Syllabus
CLIM 470 Numerical Weather Prediction
Fall 2021
MW 9:00am – 10:15 am
Research Hall 121

Instructor: Cristiana Stan
Room 267, Research Hall
703-993-5391
cstan@gmu.edu
Course Credits: 3
Course Website: Blackboard
Office Hours: Thursday – 1:00pm-2:30pm

Recommended Prerequisites: MATH 213, MATH 214 and CLIM 411

Catalog Description: Concepts and techniques of numerical prediction of weather, including the numerical models used and the rationale for large suites of meteorological forecasts. Sources of errors in the forecast: errors in the initial conditions and in the numerical weather prediction models. Interpretation of model output.

***Objectives*:** Provides undergraduate atmospheric sciences a basic grounding in the principles of numerical weather prediction. In particular:
1. Students will show an understanding of techniques and methods involved in numerical weather prediction;
2. Students will recognize the mathematical, physical and computational framework involved in numerical weather prediction;
3. Students will apply the computational framework to a simplified numerical weather prediction problem;

***Required Text*:**
Coiffier, Jean 2012: Fundamentals of Numerical Weather Prediction, Cambridge Press, ISBN 978-1-107-00103-9

Assignments:
Periodic homework is assigned and is due at the start of the class indicated. No late homework will be accepted except under prior arrangement. Homework will be graded and returned. There will be one exam during the semester and a Final. Exams are designed to test basic concepts and are closed books and closed notes. A class project will be assigned after the midterm exam. The project is due on the day of final. The project will be evaluated based on an oral presentation.
Late assignments: 10% is taken off for up to three days late; 30% is taken off for work submitted up to a week late. No assignment is accepted after one week, except for special extensions granted on the day the homework is assigned.

Grading:

Homework	10%	
Midterm Exam	20%	Tuesday, October 12, 9:00 am -10:15 am
Class Project	50%	Monday, December 13, 7:30 am -9:00 am
Final	20%	Monday, December 13, 9:00 am -10:15 am

Course Outline

1. Introduction
- The early days of numerical weather prediction
- The beginning of modern numerical weather prediction
- Numerical weather prediction today
- Developments in computing

2. What is a numerical weather prediction model?
- Weather prediction equations
- Physical parameterizations
- Data assimilation

3. Grid point models
- The finite difference methods
- The common used grids and their properties

4. Spectral models
- Spectral methods
- Spectral method on a double periodic domain

5. Time integration schemes
- Non-iterative schemes
- Iterative schemes
- Time filtering method on the sphere

6. Vertical discretization
- Hydrostatic/Non-hydrostatic models
- Sigma vertical coordinates
- Hybrid vertical coordinates

8. Errors in the models
- Aliasing errors
- The effects of time differencing on energy conservation
- Quality control of observations

9. Operational Forecasting
- The forecasting process
- Ensemble forecasting
- Forecast verification

10. Post-processing of model output
- Introduction to GrADS

11. Examples of NWP models
- The North American Mesoscale (NAM) forecast system
- The Global Forecast System (GFS)

FORTRAN MODULE

1. **Introduction to FORTRAN**
    - Creating a Fortran file
    - Compiling, linking and executing
2. **Basic elements of FORTRAN**
    - Structure of a FORTRAN Program
    - Constants and Variables
3. **FORTRAN Program Design**
    - Loops: DO, WHILE
    - The block IF, ELSE, and ELSE IF construct; SELECT CASE
4. **FORTRAN basic I/O concepts**
    - Read, Write
    - File formats
5. **Introduction to arrays and pointers**

Course Structure and Interaction:
Activities and assignments in this course will regularly use the Blackboard learning system, available at https://mymason.gmu.edu. Students are required to have regular, reliable access to a computer with an updated operating system (recommended: Windows 10 or Mac OSX 10.13 or higher) and a stable broadband Internet connection (cable modem, DSL, satellite broadband, etc., with a consistent 1.5 Mbps [megabits per second] download speed or higher.

Safe Return to Campus:
All students taking courses with a face-to-face component are required to follow the university's public health and safety precautions and procedures outlined on the university Safe Return to Campus webpage (https://www2.gmu.edu/safe-return-campus). Similarly, all students in face-to-face and hybrid courses must also complete the Mason COVID Health Check daily, seven days a week. The COVID Health Check system uses a color code system and **students will receive either a Green, Yellow, or Red email response**. Only students who receive a "green" notification are permitted to attend courses with a face-to-face component. **If you suspect that you are sick or have been directed to self-isolate, please quarantine or get testing. Faculty are allowed to ask you to show them that you have received a Green email and are thereby permitted to be in class.**

Students are required to follow Mason's current policy about facemask-wearing. As of August 11, 2021, all community members are required to wear a facemask in all indoor settings, including classrooms. An appropriate facemask must cover your nose and mouth at all times in our classroom. If this policy changes, you will be informed; however, students who prefer to wear masks either temporarily or consistently will always be welcome in the classroom.

Academic Integrity:
The integrity of the University community is affected by the individual choices made by each of us. Mason has an Honor Code with clear guidelines regarding academic

integrity. Three fundamental and rather simple principles to follow at all times are that: (1) all work submitted be your own; (2) when using the work or ideas of others, including fellow students, give full credit through accurate citations; and (3) if you are uncertain about the ground rules on a particular assignment, ask for clarification. No grade is important enough to justify academic misconduct. Plagiarism means using the exact words, opinions, or factual information from another person without giving the person credit. Writers give credit through accepted documentation styles, such as parenthetical citation, footnotes, or endnotes. Paraphrased material must also be cited, using the appropriate format for this class. A simple listing of books or articles is not sufficient. Plagiarism is the equivalent of intellectual robbery and cannot be tolerated in the academic setting. If you have any doubts about what constitutes plagiarism, please see me.

Disability Accommodations:
Disability Services at George Mason University is committed to upholding the letter and spirit of the laws that ensure equal treatment of people with disabilities. Under the administration of University Life, Disability Services implements and coordinates reasonable accommodations and disability-related services that afford equal access to university programs and activities. Students can begin the registration process with Disability Services at any time during their enrollment at George Mason University. If you are seeking accommodations, please visit http://ds.gmu.edu/ for detailed information about the Disability Services registration process. Disability Services is located in Student Union Building I (SUB I), Suite 2500. Email:*ods@gmu.edu* | Phone: (703) 993-2474

Notice of mandatory reporting of sexual or interpersonal misconduct:
As a faculty member, I am designated as a "Non-Confidential Employee," and must report all disclosures of sexual assault, sexual harassment, interpersonal violence, stalking, sexual exploitation, complicity, and retaliation to Mason's Title IX Coordinator per University Policy 1202. If you wish to speak with someone confidentially, please contact one of Mason's confidential resources, such as Student Support and Advocacy Center (SSAC) at 703-380-1434 or Counseling and Psychological Services (CAPS) at 703-993-2380. You may also seek assistance or support measures from Mason's Title IX Coordinator by calling 703-993-8730, or emailing *titleix@gmu.edu*.

Privacy:
Student privacy is governed by the Family Educational Rights and Privacy Act (FERPA) and is an essential aspect of any course. For this reason, students must use their Mason email account to receive important University information, including communications related to this class. I will not respond to messages sent from or send messages to a non-Mason email address.

Recording and/or sharing class materials:

Some kinds of participation in online study sites violate the Mason Honor code: these include accessing exam or quiz questions for this class; accessing exam, quiz, or assignment answers for this class; uploading of any of the instructor's materials or exams; and uploading any of your own answers or finished work. Always consult your syllabus and your professor before using these sites.