# *ATM 651: Introduction to Atmospheric Dynamics.* Fall 2020

Instructor: Brian Mapes, mapes@miami.edu, 786-218-3353 (text/cel); MW 10:30-11:45. Abundant online office hours will be set by student preference.

**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 the dynamics of atmospheric flow and the physically-grounded description and depiction of weather phenomena. It is intended to serve as core 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 the essentials of our physical discourses about them (emphasizing useful approximations), with enough exposure to the underlying full-complexity fundamentals to facilitate more advanced study, and to at least appreciate dynamical research seminars in the future.

**Prerequisites:**
College physics and math (up to multivariate calculus), or permission of instructor.

**Texts (optional):**
*Atmospheric Science: An Introductory Survey*, Wallace & Hobbs. Proofs, Annotated
*An Introduction to Dynamical Meteorology*, by Holton (any edition has all concepts).
*Essentials of Atm. and Oceanic Dynamics*, by Vallis (new mini-version of big tome).
*Atmospheric Dynamics*, by M. Mak, UM has unlimited online access.

**Required tools:**
Writing implements, computer. Computer should be Zoom-enabled, with Office tools for presentations and documents. Personal audio devices are recommended (I use Bluetooth headphones costing less than $20), especially if you will attend class within earshot of others. A 3-button mouse with scroll wheel for zooming (these too cost less than $20) is more intuitive and precise than trackpad gestures, for our 3D data visualization exercises with the free IDV software you are recommended to install.

**Learning Objectives (course outcomes):**

1) Students will be familiar with the *physical/mathematical framing* of discourse about atmospheric flow, the main *dynamical phenomena* of weather and climate science, *data-based quantitative views* of those phenomena in the terms of that framing (budgets), 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 course is divided in 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 in their presentation of sensible discussions (orally or in written labs), culminating in the presentation of a course project.

Mondays will typically begin with a short review/refresher, and then focus on phenomena (using real data) to motivate the development of our discourse.

Wednesdays will focus more on formal treatments, mathematical and verbal/logical. For 2020's student profile (heavy on Risk and Forecasting MPS students), I will divide this into (i) deterministic physical mechanisms (traditional "dynamics"), and (ii) statistical descriptions or treatments using random variables and probability, emphasizing limits to predictability because of long causal chains and multi-agent situations, and strategies for dealing with that.

**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, so that essential and new material can be planned around them and/or delivered individually as needed.

In 2020, because some of the course's students are remote, every class session will be (among other things) a Zoom session at *https://miami.zoom.us/j/98525218040*. Participation will take the form of audible-to-all vocalizations, visible-to-all gestures or annotations on screen-based materials (images and whiteboards), screen-sharing of student data visualizations and other meteorological materials and coursework, and offering instructor feedback on pace and clarity (made more difficult by masks), such as through Poll Responses.

These activities will frequently require students to be participants in the Zoom session, even if it is projected at the front of their physical room location. If several class participants are in the same room, headphones/earphones are needed to minimize confusion from slight audio delays, echoes, and feedback. Skillful use of Muting is also important for participants to learn. In order to skillfully host these

complex Zoom sessions, the instructor will typically be seated in headphones, whiteboarding and annotating imagery with an iPad stylus rather than trying to write on a physical board in front of a camera. (These annotated files will become class notes available to all). To minimize the multimedia confusions mentioned above, the instructor may be in a quiet private room rather than the partly-occupied classroom (which students are welcome to use according to UM campus safety guidelines, but not required to), especially in the initial weeks of the course. As the technology is learned, and as the risks and challenges and benefits of masked and physically-distanced conversations become clearer, our practices may evolve. Please note that masks may not be removed for conversations on campus, even outdoors.

