

MF2KtoMF05UC, a Program To Convert MODFLOW-2000 Files to MODFLOW-2005 and UCODE_2005 Files

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Preface

This report describes the computer code MF2KtoMF05UC. The code is in the public domain and can be downloaded from the Internet at address http://water.usgs.gov/software/ground_water.html. The code has been tested in a variety of applications, but future applications could reveal previously undetected errors. Users are requested to notify the originating office of any errors found in the report or computer code:

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Any updates to the code will be posted at the above Internet address.

Contents

Preface	iii
Abstract.....	1
Introduction.....	1
MODFLOW-2005 Files	1
UCODE_2005 Files	2
Running MF2KtoMF05UC	2
Summary and Example.....	3
References Cited.....	4

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By Arlen W. Harbaugh

Abstract

The program MF2KtoMF05UC has been developed to convert MODFLOW-2000 input files for use by MODFLOW-2005 and UCODE_2005. MF2KtoMF05UC was written in the Fortran 90 computer language. This report documents the use of MF2KtoMF05UC.

Introduction

MODFLOW-2005 (Harbaugh, 2005) is an updated version of MODFLOW-2000 (Harbaugh and others, 2000; Hill and others, 2000). Although many of the input files for MODFLOW-2005 are the same as those for MODFLOW-2000, some changes are necessary. Further, the sensitivity-analysis and parameter-estimation capabilities of MODFLOW-2000 were removed from MODFLOW-2005. These capabilities can still be obtained with MODFLOW-2005; however, using a separate program called UCODE_2005 is necessary (Poeter and others, 2005). The program MF2KtoMF05UC has been developed to make conversion from MODFLOW-2000 to MODFLOW-2005 and UCODE_2005 more convenient. The conversion program makes the required changes to files used by MODFLOW-2005 and creates files required for running UCODE_2005. MF2KtoMF05UC supports all of the functionality of parameter estimation in MODFLOW-2000 except for variance-covariance matrices for weighting flow observations and prior information. MF2KtoMF05UC will stop execution if the MODFLOW-2000 files specify variance-covariance matrices. MF2KtoMF05UC was written in the Fortran 90 computer language.

This report documents use of the MF2KtoMF05UC conversion program. It is recommended that users of the conversion program become familiar with the MODFLOW-2005 and UCODE_2005 programs. In the information below, dsname is the prefix from a MODFLOW-2000 Name File. For example, if the MODFLOW-2000 Name File is called "SIMULATION1.NAM," "SIMULATION1" is dsname.

MODFLOW-2005 Files

MF2KtoMF05UC creates several MODFLOW files that differ between MODFLOW-2000 and MODFLOW-2005. A Parameter Value file, named dsname.pvl, is created from the MODFLOW-2000 Sensitivity-Process input file. New Observation-Process input files also are created. These files have the names dsname.obh, dsname.obd, dsname.obr, dsname.obg, and dsname.obc for the head, drain, river, general-head boundary (GHB), and constant-head observation files, respectively. The MF2KtoMF05UC-created observation files cause dsname._os to be used to save the simulated equivalents of the observations (heads, drains, rivers, GHBs, or constant heads). All of these MODFLOW-2005 files have a slightly modified format compared to the MODFLOW-2000 files. Further, the observation names are changed if they do not meet the naming requirements for UCODE_2005 observations (Poeter and others, 2005, p. 83).

One naming requirement is that the first character of an observation name must be a letter. Another requirement is that the characters in the name are restricted to letters, numbers, underscore, period, colon, ampersand, # symbol, and @ symbol. Characters not meeting these two requirements are replaced by use of a numerical algorithm. UCODE_2005 also requires unique names that are not case sensitive. MF2KtoMF05UC replaces non-unique names with unique names by adding two characters if the name is less than 10 characters or by modifying the eleventh and twelfth characters. The changed names are written into file dsname.log.

A new MODFLOW-2005 Name File, with the same name as the MODFLOW-2000 Name File, is created. To avoid losing the original file, the original file is renamed to dsname_mf2k.nam before the new Name File is written. In this new Name File, the lines that specify the sensitivity and observation files are replaced by lines that specify the Parameter Value and modified observation files. File dsname._os is inserted as the file for saving the simulated equivalents of observations. MODFLOW-2005 allows only a single Listing File, while MODFLOW-2000 allows two output files designated by the file types GLOBAL and LIST. If the GLOBAL file type is specified with or without an additional LIST file,

2 MF2KtoMF05UC, a Program To Convert MODFLOW-2000 Files to MODFLOW-2005 and UCODE_2005 Files

the MODFLOW-2005 Name File will have a single file with LIST as the type and dsname.lst as the name. If only a LIST file type is specified in the MODFLOW-2000 Name File, the entry is unchanged in the MODFLOW-2005 Name File.

