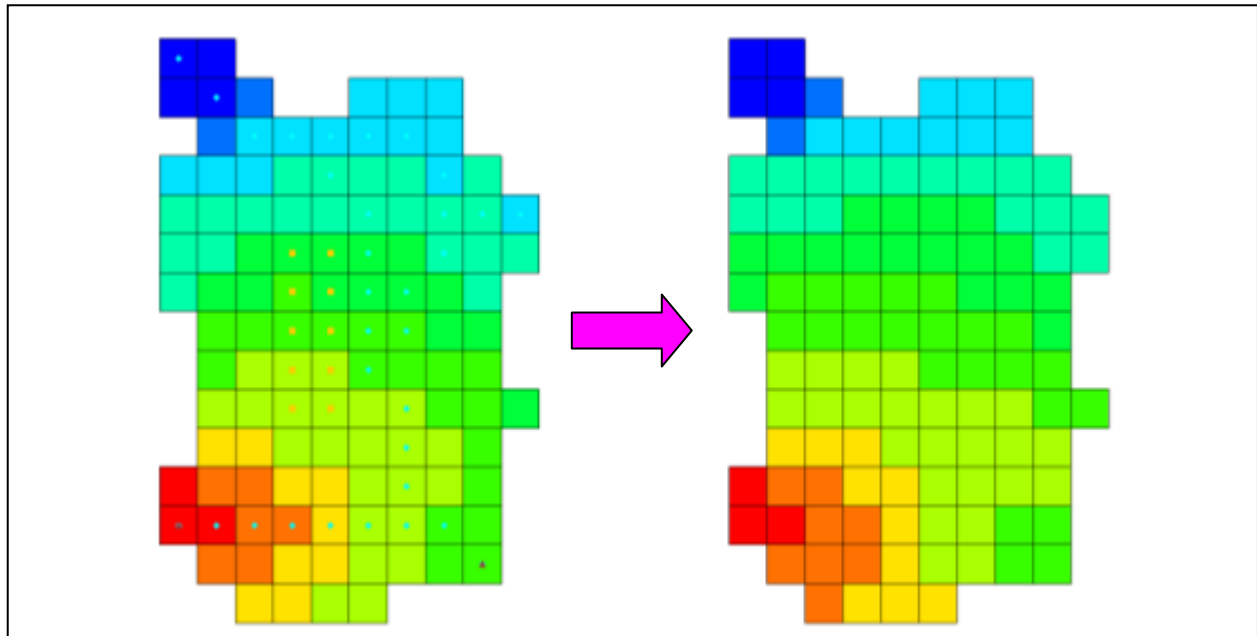


*GMS 10.0 Tutorial*

**MODFLOW-USG - Converting from MODFLOW-2005**

How to convert a non-MODFLOW-USG model into a MODFLOW-USG model.



**Objectives**

Learn how easy it is to create a MODFLOW-USG model from an existing, non-MODFLOW-USG model in GMS.

**Prerequisite Tutorials**

- MODFLOW – Grid Approach

**Required Components**

- MODFLOW 2005
- MODFLOW-USG

**Time**

- 15–30 minutes



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# 1 Introduction

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MODFLOW-USG supports most of the packages from MODFLOW-2005, and it can read and run using model files set up for structured grids with MODFLOW-2000 and MODFLOW-2005. Therefore, for simple models, it is easy to switch them to run in MODFLOW-USG. The GMS interface for this switch is very easy as well.

Converting the model from using a structured grid to an unstructured grid requires a bit more work, including the addition of a DISU file. In GMS, the model needs to be converted to a new type of unstructured grid object (i.e., a UGrid). But this conversion is very easy and GMS creates the DISU file automatically, so no manual file editing is needed.

## 1.1 Outline

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Here are the steps to this tutorial:

1. Import a model built for MODFLOW-2005, save it, run it, and read the results.
2. Switch the model to use MODFLOW-USG using a structured grid, save, run and read the results.
3. Compare the MODFLOW-2005 and MODFLOW-USG results.
4. Import another, more complex MODFLOW-2005 model, save it, run it, and read the results.
5. Convert the model to use MODFLOW-USG using an unstructured grid, save it, run it, and read the results.
6. Compare the MODFLOW-2005 and MODFLOW-USG results.

## 2 Getting Started

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Do the following to get started:

1. If necessary, launch GMS.
2. If GMS is already running, select the *File / New* command to ensure that the program settings are restored to their default state.

## 3 Importing a MODFLOW-2005 Model

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Start by opening a MODFLOW-2005 model. This model is one of the USGS sample models shipped with MODFLOW-2005.

1. Select the **Open**  button.
2. Locate and open the directory entitled *Tutorials\MODFLOW-USG\usg-from-mf2005*.
3. Open the folder called “test1ss.”
4. Change the *Files of type* to “All Files (\*.\*)”
5. Select the file named “test1ss.nam.”
6. Click **Open**.

