

GEOS-5311: Applied Groundwater Modeling Spring 2024

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Learn how to make detailed quantitative analysis and prediction of groundwater flow and chemical transport, and earn college credit. UTD's Applied Groundwater Modeling course is light on theory, heavy on application of the most widely used groundwater modeling programs (modflow, modpath, MT3D, RT3D). Based on the textbook (Anderson and Woessner, 2015) and using the DOD Groundwater Modeling System interface (GMS, Fig. 1) to build models and analyze their results. Note the book is available for free download via UTD.

This course is intended to provide the basic skills and experience needed to perform groundwater modeling studies in hydrology (e.g. see groundwater modeling jobs and GetHydrologyJobs.com). In this class, you will learn how to generate valid hydrologic flow (modflow) and transport models (modpath, MT3D, or RT3D) and to make meaningful analyses of the results. Laboratory exercises will provide hands-on experience using GMS modeling software to explore issues raised in the lectures.

Most lab exercises can be completed off-campus, since all the modeling programs used in class are public domain, and the GMS software is available at no charge to many U.S. Government employees and contractors. This semester will emphasize a considerably enhanced version of the most widely used groundwater model in the US, Modflow6.

Class meets Th 10:00AM - 12:45PM in ROC 2.701 beginning Jan. 22nd UTD Call Number 29549 (see s-syllabus).

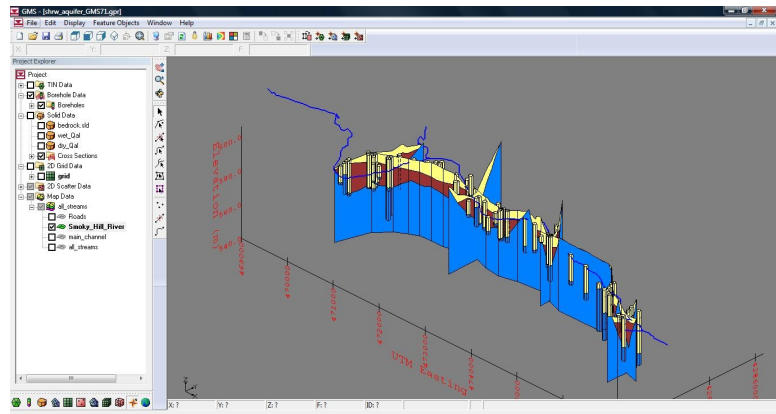


Figure 1: GMS model development and interpretation software interface.

1 Course Organization

1.1 Organizational Meeting

The first class meeting (Jan. 22nd, 10:00AM - 12:45PM) will be dedicated to an organizational meeting, at which time a general outline of the class topics, and any desired changes in lab or lecture schedule will be discussed.

1.2 Grading

Course grades determined using the following weights: 60% homework, 40% final project. Homework will be due at the beginning of class, one week after assignment.

1.3 Syllabus

Table 1: Syllabus for GEOS 5311, Spring 2024.

Week	Dates	Text Chapters	Lecture Topic	Lab
1	Jan. 22		Organizational Meeting, Examples of Groundwater Modeling (Yucca Mountain)	
2	Jan. 29	1	Introduction to Groundwater Modeling	GMS Getting Started
3	Feb. 5	2	Mathematics of Groundwater Modeling/Conceptual Models	Borehole Stratigraphy, Horizons & Solids
4	Feb. 12	3	Overview of Numerical Methods	Spreadsheet Flow Model (Hmwk 3), GMS-GIS Tutorial
5	Feb. 19		Introduction to Modflow	GMS Conceptual Model Approach 1–2 tutorials (in MODFLOW tab)
6	Feb. 26		Modflow (cont.)	GMS Conceptual Model Approach 3–4 tutorials
7	Mar. 4		Model Parameterization & Interpolation	GMS 2D Geostatistics tutorial, Interpolation homework (Hmwk 4)
-	Mar. 11		Spring Break	Hmwrk 5: Modflow version of spreadsheet model
8	Mar. 18	4	Hydrologic Boundaries and Model Boundary Conditions	Interpolating Layer Data & MODFLOW –Generating Data from Solids

