GLY 4930: Geophysical Exploration of the Cryosphere
CURE

I. General Information

Class Meetings

- Fall 2025
- Synchronous CURE (Course-based Undergraduate Research Experience). Tue/Thurs 10:40-12:45 in Williamson 210

Instructor

- Dr. Mickey MacKie
- Williamson 221
- Office Hours: TBD
- emackie@ufl.edu

Teaching Assistant(s)

- Niya Shao
- Office hours: TBD
- niyashao@ufl.edu

Course Description

This twelve-person course will provide students with a unique research experience in the field of glaciology. This course is taught in a CURE format (Course-based Undergraduate Research Experience), where students will work with the instructors to conduct Antarctic research. The research objective is to use novel geophysical and machine learning techniques to map the topography beneath Antarctic glaciers - critical constraints for ice-sheet and sea level rise models. Over the course of the semester, students will learn technical skills including how to visualize geospatial data sets, analyze geophysical data, model ice flux, conduct geostatistical analyses, and implement advanced statistical and machine learning workflows. Most weeks, the Tuesday class will be a lecture and the Thursday class will be a lab activity or discussion. All analytical work will be done in the Python programming language. This research is broken down into different lab activities and milestone assignments and will culminate in a poster presentation at the end of the semester. This course will also teach students about research ethics, data visualization, scientific communication, and navigating science and academia. This course is perfect for students who are interested in research and want to make an impact on climate change research! There are no quizzes or exams in this course.

Prerequisites: Students must have taken (or currently be taking) some physics and either calculus or linear algebra. Programming proficiency in any language is required. Please contact the instructor if you have any questions or concerns about your ability to succeed in this course. We understand that students will come from a variety of technical backgrounds. The most important quality is that you are committed to learning new skills!

Course Objectives

- Discuss the state-of-the-art of ice-sheet research.
- Explore geostatistical, geophysical, and Markov Chain Monte Carlo modeling techniques in Python.
- Map Antarctic glacier bed elevations.

Student Learning Outcomes

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

- Visualize scientific data, perform geophysical inversions, and implement advanced data science/machine learning techniques in Python.
- Explain how scientific research is conducted.
- Make and present a scientific poster.
- Describe how their research results contribute to the body of knowledge in glaciology.

Required Readings and Works

All relevant readings and materials will be provided. There are no costs associated with texts for this course.

II. Graded Work

Description of Graded Work

Assignments	Description	Points
Reading assignments	Annotate papers using the Perusall app. 5 points per paper.	35
Lit review	Provide a literature review on your study area.	10
Discussion activities	In-class discussions related to science or navigating research. Graded for participation. 2 points each.	12

Labs	The research is broken up into several different lab assignments, worth 10 points each.	40
Class video	The class will work together to make a ~5 minute video on your research experience. The class will be graded as a group.	10
Poster milestones	Milestone assignments that build up to the final poster. 5 points each.	15
Final poster	A scientific poster and presentation on your research findings.	50
GitHub repository	You will make a well-documented GitHub repository with the final code for your analysis.	20
Reflection	Written reflection on your research experience	20

Grading Scale

For information on how UF assigns grade points, visit: https://catalog.ufl.edu/UGRD/academic-regulations/grades-grading-policies/

A	94 – 100%		C	74 – 76%
A-	90 – 93%		C-	70 – 73%
B+	87 – 89%		D+	67 – 69%
B	84 – 86%		D	64 – 66%
B-	80 – 83%		D-	60 – 63%
C+	77 – 79%		E	<60

III. Annotated Weekly Schedule

Week	Topics, Homework, and Assignments
Week 0	• **Topic:** Course orientation • **Summary:** Introduce course and syllabus (Thursday only)

Week	Topics, Homework, and Assignments
	● **Required Readings/Works**: Syllabus ● **Assignment:** Skills questionnaire
Week 1	● **Topic:** Introduction to the cryosphere ● **Summary:** Provide glaciology background and introduce research topic. Background on reading scientific literature. ● **Required Readings/Works**: https://www.nature.com/articles/s41597-025-04672-y ● **Assignment:** Paper annotation 1. Discussion 1 on Bedmap3. Optional Python refresher assignment.
Week 2	● **Topic:** Geophysical measurements ● **Summary:** You will gain familiarity with different types of geophysical data sets. By the end of this week, everyone will have downloaded, compiled, and plotted the data in their study area. ● **Required Readings/Works:** n/a ● **Assignment:** Lab 1 - data visualization. Lit review assignment.
Week 3	● **Topic:** Ice flux modeling ● **Summary:** You will learn about the principles of mass conservation and forward model ice flux divergence. ● **Required Readings/Works:** **https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2011GL047338** ● **Assignments:** Paper annotation 2, Discussion 2, Lab 2 - ice flux divergence modeling
Week 4	● **Topic:** Geostatistics introduction ● **Summary:** You will be introduced to geostatistics and perform interpolations with kriging and sequential Gaussian simulation. ● **Required Readings/Works:** https://gmd.copernicus.org/articles/16/3765/2023/ ● **Assignments:** Paper annotation 3, Lab 3 - geostatistics
Week 5	● **Topic:** Scientific communication and data visualization ● **Summary:** You will start making figures for your poster ● **Required Readings/Works:** data visualization text ● **Assignments:** Poster milestone 1 - draft of data figures
Week 6	● **Topic:** Geostatistics continued ● **Summary:** You will build your understanding of geostatistics and apply this to your study area. You will then examine how your geostatistical interpolation does or does not honor mass conservation constraints. ● **Required Readings/Works:** n/a ● **Assignments:** Lab 4 - geostatistical simulation and misfit calculation

