2: Adds terms to flow equation for wells that extract or inject water in more than one cell	1.1.1	G,M
General Head Boundary	gwf2ghb7_NWT	GHB: Adds terms to flow equation to represent general head-dependent boundaries	1.0.00	G,M
Constand Head Boundary	gwf2chd7	CHD: Adds terms to flow equation to represent constant-head boundaries	1.0.00	G,M
Flow and Head Boundary	gwf2fhb7	FHB: Adds terms to flow equation to represent flow and head boundaries	1.0.00	G,M
Streamflow Routing	gwf2sfr7_NWT	SFR: Adds terms to flow equation to represent groundwater and stream interactions; modification of gwf1sfr2	1.0.00	G,M
Lake	gwf2lak7	LAK: Adds terms to flow equation to represent groundwater and lake interactions; modification of gwf1lak3	1.0.00	G,M
Unsaturated Zone Flow	gwf2uzf1_NWT	UZF: Adds terms to flow equation to represent recharge from the unsaturated zone, evapotranspiration, and groundwater discharge to land surface	1.0.00	G,M
Gage	gwf2gag7	GAG: Prints time series gage output for selected stream reaches and lakes; modification of gwf1gag5	1.0.00	G,M
Observation	obs2bas7, obs2chd7, obs2ghb7	OBS: Compares model-generated values of heads and flows to observed values for the BAS, CHD, and GHB Packages	1.0.00	G,M
Solver (7)	sip7_NWT	SIP: Solves simultaneous equations resulting from finite-difference approximations using the strongly implicit procedure	1.0.00	G,M
	pcg7_NWT	PCG: Solves simultaneous equations resulting from	1.0.00	G,M

		finite-difference approximations using a preconditioned conjugate-gradient procedure		
	de47_NWT	DE4: Solves simultaneous equations resulting from finite-difference approximations using a direct solution procedure	1.0.00	G,M
	gmg7	GMG: Solves simultaneous equations resulting from finite-difference approximations using a geometric multigrid solution of the preconditioned conjugate-gradient procedure	1.0.00	G,M
	NWT1 (various files)	NWT: Solves simultaneous equations resulting from finite-difference approximations using a Newton formulation	1.1.5	G,M
GSFLOW modules				
Computation Order	gsflow_prms	Controls model mode, the GSFLOW and PRMS daily time-step loop, and computational sequence order of GSFLOW and PRMS modules—PRMS equivalent file call_modules.f90	1.0.00	G,P,M
	gsflow_modflow	Controls sequence order for reading MODFLOW time-dependent input data and controls the computational sequence of calculations in the time-step and iteration loops for MODFLOW packages and defines variables used for converting between PRMS and MODFLOW units—MODFLOW equivalent MF_NWT.f	1.0.00	G,M
Integration	gsflow_prms2mf	Distributes the PRMS soilzone module computed gravity drainage and unsatisfied potential evaporation from HRUs to MODFLOW cells for input to the UZF Package and the PRMS surface-runoff and soilzone computed Hortonian and Dunnian surface runoff and interflow from HRUs to stream segments and lakes and precipitation and evaporation to lakes for input to the SFR and LAK Packages at the end of each time step	1.0.00	G
	gsflow_mf2prms	Distributes computed groundwater discharge from MODFLOW cells to HRUs for input to the PRMS soilzone module at the end of each time step	1.0.00	G
Summary	gsflow_budget	Computes watershed budget for GSFLOW and adjusts PRMS gravity reservoir storage using the flows to and from MODFLOW cells after the MODFLOW budget procedure and writes to the GSFLOW output file at the end of each timestep	1.0.00	G
	gsflow_sum	Computes detailed watershed water budgets for flow and storage components and writes these to the GSFLOW CSV file at the end of each timestep	1.0.00	G

Table 2. PRMS version 4.0.2 modules and MODFLOW-NWT version 1.1.2 packages not implemented in GSFLOW version 1.2.1.[HRU: hydrologic response unit]

Module or package name	**Fortran file**	**Description**
PRMS modules		
Streamflow with On-channel Lakes	strmflow_lake	Computes daily streamflow as the sum of surface, subsurface, and ground-water flow contributions to each stream segment and routes flow through lakes
Summary	prms_summary	Computes select watershed-wide variables to a Comma-Separated Values (CSV) file
MODFLOW-NWT packages		
Recharge	gwf2rch7	RCH: Adds terms to groundwater flow equation to represent areal recharge to groundwater system
Evapotranspiration	gwf2evt7	EVT: Adds terms to groundwater flow equation to represent head-dependent evapotranspiration from groundwater system
Segmented Evapotranspiration	gwf2ets7	ETS Adds terms to groundwater flow equation to represent segmented head-dependent evapotranspiration from groundwater system
Interbed Storage	gwf2ibs7	IBS: Adds terms to groundwater flow equation to represent inelastic compaction of fine-grained sediments
Subsidence	gwf2sub7_NWT	SUB: Simulates aquifer-system compaction and land subsidence
Tile Drain	gwf2drt7	DRT: Adds terms to groundwater flow equation to represent groundwater discharge to drains while accounting for irrigation return flows
River	gwf2riv7_NWT	RIV: Adds terms to groundwater flow equation to represent rivers to represent head-dependent flow between a surface water body and a groundwater system
Drain	gwf2drn7_NWT	DRN: Adds terms to groundwater flow equation to represent ground-water discharge to drains
Reservoir	gwf2res7	RES: Adds terms to groundwater flow equation to represent leakage from reservoirs
Stream	gwf2str7	STR: Adds terms to flow equation to represent groundwater and stream interactions; predecessor to SFR2 Package
Seawater Intrusion	gwf2swi27_NWT	SWI: Allows three-dimensional vertically integrated variable-density groundwater flow and seawater intrusion in coastal multiaquifer systems to be simulated
Surface-Water Routing	gwf2swr7_NWT	SWR: Surface-water routing process is designed to simulated surface-water routing in one- and two-dimensional surface-water features and surface-water/groundwater interactions
Subsidence and Aquifer-System Compaction for Water-Table Aquifers	gwf2swt7	SWT: Simulates vertical compaction in models of regional groundwater flow. The program simulates groundwater storage changes and compaction in discontinuous interbeds or in extensive confining units, accounting for stress-dependent changes in storage properties.
Link to the MT3DMS contaminant-transport model	Lmt8_NWT	LMT: Records flow information from MODFLOW for use by MT3DMS or MT3D-USGS
Hydrograph capability	gwf2hydmod7.f	HYDMOD: Records time-series data for selected data types
Observation	obs2drn7, obs2riv7, obs2str7	OBS: Compares model-generated values of heads and flows to observed values for the DRN, RIV, and STR Packages