Finally, a file named dsname.bat is created. This file facilitates running MODFLOW-2005 on a personal computer running the Microsoft Windows operating system. The MODFLOW-2005 simulation will be run by double-clicking dsname.bat within Windows Explorer. The MODFLOW-2005 executable is named MF2005 in dsname.bat; this .bat file will need to be edited if the MODFLOW-2005 executable has a different name on the computer being used or if the directory containing this executable is not listed in the PATH environmental variable.

UCODE_2005 Files

UCODE_2005 files are created if the Sensitivity or Parameter-Estimation Process is used in the MODFLOW-2000 simulation. UCODE_2005 requires a main UCODE input file, and most data for this file come from the MODFLOW-2000 Parameter-Estimation Process and Sensitivity Process input files. The main UCODE input file is named dsname_ucose.in. The required information needed by UCODE_2005 to describe parameters and observations may be included in the main UCODE input file or in separate files; MF2KtoMF05UC puts the parameter and observation data in separate files.

The UCODE_2005 parameter file is named dsname_ucose.par. Some data from the MODFLOW-2000 sensitivity file that are not required by MODFLOW-2005 are used to create the parameter file. The fields are StartValue, LowerValue, UpperValue, ScalePval, Transform, and Adjustable. Three additional values, which are not contained in the MODFLOW-2000 sensitivity file, are needed for the parameter file: Constrain, LowerConstraint, and UpperConstraint. Constrain is set to "no," LowerConstraint is set to LowerValue, and UpperConstraint is set to UpperValue. All of these values are documented in the UCODE_2005 documentation.

The UCODE_2005 observation file is named dsname_ucose.obs. Data from the MODFLOW-2000 observation files that are not required by MODFLOW-2005 are used to create the UCODE_2005 observation file. The MODFLOW-2000 STAT, STAT-FLAG, and PLOT-SYMBOL values become the UCODE_2005 Statistic, StatFlag, and GroupName values. Further, the MODFLOW-2000 PLOT-SYMBOL is made to be the UCODE_2005 PlotSymbol using the UCODE_2005 group capability. A UCODE_2005 Observation_Groups Input Block is created in the main UCODE input file, and this block assigns the PlotSymbol to be the same as the GroupName.

UCODE_2005 requires the use of template files to describe how to generate input data for running a model. MF2KtoMF05UC creates a single template file, which is

named dsname_ucose.tpl. This file allows UCODE_2005 to generate a MODFLOW-2005 Parameter Value file when UCODE_2005 runs MODFLOW-2005.

UCODE_2005 further requires the use of instruction files to be able to determine the simulated equivalents for observations from the output of a model. MF2KtoMF05UC creates a single instruction file, which is named dsname_ucose.inst. This file allows UCODE_2005 to read the simulated equivalents produced by MODFLOW-2005 from file dsname_.os.

Prior-information equations specified in the MODFLOW-2000 parameter estimation file are moved into a Linear_Prior_Information Input Block (Poeter and others, 2005, p. 95) in the main UCODE input file. Manual editing will be required if the prior-information equations include log-transformed parameters. UCODE_2005 requires prior-information equations that include log-transformed parameters to transform the parameters using the Log10 function, but MF2KtoMF05UC does not add the Log10 function. As with observations, the MODFLOW-2000 PLOT-SYMBOL for prior information is made to be the UCODE_2005 PlotSymbol using the UCODE_2005 group capability. A UCODE_2005 Prior_Information_Groups Input Block is created in the main UCODE_2005 input file to set the PlotSymbol to be the same as the GroupName.

MF2KtoMF05UC makes an additional MODFLOW-2005 Name File, which UCODE_2005 uses to run MODFLOW-2005. This file is named dsname.nam.ucose. This additional Name File is identical to dsname.nam except that the Parameter Value file is named ucode.pvl rather than dsname.pvl. The reason for the change is to avoid having UCODE_2005 overwrite the dsname.pvl file when UCODE_2005 runs. UCODE_2005 recreates the ucode.pvl Parameter Value file many times as it computes sensitivities of parameters.

Finally, a file named dsname_ucose.bat is created. This file facilitates running UCODE_2005 on a personal computer running a version of the Microsoft Windows operating system. The UCODE simulation will be run by double-clicking dsname_ucose.bat within Windows Explorer. The UCODE_2005 executable is named UCODE_2005 in dsname_ucose.bat; this .bat file will need to be edited if the UCODE_2005 executable has a different name on the computer being used or if the directory containing this executable is not listed in the PATH environmental variable. The required filename prefix for UCODE_2005 (Poeter and others, 2005, p. 29) is specified as dsname_ucose.

Running MF2KtoMF05UC

MF2KtoMF05UC should be run in a command-prompt window with the current directory being the directory that contains the MODFLOW-2000 Name File. The MODFLOW-2000 Name File can be specified as a command argument. If the argument is not specified, the user is prompted to enter the Name File.