**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).

**Course Structure:**

1. Socratic participation in class will be elicited by random draw, mostly on matters of pure logic and thought to keep everyone's brains engaged as we reason aloud, but occasionally on facts from reading or prior teaching. Good sportsmanship and a supportive atmosphere are appreciated.
2. Homeworks will be assigned to spur students to engage with equations and words and concepts. Sometimes these will be evaluated by students reporting their answers in class as above, rather than as written turn-ins.
3. An exam in the middle or late-middle of the term will spur review and test retention of the *Grammar* and *Logic* (vocabulary, verbal and mathematical) blocs of the course.
4. A final project will test student mastery of *Rhetoric* (long-form sense-making) about a weather phenomenon, a facet of theoretical understanding, a critical summary of >3 interrelated literature papers, or other topic of student interest. We will choose topics a few weeks before the end of term, and student consultation with the instructor is encouraged at any time.

**Grading:**
Focus on the material, not the points! Graduate school is different from undergrad. Grades will never again be examined in your career (except conceivably by additional graduate schools). Instead, a portfolio of work (displaying mastery of sense-making or Rhetoric) will pave your way, and letters of recommendation about the quality of your efforts and products will carry key weight. Program failure is a B average, so persistent good-faith effort almost certainly earns you at least that. That said, we must still use evaluation rubrics, and the course formula is:

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

## Week by week plan (subject to change and Teachable Moments)

| Part | Dates | Mon: Phenomena, curiosity | Wed: Frameworks & treatments |
|---|---|---|---|
| GRAMMAR | Aug 17-19 | Welcome, introductions. Physical units and quantities. W&H Chapter 1 | Math bookkeeping tools. Coordinates and functions. Sets. Vectors. Graph theory, networks, causality. |
| | 24-26 | Current weather. Answer W&H Ch1 letter questions. | Vector fields. Sums, differences, dot and cross product. Kinematics. |
| | 31-02 Sep | Transport and motion. Tracers, trajectories vs. streamlines. | Budgets in spatial boxes. Flux and its convergence. Mass and specific ___. Advection. Diffusion. |
| | 7-9 | **LABOR DAY** | Introduce stochasticism. Dynamical systems and chaos. Random variables. |
| | 14-16 | Vertical structure, balloons, dry stability and waves. | Hydrostatic balance. Potential temperature, entropy, static energy. |
| | 21-23 | Steady (ceaseless, balanced) winds. | Horizontal F=ma, Coriolis force, the closed primitive equations (PE). Geostrophy and cousins. |
| | 28-30 | Curved winds, motions of ridges and troughs | Vorticity. Questions from movie. Dynamical tracer concept generalized. PV sources and sinks. |
| LOGIC | 5-7 Oct | Interacting vortices | Vorticity interaction principles, predictability, ensembles |
| | 12-14 | Downstream development | Rossby wave dispersion relation. Rossby wave activity, sources, stats. |
| | 19-21 | PBL phenomena. Surface friction and fluxes. Cloud-topped PBL types. | Mixed layers and slight deviations (quasi-neutrality of fast instability). Moist conserved variables. |
| | 26-28 | Deeper convection and clouds and storms | Lifted parcel processes. Radiative heating/cooling. T budgets of moist weather in MERRA2. |
| | 2-4 Nov | Review for exam | Exam |
| RHETORIC | 9-11 | Midlatitude cyclones and fronts | Decomposing flows (primary/secondary, geo/ageo, rotational/divergent). |
| | 16-18 | Ageostrophic winds and cloudy weather systems | Quasi-balance concepts, glimpse of QG omega equation. |
| | Nov 23 | (Labor day makeup) | (xxx Classes Ended Monday xxx) |
| | 30-4 Dec | Finals (presentations) Online, by arrangement | |

## 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 in fall 2020.

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

**Face Coverings:** *Face coverings are mandatory at all times (with the exception of when drinking water) while in on-campus class sessions. Failure to follow this requirement is grounds for disciplinary action and may lead to removal from the classroom and/or the course.*

**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 days. 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.*

**Assigned student seating**: *The seat you use on the first day of class must be from among those identified as meeting the physical distance requirements for COVID-19; this seat will be your assigned seat for the remainder of the semester. This will enable the most effective COVID-19 contact tracing, should it be required.*

**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."*