1. Title

The interannual variation of coastal upwelling along the west coast of East China Sea

2. Members' names and affiliations

Xinyan Mao Ocean University of China

Jie Shi Ocean University of China

3. Aim

(1) Construct and validate the hydrodynamic model of northwest Pacific Ocean.

(2) Investigate the long-term variation of mass transport in the marginal sea of northwest Pacific Ocean from 1996 to 2015.

(3) Promote the exchanges and cooperation between Coastal Dynamics Group in Ocean University of China and the Center for Marine Environmental Studies (CEMS) in Ehime University.

4. Procedure

A triply nested ocean model (NEST3) is proposed by Professor Xinyu Guo and his group. The path and current intensity of simulated Kuroshio in NEST3 is the closest to observations. Therefore, we'd like to improve NEST3 model to study the long-term variation. Firstly, enlarge the model domain northward and eastward, and thus it includes the whole Sea of Japan (Fig. 1). Secondly, increase the sigma layers from 21 layers to 65 layers. Thirdly, a 20-years hindcast simulation is driven by JCOPE2 data at open boundary and ERA-interim forcing at sea surface from 1996 to 2015 without surface relaxed condition for sea surface temperature and salinity.

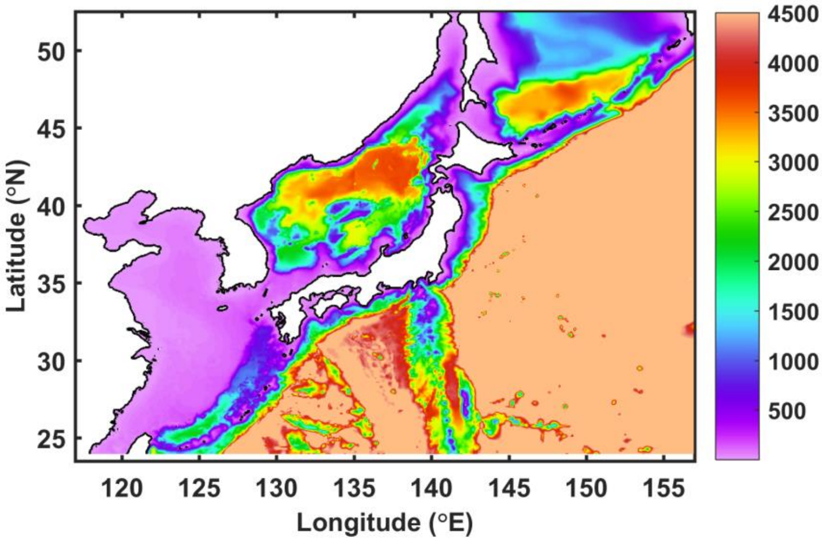

Fig. 1 Model domain and bathymetry (color shading in meter)

Besides, we build a dispersion model of the passive tracer concentration. It is coupled with improved NEST3, and includes the advection and diffusion processes of two tracers. Their units are supposed to be micromole per liter (μM). For Tracer I, it is initially set to 1.0 μM in the East China Sea (ECS) shelf where depth less than 200 m, and set to 0 at otherwhere (left panel in Fig. 2). During the simulation, its concentration in the ECS shelf are consistently kept as 1.0 μM. The setup of Tracer II is similar, but it is initially set to 1.0 μM in the ECS (west of 130° E) where depth more than 200 m, and to 0 at otherwhere (right panel in Fig.2). It is also kept as 1.0 μM in the ECS slope during the simulation.

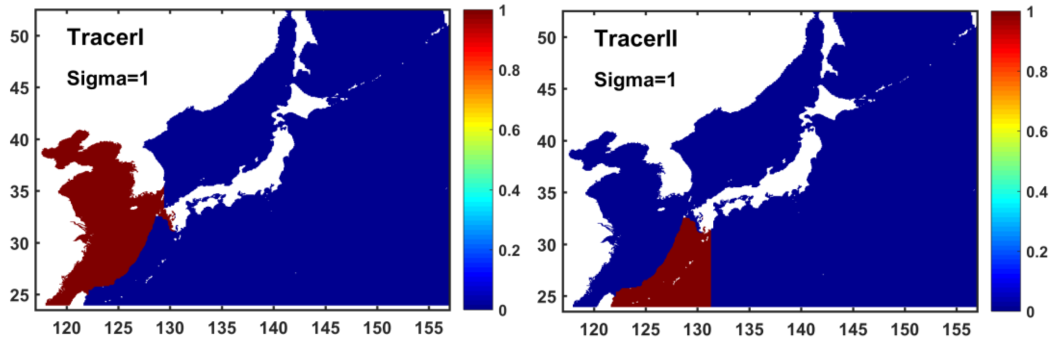

Fig. 2 Initial concentration distribution of two tracers at the first sigma layer

