Course title: **Midlatitude Synoptic Meteorology (CLIM401)**

Course type: elective
Semester: spring 2022
Credit: 3
Time: 10:30 am – 11:45 am Tuesday and Thursday
Location: 121 Research Hall

Instructor: Dr. Bohua Huang
Email: bhuang@gmu.edu
Office Hour: 1:00 pm - 2:00 pm, Thursday

Office: 269 Research Hall
Office Phone: 703-993-6084 (email communication will be preferred)

Blackboard Login Instructions

Access to MyMason and GMU email are required to participate successfully in this course. Please make sure to update your computer and prepare yourself to begin using the online format BEFORE the first day of class. Check the IT Support Center website. Navigate to the Student Support page for help and information about Blackboard. In the menu bar to the left you will find all the tools you need to become familiar with for this course. Take time to learn each. Make sure you run a system check a few days before class. Become familiar with the attributes of Blackboard and online learning.

Course Description

This course teaches students how to apply dynamical concepts and methods in weather analysis and map interpretation. We first introduce the essential dynamical tools for synoptic meteorology, the quasigeostrophic theory, isentropic analysis and potential vorticity framework. Using these tools, we examine the midlatitude weather systems and phenomena, including extratropical cyclone, front, cold-air damming and winter storm. Finally, basic procedure of numerical weather prediction and human forecasting processes are discussed.

Prerequisite:	Weather Analysis and Forecasting (CLIM301) or permission of instructor
Corequisite:	Atmospheric Dynamics (CLIM411) or permission of instructor

Course Learning Outcomes:

Upon completion of this course, students will

1. know the major ideas of bringing together the observational and theoretical meteorology to describe the mid-latitude synoptic weather systems.
2. gain an appreciation to the approaches and underlying values of conceptual models in weather analysis.
3. get knowledge of the basic synoptic methods and techniques.
4. be able to use the course information and skills in the interpretation of some weather phenomena.

Textbook

Required:

Garry M. Lackmann, 2015: Midlatitude synoptic meteorology: dynamics, analysis and forecasting, pp345, American Meteorological Society, ISBN 978-1-878220-10-3. (Book information: https://bookstore.ametsoc.org/catalog/book/midlatitude-synoptic-meteorology) (The textbook should be available in Mason bookstore.)

Supplemental (optional):

Gary M. Lackmann, Brian E. Mapes and Kelvin R. Tyle, 2017: Synoptic-dynamic meteorology lab manual, visual exercises to complement Midlatitude Synoptic Meteorology, pp120, American Meteorological Society, ISBN 978-1-878220-26-4. (Book information: https://bookstore.ametsoc.org/catalog/book/synoptic-dynamic-meteorology-lab-manual)

Reference

Toby N. Carlson, 1998: Mid-latitude weather systems, pp507, The Pennsylvania State University Press, ISBN: 978-0-271-05643-2. (Book information: https://www.psupress.org/books/titles/978-0-271-05643-2.html)

Requirements:

The lectures will be accompanied with homework assignments on a weekly basis. A 20-min discussion of current weather, led by a student, will be conducted at the beginning of each class. In addition, some exercises (or projects) will be assigned, and some classes will be devoted to the projects. The undergraduate grading scale as specified in the university-wide policies will be applied to CLIM401.

Grade breakdown:

40% tests (quizzes, mid-terms, final)
40% homework and exercises
20% weather discussion

Grading Scale

A+ 97%-100% A 93%-97% A- 90%-93%
B+ 87% - 90% B 83%-87% B- 80%-83%
C+ 77% - 80% C 73%-77% C- 70%-73%
D 60% - 70% F below 60%

Technology Requirements

Hardware: You will need access to a Windows or Macintosh computer and access to a fast and reliable broadband internet connection. You will need speakers or headphones to hear recorded content.

Software: We use Blackboard as the learning management system. You will need a browser and operating system that are listed compatible or certified with the Blackboard version available on the myMason Portal. See supported browsers and operating systems. Also, make sure your computer is protected from viruses by downloading the latest version of Symantec Endpoint Protection/Anti-Virus software for free here.

Note: If you are using an employer-provided computer or corporate office for class attendance, please verify with your systems administrators that you will be able to install the necessary applications and that system or corporate firewalls do not block access to any sites or media types.

