

The Impact of Background Currents on Diurnal Critical Latitude Effects on Internal Tides and Mixing

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The effects of latitude on the interactions of background currents with tides on the internal tidal fields, internal waves, and mixing were investigated using the Regional Ocean Modeling System (ROMS) simulations by shifting a small domain with a seamount from 20.6° to 38.6° S. This latitude range includes the critical latitudes for the K_1 and O_1 diurnal constituents. The same topography and hydrography from Barcoo Seamount off New South Wales collected during SS0906 were used for all simulations. During the voyage, a cyclonic eddy was near the seamount, resulting in background currents being present. The simulations with the background currents were compared to without background currents, which used a uniform horizontal hydrography.

The background currents induced a new peak in the diurnal and semidiurnal internal tidal velocities, just equatorward of the O_1 critical latitude and broadened the latitude range for the peak semidiurnal tidal velocities near the K_1 critical latitude by 4°, predominantly poleward. With the background currents, kinetic energy increased in the harmonics from 3-10 cpd and higher frequencies, both at the peak just equatorward of the O_1 critical latitude and the broad peak at the K_1 critical latitude. Nonlinear analysis and bispectra indicated a loss of energy from the diurnal frequencies and a gain at the semidiurnal, harmonic, and higher frequencies at these latitudes. Furthermore, the energy losses came from the along-slope velocities, while the gains occurred in the cross-slope velocities, indicating a switch in both the frequency and direction of the energy. The latitude dependence of the internal tidal beam propagation was also affected by the presence of background currents, with diurnal internal beams propagating away from the seamount poleward of the critical latitude. Diffusivities also increased dramatically, roughly a factor of 20, when background currents were present, with most of the increase near the bottom.

Keywords: critical latitude, mixing, internal tides