A Doppler Method to Measure Forward Scattering of Radiowaves at Near Grazing Angles

G. Koh and S. A. Arcone
U. S. Army ERDC-CRREL, USA

We are developing a Doppler method to measure bistatic forward and backscatter from rough surfaces on a rotating table. The method avoids interference between the forward scatter and the direct signal between antennas. We use a 90-GHz FMCW system converted for Doppler use. We use horn lens antennas to produce a 1.4 degree beamwidth that illuminates a small area of the rotating table within which the translational velocity is fairly uniform; a more exact calculation of velocity variations within the area has not yet been worked out. The table rotates at about 0.05 Hz, which provides a translational velocity of about 0.3 m/s within the illuminated area and a Doppler shift of about 75 Hz. We rectify our measured signal and form our scattering probability density functions from the peak amplitudes, of which about 1500 occur during one table rotation. Our minimum grazing angle is still a relatively large 10 degrees. However, this limitation is imposed only by blockage of the antenna aperture by the edge of the one-meter radius table; smaller angles could be achieved with a larger table. Preliminary results for very rough scattering by crushed rock of 0.5–2 cm size show Rayleigh distributions for backscatter with a greater concentration of higher amplitudes at the smaller incidence angles of 60–70 degrees. The forward scatter shows more Gaussian distributions with greater amplitudes occurring at 75–80 degrees. These general results are expected. Rms heights and autocorrelation functions of the surfaces were measured on a separate, stationary surface with a laser profilometer, but this instrument could easily be adapted to a stationary mode over the rotating table. Calibration of absolute reflectivity will require a flat plate and precise beam alignments, and a more careful description of the illumination pattern is needed because the table is not in the far field.