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

Version 2.1.0 GSFLOW release, March 04, 2020

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:
PRMS 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.

See the file 'tm6b8_PRMS_enhancements.pdf (Regan and LaFontaine, 2017) in the 'doc\Related reports' subdirectory for documentation on the dynamic parameters, water-use, lake simulation, and summary output options.

Up-to-date specifications for PRMS dimensions, parameters, and input and output variables are provided in several tables in file PRMS_tables_5.1.0.pdf in the 'doc\Related reports' subdirectory of the GSFLOW distribution. This major release adds new functionality for implementation of the SNTEMP model (module `stream_temp`) and Muskingum routing based on Manning's N (module `muskingum_mann`) are now available for PRMS-only mode. Additionally, PRMS output summary for HRU dimensioned variables optionally can be output in a gridded format. A change was made that affects soil-water evapotranspiration, which is now computed based on the potential evapotranspiration (PET) rate instead of the unsatisfied PET rate. Several bug fixes were applied to reading the dynamic parameter input files related to update of PET coefficients and soil-water content in the capillary reservoir.

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/*, accessed February 9, 2018) and *Online Guide to MODFLOW-NWT* (*http://water.usgs.gov/ogw/modflow-nwt/MODFLOW-NWT-Guide/*, accessed February 9, 2018). 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 2.1.0

Brief descriptions of the modules and packages that are supported in GSFLOW version 2.1.0 are given in table 1. This release includes all PRMS version 5.1.0 and MODFLOW-NWT version 1.1.5 Packages, thus table 2 is no longer needed.

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, and 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 a default value as given in Table A1-1for any input parameter are acceptable, the user does not need to enter a parameter block.

3. Up-to-date specifications for PRMS Control File parameters is provided in table 1-2 in file PRMS_tables_5.1.0.pdf in the ‘doc\Related reports’ subdirectory of the GSFLOW distribution.

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. Up-to-date specifications for PRMS Data File is provided in table 1-4 in file PRMS_tables_5.1.0.pdf in the ‘doc\Related reports’ subdirectory of the GSFLOW distribution.

2. Though all types of time-series data are optional, 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.

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 only are needed for the GSFLOW and PRMS-only simulation modes. Parameter Files are not needed for MODFLOW-only simulations.

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 in table 1-3 in file PRMS_tables_5.1.0.pdf in the 'doc\Related reports' subdirectory of the GSFLOW distribution. Parameters are listed by module or process usage within the PRMS. Note that not all of the parameters listed in this table are used in the GSFLOW simulation mode.

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 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 depending on values in the Data File and active modules. Tables 1-4 and 1-5 in file PRMS_tables_5.1.0.pdf in the 'doc\Related reports' subdirectory of the GSFLOW distribution describe variables that can be specified in the Data File and that are available for output from the PRMS.

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 2.1.0. [**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
Dynamic Parameter Input	dynamic_param_read	Provides the capability of varying several parameters that define landscape and climate characteristics for each Hydrologic Response Unit on any simulation time step by reading parameter values for each HRU from pre-processed files	2.0.0	G,P
Water Use Input	water_use_read	Provides the capability to specify the connectivity and flow rates of water transfers from water-supply sources to destination storage locations as a time series of values by reading water-use data values from pre-processed files	2.0.0	G,P
Temperature Distribution (1)	temp_1sta	Distributes maximum and minimum temperatures to each HRU by using temperature data measured at one station and specified monthly lapse rates (note, each HRU uses data from a single station, but, multiple stations can be used in a model with each HRU assigned data from one of those stations)	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 a 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	1.0.00	G,P

		distance, measured at each station		
	climate_hru	Reads distributed minimum and maximum air temperature values for each HRU directly from pre-processed 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
	temp_sta	Distributes maximum and minimum temperatures to each HRU by using temperature data measured at one station, similar to `temp_1sta` except there is no lapse rate (note, each HRU uses data from a single station, but, multiple stations can be used in a model with each HRU assigned data from one of those stations)	2.0.0	G,P
Precipitation Distribution (2)	precip_1sta	Determines the form of precipitation and distributes it to each HRU by using monthly correction factors to account for differences in altitude, spatial variation, topography, and measurement gage efficiency and observed data from one station (note, each HRU uses data from a single station, but, multiple stations can be used in a model with each HRU assigned data from one of those stations)	1.0.00	G,P
	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 for each HRU directly from pre-processed 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 for each HRU directly from pre-processed 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	1.0.00	G,P

		the Hamon formulation (Hamon, 1961)		
	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 for each HRU directly from pre-processed 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 for each HRU directly from pre-processed files	1.1.5	G,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 stream	1.2.0	P

