Synoptic Meteorology
EAS 4450 (3 Credit Hours) – Undergraduate Version
EAS 8803 and 8811 (3 Credit Hours) – Graduate Version
Spring 2023

Lecture Meeting Times: TR 9:30 – 10:20 AM
Lecture Location: Skiles 171

Lab Meeting Time: F 12:30 – 3:15 PM
Lab Location: ES&T L1116

Course Prerequisites for Undergraduate Students:
- EAS 4655: Atmospheric Dynamics

Course Prerequisites for Graduate Students:
- EAS 6502: Introductory Fluid Dynamics and Synoptic Meteorology

Instructor
Dr. Zachary Handlos
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Office Hours: 12-2 PM EST MW Room 1251 ES&T (or virtual) or by appointment

Course TA
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Office Hours: By appointment

Required Text
Martin, J. E. (2006), *Mid-Latitude Atmospheric Dynamics: A First Course*; ISBN-13: 9780470864654.

Highly Recommended Text
Lackmann, G. M. (2011), *Midlatitude Synoptic Meteorology: Dynamics, Analysis and Forecasting*; ISBN-13: 9781878220103.

Course Description
Synoptic Meteorology traditionally refers to the analysis of weather at a specific period of time (http://www.srh.noaa.gov/srh/jetstream/synoptic/synoptic_intro.html), with that analysis being accomplished through the investigation of observed surface and tropospheric weather data. Synoptic meteorologists would perform hand analyses of this data in order to determine the physical mechanisms responsible for any observed weather as well as forecast what would happen over the next few hours using diagnostic tools. The field of synoptic meteorology has a rich history of significant theoretical and computational discoveries that have improved the predictability of significant weather events accurately to as far out as 10 days.

Given the evolution of satellite and computer technology, synoptic meteorology in the 21st century represents the study of weather systems and jet stream phenomena that occur on horizontal spatial scales on the order of ~1000 km and a time scale of ~5-7 days. This includes extratropical cyclones and anticyclones, the polar and subtropical jet streams and jetstreaks.

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 of this calculus material that I have to learn for this major? All of these questions (and many, many more) will be answered throughout this course.

Course Topics

In this course, we will strive to learn about the following topics:

1) The life cycle of extratropical cyclones
2) Diagnostic tools for assessing the formation, maintenance and dissipation of extratropical cyclones and anticyclones (QG-Theory, Q-Vector, PV perspective)
3) Jet Streams, Jet Streaks and relation to Extratropical Cyclones
4) Fronts and Frontogenesis
5) Circulation and Vorticity
6) How to analyze observational and model forecast data and draw conclusions about the atmosphere on a synoptic scale

Earth and Atmospheric Science Core Skill Development

The School of Earth and Atmospheric Sciences at Georgia Tech strives to meet several learning standards for all students within the undergraduate program. These standards, and how they will be achieved in this course, are listed below:

1) Demonstrate **quantitative understanding** of synoptic meteorology theory and real-time synoptic scale weather events
2) Develop **critical analysis** and **problem-solving skills** through laboratory exercises and case study projects
3) Gain **practical experience** with **analyzing, interpreting and communicating** synoptic meteorology events orally (e.g., weather discussion events) and through written assignments (e.g., case study projects, WxChallenge reflection assignments)
4) Gain appreciation of the **interdisciplinary** nature of meteorology through laboratory exercises, theoretical problems, course projects and participation in WxChallenge competition
5) **Increase breadth of knowledge** within meteorology by developing foundational understanding of atmospheric physics and dynamics on synoptic scale as well as other scales that tie to synoptic meteorology (e.g., mesoscale, planetary scale)
6) Develop **comprehensive and cohesive understanding** of synoptic scale meteorology through consideration of several diagnostic tools (e.g., QG-theory, Q-vectors, PV perspective, Semi-Geostrophic Theory, z- vs. p- vs. natural coordinates)

Grading

Your grade in this course will be based on your performance within the following categories:

- Lab Assignments (6 labs/problem sets; keep top 5) and Practice Quizzes – 30% of grade
- Quizzes (5 quizzes; keep top 4) - 20% of grade
- Case Study Project – 20% of grade
- Weather Discussions and Blog Post – 15% of grade
- Class Preparation and WxChallenge – 15% of grade

Lab Assignments and Practice Quizzes (30% of grade)

See course schedule for lab assignment due dates. These assignments will require you to apply course reading material and course theory to solving a variety of synoptic-scale meteorological problems, both in traditional "problem set" format as well as using programming. Your lowest lab score will be dropped.

Due to this drop policy, there will be no makeup assignments; a missed assignment will result in a "0" score and be considered your "dropped" assignment.

Quizzes (20% of Grade)
Quizzes will assess your understanding of recently discussed course material. Your lowest quiz grade will be dropped. The actual quizzes make up 20% of your total grade. Due to the above drop policy, there will be no makeup quizzes; a missed quiz will result in a "0" score and be considered your "dropped" quiz.

