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Near Real-Time Tsunami Detection Using Satellite Altimetry

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Early warning of an impending tsunami threat is heavily dependent on the detection of the tsunami in the open ocean away from shore. The wave amplitude in the open ocean is small (generally much less than one meter), making it difficult to distinguish the tsunami signal from other ocean variability until the tsunami approaches the shore and grows rapidly in amplitude. Recent studies have demonstrated, however, that satellite observations can be used to detect the tsunami in the open ocean while the wave amplitude is still relatively small. Here, we present methods for objective and quantifiable detection of tsunamis in the sea surface height and radar backscattering strength data obtained by satellite altimeters. We focus on the 2011 Tohoku tsunami, which devastated Japan and affected coastal populations all around the Pacific Ocean. While the lead-time was not sufficient for use in warning coastal populations in Japan, satellite altimetry observations of the tsunami in the open ocean could have been used to improve predictions and warnings for other affected areas.

By comparing to both the results of the Method of Splitting Tsunami (MOST) model and historical satellite altimeter data, we use near real time satellite altimeter measurements to demonstrate the potential for detecting the 2011 Tohoku tsunami in the open ocean within a few hours of the tsunami being generated. Comparisons between the MOST model and satellite altimeter sea surface height measurements serve two purposes related to the early warning and detection of tsunamis. First, such tests on the lag time between model and satellite ocean observations could lead to better projections from MOST. By using the near real-time satellite altimetry provided by NASA/JPL PO.DAAC for such a comparison to the MOST model data, the tsunami signal can be definitively detected in the open ocean and the observations can potentially be used to improve MOST model estimates for areas affected by the impending tsunami. Secondly, such comparisons could be used to aid in near real-time to determine the presence of the tsunami signal in the satellite altimetry data. In addition, we compare radar backscatter strength data obtained by satellite altimeters during the 2011 Tohoku tsunami to historical satellite altimetry data to demonstrate the ability to detect the tsunami signal in the open ocean due to changes in ocean surface roughness, thus supporting previously published results for the 2004 Sumatra-Andaman tsunami and 2010 Chilean tsunami. The findings presented here challenge the previously held idea that the current constellation of satellite altimeters is not appropriate for use for early tsunami detection and warning.