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Effects of Shelves on Amplification of Long Waves Generated by Atmospheric Pressure Differences

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Meteotsunami is a type of long period ocean wave generated by different types of meteorological disturbances such as atmospheric gravity waves, spatial and temporal pressure distributions and squall lines. The main idea behind the occurrence of this type of long wave is that low atmospheric pressure leads to static water level rise in a part of the marine area and high atmospheric pressure leads to static water level drop in another zone. Then, it causes deformation of the water level throughout the entire sea area. The relation between the pressure difference and change of water level from normal position ($\eta = 0.99\Delta\mathrm{P}$ where η is the water level change (cm) according to the pressure difference from normal pressure $\Delta\mathrm{P}$) can be used to determine the sea level deformation. The relation represents that 1 hPa decrease in air pressure causes 1 cm rise in mean sea level. Due to the spatial and temporal changes of atmospheric pressure, the respective small amplitude long waves propagate along the entire marine area. This type of tsunami-like waves can propagate through long distances and can also be amplified due to resonant effects in the enclosed basins, offshore shelves, and nearshore/offshore coastal morphology. Therefore, it can result in considerable amplifications and causes unexpected effects in some coastal regions. This study is mainly focused on understanding of amplification of long waves generated by atmospheric pressure differences when they encounter the offshore shelves while it is propagating towards to the shore. The problem is investigated by numerically solving nonlinear shallow water equations by using regular shaped basins with different depth and shelf characteristics. In all cases, the rectangular shape large basin is triggered by spatial and temporal distributions of atmospheric pressure. The water depth and shelf formation is changed for different cases. Initially, a deep flat bottom basin is used in simulations and the reference data of water surface fluctuations are obtained. In the other cases, a shelf is located at one of the sides of the basin. Two different depths of the shelf (shallow and deep) are selected in two different simulations. Furthermore, the slope from deep sea to the shelf edge is selected as steep or mild. Hence, at least five different cases of basin bathymetries are simulated. The time histories of water surface fluctuations at selected numerical gauge points are computed in each simulation and those are compared to identify the effects of different bottom topographies on the amplification of long waves. The results are compared, discussed and presented. Using the experience from simulations, the possible effects of shelves on amplification of the long waves are discussed. Furthermore the results are used to understand the reasons of the abnormal wave event which is observed on June 27, 2014 at Odessa, the results of the investigation of shelf effect are compared with this real event. Finally, the results and discussions are generalized for the possible similar events in other regions where the shelf effect may be responsible for amplification of long waves.

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