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Table A1-1. Parameters specified in the GSFLOW Control File.
[Pathnames for all files can have a maximum of 256 characters, variable names a maximum of 32 characters; Data Type: 1=integer, 2=single precision floating point (real), 3=double precision floating point (double); 4=character string; HRU, hydrologic response unit; GWR, groundwater reservoir; CBH, climate-by-HRU; ET, evapotranspiration; >, greater than; dimensions ncascade, ncascdgw, and nsub defined in table A1-4 of this document; the first two blocks of control parameters listed in the table are recommended for every simulation, although all parameters are optional depending on the appropriateness of the default values]

Parameter name	Description	Required/Simulation condition(s)	Number of Values	Data type	Default value
	Simulation execution and input and output files				
csv_output_file[2]	Pathname of GSFLOW Comma-Separated-Values (CSV) output file for selected GSFLOW basin-area weighted flows and storages for each time step	**model_mode** = `GSFLOW` with **gsf_rpt** = `1`	1	4	`prms_summary.csv`
data_file	Pathname(s) for measured input Data File(s), typically a single Data File is specified	**model_mode** = `GSFLOW` or `PRMS`	number of Data Files	4	`prms.data`
end_time	Simulation end date and time specified in order in the control item as: year, month, day, hour, minute, second	**model_mode** = `GSFLOW` or `PRMS`	6	1	`2001`, `9`, `30`, `0`, `0`, `0`
gsflow_output_file[2]	Pathname for GSFLOW Water-Budget File of summaries of each component of the GSFLOW water budget	**model_mode** = `GSFLOW`	1	4	`gsflow.out`
gsf_rpt[2]	Switch to specify whether or not the GSFLOW Comma-Separated-Values (CSV) output file is generated (`0`=no; `1`=yes)	**model_mode** = `GSFLOW`	1	4	`1`
model_mode	Flag to indicate the simulation mode (`GSFLOW`=GSFLOW coupled model; `PRMS`=PRMS-only; `MODFLOW`=MODFLOW-only; `FROST`=growing season for each HRU; `WRITE_CLIMATE`=write CBH files of minimum and maximum air temperature (variables *tminf* and *tmaxf*-Fahrenheit), precipitation (variable *hru_ppt*-inches), solar radiation (variable *swrad*-Langleys), potential ET (variable *potet*-inches), and/or transpiration flag (variable *transp_on*-dimensionless)	required	1	4	`PRMS`
model_output_file	Pathname for Water-Budget File for results module `basin_sum`	**model_mode** = `GSFLOW` or `PRMS`	1	4	`prms.out`
modflow_name[2]	Pathname for MODFLOW Name File	**model_mode** = `GSFLOW` or `MODFLOW`	1	4	`modflow.nam`
modflow_time_zero[2]	Date and time for the first MODFLOW initial stress period in the control item as: year, month, day, hour, minute, second	**model_mode** = `GSFLOW` or `MODFLOW` and **init_vars_from_file** = `1` or **save_vars_to_file** = `1`	6	1	**start_time**
param_file	Pathname(s) for PRMS Parameter File(s)	**model_mode** = `GSFLOW` or `PRMS`	number of Parameter Files	4	`prms.params`
rpt_days[2]	Frequency with which summary tables are written to the GSFLOW Water-Budget File (`0`=none; `>0`=frequency in days, e.g., `1`=daily,	**model_mode** = `GSFLOW`	1	1	`7`

