Symposium on
"Advances in Water Resources Management"
in celebration of the 10th Anniversary of the IAHR-HK Chapter
March 25 - 27, 2008

Interactions of River Plume with Coastal Upwelling Circulation in the Northeastern South China Sea

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Abstract:

Observational and modeling studies were used to investigate the Pearl River plume and its interaction with the summer wind-driven upwelling circulation over the continental shelf of the northeastern South China Sea. After exiting the Pearl River Estuary, the discharged freshwater generates a nearly stationary bulge of freshwater near the entrance of estuary. Driven by an ambient coastal upwelling current, the freshwater in the outer part of the offshore-expanding bulge is then advected downstream and forms a buoyant plume over the shelf. The fraction of the discharged freshwater accumulated in the bulge increases with time and reaches a steady-state when all the newly discharged freshwater is transported downstream. Over the shelf, the plume detaches from the lateral and bottom boundaries, widens and deepens with its central axis offset from the upwelling jet as a result of Ekman drift and geotropic current at the nose of plume. Enhanced stratification thins the surface frictional layer and amplifies the efficiency of the surface shear stress. Yet the seaward surface transport has little effect on the intensity of the upwelling, as the compensating shoreward currents occur only in the layer beneath the plume. The density gradient between the plume and the upwelled dense waters over the inner shelf considerably speeds up the wind-driven current on the inshore edge of the plume, but a mirror gradient retards the current on the offshore edge. The plume-affected flows near the source estuary are nonlinear and penetrate into deeper waters, while the flows over the shelf are mainly dominated by geostrophy. Dynamically, the plume modulates the intensity and alongshore variation of cross-isobath transport in the upper part of the water column by strengthening the surface Ekman effects and by creating buoyancy-induced pressure gradients.