Distributions and transports of the diluted water from major rivers in East Asian Marginal Seas

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1.Introduction

East Asian Marginal Seas (EAMS) is a continuum receiving multiple large rivers. In the past, most river plume studies in the EAMS region only consider one major river with limited domain numerical model or survey area, which, however, may underestimate the area of river influence and neglect the interaction between multiple river plumes. Here in this study we develop a numerical model covering the entire EAMS area based on the Regional Ocean Modeling System (ROMS), and include 12 major rivers in the EAMS.

2.Model configuration

ROMS is configured to simulate the circulation over EAMS. The model domain and rivers' position are show in Figure 1. The horizontal resolution is approximately 10 km and the vertical resolution is 30 layers in the stretched terrain-following coordinate.

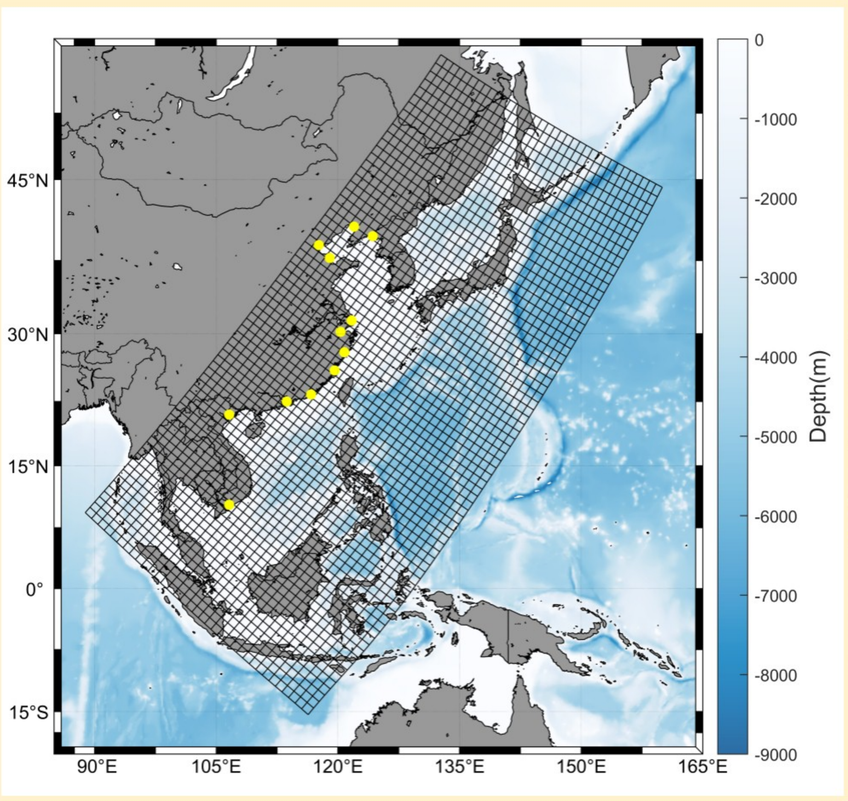

Figure 1. Model gird showed in every 10 of 1. The yellow point indicates rivers' position.
1.Yalu River,YLR
2.Liao River, LR
3.Hai River, HR
4.Yellow River, YR
5.Changjiang River, CJR
6.Qiantang River, QTR
7.Ou River, OJR
8.Min River,MJR
9.Han River, HJR
10.Pearl River, PR
11.Red River, RR
12.Mekong River,MKR

The bottom topography is extracted from GEBCO, and here we set minimum depth of 5m and maximum depth of 2500m. The initial and open boundary values are obtained from SODA. Surface forcing are obtained from the ECMWF, tides are derived from TPXO8. This model uses MPDATA 3D advection, Mellor Yamada Level-2.5 closure, Smagorinsky like viscosity and diffusion.

