RELATION BETWEEN SHAPE OF EXTREME WAVE HEIGHT DISTRIBUTIONS AND WEATHER SYSTEM

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INTRODUCTION

The extreme value analysis of wave height has been used to estimate design value of coastal structure design. The procedure of extreme value analysis is standardized but distributions change highly depending on target locations. A long-term atmospheric reanalysis is useful for engineering applications to complement observation data. Although the reanalysis dataset was insufficient for coastal engineering applications due to shorter length of period and sparse spatial resolution of modeling, recent reanalysis (e.g. CFSR) give reasonable performance for engineering applications as wave climate both accuracy and length of periods (e.g. Menendez and Losada, 2017).

This study analyzes characteristics of extreme wave heights and understands relation between extreme wave height distribution and its dependence on weather systems based on long-term analysis and observed data.

METHODS

The high resolution long-term wave analysis was performed forced by 55 years atmospheric reanalysis (JRA-55) from 1958 to 2012. The wave hindcast was conducted by WaveWatchIII v4.18 over the globe (Δx=60km) and downscaled up to Δx=7km in the East Asia and Japan region. The extreme value analysis for wave heights was also conducted over the domain using generalized extreme value distribution (GEV). Additionally, tropical cyclones and extra tropical cyclones were tracked by pressure and wind speed and archived to database. The modeled characteristics of extreme wave heights were analyzed by the storm tracks and their intensity. The modeled results of extreme waves were also validated by the long-term buoy data around Japan.

RESULTS AND DISCUSSION

Although the tropical cyclone tracks are archived systemically by WMO, extra tropical cyclone tracks are not well archived and analyzed. We analyzed historical trends and variabilities of intensity and tracks of tropical and extra tropical cyclones based on JRA-55 data. The extra tropical cyclone in the winter has been intensified the last 55 years but less change of frequency. The similar analysis was applied for tropical cyclones.

The extreme value analysis for wave height Hs were applied over the domain. The seasonal changes of extreme Hs were analyzed detail. Figure 1 shows typical extreme wave height distributions in the Pacific (●) and the Sea of Japan (▲). Although the extreme waves are generated by tropical cyclone in the Pacific in summer, they are generated both extra tropical cyclone and tropical cyclone in the Sea of Japan through the year. These source of extreme events by different atmospheric systems give characteristics of extreme value distribution of wave heights. The sensitivity of shape, scale and location parameters of GEV distribution were analyzed based on atmospheric systems including storm intensity and tracks. The scale and location parameters show significant dependence on wave climate characteristics related to atmospheric source and storm tracks but the shape parameters depend on local storm intensity. For example, Figure 2 shows spatial distribution of scale parameter of GEV distribution for extreme Hs in the East Asia. The scale parameter of GEV is large (>2) in tropical cyclone dominated area but it is small (<1.5) in the extra tropical cyclone dominated areas. The location parameter shows similar tendency but it also depends on fetch or wave age. The characteristics of extreme Hs can explain by characteristics of regional atmospheric systems.

The understanding relation between extreme wave climate and its source of atmospheric system is important to estimate accurate local coastal structure design conditions. Detail of modeling, data analysis and validation will be presented at the conference.

REFERENCES

J., Menendez et al. (2017). GOW2: A global wave hindcast for coastal applications, *Coast. Eng.*, 124, 1-11.

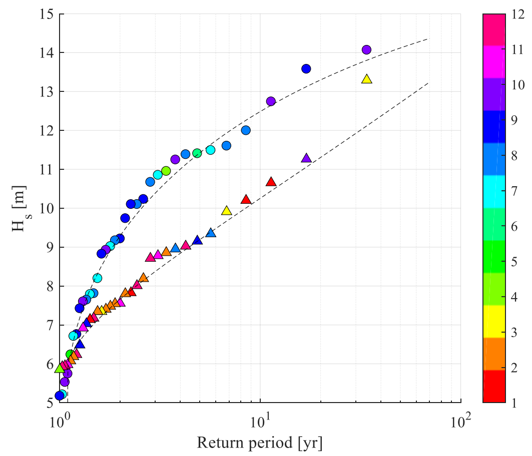

Figure 1 - Seasonal dependence of max Hs at two typical locations (circle: the Pacific, triangle: the Sea of Japan side around Japan shown in Figure 2). The dashed line indicates GEV distribution and color indicates occurred month.

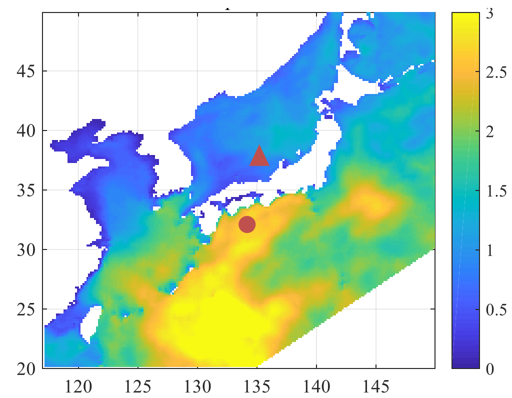

Figure 2 - Spatial distribution of scale parameter of GEV distribution for Hs based on high resolution wave hindcast.