VENUS SURFACE NORMAL REFLECTANCE THROUGH THE PRINCIPAL COMPONENT ANALYSIS OF MAGELLAN RADAR ALTIMETER DATA. N. V. Bondarenko[1, 2] and M. A. Kreslavsky[1], [1]Earth and Planetary Sciences, University of California - Santa Cruz, 1156 High Street, Santa Cruz, CA, 95064, USA (nbondar@ucsc.edu), [2]IRE, NAS of Ukraine, 12 Ak.Proskury, Kharkov, 61085, Ukraine.

Introduction: The lack of new data about the surface of Venus pushes us toward extracting new information from old data sets. The shape of the backscattering functions of Venus surface measured during the Magellan radar altimeter (RA) experiment [1] has a potential for additional information about small-scale texture of the surface including unresolved surface topography formed due to aeolian transport of particulate materials produced by large meteoritic impacts and of parabola-forming mantles [2, 3].

In the present work we focus on the surface distribution of the reflectance coefficient at normal incidence calculated through the principal component analysis of the Magellan backscattering function and its comparison with Fresnel reflectivity calculated independently on the basis of Hagfors scattering law [1].

Source data and approach: As the source data, we use the results of Magellan RA data processing, in particular, the backscattering function solution [4] archived in the PDS as a part of so-called SCVDR data set. These data are arranged as individual points along Magellan orbits; each data point obtained from analysis of 5 consecutive radar bursts. The backscattering function has been estimated [4] for a set of incidence angles from 0.25º up to ~11º (depending on latitude) with 0.5º interval.

We studied Venus surface in the 65°N-55°S latitudes zone, where source data quality is adequate. Several types of surface units (according to classification presented in [5]) including regional, smooth, lobate and shield plains, along with groove belts and impact craters with their continuous ejecta and outflows were chosen for analysis; highly tectonized units like tesserae were excluded.

We assume that the surface backscattering cross-section r can be presented as $r(\theta) = r_0 \cdot F(\theta)$, where θ is the incidence angle, r_0 is the reflectance coefficient at normal incidence which depends mainly on dielectric permittivity of the surface material, and $F(\theta)$ is a scattering function which depends on structural properties of the surface.

We calculated logarithm of the backscattering solutions from SCVDR to make the assumed factor r_0 additive. Then we applied the principal component (PC) analysis technique to the result.

Results and discussion: The first 4 PCs for the zone studied contain 99.2%, 0.49%, 0.09% and 0.06% of the total logarithm of backscattering function variability, respectively. Therefore, the first component PC1, which is related to r_0, is dominant in the near-nadir backscattering.

To compare the PC1 values with independent reflectance estimates, we need to present them in comparable units. Since there is no obvious way to calibrate particular PC1 value in terms of physical reflectance r_0, we use its rank representation: we subdivided the whole range of PC1 values into five equal-area intervals based on the PC1 distribution (see inset in Fig. 1b). The distribution of calculated PC1 over Venus surface is shown in **Fig. 1b**: blue to pink colors mark surfaces having lowest to highest values of PC1, respectively. For reference, SAR image mosaic of the Venus surface is presented in **Fig. 1a**.

Model-dependent Fresnel reflectivity retrievals R_0 calculated on the basis of Hagfors scattering law [1] were also converted to the same rank representation through the five equal-area intervals based on the R_0 distribution over Venus surface under study. These intervals are limited with R_0 values of 0.0098, 0.099, 0.109, 0.123, 0.138, and 0.434.

Comparison between calculated PC1 and the R_0 retrievals is depicted in **Fig. 1c** as an RGB composite image. The red channel codes values of R_0, the green channel codes values of PC1, and the blue channel codes their difference in the ranked representation. Dark blue color denotes surfaces, where both PC1 and R_0 are low, for example, in ridge belts inside Artemis Chasma and in Guinevera planitia. Yellow colors in Fig. 1c mark surfaces where both PC1 and R_0 are high, for example, in the vicinity of many radar-dark parabola craters. In general, area where PC1 and R_0 have simultaneously high or low values, occupy a significant area in the map, indicating a god correlation between them in consistency with interpretation of PC1 as a measure or r_0.

Red color in Fig. 1c marks places where the principal component analysis gave relatively lower r_0 values in comparison with high Hagfors-law-based Fresnel reflectivity R_0. And vise versa, light cyan color in Fig. 1c marks areas where r_0 estimates appears to be relatively higher than values of Fresnel reflectivity. The latter is the case for plains in the south Venus hemisphere. These could be areas where the Hagfors' scattering model does not represent the actual scattering by the surface sufficiently well.

Conclusions: The comparison between PC1 and R_0 made in the present work can be used for the adequate calibration of PC1 values in terms of normal reflectance r_0. In this way the results of principal component analysis of the Magellan RA backscattering functions provide independent estimate of reflectance coefficient of Venus surface at normal incidence, and therefore, dielectric permittivity of the surface material.

