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Scales of Marine Turbulence in Cook Strait (New Zealand) in the Context of Tidal Energy Turbines

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Cook Strait, the channel separating New Zealand's North and South Islands, is at it's narrowest around 22 km across with flows driven by a semidiurnal tide, wind and a baroclinic pressure gradient. Water depths are around 250-300 m in the main part of the channel, with shoals to the south and the submerged Fishermans Rock (aka pinnacle) in the centre northwest of the Strait. The substantial tidal flow speed is due to the tide being nearly out of phase comparing the ends of the strait and further enhanced by a narrowing of the strait. It has significant potential for a tidal energy resource suitable for extraction due to both its significant energy levels but also its proximity to electricity infrastructure and nationally high uptake of renewable energy in general. Here we describe recent flow and turbulence data and contextualise them in terms of scales relevant to marine energy extraction. With flow speeds reaching 3 m s^{-1} in a water column of $>$ 200 m depth the setting is heuristically known to be highly turbulent. Turbulent energy dissipation rates are modest but high for oceans, around $5\text{x}10^{-5}$ W kg^{-1}. Thorpe scales, the observed quantity representing the energy-bearing scale, are often as much as one quarter of the water depth. This means eddy sizes can potentially be larger than blade length. A boundary-layer structure was apparent but highly variable. This has implications for both operation of tidal turbines, as well as modulating their effect on the environment. Fishermans Rock itself is interesting as if can be considered a proxy for a larger array of turbines.