Abstract View

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A Study of the Growth of the Wave Spectrum with Fetch

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ABSTRACT

The development of the wave spectrum with fetch in a steady wind has been studied with a line of consecutive wave buoys in the Bothnian Sea in 1976 and 1979. The relationship that was found between dimensionless peak frequency ω_m ($=\omega_m U_{10}/g$) and dimensionless fetch $\tilde{X}$ ($=gX/U_{10}^2$) was close to previous observations. The dimensionless energy $\bar{\sigma}^2$ ($=g^2\omega^2/U_{10}^4$) was about twice that observed in the JONSWAP experiment.

In the saturation range when $\bar{\omega}>4$ the frequency spectrum was found to have the form $S(\omega) = \alpha_u U_{10} g\omega^{-4}$ where $\alpha_u=4.5\times10^{-3}$, independent of the dimensionless fetch $\tilde{X}$. The deviation from the Phillips −5 power law could not be explained by the influence of currents or finite depth. Near the peak, the spectra were satisfactorily described by the JONSWAP spectrum; above frequencies twice the peak frequency the difference becomes significant. A qualitative explanation is proposed for the dependence of the spectrum on the wind speed in the saturation range. The semi-theoretical method of Longuet-Higgins (1969) to estimate the Phillips saturation-range constant is applied to estimate α_u. The result $(4.4–6.4)\times10^{-1}$ agrees with the experimental value. The growth of a component of the dimensionless spectrum with the fetch was found to be exponential within the accuracy of the data. The exponential growth parameter agreed with previous observations. A simple model is proposed to predict the growth rate without assuming nonlinear transfer of energy by wave-wave interactions; the results agree well with observations.