11:670:433 Weather Analysis and Forecasting I: Synoptic Meteorology
Course Syllabus
Fall 2019

Instructor Information

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Textbooks

Required: *Midlatitude Synoptic Meteorology: Dynamics, Analysis & Forecasting*, by Gary Lackmann
Supplemental: *Mid-Latitude Atmospheric Dynamics*, by Jonathan Martin (**M**)

Learning Goals

Upon completion of this class, students will be able to:

1. Conduct a weather discussion and apply diagnostic, prognostic, and technological tools to evaluate atmospheric processes across a multitude of scales. (PLG 1)
2. Apply critical and analytical thinking to solve relevant scientific problems in both individual and collaborative settings. (PLG 3)
3. Effectively communicate scientific information orally and in writing, including by electronic means, at an appropriate level for their audience. (PLG 4)
4. Demonstrate mastery of the mathematical and physical foundations of meteorology and climatology as well as key atmospheric processes that occur at a variety of spatial and temporal scales.

Introduction

Welcome to Synoptic Meteorology! I know some of you are already quite excited about the topics covered in this course. Perhaps you view this course as the culmination of your career as an undergraduate student in meteorology. Indeed, this course will pull together topics you've seen in previous classes here at Rutgers. If you ever wondered why you've had to learn about things like divergence, absolute vorticity, latent heat, entropy, and cross products, you'll soon find out! The weather is my passion, and I hope to share my passion with you this semester. You will learn a great deal, and *it will require hard work*, but in the end, I think we are all in for a treat.

Meeting Times

The primary components of this course are lectures, lab periods, and weather discussions. The class meets from 10:55 AM to 12:15 PM each Monday and Thursday, with a lab period on Wednesday from 2:15 to 5:15 PM, and a brown bag weather discussion on Friday at 12:35 PM. Lectures and weather discussions are held in Room 223, but labs occur in the ICL (Room 323).

Purpose of the Course

Broadly speaking, the purpose of this course is to teach you how to think about the weather like an atmospheric scientist, or, to be more specific, like a synoptician. Synoptic meteorology is truly the course where you synthesize your knowledge from past courses in dynamics, thermodynamics, and meteorological analysis, amongst others. From this synthesis you describe (what?), diagnose (why?), interpret (how?), and theorize (so what?) about the weather. Only with this understanding in place can you *scientifically* engage in the central activity of a meteorologist, predicting the weather.

Course Description

Synoptic meteorology is the study of the weather on the regional to continental scale. This course examines important phenomena such as jet streaks, fronts, and vorticity maxima that govern the weather over thousands of square kilometers during the course of a few days. We limit ourselves to the midlatitudes. Synoptic weather systems behave very differently in the tropics, and those systems are covered in Tropical Meteorology. Smaller-scale phenomena such as thunderstorms, tornadoes, lake-effect snows, and gravity waves will be covered in the spring. Larger-scale phenomena such as ENSO, the MJO, and the NAO are the domain of Climate Dynamics, although they can modulate synoptic weather patterns. They are also key players in subseasonal forecasting, which the Special Topics course covers. Synoptic Meteorology is not simply a weather forecasting course, although you will make plenty of forecasts during the semester. Making forecasts without understanding is what computers do, so you will spend ample time learning how the weather works.

Grading Procedures

Class activities will contribute to your final grade as follows:

Exams	2 @ 9% each	18%	
Final Exam (comprehensive)		12%	Thursday, December 19, 12 PM (yay)
Projects		23%	
Class Exercises		32%	
Weather Discussions		8%	
Forecast Contest Activities		7%	

Exams will be given on October 8 and November 19, with the final exam on Thursday, December 19 at 12 PM. **If you have an issue with any of these dates, you must let me know immediately!** Although the final is comprehensive, the hour exams are not, other than to the extent that topics covered later in the course depend on previous topics.

You will complete two projects during the course. Both of these projects will entail completing a case study of a notable cyclone. The group project will count for 35% of your project grade, and will involve the study of a powerful October 2010 storm. The group project serves as a way to get your feet wet before you take on your individual project. For the individual project, you will select your storm. Although a number of past storms will be available from which you may choose, you may also select a weather event that occurs during the semester, so keep that in mind during weather discussions! More details about these projects will be made known throughout the semester.