This opens the *MODFLOW Translator* dialog.

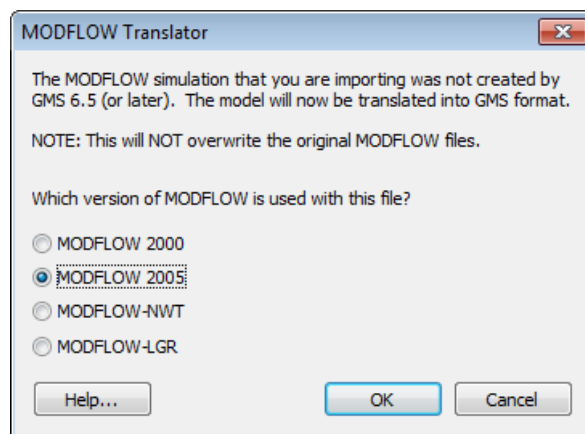


Figure 1 *MODFLOW Translator*

7. Select the *MODFLOW 2005* option.
8. Click **OK**.

The translator now runs. GMS reads the files and translates them into a standard GMS format.

9. When the *MODFLOW Translator* finishes, click **Done**.

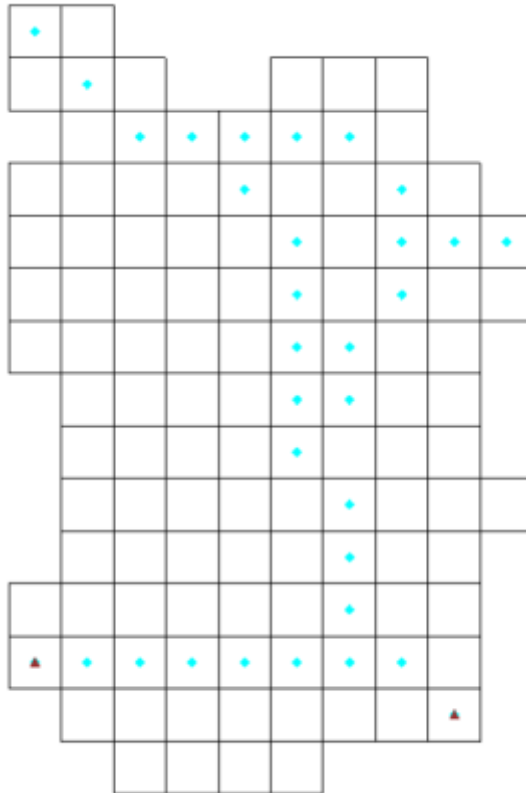



Figure 2 Imported model

The user should now see the model shown in Figure 2. This is a simple, steady-state model which uses the Streamflow Routing package, the General-Head Boundary package, the Recharge package, and the Evapotranspiration package.

### 3.1 Saving and Running MODFLOW-2005

Now save the project and run MODFLOW 2005.

1. Select the **Save**  button. This should open the *Save As* dialog.
2. Make sure to navigate to the *Tutorials\MODFLOW-USG\usg-from-mf2005* folder.
3. Accept the default name of “test1ss.gpr.”
4. Click **Save**.

5. Click the **Run MODFLOW**  button.

This launches MODFLOW 2005 in the model wrapper dialog.

6. When it finishes, click **Close**.

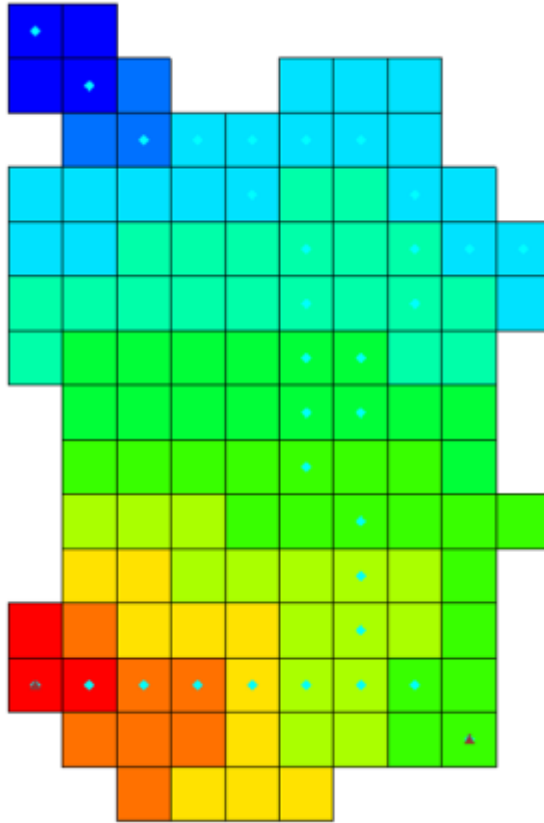


Figure 3 Block fill contours after obtaining a solution

The user should now see block-fill contours on the model as shown in Figure 3.

