

# EXTREME STORM SURGES DUE TO GLOBAL WARMING IN EAST ASIA BASED ON A MAXIMUM POTENTIAL STORM SURGE MODEL

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## INTRODUCTION

Based on climate projections considering global warming, various impact assessments have been made for temperature, precipitation, water resources, and sea-level rise (e.g., IPCC AR6, 2021). In coastal areas, sea-level rise is mainly important as a gradual change in the coastal environment. At the same time, extreme events such as tropical cyclones (TC) are expected to significantly impact storm surges. Global warming is expected to affect the characteristics of TCs, such as frequency, intensity, and track path. However, future changes in TC characteristics are still uncertain on both regional and global scales.

## METHOD

This study aims to estimate the maximum potential storm surge height (MPS) along bays in East Asia and Japan using data from the maximum potential intensity (MPI) of a TC. Here, the maximum potential represents the estimated maximum given the background environmental conditions. The background environmental conditions in the MPI and MPS indicate the kinematic and thermodynamic balance during the typhoon's maximum development and the worst path and translation speed of the TC for storm surge. Therefore, the MPS projects storm surges from a monthly averaged atmospheric environment without Global Climate Model (GCM) resolution restrictions. The MPS model consists of two steps: the first is to calculate the MPI fields of TCs in GCM climate simulations, and the second step is to calculate the MPS using the MPI data (Mori et al., 2021). The atmospheric data for MPI estimation was derived from Japanese GCM (MRI-AGCM) climate simulations.

## RESULTS

In order to examine future changes in the MPI in the Western North Pacific (WNP), we analyzed the latitudinal characteristics of future changes in the mean (total ensemble) MPI of the large ensemble climate simulation dataset, so-called d4PDF, during the TC season and September. For September, the month with the largest future changes, the maximum future changes in the MPI are observed in the 30-40°N band, with average changes of -7.8 hPa and -16.5 hPa for the +2K and +4K warming conditions. Therefore, future changes in TC intensity in the WNP strongly depend on both the month and latitude band.

We have used the 150-year climate scenario from 1950 to 2100 to perform the MPS analyses for the targeted bays in East Asia and Japan. The MPS are calculated using the monthly mean MPI values of the four nearest grid cells (pressure and wind speed) based on the d4PDF large climate ensemble and the other climate projections. In Figure 1, the time series of the MPS are shown for the Bohai Sea in China. Figure 1 shows the increasing trend

in the future. The MPS in the RCP8.5 climate scenario run shows a monotonically increasing trend, while (the MPS in) the RCP2.6 run increases initially but stabilizes around the middle of the 21st century. Similar projections are obtained for most of the East Asian bays. Furthermore, the gray horizontal line in Figure 1 shows the maximum storm surge from the dynamic storm surge simulation used for calibrating the MPS model. The maximum MPS (present and future) exceeds the dynamically simulated maximum storm surges in most of the East Asian bays.

## CONCLUSION

This study evaluates the maximum potential intensity and a storm surge of TCs for bays in East Asia and along the Pacific coast of Japan using the MPI-MPS model framework. Future changes of the MPI are analyzed for the WNP using two climate projection datasets generated by the high-resolution MRI-AGCM3.2H model: 150-year continuous scenario runs (HighResMIP) and a large ensemble (d4PDF/d2PDF). Future change trends and spatial characteristics are evaluated with sensitivity analyses for different global warming scenarios.

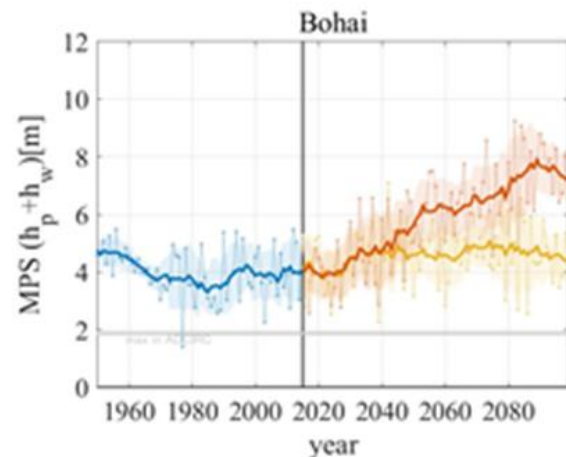


Figure 1. Time-series comparisons of the maximum potential storm surge height (MPS) for Bohai Sea during TC-season for the 150-year scenario dataset. (blue, historical; yellow: RCP2.6; orange: RCP8.5)

## REFERENCES

Mori, N., N. Ariyoshi, T. Shimura, T. Miyashita, J. Ninomiya (2021): Future projection of maximum potential storm surge height at three major bays in Japan using the maximum potential intensity of a tropical cyclone, *Climatic Change*, 164, Article number: 25.