EUROMECH Colloquium 567: Turbulent mixing in stratified flows
22-25 March 2015, DAMTP, Centre for Mathematical Sciences, Cambridge, UK

Measurements of the evolution of turbulent velocities and buoyancy flux in stably stratified flows

Pablo Huq

College of Earth, Ocean, and Environment, University of Delaware, Newark, DE 19716, USA

Abstract

This paper reports experimental data of the evolution of the velocity and buoyancy flux for sheared and shear-free, density-stratified turbulence. Experiments were undertaken in a water tunnel with stratification being induced by either salinity or temperature variations. Thus the ratio of kinematic viscosity $\boldsymbol{\nu}$ to scalar diffusivity $\boldsymbol{\kappa}$, the Schmidt number Sc is 700 or 7 for salinity, temperature respectively. Experimental parameters ranged up to St and Nt ~ 10 and buoyancy Reynolds number $Re_b \sim 10^3$. The balance of the down-gradient and counter-gradient transport in a time series is the buoyancy flux $\overline{\rho w}$. Values of $\overline{\rho w}$ for Sc = 7 data are greater than for Sc = 700 data. Conditional analysis of the time series shows that this arises because of the relatively fewer number of counter-gradient transport events for Sc = 7 data. We also report experimental data of the large-scale (w'/u') and small-scale (w_x^2/u_x^2) anisotropy measures of the velocity field. Values of both anisotropy measures approach isotropic values for increasing buoyancy Reynolds number Re_b. Comparison with heat stratified wind tunnel data (Prandtl number Pr = 0.7) shows that values of both anisotropy measures are greater for water tunnel data. The results demonstrate a molecular effect – values of large and small-scale anisotropy of the density-stratified turbulent velocity field vary with Sc (Pr). This highlights the need to consider the role of molecular diffusivities on anisotropies in the dynamics of density stratified turbulence.

*corresponding author: huq@udel.edu