Case Study Project (20% of Grade)
You will write a scientific paper describing in rigorous detail the physical mechanisms responsible for the development of a synoptic-scale event of interest. This paper will require you to perform a literature review, develop a "hypothesis" or "research question" about your case, present detailed results and discussion of your results and summarize your findings within a "Conclusions" section. You will also give a presentation to the class summarizing your findings and conclusions in a presentation format analogous to that of presenting at a conference. Your paper and presentation will be expected to follow AMS paper and presentation guidelines (more on this during class). I expect the final product that you produce to reflect your ability to critically analyze scientific data, provide correct physical reasoning and present scientific material in a clear, concise and accurate manner.

Weather Discussion and Blog Post (15% of grade)
You and one or more classmates will facilitate a weather discussion during 2 of the lab periods this semester. This weather discussion will require you to provide an in-depth analysis of the current (and recent past) weather as well as short-term forecasted weather using synoptic-scale tools learned from this course. This will allow you an opportunity to practice applying course material to weather observational analysis and forecasting.

During the second round of weather discussions, you will write a blog post for our synoptic and mesoscale meteorology blog website summarizing your portion of the weather discussion. More details about this will be discussed in class, however the general idea will be to write the information in a manner accessible to a mix of a scientific audience as well as the general public.

Class Preparation and WxChallenge (15% of Grade)
Prior to lecture meetings, you will be asked to complete readings from the Martin textbook (unless otherwise specified). You will then be required to complete a short quiz, assignment, etc… that demonstrates what you learned from the readings as well as what questions you have. Student questions will be strongly considered by the course instructor in preparation for topics discussed within class.

You will also participate within the WxChallenge forecasting competition this semester. This is a national forecasting competition, where participants enter maximum/minimum temperature, maximum wind speed and precipitation values for a forecast city over a two-week period. Prizes are awarded for forecasters that receive the least number of error points. You will be required to submit forecasts for all forecasting days for all five cities during the competition this semester.

****Graduate students completing this course will have additional expectations on lab assignments and the case study project, and these will be discussed with the course instructor****

Grading Scale
The **grading** for the course is as follows:

Grade	Percentage
A	100 – 90
B	89.99 – 80
C	79.99 – 70
D	69.99 – 60
F	<60

Depending on the distribution of student scores at the end of the course, the scores may be curved to reflect the scale described above (**up to the instructor's discretion**).

Late Work Policy

- No "Class Preparation" assignments will be accepted past their due dates – these will be graded as either "complete" or "incomplete".
- Any other assignment turned in late within this course will be deducted 20% of its total grade for each day it is late after submitted.
- The above late policies will only be waived in extreme circumstances (e.g., serious illness, family emergency, COVID-19). **You must contact me at least 24 hours prior to the due date of any assignment or ASAP** if you anticipate any issues with submitting it on time.

Lecture Notes

A significant portion of course theory will be discussed on the white board in the classroom or online using either the white board option in Bluejeans Meetings or Jam Board (via Google). It is your responsibility to take notes, as these notes will not necessarily be published on Canvas. Any Power Point slides used will be posted on Canvas.

Extra Credit

In fairness to all students, *I do not offer extra credit assignments* (unless otherwise specified).

Cheating

Cheating will not be tolerated in this course. Cheating includes the following: 1) copying answers from another student, 2) using unauthorized resources to study for course quizzes and assessments, which includes the use of electronic devices, 3) posting solutions to course quizzes and assessments on the Internet, and/or 4) any other activity that would be considered "academic misconduct".

To summarize, do not cheat; it is not worth jeopardizing your future because you wanted to look good doing something that you need to improve upon.

Academic Honor Code

The instructor and students are expected to abide by Georgia Tech's Academic Honor Code. Plagiarism of any kind (including the reproduction of materials found on the internet) is strictly prohibited and will be reported to the Office of Dean of Students for academic misconduct. The complete text of the Academic Honor Code may be found at:
https://policylibrary.gatech.edu/student-affairs/academic-honor-code

Access and Accommodations

At Georgia Tech, we strive to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we

can discuss options. You are also encouraged to contact the Office of Disability Services to explore reasonable accommodations.

The Office of Disability Services can be contacted by:
Phone: 404-894-2563
Email: dsinfo@gatech.edu
Website: http://disabilityservices.gatech.edu/

If our class meets at a campus location: Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

Support Services and Resources
In your time at Georgia Tech, you may find yourself in need of support. Below you will find some resources to support you both as a student and as a person.