For study the distribution of diluted water, we add dyes(100kg/m^3) to the inputted river water :

- CASE1:input 1 river(the Changjiang River), 1 dye
- CASE2:input 12 rivers, 1 dye(the Changjiang River only)
- CASE3:input 12 rivers, 1 dye(all rivers)

CASE1 represents a traditional single river model. By comparing CASE1 and CASE2(Figure 2), the effects of other rivers on the extension range of the Changjiang River water were shown. CASE3 represents distributions of the diluted water from major river in EAMS.

3.Result

Model run from January 2003 to November 2007, and output monthly average data to analyze. For simplicity, we chose Feb, May, Aug, Nov data to represent Winter, Spring, Summer, Autumn results. Here we select data from 2007 to analyze.

Table 1. The statistics of surface area and volume of sea water that salinity lower than 31.

River	Surface area(×10^{4}km^2)				Volume(km^3)			
	Feb	May	Aug	Nov	Feb	May	Aug	Nov
YLR	1.47	1.47	1.47	1.19	279.07	298.91	334.72	213.92
LR	2.52	2.40	2.50	2.79	481.16	476.79	494.36	540.42
HR	2.70	3.23	3.82	2.55	351.37	372.13	359.09	318.78
YR	2.37	2.89	4.52	3.03	370.54	396.07	534.77	520.84
CJR	10.68	11.55	21.27	12.63	1913.11	1745.06	2597.20	2278.64
QTR	0.52	0.61	0.58	0.50	78.31	90.83	87.26	76.73
OJR	0.17	0.23	0.24	0.15	23.62	32.01	31.86	21.64
MJR	0.34	0.57	1.31	0.39	69.59	137.96	163.39	85.42
HJR	0.35	0.81	1.11	0.27	77.95	62.15	56.32	52.81
PR	0.98	1.61	3.92	1.18	112.61	119.57	204.67	137.27
RR	1.43	2.34	5.46	2.02	248.64	294.51	589.05	417.04
MKR	0.49	1.10	1.96	1.94	49.26	72.91	77.28	136.99

According to Figure 2, if set 12 rivers, the effect of CJR on the Bohai Sea and the Yellow Sea has decreased. CJR water most gather in the central south of the Yellow Sea. Although it was difficult to transport northward, it become more easily to transport southward.

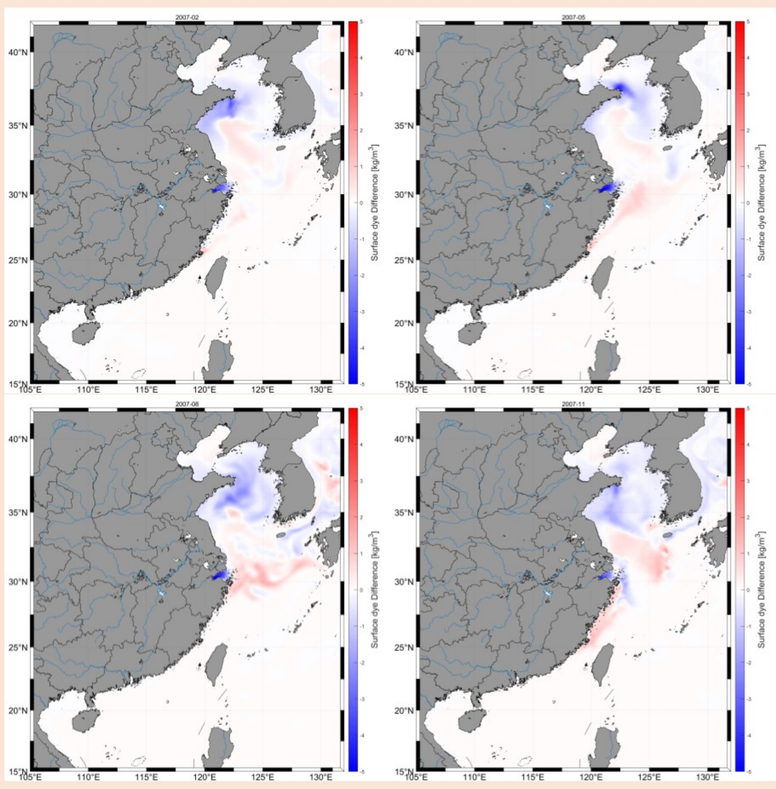

Figure 2. The result of CASE2 - CASE1. The value is difference of monthly average surface dye concentration.

