



Boils and turbulence in a weakly stratified shallow tidal sea

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Measurements of turbulence are made in a weakly stratified region of tidal straining in the eastern Irish Sea using turbulence sensors profiling vertically through the water column on FLY and profiling horizontally on the AUV Autosub. The tidal currents exceed 1 m s^{-1} at the location of the measurements in water of depth about 43.5 m, and result in turbulence extending from the seabed to the surface with a cycle of period half that of the tides, as previously observed. The time of onset of enhanced turbulence measured by the sensors on the FLY and Autosub as the speed of tidal currents increases are in good agreement, as are their mean levels. Boils on the sea surface are identified using the Autonomously Recording Inverted Echo Sounder (Mark 2), ARIES II, a two-beam upward-pointing sidescan sonar mounted on a rig resting on the seabed. The boils have mean horizontal dimensions of about 25 m. They are continually present when turbulence within the water column near the surface is large, typically when ε , the rate of dissipation of turbulent kinetic energy per unit mass, exceeds about $3 \times 10^{-6} \text{ W kg}^{-1}$, compared to the rates of about $1 \times 10^{-7} \text{ W kg}^{-1}$ near times of slack tide when no boils are observed. The top of a region with a relatively high ε gradually extends upwards from the seabed as the tidal flow increases. Upward-moving bursts of enhanced turbulence below the surface with horizontal dimensions of about 5–9 m in the direction of the tidal flow are identified in the AUV record in periods of high tidal flow using conditional sampling. The bursts result in slight upward displacements of the AUV from its set operational depth. Boils first appear at times before the region of generally enhanced turbulence reaches the surface: large localized upward-moving bursts appear to precede the main advancing region of small-scale

turbulence.