ATM OCN 452-001
The Frontal Cyclone (4 cr)
University of Wisconsin-Madison
Fall 2023

Patrick Beaty (he/him/his)	**Course Information**
PhD Student	**Time**: Lecture - Tues/Thurs 1:20pm - 2:30pm Lab - Tues/Thurs 2:30pm - 4:30pm
Office: 1421 AOSS	**Location**: 1411 AOSS
Contact: pbeaty@wisc.edu 608-395-8828	**Credits**: 6 hours in-person, 4 hours out-of-class homework/self-study Traditional Carnegie credit hour definition
Student Help Hours: Thursdays 9:00am - 11:00am 1443 AOSS	**Pre-requisites**: ATM OCN 311 and 340

Required Textbook: None for lab section

Grading breakdown:

Exams (3 @ 10% each)	30%
Final Exam	15%
Final Laboratory Project	15%
Laboratory Exercises and Weather Discussions	40%

Learning Goals

1. Gain mastery of GEneral Meteorology PAcKage (GEMPAK) programming and visualization language
2. Interpret self-made plots of meteorological data and apply course knowledge to answer questions in short paragraph form
3. Construct three weather discussions in groups using accurate scientific language to explain daily weather events
4. Hypothesize key features leading to a mid-latitude cyclone event of interest using class concepts and discuss its development in a term research paper.

Course Roles

As your instructor, I will…

1. Treat you with respect and kindness in all forms of communication and through all forms of feedback provided on assignments and presentations.
2. Arrive to lecture and lab in a timely manner and in a positive mood, excited to partake in the academic struggle as your guide.
3. Be available for questions outside of lecture, whether that be through email/brief casual conversation or during my weekly office hours.
4. Intervene if I see any form of discrimination or persecution. A zero-tolerance policy is enacted in my classroom and you will be asked to leave if you are being a disruption to other students and/or making other students feel uncomfortable or unwelcome.

As a learner, I expect you to…

1. Treat your fellow students and me with respect and kindness in all forms of communication and through all forms of peer-feedback provided on assignments and presentations.
2. Attend all class and lab periods unless otherwise communicated to me BEFORE the period you will be absent. Arrive to lecture and lab on time and in a positive mood with an open mind, ready to partake in the academic struggle.
3. I expect all in-class activities and any assignment to be completed to your best ability. This class will challenge you. I do not expect you to get everything correct on the first try, seconds after learning a concept in lecture. I am still learning more about these concepts every single day and this is my 9th year studying meteorology. I ask for your honest attempt and willingness to accept positive corrections.
4. Be honest with me. I will be honest with you during the semester, I expect the same from you. This includes communication about absences or missed work.

Course Policies and Resources

Every member of the University of Wisconsin–Madison community has the right to expect to conduct their academic and social life in an environment free from threats, danger, or harassment. You as a student also have the responsibility to conduct yourself in a manner compatible with membership in the university and local communities.

COVID-19 Requirements: During the global COVID-10 pandemic, we must prioritize our collective health and safety to keep ourselves, our campus, and our community safe. As a university community, we must work together to prevent the spread of the virus and to promote the collective health and welfare of our campus and surrounding community. You should continually monitor yourself for COVID-19 symptoms and get tested for the virus if you have symptoms or have been in close contact with someone with COVID-19. You should reach out to instructors as soon as possible if you become ill or need to isolate or quarantine, in order to make alternate plans for how to proceed with the course. You are strongly encouraged to communicate with me, your instructor, concerning your illness and the anticipated extent of your absence from the course (either in-person or remote). I, the instructor, will work with you, the student, to provide alternative ways to complete the course work.

Academic Integrity: Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these previously listed acts are examples of misconduct which may result in disciplinary action. Examples of disciplinary action include, but are not limited to, failure on the assignment/course, written reprimand, disciplinary probation, suspension, or expulsion.

Diversity and Inclusion Statement: At UW-Madison, we value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals. These values will provide the foundation for the efforts we make together in this class.

