ATM 419/563 - Applications of Numerical Weather Prediction
Fall 2024 ***Version of 24 September 2024; check for updates***

419: Class # 9289. 563: Class # 9290

Instructor: Prof. Robert Fovell
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Personal Zoom: `https://albany.zoom.us/my/rfovell` (by prior arrangement)

Office: 404 ETEC
Office hours: When I'm in my office, and by appointment.
Course page: `http://www.atmos.albany.edu/facstaff/rfovell/NWP/`
Credit: 3 hours
Class meetings: MW 1:10-2:30 PM in ETEC 450 (Map Room),
TA: Liam Sheji, lsheji@albany.edu. Office hours 2-4 Tu/Th in Collaboratorium (office is ETEC 345).

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

Useful references: Stensrud, *Parameterization Schemes*; Pielke, *Mesoscale Meteorological Modeling*; Markowski and Richardson, *Mesoscale Meteorology in Midlatitudes*; Houze, *Cloud Dynamics*.

Class 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.

Learning outcomes: 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.

Grading (A-E): Experiments and activities (60%), Final project (30%), Class participation (10%). Expected final project due date: Monday, December 16, 2024, 5 PM EST. Periodic progress reports required.

Topic list: Subject to revision/reordering.

- 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 and nudging. Experiment: ensemble sensitivity.
- MPAS (Model for Prediction Across Scales). Demonstration.
- UFS (Unified Forecast System). Demonstration.
- Machine learning weather prediction model. Demonstration.

Class Zoom: You have been emailed the link to the class Zoom sessions. You can also find these links, and archived recordings, on the Brightspace page for this class. *While we will attempt to provide access to live lectures and recordings via Zoom, technical difficulties may occur and Zoom malfunction or other problems will not serve as an acceptable excuse for late or missed classwork.* Attendance in-person is very, very highly encouraged.

Spring Break: No classes on Monday, September 2 (Labor Day); Monday, October 14 (Fall Break); Wednesday, November 27 (Thanksgiving).

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.

Absences: Class attendance is expected. Unavoidable, anticipated absences should be discussed with the instructor in advance, and arrangements should be made to make up missing work. For information on medically necessary absences, refer to `http://www.albany.edu/health_center/medicalexcuse.shtml`.

Academic integrity: Students are responsible for being familiar, and complying, with the University's academic integrity standards. Refer to `http://www.albany.edu/undergraduate_bulletin/regulations.html` for more information.

COVID-19 information: At the University at Albany, supporting the health and safety of all members of our campus community is a top priority. During the COVID-19 pandemic, we are following federal, state, and local public health guidelines, and these guidelines apply to all campus community members across all University spaces. To ensure that each of us has a healthy and safe learning experience within courses that involve in-person contact, all students, faculty members, staff, and visitors are required to adhere to the expectations outlined on the University's COVID-19 website: `https://www.albany.edu/covid-19/health-safety`.

Psychological health: If your distress is interfering with your relationships, academic, work, or daily life, confidential support is available to you. Contact Counseling and Psychological Services (CAPS) at 518-442-5800 or consultation@albany.edu to schedule an appointment with a psychologist. Virtual counseling services are available. The CAPS website (`www.albany.edu/caps/` also contains self-help resources and other valuable information.

Shared resource information: This is a shared resource class. Undergraduate and graduate students will complete the same experiments, but the expectations regarding graduate student work will be higher, especially for the final project.