According to Figure 3, after set 12 rivers, fresh water in the Bohai Sea and the South China Sea are increased. Although the Changjiang River water can't span the Taiwan Strait, the fresh water from the South China Sea can easily into the East China Sea and form a fresh water belt along the coast.

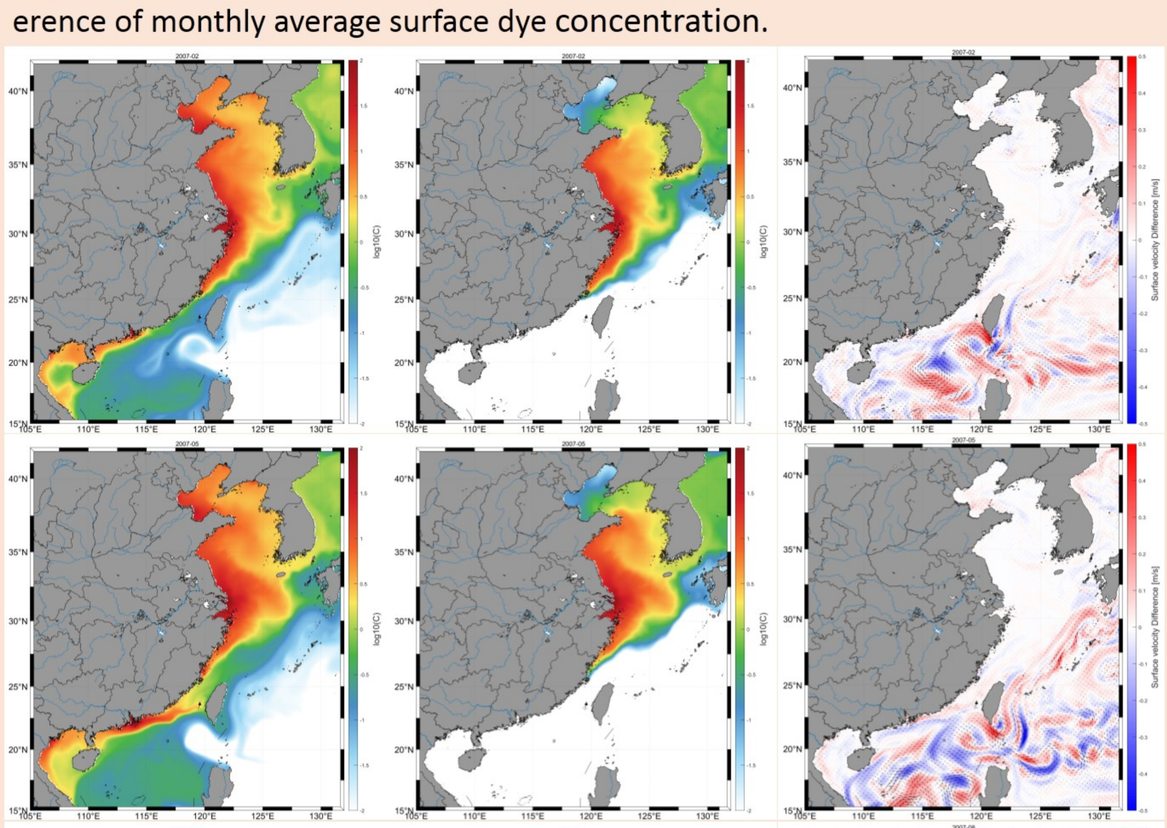

Figure 3. The result of CASE3(left column) , CASE1(central column) surface dye concentration. And right column are surface velocity difference(CASE3 - CASE2).

4.Conclusion

1.Terrestrial materials from the Changjiang River are diluted by other rivers so their transport distance is decrease, but the extent of buoyant coast current slightly increase.
2.Freshwater belt formed along the coast by adding multiple rivers.
3.Freshwater from the South China Sea can push the trajectory of Kuoshio southeastward.