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.

Significant 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 of 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 from 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.

What assignments will you work on?
- Participation and Mini-Weather Briefings – In-class activities that are some combination of pre-class reading assignments, practice problems and reflection on course material; this will also include students rotating at the start of lecture days with presenting a 5 minute summary of "what to look out for" weatherwise across the U.S. (or wherever is relevant)
- Lab Assignments – Webpage or Python programming-based assignments that require students to connect course theory to "real-world" weather events
- Knowledge Checks – assessments to check in periodically throughout the semester regarding student understanding of course material
- 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.

Why are you doing this to us? This feels very uncomfortable given that everything is based on grades at GT!
Below explains the justification for trying this out (list a mix of my thoughts and that of Dr. Hanrahan):

- It allows me to provide you with formative rather than summative feedback.
- It allows you to focus on **learning** instead of your grade (which is more like that of the "real world").
- Ungrading encourages a growth mindset instead of a fixed mindset.
- This will allow you to take risks and experiment and not be concerned about getting a bad grade.
- This will allow you to have more freedom with our curriculum, including more active learning.
- Grades are subjective, reduce the depth and quality of student thinking, encourage cheating, and get in the way of healthy relationships with your peers.
- This will help you take ownership of your learning.

Attendance Policy
You are required to show up to each class. Please notify the course instructor 24 hours prior to the start of class if you think you will be unable to attend one or more class periods (or as soon as possible if you learn the day of class that you are unable to attend, e.g., family emergency, health concern). Your attendance will be considered within the ungrading framework applied within this course.

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.

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)