Downscaling and Reanalysis of Coastal Current System on the Ibaraki Coast with Included Freshwater Impact

*Josko Troselj[1], Yuki Imai[2], Junichi Ninomiya[3], Nobuhito Mori[1]

1. Coastal Engineering Laboratory, Disaster Prevention Research Institute, Kyoto University, 2. Graduate School of Engineering, Kyoto University, 3. 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. Coastal processes, such as variabilities of shallow water temperatures, cannot be precisely reproduced by coarse scale global climate models and therefore downscaling the coastal current system to fine resolution scales is needed.

Objective of the study is providing fine scale 7-years ocean circulation reanalysis and assessment of natural variabilities of physical processes of the coastal ocean by downscaling of coastal current system for Ibaraki prefecture in Japan from 10 km scale parent dataset to related projections of 222 m scale on the Ibaraki coast, particularly taking into account freshwater outflow impact from 3 major rivers (Tone, Naka and Kuji). Our results can be used for adaptation of countermeasures for climate change impact assessment.

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 validated our modelled results with observed sea surface temperature data from Hasaki point (PARI) and satellite images from MGDSST for winter and spring seasons (Figure 1). Results for all seasons will be presented on the conference. The modelled results corresponded well with Hasaki observations in winter and with MGDSST observations in spring season and their mean and variabilities were improved compared to FORA results. Reason for that might be because vertical mixing in spring and summer seasons is lower than in autumn and winter seasons. We expect that Hasaki observations, which are located 2-3 meters below sea level, will have better fit with the modelled results during colder seasons when vertical mixing is higher. Similarly, we expect that MGDSST observations of sea surface layer will

have better fit with the modelled results during warmer seasons when vertical mixing is lower.

We showed that reproducibility of coastal natural variabilities of physical processes is increased compared to parent dataset FORA when using downscaling, both for sea surface temperature and salinity. Our model reproduced bigger variabilities of both temperature and salinity in vicinity of the coast than in the offshore zone, and it was not well reproduced in FORA.

We showed monthly, seasonal and inter-annual trends in magnitudes and directions of coastal currents. The reproducibility of the trends was improved compared to FORA, because our model provides more precise fine scale representation of coastal currents.

Summary

We conducted dynamic downscaling and reanalysis of coastal current system on the Ibaraki coast particularly considering freshwater outflow impact, with improved methodology and extended targeted period from previous study. We showed that variability of sea surface temperatures in coastal shallow waters is better represented with the downscaling than with the coarser parent model.

Reference

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.

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

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