Abstract View

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A Case Study of Wave–Current–Bathymetry Interactions at the Columbia River Entrance

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ABSTRACT

A unique set of field observations has documented intense wave–current–bathymetry interactions in a tidal inlet, providing a severe test of existing wave theory. Hourly wave spectral estimates were acquired over ten complete tidal cycles at locations offshore of, and on, the Columbia River Bar. This site has long been recognized as an extreme hazard to navigation due to the interaction of incident waves with a strong tidal jet typified by ebb currents in excess of 2 m s^{-1}. During the five-day observational period, offshore significant wave height ranged from 1 to 5 m; in contrast, the Bar wave height oscillated at tidal periods, sometimes doubling during a single six-hour flood-to-ebb cycle. In one case, the Bar wave height was 7.0 m with an offshore wave height of 2.9 m. A one-dimensional model, based on linear wave action–density conservation and incorporating shoaling, refraction and radiation stress, fits the data remarkably well; 85% of the observed variance in Bar swell height and 57% of the observed variance in Bar wind-wave height are accounted for. A significant underestimate of Bar swell height on one of the ten ebbs studied is attributed to two-dimensional effects not included in the model.