A RADAR-ECHO MODEL FOR MARS; T.W. Thompson, Calif. Inst. Tech., Jet Propulsion Laboratory, Pasadena, CA, 96011 and H.J. Moore, U.S. Geological Survey, Menlo Park, CA, 94025.

We have developed a radar-echo model for Mars based on 12.6-cm continuous-wave radio transmissions backscattered from the planet [1,2]. Our model (1) broadly matches the variations in depolarized and polarized total-radar cross sections with longitude observed by Goldstone in 1986 along 7° S. and (2) yields echo spectra that are generally similar to the observed spectra, with some departures.

In our model, Mars' surface is divided into radar map units that are based on generalized geologic map units [2]; the radar map units are further subdivided using thermal inertias [3]. Thermal inertias are used because the geologic map units are not sufficient to account for the quasi-specular echoes and normal reflectivities and thermal inertias are positively correlated along 7° S. and elsewhere [4,5]. For cratered uplands and plains units, model depolarized- echo strengths vary as A*cos[theta] (where [theta] is the incidence angle and A is a parameter assigned to the radar map unit on a degree by degree basis), and polarized diffuse-echo strengths vary as 3*A*cos[theta]. For most volcanic units, depolarized and polarized diffuse-echo strengths vary as $A*\cos^2$[theta]. Quasi-specular echoes were computed using Hagfors' scattering law [6] (integrated from -30° to +30° theta). Assignments of depolarized echo strengths, normal reflectivities, and root-mean-square (rms) slopes for the radar map units were guided by previous experience [2], thermal inertias [3], and the results from analyses of the quasi-specular echo spectra and then they were adjusted by trial and error methods to best fit the data. Coarse-scale topography is not included in the model.

Radar map units in our model include: (1) an extensive cratered uplands (background) unit with weak depolarized echo cross sections (0.01), average thermal inertias, moderate normal reflectivities (0.095), and moderate rms slopes (4.0°); (2) the volcanic units of the Tharsis, Elysium, and Amazonis regions with strong depolarized echo cross sections (0.04-0.133), low thermal inertias, low normal reflectivities (0.025-0.050), and large rms slopes (6-20°); and (3) the northern plains units with moderate to strong depolarized echo cross sections (0.017-0.045), moderate to very high thermal inertias, moderate to large normal reflectivities (0.075-0.15), and moderate rms slopes (3-5°). Arabia, an extensive unit of upland that is mantled by dust, has a low depolarized-echo cross section (0.007), low thermal inertia, small normal reflectivity (0.05), and small rms slope (3.0°). There are additional radar map units (there are about 140 radar map units). At this time, our model does not include an equatorial region extending from the vicinity of western Pavonis Mons to S.E. Elysium Planitia that has non-existent to very weak depolarized echoes or the very strong ones from the poles

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observed at 3.6-cm wavelength [7].

Like the observations, model total-polarized echo cross sections vary with longitude as a two-cycle curve with maxima near 30° and 240° W. and minima near 130° and 330° W.; model total-depolarized-echo cross sections vary with longitude as a one-cycle curve with a maximum near 135° and a minimum near 330° W.; and, the ratio of total-depolarized and total-polarized cross sections (mu) vary with longitude as a one-cycle curve.

Model depolarized- and polarized-echo spectra, as well as ratios of the two, resemble those that are observed. For smooth regions with moderate thermal inertias and normal reflectivities, the central parts of polarized-echo spectra are dominated by the quasi-specular parts that form tall, narrow peaks that rest upon low, broad domes of the diffuse echoes. In rough regions with low thermal inertias and small normal reflectivities, the quasi-specular echoes form low broad peaks that rest upon and merge imperceptibly with the broad domes of the diffuse part of the echoes. Like the observed spectra, the forms of the polarized diffuse echoes tend to mimic the depolarized echoes except near the centers of the spectra where the quasi-specular parts of the polarized echoes totally dominate the spectra. For the model and observations, ratios of the spectra of depolarized and polarized echoes are similar.

Several aspects of our model are instructive and relevant to the interpretation of radar echoes from Mars. These aspects are related to the sizes of the heterogeneous radar map units areas sampled by the radar, and the way in which the radar samples the surface; for example: (1) quasi-specular echoes from horizontal surfaces may be asymmetrical with peaks displaced from zero-doppler frequency when the radar samples adjacent units with different roughnesses; (2) quasi-specular echoes from very smooth areas with embedded very rough areas may be so dominated by the smooth areas that the rough areas are not revealed in the spectra; and (3) the diffuse parts of the polarized echoes may contribute substantially to the polarized echoes. Careful examination of observed echoes show that the surface of Mars is, like our model, heterogeneous.

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