Academic Support
- Center for Academic Success
  - 1-to-1 tutoring
  - Peer-Led Undergraduate Study (PLUS)
  - Academic coaching
- Residence Life's Learning Assistance Program
  Drop-in tutoring for many 1000-level courses
- OMED Educational Services - Group study sessions and tutoring programs
- Communication Center - Individualized help with writing and multimedia projects
- Academic advisors for your major

Personal Support
Georgia Tech Resources
- The Office of the Dean of Students | **404-894-6367** | 2nd floor, Smithgall Student Services Building; You also may request assistance here
- Counseling Center | **404-894-2575** | Smithgall Student Services Building 2nd floor
  - Services include short-term individual counseling, group counseling, couples counseling, testing and assessment, referral services, and crisis intervention. Their website also includes links to state and national resources.
  - *Students in crisis may walk in during business hours (8am-5pm, Monday through Friday) or contact the counselor on call after hours at **404-894-2204**.*
- Students' Temporary Assistance and Resources (STAR)
  - Can assist with interview clothing, food, and housing needs.
- Stamps Health Services | **404-894-1420**
  - Primary care, pharmacy, women's health, psychiatry, immunization and allergy, health promotion, and nutrition
- OMED Educational Services| 404-894-3959
- Women's Resource Center | 404-385-0230
- LGBTQIA Resource Center | 404 385 4780
- Veteran's Resource Center | 404-385-2067
- Georgia Tech Police | 404-894-2500

National Resources
- The National Suicide Prevention Lifeline | 1-800-273-8255

    - Free and confidential support 24/7 to those in suicidal or emotional distress
- The Trevor Project
    - Crisis intervention and suicide prevention support to members of the LGBTQ+ community and their friends
    - Telephone | **1-866-488-7386** | 24 hours a day, 7 days a week
    - Online chat | 24 hours a day, 7 days a week
    - Text message | Text "START" to **687687** | 24hrs day, 7 days a week

List of Course Topics*

Week	Topics	Course Reading (M = Martin text; O - Optional) - **Read Before Class**
Week 1 (1/9/23 – 1/13/23)	Atmospheric dynamics review; thermal wind; veering vs. backing	M – Ch. 1-3; 4.3 O – Lackmann Ch. 1
Week 2 (1/16/23 – 1/20/23)	Circulation and vorticity; shear vs. curvature vorticity	M – Ch. 5.1-5.3 O – Lackmann Ch. 1
Week 3 (1/23/23 – 1/27/23)	The nature of the ageostrophic wind	M – Ch. 6.1-6.2
Week 4 (1/30/23 – 2/3/23)	Sutcliffe Development Theorem; Introduction to QG-Theory	M – Ch. 6.2; 5.4 O – Lackmann Ch. 1
Week 5 (2/6/23 – 2/10/23)	QG-Theory	M – Ch. 5.4; 6.3; 8.3 O – Lackmann Ch. 2
Week 6 (2/13/23 – 2/17/23)	QG-Theory	M – Ch. 5.4; 6.3; 8.3 O – Lackmann Ch. 2
Week 7 (2/20/23 – 2/24/23)	QG-Theory; Geostrophic Paradox and Q-Vector	M – Ch. 6.4 O – Lackmann Ch. 2
Week 8 (2/27/23 – 3/3/23)	Potential Vorticity – IPV Basics; Isentropic Coordinates	M – Ch. 4.2, 9.1-9.2 O – Lackmann Ch. 3 and 4
Week 9 (3/6/23 – 3/10/23)	Potential Vorticity – Cyclogenesis from PV Perspective; Role of Diabatic Heating	M – Ch. 9.3-9.4 O – Lackmann Ch. 3 and 4

Week 10 (3/13/23 – 3/17/23)	Potential Vorticity – PV and Jet Stream Dynamics	M – Ch. 9.5 O – Lackmann Ch. 5
Week 11 (3/20/23 – 3/24/23)	SPRING BREAK	SPRING BREAK
Week 12 (3/27/23 – 3/31/23)	Extratropical Cyclones: cyclogenesis from a variety of perspectives	M – Ch. 8.4-8.8 O – Lackmann Ch. 6
Week 13 (4/3/23 – 4/7/23)	Fronts; frontogenesis equation; front types; upper level fronts; Sawyer-Eliassen equation	M – Ch. 7.1-7.2 O – Lackmann Ch. 6
Week 14 (4/10/23 – 4/14/23)	Fronts; frontogenesis equation; front types; upper level fronts; Sawyer-Eliassen equation	M – Ch. 7.3-7.4 O – Lackmann Ch. 6
Week 15 (4/17/23 – 4/21/23)	Modern Research Topics in Synoptic Meteorology	TBD
Week 16 (Tuesday, 4/25/23)	TBD	TBD
CASE STUDY PRESENTATIONS – THURSDAY, MAY 4TH, 2023 8:00 – 10:50 AM	**CASE STUDY PRESENTATIONS – THURSDAY, MAY 4TH, 2023 8:00 – 10:50 AM**	**CASE STUDY PRESENTATIONS – THURSDAY, MAY 4TH, 2023 8:00 – 10:50 AM**

*Course topics subject to change depending on how much time is needed to get through each topic of the course. Note that other readings will be assigned that complement the lecture material as necessary; this potentially includes later chapters in the course textbook not listed above.