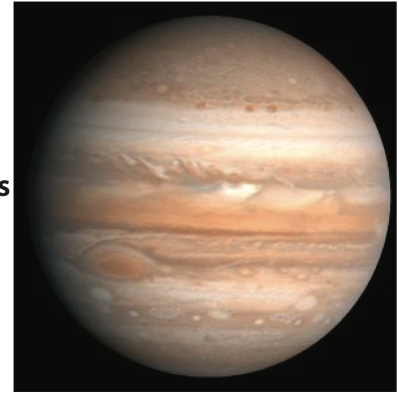


CLIM 411/511  
Introduction to Atmospheric Dynamics



**Catalog Description:** Observational bases and fundamentals of fluid dynamic principles for understanding atmospheric motions across multiple spatial and temporal scales; covers basic conservation laws of mass, momentum, and energy; concepts of circulation and vorticity; balanced atmospheric flows, e.g. geostrophic wind and shear, thermal wind; quasi-geostrophic and isentropic potential vorticity analysis for mid-latitude cyclones and fronts.

**Credits:** 3

**Recommended Prerequisites:** CLIM 111 and MATH 213 (Analytic Geometry & Calculus III), or permission of instructor.

**Time:** Tuesdays and Thursdays 1:30-2:45pm

**Venue:** Exploratory Hall L505

**Instructor:** Natalie Burls

Assistant Professor

Dept. of Atmospheric, Oceanic, & Earth Sciences

<https://cos.gmu.edu/aoes/profile-natalie-burls/>

**Office Hours:** By appointment (feel free to approach me after class and we will setup a time)

Research Hall, Room 273, Fairfax Campus

Office: (+1) 703-993-5756

Email: nburls@gmu.edu

**Course Objectives:** Students will become familiar with the basic concepts of dynamic meteorology, develop an appreciation of meteorological phenomena across multiple spatio-temporal scales, and be able to apply these concepts to understanding weather and climate phenomena. The course will focus on the following topics:

- Important dynamical balances within atmospheric motion (e.g. geostrophic, hydrostatic, and thermal wind)
- Conservation laws such as energy, mass, momentum, vorticity, and entropy
- Approximations enabling solutions describing the behavior of specific atmospheric phenomenon e.g. the quasigeostrophic equations
- Key structure and development of the mid-latitude weather systems and the related dynamical interpretation.

The CLIM 511 syllabus will follow the same textbook, lecture format and number of homework assignments as the undergraduate, senior-level CLIM 411 class. However, given that CLIM 511 is designed for MSc students typically enrolled in one of the Climate Science MSc concentrations, CLIM

511 students will receive additional, more advanced, questions on each homework assignment, as well as the mid-term and final examinations.

### Important Dates:

Please see the university calendar [[https://registrar.gmu.edu/calendars/spring\\_2026/](https://registrar.gmu.edu/calendars/spring_2026/)] for drop dates with and without a tuition penalty.

**Grading:** Homework 40%, Mid-term 30%, Final 30%

**Homework:** There are nine homework problem sets. Each set carries 4% of the total grade. Homework problem sets are due one week from when they are assigned. You will also be assigned an in-class rotating tank demonstration (see applicable Canvas assignment for grading rubric) which will form part of your homework grade and carries 4% of your total grade. You will also be asked to complete a class journal and will be assigned bonus points towards your homework grade if you complete these. All homework assignments must be submitted by the due date to be graded. The due dates on the syllabus are an approximate guide to help you plan, the true due date will be the due date associate with a homework when it is assigned in Canvas. When an issue arises a late submission will only be allowed occasionally for good reason and for a limited period of time as solutions will be reviewed in class at which point it is no longer possible to grade the homework. Any outstanding homework assignments not submitted by the due date of the final homework of the semester will not be graded as we will need to review solutions in class.

### Grade Disputes

Any dispute regarding a grade on any assignment must be made in writing via email within 1-week of receipt of the grade on that assignment.

**Required Textbook:** Martin, Jonathan E., Mid-Latitude Atmospheric Dynamics, John Wiley and Sons, 324pp. It is important that you get this textbook, either hard copy or electronic and bring it with you to every class.

