Abstract View

Volume 14, Issue 6 (June 1984)

Journal of Physical Oceanography
Article: pp. 1079–1094 | Abstract | PDF (1.13M)

Statistical Characteristics of the Large-Scale Response of Coastal Sea Level to Atmospheric Forcing

J.S. Allen and D.W. Denbo

College of Oceanography, Oregon State University, Corvallis, OR 97331

(Manuscript received November 18, 1983, in final form April 5, 1984)

DOI: 10.1175/1520-0485(1984)014<1079:SCOTLS>2.0.CO;2

ABSTRACT

As part of a study of the large-scale response of coastal sea level to atmospheric forcing along the west coast of North America during June–September 1973, Halliwell and Allen calculate space- and time-lagged cross-correlation coefficients $R_{\tau\zeta}$ between adjusted sea level ζ at fixed alongshore locations $\zeta(y_0)$ and the alongshore component of the wind stress τ at general alongshore positions $\tau(y)$. Similarly, correlation coefficients $R_{\zeta\zeta}$ and $R_{\tau\tau}$ involving, respectively, $\zeta(y_0)$ versus $\zeta(y)$ and $\tau(y_0)$ versus $\tau(y)$ are computed. The $R_{\tau\zeta}$ correlations show a consistent asymmetry in time and space lag (t_L, y_L), with maximum values of $R_{\tau\zeta}$ found for $\tau(y)$ to the south of $\zeta(y_0)$ and leading in time. The $R_{\tau\tau}$ correlations are typically symmetric in t_L and in y_L while $R_{\zeta\zeta}$ generally show sea level fluctuations to the south leading those to the north in time. It is shown here that the observed correlation coefficients involving ζ are consistent with those derived from solutions to the forced, first-order wave equation with a linear friction term where an assumed form of $R_{\tau\tau}$, based on observations, is used as a forcing function. Similar investigations are carried out in the frequency domain where corresponding theoretical space-lagged squared coherences and phases are calculated. Qualitative agreement with observed behavior is obtained in several instances for the space-lagged statistical functions in both time and frequency domains. Additional new results include theoretical expressions for the relation in wind-forced regions of alongshore propagation velocities of ζ, determined from lagged cross-correlation coefficients or cross-spectral phase differences between variables at different alongshore positions, to the free-wave propagation speed c, the determination of c from $R_{\tau\zeta}$, the variation with frequency of alongshore coherence scales of ζ and of coherence and phase between ζ and local τ.