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The Mean Flow and Long Waves Induced by Internal Wave Packets

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The divergence of the horizontal flux of horizontal momentum associated with surface gravity wavepackets results in a horizontal flow that turns out to be identical to the Stokes drift. This "divergent-flux induced flow" is itself divergent and so induces a deep response flow whose momentum is equal and opposite to the momentum associated with the Stokes drift. Thus the total momentum is zero. By contrast there is momentum associated with internal wavepackets. Like surface gravity wavepackets, the divergent-flux induced flow of horizontally localized internal waves is itself divergent. However, because the ambient is stratified, and so inhibits vertical motion, there can be no deep return flow. Different from the approach of Bretherton (1969), we follow a physically intuitive but mathematically rigorous quasi-monochromatic wavepacket analysis complemented by fully nonlinear numerical simulations to show that the dominant response is an induced horizontally long internal wave that extends laterally well to either side of the wavepacket. This suggests a new mechanism for efficient energy and momentum transfer from local to long and slow time-scale disturbances that does not involve irreversible deposition through wave breaking. Weakly nonlinear effects are discussed.