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Turbulent Scales Observed in a Buoyant River Plume Driven by a Highly Variable Flow

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Buoyant river inflows are a ubiquitous feature of the coastal ocean – and river flows are rarely steady. The inherent variability of inflow rates as well as changing density stratification of the receiving fluid affects the evolution of the plume structure and the ultimate redistribution of energy, buoyancy and momentum. Observations of the turbulence characteristics of a variable buoyant plume flowing into a fjord are described. The Manapouri hydroelectric power station tailrace flowing into Doubtful Sound, Fiordland, New Zealand, generates a clearly defined buoyant plume. A key feature is that fluctuations in power demand result in a highly temporally variable inflow, changing by as much as 50% in a few minutes.

The environment is quite challenging to meaningfully sample with most of the signal occurring in the upper-most few metres of the water column. Observations come from winter and autumn field experiments. As well as characterising the velocity and thermo-haline structure throughout the plume, turbulent mixing and overturning scales through the water column were characterised using microstructure profilers. A Lagrangian perspective is provided with both drifters and drifting yo-yoing profilers. Despite the strong river flows generating surface speeds of over 2 ms^{-1} the data suggest that fjord processes have an influence on the plume behaviour. Very high upper-layer turbulent kinetic energy dissipation rates were measured but care needs to be taken as the conditions compromise microstructure techniques. The situation enables quantification of the relative roles of steady and transitory plume dynamics.