

Mars Meter-Scale Roughness: Goldstone Solar System Radar Delay-Doppler Database

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Abstract-The entire fourteen-year database of Goldstone Solar System Radar Mars near-nadir radar scattering model fits is being revised using the latest topography from the Mars Global Surveyor Mars Orbiter Laser Altimeter instrument. The improved radar dataset will better serve the Mars exploration community for landing site selection and characterization.

I. INTRODUCTION

The Goldstone Solar System Radar (GSSR) has successfully collected radar echo data from Mars over the past 30 years. The older data provided local elevation information for Mars, along with radar scattering information with global resolution (e.g. [1,2]). Since the upgrade to the 70-m DSN antenna at Goldstone completed in 1986, Mars data has been collected during all but the 1997 Mars opposition. Radar data, and non-imaging delay-Doppler data in particular, requires significant data processing to extract elevation, reflectivity and roughness of the reflecting surface using the Hagfors scattering model [3]. The spatial resolution of these experiments is typically some 15 km in longitude by some 150 km in latitude. The interpretation of these parameters while limited by the complexities of electromagnetic scattering, do provide information directly relevant to geophysical and geomorphic analyses of Mars.

II. LANDING SITE ASSESSMENT WITH RADAR DATA

The usefulness of radar data for Mars exploration has been demonstrated in the past. Radar data were critical in assessing the Viking Lander 1 site [4, 5] as well as, more recently, the Pathfinder landing site [6]. In general, radar data have not been available to the Mars exploration community at large. One of us (Haldemann) has recently finished a project funded by the Mars Exploration Directorate Science Office at the Jet Propulsion Laboratory (JPL) to reprocess to a common format the last fourteen years worth of raw GSSR Mars delay-Doppler data in aid of landing site characterization for NASA's Mars Exploration Program. The radar data used were obtained since 1988 by the GSSR, and comprise some 72 delay-Doppler radar tracks. Twenty-eight of the tracks lie in the

latitude range proposed for landing sites for the 2003 Mars Exploration Rover (MER).

III. MARS RADAR DATABASE

The GSSR X-band (3.5 cm wavelength) database consists of Hagfors scattering model fits providing the Fresnel reflectivity of the Martian surface, and the rms-slope for length-scales around 1 m. We recently re-recognized a shortcoming of our past analytical procedure: we have not in the past accounted for the east-west slope in our fitting of scattering models to the specular cap echo. The skew of the actual echo biases the fits of the scattering parameters for regional slopes greater than 1 degree. Fortunately all past landing sites have been in regionally flat locations and those published results hold. In general the signal-to-noise of the GSSR data are not sufficient to fit for regional slope in addition to scattering model parameters. Now however, the Mars Global Surveyor Mars Orbiter Laser Altimeter (MOLA) instrument has generated a high precision global topographic dataset for Mars which we are using to drive our latest scattering model fits.

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