EAS 4440 – Mesoscale Meteorology – Fall 2026
Section: A
Number of Credits: 3

Course Instructor
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Course Description
Mesoscale Meteorology focuses on the study of weather phenomena on spatial and temporal scales that are smaller than synoptic meteorology features but larger than cumulus-scale phenomena. These events last on the order of seconds to minutes, hours, and days, with their spatial scales usually ranging between 1 km to 1000 km. While most meteorologists often associate midlatitude severe weather with mesoscale meteorology, several other phenomena also occur within this scale. This includes orographic (i.e., mountain) weather, boundary layer events, fog, lake and sea breezes, lake-effect snow, and across-front phenomena.

Considerable progress has been made regarding meteorologists' accuracy in forecasting the location and magnitude of mesoscale meteorology events. We are now able to use numerical weather prediction to often accurately forecast the timing of severe weather outbreak events as well as the development and location of many of the weather phenomena listed earlier. Machine learning and artificial intelligence (AI) are also becoming increasingly prominent within meteorology.

Why do such meteorological features occur? How do meteorologists go about analyzing such features? What theory has been discovered that can be utilized to understand, diagnose and forecast such phenomena? Is there actually a purpose to all this calculus material that I must learn for this major? All these questions (and many, many more) will be answered throughout this course.

Course Learning Outcomes
The School of Earth and Atmospheric Sciences at Georgia Tech strives for students to achieve proficiency within one or more of 5 Student Learning Outcomes (SLOs). All 5 SLOs are described below, with those elements specific to this course highlighted:

1) **Knowledge**: Graduates will be able to apply the principles of chemistry, physics, biology, mathematics, and computing to solving problems within Earth, Planetary, and Atmospheric science. Basic knowledge for all EAS includes the following:
    a. Data analysis and statistics (quantitative methods)
2) **Communication**: EAS graduates will be able to take scientific knowledge and communicate it effectively orally and in writing.
    a. Present a scientific topic (either research or lit. review) orally, either poster or conference presentation
3) **Synthesis**: Graduates will be able to use their knowledge from EAS courses to conduct original research/problem solving in Earth, Planetary, and Atmospheric sciences:
    a. Scientific experiment design and implementation
    b. Observation, laboratory experiment, and/or computer model simulation to solve problems
4) **Application**: Graduates will be able to apply the tools of the discipline to approach and address problems in the field. Examples include:
    a. Meteorology: Utilizing observational or forecast data in combination with theory to interpret past data tied to weather events of interest to society or to construct an accurate weather forecast

5) **Career**: Graduates will be able to demonstrate knowledge of the field making them prepared to enter careers or further education.
    a. Graduates will be knowledgeable of types and general availability of career opportunities in field
    b. Graduates will have developed a bridge for succession from our program to their related career path

Required Text
Markowski, P. and Y. Richardson (2010), *Mesoscale Meteorology in Midlatitudes*; ISBN-13: 9780470742136.

Recommended Text
Rauber, R. M., J. E. Walsh and D. J. Charlevoix (2013), *Severe and Hazardous Weather: An Introduction to High Impact Meteorology*; ISBN-13: 9780757597725.

Ungrading for Grading
This semester, an "ungrading" approach will be used to determine your grade within this course (adopted from Dr. Janel Hanrahan's dynamics course at Northern Vermont University). Below is an explanation of the "ungrading" grading system as well as questions about this method:

How will this work?
- After completion of any course assignments, the course instructor will provide feedback on the assignments but NOT a score or letter grade. The feedback will provide information about your successes within the assignments as well as what needs to be corrected or improved.
- You will have one week after each assignment to resubmit based on the feedback provided to improve your performance on the assignment.
- There will be two mid-semester evaluation periods in which you will evaluate your performance in the course and assign yourself a letter grade. This letter grade must be supported by evidence from your performance in the class and supported by evidence observed by the course instructor. Rubrics will be provided to help assess yourself during these checkpoints during the semester.
- At the end of the semester, you will evaluate your performance in the course one last time, and this evaluation will require you to assign a letter grade for the course. Again, evidence of your performance from the semester will be used, along with confirmation from the course instructor, to determine your final grade.

