JOHNS HOPKINS
Center for Environmental & Applied Fluid Mechanics

SPRING 2021 CEAFM VIRTUAL SEMINAR

"Exploring Some Amazing Features of Sediment-Laden Turbidity Currents"

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Hosted by Rajat Mittal (JHU - MechE)

Turbidity currents are sediment-laden turbulent shear flows that run over a sloping bed, submerged beneath a deep layer of quiescent ambient fluid, driven by the excess hydrostatic pressure. As the current travels downslope, the flow interacts with the ambient fluid layer above through entrainment at the interface. In this process, the ambient fluid is continuously incorporated into the current and the thickness of the current increases. Simultaneously, the current also interacts with the bottom bed both depositing and resuspending sediment.

Two important aspects of turbidity currents have puzzled scientists. A plume, jet or a wake does not extend over very long distances, since their coherence is lost due to continuous mixing and dilution with the ambient through entrainment. However, it has been observed that turbidity currents travel hundreds of miles confined within submarine canyons. How is this possible, if the turbidity is current is turbulent and mixes with the surrounding? Even more fascinating is the fact that after travelling for hundreds of miles they decide to suddenly drop significant portion of the suspended sediment to form massive deposits. What triggers such catastrophic events?

We try to answer these questions with high-fidelity direct and large eddy multiphase flow simulations of turbidity currents. The delicate interplay between wall-turbulence, turbulence in the shear-layers, sediment transport and the back effect of sediment on turbulence through stratification presents a fascinating contrast between supercritical and subcritical currents. We observe these currents to form two or three families of interacting coherent hairpin vortex structures that control transport of turbulence. In summary, long running currents are eventually subcritical in nature and their near-wall turbulence behaves more like a turbulent channel flow with a lutocline acting as a lid and not like a wall jet. We establish a mechanistic relation between entrainment and basal drag. Furthermore, when the delicate balance between turbulence and sediments is disturbed a turbidity current can suddenly drop most of its sediments to form massive deposits.

Friday, February 19, 2021 at 3:00 PM

https://wse.zoom.us/j/93762992307