		network by setting the outflow to the inflow		
	muskingum	Computes flow in the stream network using the Muskingum routing method (Linsley and others, 1982)	1.2.0	P
	muskingum_lake	Computes flow in the stream network using the Muskingum routing method and flow and storage in on-channel lake using several methods	2.0.0	P
	muskingum_mann	Computes flow in the stream network using the Muskingum routing method with routing coefficients based on Manning's N equation	2.1.0	P
Stream Temperature	stream_temp	Computes daily mean stream temperature for each stream segment in the stream network, module based on the Stream Network Temperature Model (SNTEMP, Theurer and others, 1984)	2.1.0	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 user-selected results dimensioned by the value of dimension **nhru** as daily, monthly, mean-monthly, mean yearly, and yearly total time-series as Comma-Separated-Values (CSV) files	1.2.0	G,P
	nsegment_summary	Writes user-selected results dimensioned by the value of dimension **nsegment** as daily, monthly, mean-monthly, mean yearly, and yearly total time-series as Comma-Separated-Values (CSV) files	1.2.2	G,P
	nsub_summary	Writes selected user-selected results dimensioned by the value of dimension **nsub** or **nhru** as daily, monthly, mean-monthly, mean yearly, and yearly total time-series as Comma-Separated-Values (CSV) files	1.2.2	G,P
	basin_summary	Writes user-selected results dimensioned by the value of dimension **one** as daily, monthly, mean-monthly, mean yearly, and yearly total time-series as Comma-Separated-Values (CSV) files	1.2.2	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	Writes climate-by-HRU Files of user-selected climate variables on the basis of distributed climate; land, subsurface, and stream processes are not computed	1.1.6	G,P
	frost_date	Writes a parameter file of the last spring frost and first fall frost for each HRU based on the simulation time period and distributed temperature as required by the `transp_frost` module; land, subsurface, and stream processes are not computed	1.2.0	P
	convert_params	Writes values for new PRMS-V parameters to a file based on a PRMS-IV Parameter File when control parameter **model_mode** is specified equal to CONVERT. Writes values for old PRMS-IV parameters to a file based on a PRMS-V Parameter	2.0.0	P

		File when control parameter **model_mode** is specified equal to CONVERT4		
	prms_summary	Computes select basin-wide variables to a Comma-Separated Values (CSV) file	2.0.0	P
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
Recharge	gwf2rch7	RCH: Adds terms to groundwater flow equation to represent areal recharge to groundwater system	2.0.0	M
Evapotranspiration	gwf2evt7	EVT: Adds terms to groundwater flow equation to represent head-dependent evapotranspiration from groundwater system	2.0.0	M
Segmented Evapotranspiration	gwf2ets7	ETS: Adds terms to groundwater flow equation to represent segmented head-dependent evapotranspiration from groundwater system	2.0.0	M
Interbed Storage	gwf2ibs7	IBS: Adds terms to groundwater flow equation to represent inelastic compaction of fine-grained sediments	2.0.0	M
Subsidence	gwf2sub7_NWT	SUB: Simulates aquifer-system compaction and land subsidence	2.0.0	M
Tile Drain	gwf2drt7	DRT: Adds terms to groundwater flow equation to represent groundwater discharge to drains while accounting for irrigation return flows	2.0.0	M
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	2.0.0	M
Drain	gwf2drn7_NWT	DRN: Adds terms to groundwater flow equation to represent groundwater discharge to drains	2.0.0	M
Reservoir	gwf2res7	RES: Adds terms to groundwater flow equation to represent leakage from reservoirs	2.0.0	M
Stream	gwf2str7	STR: Adds terms to flow equation to represent groundwater and stream interactions; predecessor to SFR2 Package	2.0.0	M
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	2.0.0	M
Hydrograph capability	gwf2hydmod7.f	HYDMOD: Records time-series data for selected data types	2.0.0	M
Horizontal Flow	gwf2hfb7_NWT	HFB: Simulates flow barriers by reducing horizontal	1.0.00	G,M

Barrier		conductance		
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
Sea Water Intrusion	gwf2swi27	SWI: Allows three-dimensional vertically integrated variable-density groundwater flow and seawater intrusion in coastal multiaquifer systems to be simulated	1.2.2	M
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.	1.2.2	M
Streamflow Routing	gwf2sfr7_NWT	SFR: Adds terms to flow equation to represent groundwater and stream interactions; modification of gwf2sfr1	1.0.00	G,M
Lake	gwf2lak7	LAK: Adds terms to flow equation to represent groundwater and lake interactions; modification of gwf2lak3	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 gwf2gag5	1.0.00	G,M
Agriculture	gwf2ag1_NWT	AG: apply agricultural demands to fields from stream segments and wells	2.1.0	G,M
Link to the MT3DMS contaminant-transport model	lmt8_NWT	LMT: Records flow information from MODFLOW for use by MT3DMS or MT3D-USGS	1.2.2	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
	obs2drn7, obs2riv7, obs2str7	OBS: Compares model-generated values of heads and flows to observed values for the DRN, RIV, and STR Packages	2.0.0	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 finite-difference approximations using a	1.0.00	G,M

		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
	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; computes PRMS surface-runoff and soilzone 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 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; PET, potential 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	Pathname of GSFLOW or PRMS Comma-Separated-Values (CSV) output file for selected GSFLOW basin-area weighted flows and storages for each time step	**model_mode** = `GSFLOW` or `GSFLOW5` with **gsf_rpt** = `1` or **model_mode** = `PRMS` or `PRMS5` with **csvON_OFF** = `1`	1	4	`prms_summary.csv`
csvON_OFF	Switch to specify whether or not the PRMS Comma-Separated-Values (CSV) output file is generated (`0`=no; `1`=yes; 2=only output pairs of simulated and measured flows)	**model_mode** = `PRMS` or `PRMS5`	1	1	`1`
data_file	Pathname(s) for measured input Data File(s), typically a single Data File is specified	**model_mode** = `GSFLOW`, `GSFLOW5`, `PRMS`, or `PRMS5`	number of Data Files	4	`prms.data`
end_time	Simulation end date and time as: year, month, day, hour, minute, second	**model_mode** = `GSFLOW`, `GSFLOW5`, `PRMS`, or `PRMS5`	6	1	`2001`, `9`, `30`, `0`, `0`, `0`
gsflow_output_file[2]	Pathname for GSFLOW Water-Budget File for writing summaries of each component of the GSFLOW water budget	**model_mode** = `GSFLOW` or `GSFLOW5`	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` or `GSFLOW5`	1	1	`1`
model_mode	Flag to indicate the simulation mode (`GSFLOW`=GSFLOW coupled model, version IV parameters; `GSFLOW5`=GSFLOW coupled model, version V parameters; `GSFLOW`=GSFLOW coupled model, version IV parameters; `GSFLOW`=GSFLOW coupled model, version IV parameters; `PRMS`=PRMS-only, version IV parameters; `PRMS5`=PRMS-only, version V parameters; `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)); POTET=simulate to potential ET; TRANSPIRE=simulate to determine transpiration period; DOCUMENTATION=write files of all declared parameters and variables in the executable)	required	1	4	`GSFLOW`

