C05

River Discharge Impact to Downscaling of Coastal Current in the Eastern Japan

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Introduction and Objective

According to conclusions from IPCC Fifth Assessment Report, 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 assessment of natural variability of physical processes of the ocean rather than their long term trend.

Methods

As a part of working group 2b from the MEXT sponsored SI-CAT program, our working group is developing methods for downscaling from FORA-WNP30 dataset (FORA) using COAWST model.

FORA is a product of the program developed by JAMSTEC and MRI/JMA. It focuses on ocean state historical analyses and projections for near future. It covers domain of Western North Pacific (15N - 65N and 117E - 160W) for period from 1982 to 2016 with 10 km resolution and 54 vertical levels. It calculates daily mean values of temperature, salinity, velocity, surface height and surface ice cover and is used as parent dataset to conduct our downscaling simulation.

We used lateral boundary conditions of velocity, temperature and salinity from FORA parent dataset downscaled by COAWST model using 3 domain nesting with 2 km (D1), 600 m (D2) and 200 m (D3) scales respectively and 30 vertical sigma levels, 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 hourly freshwater discharge with constant salinity of 0.5 PSU from Tone, Naka and Kuji Rivers.

Results and discussions

We compared our modeled results with observed Sea Surface Temperature (SST) 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 SST from the parent dataset by downscaling, both at Hasaki point and at the coastal zone near Ibaraki. Fig. 1 shows observed SST results compared with FORA reanalysis and COAWST downscaling results from at the Hasaki point plotted versus observed Tone River discharge. Fig. 2 shows FORA and COAWST simulated Sea Surface Salinity (SSS) results at the Hasaki point plotted versus observed Tone River discharge.

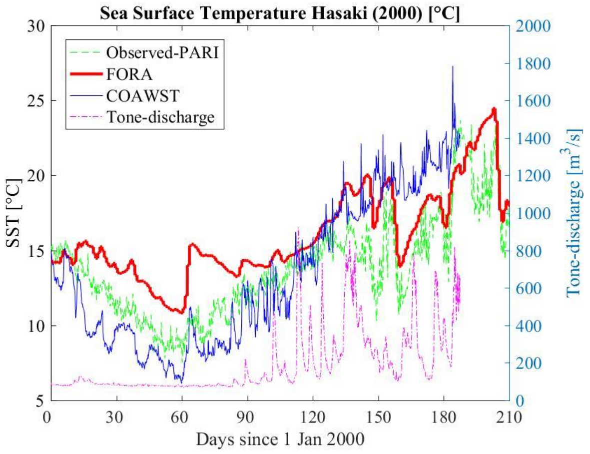

Figure 1. Observed SST results compared with FORA reanalysis and COAWST downscaling results at the Hasaki point and plotted versus observed Tone River discharge.

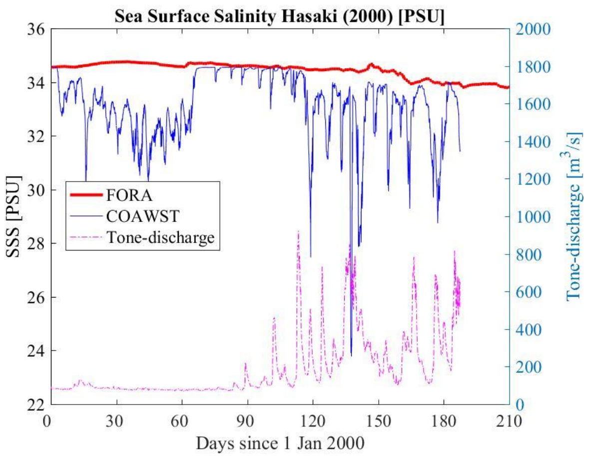

Figure 2. FORA and COAWST simulated SSS results at the Hasaki point plotted versus observed Tone River discharge.

From Fig. 1 can be seen that COAWST results are closer to observations than FORA results therefore downscaling improves the results. Freshwater impact at the Hasaki point is not obvious for SST but can be observed from SSS results. COAWST SSS results from first 60 days are affected by spin up of the model but in later months correspond well with freshwater discharge from Tone River. Fig. 3 shows simulated SST (with included velocity vectors), SSS and Velocity (V-vertical and U-horizontal direction) for D1, and Fig. 4 shows the same but for D2.

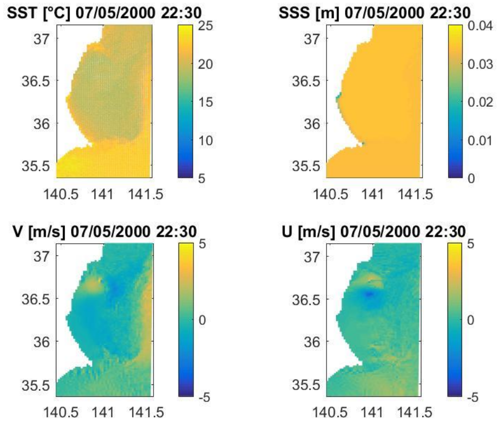

Figure 3. Simulated SST (with included velocity vectors), SSS and Velocity (V-vertical and U-horizontal direction) for D1.

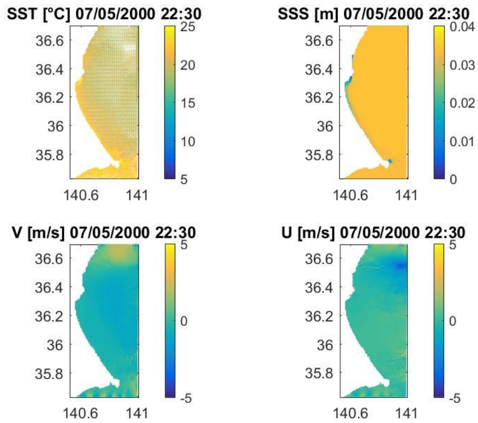

Figure 4. The same as Figure 3 but for D2.

From Figs. 3 and 4 can be seen that velocity vectors, freshwater impact shown with SSS and local coastal vortexes are better represented in finer scale D2 than in D1, as it was expected. The downscaling model still needs to be improved as it produces unexpectedly high SST and northward boundary velocities during summer season and blows up in typhoon season. Therefore, we are reducing simulated time step which is increasing model stability but at the same time is increasing total computational time.

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