CALIBRATION OF MARSIS SURFACE ECHOES.

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Introduction:

Mars surface geology at 100 meters depth scale is largely unknown. Other instruments (cameras or spectrometers) provide information at most within a few meter depth. MARSIS (Mars Advanced Radar for Subsurface and Ionosphere Sounding) offers an unique opportunity to probe tens of meters of the sub-surface of Mars [1]. However, any surface reflectivity study requires to calibrate the radar surface echoes. Here, we present a method for the relative calibration of surface echoes.

The final aim of this work is to caracterize different geological units of the tens of meters depth scale and to compare to current geological maps.

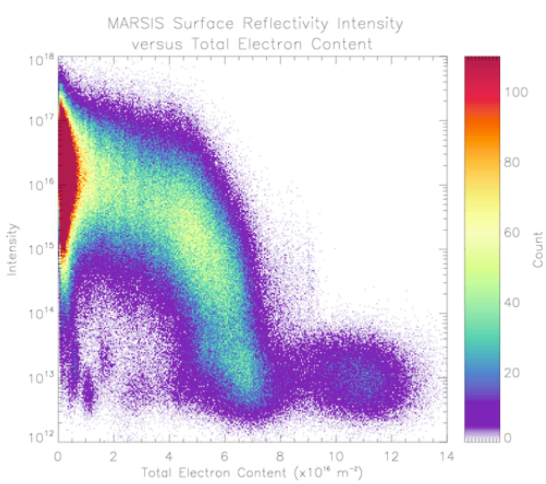
Relative Calibration of Surface Echoes (Ionospheric Attenuation):

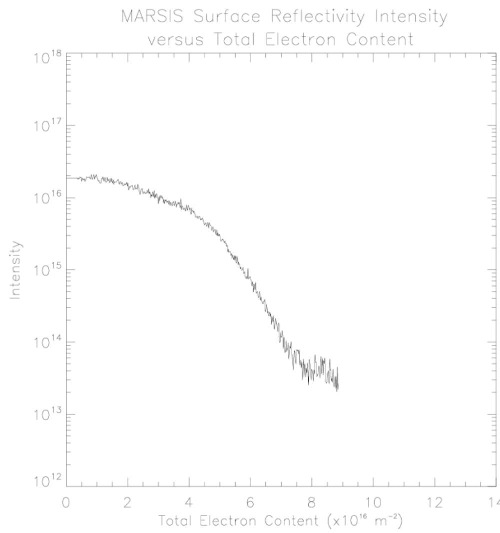
Surface echo amplitudes are extracted from each radargram applying an automatic method which uses MOLA topography [2] and provides us an estimation of surface reflectivity at MARSIS frequencies (1.8, 3, 4, 5 MHz).

We also apply an Automatic Gain Control correction and compensate the spherical wave divergence due to spacecraft altitude considering that signal is reflected by a surface corresponding to the Fresnel zone.

All of these surface reflectivity measurements show a strong dependence to the solar zenith angle (SZA) This well known effect corresponds to "ionospheric attenuation".

This attenuation depends on electron density and frequency collision profiles. As we do not know these values for each measurement, a proxy is needed to correct surface reflectivity.





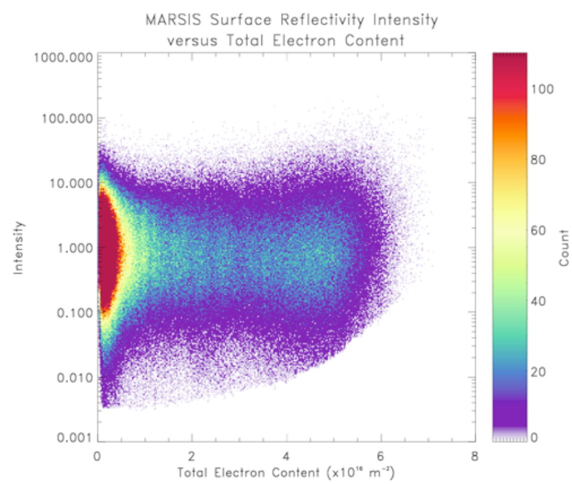


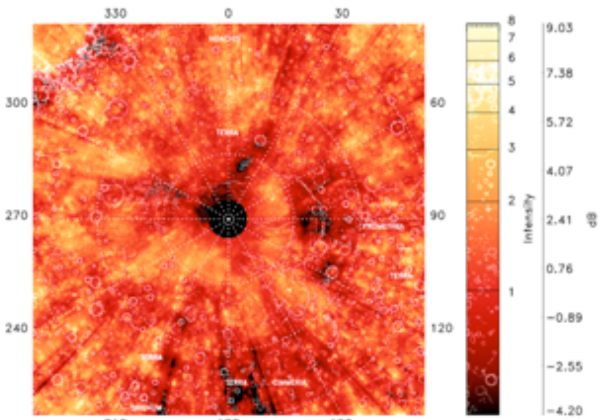
Figure 1: *(1a) reflectivity as function of Total Electron Content (TEC) before correction; (1b) mean reflectivity as function of TEC (correction factor) and (1c) reflectivity as function of TEC after the correction.*

