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Wind-shear-generated high-frequency internal waves as precursors to mixing in a stratified lake

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ABSTRACT: Field data were used to estimate the wavelength, phase speed, direction of propagation, frequency, and the vertical structure of high-frequency internal waves observed on the crests of basin-scale waves of Lake Kinneret during periods of strong wind. Shear stability analysis indicates that these waves were generated by shear in the surface mixing layer. The characteristics of the high-frequency internal waves changed within a wind event as the result of the evolution of the background flow conditions following the deepening of the surface layer and the propagation of the basin-scale internal waves. When the background conditions were appropriate, the vertical structure of the unstable mode was such that the perturbations generated visible sinuous internal waves that in turn modified the density profile in the metalimnion in such a way that secondary shear instabilities were triggered. The high-frequency internal waves were observed over larger distances, but poor coherence in temperature records from stations 200 m apart indicated that individual high-frequency internal waves were dissipated locally; these waves are thus a local mechanism allowing energy to be drawn from the energized surface layer and transported to the metalimnion, where it sustains turbulence. Part of the energy extracted from the surface layer was also returned to the mean flow in the metalimnion; high-frequency internal waves are therefore also a source of momentum for the metalimnetic currents. The vertical excursions of the waves also indicate that they could potentially play a role in phytoplankton growth by significantly altering the light regime at relatively high frequencies.

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