MAGELLAN VERTICAL POLARIZATION RADAR OBSERVATIONS. Jeffrey J. Plaut, Jet Propulsion Laboratory, California Institute of Technology, MS 230-225, 4800 Oak Grove Drive, Pasadena, CA 91109.

Introduction

The Magellan high-gain radar antenna system was designed to transmit and receive signals in a pure linear polarization state. The nominal mapping configuration placed this linear polarization direction parallel to the surface of Venus, providing SAR image data in the HH polarization (horizontal transmit and receive) and radiothermal emission data in the H (horizontal - receive only) polarization. During Magellan's extended mission (cycles 2 and 3), two brief experiments were conducted in which the spacecraft was rotated 90 degrees along the axis of the antenna boresight, producing SAR data in the VV polarization and emission data in the V polarization. This study will focus on the SAR results from the first experiment, which included portions of the highly reflective Beta Regio highlands.

Theoretical models of polarimetric backscatter [1,2], along with experimental data from terrestrial surfaces, predict VV backscatter cross section values to be higher than HH values for most natural surfaces. Randomly polarized ("depolarized") backscatter from rough surfaces is expected in equal amounts for either incident polarization. Roughness differences will therefore be more pronounced in HH measurements than in VV, because the depolarized random component makes up a proportionately larger fraction of the HH backscatter. In addition, HH cross section values are observed to fall off more rapidly than VV values with increasing incidence angle. Slope-related backscatter differences will therefore be more pronounced in HH images. The small perturbation polarimetric scattering model also predicts higher VV to HH ratios for surfaces of high dielectric constant [2,3].

Data acquisition

The Magellan VV polarization data were obtained on orbits 3716-3719 and 4567-4574. The primary target of the first experiment was the highly reflective regions near the summit areas on Rhea and Theia montes, in Beta Regio. The center of the four-orbit swath crossed the equator at about 284 degrees longitude. Data acquisition was extremely successful for the first experiment. The second experiment, designed to image elevated regions in Ovda Regio, including a "festoon"-type lava flow [4], was less successful because of degradation of the spacecraft data transmission system. The center of the second swath crossed the equator near 95 degrees longitude.

For comparison of the HH and VV SAR images, small mosaics were constructed for areas likely to show differences. Inspection of these mosaics showed subtle differences between the polarizations in some areas. Difference images were constructed that directly displayed the ratio of VV to HH backscatter cross sections. Best results were obtained using a median spatial filter on each image before calculating the cross section ratio image, to reduce the effects of speckle on the ratio determinations.

Results

Differences in HH and VV response were observed on several terrain types covered in the first experiment. The lowest backscatter areas, such as plains surfaces near impact craters (e.g. 45.5N, 282E; 13.0S, 286E) showed less contrast with the surroundings in the VV image, and therefore displayed a relatively higher VV/HH ratio than the surroundings. The most dramatic differences were observed in portions of the Beta Regio highlands showing enhanced Fresnel reflectivity and low emissivity. High VV/HH ratios are observed near the rift zone on the north flank of Theia Mons (27.0N, 282E) [5]. A VV/HH ratio of 2.6 dB is seen on an area with H polarization emissivity values ~0.55. The largest VV/HH anomaly, however, at 3.3 dB, is observed on an adjacent "dark summit" area [6] that has an H polarization emissivity of ~0.77. Along the southeastern flank of Theia Mons (24.0N, 282E), complex variations in VV/HH occur on overlapping lava flows within a low emissivity area. Although the magnitude of the VV/HH variations is small (1-2 dB), they are clearly correlated with geologic features and indicate variations in the physical properties of the lava flows. Possible causes for these scattering anomalies include differences in dielectric constant related to composition or density, or geometric elements at the surface of the flows that favor or discourage coupling of the impinging signals depending on the polarization orientation.

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References

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