Accommodations for Students with Disabilities: The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (UW-855) require the university to provide reasonable accommodations to students with disabilities to access and participate in its academic programs and educational services. Faculty and students share responsibility in the accommodation process. Students, you, are expected to inform faculty, me, of your need for instructional accommodations during the beginning of the semester, or as soon as possible after being approved for accommodations. I will work either directly with you or in coordination with the McBurney Center to provide reasonable instructional and course-related accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA

Academic Calendar & Religious Observances

Digital Course Evaluation (AEFIS): UW-Madison uses a digital course evaluation survey tool called AEFIS. For this course, you will receive an official email two weeks prior to the end of the semester, notifying you that your course evaluation is available. In the email you will receive a link to log into the course evaluation with your NetID. Evaluations are anonymous. Your participation is an integral component of this course, and your feedback is incredibly important to me. I strongly encourage you to participate in the course evaluation.

AOS Mentorship Program (AMP): Navigating college and planning your professional future can be overwhelming to say the least. If you'd like feedback and support to help with everything from finding peers to crafting your CV to where to search for research opportunities, consider joining the AOS Mentorship Program (AMP)! The goal of AMP is to foster a positive environment for AOS undergraduates while helping to build the tools and confidence necessary to succeed in your post-graduation endeavors. There are three 'tiers' to the AMP program that you can choose from: one-on-one mentoring, small group mentoring, or larger group social events.

Campus Resources:

- University Health Services
- Undergraduate Academic Advising and Career Services

- Office of the Registrar
- Office of Student Financial Aid
- Dean of Student Office

Course Assignments

Assignment	Description	Due Date
Case studies	Three progressively more complex studies of a mid-latitude cyclone of interest to enhance written scientific communication skills **Learning Goal: 1,2,4**	19 Oct., 9 Nov., 5 Dec.
Labs	Bi-weekly labs to evaluate computer and analysis skills using the computer software GEMPAK on current weather data **Learning Goal: 1,2**	Tues labs: 1:20 PM Thurs Thurs labs: 1:20 Tues following the lab
Oral presentations	Discussions of famous meteorological papers, final term paper presentation of final case study, student map discussions of current and future weather, all to enhance verbal scientific communication and public speaking skills. **Learning Goal: 3,4**	Dependent on discussion group (see course schedule)

Grading Policies

Case Studies

- Three case studies throughout the semester @ 100 points each
- Each case study builds upon aspects of the prior case study to form one complete research paper at the end of the semester
- *Case Study #1*: synoptic overview of midlatitude cyclone case of interest
- *Case Study #2*: synoptic overview and application of one dynamical analysis method to same midlatitude cyclone case of interest from *Case Study #1*

- *Case Study #3*: synoptic overview and application of roughly three dynamical analysis methods to a different midlatitude cyclone case of interest than *Case Study #1* and *Case Study #2*

Labs

- Bi-weekly lab assignments @ 100 points each
- Graded on:
    - Construction and academic merit of all answers to proposed questions
    - Eloquence of answers
    - Visualization of all plots made, including complete, descriptive captions and correct formatting

Oral Presentations

- Numerous opportunities for the refinement of public speaking
- Includes:
    - Three student-led map discussions about the current and future weather
    - One group presentation on a famous meteorological paper of choice
    - One final presentation on semester research paper

TENTATIVE Lab Schedule

Week	Date	Class Topics	Labs due, discussions, and papers	Enduring Understanding
1	7 Sep.	Introduction, philosophy and goals of ATM OCN 452, review of fundamental physics		Cyclones balance the global temperature imbalance.
2	12 Sep.	Geostrophic wind, conservation of mass, force balance of surface and aloft, effects of curvature		The upper-levels and lower-levels of the atmosphere constantly interact.
2	14 Sep.	Hypsometric equation, thermal wind equation, instabilities, vertical structure of cyclone	Hand Analysis (Surface map)	
3	19 Sep.	Cyclone development, energetics view of cyclone life cycle, definition of ageostrophic wind, Sutcliffe (1938)	Hand Analysis (700 mb map)	Cyclone development can be diagnosed using kinetic energy and/or the ω-equation.
3	21 Sep.	Quasi-geostrophic ω-equation	GEMPAK Familiarization Student map discussions begin	
4	26 Sep.	Trenberth form of the ω-equation	Sutcliffe development theorem	Trenberth (1978) used a different approach than Sutcliffe (1947) but arrived at the same diagnostic conclusion.
28 Sept. EXAM 1 1:20 PM - 2:30 PM				
4	28 Sep.	EXAM DAY	The QG Omega Equation	Surface weather is related to pressure and wind direction.
5	3 Oct.	The "geostrophic paradox" and its resolution, the	sfmap Group 1 Sutcliffe	Q-vectors restore thermal wind balance through

