Boulder Fluid Dynamics Seminar Series

Tuesday, March 18, 2014
3:30pm-4:30pm (refreshments at 3:15pm)
Bechtel Collaboratory in the Discovery Learning Center (DLC)
University of Colorado at Boulder

Geophysical Turbulence and the Duality of the Energy Flow Across Scales

Annick Pouquet and Raffaele Marino,
University of Colorado, Boulder and NCAR

The ocean and the atmosphere, and hence the climate, are governed at large scale by interactions between pressure gradient and Coriolis and buoyancy forces. This leads to a quasigeostrophic balance in which, in a two-dimensional-like fashion, the energy injected by solar radiation, winds, or tides goes to large scales in what is known as an inverse cascade. Yet, except for Ekman friction, energy dissipation and turbulent mixing occur at a small scale implying the formation of such scales associated with breaking of geostrophic dynamics through wave-eddy interactions or frontogenesis, in opposition to the inverse cascade. Can it be both at the same time? We exemplify here this dual behavior of energy with the help of three-dimensional direct numerical simulations of rotating stratified Boussinesq turbulence. We show that efficient small-scale mixing and large-scale coherence develop simultaneously in such geophysical and astrophysical flows, both with constant flux as required by theoretical arguments, thereby clearly resolving the aforementioned contradiction.

Workflow to support high-fidelity CFD simulations with application to realistic wing profiles

Michel Rasquin,
Argonne National Laboratory and the University of Colorado, Boulder

The development of massively parallel computation, along with scalable numerical methods, provides the capacity to perform high-fidelity simulations on a time scale that has enabled incredible scientific breakthroughs in the last decade. In this presentation, the key features of our massively parallel CFD solver which enables simulations of complex flows on multi-billion unstructured finite element meshes will be presented. Then, the capacities of our solver will be illustrated with a series of numerical simulations on a realistic two-component wing profile in aeronautics with application to aerodynamics and flow control.