Energetic infra-gravity Waves at the Coast - Challenging Applications for phase-resolving Wave Models

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Abstract

Many coastal communities are at constant risk from hazardous waves. Several countries have early-warning systems in place to mitigate the effects from tsunamis, hurricanes, and storm surges. In this context, the increase in computational resources has helped to improve coastal resilience - further protecting life and property. Despite research advances, unexpected wave phenomena still exist, which are unaccounted for in coastal hazard assessment, evacuation planning, and structural building codes. These waves are mostly the result of locally generated infra-gravity surges, which are difficult to predict. We will present two examples, where infra-gravity (IG) waves have resulted in hazardous - yet fatal coastal flooding - and show how phase-resolving models can be used to understand the processes.

Case 1: In November 2013, Typhoon Haiyan made landfall in the Philippines where it generated a tsunami-like bore that destroyed the entire village of Hernani in Eastern Samar. The destructive waves astonished both villagers and disaster managers, as the coast near Hernani is sheltered by a broad fringing reef. However, under the extreme storm conditions of Typhoon Haiyan individual waves overtopped the reef and the generation of IG waves from wave breaking at the reef edge favored a strong surf beat over the reef flat. The extreme surf beat caused tsunami-like surges of much longer period than regular swell waves that were responsible for the destruction of the village and the failure of its coastal defense structures.

Case 2: Over the winter months, the Northshore of O'ahu, Hawaii, is exposed to heavy ground swell from the North Pacific. The fringing reef along the shoreline favors generation of strong IG waves with periods from 0.5 to 17 minutes. Consequently, these oscillations result in strong coastal currents. The highest IG current amplitudes close to shore occur at the shortest periods, while near the outer edges of several deep channels the strongest currents occur at the longest IG periods. The investigated wave and current processes help to improve efforts on coastal hazard mitigation and mariners' safety.