		Q-vector	(1947)	secondary circulations.
5	5 Oct.	Q-vector continued	snmap Case Study #1 intro	
6	10 Oct.	Introduction to fronts, frontal slope and frontal characteristics, relation of fronts to jets	Q Vectors & Qn and Qs Group 2 Martin (1998)	Fronts in the atmosphere are regions of strong temperature and relative vorticity gradients.
6	12 Oct.	Frontogenesis (FG) and deformation fields, FG and vertical circulations	gdcross	
7	17 Oct.	Sutcliffe (1938), Sawyer-Eliassen equation	Upper air scripting	Sawyer and Eliassen diagnosed ageostrophic circulations across a front.
7	19 Oct.	FG and vertical circulations, Sutcliffe (1938), Sawyer-Eliassen equation	Frontogenesis Case Study #1 DUE Case Study #2 intro	
8	24 Oct.	Quasi-geostrophic (QG) frontogenesis and the Q vector	Cross sections through a front Group 3 Eliassen (1962)	Upper-level fronts constantly interact with the lower-levels of the atmosphere.
8	26 Oct.	Sawyer-Eliassen continued, upper-level FG **Case Study #2 work day**	Identifying upper fronts using horizontal maps	
31 Oct. EXAM 2 1:20 PM - 2:30 PM				
9	31 Oct.	EXAM DAY **Case Study #2 work day**		Upper-level fronts can rapidly intensify storm systems.
9	2 Nov.	Upper-level FG continued, upper FG and its effects on cyclogenesis		
10	7 Nov.	Mechanisms for banded precipitation at fronts, conditional symmetric instability criteria and moist potential vorticity (PV), adiabatic reduction of moist PV	Cross sections through an upper front Group 4 Keyser and Shapiro (1986) pgs. 452-474	Precipitation can be organized into bands by conditional symmetric instability.

10	9 Nov.	Cyclogenesis, Petterssen's Type A and B, QG tendency equation	Conditional symmetric instability Case Study #2 DUE	
11	14 Nov.	QG PV form of the tendency equation, applications	QG height tendency equation	Diabatic heating can aid in cyclogenesis and rapid cyclogenesis.
11	16 Nov.	Diabatic effects on cyclogenesis, explosive cyclogenesis	Cyclogenesis from QG height tendency equation Group 5 Martin (2014)	
21 Nov. EXAM 3 1:20 PM - 2:30 PM				
12	21 Nov.	EXAM DAY - **Final research papers work day**	Explosive cyclogenesis	
23 Nov. THANKSGIVING (NO CLASS)				
13	28 Nov.	"Self-development", cyclogenesis and FG as concurrent processes		Potential vorticity incorporates a lot of information about the atmosphere in one variable.
13	30 Nov.	Introduction to PV, PV invertibility, PV conservation - **Final research papers work day**	Clarifying confusion	
14	5 Dec.	Cyclogenesis from the PV perspective, mutual amplification of upper and lower anomalies	FINAL RESEARCH PAPER DUE	Upper-level potential vorticity has impacts on lower-level potential vorticity and the two can mutually amplify.
14	7 Dec.	Interior PV anomalies, diabatic effects and the PV paradigm, "self-development" from a PV perspective	Final research paper presentations	
15	12 Dec.	PV distribution in upper-level fronts, tropopause deformation in cyclogenesis, diabatic influence on PV, "PV	Final research paper presentations	Upper-level fronts bring high amounts of potential vorticity closer to the surface, which intensifies cyclogenesis.

		thinking", recent research on occluded cyclones		
16 Dec. FINAL EXAM 2:45 PM - 4:45 PM				