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Turbulent plumes and fountains in confined and unconfined environments

Period of Study: 2011- on-going

Supervisor: Professor Gary Hunt

Description of Research

Free and confined turbulent buoyant convection in stratified and uniform environments has received considerable attention in recent times, not least because the phenomenon plays an instrumental role in a wide range of engineering and geophysical flows. In particular, research in this field guides the efficient design of low-energy building ventilation, the management of atmospheric pollutant dispersion, the forecasting of global weather patterns and the prediction of seasonal variations of oceanic stratification. With an aim to enhance our understanding of the stratification development in bounded and unbounded buoyancy-driven flows, we focus on three pertinent problems: (a) the time evolution of the density stratification in a ventilated space induced by two turbulent buoyant plumes of unequal strength, (b) the turbulent entrainment of buoyant fluid across a stable density interface driven by the impingement of a vertically-forced high-Reynolds-number shear flow and (c) the flow resulting from the continuous vertical injection of dense fluid into a relatively light environment, namely, a turbulent fountain. Theoretical models of these flows are developed in order to elucidate the governing fluid mechanics. The analysis provides considerable insight into the parameters that govern the interaction between turbulent motions and a density stratification. Moreover, these mathematical models capture key features of turbulent buoyancy-driven flows relevant to aiding the design of naturally ventilated spaces and predicting the time-dependent thermal stratification of the Earth's atmosphere and oceans.

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