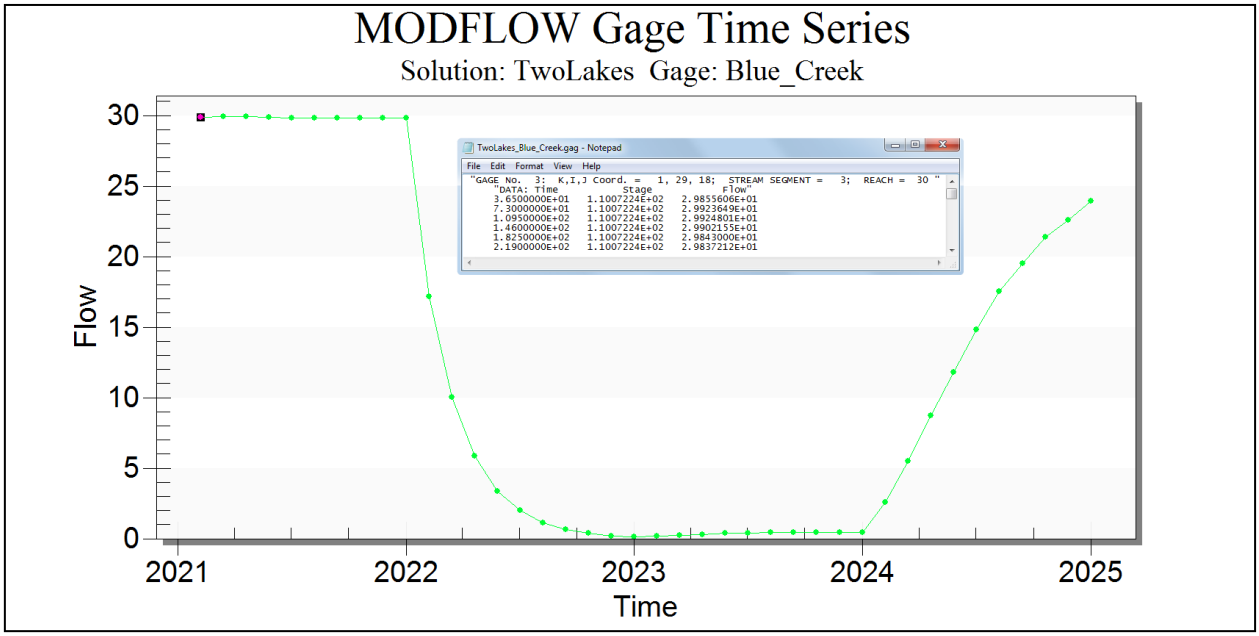
GMS 10.0 Tutorial

MODFLOW – GAGE Package

The MODFLOW GAGE Package Interface in GMS



Objectives

This tutorial explains how to use the MODFLOW GAGE package interface in GMS.

Prerequisite Tutorials

- MODFLOW - Grid Approach
- MODFLOW – Conceptual Model Approach I

Required Components

- Grid Module
- MODFLOW

Time

- 20-30 minutes

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1 Introduction

The Gage (GAGE) package was developed by the USGS to allow output of detailed time series data for a given lake ID or SFR stream reach. The Gage package provides an extensive list of options for lake time series output including stage, volume, inflows, outflows, lake conductance, UZF interaction, and several others. For an SFR reach associated with a model cell, some of the options include stage, flow, depth, width, diversion specific output, and unsaturated flow routing.

1.1 Outline

Here are the steps for this tutorial:

1. Add gage stations to an existing MODFLOW simulation.
2. Analyze the gage file output.
3. Generate a gage plot.

2 Description of Problem

The conceptual model for this tutorial is show in Figure 1. The model consists of two lakes, Clear Lake and Blue Lake, connected by a stream. The stream flows from Clear Lake and feeds Blue Lake. Blue lake is also fed by a second stream, and a third stream flows from Blue Lake into much larger body of water. The model is transient with stress periods set to cover a 4-year period, with the starting head values for the model set at steady state. The first and fourth years have normal precipitation, and second and third years are below normal. For this tutorial, the user will be adding gage stations to each of the lakes and to the end of each of the streams to see how the change in precipitation affects the lakes and streams.

