METR 6803

Advanced topics in data assimilation: Ensemble Kalman filter techniques

Instructor: Dr. Xuguang Wang (xuguang.wang@ou.edu)

Office hours: Wednesday 10:00am – 12:00am, NWC 5341

When and where: Tuesday and Thursday 10:00-11:15am, NWC 5720

Prerequisites: MATH 3113 (ODE), 4163 (PDE), and 3333 (linear algebra); ENGR 3723 (numerical methods) or equivalent or permission of instructor. Programming experience is useful. Not limited to Meteorology students.

Reference texts:
- Selected journal articles.
- Course notes.

Grading policy:
- In-class exams (35%): Mid-term exam (15%), Final exam (20%)
- 5 Homework assignments (45%), due two weeks after assigned
- In-class presentation/short paper (20%)

Objectives:
The course is designed to introduce students to the world of ensemble Kalman filter data assimilation techniques (EnKF), an advanced data assimilation method that has been recently explored extensively in Meteorology and has started to be explored in other fields such as Ecology and Hydrology etc. The students will learn the most popular EnKF techniques through lectures and hands-on project assignments, and learn the EnKF implementation status in different fields through in-class presentations and discussions. The students will not only learn various EnKF techniques but also develop their skills in scientific thinking and synthesis, written and oral communication and programming throughout the course.

Tentative topics:
- Basic concepts of data assimilation
- Mathematical preparation: matrix algebra
- Least square and Bayesian contexts

Homework Assignment 1
- Brief review of statistical interpolation, 3DVAR and 4DVAR
- Classic Kalman filter and Extended Kalman filter
- Basic concepts of Ensemble Kalman filter
  - Homework Assignment 2
- Ensemble Kalman filter with perturbed observations
  - In-class mid-term exam
- Ensemble square root filter
- Local Ensemble Transform Kalman filter
  - Homework Assignment 3
- Common problems and treatments in ensemble Kalman filters
  - Homework Assignments 4 and 5
- Ensemble smoother and other special topics
- Applications of ensemble Kalman filters
  - Student power point presentations of assigned papers on EnKF applications on atmosphere, land surface, oceanography, hydrology, ecology, etc.
  - Final exam

Notes:

1. Homework assignments 3-5 require running an ensemble Kalman filter with a simple model (provided by the instructor) and analyzing the results.
2. In-class presentation includes reviewing the paper (critically), present the paper, lead discussion, and write a summary.

The University of Oklahoma is committed to providing reasonable accommodation for all students with disabilities. Students with disabilities who require accommodations in this course are requested to speak with the professor as early in the semester as possible. Students with disabilities must be registered with the Office of Disability Services prior to receiving accommodations in this course. The Office of Disability Services is located in Goddard Health Center, Suite 166, phone 405/325-3852 or fax only 405/325-4173.

All students are expected to be familiar with and abide by the OU Academic Misconduct Code. Information on this code and other student policies is located at [http://www.ou.edu/studentcode](http://www.ou.edu/studentcode).