## Syllabus and Schedule

Lecture	Topic	Textbook Chapter	Homework Assignments	Rotating Tank Demos And notes
<b>Week 1</b> Jan 20	Nature of fluids and useful mathematical tools	1.1-1.5	HW#1 assigned	Dye Stirring
<b>Week 1</b> Jan 22	Nature of fluids and useful mathematical tools	1.1-1.5		
<b>Week 2</b> Jan 27	Nature of fluids and useful mathematical tools	1.1-1.5	HW#1 due and HW#2 assigned	
<b>Week 2</b> Jan 29	Nature of fluids and useful mathematical tools	1.1-1.5		
<b>Week 3</b> Feb 3	Fundamental forces and apparent forces	2.1-2.2		
<b>Week 3</b> Feb 5	Fundamental forces and apparent forces	2.1-2.2	HW#2 due and HW#3 assigned	Density Current
<b>Week 4</b> Feb 10	Fundamental forces and apparent forces	2.1-2.2		
<b>Week 4</b> Feb 12	Fundamental forces and apparent forces	2.1-2.2	HW#3 due and HW#4 assigned	Solid Body Rotation
<b>Week 5</b> Feb 17	Fundamental forces and apparent forces	2.1-2.2		
<b>Week 5</b> Feb 19	Conservation of momentum, mass and energy	3.1-3.3		
<b>Week 6</b> Feb 24	Conservation of momentum, mass and energy	3.1-3.3	HW#4 due and HW#5 assigned	
<b>Week 6</b> Feb 26	Conservation of momentum, mass and energy	3.1-3.3		Aim to be up to end of first part of 3.2 cons of momentum, not 3.2.1

				but do jump and discuss eqn 3.31 Aim to be doing all of 3.2.1
<b>Week 7</b> Mar 3	Conservation of momentum, mass and energy	3.1-3.3	HW#5 due	
<b>Week 7</b> Mar 5	<b>Midterm</b>			
Mar 10	<b>Spring Break</b>			
Mar 12	<b>Spring Break</b>			
<b>Week 8</b> Mar 17	Conservation of momentum, mass and energy	3.1-3.3	HW#6 assigned	Fronts Aim to be beginning 3.2.2
<b>Week 8</b> Mar 19	Conservation of momentum, mass and energy	3.1-3.3		
<b>Week 9</b> Mar 24	Equations of motion and applications	4.1-4.5	Student lecturers	
<b>Week 9</b> Mar 26	Equations of motion and applications	4.1-4.5	Student lecturers	
<b>Week 10</b> Mar 31	Equations of motion and applications	4.1-4.5	HW#6 due and HW#7 assigned	Hadley Circulation & Thermal Wind Balance I
<b>Week 10</b> Apr 2	Equations of motion and applications	4.1-4.5		Hadley Circulation & Thermal Wind Balance II
<b>Week 11</b> Apr 7	Equations of motion and applications	4.1-4.5	HW#7 due and HW#8 assigned	
<b>Week 11</b> Apr 9	Equations of motion and applications	4.1-4.5		Balanced Vortex
<b>Week 12</b> Apr 14	Equations of motion and applications	4.1-4.5		
<b>Week 12</b> Apr 16	Circulation; Vorticity; Potential Vorticity	5.1-5.3		
<b>Week 13</b> Apr 21	Circulation; Vorticity; Potential Vorticity	5.1-5.3	HW#8 due and HW#9 assigned	Rossby Waves
<b>Week 13</b> Apr 23	Circulation; Vorticity; Potential Vorticity	5.1-5.3		Flow over a Barrier on a Beta Plane
<b>Week 14</b> Apr 28	Circulation; Vorticity; Potential Vorticity	5.1-5.3	HW#9 due	
<b>Week 14</b> Apr 30	Quasi-Geostrophic System	5.4		
<b>12 May</b>	<b>Final Exam</b>	<a href="#">1:30 pm – 4:15 pm</a>		

### Late Registration and/or Add

Students who register or add the course after the first assignments are due are responsible for making up all materials and assignments that have been missed. The student must:

- Meet with the course instructor and discuss the plan for revised assignment due dates.
- Agree *in writing* with the instructor regarding the due dates for missed assignments.
- Failure to do so may result in grading penalties or a zero on missed assignments.

### Grading Schema

The following grading schema is used for this class. It might be different to what you are used to but is consistent with the way assignments are graded, when an answer is wrong 0 points are awarded.

Grades Scored Between	Will Equal
90 % and 100 %	A+
80 % and Less Than 90%	A
75 % and Less Than 80%	A-
70 % and Less Than 75%	B+
65 % and Less Than 70%	B
60 % and Less Than 65%	B-
50 % and Less Than 60%	C
0 % and Less Than 50%	F

### Accommodations for Disabilities

If you have a documented learning disability or other condition that may affect academic performance you should: 1) contact the Office for Disability Services (SUB I, Rm. 4205; 993-2474; <http://ods.gmu.edu>) to determine the accommodations you need; and 2) talk with me to discuss your accommodation needs.

