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Turbulent Mixing and Entrainment in a Buoyancy Driven Continuous Thermal Plume using Large-Eddy Simulations. SUDHEER REDDY BHIMIREDDY, KIRAN BHAGANAGAR, University of Texas at San Antonio — Understanding the effects of extreme events such as wildland fires, volcanic eruptions are some of the critical issues the scientific community is facing now. For this purpose, a high-fidelity Large-Eddy Simulation has been developed to simulate thermal plumes with subcritical Froude's number in a 4 km x 4 km x 7 km domain under idealized conditions. A fundamental fluid dynamics analysis has been performed to quantify the mean and turbulent characteristics of the thermal plumes. Additional 2-D simulations performed revealed that a well-defined head exists and travels with nearly constant velocity as long as it is attached to the plume stem. Due to intense turbulent mixing, 3-D thermal plume does not exhibit a well-defined head. To quantify the mixing and entrainment, 1st principle control volume approach based on tracking the plume interface has been used in both 2-D and 3-D cases. Using this interface we also study the plume ascent rate and half-widths based on both radial velocity and buoyancy profiles. Entrainment in 3-D thermal plumes is found to be significantly higher than in 2-D. The primary mechanism entraining the ambient fluid in 3-D is due to the instabilities at interface, whereas in 2-D, the centerline vorticity is found to be responsible for the mixing.

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