Abstract View

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Coastal Countercurrent and Mesoscale Eddy Formation by Tidal Rectification near an Oceanic Cape

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ABSTRACT

Cape St. James is an extensive triangular-shaped promontory located in a tidally energetic region at the southern tip of the Queen Charlotte Islands approximately 150 km off the mainland coast or British Columbia. Several years of oceanographic data collected in vicinity of the cape reveal a regional circulation characterized by a strong (0.50 m s^{-1}) coastal current along the western continental margin and respective clockwise and counterclockwise rotating mesoscale baroclinic eddies to the west and south of the cape. The coastal current flows counter to the prevailing winds while the anticyclonic eddy to the west of the cape is a particularly intense feature that appears consistently in AVHRR imagery of the region. The structure of the mean flow, combined with the marked O(0.1 0 m s^{-1}) low-frequency current variability at fortnightly and monthly tidal periods plus significant coherence at fortnightly periods between low-frequency currents and demodulated tidal flow, suggests that rectification of the strong diurnal and semidiurnal tidal currents is the principal cause of the residual circulation in the vicinity of the cape.

Results from an analytical model indicate that generation of the mean residual circulation is due primarily to the M_2 tidal current constituent and that maximum countercurrent velocities occur over the inner portion of the continental shelf. The fortnightly modulation of the mean flow is effected by both diurnal and semidiurnal currents but with a tendency for semidiurnal contributions to dominate in regions of greatest counterflow. Generic depth-dependent numerical simulations for nondimensional frictional parameters typical of the region verify that the asymmetry in the observed location and intensity of the eddy field, together with the presence of the strong coastal countercurrent on the west side of the cape and a narrow jet to the south of the cape, are associated with tidal rectification. These models also suggest that residual vertical motion due to topographic lifting and Ekman suction are responsible for the

observed tilting of the isopycnals and thereby the development of baroclinicity in the residual horizontal motion.

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