Abstract View

Volume 14, Issue 2 (February 1984)

Journal of Physical Oceanography
Article: pp. 276–293 | Abstract | PDF (984K)

The Fluctuating Longshore Pressure Gradient on the Pacific Northwest Shelf: A Dynamical Analysis

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(Manuscript received May 28, 1983, in final form September 8, 1983)

DOI: 10.1175/1520-0485(1984)014<0276:TFLPGO>2.0.CO;2

ABSTRACT

The majority of papers on Pacific Northwest shelf dynamics have emphasized the relationship between longshore wind stress τ_3, and longshore velocity *v*. However, attempts to illustrate a balance of momentum in the longshore direction have not been encouraging: τ_3*sol;*H* (where *H* is water depth) has insufficient magnitude to balance the vertically averaged longshore acceleration V_t,, at least during summer. In this paper it is demonstrated that the missing momentum is provided by the longshore pressure gradient force $-p_y$,. The pressure gradient was estimated using tide gauge and atmospheric pressure data at stations separated by roughly 400 km. Seasonal and long-term means from Hickey and Pola and, in some cases, nonseasonal monthly anomalies from Enfield and Allen were added to the sum of the tide gauge and atmospheric pressure data to form time series of total subsurface pressure. The pressure data were multiplied by an offshore deny factor to simulate coastal trapping.

The analysis was performed during four separate two-month periods, spanning four years and two seasons. In each case, inclusion of p_y, in the vertically averaged longshore momentum equation improved the balance with computed acceleration. Some events were forced primarily by τ_3*sol;*H*, others $-p_y$. However, during some extended periods, one or the other force dominated; for example, during summer 1978, $-p_y$, provided almost all the force to balance the acceleration. During every period, V_t, and $-p_y$, were significantly coherent at the 95% level and the phase difference between the time series was close to zero at most frequencies, as expected for a barotropic wave-like disturbance such as a first mode hybrid coastal trapped wave in this region. The pressure field at frequencies ≤ 0.3 cpd was consistent during all periods with northward propagation at speeds on the order of the free first mode coastal trapped wave or 50–200% faster. However, individual events during periods of weak local winds were observed to propagate through the region at the free first mode wave speed; also, p_y, was only weekly correlated to local τ_s. Thus it appears that whereas the local pressure field is significantly affected by local wind forcing, the pressure gradient field is generated primarily nonlocally. At the extremely energetic higher frequencies (0.35–0.50 cycles per day). during

winter, first mode freely propagating coastal trapped waves do not appear to be as important to the dynamics.

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