## 4 Changing to MODFLOW-USG

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Now the user will change the model to use MODFLOW-USG. Other than changing the solver, the user won't make any other changes to the model. The model will still use the same structured grid.

1. Select the *MODFLOW* / **Global Options** menu command to open the *MODFLOW Global/Basic Package* dialog.
2. Under *MODFLOW version*, select *USG*.
3. Click **OK**.

4. Click **OK** for the warning dialog to switch the solver to the SMS solver.

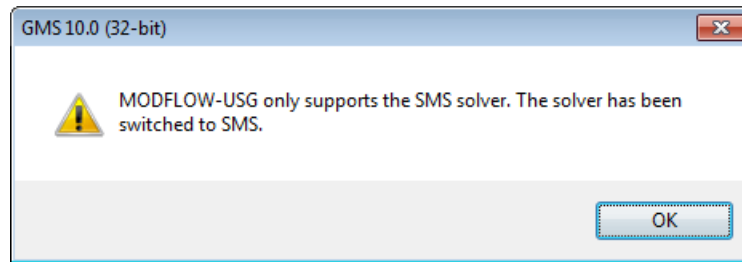



Figure 4 Warning about MODFLOW-USG only supporting the SMS solver

MODFLOW-USG can only use the SMS - Sparse Matrix solver developed by the USGS.<sup>1</sup>

## 4.1 Saving and Running MODFLOW-USG

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Save the project with a new name, run Modflow, and compare the results.

1. Select the *File* / **Save As** menu command.
2. Change the *File name* to “test1ss-usg.gpr.”
3. Click **Save**.
4. Click the **Run MODFLOW**  button.

This launches MODFLOW-USG in the model wrapper dialog.

5. When it finishes, click **Close**.



GMS now reads in the solution. The user should still see block-fill contours.

6. Click the **Save**  button again to save the project with the solution.

## 4.2 Comparing Results

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Now compare the results.

1. In the Project Explorer, alternately click on the “test1ss (MODFLOW)”  solution and the “test1ss-usg (MODFLOW)”  solution.

Notice the solutions appear to be identical.

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1. The LMG solver developed by Fraunhofer SCAI also works with MODFLOW-USG and may also be available in the GMS license. Contact Aquaveo for licensing info.

2. Double-click the “test1ss.out”  file in the Project Explorer to open the file.
3. Similarly, double-click on the “test1ss-usg.out”  file.
4. Scroll to the bottom of both files, and compare the volumetric budget results.


Notice that the results are very similar although not exactly the same. Therefore, it is apparent that a MODFLOW-2005 model using a structured grid can be converted to MODFLOW-USG and produce the same results with very little effort, so long as the original model does not use any packages that are not supported by MODFLOW-USG.


CUMULATIVE VOLUMES	L**3	CUMULATIVE VOLUMES	L**3
-----		-----	
IN:		IN:	
---		---	
STORAGE =	0.0000	STORAGE =	0.0000
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
ET =	0.0000	ET =	0.0000
HEAD DEP BOUNDS =	0.2153	HEAD DEP BOUNDS =	0.2153
RECHARGE =	1.7937	RECHARGE =	1.7937
STREAM LEAKAGE =	43.3705	STREAM LEAKAGE =	43.3599
TOTAL IN =	45.3795	TOTAL IN =	45.3689
OUT:		OUT:	
----		----	
STORAGE =	0.0000	STORAGE =	0.0000
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
ET =	35.8332	ET =	35.8535
HEAD DEP BOUNDS =	0.2483	HEAD DEP BOUNDS =	0.2483
RECHARGE =	0.0000	RECHARGE =	0.0000
STREAM LEAKAGE =	9.2975	STREAM LEAKAGE =	9.3004
TOTAL OUT =	45.3790	TOTAL OUT =	45.4022
IN - OUT =	4.8447E-04	IN - OUT =	-3.3301E-02
PERCENT DISCREPANCY =	0.00	PERCENT DISCREPANCY =	-0.07

Figure 5 Budget results for MODFLOW-2005 (left) and MODFLOW-USG (right)

## 5 Importing a MODFLOW-2005 Model and Converting to a UGrid

Now the user will open another MODFLOW-2005 model that uses the UZF package. This package is not supported by MODFLOW-USG. The user will also convert the structured grid into an unstructured grid.

1. In GMS, select the **New**  button to start a new project.
2. If asked to save, click **No**.

3. Select the **Open**  button.
4. Locate and open the directory entitled *Tutorials\MODFLOW-USG\usg-from-mf2005*.
5. Open the folder called “UZFtest2.”
6. Change the *Files of type* to “All Files (\*.\*)”
7. Select the file named “UZFtest2.nam.”
8. Select **Open**.

