1. Title

Optimization and Application of Suspended Matter Transport Module in the East China Sea Shelf

2. Members' names and affiliations

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3. Aim

1. With the full consideration of tide, river discharge, wind, sea bottom and suspended particles matters (SPM) etc., a three-dimensional nonlinear baroclinic ocean model based on the Regional Ocean Model System (ROMS) and Persistent Halogenated Hydrocarbons (PHHs) -physical-ecosystem coupled model will be established to carry out numerical studies of the biogeochemical process in the East China Sea Shelf (ECSS).

2. On the basis of the model results, the spatial distribution and seasonal variation of SPM with different particle sizes.

3. Enhance bilateral cooperation between our team (Coastal Dynamics Group, Ocean University of China) and the Center for Marine Environmental Studies of Ehime University on academics.

4. Procedure

Persistent organic pollutants (POPs) have stable physical and chemical properties and are not easy to degrade, which have become ubiquitous in the global environment. However, there are still little understanding on the adsorption processes of POPs by SPM (for example, mud, clay, sand). In our study, a three-dimensional ocean model was established based on ROMS and PHHs-physical-ecosystem coupled model to simulate distribution and transportation of the SPM.

5. Results

A three-dimensional hydrodynamic-SPM model was established based on ROMS and PHHs-physical-ecosystem coupled model to simulate spatial distribution and seasonal variation of SPM in the ECSS (Fig.1).

Eleven main river discharge sources were involved in this coupled model. The initialized seabed sediment arrays with three non-cohesive size classes (sand, silt, and clay) whose fractions were set based on measured data. The tidal forcing (include eight principal tidal constituents M_2, S_2, N_2, K_2, K_1, O_1, P_1, and Q_1) are derived from the TPXO8 tidal model data set. Besides, real-time atmosphere forces, including surface winds, heat flux, temperature, air pressure, air precipitation rate, and relative humidity was used as atmospheric forces, which were obtained from the European Centre for Medium-Range Weather Forecasts (ECMWF) ERA-5 data set. As for the open boundaries, three-dimensional daily temperature, salinity, and subtidal current fields from the Copernicus Marine environmental monitoring service (CMEMS) GLORYS data set. Outputs from this coupled model, including temperature, circulation, wave and sediment concentrations match measured data well, so it is proved to be accurate and reliable.

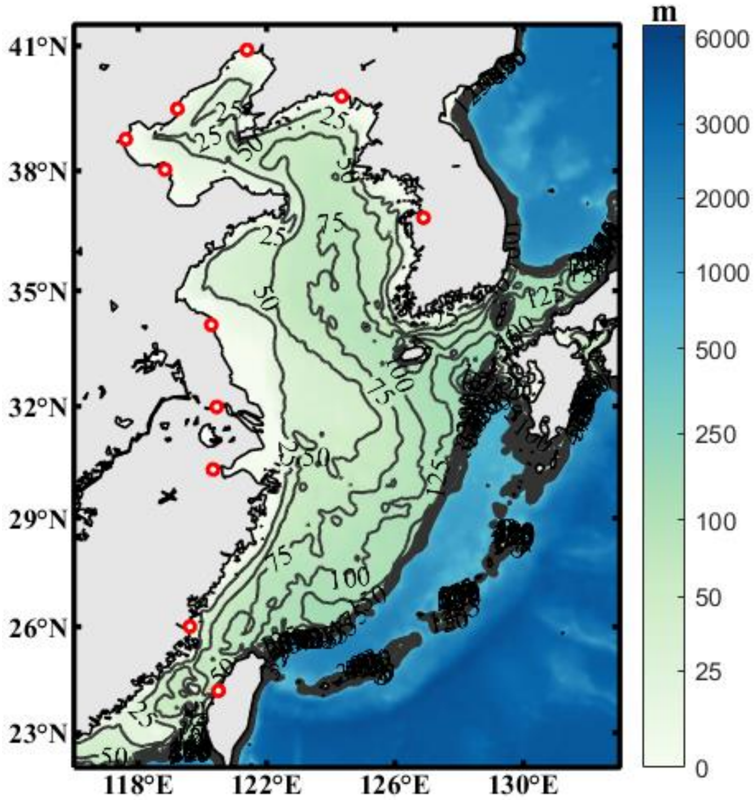

Fig.1 The distribution of water depth and river discharge (the Red dots) in the East China Sea Shelf