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Week	Dates	Text Chapters	Lecture Topic	Lab
9	Mar. 25	4-5	Source/Sinks	MODFLOW GAGE & LAK Package Tutorials
10	Apr. 1	4,7	Model Spatial and Temporal Dimensionality	Hmwrk 6: Modflow flow-to-a-well. GMS Modflow Recharge & STR Package tutorials
11	Apr. 8	3	Model Calibration	Final project map+grid, Hmwrk. 7: Lipan GAM revamp, GMS MODFLOW-Model Calibration Tutorial
12	Apr. 15	9-10	Particle Tracking & Parameter Estimation	Modpath & Parameter Estimation tutorials. Final project parameterization
13	Apr. 22	8-9	FloPy, Re-Introduction to Modflow6	GMS MODFLOW-USG - Calibration tutorials.
14	Apr. 29		Transport Modeling	GMS MT3D Conceptual Model Approach tutorial
15	May 6	-	Final Project presentations	

1.4 Final Project

Final projects can be groundwater models of a place that is significant to you, or selected from the following list of suggestions

- brackish water migration in the Texas Panhandle. See articles by Mehta et al. (2000)
- reproduce models of Five-O Lake, the focus of a homework in Hydrogeology class. See report Grubbs (1995)
- investigate a portion of the Netherlands National Multi-Model (Lange et al., 2014). See especially inputs for their groundwater model (GW, Modflow-2005). Investigate effects of climate change/sea-level rise?
- Texas Water Development Board Groundwater Availability Models (GAMS)
 - either perform sensitivity analysis, or explore effects of predicted climate change (mostly temperature-related changes in ET)
 - existing Modflow input files can be requested from the specific aquifer website (TWDB will send you a link to cloud storage). To open

- * download files from link given
- * unzip using pkZip (\geq v. 6.3) v. also possible with Linux p7zip command `7za x zipfile`
- Other tools for picking a model site
 - good to have head data to calibrate to. For U.S. check USGS Groundwater Monitoring Network. For Texas try TWDB
 - some states have nice groundwater model information websites: Colorado Div. of Water Resources, or USGS State Office model summaries for California, Nevada

2 Online Resources

2.1 Lecture Notes

PDF versions of the lecture notes are available online via eLearning. Check version numbers in the footnote on the first page to be sure you have the latest.

2.2 Homework

PDF versions of the homework assignments are available online through eLearning. Submit your solutions via eLearning by the beginning of class the week following release of the homework assignment.

2.3 Online Books and Tutorials

- “Getting Started with Modflow”, R.B. Winston, 2023 (free download)

References

- Anderson, M. P., Woessner, W. W., 2015, Applied Groundwater Modeling. Academic Press, New York, second edn., ISBN 978-0-12-058103-0.
- Grubbs, J. W., 1995, Evaluation of Ground-Water Flow and Hydrologic Budget for Lake Five-O, A Seepage Lake in Northwestern Florida. Water Resour. Investig. 94-4145, U.S. Geol. Survey, 49 pp.
- Lange, W. J. D., Prinsen, G. F., Hoogewoud, J. C., Veldhuizen, A. A., Verkaik, J., Essink, G. H. O., van Walsum, P. E., Delsman, J. R., Hunink, J. C., Massop, H. T., Kroon, T., 2014, An operational, multi-scale, multi-model system for consensus-based, integrated water management and policy analysis: The Netherlands Hydrological Instrument. Environmental Modelling & Software 59, 98 – 108.
- Mehta, S., Fryar, A. E., Banner, J. L., 2000, Controls on the regional-scale salinization of the Ogallala aquifer, Southern High Plains, Texas, USA. Applied Geochemistry 15(6), 849 – 864.