Parameter name	Description	Required/Simulation condition(s)	Number of Values	Data type	Default value
model_output_file	Pathname for Water-Budget File for results module basin_sum	**model_mode** = GSFLOW, GSFLOW5, PRMS, or PRMS5	1	4	prms.out
modflow_name[2]	Path and file name for MODFLOW Name File	**model_mode** = GSFLOW, GSFLOW5, or MODFLOW	1	4	modflow.nam
modflow_time_zero[2]	Date and time for the first MODFLOW stress period as: year, month, day, hour, minute, second; stress periods are skipped to model **start_time** if later than **modflow_time_zero**	**model_mode** = GSFLOW, GSFLOW5, 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, GSFLOW5, PRMS, or PRMS5	number of Parameter Files	4	prms.params
prms_warmup	Number of years to simulate before writing mapped results, Basin, **nhru**, **nsub**, or **nsegment** Summary Output Files	**map_resultsON_OFF** = 1, **basinOutON_OFF** = 1, **nsubOutON_OFF** = 1, **nsegmentOutON_OFF** = 1 or 2, or **nhruOutON_OFF** = 1 or 2	1	1	1
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, 7=every 7th day)	**model_mode** = GSFLOW or GSFLOW5	1	1	7
start_time	Simulation start date and time specified in the control item as: year, month, day, hour, minute, second	**model_mode** = GSFLOW, GSFLOW5, PRMS, or PRMS5	6	1	2000, 10, 1, 0, 0, 0
	Module selection and simulation options (model_mode = GSFLOW, GSFLOW5, PRMS, or PRMS5)				
cascade_flag	Flag to indicate if HRU cascades are computed (0=no; 1=yes; 2=simple cascades defined by **hru_segment**)	**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_id**, **gw_down_id**, and **gw_pct_up** do not need to be specified, which decreases the size of the parameter files	**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

Parameter name	Description	Required/Simulation condition(s)	Number of Values	Data type	Default value
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
snarea_curve_flag	Flag to specify whether to specify or compute snow depletion curves. (0=specify snow depletion curves with parameter **hru_deplcrv** and **snarea_curve**; 1=compute using parameters **snarea_a**, **snarea_b**, **snarea_c**, and **snarea_d**)	required	1	1	0
soilzone_aet_flag	Flag to specify whether to compute soil-water evapotranspiration (ET) based on unsatisfied potential ET (PET) and for GSFLOW or GSFLOW5 modes replenish the upper zone of capillary reservoir using the fraction of the upper zone of the capillary reservoir as was done in previous versions) or based on PET when specified equal to 1 and replenish by first filling the lower zone and then the upper zone to their maximum water-holding capacities (0=compute soil-water ET based on unsatisfied ET and old upper zone replenishment method; 1=based on PET and new replenishment method); set to 0 for downward compatibility of old models, though it is recommended setting to 1 for new models	required	1	1	0
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
stream_temp_flag	Flag to specify whether to simulate stream temperature, **strmflow_module** must be set to muskingum, muskingum_mann, strmflow_in_out, or muskingum_lake	**model_mode** = PRMS or PRMS5 stream temperature	1	1	0
strmflow_module	Module name for streamflow routing simulation method (strmflow, muskingum, muskingum_mann, or strmflow_in_out, muskingum_lake)	**model_mode** = PRMS or PRMS5	1	4	strmflow
strmtemp_humidity_flag	Flag to specify where humidity information is read for use by the stream_temp module (0=CBH File specified by control parameter **humidity_day**; 1=parameter **seg_humidity**; 2=Data File with values assigned based on parameter **seg_humidity_sta**), **strmflow_module** must be set to muskingum, muskingum_mann, strmflow_in_out, or muskingum_lake	**model_mode** = PRMS or PRMS5 stream temperature	1	1	0
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, temp_sta, ide_dist, or xyz_dist	required	1	4	temp_1sta

