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Few thoughts on Mixing and Entrainment of Lock-Release Turbulent Dense Currents over Rough-Surfaces

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Buoyancy driven density currents are the result of the intense turbulence exchanges that occur due to interaction of dense waters with surrounding ambient and calm waters in the ocean. E.g. in the basins of the Arctic continent shelves highly energetic and dissipative density current form due to mixing of cold, dense brine-enriched shelf waters with ambient lighter waters. Intense turbulence causes mixing, the mixed water mass descends down the continental slope. The eventual properties of the mixed water will dictate the deep-water mass. Hence, entrainment/mixing processes are central to oceanic thermohaline circulation. In spite of its importance, the entrainment and the mixing they undergo with overlying water is still not clear. In this talk, we focus on overcoming the challenges in calculating the entrainment over rough-surfaces. The analysis is conducted on lock-release density currents. A highly accurate direct numerical simulation and large eddy simulation solvers have been developed to simulate dense currents over range of rough-surfaces. A new method has been developed to calculate mixing in the head of the density-currents using principles of height-averaged density method. The results have revealed the shape of roughness elements and the standard deviation of the roughness height are the important metrics that influence the front velocity and front characteristics. Entrainment is significant in the head region of dense currents over uniform roughness, whereas for non-uniform rough surfaces, entrainment occurs throughout the current. These results have important implications in our current understanding of mixing in head region of the density current. Further, a relation has been established between the wall-shear stress and entrainment, and this has resulted in a new parameterization of the entrainment as function of the roughness metrics. This study will of be important consequence in improving the accuracy of parameterization of density currents in ocean models.