

MARSIS subsurface investigation approach and preliminary material compatibility identification

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Abstract

MARSIS (Mars Advanced Radar for Subsurface and Ionosphere Sounder) is presently collecting data on Mars surface and subsurface. The subsurface echoes signal can be hidden by synchronous echoes coming from off nadir surface reflections (surface clutter); moreover this clutter, arriving from the across track direction, can be interpreted as a signal coming from a subsurface interface. In the along track direction the clutter is naturally filtered by the synthetic antenna principle, at least up to the compressed Doppler chirp. Presently, in absence of the monopole antenna that contribute to the clutter cancellation, the analysis is primarily addressed to the return echoes from MARS south polar regions focusing the attention on the areas where the surface can be considered flat. This limitation has been assumed to avoid the risk of wrong interpretation of the echoes signals. In fact, once detected a potential subsurface signal on the processed data at a depth δ , in order to confirm that the interface is present is necessary to perform the following processing and verifications:

- Subsurface return echoes estimation (depth, level and spatial correlation)
- Analysis of surface within a range $\sqrt{2 \cdot h \cdot \delta}$ (h=satellite height, δ =interface potential height) where clutter can hidden subsurface echoes or can be confused with the searched subsurface signal. Auxiliary tool, for identification of the surface backscattering level, is the ensemble of the maps of the slope m and the angles α_x and α_y (obtained by 1/128 deg MOLA DEM). In addition a comparison of the real frames with the one generated by the surface echoes simulator is performed in order to validate the clutter backscattering. . . .
- Multi frequency analysis to obtain attenuation factor
- Analysis of the return echoes from the same surface, performed on the adjacent

available orbits to differentiate between surface and subsurface echoes (subsurface echoes will be present the same distance from the first surface echo).

- Multi look analysis to reduce the speckle noise
- Ionosphere plasma frequency estimation (by contrast loop results, surface profiles.....)

In this paper is described the subsurface analysis, according to the above highlighted verification and processing, and few compatibility potential interface are defined according to the model preliminary assumed for the radar design.