SHARAD DATA MAPPING FOR SURFACE COMPOSITION DETECTION. Luigi Castaldo[1], Daniel Mège[1], Roberto Orosei[2], Giovanni Alberti[3] , Joanna Gurgurewicz[1,4], [1]Institute of Geological Sciences PAS, Wrocław, Poland, [2]Istituto di Radioastronomia, Istituto Nazionale di Astrofisica, Bologna, Italy, [3]CO.RI.S.T.A., Napoli, Italy, [4]Space Research Centre PAS, Warsaw, Poland.

Introduction: Synthetic Aperture Sounding is an important advance over conventional sounding, and it can be used to directly resolve the stratigraphy of the subsurface and to determine the composition of the first meters of the surface. Radar echoes can be analyzed to retrieve the permittivity properties of the layers producing surface and subsurface reflections, to constraint or even identify their composition. The signal inversion of sub-surface sounding radar data is an inverse problem for which different approaches have been presented over the years [1], [2]. The Radar Shallow Subsurface Radar (SHARAD) was designed to study the interior of Martian sub-surface [3]. Data collection and processing should be transparent to the user. The first requirement, for the majority of users of SHARAD data, is that the data collection and processing techniques used to produce the images are not an issue so that their attention can focus on science. For the remote sensing scientist working on data processing, the goal is to model the relationship between geophysical parameters and sets of radar backscatter measurements. But to do this, some scientific input are needed in order to determine realistic parameter values that will be used for data calibration [4].

Calibration model: The classical method to calibrate the data, i.e. checks of the form of the impulse response, point targets such as trihedral corner reflectors with a large Radar Cross Section [5], cannot be employed on Mars surface, moreover the SHARAD reflectivity processing requires more than 2 TB of data volume. An automatic method for locating echoes has been developed to be applied to the set of global Mars data, dedicated to the extraction of the surface echo. Several parameters affect the surface echo power: the permittivity constant, roughness, and slope. Most backscattering models separate the effect of the permittivity constant from the remaining parameters [6]. In order to improve The S/N, a low-pass filter operates in azimuth, and a local regression is adopted using weighted linear least squares and a 2nd degree polynomial model on the radargrams for the benefit of keeping better uniformity of the horizontal continuity of the echoes. The wavelength of the signal is greater than the plasma frequency of the ionosphere, allowing it to pass there through. However, during the propagation of the wave, disturbances may occur, depending on the solar zenith angle between the satellite and the position of Mars. For this reason, only nocturnal data are used. A 3D electromagnetic model has been developed to estimate the backscattering from natural rough surface [7] in order to correct the variation of the echo power due to the observed geometry. A fractal geometry model has been adopted as it is scale invariant, and has high fidelity in surface backscattering estimate. The data adopted for the fractal backscattering estimate are the Precision Experiment Data Records of MOLA [8]. The model is based on the following main assumptions: (1) scattering takes place at the interface between two media, i.e. space and the Martian surface; (2) the first medium is supposed to have the permittivity of open space, the second medium is supposed to be homogeneous and non-dispersive. With these assumptions, the power backscattered by the surface is directly measurable from radargrams and can be evaluated by using the classical "radar equation" [9]. The calibration of the signal requires the determination of a calibration area. The chosen calibration area is located inside the North Polar cap, between 82°N and 84°N, and between 180°E and 200°E. The area consists primarily of water ice with a few percent of dust [10].

Surface composition: The model reveals the contribution due to the permittivity properties of the surface material. This signal is highly dependent on physical parameters (permittivity and roughness) characterizing the near surface (0-10 m deep), we can therefore potentially learn about its composition. A calibration procedure has been assessed in order to derive a relationship between the geophysical parameters, the permittivity constant, and a set of radar backscatter measurements. The model to extract the permittivity constant of the surface of Mars from the echoes of the radar takes into account the signal distortion source. The relative strength of the surface echo is equated to the reflectivity, and the effects of surface roughness are modelled using the MOLA topographic dataset. The resulting information provides insight on the nature of the materials constituting the Martian surface. The results are the production of permittivity constant maps of the Martian surface.

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