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TIDE-TSUNAMI INTERACTIONS

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ABSTRACT

In this paper we investigate important dynamics defining tsunami enhancement in the coastal regions and related to interaction with tides. Observations and computations of the Indian Ocean Tsunami usually show amplifications of the tsunami in the near-shore regions due to water shoaling. Additionally, numerous observations depicted quite long ringing of tsunami oscillations in the coastal regions, suggesting either local resonance or the local trapping of the tsunami energy. In the real ocean, the short-period tsunami wave rides on the longer-period tides. The question is whether these two waves can be superposed linearly for the purpose of determining the resulting sea surface height (SSH) or rather in the shallow water they interact nonlinearly, enhancing/reducing the total sea level and currents. Since the near–shore bathymetry is important for the run-up computation, Weisz and Winter (2005) demonstrated that the changes of depth caused by tides should not be neglected in tsunami run-up considerations. On the other hand, we hypothesize that much more significant effect of the tsunami-tide interaction should be observed through the tidal and tsunami currents. In order to test this hypothesis we apply a simple set of 1-D equations of motion and continuity to demonstrate the dynamics of tsunami and tide interaction in the vicinity of the shelf break for two coastal domains: shallow waters of an elongated inlet and narrow shelf typical for deep waters of the Gulf of Alaska.

CONFIRMATION AND CALIBRATION OF COMPUTER MODELING OF TSUNAMIS PRODUCED BY AUGUSTINE VOLCANO, ALASKA

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ABSTRACT

Numerical modeling has been used to calculate the characteristics of a tsunami generated by a landslide into Cook Inlet from Augustine Volcano. The modeling predicts travel times of ca. 50-75 minutes to the nearest populated areas, and indicates that significant wave amplification occurs near Mt. Iliamna on the western side of Cook Inlet, and near the Nanwelak and the Homer-Anchor Point areas on the east side of Cook Inlet. Augustine volcano last produced a tsunami during an eruption in 1883, and field evidence of the extent and height of the 1883 tsunamis can be used to test and constrain the results of the computer modeling. Tsunami deposits on Augustine Island indicate waves near the landslide source were more than 19 m high, while 1883 tsunami deposits in distal sites record waves 6-8 m high. Paleotsunami deposits were found at sites along the coast near Mt. Iliamna, Nanwelak, and Homer, consistent with numerical modeling indicating significant tsunami wave amplification occurs in these areas.

EXPERIMENTAL MODELING OF TSUNAMI GENERATED BY UNDERWATER LANDSLIDES

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ABSTRACT

Preliminary results from a set of laboratory experiments aimed at producing a high-quality dataset for modeling underwater landslide-induced tsunami are presented. A unique feature of these experiments is the use of a method to measure water surface profiles continuously in both space and time rather than at discrete points. Water levels are obtained using an optical technique based on laser induced fluorescence, which is shown to be comparable in accuracy and resolution to traditional electrical point wave gauges. The ability to capture the spatial variations of the water surface along with the temporal changes has proven to be a powerful tool with which to study the wave generation process.

In the experiments, the landslide density and initial submergence are varied and information of wave heights, lengths, propagation speeds, and shore run-up is measured. The experiments highlight the non-linear interaction between slider kinematics and initial submergence, and the wave field.

The ability to resolve water levels spatially and temporally allows wave potential energy time histories to be calculated. Conversion efficiencies range from 1.1%-5.9% for landslide potential energy into wave potential energy. Rates for conversion between landslide kinetic energy and wave potential energy range between 2.8% and 13.8%.

The wave trough initially generated above the rear end of the landslide propagates in both upstream and downstream directions. The upstream-travelling trough creates the large initial draw-down at the shore. A wave crest generated by the landslide as it decelerates at the bottom of the slope causes the maximum wave run-up height observed at the shore.

SAGE CALCULATIONS OF THE TSUNAMI THREAT FROM LA PALMA

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ABSTRACT

With the LANL multiphysics hydrocode SAGE, we have performed several two-dimensional calculations and one three-dimensional calculation using the full Navier-Stokes equations, of a hypothetical landslide resembling the event posited by Ward and Day (2001), a lateral flank collapse of the Cumbre Vieja Volcano on La Palma that would produce a tsunami. The SAGE code has previously been used to model the Lituya Bay landslide-generated tsunami (Mader & Gittings, 2002), and has also been used to examine tsunami generation by asteroid impacts (Gisler, Weaver, Mader, & Gittings, 2003). This code uses continuous adaptive mesh refinement to focus computing resources where they are needed most, and accurate equations of state for water, air, and rock. We find that while high-amplitude waves are produced that would be highly dangerous to nearby communities (in the Canary Islands, and the shores of Morocco, Spain, and Portugal), the wavelengths and periods of these waves are relatively short, and they will not propagate efficiently over long distances.