



## **Abnormal storm waves in the East/Japan Sea in winter: Generation process and hindcasting**

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The surface winds over the East/Japan Sea (EJS) vary distinctively with the seasons, blowing mild or moderate and variable in summer and very strong due to the East Asian monsoon and storms in winter. In winter atmospheric low pressure (extra-tropical cyclones) reacting with and passing through the EJS can sometimes cause abnormal storm waves on the Korean and Japanese coasts of the EJS.

In February 2008, abnormal storm waves due to a developed atmospheric low pressure system propagating from the west off Hokkaido, Japan, to the south and southwest throughout the EJS caused extensive damage along the central coast of Japan on the EJS side and along the east coast of Korea. The accompanying high waves were mainly swells that developed with sufficient fetch over the EJS and lasted more than a day. The observed maximum wave heights and periods along the central coast of Japan were 6.40 m and 10.2 sec at Naoetsu, 9.92 m and 16.2 sec at Toyama, 4.22 m and 14.2 sec at Fushiki Toyama, and 7.73 m and 13.2 sec at Wajima, while the observed maximum wave height and peak wave period at Anmok on the central east coast of Korea were 5.5 m and 14.17 s at 11:00:00 UTC (20:00 KST) on 24 February 2008. During February of that year, the abnormal storm waves at Toyama Bay, which are called 'Yorimawari Waves' in Japan, caused some of the most severe coastal damage ever induced by such conditions.

Since the abnormal storm waves are a key factor not only in coastal damage and disaster, but also in the design of coastal structures, it is critical to estimate these waves accurately, taking into account the meteorological conditions and topographical and bathymetric effects. Therefore, in this study we describe the study results of generation mechanisms and characteristics of abnormal storm waves in the EJS in terms of meteorological conditions and numerical simulations.

The generation processes of these abnormal storm waves during rough sea states were studied and the formation of abnormal storm waves was hindcasted using an atmosphere-wave coupled modelling system. Wind waves and swell due to developed low pressures were found to be the main components of abnormal storm waves. The meteorological conditions that generate these waves are classified into three patterns based on past literature that describes historical events as well as on numerical modelling. The speed and track of a low-pressure system (an extra-tropical cyclone) and the interaction with another pressure system in the East Asia and north Pacific regions are the main factors in the classification. In hindcasting the abnormal storm waves, a bogussing scheme originally designed to simulate a tropical storm in a mesoscale meteorological model was introduced into the modelling system to enhance the resolution of developed low pressures. The modelling results with a bogussing scheme showed improvements in terms of resolved low pressure, surface wind field, and wave characteristics obtained with the wind field as an input.