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Diahaline Mixing and Exchange Flow in A Large Multi-outlet Estuary with Islands

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The relationship between the diahaline mixing, the diffusive salt transport, and the diahaline exchange flow is examined using salinity coordinates. The diahaline inflow and outflow volume transports are defined in this study as the integral of positive and negative values of the diahaline velocity. A numerical model of the Pearl River Estuary (PRE) shows that this diahaline exchange flow is analogous to the classical concept of estuarine exchange flow with inflow in the bottom layers and outflow at the surface. The inflow and outflow magnitudes increase with salinity, while the net transport equals the freshwater discharge Q_r after sufficiently long temporal averaging. In summer, intensified diahaline mixing mainly occurs in the surface layers and around the islands. The patchy distribution of intensified diahaline velocity suggests that the water exchange through an isohaline surface can be highly variable in space. In winter, the zones of intensification of diahaline mixing occur mainly in deep channels. Apart from the impact of freshwater transport from rivers, the transient isohaline mixing is also controlled by an unsteadiness term due to estuarine storage of salt and water volume. In the PRE, the diahaline mixing and exchange flow show substantial spring-neap variation, while the universal law of estuarine mixing $m=2SQ_r$ (with m being the sum of physical and numerical mixing per salinity class S) holds over longer averaging period (spring-neap cycle). The correlation between the patterns of surface mixing, the vorticity, and the salinity gradients indicates a substantial influence of islands on estuarine mixing in the PRE.