Parameter name	Description	Required/Simulation condition(s)	Number of Values	Data type	Default value
	7=every 7th day)				
start_time	Simulation start date and time specified in order in the control item as: year, month, day, hour, minute, second	**model_mode** = GSFLOW or PRMS	6	1	2000, 10, 1, 0, 0, 0
	Module selection and simulation options (model_mode = GSFLOW or PRMS)				
cascade_flag	Flag to indicate if HRU cascades are computed (0=no; 1=yes)	**ncascade** > 0	1	1	1
cascadegw_flag	Flag to indicate if GWR cascades are computed (0=no; 1 or 2=yes). If **cascadegw_flag** = 2, the GWR cascades are set equal to the HRU cascades, so gw_up_id, gw_strmseg_down_in, gw_down_id, and gw_pct_up do not need to be specified, which can decrease the size of the parameter files significantly.	**ncascdgw** > 0	1	1	1
dprst_flag	Flag to indicate if depression-storage simulation is computed (0=no; 1=yes)	optional	1	1	0
et_module	Module name for potential-evapotranspiration method (climate_hru, potet_jh, potet_hamon, potet_hs, potet_pt, potet_pm, potet_pm_sta, or potet_pan)	required	1	4	potet_jh
gwr_swale_flag	Flag to indicate if GWR swales are allowed (0=no; 1=groundwater flow goes to groundwater sink; 3=groundwater flow goes to stream segment specified using parameter **hru_segment**	optional	1	1	0
precip_module	Module name for precipitation-distribution method (climate_hru, ide_dist, precip_1sta, precip_dist2, precip_laps, or xyz_dist)	required	1	4	precip_1sta
solrad_module	Module name for solar-radiation-distribution method (ccsolrad or ddsolrad)	required	1	4	ddsolrad
srunoff_module	Module name for surface-runoff/infiltration computation method (srunoff_carea or srunoff_smidx)	required	1	4	srunoff_smidx
strmflow_module	Module name for streamflow routing simulation method (strmflow, muskingum, or strmflow_in_out)	**model_mode** = PRMS	1	4	strmflow
subbasin_flag	Flag to indicate if internal subbasins are computed (0=no; 1=yes)	**nsub** > 0	1	1	1
temp_module	Module name for temperature-distribution method (climate_hru, temp_1sta, temp_dist2, temp_laps, ide_dist, or xyz_dist	required	1	4	temp_1sta
transp_module	Module name for transpiration simulation method (climate_hru, transp_frost, or transp_tindex)	required	1	4	transp_tindex
	Climate-by-HRU Files (model_mode = GSFLOW or PRMS)				
cbh_binary_flag	Flag to specify whether to input CBH files in a binary format using the samer order of values as the text file version (0=no; 1=yes)	**et_module**, **precip_module**, **temp_module**,	1	1	0

Parameter name	Description	Required/Simulation condition(s)	Number of Values	Data type	Default value
		solrad_module, or **transp_module** = `climate_hru`			
humidity_cbh_flag	Flag to specify whether to read a CBH file with humidity data (`0`=no; `1`=yes)	**et_module** = `potet_pm`	1	1	`0`
humidity_day	Pathname of the CBH file of pre-processed humidity input data for each HRU to specify variable *humidity_hru*-decimal fraction	**et_module** = `potet_pm`	1	4	`humidity.day`
orad_flag	Flag to specify whether or not the variable *orad* is specified as the last column of the **swrad_day** CBH file (`0`=no; `1`=yes)	**solrad_module** = `climate_hru`	1	1	`0`
potet_day	Pathname of the CBH file of pre-processed potential-ET input data for each HRU to specify variable *potet*-inches	**et_module** = `climate_hru`	1	4	`potet.day`
precip_day	Pathname of the CBH file of pre-processed precipitation input data for each HRU to specify variable *precip*-units based on value specified for parameter **precip_units**	**precip_module** = `climate_hru`	1	4	`precip.day`
swrad_day	Pathname of the CBH file of pre-processed solar-radiation input data for each HRU to specify variable *swrad*- units based on Langleys and value specified for parameter **rad_conv**	**solrad_module** = `climate_hru`	1	4	`swrad.day`
tmax_day	Pathname of the CBH file of pre-processed maximum air temperature input data for each HRU to specify variable *tmaxf*- units based on value specified for parameter **temp_units**	**temp_module** = `climate_hru`	1	4	`tmax.day`
tmin_day	Pathname of the CBH file of pre-processed minimum air temperature input data for each HRU to specify variable *tminf*- units based on value specified for parameter **temp_units**	**temp_module** = `climate_hru`	1	4	`tmin.day`
transp_day	Pathname of the CBH file of pre-processed transpiration on or off flag for each HRU file to specify variable *transp_on*-dimensionless	**transp_module** = `climate_hru`	1	4	`transp.day`
windspeed_cbh_flag	Flag to specify whether to read a CBH file with wind speed data (`0`=no; `1`=yes)	**et_module** = `potet_pm`	1	1	`0`
windspeed_day	Pathname of the CBH file of pre-processed wind speed input data for each HRU to specify variable *windspeed_hru*-meters/second	**et_module** = `potet_pm`	1	4	`windspeed.day`
		Debug options (model_mode = `GSFLOW` or `PRMS`)			
cbh_check_flag	Flag to indicate if CBH values are validated each time step (`0`=no; `1`=yes)	optional	1	1	`1`
parameter_check_flag	Flag to indicate if selected parameter-values validation checks are treated as warnings or errors (`0`=warning; `1`=errors; 2=check parameters and then stop execution)	optional	1	1	`1`
print_debug[1]	Flag to indicate type of debug output (`-1`=minimize screen output; `0`=none; `1`=water balances; `2`=`basin` module; `4`=`basin_sum` module; `5`=`soltab` module; `7`=`soilzone` module; `9`=`snowcomp` module; `13`=`cascade` module; `14`=`subbasin` module)	optional	1	1	`0`

