Documentation of Conversion of the MODFLOW Hydrogeologic-Unit Flow (HUF) Package To MODFLOW-2005

This documentation describes the changes to the HUF Package (Anderman and Hill, 2000) to convert it to work with MODFLOW-2005. See Chapter 9 of Harbaugh (2005) for further information about the MODFLOW-2005 program.

1. Fortran module GWFHUFMODULE was created to store the shared data for the HUF Package; GWFHUFMODULE incorporates the capability to support Local Grid Refinement. The following table describes the data.

Variable Name	Size	Description
IHUFCB	Scalar	Cell-by-cell budget flag and unit: <0 – Constant-head cell-by-cell budget data are written to the Listing File. 0 – No cell-by-cell budget >0 – Unit for saving cell-by-cell budget data
NHUF	Scalar	Number of hydrogeologic units
NPHUF	Scalar	Number of HUF parameters
IWETIT	Scalar	The iteration interval for attempting to wet cells. Wetting is attempted every IWETIT iteration.
IHDWET	Scalar	Flag indicating which equation to use for defining the head at a cell that has just converted from dry to wet: 0 – HNEW= BOT+WETFCT(Hn-BOT) not 0 – HNEW = BOT+WETFCT(THRESH)
IOHUFHDS	Scalar	Flag and unit number: 0 – Interpolated heads will not be written >0 – Interpolated heads will be written to unit IOHUFHDS
IOHUFFLWS	Scalar	Flag and unit number: 0 – Interpolated flows will not be written >0 – Interpolated flows will be written to unit IOHUFFLWS
WETFCT	Scalar	Factor included in the calculation of head at a cell that has just converted from dry to wet.
HDRY	Scalar	When a cell converts to dry, HNEW is set equal to HDRY.
HGUNAM	NHUF, LEN=10	Name of the hydrogeologic unit
LTHUF	NLAY	Layer-type code: 0 – A confined layer not 0 – A convertible layer
LAYWT	NLAY	Wetting flag for each layer: 0 – Wetting is inactive. not 0 – Wetting is active
IHGUFLG	5,NHUF	Print codes for printing arrays when they are defined by parameters (k is the hydrogeologic unit index): (1,k) – Print code for HK values (2,k) – Print code for HANI values (3,k) – Print code for VK values (4,k) – Print code for SS values (5,k) – Print code for SY values
HGUHANI	NHUF	Horizontal anisotropy flag or value for hydrogeologic units: 0 – indicates horizontal anisotropy is defined using HANI. >0 – HGUHANI is the horizontal anisotropy for the entire hydrogeologic unit.

HGUVANI	NHUF	Vertical anisotropy flag or value for hydrogeologic units: 0 – indicates HUFVK is vertical hydraulic conductivity. >0 – HGUVANI is the vertical anisotropy for the entire hydrogeologic unit and HUFVK is the ratio of horizontal to vertical hydraulic conductivity.
HUFHK	NHUF	Array that holds HK for the hydrogeologic units below a particular row, column location
HUFVK	NHUF	Array that holds VK or VANI for the hydrogeologic units below a particular row, column location
HUFSS	NHUF	Array that holds SS for the hydrogeologic units below a particular row, column location
HUFSY	NHUF	Array that holds SY for the hydrogeologic units below a particular row, column location
HUFHANI	NHUF	Array that holds HANI for the hydrogeologic units below a particular row, column location
HUFKDEP	NHUF	Array that holds KDEP for the hydrogeologic units below a particular row, column location
GS	NCOL,NROW	Elevation of the ground (reference) surface
VKA	NCOL,NROW,NLAY	Inverse vertical leakance of a cell.
SC1	NCOL,NROW,NLAY	Confined storage capacity.
WETDRY	NCOL,NROW,nwetd	Wetting threshold combined with wetting direction indicator. Absolute value is the wetting threshold. Negative indicates wetting only from below. 0 indicates no wetting. Positive indicates wetting from sides and below. The third dimension, nwetd, is the number of layers where wetting can occur.
HK	NCOL,NROW,NLAY	Horizontal hydraulic conductivity in the row direction.
HKCC	NCOL,NROW,NLAY	Horizontal hydraulic conductivity in the column direction.
HUFTMP	NCOL,NROW,NLAY	Temporary array
VDHD	NCOL,NROW,NLAY	Angle between the grid axis and the principal direction of hydraulic conductivity.
HUFTHK	NCOL,NROW,NHUF,2	Top elevation (1) and thickness (2) of the hydrogeologic unit.
VDHT	NCOL,NROW,NLAY,3	Components of the horizontal transmissivity tensor in the a (row) and b (column) directions (j, i, and k are the column, row, and layer indices, respectively): (j,i,k,,1) – T_{aa} (j,i,k,2) – T_{ab} (j,i,k,3) – T_{bb}
A9	NCOL,NROW,NLAY,5	Components of the stiffness matrix (j, i, and k are the column, row, and layer indices, respectively): (j,i,k,,1) – Coefficient for local cell j,i,k (j,i,k,2) – Coefficient for local cell j+1,i,k (j,i,k,3) – Coefficient for local cell j+1,i+1,k (j,i,k,4) – Coefficient for local cell j,i+1,k (j,i,k,5) – Coefficient for local cell j-1,i,k

2. All subroutines were changed to designate 2 for the process version and 7 for the package version: GWF2HUF7.

3. Subroutines GWF1HUF2ALG, GWF1HUF2KDEP1ALG, GWF1HUF2LVDA1ALG, GWF1HUF2RPGD, GWF1HUF2KDEP1RPGD, and GWF1HUF2LVDA1RPGD were combined into GWF2HUF7AR.

4. GWF2HUF7AR was modified to use ALLOCATE statements to reserve memory for the data in GWFHUFMODULE rather than reserving space in the X and IX arrays used by MODFLOW-2000.

5. Subroutine arguments that are contained in Fortran modules were replaced with USE statements in all primary subroutines called from main.

6. Subroutine GWF2HUF7DA was created to deallocate memory.

7. To support the Local Grid Refinement capability, subroutine SGWF2HUF7PNT was created to set pointers to a grid, and subroutine SGWF2HUF7PSV was created to save the pointers for a grid. The grid number, IGRID, was added as a subroutine argument to all of the primary subroutines, and subroutines SGWF2HUF7PSV and SGWF2HUF7PNT are called as appropriate.

References

Anderman, E.R., and Hill, M.C., 2000, MODFLOW-2000, the U.S. Geological Survey modular ground-water model—Documentation of the Hydrogeologic-Unit Flow (HUF) Package: U.S. Geological Survey Open-File Report 00-342, 89 p.

Harbaugh, A.W., 2005, MODFLOW-2005,the U.S. Geological Survey modular ground-water model—the Ground-Water Flow Process: U.S. Geological Survey Techniques and Methods 6-A16, variously p.