ATM 419/563: Applications of Numerical Weather Prediction
Fall Semester 2025 (3 credits), Class Number 8316/8317

Lecture: Tuesday & Thursday 9:00-10:20 in ETEC 480
https://www.atmos.albany.edu/facstaff/torn/atm419/

Instructor:

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Course Description:

This is a hands-on course in numerical weather prediction (NWP), focusing on mesoscale phenomena and dynamics. We will emphasize simulation of mesoscale weather systems (including thunderstorms, windstorms, and sea/land breezes), model verification, sensitivity (to initialization, resolution and other numerical aspects, and model physics), and how model physical parameterizations work. Our principal tool will be the Weather Research and Forecasting (WRF) model although other models will be explored.

Course Objective:

The overarching goal is to understand how NWP models like WRF work, what their strengths and limitations are, what they can and cannot do, what assumptions they entail and where and how they arose, and how and why they may fail. This will be accomplished through lectures on NWP topics and experimentation. Each student is responsible for creating a final project that utilizes their knowledge and understanding of this class and its direct and indirect prerequisites.

Prerequisites:

ATM 317, 321

Required Text:

None. Reading materials and lecture notes will be posted on the class website.

Suggested Reading:

Parameterization Schemes by D. J. Stensrud
Mesoscale Meteorological Modeling by R. A. Pielke Sr.
Mesoscale Meteorology in Midlatitudes by P. Markowski and Y. Richardson
Cloud Dynamics by R. A. Houze

Course Requirements:

Experiments and Activities: 60%
Final Project: 30%
Class Participation: 10%
Grading: A-E. Final Grades are determined based on a historical curve of all students who have taken the course.
Late Homework and off-time exams are only allowed for University-recognized reasons (https://www.albany.edu/health_center/medicalexcuse.shtml). All assignments lose 25% of their value per day it is late (i.e., an assignment turned in two days late cannot get better than a 50%).

Course Format:

Students are expected to attend each lecture. In addition, lectures will be recorded when possible and posted to Brightspace, so students can review lectures afterward. **Watching lectures online is not a substitute for attending lecture.** Absences are unavoidable; therefore, in those situations, students are expected to view the lecture recording (Brightspace keeps track of who views each lecture).

Grading Philosophy:

A key component of the course grade is the final project. An "A" level project will have identified a viable topic, constructed thoughtful hypotheses and designed a reasonable experiment to test them, analyzed the results thoroughly and with care, crafted figures that are useful, clear, and attractive, and have produced a presentation that is well-organized, coherent, and displays what you did, how you did it, and what you learned. "B" level is high quality work that shows thoughtfulness and effort but reaches the "A" standards less fully or consistently.

Course Communication:

The primary communication method for the course will be through messages through Brightspace. These messages will be archived on the course page and will automatically send to your UAlbany email address. All lecture materials and assignments will be placed on both the course web page and the course Brightspace page. Students may communicate with each other through the Brightspace discussion system. I will answer all emails within 24 h of receipt, except on weekends.

Accommodating Disabilities Policy:

Reasonable accommodations will be provided for students with documented physical, sensory, systemic, medical, cognitive, learning and/or mental health (psychiatric) disabilities. If you believe you have a disability requiring accommodation in this class, please notify Disability Access & Inclusion Student Services (DAISS) by contacting them at daiss@albany.edu or 518-442-5501. Upon verification and after the registration process is complete, DAISS will provide you with a letter that informs the course instructor that you are a student with a disability registered with DAISS and list the recommended reasonable accommodations.

Religious Observance:

Absence due to religious observance, New York State Education Law (Section 224-a): Campuses are required to excuse, without penalty, individual students absent because of religious beliefs, and to provide equivalent opportunities for make-up examinations, study, or work requirements missed because of such absences. Faculty should work directly with students to accommodate religious observances. Students should notify the instructor of record in a timely manner.

Academic Integrity:

Although students can work together, all homework assignments must be completed independently. Homework assignments that are substantially similar to other students will be given a zero for that assignment. Copying from other students on quizzes and exams may result in a zero for that work and referral for disciplinary action under the University's policy on academic integrity (https://www.albany.edu/undergraduate_bulletin/regulations.html). Every student has the responsibility to become familiar with the standards of academic integrity at the University. Claims of ignorance, unintentional error, or personal or academic pressures cannot be excuses for violation of academic integrity.

Topic list (subject to revision/reordering):

- Overview and history of numerical weather prediction
- Real-data WRF workflow. Demonstration.
- Idealized WRF modeling. Experiments: supercell thunderstorm.
- Planetary boundary layer (PBL) schemes. Example: PBL diurnal cycle with 1D WRF.
- Cloud microphysics schemes. Example: squall lines. Experiment: idealized 2D squall line.
- Modeling fundamentals, sources of error, and troubleshooting.
- Cumulus parameterizations. Experiment: a precipitating real-data case.
- Nonlinear instability and diffusion. Experiment: provoking and controlling instability.
- Model forecast verification. Experiment: verification against surface observations.
- Stochastic perturbations. Experiment: ensemble sensitivity
- MPAS (Model for Prediction Across Scales). Demonstration.
- Machine learning weather prediction model. Demonstration.