Syllabus
CLIM 470 Numerical Weather Prediction
Fall 2024
MW 9:00am – 10:15 am
Innovation Hall 139

Instructor: Cristiana Stan
Room 267, Research Hall
703-993-5391
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Course Credits: 3
Course Website: Canvas
Office Hours: By appointment

Recommended Prerequisites: MATH 213, MATH 214 and CLIM 411

Course Overview: 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.

***Learning Outcomes*:** This course is designed to enable students to:
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%	Monday, October 7, 9:00 am -10:15 am
Class Project	50%	Monday, December 16, 7:30 am -9:00 am
Final	20%	Monday, December 16, 9:00 am -10:15 am

The course is graded on the George Mason Undergraduate Grading scale.

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
- Data Formats

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

COMPUTATIONAL MODULE

1. **Introduction to GMU Computing**
   - Login into ORC computing
   - Shall commands
   - Working with files and directories
2. **Introduction to Git and GitHUB**
   - Setup and config
   - Basic snapshotting
3. **Python/Matplotlib**
   - Reading data files
   - Vector and contour plotting

3. **Introduction to FORTRAN**
   - Creating a Fortran file
   - Compiling, linking and executing

4. **Basic elements of FORTRAN**
   - Structure of a FORTRAN Program
   - Constants and Variables

5. **FORTRAN Program Design**
   - Loops: DO, WHILE
   - The block IF, ELSE, and ELSE IF construct; SELECT CASE

6. **FORTRAN basic I/O concepts**
   - Read, Write
   - File formats

7. **Introduction to arrays and pointers**

Course Structure and Interaction:
Activities and assignments in this course will regularly use the Canvas learning system, available at https://mymason.gmu.edu and Zoom. 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.

Students can use Outlook to send a calendar invitation to the instructor for a meeting (though only the instructor can confirm a meeting).

Common Policies Addendum
Policies about Academic Standards, Accommodations for Students with Disabilities, FERPA, and Title IX affecting all GMU Students:

https://stearnscenter.gmu.edu/home/gmu-common-course-policies/

Other Resources for the General University Experience
- Student Support and Advocacy Center (SSAC)
- Counseling and Psychological Services

- The Office of Diversity, Inclusion, and Multicultural Education (ODIME)
- University Career Services
- University Writing Center