Parameter name	Description	Required/Simulation condition(s)	Number of Values	Data type	Default value
	Statistic Variables (statvar) Files (model_mode = GSFLOW or PRMS)				
nstatVars	Number of variables to include in Statistics Variables File and names specified in **statVar_names**	**statsON_OFF** = 1	1	1	0
stat_var_file	Pathname for Statistics Variables File	**statsON_OFF** = 1	1	4	statvar.out
statsON_OFF	Switch to specify whether or not the Statistics Variables File is generated (0=no; 1=statvar text format; 2=CSV format)	**statsON_OFF** = 1	1	1	0
statVar_element	List of identification numbers corresponding to variables specified in **statVar_names** list (1 to variable's dimension size)	**statsON_OFF** = 1	**nstatVars**	4	none
statVar_names	List of variable names for which output is written to Statistics Variables File	**statsON_OFF** = 1	**nstatVars**	4	none
	Initial Condition Files				
init_vars_from_file	Flag to specify whether or not the Initial Conditions File is specified as an input file (0=no; 1=yes)	optional (available for all model modes)	1	1	0
save_vars_to_file	Flag to determine if an Initial Conditions File will be generated at the end of simulation (0=no; 1=yes)	optional (available for all model modes)	1	1	0
var_init_file	Pathname for Initial Conditions input file	**model_mode** = GSFLOW or PRMS and **init_vars_from_file** = 1	1	4	prms_ic.in
var_save_file	Pathname for the Initial Conditions File to be generated at end of simulation	**model_mode** = GSFLOW or PRMS and **save_vars_to_file** = 1	1	4	prms_ic.out
	Animation Files (model_mode = GSFLOW or PRMS)				
ani_output_file	Root pathname for Animation Files(s) to which a filename suffix based on dimension name associated with selected variables is appended	**aniOutON_OFF** = 1	1	4	animation.out
aniOutON_OFF	Switch to specify whether or not Animation File(s) are generated (0=no; 1=yes)	animation output	1	1	0
aniOutVar_names	List of variable names for which all values of the variable (that is, the entire dimension size) for each time step are written to Animation Files(s)	**aniOutON_OFF** = 1	**naniOutVars**	4	none
naniOutVars	Number of output variables specified in the **aniOutVar_names** list	**aniOutON_OFF** = 1	1	1	0
	Mapped Results Files (model_mode = GSFLOW or PRMS)				
mapOutON_OFF	Switch to specify whether or not Mapped Output file(s) by a specified number of columns (parameter **ncol**) of daily, monthly, yearly, or total simulation results is generated (0=no; 1=yes)	optional	1	1	0
mapOutVar_names	List of variable names for which output is written to mapped output files(s)	**map_resultsON_OFF** = 1	**nmapOutVars**	4	none
nmapOutVars	Number of variables to include in mapped output file(s)	**map_resultsON_OFF** = 1	1	1	0

Parameter name	Description	Required/Simulation condition(s)	Number of Values	Data type	Default value
		Nhru Summary Results Files (**model_mode** = GSFLOW or PRMS)			
nhruOutBaseFileName	Base pathname for each Nhru Summary Output File; the name of the selected variable is appended to this value	**nhruOutON_OFF** = 1	1	4	nhruout_path
nhruOutON_OFF	Switch to specify whether or not Nhru Summary Output File(s) are generated (0=no; 1=yes)	optional	1	1	0
nhruOutVar_names	List of variable names for which output is written to Nhru Summary Output File(s). Each variable is written to a separate file with the prefix of each file equal to the value of **nhruOutBaseFileName**.	**nhruOutON_OFF** = 1	**nhruOutVars**	4	none
nhruOutVars	Number of variables to include in Nhru Summary Output File(s)	**nhruOutON_OFF** = 1	1	1	0
nhruOut_freq	Output frequency and type of the Nhru Summary Output File(s) (1=daily; 2=monthly; 3=both; 4=mean monthly)	**nhruOutON_OFF** = 1	1	1	1

[1]File and screen output options: 1=water balance output files written in current directory, for intcp module file intcp.wbal; for snowcomp module snowcomp.wbal; for srunoff module srunoff_smidx.wbal or srunoff_carea.wbal; for soilzone module soilzone.wbal; for gwflow module gwflow.wbal; 2=basin module output written to screen; 4=basin_sum debug information written to file basin_sum.dbg in current directory; 5=soltab module output written to the file soltab_debug in current directory; 7=soilzone debug information concerning input parameter consistency written to file soilzone.dbg in current directory; 9=arrays of *net_rain*, *net_snow*, and *snowmelt* written to screen; 13=subbasin error and warning messages and cascade paths are written to the file cascade.msgs in current directory; 14=subbasin computation order written to file tree_structure in current directory.

[2]Parameter not needed for a PRMS-only simulation.

Table A1-4. Dimensions defined in the PRMS Parameter File.

[Dimensions only need to be defined for GSFLOW and PRMS-only simulation modes and are not needed for MODFLOW-only mode; HRU, hydrologic response unit; GWR, groundwater reservoir; >, greater than; control parameters **temp_module**, **precip_module**, **solrad_module**, **et_module**, **strmflow_module**, **subbasin_flag**, **cascade_flag**, **cascadegw_flag**, and **mapOutON_OFF** are defined in table A1-1 of this document; parameter **hru_solsta** defined in table 1-3 of online PRMS-IV documents; note that Dimensions that do not have an associated parameter specified in the Parameter File(s) or variable specified in the Data File are optional]