In addition to providing me with the appropriate form, please take the initiative to discuss accommodation with me at the beginning of the semester and as needed during the term. Because of the range of learning differences, faculty members need to learn from you the most effective ways to assist you. If you have contacted the Center for Disability Services and are waiting to hear from a counselor, please tell me.

### Student Use of Electronic Devices

Cell phones and other communicative devices are not to be used during class. Please keep them stowed away and out of sight. Laptops or tablets are permitted for the purpose of viewing an electronic version of the class's textbook only. Engaging in activities not related to the course (e.g., gaming, email, chat, etc.) is not permitted.

### Academic Integrity

GMU is an Honor Code university: It is expected that students adhere to the George Mason University Honor Code as it relates to integrity regarding coursework and grades. The Honor Code reads as follows: "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 and/or lie in matters related to academic work." More information about the Honor Code, including definitions of cheating, lying, and plagiarism, can be found at the Office of Academic Integrity website at <http://oai.gmu.edu>

The principle of academic integrity is taken very seriously and violations are treated gravely. What does academic integrity mean in this course? Essentially this: your work is your own, 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.

***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. Using AI tools such as ChatGTP to answer homework and test questions is prohibited.***

## **Privacy**

Students must use their Mason email account to receive important University information, including messages related to this class. See <http://masonlive.gmu.edu> for more information.

## **Campus Closure**

*If the campus closes or class is canceled due to weather or other concern, students should check Canvas [or other instruction as appropriate] for updates on how to continue learning and information about any changes to events or assignments.*

## **Mason Diversity Statement**

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.

An emphasis upon diversity and inclusion throughout the campus community is essential to achieve these goals. Diversity is broadly defined to include such characteristics as, but not limited to, race, ethnicity, gender, religion, age, disability, and sexual orientation. Diversity also entails different viewpoints, philosophies, and perspectives. Attention to these aspects of diversity will help promote a culture of inclusion and belonging, and an environment where diverse opinions, backgrounds and practices have the opportunity to be voiced, heard and respected.

The reflection of Mason's commitment to diversity and inclusion goes beyond policies and procedures to focus on behavior at the individual, group and organizational level. The implementation of this commitment to diversity and inclusion is found in all settings, including individual work units and groups, student organizations and groups, and classroom settings; it is also found with the delivery of services and activities, including, but not limited to, curriculum, teaching, events, advising, research, service, and community outreach.

Acknowledging that the attainment of diversity and inclusion are dynamic and continuous processes, and that the larger societal setting has an evolving socio-cultural understanding of diversity and inclusion, Mason seeks to continuously improve its environment. To this end, the University promotes continuous monitoring and self-assessment regarding diversity. The aim is to incorporate diversity and inclusion within the philosophies and actions of the individual, group and organization, and to make improvements as needed.

## **Sexual Harassment, Sexual Misconduct, and Interpersonal Violence**

George Mason University is committed to providing a learning, living and working environment that is free from discrimination and a campus that is free of sexual misconduct and other acts of interpersonal violence in order to promote community well-being and student success. We encourage students and employees who believe that they have been sexually harassed, sexually assaulted or subjected to sexual or interpersonal misconduct to seek assistance and support. [University Policy 1202: Sexual Harassment and Misconduct](#) speaks to the specifics of Mason's process, the resources, and the options available to students and employees.

**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](mailto:titleix@gmu.edu).*

### Useful Campus Resources:

University Catalog: <http://catalog.gmu.edu/>

University Policies: <http://universitypolicy.gmu.edu/>

Student Support Resources on Campus (<https://ctfe.gmu.edu/teaching/student-support-resources-on-campus>)

Name of Resource	Description of Resource
<a href="#">Mathematics Tutoring Center</a>	Offers tutoring on a walk-in basis for all George Mason University students who are enrolled in math courses up to MATH 290.
<a href="#">Advising for Exploratory Students</a>	Provides advisors and coaches for students seeking or changing their major.
<a href="#">Assistive Technology Initiative</a>	Manages the production of accessible text for Mason students with disabilities. They also ensure access to information technology and communications to the entire university community through the use of adaptive equipment and provision of technical assistance.
<a href="#">Counseling and Psychological Services</a>	CAPS is a mental health center that is dedicated to promoting the emotional and psychological health and wellness of our students, provide time-limited individual and group counseling, referral to community mental health providers, psychiatric and crisis counseling, and academic and wellness workshops.
<a href="#">University Career Services</a>	Provides information on career choices, internships and employment, and graduate and professional school.
<a href="#">Office of Coalition Building and Diversity Education (CBDE)</a>	Through collective and collaborative work with campus and community partners, supports, builds, and enhances the understanding of interpersonal identities to respond to systemic inequities, through engagement, advocacy, and education. CBDE aims to be a catalyst for change by creating, promoting and sustaining an inclusive and equitable campus community.