5. Results

To evaluate the model performance of improved NEST3, the seasonal cycle of water temperature, salinity and current at different layers are obtained and compared with previous studies. As for the water temperature, the front between Kuroshio and Oyashio currents and seasonal variation can be resolved. Seasonal variation of Changjiang dilute water is clear in the salinity distribution. Intensity and pathway of Kuroshio current show seasonal shift. All the features are reproduced successfully by improved NEST3. Considering the report length, we only show the comparison of simulated and AVISO reanalysis sea surface height (SSH) in Fig.3. The simulated Kuroshio meander is not so significant as that in observation. Root-mean-square (rms) of SSH is also weaker at south of Japan in our model.

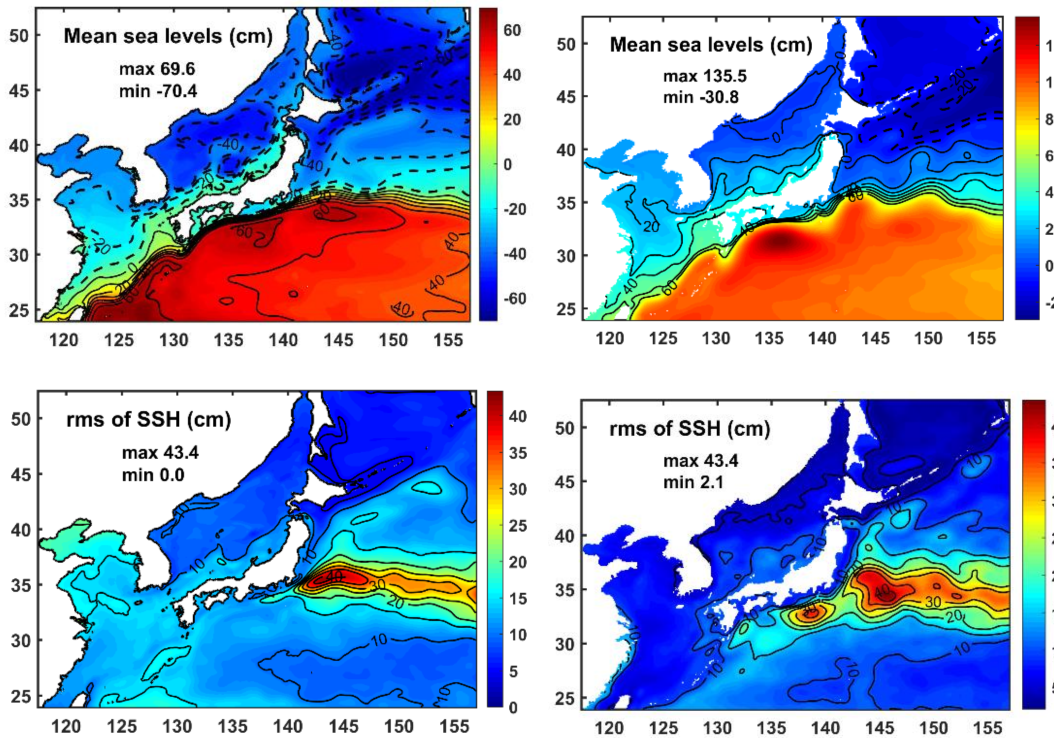

Fig. 3 Comparison of mean sea level (upper panel) and rms of SSH (lower panel) between model (left column) and AVISO reanalysis data (right column)

From Fig. 4, it can be obtained that Tracer I mainly affect the upper 200 m in the Sea of Japan, south of Japan and Kuroshio extension region. To discuss the transport of Tracer I to the Sea of Japan and the area south of Japan, PM line and Tokara Strait are chosen as the typical sections in these two downstream regions. At PM line, the normal velocity shows some eddy pattern, and Tracer I is transported in upper 200 m layers. At Tokara Strait, Tracer I is advected by Kuroshio current from northern part of the section, and can reach 400 m. Although the Volume Transport (VT) at Tokara Strait is 10 times higher than that at PM line, the mass flux of Tracer I is in the same order of magnitude (Figures not shown).