Dimension	Description	Default	Required/Simulated Condition(s)
Spatial dimensions			
ngw[1]	Number of GWRs (used in PRMS-only simulations)	1	**model_mode** = `GSFLOW` or `PRMS`
ngwcell	Number of cells in the MODFLOW grid (includes active and inactive cells)	0	**model_mode** = `GSFLOW` or when **mapOutON_OFF** = 1 and **model_mode** = PRMS
nhru[1]	Number of hydrologic response units	1	**model_mode** = `GSFLOW` or `PRMS`
nhrucell	Number of unique intersections between HRUs and spatial units of a target map for mapped results	0	**model_mode** = `GSFLOW` or when **mapOutON_OFF** = 1 and **model_mode** = PRMS
nlake	Number of lakes	0	**model_mode** = `GSFLOW` or `PRMS` when any HRU has **hru_type** specified equal to `2`
nreach	Number of reaches on all stream-channel segments	0	**model_mode** = `GSFLOW`
nsegment	Number of stream-channel segments	0	**model_mode** = `GSFLOW` or when HRU or GWR cascading flow is active or **strmflow_module** = `strmflow_in_out` or `muskingum` when **model_mode** = `PRMS`
nssr[1]	Number of subsurface reservoirs	1	**model_mode** = `GSFLOW` or `PRMS`
nsub	Number of internal subbasins	0	**model_mode** = `GSFLOW` or `PRMS` and **subbasin_flag** = `1` or parameter **subbasin_down** is specified
Time-series input data dimensions (model_mode = `GSFLOW` or `PRMS`)			
nevap	Number of pan-evaporation data sets	0	**et_module** = `potet_pan` or when any HRU has **hru_pansta** specified > `0`
nhumid	Number of relative-humidity measurement stations	0	required if **et_module** = `potet_pm_sta`
nlakeelev	Number of lake-elevation measurement stations	0	optional
nobs	Number of streamflow-measurement stations	0	optional in general and required when using the replacement flow option when **strmflow_module** = `muskingum` or `strmflow_in_out` and **model_mode** = `PRMS`
nrain	Number of precipitation-measurement stations	0	**precip_module** = `precip_1sta`, `precip_laps`, `precip_dist2`, `ide_dist`, or `xyz_dist`
nsnow	Number of snow-depth measurement stations	0	optional
nsol	Number of solar-radiation measurement stations	0	**solrad_module** = `ddsolrad` or `ccsolrad` and when any HRU has **hru_solsta** specified > `0`
ntemp	Number of air-temperature-measurement stations	0	**temp_module** = `temp_1sta`, `temp_laps`, `temp_dist2`, `ide_dist`, or `xyz_dist`
nwind	Number of wind-speed measurement stations	0	required if **et_module** = `potet_pm_sta`

Dimension	Description	Default	Required/Simulated Condition(s)
	Computation dimensions (model_mode = GSFLOW or PRMS)		
ncascade	Number of HRU links for cascading flow	0	**cascade_flag** = 1
ncascdgw	Number of GWR links for cascading flow	0	**cascadegw_flag** = 1 or 2
ndepl	Number of snow-depletion curves	1	required
ndeplval	Number of values in all snow-depletion curves (set to **ndepl***11)	11	required
	Fixed dimensions (model_mode = GSFLOW or PRMS)		
ndays	Maximum number of days in a year	366	optional
nlapse	Number of lapse rates in X, Y, and Z directions	3	**precip_module** = xyz_dist
nmonths	Number of months in a year	12	optional
one	Dimension of scalar parameters and variables	1	optional

[1]Dimensions **ngw**, **nhru**, and **nssr** must be equal.

Table A1-23. Input parameters specified for GSFLOW modules in the PRMS Parameter File(s).
[HRU, hydrologic response unit; Dimensions are defined in table A1-4 of this document]

Parameter name	Description	Dimension	Type	Units	Range	Default	Required/Simulated condition(s)
gvr_cell_id	Index of the grid cell associated with each gravity reservoir	**nhrucell**	integer	none	0 to **ngwcell**	0	**model_mode** = `GSFLOW` or when **mapOutON_OFF** = 1 and **model_mode** = PRMS
gvr_cell_pct	Proportion of the grid-cell area associated with each gravity reservoir	**nhrucell**	real	decimal fraction	0.0 to 1.0	0.0	**model_mode** = `GSFLOW` or when **mapOutON_OFF** = 1 and **model_mode** = PRMS and **nhru** not equal to **nhrucell**
gvr_hru_id	Index of the HRU associated with each gravity reservoir	**nhrucell**	integer	none	`1` to **`nhru`**	`1`	**model_mode** = `GSFLOW` or when **mapOutON_OFF** = 1 and **model_mode** = PRMS and **nhru** not equal to **nhrucell**
gvr_hru_pct	Proportion of the HRU area associated with each gravity reservoir	**nhrucell**	real	decimal fraction	0.0 to 1.0	0.0	**model_mode** = `GSFLOW` or when **mapOutON_OFF** = 1 and **model_mode** = PRMS and **nhru** not equal to **nhrucell**
id_obsrunoff	Index of measured streamflow station corresponding to the basin outlet	**one**	integer	none	`1` to **`nobs`**	`0`	required
lake_hru_id	Identification number of the lake associated with an HRU; more than one HRU can be associated with each lake	**nhru**	integer	none	`0` to **`nhru`**	`0`	**model_mode** = `GSFLOW` or `PRMS` and **nlake** is greater than 0
mnsziter[1]	Minimum number of iterations for which soil-zone states are computed	**one**	integer	none	`3` to `5,000`	MODFLOW convergence criterion[2]	**model_mode** = `GSFLOW`
mxsziter[1]	Maximum number of iterations for which soil-zone states are computed	**one**	integer	none	**`mnsziter`** to `5,000`	MODFLOW convergence criterion[2]	**model_mode** = `GSFLOW`
szconverge	Significant difference for checking soilzone states	**one**	real	inches	`1.0e-15` to `1.0e-01`	`1.0e-8`	**model_mode** = `GSFLOW`

[1]Parameter is not required in MODFLOW-only simulations.

