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A new typhoon bogussing scheme and its application for assessment of impacts of the possible maximum storm surges in Ise

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We developed a new typhoon bogussing scheme to obtain the possible maximum typhoon approaching any region under any climatic conditions by using a potential vorticity inversion method (Shimokawa et al., 2014). Usually, to evaluate the impact of typhoon with a specific strength (e.g., strength of Isewan Typhoon) on another region (e.g., Tokyo bay), it is needed to select a typhoon with the strength approaching to the region. However, an adequate example of such a typhoon does not always exist (does not rather exist in most cases). One of the ways to resolve this problem is to remake the environment field of the typhoon (e.g., Isewan Typhoon) by some methods to adapt to the region. It is possible by using the new typhoon bogussing scheme with the potential vorticity inversion method.

Numerical simulations with the new typhoon bogussing scheme are conducted for assessment of storm surges by possible maximum typhoons under the present-day and global warming climatic conditions in Ise and Tokyo Bays in Japan. Totally, 200 cases are conducted. The results suggest that the storm tide higher than the maximum storm tide in recorded history can occur in Ise and Tokyo Bays even for the present-day climate and the storm tide higher than the design sea level can cause severe damage to Nagoya and Tokyo megacities.

In particular, for the global warming climate in Ise Bay, the storm tide reaches the maximum among our results. This is because Ise Bay maintains the following conditions to amplify the storm surge: broad mouth of the bay (around 35 km) and shallow depth of the bay (average depth of around 19 m). In addition, low height shore protections on the coast of Ise Bay can amplify damage due to storm surge. On the other hand, in Tokyo Bay, mouth of the bay is narrow (around 20 km). Moreover, in Tokyo Bay, the average depth of the inner bay is shallow (around 17 m), but the depth at mouth of the bay reaches 700 m. In addition, higher mountains near Tokyo Bay have a tendency to decrease the strength of typhoons and, therefore, the height of the storm surges caused by the typhoons.

These results will affect port facilities in Ise and Tokyo Bays, for example, the airports (i.e., Chubu and Haneda International Airports). In particular, at Chubu International Airport, storm tide reaches 3.54 m. In addition, when the mean monthly highest water level of T.P. +1.22 m and mean sea level rise due to global warming (A1B scenario, IPCC, 2007) of T.P. +0.48 m are added to the storm tide at at Chubu International Airport (i.e., 3.54 m), maximum sea level in Ise Bay reaches T.P +5.24 m. This is higher than not only the ground level of the runway and airport facilities in Chubu International Airport, T.P. +3.29 m, but also the highest shore protection around the airport, T.P. +4.79 m. In addition, the effect of a high wave above 6.0 m in this model is not considered in this estimation. When the effect of a high wave is added to it, catastrophic damage can be caused to Chubu International Airport.

These results suggest that the new typhoon bogussing scheme we developed is useful for assessment of impacts of storm surge by the possible maximum typhoons because it can make possible to assess impacts of possible maximum storm surge in any region and under any climate conditions.

References:

S. Shimokawa, T. Murakami, S. Iizuka, J. Yoshino, and T. Yasuda, 2014, A new typhoon bogusing scheme to obtain the possible maximum typhoon and its application for assessment of impacts of the possible maximum storm surges in Ise and Tokyo Bays in Japan, Natural Hazards, 74, 2037-2052 (doi:10.1007/s11069-014-1277-2).

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