High-resolution temperature sensors: a decade of internal wave turbulence observations

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An overview is presented of high-resolution temperature observations from various shallow and deep sites in the generally stably stratified ocean. The stratification supports internal waves with up to 100 m amplitudes. The breaking of these waves is considered to dominate vertical, diapycnal mixing in the ocean. The Eulerian mooring technique is used to monitor temperature variations by typically 100 sensors distributed over lines between 40 and 400 m long. The independent sensors' precision of 0.1 mK and sampling rate of 1 Hz are sufficient to resolve the large, energy containing turbulent eddies and details of the internal waves and their breaking. Such underwater wave breaking is found above underwater topography. In this presentation key examples are shown of this turbulence process from different topography.

Under conditions of tight temperature-density relationship, the temperature data are used to quantify turbulent overturns. These observations show two distinctive turbulence processes that are associated with different phases of a large-scale, mainly tidal, internal gravity wave: i) highly nonlinear turbulent bores during the upslope propagating phase, and ii) Kelvin-Helmholtz billows, at some distance above the slope, during the downslope phase. While the former may be associated in part with convective turbulent overturning following Rayleigh-Taylor instabilities, the latter are mainly related to shear-induced instabilities. Under weaker stratified conditions, away from boundaries, free convective mixing appears more often, but a clear inertial subrange in temperature spectra is indicative of dominant shear-induced turbulence. With stratification, turbulence is seen to increase in dissipation rate and diffusivity all the way to the bottom, which challenges the idea of a homogeneous bottom boundary layer.

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