Week	Topics, Homework, and Assignments
Week 7	● **Topic:** Geophysical inversion ● **Summary:** Introduce geophysical inverse modeling, and why it's so complicated. We will discuss how this course approaches this challenge. There will also be time to catch up on data processing and labs. ● **Required Readings/Works:** https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2011GL048659 ● **Assignments:** Paper annotation 4. Discussion 3 activity on reading and next steps for the remainder of this course.
Week 8	● **Topic:** Bayesian statistics and Markov Chain Monte Carlo (MCMC) ● **Summary:** Introduce Bayesian statistics and MCMC, and how you will use it to solve a gravity inversion. ● **Required Readings/Works:** MCMC inversion manuscript ● **Assignments:** Paper annotation 5. Discussion 4 activity on reading and next steps for the remainder of this course.
Week 9	● **Topic:** Putting the experiment together ● **Summary:** You will continue gaining familiarity with the different technical components and begin implementing the full MCMC workflow. ● **Required Readings/Works**: n/a ● **Assignments:** n/a
Week 10	● **Topic:** Project work time ● **Summary:** Continue working on project. ● **Required Readings/Works:** n/a ● **Assignments:** Poster milestone 2 - Poster outline.
Week 11	● **Topic:** Project work time ● **Summary:** Continue working on project, discuss ice-sheet modeling ● **Required Readings/Works:** https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2021GL096589 ● **Assignments:** Paper annotation 6, Discussion 5
Week 12	● **Topic:** Project work time ● **Summary:** Continue working on project, continue modeling discussion ● **Required Readings/Works:** https://www.science.org/doi/full/10.1126/sciadv.abq5180 ● **Assignments:** Paper annotation 7, Discussion 6
Week 13	● **Topic:** Project work time ● **Summary:** Continue working on project. ● **Required Readings/Works:** n/a ● **Assignments:** Poster milestone 3 - Drafts of figures and poster
Week 14	● **Topic:** Project conclusion and presentation ● **Summary:** Poster presentation (Tuesday only). ● **Required Readings/Works:** n/a ● **Assignments:** Class video, final poster, GitHub repository, Reflection.

VI. Required Policies

This course complies with all UF academic policies. For information on those policies and for resources for students, please see this link:
https://syllabus.ufl.edu/syllabus-policy/uf-syllabus-policy-links/.

Professionalism and Communication

Professionalism and collegiality are important in the scientific community and make for better collaborations. Be respectful of your classmates, support each other, and try not to dominate the conversation or interrupt others. Approach different viewpoints with curiosity, not judgment. Be courteous in your communication with your classmates and instructors. In an increasingly online world, it's easy to digitally say things that we do not mean. So be mindful not to say anything over email that you wouldn't say in person. You may address the instructor as Mickey or Dr. MacKie (not Ms. MacKie). You may communicate with the instructors over Canvas or email. The instructors will typically respond within a few hours during work hours (M-F 9-5) but will not necessarily be available outside of these hours.

Grade Dispute Policy

Grade disputes happen, sometimes due to instructor error. If you would like to dispute a grade, you must send Dr. MacKie an explanation in writing within 48 hours of receiving the grade. Requests for reappraisal will not be considered if the statement includes references to how much effort was put into the assignment, or how this assignment impacts your final grade/grad school prospects. Grading is based solely on the assignment rubrics and late days. There are no extra credit opportunities in this course.

AI Policy

AI tools such as ChatGPT are now widely used. You are encouraged to learn more about their strengths and limitations. We do not prohibit the use of AI tools in this course. In fact, ChatGPT can be very useful for debugging code or checking for grammatical errors. However, we caution students against relying too heavily on these tools for writing. ChatGPT does not write at the level of precision required in academia, and it is not well-versed in the content in this course. You are responsible for taking ownership of the quality of your work - whether or not you use AI. We will not check assignments for ChatGPT origins. Ultimately, assignments will be graded solely on quality according to their rubrics.