Density currents dispersing over regular roughness elements

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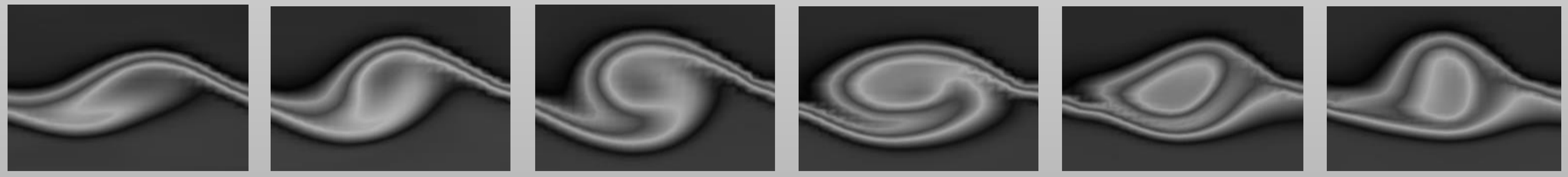
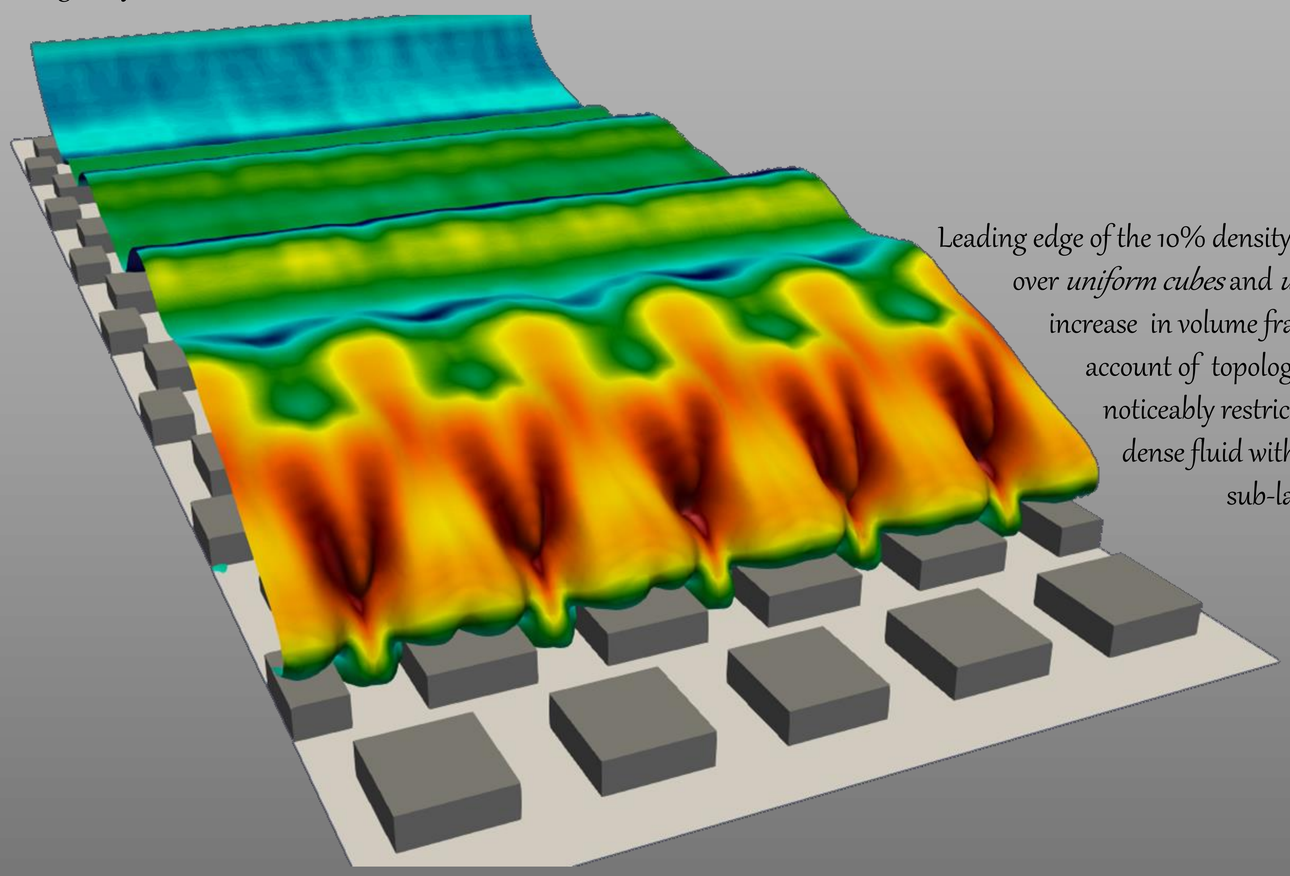
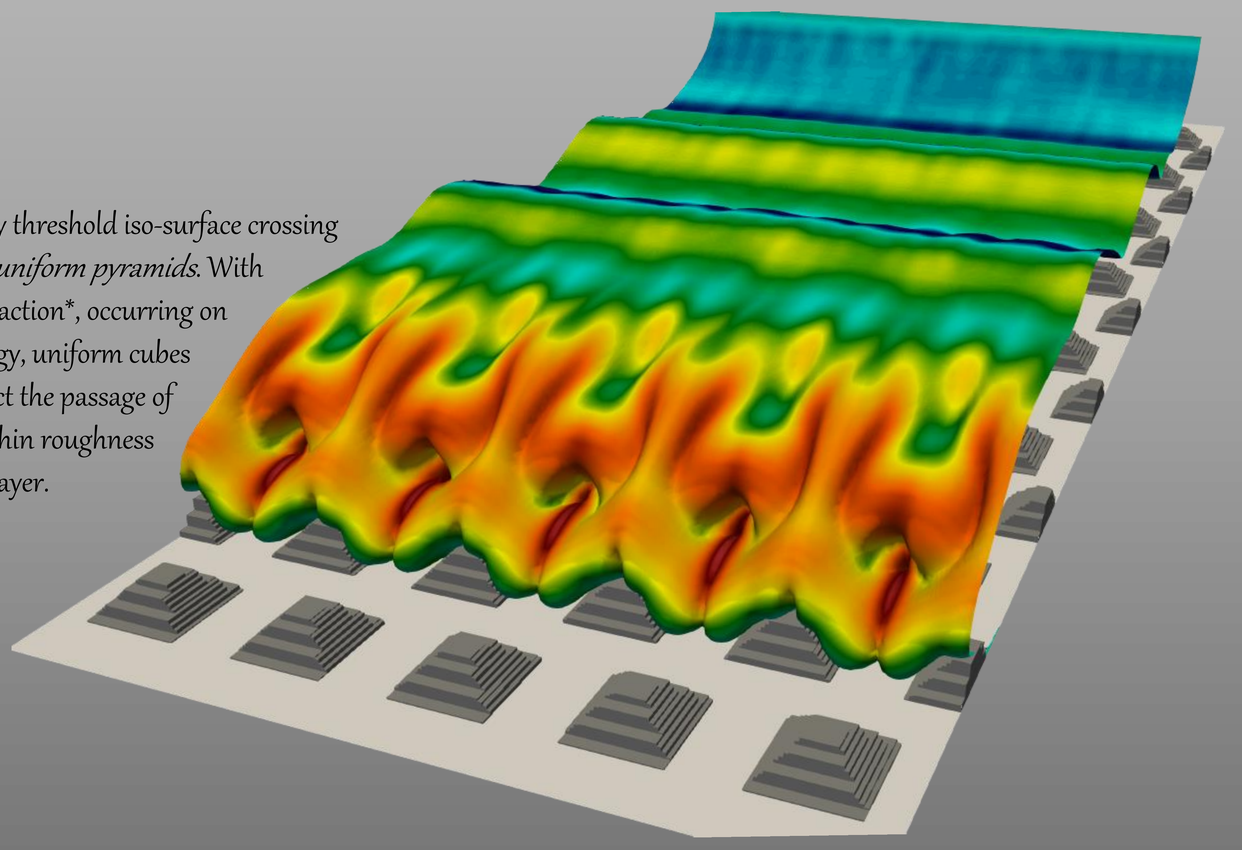
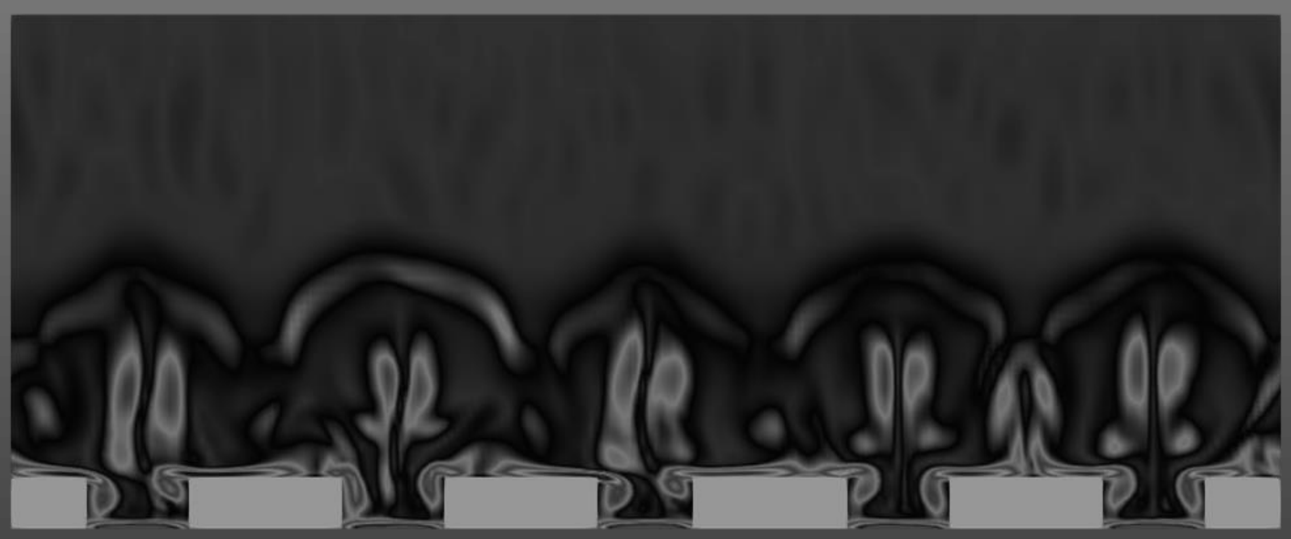


