Tidally induced instability processes suppressing river plume spread in a nonrotating and nonhydrostatic regime

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論 文 内 容 の 要 旨

Theis Summary

Numerical study showed the fine scale structures induced by the tidal currents play a role confining fresh water near a river mouth. In this study, field surveys near a river mouth and numerical model experiments were conducted to investigate how fine structures generated in a tidally influenced river plume (tidal plume) affect plume behavior.

For comparison with the modeled river plume in the present study, two sets of field observations were conducted on a river plume. One involved low-altitude remote sensing to provide a plan view of the river plume spreading across the sea surface. The other involved conductivity-temperature (CTD) casts to determine the vertical structure of the river plume. The estuarine front, which was accompanied by a meander with a wavelength of several tens of meters, was visualized based on accumulated foam and debris visible in aerial photographs taken by a ship-towed balloon equipped with a digital camera. CTD casts were deployed 10 times along a survey line, which was set approximately perpendicular to an estuarine. The CTD casts suggested the bottom of the river plume with a thickness of <5 m undulated because of the development of small eddies with horizontal lengths of <100 m.

The numerical model used to reproduce the river plume fluctuations due to the tidal currents. A nonhydrostatic numerical model was able to reproduce the observed fine-scale disturbances in the tidal plume. The river plume without tidal currents expanded offshoreward like a balloon, while the tidal plume was confined near the river mouth. It was found that the tidal plume was dynamically equilibrated between the pressure gradient term and the advection term. The latter was composed mainly of contributions from the fine-scale disturbances, which act as friction because of the momentum exchange between the plume and ambient saline water. The horizontal and vertical components of the disturbances were generated by inertial and Kelvin–Helmholtz instability processes, respectively. It is considered that a combination of the river plume and tidal currents enhances the current shear favorable for such instabilities to occur.