Boulder Fluid Dynamics Seminar Series

Tuesday, March 10, 2015
3:30pm-4:30pm (refreshments at 3:15pm)
Bechtel Collaboratory in the Discovery Learning Center (DLC)
University of Colorado at Boulder

Operation of the Solar Global Convective Dynamo

Juri Toomre, *University of Colorado, Boulder*

Our nearest star the Sun exhibits prominent 11-year cycles of magnetic activity, with emerging sunspots following reasonably well defined rules as the cycles proceed. The origin of these strong magnetic fields must rest with dynamo processes resulting from the interaction of convection, rotation, shear and magnetism within the highly turbulent convection zone occupying the outer 30% by radius of this star just below its surface. Helioseismology has allowed us to probe some of the subsurface flows and the differential rotation of that zone, providing important guidance and constraints for theoretical dynamo models. We will discuss results achieved with our 3-D Anelastic Spherical Harmonic (ASH) global simulations that are revealing how strong toroidal wreaths of magnetism can be built within the convection zone itself, and how portions can become unstable and rise toward the surface, likely becoming emerging flux structures. Many of the models possess cycles in which the global fields can reverse the polarity of their wreaths. Our most recent models can have strikingly regular magnetic cycles that are interrupted by a period of relative quiescence, not unlike observed grand minina, before resuming their cycling. There are major challenges in studying these turbulent processes, yet the 3-D modeling is helping to unravel dynamical elements that must be at work deep within our nearest star.

State-of-the-art Experimental Fluid Mechanics Towards Resolving Biophysical Processes in Marine Ecosystems

Aaron True, *University of Colorado, Boulder*

In the last few decades, a fascinating and interdisciplinary world of research has exploded which examines the coupling of biological, chemical, and physical realities in marine ecosystems. From chemotactic bacterial tracking of free-falling marine snow aggregates to turbulent "unmixing" of motile phytoplankton, this fruitful field promises to yield big answers to big questions. Here, we present design work, numerical modeling, and preliminary experimental findings related to two biophysically-inspired projects as illustrative examples of how we are leveraging state-of-the-art methods from experimental fluid mechanics to investigate fundamental and far-reaching problems in marine ecosystems: siphon-generated flows from benthic bivalves and the dynamics of motile phytoplankton in turbulent flows. For the siphon-flow project, numerical modeling (COMSOL) not only revealed nontrivial departures from the idealized inviscid flow fields at low Reynolds number but also gave critical insights used to design an index of refraction-matched flume facility in which we will employ planar particle image velocimetry (PIV) to quantify transient and steady state flow fields both within and outside the siphon tube. For the phytoplankton-turbulence project, we've built a 1 L oscillating grid turbulence tank, quantified the turbulence characteristics via PIV, and directly imaged distributions of a motile dinoflagellate (*Heterosigma akashiwo)* in nearly homogeneous, isotropic turbulence via planar laser-induced fluorescence (PLIF) of the cells themselves. Preliminary spatial probability distribution functions revealed patches of cells with concentration enhancement factors comparable to those found in a direct numerical simulation (DNS) of motile "cells" in turbulence. As these projects are very much in their infancy, we freely invite questions, critiques, and suggestions to sharpen and hone the science!