Parameter name	Description	Required/Simulation condition(s)	Number of Values	Data type	Default value
transp_module	Module name for transpiration simulation method (climate_hru, transp_frost, or transp_tindex)	required	1	4	transp_tindex
	Dynamic Parameter Input **(model_mode** = GSFLOW, GSFLOW5, PRMS, or PRMS5**)**				
covden_sum_dynamic	Pathname of the time series of pre-processed values for summer plant-cover density used to set values of **covden_sum** for each HRU	**dyn_covden_flag =** 1 or 3	1	4	dyncovsum
covden_win_dynamic	Pathname of the time series of pre-processed values for winter plant-cover density used to set values of **covden_win** for each HRU	**dyn_covden_flag =** 2 or 3	1	4	dyncovwin
covtype_dynamic	Pathname of the time series of pre-processed values used to set values of **cov_type** for each HRU	**dyn_covtype_flag =** 1	1	4	dyncovtype
dprst_depth_dynamic	Pathname of the time series of pre-processed values used to set values of **dprst_depth_avg**	**dyn_dprst_flag =** 2 or 3	1	4	dyndprst_depth
dprst_frac_dynamic	Pathname of the time series of pre-processed values used to set values of **dprst_frac**	**dyn_dprst_flag =** 1 or 3	1	4	dyndprst_frac
dyn_covden_flag	Flag to indicate if a time series of plant-canopy density values are input in a Dynamic Parameter File(s) (0=no; 1=file **covden_sum_dynamic**; 2=file **covden_win_dynamic**; 3=both)	dynamic canopy cover density	1	1	0
dyn_covtype_flag	Flag to indicate if a time series of plant-canopy type values are input in a Dynamic Parameter File with pathname specified by **covtype_dynamic** (0=no; 1=yes)	dynamic canopy cover type	1	1	0
dyn_dprst_flag	Flag to indicate if a time series of surface-depression values are input in a Dynamic Parameter File(s) (0=no; 1=file **dprst_frac_dynamic**; 2=file **dprst_depth_dynamic**; 3=both)	dynamic surface depression	1	1	0
dyn_fallfrost_flag	Flag to indicate if a time series of transpiration start Julian day values are input in a Dynamic Parameter File(s) (0=no; 1 =file **fallfrost_dynamic**)	dynamic transpiration and transp_module = transp_frost	1	1	0
dyn_imperv_flag	Flag to indicate if a time series of impervious values are input in a Dynamic Parameter File(s) (0=no; 1=file **imperv_frac_dynamic**; 2=file **imperv_stor_dynamic**; 3=both)	dynamic impervious	1	1	0
dyn_intcp_flag	Flag to indicate if a time series of plant canopy interception values are input in a Dynamic Parameter File(s) (0=no; 1=file **wrain_intcp_dynamic**; 2=file **srain_intcp_dynamic**; 4=file **snow_intcp_dynamic**; additive combinations, such as 3=file wrain_intcp_dynamic and srain_intcp_dynamic, but not snow_intcp_dynamic)	dynamic interception	1	1	0
dyn_potet_flag	Flag to indicate if a time series of potential ET coefficient values are input in a Dynamic Parameter File with pathname specified by **potet_coef_dynamic** to update coefficients for the specified month for the selected potential ET module specified by control parameter **et_module** (0=no; 1=parameter **jh_coef**, **pt_alpha**, **hs_krs**,	dynamic potential ET	1	1	0

Parameter name	Description	Required/Simulation condition(s)	Number of Values	Data type	Default value
	hamon_coef, **epan_coef**, **potet_cbh_adj**, and **pm_n_coef** used in potet_jh, potet_pt, potet_hs, potet_hamon, potet_pan, climate_hru, potet_pm, and potet_pm_sta modules, respectively; 2=parameter **jh_coef_hru, pm_d_coef** used in potet_jh , potet_pm, and potet_pm_sta modules, respectively)				
dyn_radtrncf_flag	Flag to indicate if a time series of solar radiation values are input in a Dynamic Parameter File with pathname specified by **radtrncf_dynamic** (0=no; 1=yes)	dynamic solar radiation transmission	1	1	0
dyn_soil_flag	Flag to indicate if a time series of soil-water capacity values are input in a Dynamic Parameter File(s) (0=no; 1=file **soilmoist_dynamic** only, 2=file **soilrechr_dynamic** only; 3=both)	dynamic soil moisture	1	1	0
dyn_springfrost_flag	Flag to indicate if a time series of transpiration start Julian day values are input in a Dynamic Parameter File(s) (0=no; 1=file **springfrost_dynamic**)	dynamic transpiration and transp_module = transp_frost	1	1	0
dyn_sro2dprst_perv_flag	Flag to indicate if a time series of fraction of surface runoff from the pervious portion of an HRU are input in Dynamic Parameter File **sro2dprst_perv_dyn** (0=no; 1=yes)	dynamic surface depression	1	1	0
dyn_sro2dprst_imperv_flag	Flag to indicate if a time series of fraction of surface runoff from the impervious portion of an HRU are input in Dynamic Parameter File **sro2dprst_imperv_dynamic** (0=no; 1=yes)	dynamic surface depression	1	1	0
dyn_transp_flag	Flag to indicate if a time series of transpiration month values are input in a Dynamic Parameter File(s) (0=no; 1=file **transpbeg_dynamic**; 2=file **transpend_dynamic** only, 3=both)	dynamic transpiration and transp_module = transp_tindex	1	1	0
dynamic_param_log_file	Pathname of the log file that summarizes dynamic parameter changes	for all dynamic parameter input	1	4	dynamic_parameter.out
fallfrost_dynamic	Pathname of the time series of pre-processed values for dynamic parameter **fall_frost**	**dyn_fallfrost_flag =** 1 and transp_module = transp_frost	1	4	dynfallfrost
imperv_frac_dynamic	Pathname of the time series of pre-processed values for dynamic parameter **hru_percent_imperv**	**dyn_imperv_flag =** 1 or 3	1	4	dynimperv
imperv_stor_dynamic	Pathname of the time series of pre-processed values for dynamic parameter **imperv_stor_max**	**dyn_imperv_flag =** 2 or 3	1	4	dynimperv
potet_coef_dynamic	Pathname of the time series of pre-processed potential evapotranspiration coefficient values where the parameter is dependent on the value of **et_module**	**dyn_potet_flag** = 1 or 2	1	4	dynpotetcoef
radtrncf_dynamic	Pathname of the time series of pre-processed values for dynamic parameter **rad_trncf**	**dyn_radtrncf_flag =** 1	1	4	dynradtrncf
snow_intcp_dynamic	Pathname of the time series of pre-processed values for dynamic parameter **snow_intcp**	**dyn_intcp_flag =** 4, 5, 6, or 7	1	4	dynsnowintcp

