Atmospheric Predictability (ATM 652)
Fall Semester 2020 (3 credits), Class Number 9340

Lecture: Tuesday & Thursday 9:00-10:20 in BB 141
http://www.atmos.albany.edu/facstaff/torn/atm652

Instructor:

Professor Ryan Torn
Office: ES 229
Phone: 442.4560
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Office hours: Wednesday 1:00-2:30 (in person: 1:00-2:00, Zoom: 1:30-2:30), and by appointment

Course Objective:

This course will describe methods of evaluating the ability of a model to predict the evolution of the atmosphere, which is an example of a chaotic system. In addition, the course will cover techniques used to address the challenges associated with these systems, including ensemble prediction systems, improving a model's initial conditions through data assimilation and methods of identifying sensitive aspects of the model.

Course Format:

The course will primarily consist of lectures and student-lead discussions of assigned papers related to course topics. In order to promote a safe learning environment for everyone, the lectures will be simulcast on Zoom, as well as being recorded, and posted to Blackboard. Students may choose to attend some or all lectures virtually, rather than in-person. Virtual and in-person office hours (hosted via Zoom) will be available for everyone in the course. Paper discussions, which will take place every other week, will occur via Zoom (i.e., there will not be any in-person instruction during those class periods). If the pandemic forces instruction to be entirely remote, all lectures will be posted to Blackboard ahead of the date of the scheduled lecture, and the assigned class period will be used as a discussion period.

Prerequisites:

ATM 562 recommended, familiarity with linear algebra, differential equations, and computer programming.

Course Communication:

The primary communication method for the course will be through messages through Blackboard. 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 Blackboard page. Students may communicate with each other through the Blackboard message system. I will answer all emails within 24 h of receipt, except on weekends.

Course Requirements:

Paper Discussion: 10%

Guided projects 30% each
Independent Project: 30%
Grading: A-E

Paper Discussions:

During every fourth lecture, registered students will lead a 40-minute discussion of an assigned paper (two papers will be discussed per lecture). The discussion leader will be expected to provide an overview of the paper, significant results and conclusions that can be drawn from the work, and critiques and limitations of the research. Students will be graded based on the completeness of the discussion. Students who are registered for the class are expected to participate in the discussion (i.e., the paper discussions are not lectures by the leader; they are meant to be interactive discussions).

Course Projects:

Grades will primarily be based on two guided projects and an independent project that will be assigned throughout the semester. The guided projects will provide step-by-step instructions that are meant to provide hands-on experience using the concepts that will be presented during the lecture. The guided projects will require you to manipulate python code. For the independent project, you will carry out a small research project that is an offshoot of your current thesis topic, which also overlaps with some aspect of the course. Students will be expected to provide a written and oral report on their results of the independent project at the end of the course. Additional details will be provided when these projects are assigned.

Recommended Text:

Atmospheric Modeling, Data Assimilation and Predictability, by E. Kalnay

Course Outline:

1. Introduction (1 week)
    - Overview of the course and topics
    - Review of linear algebra and probability (handout)
2. Fundamentals of Chaotic Systems (3 weeks)
    - Non-linear systems
    - Flow stability
    - Lyapunov vectors and exponents
    - Finite time stability (singular vectors)
3. Data Assimilation (3 weeks)
    - Early Schemes: Successive correction and nudging
    - Baysian Estimates

- Multivarate methods: Variational and OI
- Least squares: Kalman Filter and ensemble Kalman Filter
- Hybrid schemes
- Treatment of observations

4. Ensemble Forecasting (3 weeks)
    - Liouville Equation
    - Monte Carlo methods
    - Ensemble Prediction: initial condition techniques
    - Representation of model error in ensembles
    - Probabilistic Verification
5. Forecast Sensitivity Analysis (3 weeks)
    - Adjoint Methods
    - Ensemble-based methods
    - Observation impact and targeting
    - Longer-range predictability

Attendance Policy:

Students are expected to attend each lecture, either in person or through Zoom. Absences are unavoidable; therefore, in those situations, students are expected to view the lecture online (Blackboard keeps track of who views each lecture). The instructor reserves the right to assign extra readings for students who have an excessive number of unexcused absences from either in-person or remote lectures.

Accommodating Disabilities Policy:

Reasonable accommodations will be provided for students with documented physical, sensory, systemic, cognitive, learning and/or psychiatric disabilities. If you believe you have a disability/disabilities requiring accommodation in this class, please notify the Disability Resource Center (CC 130, 442-5501, DRC@albany.edu). Upon verification and after the registration process is complete, the DRC will provide you with a letter that informs the course instructor that you are a student with a disability registered with the DRC and list the recommended reasonable accommodations.

Religious Observance:

Students must notify the instructor of any lectures and assignment due dates that conflict with recognized religious observances (https://www.albany.edu/registrar/registrar_assets/Religious_Calendar.pdf) well in advance. The instructor will work with the student to provide an alternative arrangement.

Academic Integrity:

Although students can work together, all projects must be completed independently. Assigned work that is substantially similar to other students will be given a zero for that assignment and referred for disciplinary action under the University's policy on academic integrity (http://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.