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MARSIS and SHARAD Data Recovery for Subsurface Features Estimation

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The primary scientific objectives that can be accomplished by orbiting Ground Penetrating Radars like the Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS) and the Shallow Radar (SHARAD) are the surface characterization and the subsurface geological probing in search of waters reservoirs, both liquid and solid in the upper portion of the crust. The subsurface geological probing requires the estimation of the subsurface dielectric constant via a data inversion approach. More clearly, the data inversion process is the estimation of the dielectric constant of the material composing the different detected interfaces including any impurity within the host material of each layer and its percentage. Geologists will then select the proper materials according to the estimated dielectric constants. In the backscattered signal are simultaneously present the material feature and the geometric contribution. Therefore, it is necessary to study the scattering behavior of the surface/subsurface, related to its characteristics (flat or rough). This implies, in particular, the selection of the backscattering model among Physical Optics, Geometrical Optics and Fractal Models.

MARSIS and SHARAD also have a Doppler Beam Sharpening capability to reduce the clutter coming from the topographic features not immediately below the radar. From the available data (frames) it is possible to measure the surface echo power Ps, the subsurface echo power Pss, and the relevant time delay $\Delta\tau$. Assuming the surface reflectivity known it is possible, using a multi-frequency approach, to estimate the crust attenuation and the values of the dielectric constant for the various subsurface interfaces prior detected in products such as frames and radargrams.

The selection of stationary regions is a primary task in order to find clustered areas with uniform attenuation and similar subsurface features. In particular, several stationary areas have been identified by MARSIS on the Mars South Pole. The proposed procedure is a fully automatic technique that can be applied over stationary areas.