Parameter name	Description	Required/Simulation condition(s)	Number of Values	Data type	Default value
soilmoist_dynamic	Pathname of the time series of pre-processed values for dynamic parameter **soil_moist_max**	**dyn_soil_flag =** 1 or 3	1	4	dynsoilmoist
soilrechr_dynamic	Pathname of the time series of pre-processed values for dynamic parameter **soil_rechr_max_frac**	**dyn_soil_flag =** 2 or 3	1	4	dynsoilrechr
springfrost_dynamic	Pathname of the time series of pre-processed values for dynamic parameter **spring_frost**	**dyn_springfrost_flag =** 1 and transp_module = transp_frost	1	4	dynspringfrost
srain_intcp_dynamic	Pathname of the time series of pre-processed values for dynamic parameter **srain_intcp**	**dyn_intcp_flag =** 2, 3, 6, or 7	1	4	dynsrainintcp
sro2dprst_perv_dynamic	Pathname of the time series of pre-processed values for dynamic parameter **sro_to_dprst_perv**	**dyn_sro2dprst_perv_flag** = 1	1	4	dynsrotodprst_perv
sro2dprst_imperv_dynamic	Pathname of the time series of pre-processed values for dynamic parameter **sro_to_dprst_imperv**	**dyn_sro2dprst_imperv_flag =** 1	1	4	dynsrotodprst_imperv
transpbeg_dynamic	Pathname of the time series of pre-processed values for dynamic parameter **transp_beg**	**dyn_transp_flag** = 1 or 3 and transp_module = transp_tindex	1	4	dyntranspbeg
transpend_dynamic	Pathname of the time series of pre-processed values for dynamic parameter **transp_end**	**dyn_transp_flag =** 2 or 3 and transp_module = transp_tindex	1	4	dyntranspend
wrain_intcp_dynamic	Pathname of the time series of pre-processed values for dynamic parameter **wrain_intcp**	**dyn_intcp_flag =** 1, 3, 5, or 7	1	4	dynwrainintcp
	Water Use Input **(model_mode** = GSFLOW, GSFLOW5, PRMS, or PRMS5**)**				
dprst_transfer_file	Pathname of the time series of pre-processed flow rates for transfers from surface-depression storage	**dprst_transferON_OFF =** 1 and **dprst_flag** = 1	1	4	dprst.transfer
dprst_transferON_OFF	Flag to indicate to use time series of surface-depression transfer flow rates from the **dprst_transfer_file** (0=no; 1=yes)	surface depression transfer and **dprst_flag** = 1	1	1	0
external_transfer_file	Pathname of the time series of pre-processed flow rates for transfers from external sources	**external_transferON_OFF = 1**	1	4	ext.transfer
external_transferON_OFF	Flag to indicate to use external transfer flow rates from the **external_transfer_file** (0=no; 1=yes)	external transfer	1	1	0
gwr_transfer_file	Pathname of the time series of pre-processed flow rates for transfers from groundwater reservoir storage	**gwr_transferON_OFF =** 1	1	4	gwr.transfer
gwr_transferON_OFF	Flag to indicate to use groundwater transfer flow rates from the **gwr_transfer_file** (0=no; 1=yes)	groundwater transfer	1	1	0
lake_transfer_file	Pathname of the time series of pre-processed flow rates for transfers from lake HRUs	**lake_transferON_OFF =** 1	1	4	lake.transfer
lake_transferON_OFF	Flag to indicate to use lake HRU transfer flow rates from the **lake_transfer_file** (0=no; 1=yes)	lake water transfer	1	1	0
segment_transfer_file	Pathname of the time series of pre-processed flow rates for transfers	**segment_transferON_OFF**	1	4	seg.transfer

Parameter name	Description	Required/Simulation condition(s)	Number of Values	Data type	Default value
	from stream segments	= 1			
segment_transferON_OFF	Flag to indicate to use stream segment transfer flow rates from the **segment_transfer_file** (0=no; 1=yes)	stream water transfer	1	1	`0`
	Climate-by-HRU Files (model_mode = `GSFLOW`, `GSFLOW5`, `PRMS`, or `PRMS5`**)**				
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**, **solrad_module**, or **transp_module** = `climate_hru`	1	1	`0`
humidity_cbh_flag	Flag to specify whether to read a CBH file with humidity data (`0`=no; `1`=yes)	**et_module** = `potet_pm` or `potet_pt`	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`, `potet_pm_sta`, or `potet_pt`	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`, `GSFLOW5`, `PRMS`, or `PRMS5`**)**				
cbh_check_flag	Flag to indicate if CBH values are validated each time step (`0`=no; `1`=yes)	optional	1	1	`1`

