ASSESSMENT OF UNCERTAINTY IN ESTIMATING FUTURE EXTREME STORM SURGE EVENTS IN OSAKA BAY USING LARGE ENSEMBLE TYPHOON DATA

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INTRODUCTION AND PURPOSE

Risk assessment of low-frequency catastrophic events requires observation/simulation data of a large number of disaster events. When we consider the risk of storm surge, high waves, and strong wind caused by tropical cyclone, the way of stochastic tropical cyclone model approach has been conducted. The stochastic model can create a lot of synthetic tropical cyclone track data which has same statistic characteristics with historical data got in short period. In addition, climate change impact assessment requires comparison of many ensemble results (models and scenarios) in order to consider the uncertainty of future projections. However, there are few proposals for stochastic models that can predict the future climate change effects. Even if a large amount of tropical cyclone track data is produced, it is practically impossible to simulate disasters for all of them. For this reason, methods for calculating storm surge and storm waves using ANN models and regression models have been proposed, but the validity of data screening using such simplified methods needs to be further investigated. This study examines the validity of the newly developed regression model and its applicability to the screening of hazardous storm surge events. Future changes in storm surge risk in Osaka Bay are analyzed by combining the regression model results with detailed numerical methods.

METHODS

We calibrated the stochastic tropical cyclone model (Nakajo et al., 2014) based on tropical cyclone track data from d4PDF, a large ensemble GCM dataset. Model biases of GCM in the d4PDF were corrected by comparison with observation data, IBTrACS. In addition to the stochastic model PTC calibrated with GCM results of past reproductions, 6 models, FTCs of future projections were also constructed.

From the 25,000 years PTC results, 3,543 cases passing around Osaka Bay were randomly selected, and we simulated storm surge using nonlinear long wave equations in order to make regression model for maximum storm surge height. The model coefficients are divided according to whether the typhoon passes through the hazardous or navigable semicircle of the target area. The validity of screening by the regression model was examined by comparing the reproducibility of the cumulative frequency distribution of maximum storm surge height with other selection methods, as well as by comparing the reproducibility of the maximum storm surge height directly to simulation results. Finally, detailed numerical simulations were conducted for a total of approximately 3,500 cases screened by the regression model from 10,000 years PTC and FTCs to estimate low-frequency storm surge event in Osaka Bay.

RESULTS AND CONCLUSION

The reproducibility of regression model was improved by division of dataset based on tropical cyclone track and selection of regression term for determination of model coefficient. The cumulative frequency distribution of maximum storm surge height based on data screening using the proposed regression model was in high agreement with the results obtained when all cases were analyzed by numerical simulation. The detailed analysis of the tropical cyclone scenarios selected by the regression model showed regional differences in the amount of future changes and their uncertainty ranges of the low-frequency storm surge at each location in Osaka Bay (e.g. Figure 1). The distribution patterns of storm surge height in Osaka Bay varied significantly in the 6 FTCs results (the reverse sign change was also confirmed), although the 3 FTCs results were almost same.

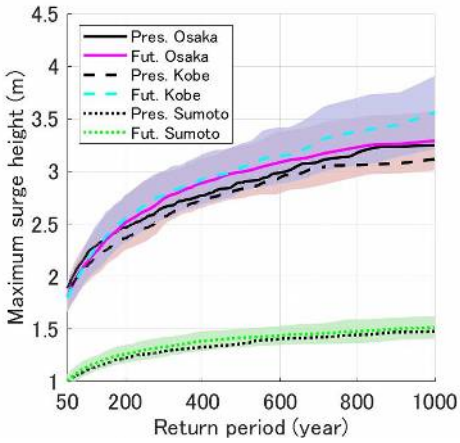

Figure 1 - Future change of return period of maximum surge height (shading is uncertainty range)

REFERENCES

S. Nakajo et al. (2014), Global Stochastic Tropical Cyclone Model Based on Principal Component Analysis and Cluster Analysis, J. Appl. Meteo. Clim., Vol. 53(6), pp. 1547-1577.