Boulder Fluid Dynamics Seminar Series

Tuesday, September 16, 2014
3:30pm-4:30pm (refreshments at 3:15pm)
Bechtel Collaboratory in the Discovery Learning Center (DLC)
University of Colorado at Boulder

Arterial Stiffness, Blood Flow Pulsatility and Vascular Diseases

Wei Tan, *University of Colorado Boulder*

It is increasingly accepted that arterial stiffening is associated with and probably causes damage of small vasculature in perfused organs, inducing or perpetuating hypertension, stroke, chronic kidney disease and Alzheimer disease. Artery stiffening, manifested as increased elastic modulus and compliance of arteries due to aging, diabetes or hypoxia, also predicts pharmacological outcomes in a variety of small blood vessel dysfunction. Despite clear clinical evidence, the contribution of artery stiffening to changes in blood flow environments and consequent vascular responses remains elusive. Our recent studies have revealed the important role of arterial elasticity in altering pressure and flow pulsatility as well as dynamic profiles of vessel wall shear stress, which led to pro-inflammatory and vasoconstrictive responses from vascular cells through cytoskeleton-mediated mechano-transduction. In addition to increasing flow pulsatile stress, reduced hydraulic cushion function of elastic arteries also changes flow energy expenditure in the vasculature. Improved understanding of artery stiffening-induced flow changes and consequent vascular cell mechanosensing mechanisms will greatly assist the development of novel therapies of associated diseases.

Autonomic Closure for Large Eddy Simulations

Ryan King, *University of Colorado Boulder*

Motivated by the application of adjoint techniques for rapidly solving large optimization problems, a fundamentally new autonomic closure is discussed that allows an essentially model-free, dynamic subgrid-scale closure for large eddy simulations (LES). The autonomic closure addresses nonlinear, nonlocal, and nonequilibrium turbulence effects and, in its most general form, is based on all possible tensorally-invariant, dimensionally-consistent relations between the local subgrid-stress tensor and resolved scale primitive variables. This introduces a large matrix of spatially and temporally varying coefficients that can be optimized using a test filter approach and then applied at the LES filter scale by invoking scale similarity. The autonomic closure is intended to avoid the need to specify a model for the subgrid stresses, and instead allows the simulation itself to determine the best local relation between the subgrid stresses and resolved state variables. A priori tests of this approach are presented using data from direct numerical simulations of homogeneous isotropic turbulence, and application of the closure to practical simulations is discussed.