Parameter name	Description	Required/Simulation condition(s)	Number of Values	Data type	Default value
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 (-2=minimal output to screen and no **model_output_file** or gsflow.log file; -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
	Statistic Variables (statvar) Files (model_mode = GSFLOW, GSFLOW5, PRMS, **or** PRMS5**)**				
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; 2=yes and use parameters **dprst_frac_init**, **snowpack_init**, **segment_flow_init**, **elevlake_init**, **gwstor_init**, (**soil_rechr_init**, **soil_moist_init**, **ssstor_init** for **model_mode**=PRMS or GSFLOW) or (**soil_rechr_init_frac**, **soil_moist_init_frac**, **ssstor_init_frac** for **model_mode**=PRMS5 or GSFLOW5), and **stream_tave_init**; 3=yes and use parameter **snowpack_init**; 4=yes and use parameter **elevlake_init**; 5=yes and use parameters (**soil_rechr_init**, **soil_moist_init**, **ssstor_init** for **model_mode**=PRMS or GSFLOW) or (**soil_rechr_init_frac**, **soil_moist_init_frac**, **ssstor_init_frac** for **model_mode**=PRMS5 or GSFLOW5); 6=yes and use parameter **gwstor_init**; 7=yes and use parameter **dprst_frac_init**; 8=yes and use parameter **stream_tave_init**). Note, **segment_flow_init**, **elevlake_init**, **gwstor_init**, and **stream_tave_init** are not used for GSFLOW or GSFLOW5 simulation modes	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,	1	4	prms_ic.in

Parameter name	Description	Required/Simulation condition(s)	Number of Values	Data type	Default value
var_save_file	Pathname for the Initial Conditions File to be generated at end of simulation	GSFLOW5, PRMS, or PRMS5 and **init_vars_from_file** = 1 **model_mode** = GSFLOW, GSFLOW5, PRMS, or PRMS5 and **save_vars_to_file** = 1	1	4	prms_ic.out
	Animation Files (model_mode = GSFLOW, GSFLOW5, PRMS, or PRMS5**)**				
ani_output_file	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, GSFLOW5, PRMS, or PRMS5**)**				
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
	Nhru Summary Results Files (model_mode = GSFLOW, GSFLOW5, PRMS, or PRMS5**)**				
nhruOutBaseFileName	Base pathname for each Nhru Summary Output File	**nhruOutON_OFF** =1 or 2	1	4	nhruout_path
nhruOutNcol	Number of columns written per line, which can be used to generate gridded output (0=all values for each timestep are written on a single line as in previous versions; >0 number of columns)	**nhruOutON_OFF** =1 or 2	1	1	0
nhruOutON_OFF	Switch to specify whether or not Nhru Summary Output File(s) are generated (0=no; 1=yes)	**nhru** summary results	1	1	0
nhruOutVar_names	List of variable names for which output is written to **nhru** Summary Comma Separated Values (CSV) Output Files(s). Each variable is written to a separate file with the prefix of each file equal to the value of **nhruOutBaseFileName**; variables must be of type real or double. Each variable is written to a separate file with the prefix of each file equal to the value of **nhruOutBaseFileName**. The suffix of the files is based on the value of **nhruOut_freq** and will be .csv; _meanyearly.csv; _yearly.csv; _meanmonthly.csv; or _monthly.csv. Variables must be of type real or double	**nhruOutON_OFF** = 1 or 2	**nhruOutVars**	4	none
nhruOutVars	Number of variables to include in Nhru Summary Output File(s)	**nhruOutON_OFF** = 1 or 2	1	1	0

Parameter name	Description	Required/Simulation condition(s)	Number of Values	Data type	Default value
nhruOut_format	Format of values (1=scientific notation with 4 significant digits (default); 2=2 decimal places; 3=3 decimal places; 4=4 decimal places; 5=5 decimal places)	**nhruOutON_OFF** = 1 or 2	1	1	1
nhruOut_freq	Output frequency and type (1=daily; 2=monthly; 3=both; 4=mean monthly; 5=mean yearly; 6=yearly)	**nhruOutON_OFF** = 1 or 2	1	1	1
nsegment Summary Files **(model_mode** = GSFLOW, GSFLOW5, PRMS, or PRMS5**)**					
nsegmentOutBaseFileName	String to define the prefix for each **nsegment** Summary Output File.	**nsegmentOutON_OFF** = 1 or 2	1	4	nsegmentout_path
nsegmentOutON_OFF	Switch to specify whether or not **nsegment** Summary Output Files are generated (0=no; 1=yes)	**nsegment** summary results	1	1	0
nsegmentOutVar_names	List of variable names for which output is written to **nsegment** Summary Comma Separated Values (CSV) Output Files(s). Each variable is written to a separate file with the prefix of each file equal to the value of **negmentOutBaseFileName**; variables must be of type real or double. Each variable is written to a separate file with the prefix of each file equal to the value of **nsegmentOutBaseFileName**. The suffix of the files is based on the value of **nsegmentOut_freq** and will be .csv; _meanyearly.csv; _yearly.csv; _meanmonthly.csv; or _monthly.csv. Variables must be of type real or double	**nsegmentOutON_OFF** = 1 or 2	**nsegmentOutVars**	4	none
nsegmentOutVars	Number of variables to include in **nsegment** Summary Output File(s)	**nsegmentOutON_OFF** = 1 or 2	1	1	0
nsegmentOut_format	Format of values (1=scientific notation with 4 significant digits (default); 2=2 decimal places; 3=3 decimal places; 4=4 decimal places; 5=5 decimal places)	**nsegmentOutON_OFF** = 1 or 2	1	1	1
nsegmentOut_freq	Output frequency and type (1=daily; 2=monthly; 3=both; 4=mean monthly; 5=mean yearly; 6=yearly)	**nsegmentOutON_OFF** = 1 or 2	1	1	1
nsub Summary Files **(model_mode** = GSFLOW, GSFLOW5, PRMS, or PRMS5**)**					
nsubOutBaseFileName	String to define the prefix for each **nsub** Summary Output File.	**nsubOutON_OFF** = 1	1	4	nsubout_path
nsubOutON_OFF	Switch to specify whether or not **nsub** Summary Output Files are generated (0=no; 1=yes)	**nsub** summary results	1	1	0
nsubOutVar_names	List of variable names for which output is written to **nsub** Summary Comma Separated Values (CSV) Output Files(s). Each variable is written to a separate file with the prefix of each file equal to the value of **nsubOutBaseFileName**; variables must be of type real or double. Each variable is written to a separate file with the prefix of each file equal to the value of **nsubOutBaseFileName**. The suffix of the files is based on the value of **nsubOut_freq** and will be .csv; _meanyearly.csv; _yearly.csv; _meanmonthly.csv; or _monthly.csv. Variables must be of type real or double	**nsubOutON_OFF** = 1	**nsubOutVars**	4	none