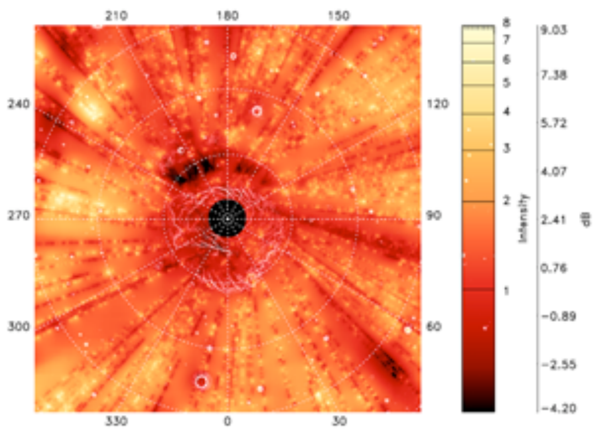
Furthermore the correction of the ionospheric distortion gives the Total Electron Content of the ionosphere [3][4] for each surface reflectivity measurement.

In Figure 1a, we plot surface reflectivity versus TEC. We then assume that, statistically, the dataset from the whole planet should have the same mean reflectivy for all TEC. Consequently, it is easy to compensate attenuation by a factor given in Figure 1b. After correction, the mean reflectivity must be constant overall TEC values as we show in Figure 1c.

Surface Reflectivity Map at 4 MHz by MARSIS:

We report here three interpolated maps (Figure 2) of the surface reflectivity, as seen by MARSIS at 4 MHz (band3). It appears that the surface roughness plays a major role in surface reflectivity. Since a 4 MHz frequency corresponds to a 75 meters wavelengh, we have to compare our reflectivity maps to roughness map at same scale [5][6].





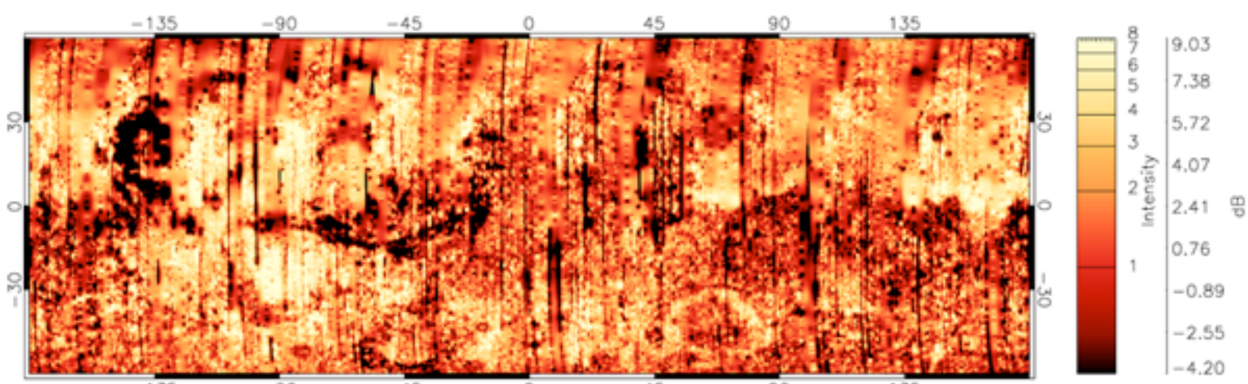


Figure 2 : *All three maps on the page represent the reflectivity at 4 MHz (bright values correspond to high reflectivity and dark ones to low reflectivy). Top to bottom we find, (2a) south polar stereographic map, (2b) north polar stereographic map and (2c) cylindric map of Mars between latitudes 60° and -60°.*

Summary: We present here a method to calibrate MARSIS surface echoes. We report all these MARSIS measurements at 4 MHz on three map and observe that surface reflectivities are highly dependent on the surface roughness. The next step is to quantify the reflectivity behaviour as function of surface roughness. If this quantication is possible, and one will be able to caracterize different regions in terms of reflectivity and dielectric constant. Furthermore, we will compare different area with low roughness and look for different reflectivities.

References

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