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Special Guest Lectures

Paradigm for Multiscale Modeling of Fluid-sediment Boundary Layer Flows**Joseph Calantoni, Naval Research Laboratory, Stennis Space Center**

Head of Sediment Dynamics Section, Marine Geosciences Division

Digital Media Center Theatre
September 05, 2013 - 02:00 pm**Abstract:**

We propose a new paradigm for modeling multiscale geophysical boundary layer flows with the goal of producing highly accurate and highly efficient forecasting of the complexity of the natural environment across the full range of relevant length and time scales. The assumption that computing technology will never allow us to perform direct numerical simulations (DNS) of the natural environment often limits our ambition in forward thinking model development and produces only incremental improvements in the state-of-the-art technology. Regional and global forecasting models for earth, ocean, and atmospheric processes based on averaged equations (e.g. RANS) must advance beyond simple closures relations obtained for single-phase fluid turbulence (e.g., k-epsilon, k-omega, and Mellor-Yamada). We propose using a hierarchy of computationally intensive, high fidelity simulations to resolve subgrid processes across a range of cascading length and time scales in the model domain to generate numerical interpolations for the unresolved physical processes (e.g., in the fluid-sediment boundary layer). As an example, we present a hierarchy of models developed for studying sediment dynamics at different scales. At subparticle scales we use DNS to explicitly model turbulent fluid-particle interactions; the DNS is limited to $O(1000)$ particles. At particle scales we use the discrete element method (DEM) for the sediment phase coupled to a RANS fluid model. The DEM-RANS simulation includes closures for turbulence and hydrodynamic particle forces and is used to simulate intermediate scales with spatially uniform conditions such as in sheet flow transport. At bedform scales, a mixture model (SedMix3D), exploits closures for mixture viscosity, diffusivity, sedimentation rates and particle pressure. The mixture model is used to simulate the coupling of bedforms and coherent vortex structures in the turbulent boundary layer. At each scale of interest, we will show comparisons of model results with detailed laboratory measurements. Pathways for connecting simulations across length and time scales will be identified and explored.

Speaker's Bio:

Dr. Joe Calantoni is the head of the Sediment Dynamics Section in the Marine Geosciences Division of the Naval Research Laboratory (NRL) at Stennis Space Center, Mississippi. The Sediment Dynamics Section performs basic and applied research leading to advanced technology development, and demonstration and validation efforts focused around the physical, mechanical, and acoustical properties of seafloor, estuarine, and riverine sediments through a combination of high performance computing simulations and numerical modeling, detailed laboratory measurements, and field experiments.

He received an undergraduate degree from the Pennsylvania State University and master's and doctoral degrees from North Carolina State University all in physics. He was granted a National Research Council Research Associateship Award and began working as a postdoctoral fellow at NRL immediately after defending his dissertation in late 2002. In 2004, he accepted a position as a full-time NRL research physicist.

Dr. Calantoni is internationally recognized for his novel approach to sediment transport modeling and simulation where the motions and interactions of every grain of sand are directly computed. Since August of 2009, he also has been acting as the National Defense Education Program (NDEP) site coordinator for NRL at Stennis Space Center. NDEP encourages a new generation of scientists and engineers to apply their talents in Department of Defense (DoD) laboratories. He has initiated and oversees a K-12 education outreach program to promote science, technology, engineering, and mathematics (STEM) in the classroom.

