Other - Joint Coastal Interview with Civil Engineering

Turbulence Resolving Two-Phase Flow Simulations in Wave-driven Boundary Layers and its Implications to the State of Muddy Seabed

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Abstract:

To understand and predict the hydrodynamics of the environmental flows stipulate the use of a hierarchy of models at different scales despite the increased computational resource availability. The accuracy and predictive capability of the models towards the largest scale in this hierarchy necessitate accurate and robust parameterization of smaller scale physical mechanisms. The large scale hydrodynamics models are extensively used for forecasting the flow nearshore and in the ocean, e.g. to evaluate coastal hazard. Therefore, the accuracy of such models is quite critical for strategy development to measure the adverse effects of environmental flows. In this presentation, the necessity for accurate modeling and parameterization in larger scales will be addressed by the results of turbulence resolving two phase simulations of fine sediment transport in Stokes Boundary layer that cannot be predicted by conventional turbulence closure models.

Understanding the state of the muddy seabed is critical to fine sediment transport, hydrodynamic dissipation, and seabed properties and thereby coast line evolution, national security, and the environment. However, its complete understanding is challenging due to uncertainties in the field such as intermittency of turbulence, sediment-induced density stratification, cohesion among small particles that form fluid-mud mixture. Resolving turbulence and transitional flows and its interaction with mud constitutes an important step towards understanding the fluid-mud dynamics. In this talk, the effect of sediment-induced stable density stratification due to dense deposits in the river mouths, i.e., high mud concentrations, and that due to comparably larger sediment particles in the fluid-mud mixture, i.e., particles with higher settling velocity, on flow turbulence through turbulence resolving simulations will be discussed. Based on the results of these simulations, four states of fluid-mud is revealed in a moderately energetic surface wave field: (i) fully turbulent regime where virtually no turbulence modulation is observed in the case of very dilute sediment concentration, (ii) slightly modified turbulent regime where slight turbulence attenuation is observed (iii) laminar regime with intermittent instability (iv) completely laminar regime due to strong particle-induced stable density stratification. These four regimes can explain the wave energy dissipation and transport of fine particles to long distances under mild gravitational acceleration. The current status of ongoing research on transitional flows in linear and nonlinear wave-driven boundary layers and its comparison with the recent observations in the Louisiana Shelf, and future perspectives shall also be discussed.

Speaker's Bio:

Dr. Celalettin Emre Özdemir graduated with B.S. and M.S. degrees in Civil Engineering Department at the Middle East Technical University, Ankara, Turkey. He earned his Ph.D. from Civil and Coastal Engineering Department at the University of Florida in 2010. Upon his graduation, he worked as a Postdoctoral Researcher at the Center for Applied Coastal Research in University of Delaware. Since 2012, he works as a Postdoctoral Investigator at the Applied Ocean Physics and Engineering Department in Woods Hole Oceanographic Institution.

Dr. Özdemir's research interests are mainly motivated to understand and predict environmental flows, sediment transport, and fluid structure interaction that have critical implications to evaluation and mitigation of coastal hazard, sustainable design and management practices. His particular expertise is in multiphase flow modeling, simulation and modeling turbulent flows, hydrodynamic stability analyses, and parallel computing. His research efforts are currently focused on understanding the different scales in environmental flows via hierarchy of models. His goal is to improve the predictive capability of the models in the hierarchy towards the larger scales which are extensively used to estimate mixing and transport in flows in ocean and nearshore.

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