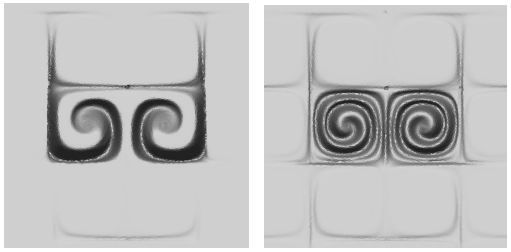
Last Update: 12/19/2023

SYLLABUS

CLIM-715
Numerical Methods for Climate Modeling



Spring Semester, 2024
Mondays, 1:30 - 4:10pm EST

Innovation Hall 139

Instructor: Prof. Zafer Boybeyi

Introduction:

CLIM-715, Numerical Methods for Climate Modeling, is a graduate course (3-credit) under the Department of Atmospheric, Oceanic & Earth Sciences (AOES). This course introduces graduate students **major components** of numerical modeling for weather & climate studies. This course consists of a combination of **lectures** and **a final project** designed to familiarize the student with the important numerical methods used in weather & climate models and with the general nature of modeling as **experimental science**.

General Course Goals:

- Understanding of numerical methods for the solution of PDEs as are used in weather/climate/ocean models
- Understanding of weather/climate models
- Experience with using weather/climate models

General Course Topics:

- Modeling History
- Basic Tools & PDEs
- Governing Equations, Flow Decomposition, Simplifying Assumptions & Waves
- Finite Difference Methods (Downstream, Upstream, Center)
- Properties of Numerical Schemes (Accuracy, Consistency, Stability, Convergence)
- Advection Term & Application of Finite Difference Methods
- Basic Evaluation Tests for Advection Term
- Aliasing Error & Nonlinear Instability
- Spectral & Finite Volume Methods
- Diffusion Term, Tridiagonal Solver & Turbulence Closure Problem
- Transport & Dispersion Modeling (Eulerian & Lagrangian)
- Numerical Methods for Source and Sink Terms & Sub-Grid Scale Processes

- Common Numerical Modeling Misconceptions

Final Modeling Project as Experimental Science:

The course requires a final modeling project to familiarize the student with the general nature of modeling as experimental science:

- Identify a question of interest
- Question whether the problem is testable
- Formulate your hypothesis and identify your prediction
- Choose a model that is suitable to conduct your experiment
- Run your experiment
- Analyze & present the results

Instructor and Contact Information:

Prof. Zafer Boybeyi
Research I, Room 217
Mail Stop 6A2
Email: zboybeyi@gmu.edu
Office Hours: Mondays, 9:00-10:30am EST
Additional hours by appointment

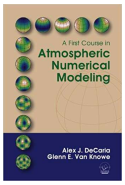
Course Website:

GMU Blackboard: https://gmu.blackboard.com/

In order to comply with student privacy laws, faculty and students need to use their GMU e-mail accounts when corresponding with each other.

Recommended Textbook:

A First Course in Atmospheric Numerical Modeling
Alex J. DeCaria & Glenn E. Van Knowe
ISBN 978-0-9729033-4-9



Additional Supplementary Textbook:

- Numerical Prediction & Dynamic Meteorology (George J. Haltiner & Roger T. Williams)
- Numerical Methods for wave Equations in Geophysical Fluid Dynamics (Dale R. Duran)
- Mesoscale Meteorological Modeling (Roger A. Pielke)

Course Format:

- Lectures
- Homework assignments
- Reading assignments supplemental material
- A final project
- Midterm exam
- Take home final exam
- Lecture notes will be posted on GMU Blackboard

Tentative Travel Schedule:

I have travel plan from February 19 to 22.

February 19 lecture will be online via Zoom.

