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New multiple-parameter map of meter-scale Venus surface roughness: Clues about surface structures

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Abstract

We propose three parameters that describe radar echo profiles taken by Magellan radar altimeter. We use these parameters to make a new map for geomorphological analysis and understanding of surface processes on Venus surface. In particular, the new map allows distinguishing between slightly undulating surface and flat surface with small-scale roughness elements.

1. Introduction

Radar echo profiles recorded with the Magellan radar system in the radar altimeter (RA) mode have been used to estimate normal reflectivity and a roughness parameter [1]. However, as it was shown in [2], the echo profiles contain more information about scattering properties of the surface than covered by these two parameters. Here we present our tentative results on global mapping of several roughness parameters from RA echo profiles

2. Approach and data processing

The RA echo profile (the received power as a function of time) is controlled by the range to the surface and the shape of the surface backscattering function (the specific backscattering cross-section as a function of the incidence angle), which, in turn, is controlled by surface roughness at scales from decimeters to decameters. The raw echo profiles are used to map surface roughness. Each 9.87 μs long echo profile was normalized by its total power. We considered only the 1st cycle data and only parts of the orbits close to the periapsis (24ºS – 44ºN latitude zone).

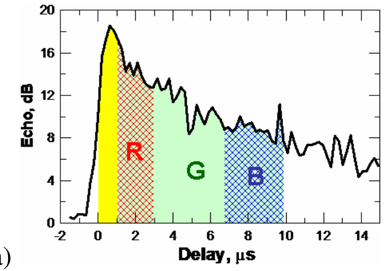
We choose the following set (Fig. 1a) of tree parameters. (1) We consider the first 1.05 μs of the echo as the main peak produced by reflection off a flat surface (yellow area in Fig. 1a). The total power *G* of the rest 8.82 μs of the echo is a general measure of roughness. We use *G* as a green channel in the color composite map (Fig. 1b). (2) We consider the delays 1.05 – 3.15 μs interval after the peak as a peak shoulder *R*. *R* characterizes the sharpness of echo peak. We consider *R* as a parameter of "flatness" and used it as a red channel in Fig. 1b. (3) We consider the last 3.36 μs of the echo as the echo tail. Its power *B* characterizes shorter-scale roughness and is used as a blue channel in Fig. 1b.

3. Analysis

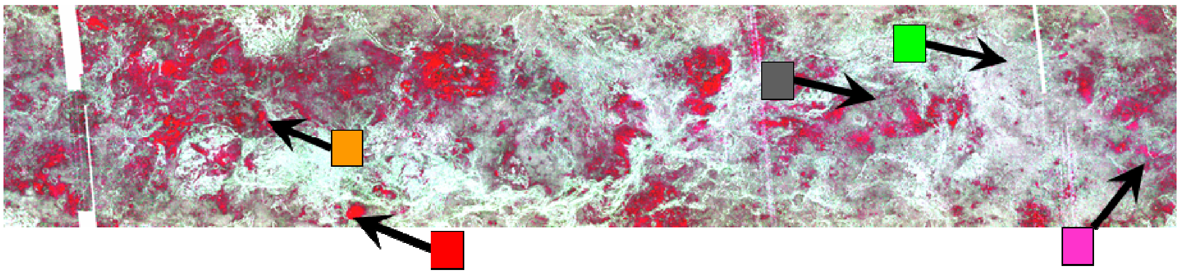
The chosen parameters emphasize differences in backscattering details and lead to recognition of particular surface structures. For example, a slightly undulating plain and a perfectly flat plain with a few scattered boulders can have the same *G*, but the latter has higher *B*, it is "flatter".

Average backscattering functions of different surface types (seen in Fig. 1b) are presented in Fig. 2a along with the expected corresponding surface structure (Fig. 2b). For rough areas all three (*R*, *G*, *B*) parameters correlate well with each other, and the color composite map (Fig. 1b) is mostly grayish; brighter shades meaning rougher surface (“green” sample vs. “gray” sample in Fig. 1b, 2).

Red patches in Fig. 1b mean "flat" plains, while dark shades are smooth, but not "flat". Not surprisingly, the smoothest areas are also very flat. One of them coincides with the distinctive radar-dark lava flow in Bereghinya Planitia shown in [3]. Several smoothest flat areas are associated with radar-dark diffuse features, e.g., near crater Boleyn or in Viriplaca Planum (“red” sample in Fig. 1b, 2). The flat area in the south-western part of Heng-o Corona (“pink” sample in Fig. 1b, 2) looks pinkish in comparison to the flattest areas mentioned above. Here B is quite high indicating the presence of small-scale roughness features (e. g., boulders). This is consistent with that this place is rather bright in the radar mosaics.



a)



b)

Figure 1: Parameters of the RA echo profile (a) and color composite map (b).

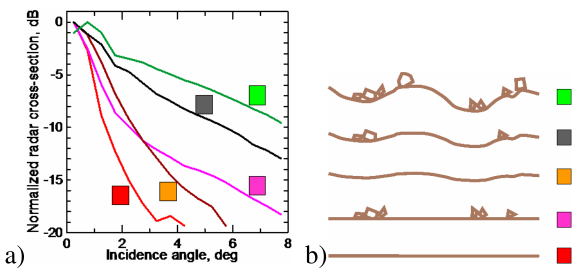


Figure 2: Backscattering functions for five surface types (a) and possible corresponding surface structures (b).

4. Conclusions

Discussed examples illustrate the potential use of the new maps for geomorphologic analysis and understanding of surface processes. The new map distinguishes between slightly undulating surface and flat surface with small-scale roughness elements.

References

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