Changes from PRMS version 5.2.1 for 5.2.2

Changed module version dates for modified modules

Removed GSFLOW related code from basin.f90, climateflow.f90, soilzone.f90, subbasin.f90, call\_modules.f90, and setup\_cont.c

**MMF**

setup\_cont.c – removed **gsflow\_output\_file**, **gsflow\_csv\_file**, **creator\_email**, **cbh\_binary\_file**, added **forcing\_check\_flag**

No changes: basin\_summary.f90, convert\_params.f90, frost\_date.f90, gwflow.f90, map\_results, muskingum.f90, potet\_hamon.f90, potet\_hs.f90, potet\_jh.f90, potet\_pan.f90, potet\_pm.f90, potet\_pm\_sta.f90, potet\_pt.f90, precip\_dist2.f90, prms\_constants.f90, prms\_summary.f90, setup\_param.f90, strmflow\_character.f90, strmflow\_in\_out.f90, temp\_dist2.f90, transp\_frost.f90, transp\_tindex.f90, write\_climate\_hru.f90

**PRMS**

precip\_form routine in climateflow.f90 – added HRU ID as argument so that the ID is identified in an error message. Added **forcing\_check\_flag** to optionally check *hru\_ppt* < 0, *hru\_rain* < 0, and *hru\_snow* < 0. This change affects precip\_1sta, precip\_laps, xyz\_dist, ide\_dist, precip\_map, and climate\_hru.

temp\_set routine in climateflow.f90 – Added **forcing\_check\_flag** to optionally check *tmax* < *tmin*, *tminf* < -150 and *tmaxf* < 200. This change affects temp\_1sta, temp\_laps, temp\_sta, xyz\_dist, ide\_dist, temp\_map, temp\_dist2, and climate\_hru.

find\_header\_end routine modified to removed code specific to reading CBH Files; it reads input files to the first line that starts with ####. This routine is in utils\_prms.f90 and is used in dynamic\_param\_read.f90, dynamic\_soil\_param\_read.f90, nhru\_summary.f90, precip\_map.f90, temp\_map.f90, and water\_use\_read.f90.

find\_current\_time routine in utils\_prms.f90 modified to remove code related to **cbh\_binary\_flag**. This affects climate\_hru.f90, precip\_map.f90, and temp\_map.f90

Use “:” instead of 1 to pass two-dimensional arrays which is more portable; affected soltab, nhru\_summary, nsub\_summary, nsegment\_summary, glacr\_melt, and dynamic\_param\_read

basin\_sum.f90 – glacier variables *basin\_glacrb\_melt*, *basin\_glacrevap*, *basin\_gl\_to\_melt*, and lake variable *basin\_2ndstflow* added to computations

call\_modules.f90 - call strmflow\_character only when stream\_temp is active, version set to 5.2.2 11/11/2022, new control parameter **forcing\_check\_flag** and new dimension **nstreamtemp**, call new module dynamic\_soil\_param\_read for soilzone, dprst, and impervious dynamic parameters, removed checking for ierr return code from module functions if the return code can only be 0. When model\_mode equal CLIMATE, TRANSPIRE, POTET, or FROST, check for **model\_mode** CLEAN and return; add check to be sure **start\_time** is before **end\_time**, when **snarea\_curve\_flag** is 1, **ndepl** is set to **nhru** and **ndeplval** is set to **nhru**\*11

cascade.f90 – add PRMS\_open\_module\_file declared as EXTERNAL

ccsolrad.f90 – BUG FIX: check for divide by zero when *soltab\_horad\_potsw* or *hru\_cossl* = 0.0, needed for Alaska model

climate\_hru.f90 – BUG FIX: removed **chb\_binary\_flag** as use of binary CBH Files does not work. Identify climate\_hru as module an error occurred in reading CBH file(s). Add check for *tmin* < *tmax* as input in CBH Files and adjusted *tmin* < *tmax* when **forcing\_check\_flag** = 1. climate\_hru is printed as module used when using CBH Files of *humidity*, *albedo*, *cloud\_cover*, and/or *windspeed*. Add routine find\_cbh\_header\_end that reads a CBH to the first line that starts with ####, which is a modification of routine find\_header\_end.

climateflow.f90 – added variables dprst\_total\_open, dprst\_total\_open\_out, dprst\_total\_close\_in, dprst\_total\_close\_out, moved pref\_flow\_stor from soilzone module so it can be updated used in dynamic parameters.

ddsolrad.f90 – BUG FIX: check for divide by zero when *soltab\_horad\_potsw* or *hru\_cossl* = 0.0, needed for Alaska model

dynamic\_param\_read.f90 – moved code related to impervious, dprst, and soilzone dynamic parameters to new function dynamic\_soil\_param\_read.f90. Added check for errors reading dynamic parameter files. Check values of active HRUs for changed values instead of all HRUs. This module does not adjust any states.

dynamic\_soil\_param\_read.f90 – new module that reads and checks impervious, dprst, and soilzone dynamic parameters and adjusts associated storage. The log file for this module is named using control parameter **dynamic\_soil\_param\_log\_file**. If storage on impervious fraction with change making impervious fraction = 0, that storage is added to the gravity reservoir instead of capillary reservoir. If storage on dprst fraction with change making dprst fraction = 0, that storage is added to the gravity reservoir instead of capillary reservoir;. Note: error messages are triggered if impervious plus dprst fraction add up to > 0.999; if dprst\_frac > 0 and dprst\_depth\_avg = 0; if **soil\_rechr\_max\_frac** > 1.0 it is set to so that **soil\_rechr\_max** >= 0.00001; if **soil\_moist\_max** < 0.00001 or **soil\_rechr\_max** < 0.00001 they are set to 0.00001. BUG FIXES: a) if variable *soil\_moist* is updated, *basin\_soil\_moist* is reset so that water balance is computed correctly; b) if variable *slow\_stor* is updated, *ssres\_stor* and *basin\_ssstor* are reset so that water balance is computed correctly; c) if variable *slow\_stor* is updated, *ssres\_stor* and *basin\_ssstor* are reset so that water balance is computed correctly. c) if dprst volumes are updated, *dprst\_stor\_hru* is reset so that water balance is computed correctly.

