IMPROVING SEA STATES MONITORING OF NAUTICAL RADAR USING DISPERSION RELATION OF NONLINEAR OCEAN WAVES

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In recent years, considerable interest has been shown in the application of remote sensing techniques to the measurement of sea states. Compared to other air and spaceborne remote sensing systems, nautical radar images cover smaller areas but they obtain the temporal information of the sea surface with high temporal and spatial resolution. Hence, it allows monitoring the spatial and the time evolution of wave fields.

The measurement of sea states using nautical radars is based on the backscatter of the electromagnetic fields by the ripples and the roughness of the free sea surface. The pattern of returned electromagnetic energy is modulated by the larger structures, such as swell and wind sea waves. The final pattern shown on the radar screen is known as sea clutter. To derive sea state parameters from sea clutter time series, the concept of sea state is taken into account, which is based on linear wave theory and assumes spatial homogeneity and temporal stationary of the wave field. Under these assumptions, sea states are described as a Gaussian zero-mean random processes varying in space and time and ocean surface waves are dispersive with a dispersion relation of linear ocean waves [1-5]. While analyzing the image sequences spectrum, the energy associated with ocean waves can be separated from background noise by applying linear wave dispersion relationships as a filter [1]. The present methods for estimating the wave parameters from radar backscatter are based on the relationship between spectral energy and noise, which are both estimated by the dispersion relation of linear wave theory.

However, the features seen in the radar backscatter data are nonlinear. Radar backscatter would result in shadowing if the higher waves hide the lower waves from radar antenna illumination, such as in the case of lower grazing incidence [6]. Senet et al [7] proposed that the nonlinearity of a radar signal would affect the energy distribution in the domain of radar image sequences spectrum, causing the distribution of ocean wave energy against the linear wave dispersion relationship. In other words, the energy distribution of an image sequences spectrum would not match the dispersion relation curve of linear ocean waves. Wolf and Bell [8] studied the characteristics of X-band radar image sequences spectra and found that the energy from does not always correspond to the linear dispersion relation curve, especially in the lower and upper frequency band.

Therefore, we chose to explore the nonlinear features of ocean wave in its application to sea states monitoring. The analysis process, based on finite amplitude wave theory, derives the dispersion relation of nonlinear waves and takes advantages of nonlinear character of ocean waves. Instead of the assumption of linear wave theory, we will analyze different phenomena and radar imaging mechanisms, which are responsible for the final image shown on the radar screen. Thus, it is expected that method will fully explore the differences between spectral energy and noise and improve the accuracy of estimating the wave parameters from the radar image sequences spectrum. And the study will shred a new light to improve the operation of nautical radar.

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