After MF2KtoMF05UC is run, MODFLOW-2005 can be run without parameter estimation by double-clicking the file `dsname.bat` within Windows Explorer. If a command-prompt window is being used, run MODFLOW-2005 with the command:

```
mf2005 dsname
```

If the original MODFLOW-2000 simulation included sensitivity analysis or parameter estimation, UCODE_2005 can be run by double-clicking the file `dsname_ucose.bat` within Windows Explorer. If a command-prompt window is being used, run UCODE_2005 with the command:

```
ucose_2005 dsname_ucose.in fn
```

where “fn” is the filename prefix used by UCODE to generate output files.

MF2KtoMF05UC creates a file named `dsname.log`, which contains information about the data read from the MODFLOW-2000 files. This file will contain information about any problems with the file conversions. Modifications of observation names to meet UCODE_2005 naming conventions will be shown in `dsname.log`.

Summary and Example

In summary, MF2KtoMF05UC will create up to eight new files for running MODFLOW-2005 and seven new files for running UCODE_2005. If the MODFLOW-2000 Name File is `dsname.nam`, the new MODFLOW-2005 files are as follows:

```
dsname.nam – MODFLOW-2005 Name File
dsname.pvl – MODFLOW-2005 Parameter Value file
dsname.obh – MODFLOW-2005 head observation file
dsname.obd – MODFLOW-2005 drain observation file
dsname.obr – MODFLOW-2005 river observation file
dsname.obg – MODFLOW-2005 general-head boundary
observation file
dsname.obc – MODFLOW-2005 constant-head observa-
tion file
dsname.bat – File for running MODFLOW-2005 from
within Windows Explorer
```

Each observation file is created only if the respective observation type exists in the MODFLOW-2000 simulation. The UCODE_2005 files are as follows:

```
dsname_ucose.in – Main UCODE_2005 input file
dsname_ucose.par – UCODE_2005 parameter file
dsname_ucose.tpl – UCODE_2005 template file
dsname_ucose.obs – UCODE_2005 observation file
dsname_ucose.inst – UCODE_2005 instruction file
```

```
dsname.nam.ucose – Modified MODFLOW Name File
used when UCODE_2005 runs MODFLOW-2005
dsname_ucose.bat – File for running UCODE_2005 from
within Windows Explorer
```

An additional file named `dsname_mf2k.nam`, which is a copy of the original MODFLOW-2000 Name File, is also made.

An example simulation, which is called `tc1`, is included with Hill and others (2000). The original `tc1` files and the new files created by MF2KtoMF05UC are distributed along with the MF2KtoMF05UC code so that users can check to see that MF2KtoMF05UC is running properly. The original `tc1` simulation input files are as follows:

```
tc1.nam – MODFLOW Name File
tc1.dis – Discretization file
tc1.zon – Zone array file
tc1.mlt – Multiplier array file
tc1.bas – Basic Package input file
tc1.oc – Output Control Option input file
tc1.lpf – Layer-Property Flow Package input file
tc1.wel – Well Package input file
tc1.ghb – General-Head Boundary Package input file
tc1.riv – River Package input file
tc1.rch – Recharge Package input file
tc1.pcg – Preconditioned Conjugate-Gradient Package
input file
tc1.obs – Observation input file
tc1.ohd – Head observation input file
tc1.orv – River observation input file
tc1.sen – Sensitivity-Process input file
tc1.pes – Parameter-Estimation Process input file
```

When MF2KtoMF05UC is run with the `tc1` data set, the following changes occur. The file `tc1.nam` is modified as described above, but a copy of the original file is made using the name `tc1_mf2k.nam`. Many new files are made using data from the original MODFLOW-2000 files, but the original files are not changed:

```
tc1.obh is created from tc1.ohd
tc1.obr is created from tc1.orv
tc1.pvl is created from tc1.sen
tc1_ucose.in is created primarily from tc1.pes
tc1_ucose.par is created from tc1.sen
tc1_ucose.tpl is created from tc1.sen
tc1_ucose.obs is created from the observation files
tc1_ucose.inst is created from the observation files
```

In the original simulation, the head observations have names that start with numbers, and this convention is not allowed by UCODE_2005. MF2KtoMF05UC changes these names to start with a letter.

4 MF2ktoMF05UC, a Program To Convert MODFLOW-2000 Files to MODFLOW-2005 and UCODE_2005 Files

MODFLOW-2005 can be run using the tc1.nam Name File. Output will go into tc1.lst. If using Windows Explorer, MODFLOW-2005 can be run by double-clicking on tc1.bat. UCODE_2005 can be run using the tc1_ucose.in main UCODE input file. Output will go into tc1_ucose.#uout. If using Windows Explorer, UCODE_2005 can be run by double-clicking on tc1_ucose.bat.

The original simulation can still be run with MODFLOW-2000 using the tc1_mf2k.nam Name File. Output will go to tc1.glo and tc1.lst.

References Cited

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