Abstract View

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The Response of Stratified, Frictional Flow of Shelf and Slope Waters to Fluctuating Large-Scale, Low-Frequency Wind Forcing

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ABSTRACT

Numerical and analytical models are developed to discuss large-scale, low-frequency, wind-driven fluctuations over the continental shelf and slope in the presence of realistic density stratification and bottom friction. The models employ the "long-wave" assumption that frequencies are small relative to the inertial frequency and that alongshore scales are large relative to cross cross-shelf scales. An attempt is made to make the effect of bottom friction on the flow as realistic as possible by taking into account the influence of surface gravity waves on bottom stress. The results were obtained for sinusoidal wind forcing having frequency ω and alongshore wavenumber *l* and are described below.

A general criterion for barotropic shelf water response for wind forcing frequencies ω in the "weather" band (2π/few weeks to 2π/few days) can be derived. For the purpose of rapid calculation, this criterion reduces, approximately, to here N_s^2 is a shelf-averaged value of the buoyancy frequency squared, α is an averaged shelf bottom slope and *f* is the Coriolis parameter. The criterion implies that shelf waters respond barotropically on non-narrow nonequatorial shelves. Under the more restrictive condition $N_s^2 \alpha f^{-1} \ll 1$, analysis shows that the shelf edge pressure is zero and essentially all the wind-driven fluctuating flow occurs on the shelf.

Bottom-stress enhancement due to surface gravity waves can significantly affect the low-frequency, large-scale flow.

As an indication of how the numerical model can be used to determine the stratified frictional shelf and slope water response, calculations were performed for the CODE (Coastal Ocean Dynamics Experiment) region. We found that currents were usually strongest nearshore with a monotonic decrease in amplitude offshore and no zero-crossings. Current amplitudes tended to decrease with depth, particularly over the slope. Nearshore fluctuations generally led those farther offshore in time. For A dyn cm^{-2} wind stress forcing, typical alongshore current velocity amplitudes decreased from about 15–25 cm s^{-1} nearshore to 1–15 cm s^{-1} at the shelf edge.

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