FALL 2012

SYLLABUS

METR 5303 - Objective Analysis and Data Assimilation

Instructors: Dr. Fred Carr (fcarr@ou.edu) and Dr. Ming Xue (mxue@ou.edu)
Office Hours: Carr - MWF, 9:00 – 11:00 am (or by appointment)
Xue - TF, 11:00am – 12:30pm (or by appointment)

When and Where: TR 1:00-2:15 pm; Room NWC 5930

Prerequisites: METR 5113 or concurrent enrollment; knowledge of a programming language (e.g., Fortran, C, C++, IDL, Matlab, Java, Python, etc.). Or permission of instructor.

Texts: E. Kalnay, 2002, *Atmospheric Modeling, Data Assimilation and Predictability*, Cambridge University Press, 341pp.

R. Daley, 1995, *Atmospheric Data Analysis*, Cambridge University Press, 472pp (not required to purchase; on reserve in the NWC library)

Also, Selected material from journals and review articles. A web site has been set up for the course at http://twister.ou.edu/OBAN2012/.

Tests: Exam 1: Tuesday, October 2
Exam 2: Thursday, November 8
Final Exam: Monday, December 10, 1:30 – 3:30pm.

Grading Policy:

In-class exams (2):	15% each
Computer assignments (5-6)	40%
Final Exam	30%

Objectives: This course is designed to improve our understanding of what is (or should be) done to "raw" observations before they are used in diagnostic studies of the atmosphere or in numerical weather prediction. With the avalanche of data from new observing systems (Radars, numerous satellites, ASOS and mesonets, aircraft, etc.), it is important to understand these data and the techniques used to optimize their information content. Of particular importance are the procedures used to analyze data onto regularly-spaced grids for the purpose of diagnostic computations or for initial conditions for numerical models. Numerous objective analysis techniques will be presented. The concepts of balancing the data and data assimilation will be explained. New developments in the use of the model equations to achieve the balance and to assimilate indirect observations (four-dimensional data assimilation, adjoint techniques, ensemble Kalman filtering, etc.) will be presented. The data assimilation methods will also be discussed in the context of optimal estimation theory. Although much of the literature on these subjects concerns large-scale NWP, we will emphasize techniques with promise for use in meso- and cloud-scale models.

Tentative List of Topics:

1. General comments on observing systems; today's operational data base

2. Objective Analysis
   - (a) General concepts; function fitting
   - (b) Cressman, Barnes and Bratseth techniques
   - (c) Filtering concepts
   - (d) Statistical analysis
     - (i) optimum interpolation
     - (ii) multivariate O.I.

3. Three-Dimensional Variational Analysis and Data Assimilation (3DVAR)

4. Four-dimensional Data Assimilation
   - (a) Historical approaches; Newtonian relaxation or nudging
   - (b) Variational Approaches; 4DVar
   - (c) Adjoint techniques for minimization

5. Kalman Filters
   - (a) Classic Kalman filter and extended Kalman Filter
   - (b) Ensemble Kalman Filter
   - (c) Hybrid methods

6. Special Topics (if time allows)
   - (a) Methods used in current operational forecast systems
   - (b) Methods for mesoscale and storm-scale prediction
   - (c) Observing System Simulation Experiments (OSSE)

Computer programs will be written as part of the homework assignments. Thus working knowledge of a programming language is required. By the end of the course each student will have at least three working objective analysis codes and have worked one or two simple variational analysis problems. Note that homework determines a significant part of the final grade, so that your efforts there will be rewarded.

Any student in this course who has a disability that may prevent him or her from fully demonstrating his or her abilities should contact me personally as soon as possible so we can discuss accommodations necessary to ensure full participation and facilitate your educational opportunities.

All students are expected to be familiar with and abide by the OU Academic Misconduct Code. Information on this code is at http://www.ou.edu/studentcode