University of Florida – Department of Geological Sciences
GLY 4862 / GLY 6862 – Quantitative Methods in Earth Sciences
Fall 2025
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Office Hours: By appointment (email to schedule) – Tuesdays, 3–5 pm

Course Description

This course is intended for students with little or no background in numerical modeling. Students will learn how to approach and set up modeling problems in Python, primarily using Google Colab for an accessible, cloud-based coding environment. Those comfortable with other tools may use alternatives such as Spyder, VS Code, or equivalent IDEs. Topics include ordinary and partial differential equations, optimization, and moving boundary problems, as well as applications of complex systems and nonlinear dynamics to Earth science modeling.

Course Structure

Each week focuses on a specific theme. The first part of class introduces key principles through lecture, followed by hands-on numerical modeling exercises and/or discussion of assigned readings. Most coding activities will be completed in Python using Google Colab, allowing students to run and share notebooks without local software installation. MATLAB and other programming languages may also be used, depending on student background and project needs.

On the second day of class, each student will give a brief two-slide presentation introducing:

1. The Earth system they plan to study.
2. Two to three relevant peer-reviewed publications they are considering for their semester project.

These short presentations will help identify shared research themes and allow students to learn from each other's perspectives. They will serve as the foundation for the final project presentation at the end of the semester.

Learning Outcomes

By the end of the course, students will be able to:

- Apply basic quantitative methods to solve Earth science problems.
- Implement and analyze models in Python (or other approved environments).
- Interpret and present results from quantitative analyses.
- Critically engage with literature on numerical modeling and Earth systems

Assignments

Most weeks will include a topic-specific assignment designed to reinforce the material from lectures and exercises. Assignments typically involve running and modifying provided Google Colab code, answering targeted questions, and interpreting results in the context of Earth system processes. These assignments are intended to build coding skills, deepen conceptual understanding, and prepare students for their semester project.

Semester Project

You will investigate the evolution or dynamics of an Earth system of your choice, conduct a literature review, and perform quantitative analysis to better understand its behavior. The project will progress through several stages:

- **Two-Slide Introductory Presentation (Week 2):** Introduce your Earth system of interest and potential papers for discussion.
- **Project Development:** Incorporate feedback from instructors and peers as you refine your focus, methods, and analyses.
- **Final Presentation:** Synthesize your findings into a clear, logically organized, and engaging talk suitable for a broad audience.
- **Final Report:** A written summary of your project, graded for scientific rigor, clarity, completeness, and adherence to formatting guidelines.

The semester project grade includes both written and oral components. For undergraduates, this is an opportunity to practice presenting and discussing complex topics professionally; for graduate students, it offers a chance to refine work that could form part of a research proposal or thesis defense.

Evaluation

- In-Class Contribution: 10%
- Weekly Assignments: 20%
- Semester Project: 70%

UF Grading Scale

%	Letter	GPA
≥93.0	A	4.0
90.0–92.9	A–	3.67
87.0–89.9	B+	3.33
83.0–86.9	B	3.0
80.0–82.9	B–	2.67
77.0–79.9	C+	2.33
73.0–76.9	C	2.0
70.0–72.9	C–	1.67
67.0–69.9	D+	1.33
64.0–66.9	D	1.0
60.0–63.9	D–	0.67
<60.0	E	0

Course Materials

No required textbook. Readings will consist of journal articles and materials posted on Canvas.

Communication

All announcements, lecture materials, and assignments will be posted on the UF Canvas site. Class emails will be sent through Canvas to your UF email account; check it regularly.

Tentative Schedule

1. **Introduction to Python and review of basic math**
   Python basics in Google Colab, including variables, arrays, loops, functions, and core scientific libraries, with a review of algebra and calculus concepts applied to Earth system examples.
2. **Plotting functions with Earth science applications**
   Visualizing sinusoidal, exponential, and other functions; exploring parameter effects and interpreting patterns in real-world Earth system processes.
3. **Data handling and visualization**
   Loading, processing, and plotting datasets using Python, with multiple plot types and subplots to explore trends and relationships.
4. **Numerical differentiation and integration in Earth science**
   Applying numerical and analytical methods to compute rates of change and cumulative quantities, with examples from sediment transport and other processes.
5. **Introduction to optimization methods**
   Solving max–min problems for algebraic expressions and selected analytical solutions, with simple examples relevant to Earth systems.
6. **Ordinary differential equations and open channel flow**
   Numerical methods for solving ODEs and applying them to backwater curves and other Earth system dynamics.
7. **Linear diffusion and sediment transport in 1D**
   Modeling profile evolution using the linear diffusion equation; stability, discretization, and boundary condition effects.
8. **Moving boundary problems in 1D**
   Simulating systems where boundaries evolve in time, such as delta shorelines and other transport-limited fronts.
9. **Coupling PDEs and ODEs**
   Linking multiple processes in models, with an example of wave-dominated delta evolution.
10. **Additional topics (time and student background dependent)**
    Potential extensions include advection–diffusion in 1D, 2D diffusion and Landlab/CSDMS tools, multiple moving boundaries, Google Earth Engine applications, and image processing/machine learning for vegetation and landform detection.

University policies & resources

This course complies with all University of Florida academic policies. For information on attendance and make-up policies, the Disability Resource Center, grading, GatorEvals, the Student Honor Code, in-class recording, and academic/wellness resources, please visit:
UF Syllabus Policy – Required Links & Resources