[2]MXITER, ITMX, or MAXITEROUT

Table 1-5. Selected GSFLOW output variables for which values can be written to the PRMS Statistic Variables File and PRMS Animation Variables File(s) (supercedes Table A1-2 in Markstrom and others, 2008).[HRU, hydrologic response unit; ET, evapotranspiration; cfs: cubic feet per second; L3, cubic length units of MODFLOW; L3/T, cubic length units of MODFLOW per MODFLOW timestep; >, greater than; <, less than]

Variable name	Description	Dimension[1]	Units	Data type	Original Variable Name
actet_gw	Actual ET from each GW cell	**one**	inches	real	
actet_tot_gwsz	Total actual ET from each GW cell and PRMS soil zone	**one**	inches	real	
ActualET_Q	Volumetric flow rate of actual evapotranspiration from HRUs	**one**	L3/T	double	*basinactet*
Ave_SoilDrainage2Unsat_Q	Running average gravity drainage to the unsaturated and saturated zones	**one**	L3	double	ave_uzf_infil
basin_gw2sm	Basin average water exfiltrated from unsaturated and saturated zones and added to soil zone	**one**	inches	double	
basin_reach_latflow	BasLateral flow into all reaches in basin	**one**	cfs	double	
basingvr2sm	Volumetric flow rate of flow from gravity reservoirs to capillary reservoirs	**one**	L3/T	double	
basinrain	Volumetric flow rate of rain	**one**	L3/T	double	
basinseepout	Volumetric flow rate of groundwater discharge from the saturated zone to the soil zone	**one**	L3/T	double	
basinsm2gvr	Volumetric flow rate of flow from capillary reservoirs to gravity reservoirs	**one**	L3/T	double	
basinsnow	Volumetric flow rate of snow	**one**	L3/T	double	
basinsoilstor	Volume of soil moisture storage	**one**	L3	double	
BoundaryStreamFlow_Q	Volumetric flowrate of streamflow entering the model domain to SFR	**one**	L3/T	double	new
Canopy_S	Volume of intercepted precipitation in plant-canopy reservoirs	**one**	L3	double	*basinintcpstor*
CanopyEvap_Q	Volumetric flow rate of evaporation of intercepted precipitation	**one**	L3/T	double	*basinintcpevap*
Cap_S	Volume of water in capillary reservoirs of the soil zone	**one**	L3	double	*basinsoilmoist*
CapDrainage2Sat_Q	Volumetric flow rate of direct drainage from excess capillary water to the unsaturated zone	**one**	L3/T	double	*basinsoiltogw*
CapET_Q	Volumetric flow rate of evapotranspiration from pervious areas	**one**	L3/T	double	*basinpervet*
cell_drain_rate	Recharge rate for each cell	**ngwcell**	L3/T	real	
cum_pweqv	Cumulative change in snowpack storage	**one**	L3	double	
cum_satstor	Cumulative change in saturated storage	**one**	L3	double	
cum_soilstor	Cumulative change in soil storage	**one**	L3	double	
cum_uzstor	Cumulative change in unsaturated storage	**one**	L3	double	
Dprst_S	Volume of water in surface dpressions	**one**	L3	double	new
DprstEvap_Q	Volumetric flow rate of evaporation from surface depressions	**one**	L3/T	double	new
DunnInterflow2Cap_Q	Volumetric flow rate of cascading Dunnian runoff and interflow	**one**	L3/T	double	*basindnflow*

	to HRUs				
DunnInterflow2Lake_Q	Volumetric flow rate of Dunnian runoff and interflow to lakes	**one**	L3/T	double	*basinlakeinsz*
DunnSroff2Stream_Q	Volumetric flow rate of Dunnian runoff to streams	**one**	L3/T	double	*basin_dunnian*
Grav_S	Volume of water in gravity reservoirs of the soil zone .	**one**	L3	double	*basingravstor*
gw_rejected_grav	Recharge rejected by UZF for each gravity-flow reservoir	**nhrucell**	inches	real	
gw2sm	HRU average water exfiltrated from groundwater model and added back to soil zone	**nhru**	inches	real	
HortSroff2Lake_Q	Volumetric flow rate of Hortonian runoff to lakes	**one**	L3/T	double	*basinhortonianlakes*
HortSroff2Stream_Q	Volumetric flow rate of Hortonian runoff to streams	**one**	L3/T	double	*basinhortonian*
Imperv_S	Volume of water in impervious reservoirs	**one**	L3	double	*basinimpervstor*
ImpervEvap_Q	Volumetric flow rate of evaporation from impervious areas	**one**	L3/T	double	*basinimpervevap*
Infil2CapTotal_Q	Volumetric flow rate of soil infiltration into capillary reservoirs (including precipitation, snowmelt, and cascading Hortonian and Dunnian runoff and interflow minus infiltration to preferential-flow reservoirs)	**one**	L3/T	double	*basininfil_tot*
Infil2Pref_Q	Volumetric flow rate of soil infiltration into preferential-flow reservoirs (including precipitation, snowmelt, and cascading surface runoff)	**one**	L3/T	double	*basininfil2pref*
Infil2Soil_Q	Volumetric flow rate of soil infiltration (including precipitation, snowmelt, and cascading Hortonian flow)	**one**	L3/T	double	*basininfil*
Interflow2Stream_Q	Volumetric flow rate of slow plus fast interflow to streams	**one**	L3/T	double	*basininterflow*
KKITER	Current iteration in GSFLOW simulation	**one**	none	integer	*KKITER*
Lake_dS	Change in lake storage	**one**	L3	double	*lake_change_stor*
Lake_S	Volume of water in lakes	**one**	L3	double	*lake_stor*
Lake2Sat_Q	Volumetric flow rate of lake leakage to the saturated zones	**one**	L3/T	double	*lakebed_loss*
Lake2Unsat_Q	Volumetric flow rate of lake leakage to the unsaturated zones	**one**	L3/T	double	*lakebed_loss*
LakeEvap_Q	Volumetric flow rate of evaporation from lakes	**one**	L3/T	double	*basinlakeevap*
LakeExchng2Sat_Q	Volumetric flow rate of exchange between lakes and the saturated zone (value is equal to *Lake2Sat_Q* minus *SatDisch2Lake_Q*, where a negative value indicates a net loss from lakes)	**one**	L3/T	double	new
LakePrecip_Q	Volumetric flow rate of precipitation on lakes	**one**	L3/T	double	*basinlakeprecip*
net_sz2gw	Net volumetric flow rate of gravity drainage from the soil zone to the unsaturated and saturated zones	**one**	L3/T	double	
NetBoundaryFlow2Sat_Q	Volumetric flow rate to the saturated zone along the external boundary (negative value is flow out of model domain)	**one**	L3/T	double	*gw_inout*
NetWellFlow_Q	Net volumetric flow rate of groundwater injection or removal from wells	**one**	L3/T	double	*basinnetgwwel*
obs_strmflow	Volumetric flow rate of streamflow measured at a gaging station	**one**	L3/T	double	
PotGravDrn2Unsat	Potential volumetric flow rate of gravity drainage from the soil zone to the unsaturated zone (before conditions of the unsaturated and saturated zones are applied)	**one**	L3/T	double	*basinsz2gw*

