Abstract View

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On the Response of the Ocean to a Moving Storm: The Nonlinear Dynamics

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ABSTRACT

A novel and efficient numerical method is used to investigate the nonlinear equations of motion for the upper layer of a two-layer ocean in which the lower layer is infinitely deep and at rest. The efficiency is achieved by seeking solutions that are in a steady state, translating in equilibrium with the storm. Oscillations are found in the wake of the storm. Two features of the response are attributed to the nonlinear terms in the equation of motion: 1) a rapid transition from a maximum in the downwelling phase, to a maximum in the upwelling phase of each oscillation, followed by a gradual relaxation to the next downwelling maximum; and 2) a displacement of the maximum response, usually to the right of the storm track, by ~ 40 km. It is shown that the horizontal pressure gradient terms can be neglected from the momentum equations for “fast”, “large” storms, in which case a Lagrangian integration can be performed, following fluid particles. This enables feature 1) to be attributed to the along-track advection terms and 2) to be associated with the cross-track advection terms. When the horizontal pressure gradient terms are more important, feature 1) remain but the maximum response is displaced, in the wake, to the left of the track from the right. It is shown that even a symmetric storm can produce a strongly asymmetric response. Finally, results are compared with observations of the response of the ocean to hurricanes.