Class exercises consist of lab assignments, occasional exercises based on lecture material, and pop quizzes. I've designed many of the lab periods to acquaint you with modern computer-based tools used by synopticians around the globe. You will find these tools very handy when preparing for your weather discussions and projects.

Weather discussions are held three times a week; they last 15–20 minutes, except on Fridays. The first two discussions take place on Monday and Thursday, at the beginning of class. Performance and participation (including your prompt attendance) are graded during these discussions. The Friday discussion is slightly different. Friday discussions occur over the lunch hour, and are open to the greater Rutgers community, including other professors and students. Participation, but not performance, will be graded at these discussions. All attendees are encouraged to bring their lunches to these discussions, which will usually last around 30 minutes, and may include an RU football forecast. It is highly unlikely the entire 80-minute time slot will be used for these discussions, unless Hurricane Lorenzo is aiming for New Jersey. Helpful tips on weather discussions may be found in textbook §§11.6.0–1.

We will participate in two <u>forecasting contests</u> during the semester:

1. The New Brunswick Forecasting Game (NBFG) has been held at Rutgers since time immemorial. In this contest, we will issue *probabilistic* forecasts each lab day for New Brunswick and a varying location of my choosing. At the end of the semester, students who have beaten Lauren or me will receive one bonus percentage point on their final grades. Students that beat both Lauren *and* me will receive three bonus percentage points. This contest will run from September 4 to December 4.
2. The WxChallenge is an intercollegiate forecasting contest administered by the University of Oklahoma. In this contest, we will issue *deterministic* forecasts four times a week (Mondays through Thursdays), with the forecast city fixed for two weeks at a time. This contest runs throughout the school year; this semester it will begin September 30 and end December 13. For this contest, you will complete forecast worksheets on each forecast day, which will help you not only with your forecast, but also with your "bust" summaries. "Bust" summaries are essays detailing what went wrong with your worst forecast for each forecast city (cf. textbook §11.6.2). These summaries are generally due the Wednesday after a city change. More details will be provided later in the semester on these assignments. As for the NBFG, one or three bonus percentage points will be awarded to students beating Lauren and/or me. In addition, if you win the junior/senior division of the contest for a particular forecast city, you will receive one bonus percentage point on your final grade.

Your final percentage grade in the course will be a number between 0 and 111. These percentages will be converted to grades using the following scale:

A	91+	C	70–75
B+	86–90	D	60–69
B	81–85	F	<60
C+	76–80		

The grade cutoffs may be lowered, but they will never be raised. That is, a 91 is guaranteed to be an A, but a 90 may end up being an A as well.

Late Assignment Policy

I expect homework to be submitted on the given due date. However, I understand that unforeseen circumstances (e.g., illness, family emergency, computer crash, etc.) may hinder your ability to meet the due date. Thus, **you have two "late days" that you may use over the course of the semester.** You may turn in one assignment two days late, or two assignments one day late each, without being penalized. (Going from Friday to Monday counts as one day instead of three.)

<u>Upon using your two late days, a late assignment will incur a 10-percentage-point drop for each day it is late, no matter what reason you have for being late.</u>

Your Feedback

I have taught this course many times. Most things will go right, but unfortunately, some things may go wrong. I welcome any feedback (positive or negative) you have about this course. You can provide this feedback in two ways:

- E-mail me, or talk to me directly. Not anonymous, but very effective.
- Slip an anonymous note in my mailbox.

Success

I want everyone to succeed in this course. If everyone comes out of the course with the ability to interpret weather maps in an effective and meaningful way in front of an audience of experts, I will be overjoyed. If everyone is able to give a reasonable explanation about why the weather is doing what it doing, I will be ecstatic. I will work with you to achieve these goals, but you must have grit[1]!

Two things in particular to be aware of are:

1. I consider the grades "A" and "B" to indicate above average work. Simply completing an assignment in a perfunctory way is "average". Even if you have the "right" answer, if you do not include depth, detail, and care in your response, you are only doing average work. Sloppy, illegible responses riddled with spelling errors will be given C's no matter how accurate the content may be.
2. Never shy away from asking questions. Make sure you understand what is going on. Don't be afraid to be a nerd, geek, or weather weenie!