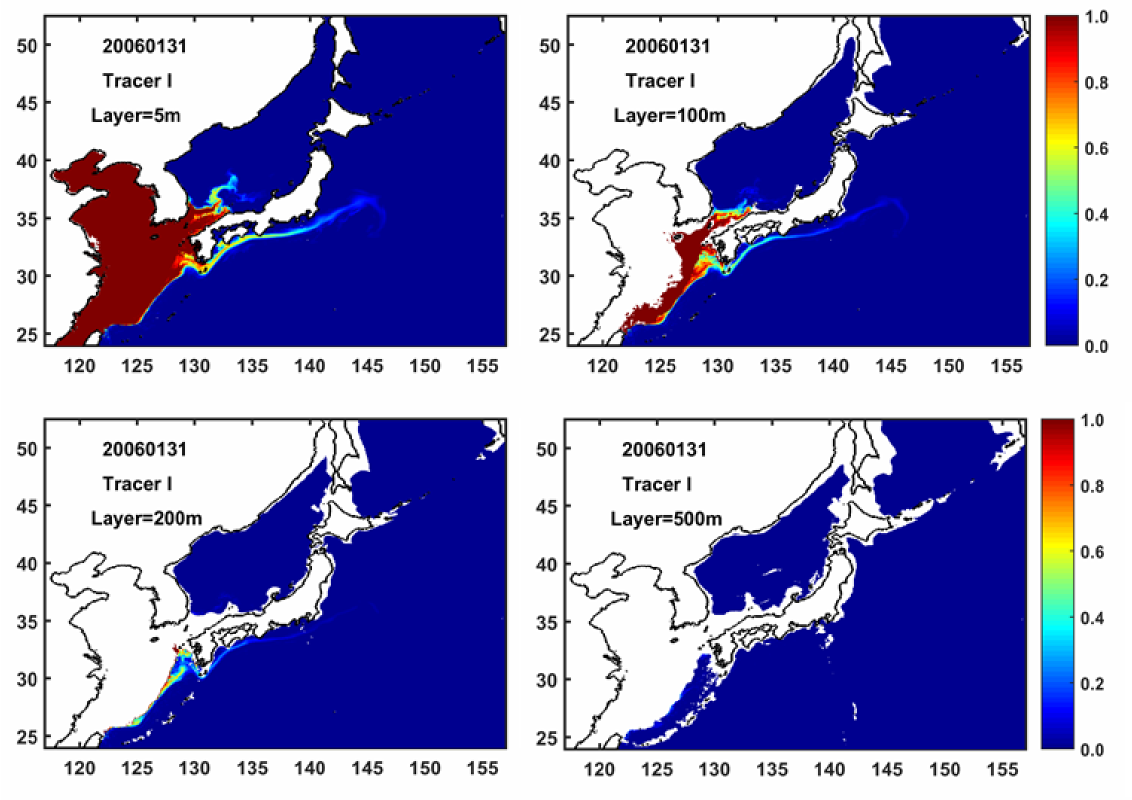

Fig. 4 Distribution of Tracer I at 5 m, 100 m, 200 m and 500 m after one month

Fig. 5 shows the distribution of Tracer II concentration in different layer. In the inner shelf of ECS, we can see the higher concentration region. It might be brought by the bottom current and upwelling to the surface. From 100m layer, the Kuroshio intrudes onto the shelf mainly at two locations: northeast of Taiwan and southwest of Kyushu. Tracer II entering the Sea of Japan from 100 m occurs earlier than that from surface. As for the transport of Tracer II to south of Japan and Kuroshio extension, it is seen clearly until 500 m layer. Two sections are chosen to discuss the transport of Tracer II to the downstream areas. Tsushima strait describes the transport into the Sea of Japan and 137° E line suggests the transport to south of Japan. Considering the report length, figures of two sections are not shown here. Tracer II enter the Sea of Japan from the bottom layer of east channel at Tsushima strait, where the concentration of Tracer II is larger at bottom than surface, but normal velocity is stronger in upper layer, so the mass flux of Tracer II in the central part of two Tsushima strait channels are uniform vertically.

