

Free mode excitation of the Pacific Basin during the 2011 large Tohoku tsunami

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Several studies showed that the March 2011 large tsunami offshore northeastern Japan caused long oscillations in the Pacific Basin persisting almost 4-5 days. Analysis of tide gauge records of this tsunami revealed that relatively high-energy waves caused by this tsunami persisted at least 3 days in the Pacific Basin. Therefore, speculations were made in the tsunami community attributing these long energetic oscillations to free-mode excitation of the Pacific Basin. Free mode excitation is the main source of long oscillations and sloshing inside closed or semi-closed basins which results in long-duration and energetic waves in the basins. This is typical of harbors and lakes. However, when the source is large like the one for the March 2011 Japan tsunami, free-mode excitation may occur in large basin like the Pacific Basin. It is clear that a basin as big as the Pacific one can have several eigen modes and that a particular tsunami source can excite one or some of the free modes.

To examine this hypothesis, here first we apply a numerical algorithm to estimate the free modes of the Pacific Basin. This algorithm is based on numerical modeling of tsunami and spectral analysis of the wave time-series recorded at different locations. We then study the spectral characteristics of the selected tide gauge records of the March 11, 2011 Tohoku tsunami to examine if some of the free modes of the basin are present in the tide gauge records or not. Comparative study is performed to determine the contribution of the free mode excitation of the basin to the total energy of the March 2011 tsunami.

Keywords: March 2011 Tohoku earthquake, Pacific Basin, Free mode, Spectral analysis, Sloshing, numerical modeling