The most obvious spatial distribution characteristics of suspended matter in the ECSS are high concentration near shore and low concentration in offshore. There are 9 high suspended sediment concentration (SSC) regions (whose SSC is higher than 30 mg/L) in then the ECSS：(a). the LiaoDong Bay; (b). the Bohai Bay; (c). the Laizhou Bay; (d). Cheng- shantou area; (e). the Subei shoal; (f). Yangtze Estuary; (g). Fujian and Zhejiang coast; (h). the offshore of Yangtze Estuary; (i). the south of Korean Peninsula.

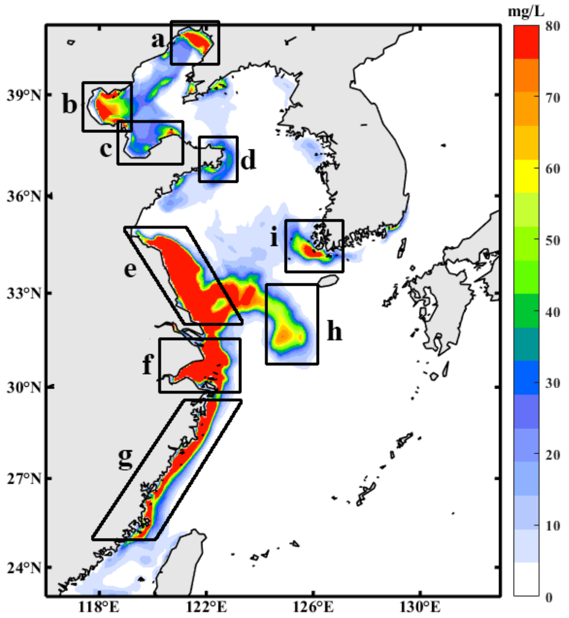

Fig.2 The spatial distribution of SPM in the ECSS

The high SSC regions may have the following characteristics：First, their water depth is shallower than 50m, which make it easier for hydrodynamic processes to promote sediment re-suspension to sea surface; Second, they always have estuary with large river runoff (like Yellow River, Yangtze River, and the Qiantang River). There is a large amount of terrigenous material in the nearshore area, which provides a rich material source for the SPM for the near shore. Third, the high SSC regions tend to have sediments with finer grain size, such as mud, silty clay or clayey silt. The sediment with smaller the particle size will be easier to re-suspended to the sea surface through the vertical mixing process.

The seasonal variation of SPM in the ECSS also shows obvious regularities: the concentration and area of SPM in winter are significantly higher than those in summer, and the distribution pattern of SPM concentration in spring and autumn is a transition to summer and winter.

In winter, all the high SSC regions expand outwards. The SSC in Bohai sea is much higher than that in summer. At the top of Laizhou Bay, the high SSC region(c) appears because of its fine sediment and the strong wave-current interaction. The Shandong Coastal Current, which contains a large number of SPM, transported close to Shandong Peninsula. As a result, the top of the Shandong Peninsula is surrounded by an obvious high SSC belt. Strong northerly wind enhanced the wave-current interaction in sea area less than 50m, and therefore significantly increase the SSC. Region(e), (f), (h) connect to each other and form a h-type SSC regions in the south Yellow Sea and the East China Sea.