Course Schedule:

Week I (01/24-01/28) **Background, a weather map view of basic dynamics** (Chapter 1)

1. Course introduction
2. Coordinate systems
3. Scale of motions and governing equations
4. Potential temperature and equivalent potential temperature
5. Installation of Integrated Data Viewer (IDV)

Week 2 (01/31-02/04) **Thermal wind and temperature advection** (Chapter 1)

1. Geopotential height and thickness
2. Thermal wind relation and upper-level jet stream
3. Temperature advection, frictional veering

Week 3 (02/7-02/11) **Vorticity and vorticity equation** (Chapter 1)

1. Vorticity (relative and planetary vorticity, shear and curvature)
2. Vorticity equation
3. Barotropic vorticity equation and Rossby waves

Week 4 (02/14-02/18) **Quasigeostrophic approximation** (Chapter 2)

1. QG approximation for vorticity equation
2. Thermodynamic equation and QG approximation

Week 5 (02/21-02/25) **Review and mid-term 1**
Section review (02/22)
Mid-term 1 (Thursday, 02/24)

Week 6 (02/28-03/04) **QG Omega equation** (Chapter 2)
1. Derivation and physical meaning
2. Height tendency equation (map application)
3. QG potential vorticity
4. Application: Jet streak

Week 7 (03/07-03/11) **Alternative expressions for vertical motion**
1. Sutcliffe development theorem
2. Petterssen's development equation
3. The Trenberth approximation
4. Q-vector

Week 8 (03/14-03/18) Spring Recess

Week 9 (03/21-03/25) **Isentropic analysis** (Chapter 3)
1. Basics
2. Construction and interpretation of isentropic charts
3. Representation of vertical motion on an isentropic surface

Week 10 (03/28-04/01) **The potential vorticity framework** (Chapter 4)
1. Definition
2. PV tendency equation
3. PV distribution and dynamic tropopause
4. PV changes and heat sources
5. Examples of PV inversion

Week 11 (04/04-04/08) **Review and mid-term 2**
Section review (04/05)
Mid-term 2 (04/07, Thursday)

Week 12 (04/11-04/15) **Extratropical cyclones** (Chapter 5)
1. Climatology of cyclones
2. An historical review
3. Cyclogenesis (QG interpretation, Sutcliffe-Patterssen formulation)

Week 13 (04/18-04/22) **Fronts** (Chapter 6)
1. Frontal properties and types
2. Kinematic frontogenesis
3. Dynamic frontogenesis

Week 14 (04/25-04/29) **Cold-air damming (CAD)** (Chapter 8)

1. CAD in the southeastern US
2. CAD as a geostrophic adjustment
3. Thermal advection and diabatic processes
4. Synoptic settings

Week 15 (05/02-05/07) **Winter storms** (Chapter 9)

1. General forecasting considerations
2. Physical processes
3. Precipitation-type forecasting techniques
4. Lake-effect precipitation
5. Review

Final Exam (05/17, Tuesday, 10:30am-1:15pm)

Homework Description: For each week, homework assignment is posted on Thursday. The homework assignment is due in one week on Thursday at 11:59 pm. There is no homework due in mid-term weeks.

Policy for late assignments: Late homework submitted within one week after the due date is still accepted with a 3% reduction of the assigned points after each day. Homework late for more than one week is not accepted.

Quizzes: An online quiz is given at the end of each week except for the review weeks. Each quiz has five multiple-choice questions. You will have 30 minutes to complete the quiz. Quizzes are open book.

Mid-terms and Final. The two mid-term exams will be on Feb. 24 and Apr. 7. The final exam will be on May 17. All exams will be closed book.

University Policies and Resources

a. Academic Honesty: You are expected to be familiar with and abide by the University's Honor Code. The Code can be found here. It is your responsibility to see me if you have questions about these policies. George Mason University has an honor code that states the following:
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 for this Honor Code: Student Members of the George Mason University community pledge not to cheat, plagiarize, steal, or lie in matters related to academic work.
b. Students must follow the university policy for Responsible Use of Computing

c. Student services: The University provides range of services to help you succeed academically and you should make use of these if you think they could benefit you. I also invite you to speak to me (the earlier the better).
d. Students are responsible for the content of university communications sent to their George Mason University email account and are required to activate their account and check it regularly. All communication from the university, college, school, and program will be sent to students solely through their Mason email account.
e. The George Mason University Counseling and Psychological Services (CAPS) staff consists of professional counseling and clinical psychologists, social workers, and counselors who offer a wide range of services (e.g., individual and group counseling, workshops and outreach programs) to enhance students' personal experience and academic performance. Counseling Center: Student Union I, Room 364, 703-993-2380.
f. Students with disabilities who seek accommodations in a course must be registered with the George Mason University Office of Disability Services (ODS) and inform their instructor, in writing, at the beginning of the semester. All academic accommodations must be arranged through that office. Please note that accommodations MUST BE MADE BEFORE assignments or exams are due. I cannot adjust your grade after the fact.
g. Students must follow the university policy stating that all sound emitting devices shall be turned off during class unless otherwise authorized by the instructor.
h. The George Mason University Writing Center staff provides a variety of resources and services (e.g., tutoring, workshops, writing guides, handbooks) intended to support students as they work to construct and share knowledge through writing. University Writing Center: Robinson Hall Room A114, 703-993-1200. The writing center includes assistance for students for whom English is a second language.
i. Diversity: George Mason University promotes a living and learning environment for outstanding growth and productivity among its students, faculty and staff. Through its curriculum, programs, policies, procedures, services and resources, Mason strives to maintain a quality environment for work, study and personal growth.