

ATM 651: Introduction to Atmospheric Dynamics. Fall 2022

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Class MW 10:30-11:45.

I am available afterward, on class-day afternoons, and by arrangement.

Brief Description for UM Bulletin (<http://bulletin.miami.edu/courses-az/atm/>): "This course surveys the dynamics of atmospheric flow and weather phenomena, aiming at the first-year graduate level."

Course Description: This course surveys atmospheric flow and the physically-based description and depiction of weather phenomena. It is intended to serve as useful preparation for incoming PhD students whose research will be dynamical, while also serving as an accessible overview for students in other subdisciplines. For these reasons, it stresses phenomena and *essentials* (the most useful approximations), with enough fluency to appreciate full-complexity *fundamentals* (in seminars or journals).

Prerequisites:

College physics and math up to vector calculus and exposure to differential equations, or permission of instructor.

The meaning of “dynamics” in this course:

In some atmospheric science curricula, “dynamics” refers narrowly to the calculus of flow and transport of air on the sphere, often neglecting the complications of water and its phase changes. There, an Introduction course (first of a sequence) would be quite mathematical and preparatory. Of course, we must encounter such material, and do some tractable algebra and calculus problems about it. But the word “dynamics” is also used for the study of complex interactive behaviors in any system comprised of multiple components or processes. This course aspires to instill this sense of the word, which clearly is a vast topic for lifelong learning!

Texts (optional):

Atmospheric Science: An Introductory Survey, Wallace & Hobbs, second edition.

An Introduction to Dynamical Meteorology, by Holton (any edition has all concepts).

Essentials of Atm. and Oceanic Dynamics, by Vallis (new mini-version of great tome).

Atmospheric Dynamics, by M. Mak, UM has [unlimited online access](#).

Required tools:

Writing implements, computer. Computer must be Zoom-enabled, with office tools for presentations and documents. A 3-button mouse with scroll wheel for zooming (these cost less than \$20) is more intuitive and precise than trackpad gestures for our 3D data visualization exercises with the free IDV software.

Learning Objectives (course outcomes):

- 1) Students will be fluent in the *physical/mathematical framing* of discourse about atmospheric flow and models thereof, major *dynamical phenomena* of weather and climate science, *data-based quantitative views* such as budgets of those phenomena, and the *words in common use for all of that*.
- 2) Students will be able to access, manipulate, display, and speak and write in scientifically meaningful ways about atmospheric data in light of the above.
- 3) Students will be able to access, parse, and accurately paraphrase or summarize the scientific literature (including accurate expression of the limits both of their own understanding, and of fundamental scientific knowability).

Course structure and philosophy:

The progression follows 3 sequential segments according to the Classical education model of the *trivium*: Grammar, Logic, Rhetoric.

Grammar refers to the set of words and symbols and their meanings (elemental concepts) that underpin the subject.

Logic refers to the way sensible, meaningful combinations of these elemental concepts are linked into higher-level concepts and descriptions of complex phenomena.

Rhetoric refers to the student's own sense-making activity, utilizing both the grammar and logic of the subject. It is evaluated from their presentation of sensible discussions, culminating in the presentation of a course project.

Course Policies

Class Participation:

Interactive participation is crucial for the Learning Objectives above, so all students are expected to participate during class hours. Absences should be communicated, hopefully in advance. Your good humor around Socratic participation (when called upon by random sampling) is appreciated! I will try to ensure success for everyone, and this really helps me stay connected to student learning, to better serve you.

Honor Code:

Collaboration and peer learning are actively encouraged, but students are expected to follow the University of Miami's honor code ([https://www.grad.miami.edu/assets/pdf/graduate student honor code 2016 2017.pdf](https://www.grad.miami.edu/assets/pdf/graduate_student_honor_code_2016_2017.pdf)).

Grading:

Graduate school is different from undergrad! Focus on the material, not the points.

