

FUTURE CHANGES IN SPECTRAL WAVE CLIMATE AROUND JAPAN UNDER GLOBAL WARMING

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INTRODUCTION

Future projections of ocean wave climate related with global warming has been conducted for the assessment of climate change impacts on coastal disaster, beach morphology, and coastal structure design. The study by international comparison project of future global wave climate projection indicated that approximately 50% of the world's coastline is at risk from wave climate change (Morim et al., 2019).

In terms of ocean around Japan, Shimura et al. (2016) analyzed CMIP5 based wave climate projection dataset and showed significant decreases in mean wave heights around Japan under global warming condition. The previous studies on future wave climate assessment have been based on the data of global scale, and the computing resolution is not enough for the assessment of coastal wave climate with ~ 10 km scale. Furthermore, wave climate projection studies have been using mainly averaged significant wave heights as wave climate statistics and analysis on wave period and direction is not enough proceeded. In this study, we conduct the high-resolution future wave climate projection in the East Asia region and detail analysis on wave climate based on two-dimensional wave spectra in addition to conventional wave statistics (significant wave height).

OUTLINE OF RESEARCH

Climate simulations by the Atmospheric Global Climate Model developed by the Japanese Meteorological Research Institute (MRI-AGCM) are used for wave climate projections. In order to assess the uncertainty in projection, ensemble experiment of MRI-AGCM consist of simulations with different spatial resolutions, initial conditions, future greenhouse gas concentration scenarios, boundary conditions.

The wave climate projection is conducted using the wave model WAVEWATCHIII. WAVEWATCHIII is forced with the surface wind data and the sea ice fields by MRI-AGCM. The experimental period is 25 years; 1979 - 2003 for present climate and 2075 - 2099 for future climate. The spatial resolution of MRI-AGCM is approximately 20 km. The three domains are determined using a nesting process for the Global domain (spatial resolution: 30 min), the western North Pacific domain (10 min), and Japanese coastal domain (4 min). The boundary of the finest domain around Japan is approximately 100 km from the Japanese coast.

The spectral wave climate is represented by temporal averaged two-dimensional (direction-frequency) wave spectra. Temporal averaged significant wave height, mean wave period, and mean wave direction are newly defined by based on temporal-averaged wave spectra. Future changes in the wave climate statistics (the temporal averaged wave spectra, significant wave height, mean period, and mean

direction) around Japan are addressed.

RESULTS AND DISCUSSION

The temporal averaged significant wave heights and mean wave periods around Japan would be decreased in the future climate (RCP8.5 scenario; business as usual scenario) by 10% and 3%, respectively. As an exception, in the sea ice covered region, wave heights and wave period would be increased due to future sea ice loss and increases in fetch. The magnitude of decreases in wave heights under the RCP2.6 (the mitigation scenario) is less than that under RCP8.5. Temporal average of wave spectra was analyzed in addition to the bulk wave parameters. Energy decreases all over frequency-direction domain lead to decreases in climatology of wave heights and periods around Japan (Fig. 1). In the Japan Sea side, the larger magnitude of energy decreases at clock-wise direction of mean wave direction causes the future anti-clock wise changes in mean wave direction by 3.5° . In the Pacific side of east Japan, mean wave direction would be changed clock-wise by 4.5° because of future energy decreases at the peak of mean wave spectra. Future changes in wave height, period and direction can be discussed consistently owing to analysis on the mean wave spectra.

REFERENCES

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Shimura et al. (2016): Variability and future decreases in winter wave heights in the Western North Pacific, *Geophysical Research Letters*, 43, pp. 2716-2722.

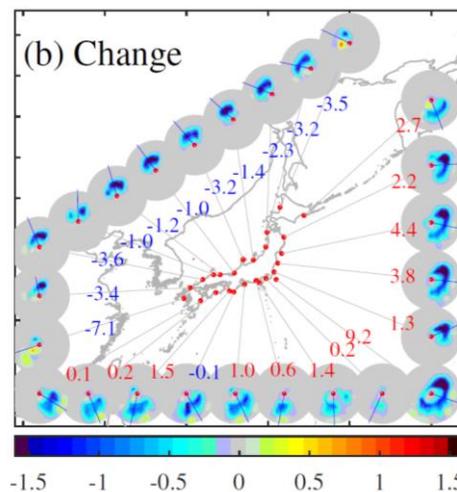


Figure 1. Future changes in temporal averaged two-dimensional wave spectra around Japan (unit: $10^{-3} \text{ m}^2 / (\text{s} \cdot \text{rad})$). The numbers indicate the future changes in wave direction (red: clockwise, blue: anti-clockwise).