Parameter name	Description	Required/Simulation condition(s)	Number of Values	Data type	Default value
nsubOutVars	Number of variables to include in **nsub** Summary Output File(s)	**nsubOutON_OFF** = 1	1	1	0
nsubOut_format	Format of values (1=scientific notation with 4 significant digits (default); 2=2 decimal places; 3=3 decimal places; 4=4 decimal places; 5=5 decimal places)	**nsubOutON_OFF** = 1	1	1	1
nsubOut_freq	Output frequency and type (1=daily; 2=monthly; 3=both; 4=mean monthly; 5=mean yearly; 6=yearly)	**nsubOutON_OFF** = 1	1	1	1
	Basin Summary Results Files **(model_mode** = GSFLOW, GSFLOW5, PRMS, or PRMS5**)**				
basinOutBaseFileName	String to define the prefix for each Basin Summary Output File.	**basinOutON_OFF** = 1	1	4	basinout_path
basinOutON_OFF	Switch to specify whether or not basin Summary Output Files are generated (0=no; 1=yes)	Basin summary results	1	1	0
basinOutVar_names	List of variable names for which output is written to Basin Summary Comma Separated Values (CSV) Output Files(s). Each variable is written to a separate file with the prefix of each file equal to the value of **basinOutBaseFileName**; variables must be of type real or double. Each variable is written to a separate file with the prefix of each file equal to the value of **basinOutBaseFileName**. The suffix of the files is based on the value of **basinOut_freq** and will be .csv; _meanyearly.csv; _yearly.csv; _meanmonthly.csv; or _monthly.csv. Variables must be of type real or double	**basinOutON_OFF** = 1	**basinOutVars**	4	none
basinOutVars	Number of variables to include in Basin Summary Output File(s)	**basinOutON_OFF** = 1	1	1	0
basinOut_freq	Output frequency and type (1=daily; 2=monthly; 3=both; 4=mean monthly; 5=mean yearly; 6=yearly)	**basinOutON_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 a Dimension is optional if there is no associated parameter specified in the Parameter File(s) or variable specified in the Data File]

Dimension	Description	Default	Required/Simulated Condition(s)
	Spatial dimensions		
ngw[1]	Number of GWRs (used in PRMS-only simulations)	1	**model_mode** = GSFLOW, GSFLOW5, PRMS, or PRMS5
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 or PRMS5
nhru[1]	Number of hydrologic response units	1	**model_mode** = GSFLOW, GSFLOW5, PRMS, or PRMS5
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 or PRMS5
nlake	Number of lakes	0	**model_mode** = GSFLOW, GSFLOW5, PRMS, or PRMS5 when any HRU has **hru_type** specified equal to 2
nreach	Number of reaches on all stream-channel segments	0	**model_mode** = GSFLOW or GSFLOW5
nsegment	Number of stream-channel segments	0	**model_mode** = GSFLOW, GSFLOW5 or when HRU or GWR cascading flow is active or **strmflow_module** = strmflow_in_out, muskingum, muskingum_mann, or muskingum_lake when **model_mode** = PRMS or **cascade_flag** = 1 or 2 or **cascadegw_flag** = 1 or 2
nssr[1]	Number of subsurface reservoirs	1	**model_mode** = GSFLOW, GSFLOW5, PRMS, or PRMS5
nsub	Number of internal subbasins	0	**model_mode** = GSFLOW, GSFLOW5, PRMS, or PRMS5 and **subbasin_flag** = 1 or parameter **subbasin_down** is specified
	Time-series input data dimensions (model_mode = GSFLOW, GSFLOW5, PRMS, or PRMS5**)**[2]		
nconsumed	Number of consumptive water-use destinations	0	optional
nevap	Number of pan-evaporation data sets	0	**et_module** = potet_pan or when any HRU has **hru_pansta** specified > 0
nexternal	Number of external water-use sources or destinations	0	optional
nhumid	Number of relative-humidity measurement stations	0	required if **et_module** = potet_pm_sta
nobs	Number of streamflow-measurement stations	0	optional in general and required when using the replacement flow option when **strmflow_module** = strmflow_in_out, muskingum, muskingum_mann, or muskingum_lake and **model_mode** = PRMS or PRMS5
npoigages	Number of points-of-interest streamflow gages	0	optional
nrain	Number of precipitation-measurement stations	0	**precip_module** = precip_1sta, precip_laps, precip_dist2, ide_dist, or xyz_dist
nratetbl	Number of rating-table data sets for lake elevations	0	**strmflow_module** = muskingum_lake
nsnow	Number of snow-depth measurement stations	0	optional