Precip_Q	Volumetric flow rate of precipitation	**one**	L3/T	double	*basinppt*
Pref_S	Volume of water stores in preferential-flow reservoirs of the soil zone	**one**	L3	double	*basinprefstor*
rate_pweqv	Change in snow pack storage	**one**	L3	double	
rate_satstor	Change in saturated storage	**one**	L3	double	
rate_soilstor	Change in soil storage	**one**	L3	double	
rate_uzstor	Change in unsaturated storage	**one**	L3	double	
reach_cfs	Stream flow leaving each stream reach	**nreach**	cfs	real	
reach_wse	Water surface elevation in each stream reach	**nreach**	L	real	
RechargeUnsat2Sat_Q	Volumetric flow rate of recharge from the unsaturated zone to the saturated zone	**one**	L3/T	double	*uzf_recharge*
Sat_dS	Change in saturated-zone storage	**one**	L3	double	*sat_change_stor*
sat_recharge	HRU total recharge to the saturated zone	**nhru**	L3	real	new
Sat_S	Volume of water in the saturated zone	**one**	L3	double	*sat_stor*
Sat2Grav_Q	Volumeteric flow rate of groundwater discharge from the saturated zone to the soil zone	**one**	L3/T	double	*basingw2sz*
SatDisch2Lake_Q	Volumetric flow rate of groundwater discharge to lakes	**one**	L3/T	double	*gwflow2lakes*
SatDisch2Stream_Q	Volumetric flow rate of groundwater discharge to streams	**one**	L3/T	double	*gwflow2strms*
SatET_Q	Volumetric flow rate of evapotranspiration from the saturated zone	**one**	L3/T	double	*sat_et*
SnowEvap_Q	Volumetric flow rate of snowpack sublimation	**one**	L3/T	double	*basinsnowevap*
SnowMelt_Q	Volumetric flow rate of snowmelt	**one**	L3/T	double	*basinsnowmelt*
SnowPweqv_S	Volume of water in snowpack storage	**one**	L3	double	*basinpweqv*
SoilDrainage2Unsat_Q	Volumetric flow rate of gravity drainage to the unsaturated and saturated zones	**one**	L3/T	double	*uzf_infil*
Sroff2Stream_Q	Volumetric flow rate of surface runoff to streams	**one**	L3/T	double	*basinsroff*
stream_inflow	Specified volumetric stream inflow into model	**one**	L3	double	
Stream_S	Volume of water in streams (non-zero only when transient routing option is used in SFR2)	**one**	L3	double	*strm_stor*
Stream2Sat_Q	Volumetric flow rate of stream leakage to saturated zones	**one**	L3/T	double	*streambed_loss*
Stream2Unsat_Q	Volumetric flow rate of stream leakage to unsaturated zones	**one**	L3/T	double	
StreamExchng2Sat_Q	Volumetric flow rate of exchange betweeen streams and the unsaturated and saturated zones (value is equal to *Stream2Sat_Q* minus *SatDisch2Stream_Q*, where a negative value indicates a net loss from streams)	**one**	L3	double	*stream_leakage*
streamflow_sfr	Streamflow as computed by SFR for each segment	**nsegment**	cfs	real	
StreamOut_Q	Volumetric flow rate of streamflow leaving the model domain	**one**	L3/T	double	*basinstrmflow*
SwaleEvap_Q	Volumetric flow rate of evaporation from swale HRUs	**one**	L3/T	double	*basinswaleet*
total_pump	Total pumpage from all cells	**one**	L3	double	
total_pump_cfs	Total pumpage from all cells	**one**	cfs	double	
Unsat_dS	Change in unsaturated-zone storage	**one**	L3	double	*uzf_del_stor*

Unsat_S	Volume of water in the unsaturated zone	**one**	L3	double	*unsat_stor*
UnsatDrainageExcess_Q	Volumetric flow rate of gravity drainage from the soil zone not accepted due to conditions in the unsaturated and saturated zones	**one**	L3	double	*basinszreject*
UnsatET_Q	Volumetric flow rate of evapotranspiration from the unsaturated zone	**one**	L3/T	double	*uzf_et*
UnsatStream_dS	Change in unsaturated-zone storage under streams	**one**	L3	double	*sfruz_change_stor*
UnsatStream_S	Volume of water in the unsaturated zone under streams	**one**	L3	double	*sfruz_tot_stor*
uzf_et	Volumetric flow rate of evapotranspiration from the unsaturated and saturated zones	**one**	L3/T	double	
uzf_infil_map	HRU total gravity drainage to UZF cells	**nhru**	L3/T	double	

[1]Dimension variables defined in table 1-1.

