Turbulent plumes transport in the atmosphere: Implications and fundamental understanding

Kiran Bhaganagar, PhD, Associate Professor, Department of Mechanical Engineering, University of Texas at San Antonio

An overview of the important problem of turbulent plume transport will be given. Our group has conducted studies on oceanic density currents and atmospheric vertical turbulence plumes and developed a universal framework for entrainment. I will focus on the high-resolution Advanced Research Weather Research and Forecast model that has been developed to understand the role of atmospheric stability on the short-term transport of a continuous release passive scalar plume. For this purpose, the plume was released in different convective boundary layer regimes: highly convective, combined shear and buoyancy, and shear dominated. Scaling laws have been developed for the horizontal transport of the plume which scales with the initial wind conditions for surface and near-surface releases, and the vertical transport which scales with atmospheric stability parameter. Mean plume height and vertical dispersion parameter obtained by convective scaling laws reached their asymptotic values after getting well-mixed in the boundary layer. The dimensionless downwind distance for the mean plume height to reach its asymptote is found to follow a power-law with respect to the atmospheric stability parameter. I will conclude with a discussion of the new NASA MIRO Center for Advanced Measurements in Extreme Environments (CAMEE) research directions and possible collaborations.