intcp.f90 – maximum dimensions of parameters **snow\_intcp**, **srain\_intcp**, and **wrain\_inctp** changed from **nhru** to **nhru**,**nmonths**; also affects water\_balance.f90

Makefile – added strmflow\_character and dynamic\_soil\_param\_read

muskingum\_lake.f90 – BUG FIX: lake\_transfer was subtracted instead of added to lake\_outflow (water use issue). Routine error\_stop declared as EXTERNAL.

nhru\_summary.f90 – BUG FIX: didn't include the last day of each month when computing mean monthly output.

obs.f90 – added dimension **nstream\_temp** and observed variable *stream\_temp* for use as stream temperature replacement.

precip\_map.f90 – removed declaring read\_cbh\_date as EXTERNAL as not used.

prms\_time.f90 - use constants YEAR, MONTH, DAY instead of 1, 2, 3 for startday.

routing.f90 – BUG FIX: stream velocity was computed prior to check for seg\_slope < 0.0000001.

snowcomp.f90 – intrinsic function SNGL used when it shouldn't be to compute pk\_den; use local variable *hruarea\_dble* set to **hru\_area\_dble**, instead of referencing array hru\_area multiple times computing basin variables to be more efficient.

soilzone.f90 - added variable *hru\_perv\_actet*, added check to be sure **soil\_rechr\_max** > 0 to compute *basin\_soil\_rechr\_stor\_frac*, initialize fluxes that weren't already initialized to 0 outside HRU loop instead of inside. GSFLOW related code removed. Variable *pref\_flow\_stor* moved to climateflow.f90 so it can be used in dynamic\_soil\_param\_read.f90. In descriptions for **soil2gw\_max**, **ssr2gw\_rate**, and **ssr2gw\_exp** change GWR to groundwater reservoir storage. Maximum value for **fastcoef\_lin** changed to 1.5. *ssres\_stor* is set to *slow\_stor* + *pref\_flow\_stor* in INIT procedure as a precaution. Print warning if *avail\_potet* is less than -CLOSEZERO and if *avail\_potet* < 0 set *hru\_actet* to *potet*. Pass HRU ID to compute\_szactet so the ID can be printed in the warning message for *perv\_actet* > *avail\_actet*; simulation date also printed. Added check to be sure **soil\_rechr\_max** > 0 before being used in division in compute\_actet. BUG FIX: for frozen ground the water that should have gone into the capillary reservoir is add to *sroff*, *hru\_sroffp*, *hortonian\_flow*, *basin\_hortonian*, *basin\_sroff*, and *basin\_sroffp*. BUG FIX: for frozen ground flow Dunnian flow due to infiltration from the land surface is left in preferential flow reservoir and Dunnian flow due to discharge from the gravity reservoir is left in slow storage.

srunoff.f90 - added code to compute new variables *dprst\_total\_open*, *dprst\_total\_open\_out*, *dprst\_total\_close\_in*, *dprst\_total\_close\_out*; removed extra check of **glacier\_flag**. Change comment text from inch-acres to acre-inches. Add declare of read\_error as EXTERNAL in dprst\_init. For frozen ground dprst storage is assumed to be frozen, thus *dprst\_seep\_hru*, *dprst\_sroff\_hru*, and *dprst\_evap\_hru* are set to 0 and all input water is added to *sroff*. As a precaution for no snowmelt and no snowpack but there was net snow that evaporated, check pptmix\_nopack = 0 to be sure net\_rain isn’t added twice.

stream\_temp.f90 – check for **seg\_slope** < 0.00001, if so changed to 0.00001;set return values as 0.0 when *seg\_width* <= NEARZERO for subroutine *shday*; rely on strmflow\_character for segment width, so that code removed (variable *seg\_width* and parameters **width\_alpha** and **width\_m** moved to strmflow\_character); **seg\_length** default 1.0, maximum 100000.0; **seg\_slope** default 0.0001, minimum 0.015, description: Surface slope of each segment as approximation for bed slope of stream. Added code to allow for replacement of stream temperature for selected segments using parameter **tempIN\_segment** and variable **stream\_temp** read in by obs.f90 with **nstream\_temp** number of values. Comment out check for *seg\_tave\_water* < -98.0 and set *t\_o* *seg\_tave\_water* as unneeded as all cases caught later in code. BUG FIX: is *seg\_width* <= NEARZERO, which means no flow, *shade* and *svi* are set to 0 in routine shday.

temp\_1sta\_laps.f90 – BUG FIX: didn't print the module name correctly when **temp\_module** = temp\_sta.

temp\_map.f90 – removed declaring precip\_form and read\_cbh\_date as EXTERNAL as not used.

utils\_prms.f90 – code related to **cbh\_binary\_flag** removed from routines find\_current\_time and find\_header\_end. Added routine find\_cbh\_header\_end for exclusive use reading CBH Files.

water\_balance.f90 – allow for **srain\_intcp**, **wrain\_intcp**, and **snow\_intcp** to be dimensioned **nhru**,**nmonths**. intrinsic function dble used when it shouldn't be to compute *hru\_in*; added more information to HRU water balance warnings.