Boulder Fluid Dynamics Seminar Series

Tuesday, July 29, 2014
3:30pm-4:30pm (refreshments at 3:15pm)
Bechtel Collaboratory in the Discovery Learning Center (DLC)
University of Colorado at Boulder

Spectral Methods for Uncertainty Quantification

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Realistic analysis and design of multi-disciplinary engineering systems requires not only a fine understanding and modeling of the underlying physics and their interactions but also recognition of intrinsic uncertainties and their influences on the quantities of interest. Uncertainty Quantification (UQ) is an emerging discipline that attempts to address the latter issue: It aims at meaningful characterization of uncertainties from the available measurements, as well as efficient propagation of these uncertainties through the governing equations for a quantitative validation of model predictions.

In this talk, I will provide a brief introduction to uncertainty propagation using spectral methods, specifically Polynomial Chaos expansions. I will then discuss numerical challenges associated with these methods when the system uncertainty is characterized by a large number of random variables. Following that, I will introduce some recent numerical developments and research opportunities based on sparse approximations to tackle these difficulties.

Energy Transfer in Anisotropic Flows

Raffaele Marino, *National Center for Atmospheric Research*

Results are presented from direct numerical simulations of the Boussinesq equations up to 1024^3 grid points in the presence of rotation ($f = 2\Omega$) and/or stratification (N). The transfer of energy from three-dimensional to two-dimensional modes is found to be most efficient in the range $1/2 \leq N/f \leq 2$, in which resonances disappear. In this range, the inverse energy cascade is faster than in the purely rotating case, and thus the interplay between rotation and stratification helps creating large-scale structures. The purely stratified case is characterized instead by an early-time, highly anisotropic transfer to large scales with almost zero net isotropic energy flux. This is consistent with previous studies that observed the development of vertically sheared horizontal winds, although only at substantially later times. However, and unlike previous works, when sufficient scale separation is allowed between the forcing scale and the domain size, the total energy displays a perpendicular (horizontal) spectrum with power law behaviour compatible with $k_\perp \sim -5/3$, including in the absence of rotation.