Statistical Modeling of Monostatic S-Band Returns from Inland Water Surface under Moderate Winds

Kung-Hau Ding*
Sensors Directorate, Air Force Research Laboratory
Wright-Patterson AFB, OH 45433-7320
Email: Kung-Hau.Ding@wpafb.af.mil

William G. Stevens (retired), James Park, Kristopher Kim, Saba Mudaliar, and Panos Tzanos
Sensors Directorate, Air Force Research Laboratory
Wright-Patterson AFB, OH 45433-7320

Abstract

The statistical distribution of electromagnetic wave scattering from terrestrial terrain is an active research area for modern radar applications in remote sensing, communication, imaging and detection. Commonly used amplitude statistical models include Rayleigh, lognormal, Weibull, and K- distributions. On the other hand, the clutter phase generally resembles a uniform distribution. A polarimetric S-band (2.71 GHz) scattering measurement campaign of wind-roughened water surface was conducted at a reservoir located in eastern Massachusetts. The data collection was carried out over 180 distinct radar geometries, with grazing angles varied from 3° to 12° while the azimuth angle varied from 87° to 160°. The wind speeds varied from 2 m/s to 6 m/s.

In this paper, we perform the statistical study of reservoir clutter data using analytically derived probability density functions (pdfs) of amplitude and phase. The amplitude pdf is expressed in terms of sums of modified Bessel functions, while the phase pdf is in terms of the error function. The advantage of these pdf models is that they require only the first and second moments of the received signals, the mean, variance, and correlation coefficient of the real and imaginary parts of scattered fields, which can be easily evaluated from measured data. A comparison of measurement data with the analytical distributions will be presented. Results show that the amplitude and phase pdfs vary with observation angle, polarization and wind speed. The amplitude of vertically polarized reservoir returns shows a wider distribution than for horizontal polarization, while the phase of the scattered field from the reservoir water surface may depart from the uniform distribution. Moreover, the analytical amplitude and phase distributions are in good agreement with the empirical distributions of data sets.

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