Table 1-6. GSFLOW output variables written to the GSFLOW Comma-Separated-Values File (supercedes Table 12 in Markstrom and others, 2008).
[HRU, hydrologic response unit; ET, evapotranspiration; cfs: cubic feet per second; L3, cubic length units of MODFLOW; L3/T, cubic length units of MODFLOW per MODFLOW timestep; >, greater than; <, less than]

Variable name	Description	Dimension[1]	Units	Data type	Original Variable Name
BoundaryStreamFlow_Q	Volumetric flowrate of streamflow entering the model domain to SFR	**one**	L3/T	double	new
Canopy_S	Volume of intercepted precipitation in plant-canopy reservoirs	**one**	L3	double	*basinintcpstor*
CanopyEvap_Q	Volumetric flow rate of evaporation of intercepted precipitation	**one**	L3/T	double	*basinintcpevap*
Cap_S	Volume of water in capillary reservoirs of the soil zone	**one**	L3	double	*basinsoilmoist*
CapET_Q	Volumetric flow rate of evapotranspiration from pervious areas	**one**	L3/T	double	*basinpervet*
Dprst_S	Volume of water in surface dpressions	**one**	L3	double	new
DprstEvap_Q	Volumetric flow rate of evaporation from surface depressions	**one**	L3/T	double	new
DunnInterflow2Lake_Q	Volumetric flow rate of Dunnian runoff and interflow to lakes	**one**	L3/T	double	*basinlakeinsz*
DunnSroff2Stream_Q	Volumetric flow rate of Dunnian runoff to streams	**one**	L3/T	double	*basin_dunnian*
Grav_S	Volume of water in gravity reservoirs of the soil zone .	**one**	L3	double	*basingravstor*
HortSroff2Lake_Q	Volumetric flow rate of Hortonian runoff to lakes	**one**	L3/T	double	*basinhortonianlakes*
HortSroff2Stream_Q	Volumetric flow rate of Hortonian runoff to streams	**one**	L3/T	double	*basinhortonian*
Imperv_S	Volume of water in impervious reservoirs	**one**	L3	double	*basinimpervstor*
ImpervEvap_Q	Volumetric flow rate of evaporation from impervious areas	**one**	L3/T	double	*basinimpervevap*
Infil2Soil_Q	Volumetric flow rate of soil infiltration (including precipitation, snowmelt, and cascading Hortonian flow)	**one**	L3/T	double	*basininfil*
Interflow2Stream_Q	Volumetric flow rate of slow plus fast interflow to streams	**one**	L3/T	double	*basininterflow*
KKITER	Current iteration in GSFLOW simulation	**one**	none	integer	*KKITER*
Lake_S	Volume of water in lakes	**one**	L3	double	*lake_stor*
Lake2Unsat_Q	Volumetric flow rate of lake leakage to the unsaturated zones	**one**	L3/T	double	new
LakeEvap_Q	Volumetric flow rate of evaporation from lakes	**one**	L3/T	double	*basinlakeevap*
LakeExchng2Sat_Q	Volumetric flow rate of exchange between lakes and the saturated zone (value is equal to *Lake2Sat_Q* minus *SatDisch2Lake_Q*, where a negative value indicates a net loss from lakes)	**one**	L3/T	double	new
NetBoundaryFlow2Sat_Q	Volumetric flow rate to the saturated zone along the external boundary (negative value is flow out of model domain)	**one**	L3/T	double	*gw_inout*
NetWellFlow_Q	Net volumetric flow rate of groundwater injection or removal from wells	**one**	L3/T	double	*basinnetgwwel*
Precip_Q	Volumetric flow rate of precipitation	**one**	L3/T	double	*basinppt*
RechargeUnsat2Sat_Q	Volumetric flow rate of recharge from the unsaturated zone to the saturated zone	**one**	L3/T	double	*uzf_recharge*

Sat_S	Volume of water in the saturated zone	**one**	L3	double	*sat_stor*
Sat2Grav_Q	Volumeteric flow rate of groundwater discharge from the saturated zone to the soil zone	**one**	L3/T	double	*basingw2sz*
SatET_Q	Volumetric flow rate of evapotranspiration from the saturated zone	**one**	L3/T	double	*sat_et*
SnowEvap_Q	Volumetric flow rate of snowpack sublimation	**one**	L3/T	double	*basinsnowevap*
SnowPweqv_S	Volume of water in snowpack storage	**one**	L3	double	*basinpweqv*
SoilDrainage2Unsat_Q	Volumetric flow rate of gravity drainage to the unsaturated and saturated zones	**one**	L3/T	double	*uzf_infil*
Stream_S	Volume of water in streams (non-zero only when transient routing option is used in SFR2)	**one**	L3	double	*strm_stor*
Stream2Unsat_Q	Volumetric flow rate of stream leakage to the unsaturated zones	**one**	L3/T	double	new
StreamExchng2Sat_Q	Volumetric flow rate of exchange betweeen streams and the unsaturated and saturated zones (value is equal to *Stream2Sat_Q* minus *SatDisch2Stream_Q*, where a negative value indicates a net loss from streams)	**one**	L3/T	double	*stream_leakage*
StreamOut_Q	Volumetric flow rate of streamflow leaving the model domain	**one**	L3/T	double	*basinstrmflow*
SwaleEvap_Q	Volumetric flow rate of evaporation from swale HRUs	**one**	L3/T	double	*basinswaleet*
Unsat_S	Volume of water in the unsaturated zone	**one**	L3	double	*unsat_stor*
UnsatET_Q	Volumetric flow rate of evapotranspiration from the unsaturated zone	**one**	L3/T	double	*uzf_et*
UnsatStream_S	Volume of water in the unsaturated zone under streams	**one**	L3	double	*sfruz_tot_stor*

[1]Dimension variables defined in table 1-1