

OBSERVATIONS OF MARS DURING THE 1990 OPPOSITION FROM THE GOLDSTONE SOLAR SYSTEM RADAR FACILITY AT 3.53 CM WAVELENGTH; T.C. O'Brien¹, R.F. Jurgens², M.A. Slade², S.D. Howard², H.J. Moore³, and T.W. Thompson² ¹The University of California, Berkeley, CA, 94720 ²The Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, 91106 ³U.S. Geological Survey, Menlo Park, CA, 94025

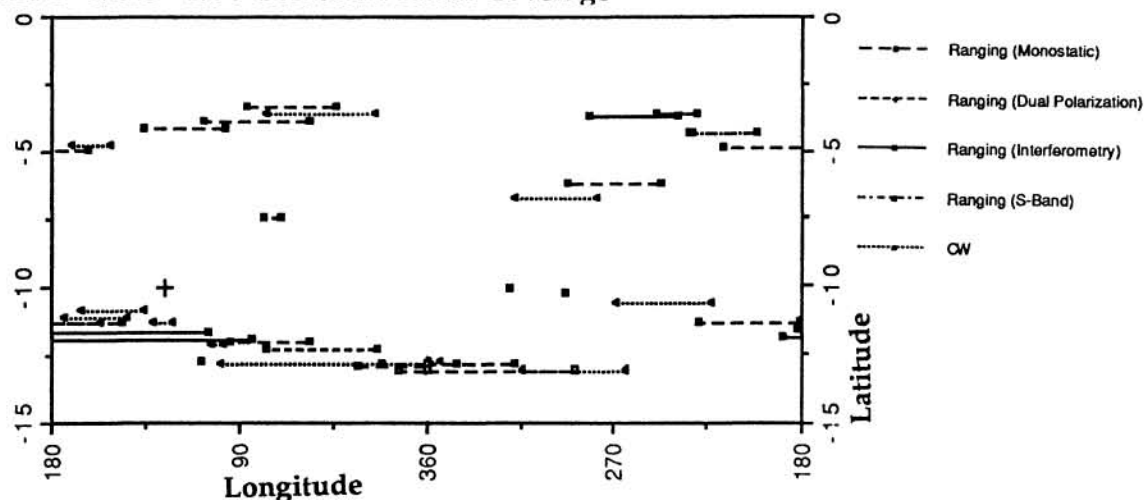
During the 1990 opposition of Mars, the Goldstone Solar System Radar (GSSR) Group at the Jet Propulsion Laboratory performed ranging observations of Mars transmitting at 8495 MHz (X-Band) and receiving monostatically using the 70 meter antenna and, on some occasions, bistatically using both the 70 meter antenna and the 26 meter antenna at DSS-13.

On 4 of the days of ranging observations, the GSSR facility was able to perform the first delay-Doppler real-time interferometry of Mars by computing the complex cross-correlation of the signals received at the 70 meter and 26 meter antenna. The data from the real-time interferometry observations may be used in conjunction with existing monostatic data and to build high resolution parametric images of the altimetry, Fresnel reflectivity and Hagfor's C parameter¹. On two additional days, the new data acquisition system was used to form the Stokes vectors from monostatic observations. In the design of the real-time interferometry experiment and the dual polarization experiment, emphasis was placed on increasing the amount of useful information obtained from each observation, while not compromising the essential purpose of ranging data acquisition.

The coverage obtained from two of the real-time interferometry tracks were the most extensive received at the GSSR facility during the 1990 opposition, providing 78° and 104° of overlapping longitudinal coverage crossing the Tharsis region. This region, and particularly the area dubbed "Stealth" (Muhleman et al.)², is of particular interest due to the extremely variable reflectivity of the terrain; a 20dB difference in signal to noise ratio was observed during one of these observations.

Continuous Wave (CW) observations of Mars were also made at the GSSR facility 70 meter antenna (DSS-14) on 12 separate days receiving both opposite sense (OC) and and same sense (SC) polarizations. During the 12 days of observations, 76 spectra were accumulated at various longitudes and latitudes, as indicated in figure 1.