References: [1] Ford P. G. and Pettengill G. H. (1992) *JGR, 97*, 13,103– 13,114. [2] Bondarenko N. V. and Kreslavsky M. A. (2013) *LPSC 44*, # 1648. [3] Bondarenko N. V. and Kreslavsky M. A. (2015) *LPSC 46*, # 1832. [4] Tyler G. L. et al. (1992) *JGR, 97*, 13,115– 13,139. [5] Ivanov M. A. and Head J. W. (2011) *PSS, 59*, 1559–1600.

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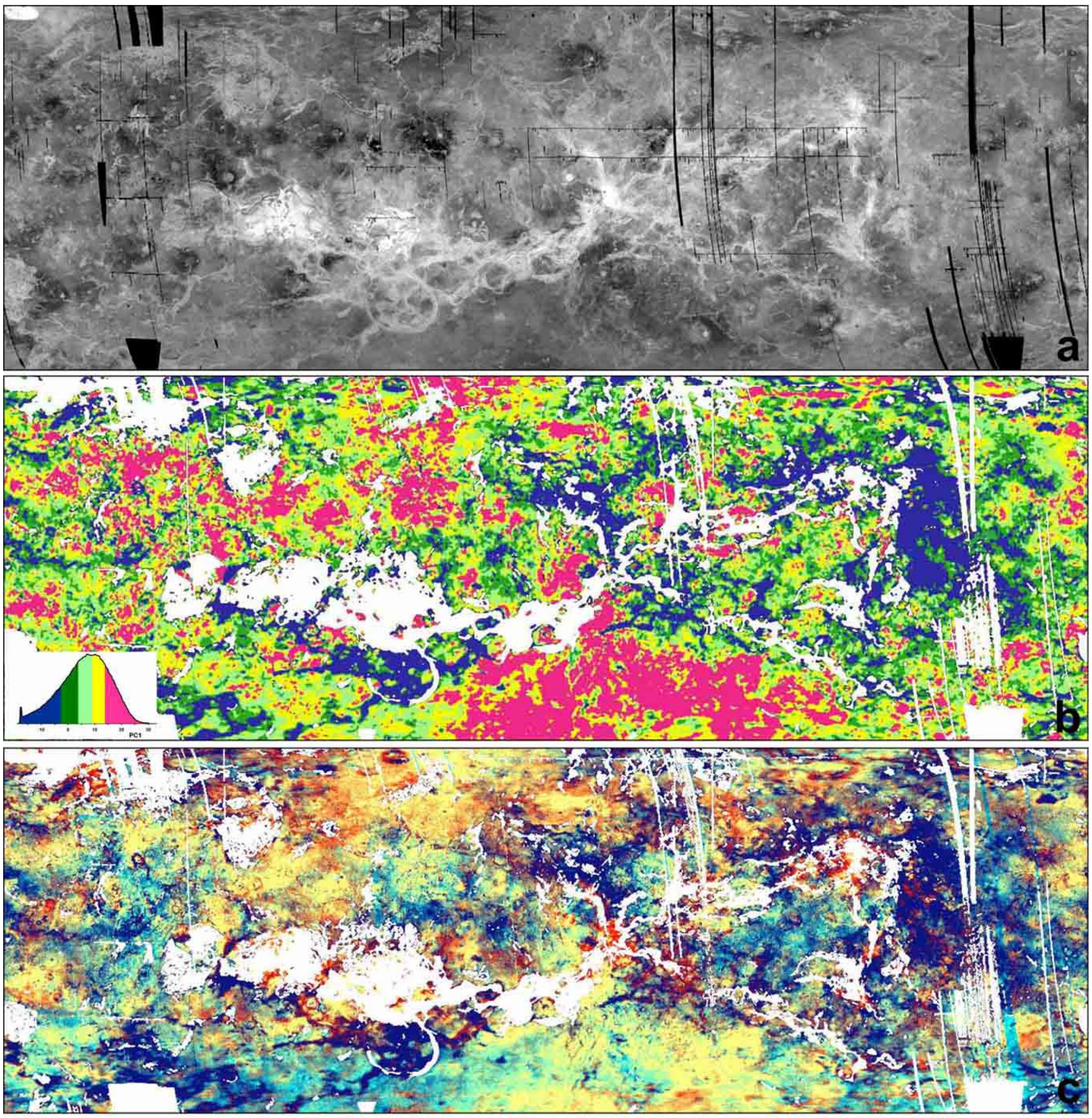

Fig. 1. Global maps of Venus surface between 65°N and 55°S latitudes: (a) SAR image mosaic; (b) PC1 values, inset – PC1 area distribution and color scheme; (c) RGB composite illustrating correlation and differences between PC1 and Fresnel reflectivity R_0 in a way described in the text.