Syllabus: GEOL 450 Geosystems Fall, 2024

Catalogue Description: Geosystems, such as mantle convection, active faults, climate, and the carbon cycle, will be studied using numerical models and concepts such as chaos, universality, emergence, and intermittency. (Prereq: Math 125, Recommended: Math 126)

Overview:
Earth Sciences is becoming more focused on system-level approaches to understanding the behavior of the Earth. The course will consider geosystems from different disciplines of Earth Science and explore their dynamics using simple experiments and graphical imaging/visualizing/computer-modeling tools to develop and illustrate the systems concepts. Students will be expected to become familiar with use of excel spreadsheets, simple matlab codes, and use of some community platforms for running more sophisticated models. An extensive background in geology is not required, and students majoring in other fields, such as applied math or physical science, are encouraged to enroll. An interest in quantitative approaches to science is helpful.

Instructors:
Doug Hammond: dhammond@usc.edu 310-490-7896 zhs325
TA: TBD

Lectures: WF 2:00-3:20 in zhs200, **Lab:** M 10:00-11:50 in zhsB65. During some weeks, lecture periods will be used for lab exercises, and lab periods will be used for lecture.

Text: Material including assigned readings will be distributed with each teaching topic.

Grading: Approximately 13 exercises will be completed as labs or homework. Each is worth 10 points. A project worth 70 points will be completed. Letter grades will be assigned based on the total point score.

Labs/Problem Sets will include ~weekly exercises, consisting of problem sets or experimental write-ups. They will be due 1 week after the lab is done, or an exercise is assigned. Late submissions will be penalized 5% per day.

Student Project: Each student will do an independent investigation of a geosystem. This will include choosing a geosystem to explore, reading relevant literature, and working with a computational module to explore the system behavior. The computational work should allow the student to adjust parameters in the selected geosystem to explore possible behaviors. The project should be selected and carried out under the mentorship of the instructor(s), involving regular consultation. Results of the geosystem study will be presented to the class, in an illustrated talk of 15-20 minutes given near the end of the term, or during the scheduled final exam period. The results will also be written up in a report of 10-15 pages (including figures, tables and references). This component will be worth 70 points. **Topic choice is due by Sept. 16. A one-page progress report with a brief oral description is due Oct. 21. The write up is due December 4.**

Learning Objectives:

- An ability to view Earth processes as characterized by dynamics, allowing flow of energy and material through and within the system.
- An ability to describe these dynamics with equations that capture essential behaviors.
- An ability to formulate and apply simplified geosystem models, and comprehend the general architecture of more complex model.
- An ability to read current literature critically.
- An appreciation of the integration of cross-cutting disciplines for understanding Earth Systems behaviors.

POLICIES & GUIDELINES:

Attendance: is essential, with sessions held in person. Reading in the recommended texts, or on line, will augment, but not replace, class meetings and exercises—a missed class meeting is hard to make up. Please prearrange excused absences or let us know before class (via email) if you are going to be out with an illness. It will be difficult, or perhaps impossible to make up any missed exercises. For periods where discussion is expected, you are expected to be present in person, unless specifically excused by the instructor.

Academic Honesty: You are expected to observe the rules of academic conduct outlined in the Student Handbook. We encourage you to work together on labs and assignments; however, always turn in your own work (describe results in your own words). This helps you better learn the material and helps us see your individual progress.

Academic Accommodations: Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me as early in the semester as possible. DSP can be reached at ability@usc.edu and is open 8:30am-5:00pm Monday through Friday. The phone number for DSP is 213-740-0776.

Comments on Presentations:

Giving scientific presentations in front of an audience of your peers can be intimidating. But being well prepared and practicing it prior to your formal presentation is an important method for reducing anxiety and working out any difficulties that can arise, particularly when presenting information that you are not completely familiar with, or when there are aspects of your presentation that are complex. Be sure to practice your presentation ahead of time and perhaps ask a classmate to listen as you practice, providing feedback.

