Understanding role of roughness effects on turbulence mixing in Turbulence buoyancy driven flows

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Turbulent Density currents are an important class of buoyancy-driven flows that have important conséquences in the modeling of oceanic flows and circulation and meteorological flows (Simpson 1997, Turner 1986). As heavy fluid (or a higher concentration) flows into lighter fluid the density difference between two fluids generates buoyancy force that drives the density current to propagate horizontally. The density current entrains the surrounding ambient fluid, causing significant mixing within the current. Density currents are generated from instantaneous finite volume sources, which are referred to as a lock-exchange release (L-E). L-E has drawn a lot of attention in the literature. The presence of surface roughness complicates the flow and modified the entrainment and mixing within the current. The focus of the present study is to understand the mixing and front characteristics of density currents over roughness.

For this purpose, we developed a novel Large-Eddy-Simulations (LES) tool for density currents over rough wall using novel penalization based immersed boundary method for the complex bottom-surface. Instead of traditional k- and d- type of roughness, we characterize roughness in terms of volume fraction. The results demonstrate intriguing results the mixing and dilution scales with friction Re (Re_tau) , in addition to Reynolds and the Froude's number. Roughness results in an additional mixing and an enhanced dilution that is related to the wall-shear-stress. In this talk instantaneous mixing processes and bulk-averaged parameters that influence the mixing in the current are discussed.