Abstract View

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Mean Currents Driven by Topographic Drag over the Continental Shelf and Slope

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ABSTRACT

A sequence of numerical simulations is described of wind-driven flow over irregular continental shelf topography. The model is barotropic, nonlinear, and forced by a periodic, spatially uniform alongshelf wind stress. The objective of the study is to determine whether topographic drag, known to be asymmetric for barotropic flow over the shelf, can generate substantial time-averaged alongshore currents in the presence of a fluctuating zero-mean wind stress.

With realistic parameters, mean maximum alongshore currents of 0.05 to 7.0 cm s^{-1} are realized with flow in the direction of freely propagating shelf waves. The residual current strength is a strong function of wind stress period and bottom bump wavelength: larger forcing periods and shorter bump wavelengths enhance the time-mean circulation. Particle paths are generally observed to be chaotic, in contrast to the nearly cyclic behavior of the Eulerian velocity field. However, cross-shore particle dispersion is well correlated with the mean alongshore currents and may represent a testable observational signature of topographic drag effects.

Model simulations using realistic spectra for both wind stress and bottom roughness yield a maximum flow of approximately 2.5 cm s^{-1}. These results demonstrate that topographic drag asymmetries can lead to observable mean currents on continental shelves and may be a partial explanation for certain observed mean currents that run counter to mean alongshore winds.

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