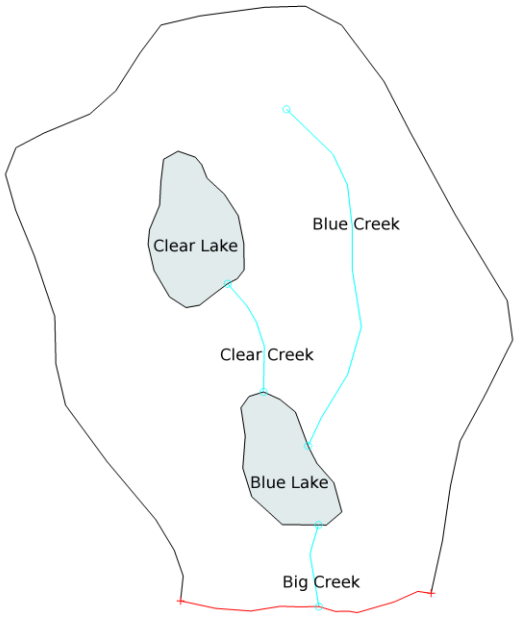

Figure 1 Conceptual model

3 Getting Started

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.

4 Reading in the Project

First, it is necessary to read in the project:

1. Select the **Open** button (or the *File* | **Open** menu command).
2. Browse to the *\Tutorials\MODFLOW\gage* folder.
3. Select the file entitled "start.gpr" file.
4. Click the **Open** button.

The user should see a MODFLOW model as shown below.

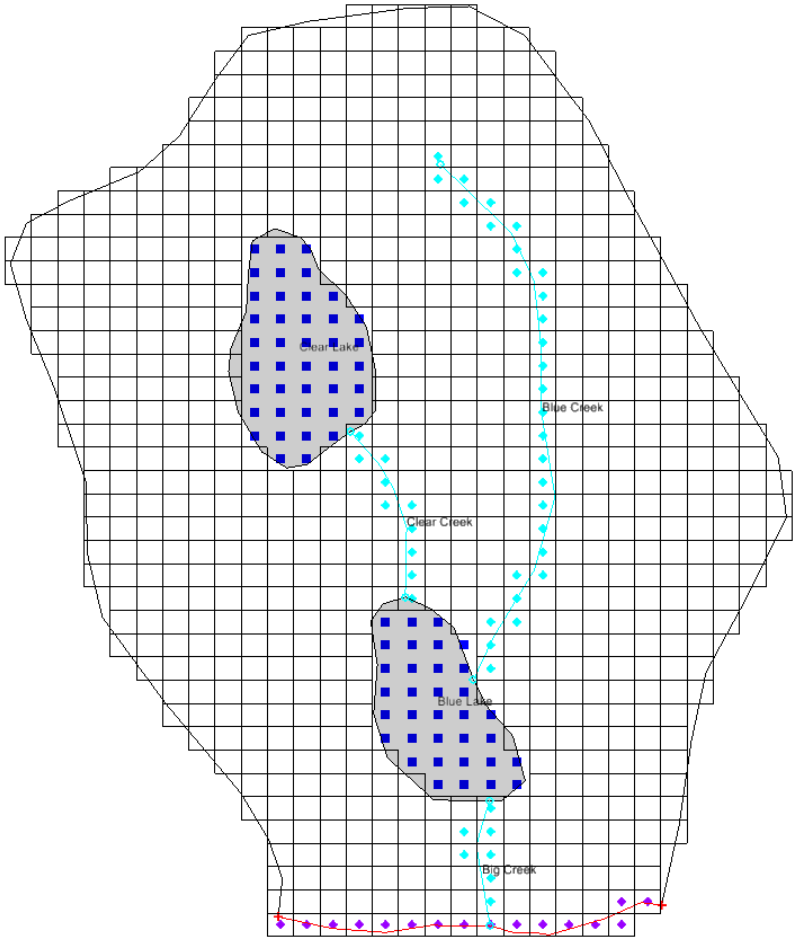

Figure 2 MODFLOW model

5 Save the model with a new name

The next step is to start making changes. First, save the model with a new name.

1. Select the *File* | **Save As** menu command.
2. Stay in the *\Tutorials\MODFLOW\gage* folder.
3. Change the project name to "TwoLakes.gpr."
4. Save the project by clicking the **Save** button.

