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Development of Operational Wave-Tide-Storm surges Coupling Prediction System

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The Korean Peninsula is surrounded by the Yellow Sea, East China Sea, and East Sea. This complex oceanographic system includes large tides in the Yellow Sea and seasonally varying monsoon and typhoon events. For Korea's coastal regions, floods caused by wave and storm surges are among the most serious threats. To predict more accurate wave and storm surges, the development of coupling wave-tide-storm surges prediction system is essential. For the time being, wave and storm surges predictions are still made separately in KMA (Korea Meteorological Administration) and most operational institute. However, many researchers have emphasized the effects of tides and storm surges on wind waves and recommended further investigations into the effects of wave-tide-storm surges interactions and coupling module. In Korea, especially, tidal height and current give a great effect on the wave prediction in the Yellow sea where is very high tide and related research is not enough.
At present, KMA has operated the wave (RWAM : Regional Wave Model) and storm surges/tide prediction system (STORM : Storm Surges/Tide Operational Model) for ocean forecasting. The RWAM is WAVEWATCH III which is a third generation wave model developed by Tolman (1989). The STORM is based on POM (Princeton Ocean Model, Blumberg and Mellor, 1987). The RWAM and STORM cover the northwestern Pacific Ocean from 115°E to 150°E and from 20°N to 52°N. The horizontal grid intervals are 1/12° in both latitudinal and longitudinal directions.
These two operational models are coupled to simulate wave heights for typhoon case. The sea level and current simulated by storm surge model are used for the input of wave model with 3 hour interval. The coupling simulation between wave and storm surge model carried out for Typhoon Nabi (0514), Shanshan(0613) and Nari (0711) which were effected on Korea directly. We simulated significant wave height simulated by wave model and coupling model and compared difference between uncoupling and coupling cases for each typhoon. When the typhoon Nabi hit at southern coast of Kyushu, predicted significant wave height reached over 10 m. The difference of significant wave height between wave and wave-tide-storm surges model represents large variation at the southwestern coast of Korea with about 0.5 m. Other typhoon cases also show similar results with typhoon Nabi case. For typhoon Shanshan case the difference of significant wave height reached up to 0.3 m. When the typhoon Nari was affected in the southern coast of Korea, predicted significant wave height was about 5m. The typhoon Nari case also shows the difference of significant wave height similar with other typhoon cases. Using the observation from ocean buoy operated by KMA, we compared wave information simulated by wave and wave-storm surges coupling model. The significant wave height simulated by wave-tide-storm surges model shows the tidal modulation features in the western and southern coast of Korea. And the difference of significant wave height between two models reached up to 0.5 m. The coupling effect also can be identified in the wave direction, wave period and wave length. In addition, wave spectrum is also changeable due to coupling effect of wave-tide-storm surges model.
The development, testing and application of a coupling module in which wave-tide-storm surges are incorporated within the frame of KMA Ocean prediction system, has been considered as a step forward in respect of ocean forecasting. In addition, advanced wave prediction model will be applicable to the effect of ocean in the weather forecasting system. The main purpose of this study is to show how the coupling module developed and to report on a series of experiments dealing with the sensitivities and real case prediction of coupling wave-tide-storm surges prediction system.