The slides you choose for your talk are as important as what you say in your presentation. There are numerous resources available on-line that provide good examples of Power Point presentations that you can learn from. Look for presentations from experts who have given talks on your subject to see how they organized their figures and how they conveyed the information within their slides.

In most cases (if time permits), it is a good idea to provide your audience with an outline slide following your title slide. This is a way to provide your audience a roadmap so that they can easily follow along as you work through each slide.

Importantly, make sure that each slide is as simple as possible. Sometimes, it not possible to simplify a slide. Therefore, it is essential that you walk your audience through the important elements of each slide by pointing to those things you wish them to see. And oftentimes, it is a good idea to tell the audience what they should take away from a slide. This requires that each element of the slide is clearly visible to everyone in the room. Make sure the fonts are large and highlight specific things that are important so that your audience doesn't miss it. For example, if you are showing a data slide that plots one variable against another, make sure to point to the axes and state what variable is plotted along with its units. Your axis labels must be large enough to read easily!

If you are using pictures or data prepared by others, you need to provide a brief citation on the visual you have adopted. At the end of the talk, you can have a slide with the full citations for all items you referenced briefly.

One of the most important things to remember when giving a scientific presentation is to engage your audience. You want them to stay engaged throughout your talk. To do this requires that you look directly at your audience when speaking. Do not use cue cards.

Finally, at the end of your talk, tell the audience what they should have learned. You began your presentation with an introduction with an outline. End your presentation with a conclusion slide (if time permits) and remind your audience what they should have learned from your talk.

General Comments on Papers:

Writing a scientific paper can be one of the most challenging things you'll do as a student. It often takes years of practice to become a good writer. And there are key elements of

every well written scientific paper that you should remember. Most scientific journals follow a standard format (except for short venue articles such as Science or Nature). The format will include the following elements:
1: Title
2: Abstract
3: Introduction
4: Methods
5: Results
6: Discussion
7: Conclusion
8: Acknowledgements
9: Citations

This is a tried and true formula for presenting scientific information and it provides a reader with a roadmap, just as your outline slide does for your oral presentation. And you'll find that as you delve into a research topic, it will be necessary to read numerous papers, all focused on a common question or problem. Having papers organized with common sections (outlined above) allows you to swiftly move to those sections of a paper that contain the information you need. For example, if you are trying to piece together how two different papers may have come to different conclusions after analyzing the same data, you might turn directly to the Methods section of each paper and evaluate if and how the methodologies differed. Having each section broken out into a discrete section allows the reader to quickly find the information needed.

Many journals have strict rules for formatting and you should look to the guidelines of a journal for specific 'rules' to follow, including how citations should be formatted properly within the text.

Typically, the Abstract must be short and concise. It should start with a sentence or two that will frame the problem your study is designed to explore. You must also concisely state what you did (Methods) and then what you found (Results). End with a Conclusion or summary of findings, perhaps mentioning implications of your work. Abstracts can be a challenge to write when all of these elements must be fit into a short paragraph. Look to journals for good examples to learn from.

The Introduction section is often where you will engage your reader in your study. Although you are typically writing for an informed audience, the introduction must convince your informed reader that they have something to learn by reading further. It should review relevant previous work and define objectives of your study. If your paper involves a hypothesis that is being tested, be sure to state what that hypothesis is in the Introduction.

The Methods section will typically follow a 'recipe' that has standard elements, which vary with the type of study you have conducted. Follow the guidelines of a journal.

The Results section is the 'heart' of the paper. This is where your words and your figures must be precise and rigorous. The figures can be the difference between a convincing discussion and one that is not convincing to the reader. You may spend as much time making good figures as you spend writing sections of the paper. Make your figures and tables first and then use text to point out key relationships. This is time well spent and you should look again turn to examples from journals to see what makes for good visuals, particularly when the data is complex. As you do for an oral presentation, you want to make sure that each important element of a figure is easily seen and convincing.

