The Department of Civil and Environmental Engineering at the University of Houston presents...

CIVE 6111 Graduate Seminar

Multiscale Exascale Earth System Modeling (E3SM): gaining clarity on earth system evolution through mixing across scales in global to coastal ocean modeling

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Abstract
Mixing in the ocean and coastal areas is ubiquitous with a variety of environmental consequences, ranging from entrainment of heat and carbon into the deep ocean affecting climate change to transport of nutrients within coastal areas responsible for coastal hypoxia and harmful algal blooms. However, the complexity of the entire Earth System presents some unique challenges, particularly due to the large spatiotemporal scales involved and human interest in understanding regional, small-scale responses at decadal to century scales. Traditionally, scientific domains have been limited to focus on either the global, regional or coastal scales. However, recent Los Alamos Laboratory Directed Research and Development and U.S. Department of Energy Office of Science Biological Environmental Research investments are beginning to open the door to simultaneously consider interactions across scales, processes, and model components through the Energy Exascale Earth System Model (E3SM). The value in this approach will first be illustrated by presenting a variety of mixing applications at different scales, including diagnosis of Atlantic-basin- and Southern Ocean shelf-scale mesoscale mixing using Lagrangian In-situ Global High-performance particle Tracking (LIGHT), understanding sources of nutrients for seaweed growth for biofuels in the Gulf of Mexico, to small scale mixing by combined tides and river flows in a tidal river junction. Each application, however, has implications for humans living in coastal areas. These applications span global to regional to coastal domains, but are only partially represented via coupled Earth System Modeling today because coastal processes are not yet included in E3SM. I present recent E3SM results focusing on the Model for Prediction Across Scales Ocean (MPAS-O) and highlight new cross-component capabilities we are developing to simulate coastal responses to decadal scale natural and human system changes. Leveraging flexible, multiscale meshes within the Energy Exascale Earth System for Earth System Modeling as well as multi-component, e.g., land-river-ocean, process interactions is opening up the door to simulate global to coastal scales to understand decadal coastal changes.

Bio
Phillip J. Wolfram leads Energy Exascale Earth System Model (E3SM) Coastal Waves Next Generation Development and Integrated Coastal Modeling (ICoM) Earth System Model Development for the DOE Office of Science Biological Environmental Research; and global to regional coastal biogeochemical modeling in the United States Exclusive Economic Zone for the Advanced Research Projects for Energy Macroalgae Research Inspiring Novel Energy Resources (MARINER) program. He is a staff scientist at the Los Alamos National Laboratory and is a graduate of the Environmental Fluid Mechanics Laboratory at Stanford University (M.S., Ph.D.) and the Colorado School of Mines (BS) with broad interests in mixing processes, computational fluid mechanics and coupled Earth System Modeling, scientific visualization, and Roman Engineering.