IMPACT ASSESSMENT OF CLIMATE CHANGE ON COASTAL HAZARDS DUE TO WINTER CYCLONE AROUND JAPAN USING LARGE ENSEMBLE DATABASE

Junichi Ninomiya, Kanazawa University, jnino@se.kanazawa-u.ac.jp
Yuya Taka, Kanazawa University, yt.gazette@gmail.com
Nobuhito Mori, Kyoto University, mori.nobuhito.8a@kyoto-u.ac.jp

INTRODUCTION

IPCC AR5 reported that the extreme events like tropical cyclone, heavy rainfall and so on will be strengthen. The winter cyclone is one of the cause of coastal hazard. The winter cyclone is defined as the extratropical depression with rapid development. It causes high wave and storm surge from winter to spring, and Japan sometimes have casualties and economical loss. Some researches reported that the number of winter cyclone tend to increase. Because its tendency seems to go on, future change estimation of winter cyclone activity is important for disaster reduction.

Understanding of winter cyclone is developing. For example, Yoshida and Asuma showed that the winter cyclones are classified by their track and the development of winter cyclone is related to lateral heat flux. On the other hand, almost of all researches of impact assessment on coastal hazard focus on the tropical cyclone. Mori et al. showed the maximum potential storm surge in Japan using maximum potential intensity of tropical cyclone and GCM outputs, and large storm surge will increase. Shimura et al. showed that extreme wave caused by the tropical cyclone will develop at offshore region of east from Japan.

This research aims to reveal stochastic future change of winter cyclone using the database for policy decision making for future climate change (after here, d4PDF) which is huge ensemble dataset of present- and future-climate. Then, the risk of coastal hazard will be evaluate.

METHODOLOGY

1. Outline of d4PDF

This research uses experiment result of regional model around Japan. This data has 20 km spatial resolution and 1 hour time resolution. Present climate experiment has 50 ensemble member in 1950 – 2011, and future climate experiment has 90 ensemble member in 2050 – 2111. Future ensemble member is given from 6 kinds of SST patterns which are defined from cluster analysis result and 15 kinds of oscillations.

2. Extraction of winter cyclone

Extraction method is summarized 3 steps. (1) SLP (Sea Level Pressure) smoothing with Gaussian filter and find the location with minimum value at each timestep, (2) tracking the locations continuously, (3) calculating development rate of winter cyclone using the equation,

$$\frac{P(t-12)-P(t+12)}{24}\times\frac{\sin 60^\circ}{\sin\varphi(t)},$$

P is SLP [hPa], t is time and φ is latitude [degree], and threshold value is 1 [hPa/hour].

RESULTS

1. Future change of winter cyclone track

Yoshida and Asuma suggested that winter cyclone is classified Pacific type and Japan sea type around Japan. The number of Pacific type winter cyclone is larger than Japan sea type. In d4PDF, future change of the passing density is calculated (Fig. 1). This result shows that Pacific type of winter cyclone decrease about 10 %, and

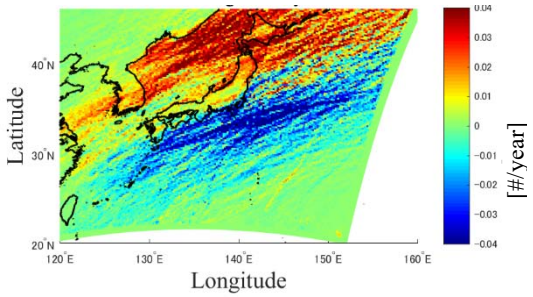

Fig.1 Future change of passing density distribution

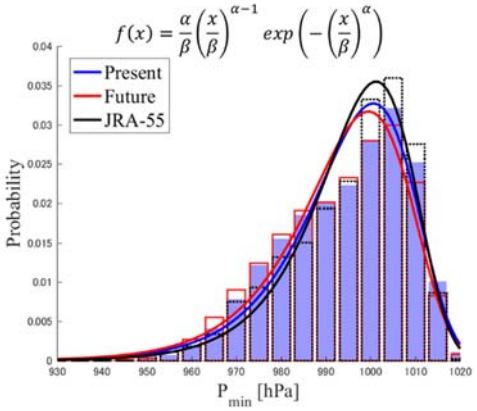

Fig. 2 Central pressure histogram of winter cyclone

Japan sea type increase 20 %. Ordinary, Pacific type of winter cyclone is peak at offshore Northwest Japan. Risk of coastal hazard due to Pacific type is small. However, Japan sea type sometimes becomes peak near Hokkaido Island, so risk evaluation of Japan sea type is important.

2. Future change of winter cyclone strength

Strength of winter cyclone is compared among JRA-55 and present-, future-climate d4PDF (Fig. 2). From the comparison between JRA-55 and present-climate d4PDF, d4PDF underestimates the number of weak winter cyclone, but the number of very strong winter cyclone which is important for coastal risk evaluation agrees with JRA-55. From the comparison between present- and future-climate d4PDF, the number of strong winter cyclone increases. Then, solid lines of Fig. 2 show approximation of Weibull distribution that gives quantitative future change evaluation of winter cyclone intensity.

FUTURE PLAN - Wave and storm surge simulation

To evaluate coastal hazard risk, wave and storm surge simulation using Wave Watch III and SuWAT will be carried out.

REFERENCES

Yoshida, Asuma (2004): Structures and Environment of Explosively Developing Extratropical Cyclone in the Northwestern Pacific Region, Mon. Wea. Rev, 132, pp. 1121-1142.