Textbook Tidbits

Lovers of winter weather need not despair; the material in chapters 8 and 9 will be addressed next semester. Historians may enjoy §§5.3.8–5.4.

Pencils

We will use colored pencils more extensively next semester, but it is a good idea to have some handy this fall just in case.

Absence Policy

I don't keep track of attendance for lecture and lab periods. However, I do keep track of your attendance during Friday weather discussions and any missed forecasts you may have. At the end of the semester, I will add up the number of days you did not attend Friday's weather discussion, the number of NBFG forecasts you did not make, and the number of WxChallenge forecasts you did not make. I will subtract four, and convert any remaining absences into percentage point deductions off your final grade. **You can think of this as four free absences. Use them wisely!** I will not accept excuses for additional absences. EXAMPLE: Sophia has a 91% for the course, but misses one Friday discussion, three NBFG forecasts, and two WxChallenge forecasts, for a total of six. Subtracting four gives two left over, so Sophia's final grade will be reduced by 2 percentage points to 89%.

Please use the Rutgers absence-reporting website at https://sims.rutgers.edu/ssra/ to automatically generate emails to each of your professors.

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[1] Duckworth et al. (2007) define "grit" as *perseverance and passion for long-term goals*.

Schedule

Date		*Topic*		*Reading*
September	*4*	Lab № 1: Met Analysis review; GEMPAK I – Intro; MetPy		12
	5	Introduction; Dynamics review		1.0–2
	9	Lecture I: More dynamics review		1.3–5
	11	Lab № 2: HTML		
	12	Lecture II: Energetics		2.7, 5.0–1
	16	Lecture III: Importance of ageostrophy		**M**6.1.0
	18	Lab № 3: GEMPAK II – Basic programs		
	19	Lecture IV: Manipulations of the ageostrophic wind		**M**6.1.1–2
	23	Lecture V: Sutcliffe development theorem		**M**6.2
	25	Lab № 4: GEMPAK III – Scripting and four-panel plots		
	26	Lecture VI: Traditional QG omega equation		2.0–3a
	30	Lecture VII: $\vec{Q}$ vectors		2.3b
October	*2*	Lab № 5: Automated plot generation		
	3	Lecture VIII: Le Chatelier's Principle; $\vec{Q}$ part 2		**M**6.4.2
	7	**First Exam**		
	9	Lab № 6: An idealized QG model		
	10	Lecture IX: Weather forecasting		11.1–5
	14	Lecture X: Wx forecasting competence		11.6.3
	16	Lab № 7: Diagnosis of vertical motion	*City 1 due*	
	17	Lecture XI: Isentropic analysis		3
	21	Lecture XII: Fronts		6.0–1
	23	Work on Group Project		
	24	Lecture XIII: Frontogenesis		6.2
	28	Lecture XIV: Frontogenesis and vertical motion		6.3
	30	Work on Group Project	*City 2 due*	
	31	Lecture XV: Types of fronts		6.4.0–2
November	4	**Group Project Presentations**		
	6	Lab № 8: Analyzing wx conditions at a pt		
	7	Lecture XVI: Special fronts		6.4.4–6.5
	11	Lecture XVII: Friction		1.6
	13	Lab № 9: Isentropic analysis; Intro to Ind. Project	*City 3 due*	
	14	Lecture XVIII: Cyclogenesis		2.4, 2.6, 5.2–5.3.4
	18	**Second Exam**		
	20	Work on Individual Project		
	21	Lecture XIX: Explosive cyclogenesis		2.5, 5.3.7
	22	Last Weather Discussion		
	25	Lecture XX: Cyclone life cycles		5.3.5, 6.4.3
	26	Lecture XXI: Potential vorticity (NOTE: Thur. schedule)		4.0–2
	27	**No Discussion** (NOTE: Fri. schedule)		
December	2	Lecture XXII: More potential vorticity	*City 4 due*	4.3–4, 5.3.6
	4	Work on Individual Project		
	5	Lecture XXIII: NWP		10
	6	**Special Lab Period (in 323)**		
	9	Lecture XXIV: Baroclinic instability		7
	11	**Individual Project Presentations**	*City 5 due*	
	19	**Final Exam** (12–3 PM)		