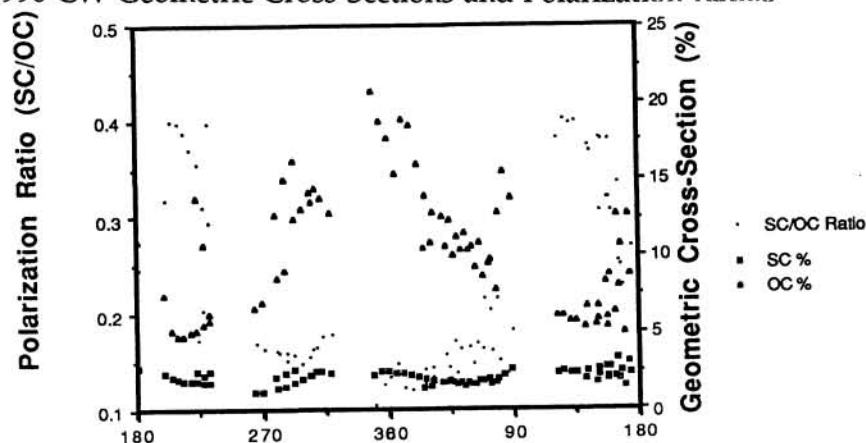
Figure 1 Mars - 1990 Goldstone Radar Coverage



During most of the CW observations, the signals were also received and processed at the DSS-14 facility providing greater resolution on the central 20KHz of the returned signal, and allowing computation of the circular Stokes vectors. Analysis of the Stokes vector may provide details about surface and subsurface rock populations since one mechanism for coupling between the two polarizations is reflections produced by surface rocks.

As has been noted in previous observations of Mars (Thompson, Moore)³, the radar cross-sections and polarization ratios fluctuate tremendously depending upon the terrain. Measurements of cross-sections reported previously at S-Band have indicated values for OC polarization cross-sections ranging between 5% and 16%, and polarization ratios ranging between about .1 and .5. The data produced from the most recent observations indicate values for the opposite sense polarization varying between 4.8% and 20% of the geometric area, with polarization ratios ranging from .13 to .4 as indicated in figure 2. The region near Arsia Mons produces significant increases in the SC component, while the region immediately to the west of Arsia produces significant decreases in both the OC and SC returns. This region produces overall geometric cross-sections that range from 4.9% to 8% in the OC polarization, and polarization ratios of .4 are typical.

Figure 2 Mars - 1990 CW Geometric Cross-Sections and Polarization Ratios



The accumulated data from the 1990 observations provide dual polarization CW coverage of the planet, with overlapping coverage on several features of interest. This data set also complements data recorded during the 1988 opposition. The CW data from both the 1988 and 1990 observations are currently being used to correlate geological features to brightness maps derived from direct inversion (Slade, Hudson and Ostro)^{4 5}, and to develop "forward" models (Moore, Thompson)⁶, which fit theoretical spectra created from geological models of the planet to the observed spectra.

REFERENCES: ¹ Jurgens, R.F., Howard, S.D., Slade, M.A., Robinett, L., and Strobert, D. (1991), LPSC XXII, A Preliminary Study of the Potential for High Resolution Parametric Radar Imaging of Mars by Ground-Based Radar (abstract). ² Muhleman, D.O., Butler, B., Grossman, A.W., Slade, M., and Jurgens, R.F., (1989), Fourth International Conference on Mars, Jan 10-13, Tuscon Arizona (abstract). ³ Thompson, T.W., Moore, H.J. (1989), Proceedings of the 19th Lunar and Planetary Science Conference, 409-422. ⁴ Slade, M.A., Hudson, R.S., O'Brien, T.C., and Jurgens, R.F., (1990), LPSC XXII, Mars Reflectivity Images from 1988 and 1990 CW Spectra (abstract). ⁵ Hudson, R.S., and Ostro, S.J., (1990) JGR, 95 B7, 10947-10963. ⁶ Moore, H.J., O'Brien, T.C., Jurgens, R.F., Slade, M.A., and Thompson, T.W., (1991), LPSC XXII, Preliminary Comparison of 3.5 and 12.6 CM Wavelength Continuous Wave Observations of Mars (abstract).