Storm Surge Response to Freshwater Outflow from Typhoons on the Ibaraki Coast

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Introduction and Objective

Collaborative results (Troselj et al., 2017) have permitted for the first time to quantitatively evaluate the influence of extreme freshwater outflow to the coastal ocean due to typhoon passage by combining river and ocean models using hourly time step data and remote-sensing technology. They found that projection of coastal Sea Surface Salinity was improved (up to 10 PSU difference) and became more realistic with included freshwater impact and concluded that extreme events freshwater outflows significantly decrease Sea Surface Salinity distribution in the coastal zone.

With the advance of weather forecasting systems and specific availability of forecasting typhoon trajectory and intensity, the research team aims to be able to apprehend freshwater impacts on the coastal marine environment in advance of typhoon events, and contribute to the comprehensive management and protection of coastal zones.

In our JpGU presentation (2018), we concluded that our findings that the freshwater outflow impact to the storm surge is negligible during the typhoon passage but is important to be considered in evaluating an after-runner storm surge mechanism should be further confirmed in future works by testing the applicability of using the same method with many other typhoon event cases.

A follow up of the previous studies is shown here. As parameters which affect the total sea level are storm surge, tides, waves and freshwater impact, the main objective of the study is to test dependence between storm surge heights and the freshwater impact before and after passing of several typhoons over the Ibaraki Coast, Japan.

Methods

We continued the study from Troselj et al. (2018) with improved downscaling model methodology and extended analyzed period into 7 years (2000-2006). We applied better vertical transformation equation (Vtransform=2, new formulation developed by A. Shchepetkin) and different vertical stretching function (Vstretching=4, where A. Shchepetkin improved double stretching) compared to Troselj et al. (2018). River forcing conditions were applied as observed river temperature and discharge (MLIT, 2017) with constant salinity of 0.5 PSU for Tone, Naka and Kuji rivers.

Discussions

We compared coastal storm surge heights for cases with and without freshwater outflow impact and discussed differences in results, for several typhoons passing over Ibaraki Coast during the analysed period. With new results, our conclusions from JpGU presentation (2018) cannot yet be certainly

confirmed. The mechanism which we found then, presence of so called after-runner storm surge occurring about 4 days after passage of the event, is occurring in some typhoon cases but not every time. Therefore, its occurrence is function of many parameters occurring simultaneously such as typhoon trajectory, intensity and central pressure, actual state of the ocean (tides, waves), river discharge magnitude and temporal distribution and model conditions.

Summary

Using dynamic downscaling for reanalysis of coastal current system in the Ibaraki Coast, our goal was to test dependence between storm surge heights and the freshwater impact before and after typhoon events. We found that the mechanism found in the previous study is not occurring every time on the same way but is rather function of many other dependent parameters.

References

Troselj J, Sayama T, Varlamov SM, Sasaki T, Racault M-F, Takara K, Miyazawa Y, Kuroki R, Yamagata T, Yamashiki Y (2017). Modeling of extreme freshwater outflow from the north-eastern Japanese river basins to western Pacific Ocean, Journal of Hydrology, Vol. 555, pp. 956-970, doi:10.1016/j.jhydrol.2017.10.042.

Troselj, J, Imai, Y, Ninomiya, J, Mori, N (2018). Coastal Current Downscaling Emphasizing Freshwater Impact on Ibaraki Coast, Journal of Japan Society of Civil Engineers, Ser. B2 (Coastal Engineering), vol.74, no.2, pp. 1357-1362.

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