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The Hawaiian PLUME Project: A Broadband Seismic Dataset Provides Glimpses into Ocean and Atmosphere Processes

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The Hawaiian PLUME (Plume-Lithosphere Undersea Mantle Experiment) project operated a two-stage network of nearly 70 broadband ocean-bottom and 10 land seismometers from January 2005 through May 2007. With an aperture exceeding 1000 km, PLUME has been one of the first and largest, long deployments of broadband ocean bottom seismometers (OBSs) (Laske et al., 2009). The land stations were equipped with three-component Wielandt-Streckeisen STS-2 broadband seismometers and most ocean bottom stations were equipped with three-component Güralp CMG-3T or Nanometrics Trillium 240 broadband seismometers. In addition, the ocean bottom sites also operated a Cox-Webb differential pressure gauge. The deployment of broadband instruments allowed us to apply a wide range of seismic analyses to determine crust and mantle properties around Hawaii thereby revealing structure with unprecedented detail (e.g. Wolfe et al., 2009).

The continuous recordings, however, provided much more than the waveforms needed to image Hawaii's seismic structure. Somewhat unexpectedly, we were able to compile free oscillation spectra of a quality previously not seen on unburied seismometers. Our network also produced excellent pressure recordings of the enigmatic tsunami that was triggered by the magnitude 8.3 15 November 2006 Kuril islands earthquake. The relatively few, near-coastal tide gauge stations in the western Pacific Ocean recorded peak-to-peak tsunami heights of no more than 50 cm, and it caused no significant damage in Japan. Yet, after crossing the North Pacific Ocean, it reached a height of over 1.5 m in Crescent City, CA, causing damage to docks of nearly $2 million. The PLUME DPG network documents a marked amplitude disparity between northern and southern stations consistent with either source radiation effects or shadowing effects by the islands. The tsunami was recorded best on the DPGs but some horizontal seismometer components also show a signal.

The PLUME instruments also recorded the development of 2006 Hurricane Ioke and its release of energy along its journey. This long-lived category 5 hurricane was the largest recorded hurricane to form in the Central Pacific Ocean. Unlike 2005 Hurricane Katrina, which generated the most seismic energy when it made landfall as a weakened hurricane, Hurricane Ioke did not encounter a significant coastline. Yet, we recorded strong seismic signals with very patchy characteristics throughout the network. The seismic signals on the lee-side of the Hawaiian islands are consistent with the small wave heights recorded on near-coastal wave buoys. In an area to the far westsouthwest of Oahu, on the other hand, we recorded extremely strong signals, implying large waves that were not otherwise detected, due to lacking wave buoys in that area.

References:

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