At 137° E line, the transport of tracer II can reach 2000 m. Although the VT at 137 line is 20 times higher than that Tsushima strait, the transport flux are only twice more than the latter.

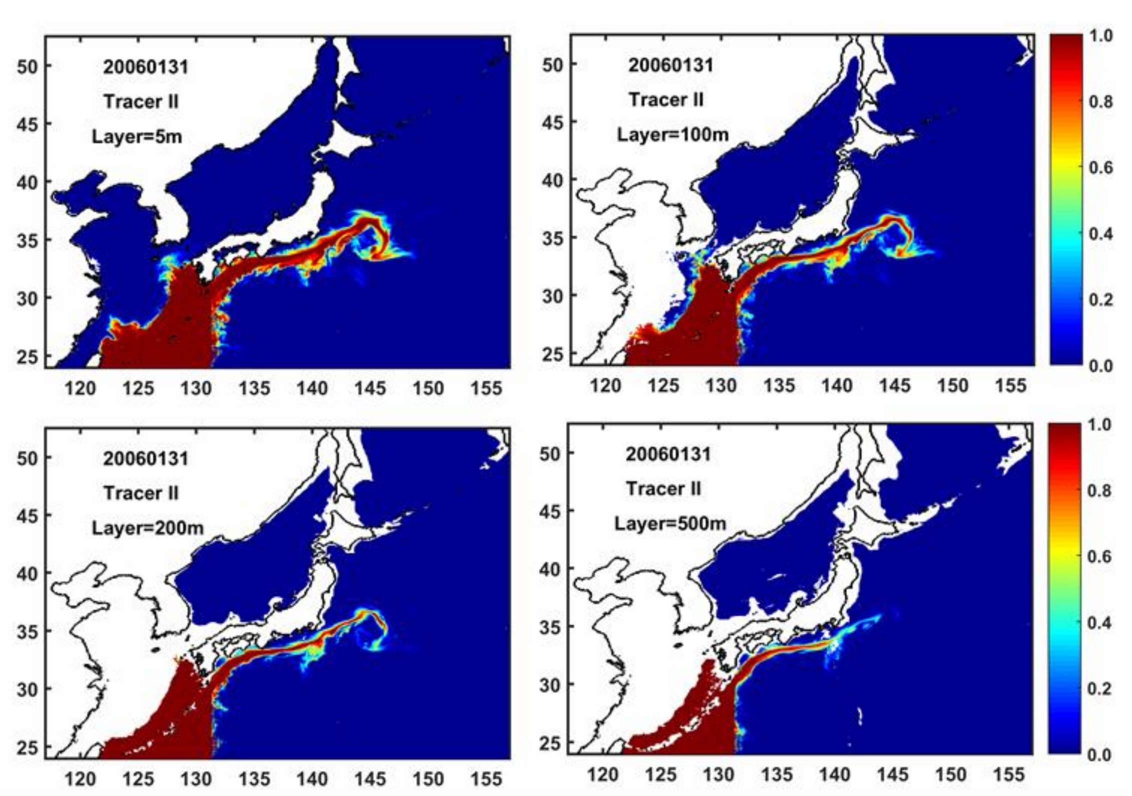

Fig. 5 Similar to Fig. 4, but for Tracer II

6. Publication/Conference presentation

Conference presentation

Title: Long-term variation of mass transport in the marginal sea of Northwest Pacific Ocean

Speaker: Xinyan Mao

Date: 19 November 2019.

Location: Ehime University.

7. Perspectives in Future

(1) Complete the 20-year simulation with surface relaxed conditions and dispersion model of two tracers.

(2) Analyze the seasonal and interannual variation in mass transport of two tracers.

(3) Analyze the interannual variation of coastal upwelling along the west of ECS shelf by use of the 20-year simulation of Tracer II.

(4) Enhance the cooperation between Ocean University of China and CEMS of Ehime University.