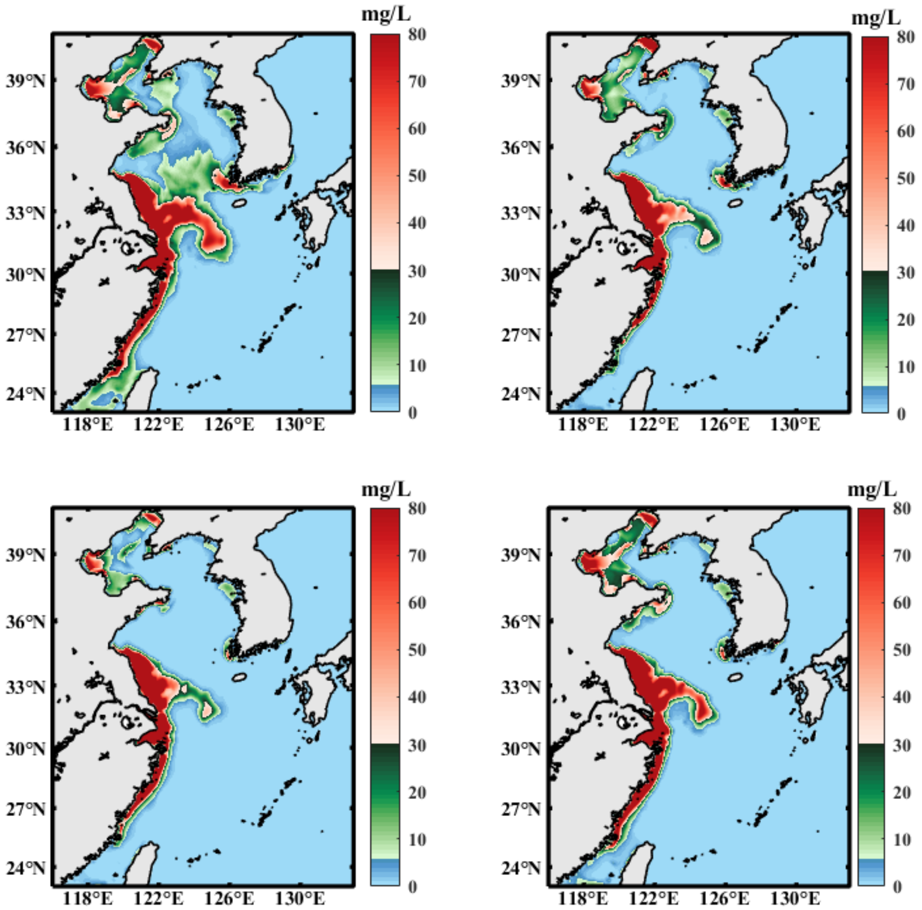

Fig.3 The seasonal variation of SPM in the ECSS

In spring, the high SSC regions begin to shrink back toward the shore. The high SSC region(b) retreated back into the bay. The high SSC regions(c) and (d) also begins to dissipate. The h-type high SSC region begins to disperse into two separate parts, and the nearshore side began to shrink toward the shore.

In summer, the high SSC regions further shrink to the shore, and the areas of all the high SSC regions reach the minimum of the whole year. The high SSC region(d) and (i) completely dissipated.

Until autumn, the distribution of SPM starts to extend to the offshore.

6. Perspectives in Future

Professor Xinyu Guo and his research team established the PHHs-physical-ecosystem coupled model for ECSS, which is an essential part to couple with the hydrodynamic-SPM model, and therefore build the Hydrodynamic-ecological-SPM-PHHS coupling model. There is no doubt that the coupling model will provides a key to reveal the migration and transformation process of PHHs in the ocean, and be helpful to realize the long-term inversion and prediction of PHHs transportation.

Therefore, Zhaojun Du will go on general collaboration with Professor Xinyu Guo to discuss based on the coupled model and data. All of the collaborations will be helpful to Enhance bilateral cooperation between the Coastal Dynamics Group, Ocean University of China and the Center for Marine Environmental Studies, Ehime University.