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Characteristics and driving mechanisms of mixing and stratification in the North Passage of the Changjiang Estuary, China

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Abstract

After the implementation of large-scale deep-water channel regulation project in the North Passage of the Changjiang Estuary, the channel has been faced with the problem of large amount of siltation, at the same time, the mixing and stratification process of water column has an important impact on sediment transport. Based on the measured hydrological and sediment data of spring and neap tides in dry and flood seasons of 2016 in the North Passage of the Changjiang Estuary, the gradient Richardson number, Simpson number and potential energy anomaly were calculated to analyze the tidal cycle, spring-neap variation and seasonal variation of mixing and stratification. Taking into account the vertical difference of horizontal density gradient, the contribution terms of time derivative of potential energy anomaly was derived, including depth-mean straining, advection, non-mean straining and tidal stirring. The driving mechanisms of mixing and stratification was investigated by calculating and comparing these four contribution terms. The results show that the seasonal variation of freshwater discharge mainly affected the distance of saltwater intrusion, the saline wedge moved upstream in dry season, while the tidal dynamics had significant impacts on mixing and stratification. In the reaches with saline wedge tip migration, the water column was periodically stratified, and the process was dominated by advection term. In the main reaches of saltwater intrusion, during spring tide, the water column was periodically stratified, which was stratified during flood tidal current, and well mixed during ebb tidal current, and the stratification during flood tidal current was promoted by advection and depth-mean straining, and the mixing during ebb tidal current was promoted by tidal stirring and advection; during neap tide, the water column was permanently stratified, the stratification was enhanced during flood tidal current and weakened during ebb tidal current, and the stratification was mainly maintained by depth-mean straining.

Keywords

mixing and stratification, potential energy anomaly equation, the North Passage of Changjiang Estuary, China, saltwater intrusion