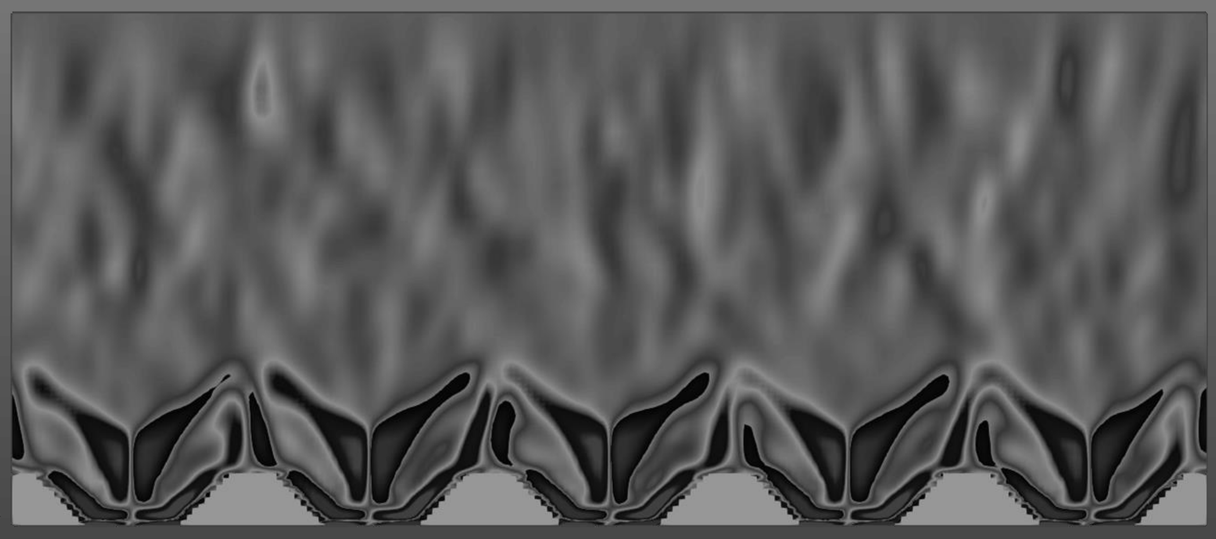
Differences in either concentration or temperature between two fluids introduces a buoyancy forcing that manifests in the form of density currents. The participating fluids interact and cultivate a stably stratified shear layer. As the current spreads the shear layer experiences positive vorticity. The rolling action places dense fluid particles in curved reversed trajectories called Kelvin-Helmholtz (K-H) instabilities. As the K-H rollers augment in size and intensity the dense fluid particles rise further into the ambient fluid and a streak of heavy fluid is bent upstream. When the curved path of these dense streaks completes at the rear of the current, it entrains ambient fluid into the gravity current.





Leading edge of the 10% density threshold iso-surface crossing over *uniform cubes* and *uniform pyramids*. With increase in volume fraction*, occurring on account of topology, uniform cubes noticeably restrict the passage of dense fluid within roughness sub-layer.





Wall normal vorticies emanating from roughness elements. Their vertical expanse can be seen monotonically rising with the volume fraction. Along the azimuth we see counteracting vortical structures emerging on account of wall shear. For the Reynolds numbers under consideration, notwithstanding local buoyancy fluctuations, the form drag introduced by the roughness elements is primarily responsible for momentum imbalance . Thus, with the advancing current carrying signatures of the underlying topography, the heavily disturbed neighborhood of the nose experiences increased incorporation of ambient fluid underneath. It is intuitive to relate the wake profile of the roughness features with the relative volume of ambient fluid entering via resultant lobe-cleft structures. Furthermore, the convective transport offered by the counteracting vortices allows enhanced homogenization between the participating fluids. Metaphorically, the vortex distribution over uniform cubes holds close semblance to altars housing couples for their nuptials and that over uniform pyramids depicts the head of a Texas longhorn.

* Volume fraction = volume occupied by roughness elements/volume of the simulation domain