The development of turbulence in convectively breaking internal solitary waves of depression shoaling over gentle slopes in the South China Sea

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This talk will present an overview of results from recent three-dimensional turbulence-resolving simulations of shoaling internal solitary waves (ISWs) over a gentle bathymetric slope and background stratification/current profiles directly sampled in the South China Sea. Following an introduction on the fundamentals of ISWs, we will discuss the motivating oceanographic observations, the computational process study set-up and the, largely qualitative, analysis of results performed so far. Under the realistic constraint of normal-to-isobath wave propagation, the massively parallel simulations leverage a custom-designed hybrid high-order spectral-element/Fourier-Galerkin flow solver (Diamantopoulos et al., Ocean Modeling, 2022). Three values of initial ISW amplitude (max. isopycnal displacement) of 136m, 143m and 150m are considered. The O(1km)-long waves propagate from 900m to 350m depth waters over a distance of 75km. As soon as the ISW arrives at the steepest slope of the propagation track, a distinct convective instability develops with the outer waveform of the ISW remaining, nevertheless, distinctly symmetric. A turbulent plunging gravity-current then emerges which propagates through the ISW interior. The rear half of the wave core is mixed giving rise to values of the Richardson number at the wave trough which are sufficiently low to trigger a shear-instability, with 15-20m-tall overturning Kelvin-Helmholtz billows advecting along the rear of the wave, establishing a distinct turbulent wake. The presentation concludes with a detailed examination of the structure and evolution of the turbulent kinetic energy intensity and a discussion of a potential shortcoming of the simulations due to limited domain width, as enforced by available computing resources.

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