Tidally-induced instability processes governing the river plume behavior in a non-rotating regime

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River plumes play a significant role on the ecosystem as well as the ocean circulation in coastal waters, because they include terrigenous nutrients, sediments, and pollutants in addition to the buoyancy, and thus behavior of river plumes has been an important topic in the coastal oceanography. Recently, an attention has been placed on river plumes fluctuating owing to tidal currents near the river mouth (tidal plume). However, previous numerical studies on the river-plume dynamics have been almost conducted under the hydrostatic assumption, and so it was difficult to investigate how fine structures such as Kelvin-Helmholtz (K-H) bellows observed at the base of tidal plumes alters behavior of river plumes. This is the objective of the present study reproducing the fine structures in tidal plumes using a non-hydrostatic numerical model (MITgcm with 5-m grid cell). First, two sets of field observations were conducted around the Hiji River mouth, the Seto Inland Sea, Japan on July 1st, 2013. One is the CTD casts to depict a vertical section of the river plume, and the other is an aerial photography using a ship-towed balloon equipped with a digital camera to depict a horizontal view of the river plume. The estuarine front visualized by accumulated debris and foams was accompanied by a meander with a wavelength of a few ten meters. The river plume with a thickness of a few meters had the undulated plume owing to the development of small eddies horizontal length less than ~100 m. Numerical experiments were conducted to reproduce the river plume fluctuating owing to the tidal currents, and to investigate the effect of fine structures to the behavior of the river plume. It is confirmed that the horizontal and vertical disturbances observed in the field observations were likely to occur due to the inertial instability and K-H instability, respectively. It is indicated that these disturbances are generated by a combination between river plume and ambient tidal currents, act as friction to prevent for the river plume from expanding offshore-ward.

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