Name of Resource	Description of Resource
<a href="#">Center for Culture, Equity, and Empowerment (formerly ODIME and LBGTQ+)</a>	<p>Leverages programs and services focused on advocacy and direct student support to strengthen equity and inclusion at George Mason University. Our advising fosters opportunities for identity development, cross-cultural engagement, and inclusive learning communities, affirming the indivisible aspects of all our identities. Our three areas: <a href="#">Student Access and Equity (SAE)</a>, <a href="#">Student Engagement for Racial Justice (SERJ)</a>, and <a href="#">LBGTQ+ Resources</a>, serve as resources to those in the Mason Community who seek to meaningfully engage and interact with people with different identities and intersections to co-create an equitable campus environment.</p>
<a href="#">Office of the Ombudsman</a>	<p>Acts as a unique resource for students to discuss concerns and complaints and serves as a safe space to facilitate the resolution of conflicts. As an impartial party, the office does not take sides in any conflict and operates independently of any formal channels at the university.</p>
<a href="#">Disability Services</a>	<p>Serves individuals who are deaf/hard of hearing and blind/low vision, and those with mobility and medical difficulties. They also serve those with ADHD, Autism, learning, temporary and psychological disabilities, and more. Accommodations are developed on a case-by-case basis through an individual interview and documentation. Accommodations can be implemented at any time during a student's enrollment.</p>
<a href="#">Learning Services</a>	<p>Provides a variety of experience based learning opportunities through which students explore a wide range of academic concerns. Services include support to students with learning differences, individual study skills counseling, individualized programs of study, and provision of tutoring resources. Presentations on a variety of academic skill topics are available to the university community. The programs are open to all George Mason University students free of charge. Services are confidential and use of these services does not become part of the student's academic record.</p>
<a href="#">Safe Zone</a>	<p>Creates a safer, more welcoming and inclusive campus environment to strengthen community and encourage networking among faculty, staff, and students toward the goal of supporting the well-being of LBGTQ people.</p>
<a href="#">Mason Student Services Center</a>	<p>Provides one-stop, integrated information and referrals regarding admissions, registrar, student accounts, and financial aid.</p>
<a href="#">Military Alliance Program (M.A.P.)</a>	<p>Provides faculty and staff participants with an understanding of military students at Mason and how they can be supported. Upon completion of M.A.P. training, participants are certified by the Office of Military Services as a "Military Friendly Staff Member".</p>
<a href="#">Office of Academic Integrity</a>	<p>Provides information on the honor code and resources for students and faculty.</p>

Name of Resource	Description of Resource
<a href="#">International Programs and Services</a>	Provides guidance to students and scholars studying and working at George Mason University on immigration, employment and taxation, and adjustment issues, while fostering cross-cultural understanding through programs highlighting global themes.
<a href="#">Copyright Resources Office</a>	Provides assistance to faculty and students regarding copyright policies.
<a href="#">Social Action and Integrative Learning (SAIL)</a>	Fosters experiential learning opportunities on campus, regionally, and globally for the Mason community with a particular emphasis on effecting positive social change. SAIL is Mason's home for service-learning initiatives.
<a href="#">Student Health Services</a>	SHS is an on-campus healthcare clinic staffed by dedicated medical professionals who provide accessible and affordable health care to all enrolled students. SHS provides diagnosis and treatment of illnesses and minor injuries, health counseling, lab testing, and a variety of other services.
<a href="#">Student Support and Advocacy Center</a>	Offers educational programs and support services to help students address issues related to personal wellness, interpersonal violence, and alcohol and drug use. SSAC also assists students who are encountering life challenges or crises.
<a href="#">Student Conduct</a>	Provides information about university policies, the student conduct process, and resources for faculty related to addressing student behaviors of concerns and other disruptive behaviors.
<a href="#">UNIV Courses and Programs</a>	Serves as a resource and development center for undergraduates, providing courses, programs, and services to facilitate students' personal and academic success.
<a href="#">University Life</a>	Enhances students' in- and out-of-class experiences, in addition to facilitating interactions among faculty, staff, and other students. These resources help students achieve academically, stay healthy, get involved with campus life, find jobs, and identify resources to enrich their learning.
<a href="#">University Writing Center</a>	Offers free individual writing consultations for students, who choose between meeting a tutor in person, on Zoom or submitting a draft for the tutor's written feedback. Also offers online writing guides on specific genres of writing, citation style, and other topics. Additionally, the Writing Center provides assistance to faculty who are interested in holding in-class writing workshops, developing effective writing assignments, or evaluating students' writing.