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The influence of tidal stream polarity on the structure of turbulent dissipation

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A key question in the study of mixing processes in shelf seas concerns the relative roles of Ekman dynamics and energy constraints in limiting the vertical extent of mixing in the bottom tidal boundary layer. Model studies have indicated that, while energy constraints predominate for clockwise and neutral (P=0) polarisation (NH), the effects of rotation should be apparent at large positive values of polarisation. To investigate the question directly, measurements of flow structure (with ADCPs) and turbulent dissipation (FLY Profiler) have been made at two similar locations in the Celtic Sea with polarities of approximately equal magnitude but opposite sign (P=$\pm$0.6). The results demonstrate clearly the influence of polarity on both the vertical structure of the tidal current and the distribution of dissipation and mixing. For strong anti-clockwise polarisation (P$\approx$ +0.6), the bottom boundary layer in the tidal flow is limited to $\sim$15m and significant dissipation from bottom boundary friction is constrained within this layer. By contrast, at the site with clockwise polarity (P$\approx$ - 0.6), significant dissipation was observed to penetrate much further up the water column with significant dissipation ($\sim$$10^{-4.5}$ Wm$^-$3) reaching to the base of the pycnocline at 70-80m above the bed. This pattern was also apparent in the vertical structure of the dominant clockwise rotary component in which the velocity defect extends into the upper half of the water column. The mean and peak values of dissipation close to the bed were higher at the anticlockwise site although the free stream velocities were lower than those at the clockwise station. Scaling the depth by u* /ω to allow for this difference in flow speed confirms the strong contrast in the vertical structures of ε at the two sites.