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Cross-isobath energy fluxes in semidiurnal barotropic Kelvin waves propagating on wide continental shelves

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Continental shelf modifies a Kelvin wave into a hybrid Kelvin-edge wave with a non-zero cross-isobath velocity and a phase speed that decreases with increasing wavenumber while the group velocity reaches a minimum at intermediate wavenumbers. We model the modified semidiurnal Kelvin wave adjustment to alongshore variations of the shelf width. The model domain consists of two alongshore-uniform continental shelves of different widths adjoined through a 150 km-long transition zone. Continental shelf and slope topography is adjacent to an ocean of a constant depth, allowing radiation of Poincaré waves. We consider three shelf widths of 150, 250, and 300 km, where properties of a zero mode at semidiurnal frequency change from Kelvin wave-like to edge wave-like. For each shelf width, a zero wave mode has its distinctive alongshore energy flux structure on the shelf. As the incident wave encounters a shelf width variation, the alongshore energy flux converges (diverges) on the shelf resulting in an offshore (onshore) energy flux over the continental slope. Furthermore, if the group velocity approaches zero in the area of the variable shelf width, the incident wave mode scatters into radiating Poincaré waves. On sufficiently wide shelves, a strong cross-isobath energy flux comparable with the incident wave energy flux can be triggered even by relatively modest shelf width variations. The results yield a simple diagnostic for the energy flux direction across the continental margin in a modified semidiurnal Kelvin wave based on the theoretical mode structure and its dispersion properties.