Description of Assignments and Assessments to be Ungraded
- Course Engagement – This ungrading component focuses on any factors that demonstrate a student's commitment to positioning themselves best for success within the course. This can be assessed in a variety of ways, including (but not limited to) any of the following:
    - Showing up to class on time and minimizing unexcused absences (i.e., absences in which no instructor notification is provided)
    - Engaging within in-class discussion of course material – examples include:
        - Raising hand and answering questions during class
        - Engaging within in-class activities
        - Collaborating with others in-class with respect to course material discussion and/or practice problems
        - Visiting office hours to ask questions

    - Emailing or Canvas messaging the course instructors to ask questions
- Knowledge Checks – Summative assessments for this course will take the form of "knowledge checks" within class when assigned. Knowledge checks will assess students' understanding of course material. Students will have two attempts on each knowledge check, with the second attempt allowing students to review positive and constructive feedback from the course instructors to demonstrate knowledge proficiency and growth. A rubric will be provided for each knowledge check that assesses student performance based on a combination of knowledge content understanding, ability to communicate responses through writing in a manner that clearly and concisely demonstrates one's thought process in arriving at their responses.
- Lab Assignments – Webpage or Python programming-based assignments that require students to connect course theory to "real-world" weather events. Students will have two attempts on each lab assignment, with the second attempt allowing students to review positive and constructive feedback from the course instructors to demonstrate knowledge and relevant skill set proficiency and growth. A rubric will be provided for each lab assignment that assesses student performance based on a combination of knowledge content understanding, programming ability (if applicable) and ability to communicate responses through writing in a manner that clearly and concisely demonstrates one's thought process in arriving at their responses.
- Weather Discussions and Forecasting – a combination of weather discussions and WxChallenge forecasting competition forecasting and discussion to practice presenting complex course material to peers and to a general audience
- Case Study Research Project and Mesofest – first, students will participate in an activity in which students will read one peer-reviewed academic journal article and facilitate a discussion about the article with the class to familiarize everyone with case study-type of research. Then, near the end of the course, students will individually research an interesting past weather event within the context of mesoscale meteorology theory, products and application discussed throughout the semester. Students will then create research posters (following AMS research poster guidelines) about their projects to present to the class during the "Mesofest" poster event during the last lab meeting of the semester.

Course Topics

1) Atmospheric Dynamics Refresher
2) Tropical Cyclones
3) Mesoscale Frontal Dynamics
4) Boundary Layer Meteorology and Hazards (e.g., Lake-Effect Convection)
5) Orographic Meteorology (e.g., Downslope Windstorms)
6) Deep Moist Convection (e.g., Severe Weather)
7) Numerical Weather Prediction (NWP)

Attendance Policy

You are required to attend every class period. If you are unable to attend class due to an excused absence, please notify the course instructor or TA 24 hours prior to the start of class or ASAP if the reason for an absence emerges the day of class.

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. Review Georgia Tech's Honor Code and the student Code of Conduct.

Any student suspected of cheating or plagiarism on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

Accommodations for Students with Disabilities
If you are a student with learning needs that require special accommodation, contact the Office of Disability Services (404-894-2563) as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

Student-Faculty Expectations Agreement
At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. The Student-Faculty Expectations articulate some basic expectations that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

Other Course Procedures & Policies
Late Policy: No late assignments will be accepted unless a valid reason for submitting an assignment late is discussed with the course instructor **at least 24 hours in advance of assignment due date or ASAP on the day of the assignment due date if an unexpected illness or emergency arises**.

Extra Credit: Given the ungrading methodology utilized within this course, no extra credit opportunities will be provided.

Artificial Intelligence (AI): We now live in a world where AI is everywhere, and it is very convenient to use for a lot of day-to-day applications. This also includes looking up answers to questions for courses as well as assisting (or fully writing) answers or papers on written assignments. Here is a breakdown of when AI is authorized vs. unauthorized in this course, noting that **any unauthorized use of AI is a violation of the Georgia Tech Academic Honor Code**:

When AI is **authorized** in this course:
- Assisting with note taking during lecture
- Double-checking information related to in-class activities
- Producing figures and code for lab assignments and the course Mesofest project provided that all AI prompt information and output are provided when submitting final course project deliverables

When AI is **unauthorized** in this course:
- Knowledge Checks – this includes both attempts for each knowledge check assessment

Undergraduate Student Academic Success Resources
A list of resources for undergraduate students' academic success and information about advising can be found at Success at Tech.

Academic Support: Academic Success and Advising (a unit in the Office of Undergraduate Education & Student Success) provides free support for your courses. Students can attend scheduled supplemental review (PLUS) sessions, stop by Drop-In Tutoring, or schedule a one-on-one appointment through Knack. To explore what options work best for you, please visit us online at success.gatech.edu/tutoring, email us at tutoring@gatech.edu, or come see us at Clough Undergraduate Learning Commons, Suite 283.

Student Well-Being
At Georgia Tech, we are concerned about your overall physical, social, and mental well-being. A comprehensive list of wellness related resources has been compiled and maintained by the Office of the Vice President for Student Engagement and Well-being (https://students.gatech.edu/student-resource-guide).

More resources on supporting student well-being on the syllabus and beyond are available through the Learning Well Initiative.