Numerical Modelling of Submesoscale Processes in an Idealized Coupled Estuary-Shelf System off Hong Kong

By
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ABSTRACT
We conduct a numerical simulation on an idealized estuary-shelf system to investigate submesoscale processes under multiple forcing of winds and buoyancy from river runoff. The system is analogue to physical settings of the Pearl River Estuary (PRE) and adjacent shelf off Hong Kong. Based on Regional Ocean Modeling Systems (ROMS) of primitive equations with turbulent closure scheme, the numerical model is implemented by a high horizontal resolution of 100mx100m grid with open boundaries in a limited-area computational domain. The model is forced by prevailing monsoon wind stress and buoyancy from river discharge. By utilizing various combinations of physical forcing and numerical implementations, we successfully simulate the submesoscale flow structures characterized by horizontal length scale of \(O(100) \text{m}\) and examine the response of estuarine and shelf circulation to the multiple forcing. In particular, we study the freshwater bulge, frontal formation and estuary-shelf exchange under the influence of active submesoscale processes in the system. The instability associated with submesoscale fronts induced by river plume is closely bounded to the interaction between wind-driven currents and buoyancy effects. We found that submesoscale processes develop at the edge of the river plume and they spread and intensify with time. This is because of underlying nonlinear effects and unbalanced motions. This study develops a submesoscale-resolving numerical model and improves our understanding of the ocean circulation around the PRE by identifying the underlying submesoscale processes unmentioned before.

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