Effect of the Sea Level Variation on Storm Surge in the East China Sea

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ABSTRACT

A three-dimensional high-resolution hydrodynamic model (ECOMsed) was used to analyze the effects of sea level variations on the storm surge and the check water levels along the coast of East China Sea (ECS). Based on IPCC AR4 A1B scenario, the sea level inter-annual variation with 4-8 years period performed noticeably in middle of the 21st century, and sea level reached the highest level in the 2060 year. The “nominal storm surge” combined with the relevant monthly sea level in the 2060 year in 21st century was simulated in the East China Sea (ECS) by 1989-2008 typhoon cases. The model results exhibited that sea level variations play a significant role on storm surge evolution. Residual elevation difference performed 10 cm in the three tide gauges, and equated to the one fifth of the ECS sea level variability. The influence of sea level variations mapped the geographical variability. The elevation range and the maximal residual elevation increased along the northern coastline of the Jiangsu province and Liaodong Peninsula. The check water level in the ECS coast could reach to 4.5m in 21st century.

KEY WORDS: storm surge; sea level variations; East China Sea; IPCC A1B scenario.

INTRODUCTION

The climate change and the rising sea level are concerned by the international governments and scientists nowadays. As human activities influence on marine and atmospheric processes, the sea level variations become the major issues. There will be more than millions of people suffered from the sea level rise in the eighty decade of 21st century, reported in the IPCC Fourth Assessment Report (IPCC, 2007). Storm surge disaster resulted in huge casualties and enormous economic loss along China coastal area in the last decades. The development of social industry and agriculture and so as the increase in infrastructure, the disaster loss would be heavier in storm surge. Then, it is an important issue in understanding storm surge change with consideration of sea level variations. The storm surge elevation is affected by changing topography, and the nonlinear interaction between the tidal and storm surge (Duan et al., 2005; Jiang and Sun, 2002; Huang and Deng, 2007). Former research mainly focused on the effects of long-term sea-level variation on check water levels of multiyear return periods (Du et al., 2007). Yu et al. (2007) simulated tide waves with 1 m mean-sea-level rise, and they presented that the astronomical tidal elevation could change 12-16 cm. Gao et al. (2008) discovered that the surge elevation changed little with mean sea level rise and differed non-uniformly on 5 tide gauges during the three different typhoon cases.

Woodworth and Blackman (2002) concluded that the annual maximum surge-at-high-water was larger in the late 18th, late 19th and late 20th centuries than for most of the 20th century, qualitatively consistent with the long-term variability in storminess from meteorological data. It was reported that the future tropical cyclones (typhoons and hurricanes) will become more intense. Some delta region in Asia will be threat by more storm surge attributed to the sea level rise (IPCC, 2007). Based on the assessment results of IPCC AR4 relative sea level (RSL) rising, Liu (2004) reported storm surge would stronger due to higher RSL and more tropical cyclones. Cui and Shi (2001) found that intensity of storm surges in the China seas increased, although less surges was observed in the 1990’s.

Former analysis focused on the effect of sea-level rise on storm surge. The sea-level variations consist of seasonal, inter-decadal and secular variations. Therefore, these remarkable variations should be considered in storm surge research. In these numerical simulations, the sea level during every typhoon seasons, especially from May to October, act as an important indicts. The influence of sea level variations on storm surge in the East China Sea (ECS) was illustrated considering of the IPCC SERS A1B scenario (IPCC, 2007).

DATA AND MODEL

Data

Our storm surge simulation in ECS (117-131°E, 24-41°N) used the high resolution topography data which was interpolated from the measuring data provided by the Chinese Navy. The 4-time daily sea level pressure