6 Adding the Gages

Before adding gage stations to the simulation, it is necessary to determine the stream segment and reach for each SFR gage. To do this, the user will view the lake and SFR boundary conditions in the package dialogs.

6.1 The Lake Package Dialog

1. Select the *MODFLOW* | *Optional Packages* | **LAK - Lake** command to open the *MODFLOW Lake Package* dialog.

The lake boundary conditions are shown in the *MODFLOW Lake Package* dialog. By looking at the Lake ID and initial stage columns, the user can see that Blue Lake is Lake ID 1, and Clear Lake is Lake ID 2.

2. Select **OK** to exit the dialog.

6.2 The SFR Package Dialog

1. Select the *MODFLOW* | *Optional Packages* | **SFR2 – Stream**flow-Routing command to open the *MODLFLOW Stream (SFR2) Package* dialog.

The dialog contains two tables: the segments table containing a segment entry for each stream, and the reaches table containing the reaches for all segments. In order to find the appropriate segment and reach, it is necessary to look in the reaches table. The ISEG column of the table contains the segment number, and the IREACH column contains the reach number. Reaches are ordered in the direction of flow, so the user must look for the highest numbered reach for each segment. From the table, the segment-reach pairs to be located include 1-10, 2-7, and 3-30.

2. Select **OK** to exit the dialog.

6.3 Enabling the GAGE Package

Before adding gages, the user needs to ensure that the GAGE package is enabled.

1. Select the *MODFLOW* | **Global Options…** menu item.

2. In the *MODFLOW Global/Basic Package* dialog, click on the **Packages…** button to open the *MODFLOW Packages* dialog.

3. If necessary, toggle on the *Gage (GAGE)* item in the Optional packages section of the dialog.

4. Select **OK** to exit the *MODFLOW Packages* dialog.

5. Select **OK** to exit the *MODFLOW Global/Basic Package* dialog.

6.4 Adding Gages

Gages are added in the *GAGE Package* dialog.

1. Select the *MODFLOW* | *Optional Packages* | **GAGE - Gage** menu to open the *Gage Package* dialog.

2. In the Stream Gages table at the top, add three rows by clicking three times on the **Insert Row** button at the bottom of the Stream Gages table.

3. Enter the following values:

Name	GAGESEG	GAGERCH
Clear_Creek	1	10
Big_Creek	2	7
Blue_Creek	3	30

The OUTTYPE column gives options for several different types of gage output. For this tutorial, the default value will be used.

4. At the bottom of the Lake Gages table, click on the **Add All Lakes** button to add gages for both lakes.

5. Change the lake names. Lake_1 should be changed to "Blue_Lake," and Lake_2 should be changed to "Clear_Lake."

6. Select the **OK** button to exit the *Gage Package* dialog.

7 Run MODFLOW

Now it is possible to save these changes and run MODFLOW.

1. Select the **Save** button (or the *File* | **Save** menu command).

2. Select the **Run Modflow** button (or the *MODFLOW* | **Run MODFLOW** menu command).

3. When MODFLOW finishes, select the **Close** button.

4. Select the **Save** button to save the project with the new solution.

8 Examine the Solution

Now the user will look more closely at the computed solution.

8.1 The Head Solution

1. Expand the "3D Grid Data" folder in the Project Explorer.

2. In the Project Explorer, click on the "Head" dataset in the "TwoLakes (MODFLOW)" solution.

The *Time Step* window appears at the bottom of the Project Explorer, and the first stress period is selected.

3. Scroll through the *Time Step* window, clicking on a time step near the middle of the simulation and then the time step at the end.

Upon changing between the different time steps, the user will notice that the first and last time steps have similar head contours, while, for time steps near the middle of the simulation, the head values are lower.

8.2 Gage Output Files

The gage output files can be found in the solution folder in the Project Explorer.

1. If necessary, expand the "Gage Files" folder in the Project Explorer.
2. Then double-click on the "TwoLakes_Blue_Creek.gag" file (or right click on the file and select **View File**).

The gage text file will open, which includes columns for time, stage, and flow.

3. Scroll through the text file that opens, noticing the change in the Flow column.

The gage file is show in Figure 3. For this stream, the flow rate drops by about 30 pct during the time of below-normal precipitation.

