Title

Tracing external sources of nutrients in the East China Sea and evaluating their contributions to primary production

Members' names and affiliations

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Aim

The research aims to apply the new tracking technique to the multi-source nutrients in the East China Sea (ECS), evaluate their roles in the primary productions over the continental shelf of the ECS and explore the corresponding dynamic mechanism.

Procedure

The technique has been applied into the physical-biological coupled model for the ECS. The model domain is shown in Fig. 1 and the area of interest in this study is the continental shelf of the ECS is indicated by dark blue. We first analyzed the distribution characteristics and the seasonal variations of the nutrients and primary production in the ECS; then found the dynamic mechanism for the distribution of nutrients from different sources; finally evaluated the contribution of each source of nutrients to the nutrient inventory and primary production over the ECS shelf.

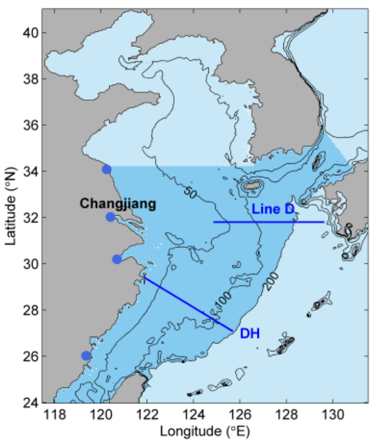

Fig. 1 Bathymetric map of the East China Sea. The study area of interest is shaded in dark blue. Contour lines in black represent the 50-m, 100-m, and 200-m isobaths. The

blue dots denote the positions of inflow from rivers. The blue line shows the position of two sections.

Result

Using the physical-biological coupled model and a tracking module, we examined the distributions of DIN with different origins and the corresponding primary production in four seasons over the ECS, and evaluated the roles of DIN with different origins in primary production in the inner, middle, outer and entire shelves of the ECS. Both physical and biological processes affect the distributions of nutrients with different origins. Physical processes regulate the distribution of the nutrients, mainly through transport and mixing. For example, the dominant areas of each source nutrient in the inventory of nutrients generally follow distributions of the water masses. On the other hand, biological processes likely contribute to change the concentrations of nutrients locally, which rely closely on local temperature and light intensity. This appears as different distributions of DIN from the same source, which are determined only by biological processes.

The DIN from rivers (DIN_R), the atmosphere (DIN_A), the Kuroshio (DIN_K), and the Taiwan Strait (DIN_T) play different roles in different areas (Table. 1). In the inner shelf, the DIN_R (mainly the Changjiang) shares more than half of DIN inventory and supports more than half of primary production. The DIN_A is the secondary source (>20%) while those from the Kuroshio and Taiwan Strait both share only ~10% of DIN inventory and support ~10% of primary production in the inner shelf. In the middle shelf, the DIN_K shares ~40% of DIN inventory and supports ~40% of primary production. The DIN_T and DIN_A have a similar ratio (~20%) in the DIN inventory and primary production and the DIN_R share the residual 10% in both DIN inventory and primary production in the middle shelf. In the outer shelf, the DIN_K shares >90% of DIN inventory and supports ~80% of primary production. Therefore, the Kuroshio is a dominant source for the nutrients inventory and primary production.

Considering the ECS as a whole, DIN_K are the largest contributor in the nutrient inventory and primary production. The DIN from the Taiwan Strait, rivers and atmosphere shares equal contributions in nutrient inventory and primary production. Primary production supported by each source is a direct criterion, while neither input flux nor inventory of nutrient is a good index to represent the contribution of nutrients from different sources to primary production. The production efficiency of each source of DIN is a way to understand the relation among these evaluation methods. The Kuroshio shows a leading role in input flux, nutrient inventory, and primary production, but its DIN has low production efficiency because a large amount of them distribute below the euphotic layer. The DIN_R has a dominant role in coastal area, but its production efficiency is also low due to local limitations of DIP and high turbidity. The DIN_T is efficient but has no advantage in terms of input flux, inventory of nutrient, or primary production. The DIN_A from atmosphere are also efficient because they enter the sea from the surface.

Table 1. Inventory (TN, 10^7 kmol), primary production (N-IPP, kmol s^{-1}), and production efficiency (E_{PC}) of DIN from rivers, the Kuroshio, the Taiwan Strait and the atmosphere. Production efficiency is defined as the ratio of N-IPP to TN. The 'Total' column shows the situation of the total DIN, sum of the DIN with different sources. The numbers in parentheses are the corresponding percentages.

		Rivers	Kuroshio	Taiwan Strait	Atmosphere	Total
Inner shelf (0-50 m)	TN (10^7 kmol)	2.5 (58%)	0.4 (9%)	0.4 (9%)	1.0 (23%)	4.3
	N-IPP (kmol s^{-1})	4.1 (56%)	0.8 (11%)	0.8 (11%)	1.6 (22%)	7.3
	E_{PC} (day^{-1})	1/71	1/58	1/58	1/72	1/68
Middle shelf (50-100 m)	TN	0.9 (12%)	3.1 (42%)	1.6 (22%)	1.7 (23%)	7.3
	N-IPP	1.7 (11%)	5.8 (38%)	4.4 (29%)	3.5 (23%)	15.4
	E_{PC}	1/61	1/62	1/42	1/56	1/55
Outer shelf (100-200 m)	TN	0.1 (0.6%)	8.1 (92%)	0.4 (5%)	0.3 (3%)	8.9
	N-IPP	0.2 (1%)	13.5 (78%)	1.6 (9%)	1.9 (11%)	17.2
	E_{PC}	1/29	1/69	1/29	1/18	1/60
The entire shelf (0-200 m)	TN	3.5 (17%)	11.6 (57%)	2.4 (12%)	3.0 (15%)	20.5
	N-IPP	6.0 (15%)	20.1 (50%)	6.8 (17%)	7.0 (18%)	39.9
	E_{PC}	1/67	1/67	1/41	1/50	1/59

Publication/conference presentation

Zhang, J., Guo, X., Zhao, L. Tracing external sources of nutrients in the East China Sea and evaluating their contributions to primary production. Progress in Oceanography, in 2nd revision.

Perspectives in future

The production efficiency was proposed to evaluate the roles of DIN from different sources in primary production over the ECS. But the influence factors for the spatiotemporal variations of production efficiency need further examinations. The primary production consists of two parts: new production and regenerated production. It is assumed that DIN with more regeneration times is more efficient. So, we are planning to apply this tracing model to separate the new and regenerated DIN.