This opens the *MODFLOW Translator* dialog.

9. Ensure the *MODFLOW 2005* option is selected.
10. Click **OK**.

The translator will now run. GMS reads the files and translates them into a standard GMS format.



11. When it finishes, click **Done**.

The user should now see a model similar to the one shown in Figure 2 but with some additional symbols. This model looks almost the same as the previous model because it uses the same grid layout. However, this model is transient and it uses the UZF package instead of the Recharge and Evapotranspiration packages. It also uses the Well package.

## 5.1 Saving and Running MODFLOW-2005

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Save the project and run MODFLOW 2005.


1. Select the **Save**  button. This should open the *Save As* dialog.
2. Make sure to navigate to the *Tutorials\MODFLOW-USG\usg-from-mf2005* folder.
3. Accept the default name of “UZFtest2.gpr.”
4. Click **Save**.
5. Click the **Run MODFLOW**  button.

This launches MODFLOW 2005 in the model wrapper dialog.

6. When it finishes, click **Close**.

The user should now see block-fill contours on the model similar to those shown in Figure 3.







7. Click the **Save**  button again to save the project with the solution.

## 6 Converting from the 3D Grid to a UGrid

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MODFLOW-USG supports unstructured grids, meaning grids with all different kinds of cells and discontinuous layers. GMS provides support for these types of grids using an unstructured grid, or UGrid, object. The user will now convert the model from using a structured grid to an unstructured grid. The user won't actually introduce any new cell types into the model or create discontinuous layers, but the model will use a grid that supports this.


1. Right-click on the “MODFLOW”  model in the Project Explorer.
2. Select the **Convert to MODFLOW-USG Simulation** command from the pop-up menu.
3. If necessary, select **No** at the prompt so that inactive cells are not included in the new UGrid.
4. Select **OK** at the prompt explaining that the SIP and UZF packages will not be included in the MODFLOW-USG simulation.

Notice that GMS creates a new folder called “UGrid Data”  with one “UGrid”  below it and a “MODFLOW”  simulation below that.


### 6.1 Comparing Grids

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GMS created the UGrid from only the active cells of the structured, 3D grid. Therefore, the grids have a different number of cells.

1. Right-click on the structured, “grid” .
2. Select the **Properties** command from the pop-up menu to open the *Properties* dialog.


Notice the number of cells is 150 (the user may have to scroll down the list to see it).

3. Click **OK** to exit the dialog.
4. Similarly, right-click on the “ugrid”  item.
5. Select the **Properties** command from the pop-up menu to open the *Properties* dialog.

Notice the number of cells is 116. The number is lower because the inactive cells in the structured grid were not preserved in the UGrid.

6. Click **Done** to exit the dialog.




The user will hide the old model while working with the new model.

7. Turn off the “3D Grid Data”  in the Project Explorer to hide the old model.

## 6.2 Saving and Running MODFLOW-USG

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Save the project and run MODFLOW-USG.

1. Select the **Save**  button.
2. Make sure the “MODFLOW”  simulation under the “ugrid” item is the active one (the icon should be blue, not grey). If it's not active, simply click on the MODFLOW icon to make it active.
3. Click the **Run MODFLOW**  button.

This launches MODFLOW-USG in the model wrapper dialog.



4. When it finishes, click **Close**.

The user should now see block-fill contours on the model similar to those shown in Figure 3.

## 6.3 Comparing Results

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Now compare the results of the two models, similar to how this was done before.

1. Double-click the “UZFtest2.out”  file under the old model to open the file.
2. Similarly, double-click on the “UZFtest2.out”  file under the new model. (This file has the same name but is in a different folder.)
3. Scroll to the bottom of both files and compare the volumetric budget results.

Notice that the results are quite different. The new USG model doesn't include the UZF package, so there is no Recharge or ET. At this point, the user could try to use the Recharge and EVT packages in the new model to mimic what the UZF package is doing in the old model, but that goes beyond the scope of this tutorial.

Here is a list of the more popular packages in MODFLOW-2005 that are not supported in version 1.0 of MODFLOW-USG:

- HUF
- MNW1
- MNW2
- UZF

## 7 Conclusion

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This concludes the tutorial. Here are some of the key concepts in this tutorial:

- A model can be converted to MODFLOW-USG and run with a structured grid by simply changing an option in the *MODFLOW Global/Basic Package* dialog.
- To convert a model to an unstructured grid, right-click on the model and select the **Convert to MODFLOW-USG Simulation** command. This creates a new UGrid and MODFLOW simulation.
- Some packages such as UZF are not supported in MODFLOW-USG.