Dimension	Description	Default	Required/Simulated Condition(s)
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`, `temp_sta`, `ide_dist`, or `xyz_dist`
nwind	Number of wind-speed measurement stations	0	required if **et_module** = `potet_pm_sta`
	Computation dimensions (model_mode = `GSFLOW`, `GSFLOW5`, `PRMS`, or `PRMS5`**)**		
ncascade	Number of HRU links for cascading flow	0	**cascade_flag** = `1` or `2`
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
	Lake computation dimensions (model_mode = `PRMS` or `PRMS5`**)**		
mxnsos	Maximum number of storage/outflow table values for lakes routed using the Puls method	0	**strmflow_module** = `muskingum_lake`
ngate	Maximum number of reservoir gate-opening values (columns) for lake rating table 1	0	**strmflow_module** = `muskingum_lake` and **nratetbl** > `0`
ngate2	Maximum number of reservoir gate-opening values (columns) for lake rating table 2	0	**strmflow_module** = `muskingum_lake` and **nratetbl** > `1`
ngate3	Maximum number of reservoir gate-opening values (columns) for lake rating table 3	0	**strmflow_module** = `muskingum_lake` and **nratetbl** > `2`
ngate4	Maximum number of reservoir gate-opening values (columns) for lake rating table 4	0	**strmflow_module** = `muskingum_lake` and **nratetbl** > `3`
nstage	Maximum number of lake elevations values (rows) for lake rating table 1	0	**strmflow_module** = `muskingum_lake` and **nratetbl** > `0`
nstage2	Maximum number of lake elevations values (rows) for lake rating table 2	0	**strmflow_module** = `muskingum_lake` and **nratetbl** > `1`
nstage3	Maximum number of lake elevations values (rows) for lake rating table 3	0	**strmflow_module** = `muskingum_lake` and **nratetbl** > `2`
nstage4	Maximum number of lake elevations values (rows) for lake rating table 4	0	**strmflow_module** = `muskingum_lake` and **nratetbl** > `3`
	Fixed dimensions (model_mode = `GSFLOW`, `GSFLOW5`, `PRMS`, or `PRMS5`**)**		
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.

[2]All associated data specified in Data File can be used for calibration purposes. While the default value for these dimensions is 0, there must be at least one column of measured data in the Data File, which could be a column of zeros.

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 `GSFLOW5` or when **mapOutON_OFF** = 1 and **model_mode** = `PRMS` or `PRMS5`
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 `GSFLOW5` or when **mapOutON_OFF** = 1 and **model_mode** = `PRMS` or `PRMS5` 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 `GSFLOW5` or when **mapOutON_OFF** = 1 and **model_mode** = `PRMS` or `PRMS5` 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 `GSFLOW5` or when **mapOutON_OFF** = 1 and **model_mode** = `PRMS` or `PRMS5` 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`, `GSFLOW5`, `PRMS`, or `PRMS5` and **nlake** is greater than 0
mxsziter[1]	Maximum number of iterations for which soil-zone states are computed	**one**	integer	none	`0` to `5,000`	MODFLOW maximum number of outer iterations[2]	**model_mode** = `GSFLOW` or `GSFLOW5`

[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; TM 6D1). [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 PRMS soil zone, and deeper unsaturated and saturated zones	**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	Lateral 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 precipitation falling as snow	**one**	L3/T	double	
basinsoilstor	Volume of soil moisture storage	**one**	L3	double	
basin_szreject	Basin average recharge from SZ and rejected by UZF	**one**	inches	double	
BoundaryStreamFlow_Q	Volumetric flow rate 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**	L/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-depression storage	**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 to HRUs	**one**	L3/T	double	*basindnflow*
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	HRU average recharge rejected by UZF	**nhru**	inches	real	
gw_rejected_grav	Recharge rejected by UZF for each gravity-flow reservoir	**nhrucell**	inches	real	
gw2sm	HRU average groundwater flow to soil zone	**nhru**	inches	real	
HortSroff2Lake_Q	Volumetric flow rate of Hortonian surface runoff to lakes	**one**	L3/T	double	*basinhortonianlakes*
HortSroff2Stream_Q	Volumetric flow rate of Hortonian runoff to streams	**one**	L3/T	double	*basinhortonian*
hru_ag_irr	Depth per unit area of irrigation added to soil-zone capillary reservoir from MODFLOW	**nhru**	inches	real	*new*
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 and 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 stored 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_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/T	double	
Stream_S	Volume of water stored 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/T	double	*stream_leakage*
streamflow_sfr	Volumetric flow rate of streamflow 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/T	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	

[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; TM 6-D1). [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