Abstract View

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The Noutidal Flow in the Providence River of Narragansett Bay: A Stochastic Approach to Estuarine Circulation

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ABSTRACT

Atmospherically driven flow in the Providence River (a partially mixed estuary) has been examined using a 51-day velocity record measured 2 m from the bottom. Velocity fluctuations at time scales between the steady-state gravitational convection and the tidal oscillations were large and almost exclusively wind-induced. The mean and variance of the velocity component lying along the channel axis were 11.7 cm s^{-1} (landward) and 166.9 cm^2 s^{-2}. Of this axial current variance 48% resided at subtidal frequencies as compared to 45% associated with semidiurnal tides (the remaining 7% was mostly due to higher tidal harmonies). Over the most energetic portion of the axial current spectrum (periodicities of 4–5 days), 97% of the variance was coherent with the wind velocity component lying along the direction of maximum fetch, with the current lagging the wind by about 4 h. Owing to this extremely high coherence, a linear time-invariant stochastic model reproduced the axial current from the two orthogonal wind velocity components to within an rms error of 2.3 cm s^{-1}. The wind also had a marked effect upon the density field. It is concluded that the effects of wind can permeate the entire water column of a partially mixed estuary arid can be of equal (or greater) importance to the circulation as the tides or gravitational convection.