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Observing and estimating of intensive triad interaction occurrence in very shallow water

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Abstract

In this study, a series of field measurements were carried out to investigate triad interactions of spectral peak in near shore. The water level fluctuations were recorded at 5 stations with depths varying from 0.8 to 5 meters along a shore-perpendicular transect at sandy coasts of Nowshahr, located in the southern Caspian Sea coast. Two storms with significant wave height of approximately 1.4 m were observed during the measurement period.
Using bispectral analysis, a new quantitative index is proposed to investigate temporal and spatial intensity of nonlinear interaction between spectral peak and other harmonics. The proposed index was evaluated for time series of water level data and compared with the bicoherence value of self-spectral peak triad interaction (SSPT); $b^2(f_p, f_p)$. Comparing to SSPT, the proposed new index includes all positive and negative triad interactions with spectral peak. The relative depth, $k_p d$, of non-breaking waves varied from 0.25 to 2.00 along the transect during the study period, where k_p is the wave-number and d is the water depth. In general, SSPT increased by decreasing $k_p d$; however, the results showed that in two shallow stations the maximum SSPT did not correspond to the lowest values of $k_p d$. A considerable time lag was observed between occurrence of the most intensive triad interactions and termination of wave breaking in post storm condition. Furthermore, the intensive triad interactions happened several hours after the largest Ursell numbers of non-breaking waves.

Keywords: intensive triad interaction, spectral peak, bicoherence, field investigation

1. Introduction

As waves propagate toward shallow waters, orbital motions of particles are disturbed by sea bed and asymmetrical profile of surface waves are observed. As a result, waves become skewed and then asymmetrical and other consequent phenomena such as shoaling, breaking and triad interactions affect the wave profile and energy spectrum, significantly.
One of the most important reasons for nonlinearity of waves is the second order interaction (triad) which is usually more evident in shallow water and can reach to resonant state before wave breaking in shoaling zone (Elgar et al., 1995). Also, waves can interact nonlinearly at higher order in deep waters. The freak waves are evaluated as a result of resonant third order nonlinear (Mori and Yasuda, 2000).
Phillips (1960) showed theoretically, that the second-order Stokes wave is an outcome of a nonlinear interaction of two primary wave trains. Using laboratory experiments, Longuet-Higgins and Smith (1966) confirmed this theory.

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