Tentative Schedule for Final Project & Exam Timeline:

Week 1 (Jan. 22)	
Week 2 (Jan. 29)	
Week 3 (Feb. 5)	Problem chosen
Week 4 (Feb. 12)	Present hypothesis
Week 5 (Feb. 19)	Obtain, get access, and describe model that you choose
Week 6 (Feb. 26)	(**Midterm Exam**)
Week 7 (Mar. 4)	**(Spring Recess)**
Week 8 (Mar. 11)	Preliminary demonstration runs
Week 9 (Mar. 18)	
Week 10 (Mar. 25)	Configure your final runs
Week 11 (Apr. 1)	
Week 12 (Apr. 8)	Runs complete
Week 13 (Apr. 15)	
Week 14 (Apr. 22)	(Present results)
Week 15 (Apr. 29)	(**Final Take-Home Exam**)

May 6 Final Exam at 1:30pm

Important Notes:

- Attendance Policy: Students **MUST ATTEND** all classes.
- If you have a schedule conflict and cannot take an exam on the scheduled day, let me know ahead of time and I will try to arrange an alternative test date.

Makeup Policy:

Students will be permitted to submit late homework on a case-by-case basis. Late exams will be permitted if the instructor is provided with an acceptable explanation and if performed within one week of the original exam. Make-up exams must be scheduled **IN ADVANCE** with instructor permission.

Important Course Dates:

- **First lecture**: Monday, January 22, 1:30-4:10pm EST
- **Midterm Exam**: Monday, February 26, 1:30-4:10pm EST
- **Final Exam:** Take-Home

Course Grading Policy:

Homework	20%
Final Project*	20%
Midterm Exam**	25%
Take-Home Final Exam***	35%

*The students will submit and present a final modeling project.
**You are responsible for all material from text and any additional assigned readings.

***The final exam is comprehensive (covering all material covered in the course).

Numerical Grade Ranges:

A	94-100%
A-	90-93%
B+	87-89%
B	83-86%
B-	80-82%
C+	77-79%
C	73-76%
C-	70-72%
D	60-69%
F	Below 60%

Policy on Use of Personal Technology in the Classroom:

Laptops are permitted only for use only for this course and its related activities. Email and web surfing is not allowed and are distracting to both the student and to classmates. Please use common courtesy and do not use your laptop for any activities other than those related to this course. Cellphones must be turned off or on vibrate. Please do not take calls or text in the lectures.

Classroom Conduct:

Discussions, whether face-to-face or electronic, should be conducted with respect for each other and at a high level of civil discourse. Disruptive behavior may result in a student being asked to leave the classroom or be temporarily barred from participating class activities.

Privacy:

In order to comply with student privacy laws, faculty and students need to use their GMU email accounts when corresponding with each other and the instructor. I will not respond to messages sent from non-Mason email addresses.

Religious Holidays and Observations:

http://ulife.gmu.edu/calendar/religious-holiday-calendar/ is available to help minimize difficulties for students of different faiths. It is the student's responsibility to speak to the instructor in advance should their religious observances impact their participation in class activities and assignments.

Students with Disabilities:

If you are a student with a disability and you need academic accommodations, please see me and contact the Office of Disability Resources at 703/993-2474. All academic accommodations must be arranged through that office.

Diversity and Inclusion:

The College of Science seeks to create a learning environment that fosters respect for people across identities. We welcome and value individuals and their differences, including gender

expression and identity, race, economic status, sex, sexuality, ethnicity, national origin, first language, religion, age and ability. We encourage all members of the learning environment to engage with the material personally, but to also be open to exploring and learning from experiences different than their own.

George Mason University Honor Code:

GMU is an Honor Code university; please see the University Catalog for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and violations are treated gravely.

What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else's work in an aspect of the performance of that task, you will give full credit in the proper, accepted form.

Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind), please ask for guidance and clarification.

To promote a stronger sense of mutual responsibility, respect, trust, and fairness among all members of the George Mason University community and with the desire for greater academic and personal achievement, we, the student members of the University Community have set forth this:

Student members of the George Mason University community pledge not to cheat, plagiarize, steal, or lie in matters related to academic work.
http://www.gmu.edu/departments/unilife/pages/honorcode.html