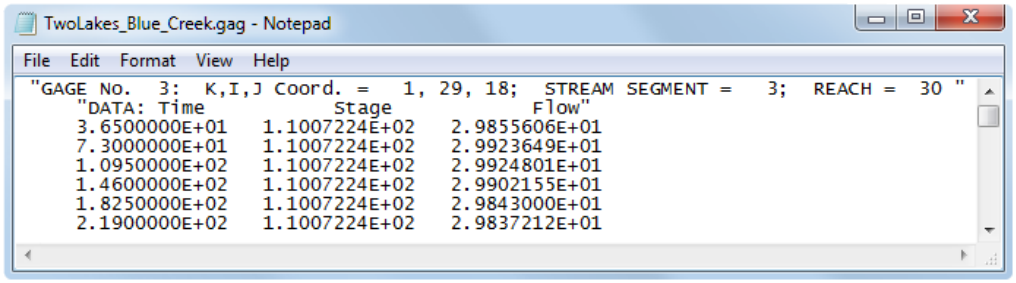

Figure 3 Gage file for Blue Creek

4. Double-click on the TwoLakes_Clear_Creek.gag file in the Project Explorer.

This stream shows a less significant change in flow rate. The user may wish to check the gage output for the other three gage stations as well.

5. Close the open gage files and return to GMS.

8.3 Create a Gage Plot

GMS also allows plots to be generated from solution gage files.

1. Select the **Plot Wizard** macro from the tool bar at the top of GMS (or select the Display | **Plot Wizard…** menu item).

2. In the *Plot Wizard* dialog, on the *Plot Type* list, select *Gage Package Value vs. Time*.
3. Click on the **Next** button.
4. Select *Blue_Creek* for the gage file and *Flow* for the data column.
5. Click on the **Finish** button.

The generated plot is shown in Figure 4. The plot shows that, for this stream, the flow rate drops rapidly as the period with less precipitation begins and then recovers to near the initial flow rate during the final year.

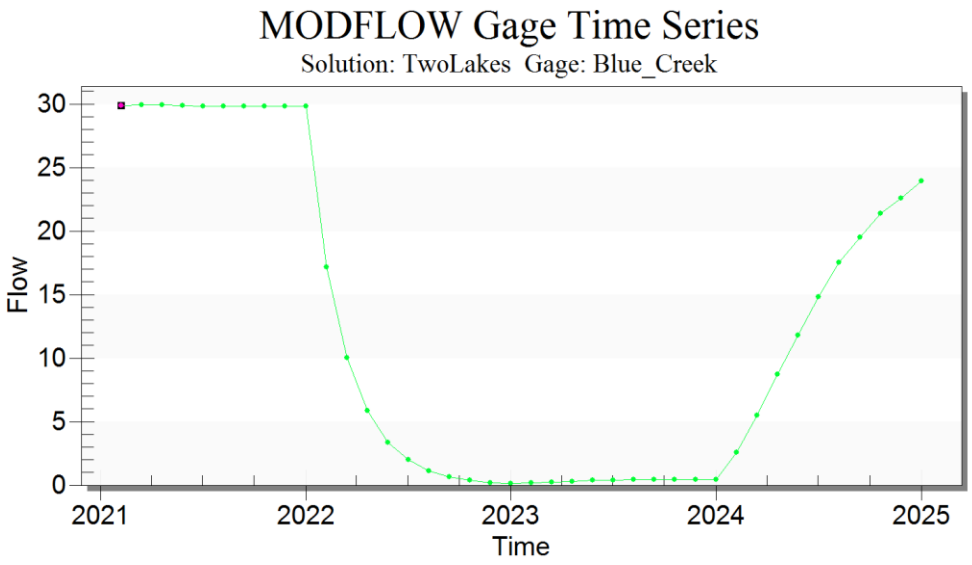

Figure 4 Gage plot for Blue Creek

9 Conclusion

This concludes the tutorial. Here are the key concepts from this tutorial:

- GMS supports the MODFLOW GAGE package.
- Gages are entered in the *Gage Package* dialog.
- Gage output text files can be viewed by opening them from the Project Explorer.
- Gage plots can be generated using the *Plot Wizard*.