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On Internal Wave Caustics

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ABSTRACT

Ray-tracing models of short, oceanic internal waves commonly predict the existence of caustics, where neigh-boring rays cross. Here we present a linear model of short-wave refraction that yields caustics for the short waves at all intrinsic frequencies and vertical wavenumbers. The caustics form as the short waves are focused by a single progressive inertial wave that is modeled first as infinitely sinusoidal and then as a localized packet. The solutions are obtained by a combination of analytical and numerical techniques. A boundary-layer matching gives a convenient expression for the maximum amplitude near the caustic, while the more robust, uniformly valid solution indicates that the boundary-layer results are accurate for realistically large inertial shears only at very close distance to the caustic. Analytic solutions allow parameter dependences to be studied in detail. Implications for wave breaking are also drawn: in this model, the changes in short-wave amplitude (corrected to remove the ray singularity at the caustic) are by far largest near the caustic, while critical-layer processes are prevented by the time dependence of the inertial shear. Attention is also given to practical considerations for implementing caustic solutions in a ray-tracing algorithm.

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