

Downscaling of Coastal Current to 200 m Scale in the Ibaraki Prefecture with Included Freshwater Outflow Impact

*Josko Troselj¹, Yuki Imai¹, Junichi Ninomiya², Nobuhito Mori¹

1. Coastal Engineering Laboratory, Disaster Prevention Research Institute, Kyoto University, 2. Kanazawa University

Introduction and Objective

Global mean sea level, surface temperatures and extreme precipitation amounts are expected to increase in 21st century under the climate change impact. It will especially affect coastal zones which are sensitive to all of these factors because extreme freshwater inflow, inundation levels, erosion as well as fishery industry nearshore are expected to be largely impacted.

Objective of the study is developing methods for downscaling of coastal current system for Ibaraki prefecture in Japan from 10 km scale parent dataset to related projections of 200 m scale with included freshwater impact from three major rivers. Its purpose is to formulate techniques for providing fine scale ocean circulation reanalysis and future projection which can be used for adaptation of countermeasures for climate change impact assessment. With using downscaling approach, our main focus is natural variability of physical processes of the ocean rather than their long term trend.

Methods

We used lateral boundary conditions of velocity, temperature and salinity from FORA-WNP30 parent dataset (10 km scale) downscaled by COAWST model using 3 domain nesting with 2 km, 600 m and 200 m scales respectively, for targeted reanalysis period of 2000.

Surface boundary conditions of wind speed, sea level pressure, air temperature, precipitation, shortwave radiation flux and cloud fraction are used from JRA-55 dataset, while forcing conditions are used as observed temperature and discharge with constant salinity of 0.5 PSU from Tone, Naka and Kuji rivers.

Discussions

We compared our modeled results with observed surface temperature data from Hasaki point (from PARI) and coastal zone near Ibaraki (from JMA). We found noticeable freshwater impact at Hasaki point and improved results of surface temperature from the parent dataset by downscaling both at Hasaki point and at the coastal zone near Ibaraki. The freshwater impact was evaluated by comparison between the observed freshwater discharges and modeled salinity at the Hasaki point, which showed good correlation.

We have modeled storm surge heights before, during and after the typhoon passage. We found that coastal storm surge heights several hours before the typhoon passage exceeded values of 1 meter thus forming so called fore-runner storm surge. We also found that so called after-runner storm surge heights are for more than 20 cm lower in coastal zones and for more than 20 cm higher offshore during the

after-runner surge time of about 3 days after the typhoon passage when using freshwater outflow impact compared to the case with no rivers, thus showing that the freshwater outflow impact is important to be considered for the storm surge assessment.

Conclusions

We found that our downscaling model can precisely simulate related projections of coastal currents and other ocean parameters on the fine scale of 200 m with better precision than with the rough scale parent dataset model. However, our results are still subject for improvement because they are still showing unexpectedly high surface temperatures during the summer and typhoon season.

We found that the freshwater outflow impact to surface temperature is mostly negligible but it can have significant impact to surface salinity (by reducing it for up to 10 Practical Salinity Units) and consequently to water density and ocean circulation patterns. We found that the freshwater outflow impact to the storm surge is negligible before and during the typhoon passage but is important to be considered in evaluating the after-runner storm surge mechanism when a hysteresis curve is at descending stage, which is known as a river flow mechanism when the same discharge values correspond to bigger water level values than at an ascending stage.

Keywords: downscaling, coastal current, freshwater impact, natural variability, climate change, COAWST