The Discussion section is where you can convey your interpretations and your evaluation of the results. In this section you either 'win over' the reader or the reader will reject your interpretations. So be sure that you are rigorous as well as thoughtful. Don't expect the reader to do the work of interpreting your results if you wish them to accept your interpretation.

The Conclusion section, like the abstract, will typically be a short summary and statement of your conclusions. This should return to your original hypothesis, if you put one forth. Or, it should return to the question you posed in the introduction so that you convey to the reader how your results informed your decision to accept or reject the hypothesis or have answered the question.

The Acknowledgments are also important. Science is community. That community involves colleagues, funding agencies and reviewers of your work. Make sure that you give credit to anyone who has helped or influenced your findings.

These offer some general comments about your presentations, and I encourage you to talk further with me if you have any questions or need more specific guidance.

Geosystems GEOL 450 Tentative Schedule 2024 (Lab and Lecture dates interchangable)			
Date	**Module**	**Lecture**	**Lab**
26-Aug	Introduction to Geosystems	Overview of Earth, Geosystems, & Concepturalization	
28-Aug		Earth History & Geosystems	
30-Aug			1. Discussion of Geosystem Concepts
2-Sep	Labor Day: No Class	No Class: Labor Day	
4-Sep		Box Model, Residence time, Leaky Bucket Lab O2 Demo	
6-Sep			2.Analysis of Leaky Bucket Lab/Matlab
9-Sep		CFC Dynamics, Matlab Coding and Plotting	
11-Sep			3. Box Models with CFCs via Matlab
13-Sep		Excel Spreadsheets & Matlab Programming Intro	
16-Sep	Climate System & Radiation Balance	Thermodynamics, Electromagnetic Radiation	**Project Topic Due**
18-Sep		Energy and Mass Transfers within Earth's Climate System	
20-Sep			4. Earth Radiation Balance (1 box model)
23-Sep		Energy and Mass Transfers within Earth's Climate System	
25-Sep			5. Earth Radiation Balance (2 box model)
27-Sep		Proxies and Past Climates	
30-Sep			6. Fish Tank Oceanography
2-Oct		Proxies and Past Climates	
4-Oct		Ocean Circulation	
7-Oct	Carbon Cycle		7. Carbon Footprint
9-Oct		Overview of the Carbon Cycle	
11-Oct	Fall Recess	No Class: Fall Recess	
14-Oct		Carbon Transport & 4 Box Model	
16-Oct		4 Box Model;	**Project Progress Report Due**
18-Oct			8. Atm pCO2 simulation: 4 box model
21-Oct		Atmospheric pCO2: Short term	
23-Oct		Atmospheric pCO2: Long term	
25-Oct			9. Harmonic Oscillators
28-Oct	Non-linear Systems		10. Lorenz System
30-Oct		Harmonic Oscillator; Linear and Non-linear Systems	
1-Nov		Lorenz Equations	
4-Nov	Earthquakes		11. Stress and Strain - Friction and Slider
6-Nov		Plate Tectonics and Earthquake Cycles	
8-Nov		Andersonian faulting,	
11-Nov			12. Spring-slider and chaos
13-Nov		Fault Dynamics and Heat flow paradox	
15-Nov		Deterministic chaos;	
18-Nov			13. Earthquake prediction (Probability)
20-Nov		Spring-slider model	
22-Nov		Statistical & Neural Network Approaches	
25-Nov	Civilization as a Geosystem	Society as a Geosystem	
27-Nov	Thanksgiving Break	no class	
29-Nov	Thanksgiving Break	no class	
2-Dec		Society as a Geosystem	
4-Dec		Student Presentations	
6-Dec		Student Presentations, Evals	
13-Dec		**FINAL EXAM SCHEDULED 2:00 AM-4:00 PM**	