Department of Atmospheric Sciences

COURSE ANNOUNCEMENT – SEMESTER I – 2007–2008

ATMS 502: **Numerical Fluid Dynamics**
(Same as CS 505, CSE 566)

Call number: 37123
Instructor: Prof. Brian Jewett, 212 Atmos. Sci. Bldg., 333-3957
E-mail: bjewett@uiuc.edu
Room and Time: 109 Atmospheric Science Bldg., 3:00-4:15 T R
Credit: 4 Hours
Prerequisites: Math 380 or consent of instructor

FOR: This course is for those interested in numerically solving partial differential equations that describe compressible fluid flow, utilizing high performance computers at the National Center for Supercomputing Applications (NCSA) at the University of Illinois.

<u>Key objectives:</u> Those taking the course leave it with –

- A thorough understanding of the fundamentals – the basis for choosing and evaluating numerical methods
- The ability to critically interpret numerical methods as presented in the literature. We will work through several papers and examine the descriptions of their methods and how they are assessed in terms of stability, accuracy, and error characteristics
- Most important: the ability to apply these methods on high-performance computers. There will be no “black boxes” in the course – the emphasis is on coding and understanding numerical method behavior as applied to linear and nonlinear fluid flow problems in 1-D, 2-D and 3-D settings.

COURSE OVERVIEW: The course focuses on the use of numerical methods in solving wave equations. Content is directed at providing an understanding of how finite difference, finite volume and semi-Langrangian methods affect the solution of advection and Burger's equations. Topics include time and space approximations, use of staggered meshes, nested grid implementation and limitations, temporal and directional splitting, monotonicity, positive definiteness, and flux limiting. Nonlinear systems including the shallow-water, Euler equations and quasi-compressible systems are discussed. Throughout the course, fundamental principles such as stability, accuracy, convergence, nonlinear instability and aliasing are introduced and related to the behavior of different numerical approximations.

COMPUTER PROBLEMS: High-speed computers will be used to solve fluid flow problems in one, two and three dimensions, using regular and nested grid approaches. Techniques for writing clear and effective programs will be presented, including code structuring for efficient use of parallel computers. Course assignments may be programmed in Fortran or C, and introductory codes in both languages will be provided. The behavior of the numerical solutions will be compared to known solutions when they are available.

TEXT: Numerical Methods for Wave Equations in Geophysical Fluid Dynamics, by Dale Durran, Springer-Verlag New York, Inc., 1999. (Required)