1. 40% Attendance, class participation, homework assignments
2. 30% Exams (with opportunity to make up any shortcomings)
3. 30% Final presentation (where extra effort can earn extra credit if needed)

Week by week sketch (subject to change)

Detailed calendar at

https://github.com/ATMOcanes/ATM651/blob/master/Calendar_2022.md

Part	Week	Monday	Wednesday
G R A M M A R	1	Welcome, introductions.	Math and physics review
	2	Stuff in Space accounting	Treansport accounting
	3	Kinematics and description	Conserved quantities
	4	Thermodynamics	Thermo diagrams
	5	Dynamical balances	Vorticity equation(s)
	6	Potential vorticity	Introduction to models
	7	MERRA2 budget exercise	Midterm vocabulary exam
L O G I C	8	Interacting vortices	Vortices and predictability
	9	Rossby waves	Downstream development
	10	Turbulence, friction, fluxes	Vertical fluxes and climate balances
	11	Deeper convection, clouds and storms	Applied deep convection reasoning
	12	Strategic decompositions	Logic of the QG triumph, omega eq.
R H E T O R I C	13	Midlatitude storms seen from various angles	Wallace and Hobbs Ch8 case study
	14	Toward <i>general circulation</i> of the atmosphere	Climate dynamics reasoning
	15	Project presentations	Project presentations

Appendix: Required Course Syllabi Language

The following text is required by the Provost to be part of each syllabus. Underlined phrases are specific to ATM 651.

Camera While Remote: *Students who are attending a class session synchronously are required to have their video enabled. Exceptions are allowed for good cause.*

Recordings: *Students are expressly prohibited from recording any part of this course. Meetings of this course might be recorded by the University. Any recordings will be available to students registered for this class as they are intended to supplement the classroom experience. Students are expected to follow appropriate University policies and maintain the security of passwords used to access recorded lectures. Recordings may not be reproduced, shared with those not in the class, or uploaded to other online*

environments. If the instructor or a University of Miami office plans any other uses for the recordings, beyond this class, students identifiable in the recordings will be notified to request consent prior to such use.

Class Attendance Policy: *You are expected to participate with your video enabled during non-classroom attendances. If at some point in the semester you cannot attend class sessions due to illness, injury, or other approved absence, contact the instructor.*

Synchronous Course Language: *If you are approved to take this course under the Remote Learning Option, attendance in the virtual class is required as scheduled unless this creates undue hardship due to differences in your residential time-zone and that of Miami Florida. If you are a Remote Learning Option student, you may not under any circumstances physically attend the class on campus. If you cannot attend the virtual class due to illness or other reason, you must contact the instructor. Unexcused absences may affect your grade or lead to failing the course. In this class, clear communication of absences is sufficient to not harm final grades, as long as a student's good-faith effort in the course is maintained.*

Asynchronous Course Language: *If you are approved to take this course under the Remote Learning Option, you must keep up with the virtual class as scheduled. You may not under any circumstances physically attend the class on campus. If you cannot keep up with the virtual class due to illness or other reason, contact the instructor. Failure to keep up with the virtual class as scheduled may affect your grade.*

Daily symptom checker: *Students are required to use the Daily Symptom Checker and be cleared to attend class each day. Students may be asked to show the green “Good to Go” notice. You may be required to produce your notice at any time while on campus. Students who fail to comply or to produce their “Good to Go” notice will be asked to leave the classroom.*

Intellectual property: *“The instructor of each class is the copyright owner of the courseware; individual recordings of the materials on Blackboard and/or of the virtual sessions are not allowed; and that such materials cannot be shared outside the physical or virtual classroom environment.”*

Well-Being Resources and Support: *As you complete your coursework, consider how you can maintain your health and well-being as a top priority. To help you become familiar with the many programs and services available on campus, review the information collected on the Division of Student Affairs Student Well-Being and Resiliency website available at miami.edu/well-being. Please reach out to me or any of the resources listed on that site if you need assistance or support throughout the semester.*