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MESOSCALE ROUGHNESS OF VENUS: J. B. Garvin, NASA/Goddard, Geodynamics, Code 921, Greenbelt, MD 20771, and J. J. Frawley, Herring Bay Geophysics, Herring Bay, MD 20754

The global distribution of multi-kilometer (~9 km) length scale "roughness" (hereafter *mesoscale roughness* or MR) on Venus can be estimated from the Magellan global altimetry dataset (GxDR), and then compared with MR data derived for Earth from 5' ETOP5 data and for Mars (from USGS Mars DTM dataset). The mesoscale roughness parameter (MR) represents the RMS variance in meters of the actual planetary surface topography relative to the best fitting tangent plane defined on the basis of a 3x3 pixel sliding window [1]. The best-fit plane was computed using a least-squares solution which minimizes ΔH, the sum of the squares of the differences between the 9 local elevation values (H_i) and the elevation of best-fit plane ($ax_i + by_i + c$) at the same grid location:

$$\Delta H = \Sigma_i[H_i - (ax_i + by_i + c)]^2 \quad \text{for } i = 1 \ldots 9.$$

Using the best-fit plane and ΔH, we have computed the RMS "roughness" $var(\Delta R)$, given by:

$$var(\Delta R) = \sqrt{\{(1/9)*\Delta H\}},$$

where this parameter is always minimized on the basis of its calculation using least squares. We have called this "ruggedness" parameter the *Mesoscale Roughness* (MR) because it is directly related to the high-frequency variance of topography after mesoscale slopes and tilts (i.e., for Venus, the baseline over which MR is computed {dx} is ~ 8.8 km; dx for Earth is ~ 9.3 km) are removed. As such, MR represents the degree to which a planetary surface is more rugged than approximately 10 km scale facets or tilts. It should not be confused with the radar "RMS Roughness" parameter computed at 0.1 to 10 m length scales on the basis of the Magellan radar altimeter echo [2]. We will use our MR parameter to investigate the global ruggedness properties of Venus as they relate to geological provinces, and in comparison with the spatial pattern of MR for Earth and Mars.

Figure 1 illustrates the frequency distribution of the MR parameter for Venus, Earth, and Mars in a semi-log format. It is evident that there are broad similarities between the distributions for Venus and Earth, although the slopes of the frequency distributions are very different. The Venus MR distribution demonstrates a *mode* at ~5 m, unlike the monotonic Earth and Mars distributions. In addition, the Venus MR distribution crosses that of Earth first at 7 m, and then again at 40 m. The rapid, exponential decay of the Mars MR curve accentuates the extreme limitations of the dataset from which it was derived, reason more to return to Mars with a Mars Observer-class mission. From 7 to 40 m, the Venus distribution lies above that for Earth, and it represents some 23% of the surface area of the planet. Much of this intermediate level MR is represented by the flanks of the lattice-work of weakly connected uplands, especially those that interconnect Aphrodite and Beta-Atla-Themis. Perhaps the most intriguing aspect of the spatial pattern of MR on Venus relative to that of Earth is the paucity of extremely low (0 to 5 m) MR regions. On Earth, the continental cratons, the older patches of sediment-covered seafloor, and the continental shelves display MR values in the 1-5 m range; in contrast, Venus MR values are reduced by a factor of 4 in terms of occurrence at such low ruggedness levels. At least on Earth, the relative level of erosion and sediment cover exerts a strong control on the spatial pattern of MR; indeed, the most geologically active mountain belts and the mid-ocean ridge systems exhibit MR values in excess of 40 m. The limited spatial extent of low MR zones on Venus could provide evidence for the reduced role of erosion and basin-scale deposition.

Another possibility is that the dominance of vertical tectonism associated with a global network of tectonized zones produces huge aprons of mass-wasted debris along the flanks of such regions at the requisite multi-kilometer (i.e., 9-19 km) length scales. Such debris covered surfaces, while sloped in relation to the source regions of the debris, could display an excess of roughness (in the 7-40 m range) relative to any simple facet model which describes them at ~ 10 km spatial scales.

These very preliminary findings for Venus indicate that a derived parameter such as mesoscale roughness (MR), even at spatial scales no smaller than 9 km, provides a potentially valuable new perspective on the intensity of global-scale surface processes [3,4]. Our analysis thus far of the MR pattern for Venus versus that for Earth reaffirms the dominance of degradational processes on Earth (erosion and sediment infill) and the lack of such effects at multi-kilometer length scales on Venus. {We gratefully acknowledge the support of VDAP, through RTOP no. 889-62-10-41}.

REFERENCES: (1) Harding D. J. et al. (1994) in press, in *IEEE Trans. Geosci. Rem. Sens.*, 35 pp. {Satellite laser altimetry of terrestrial topography}. (2) Ford P. and G. Pettengill (1992) *JGR 97*, p. 13103-13116. (3) Sharpton V. and J. Head (1986) *JGR 91*, p. 7545-7556. (4) Malin M. C. et al. (1993) in *LPSC XXIV*, p. 927-928, LPI, Houston.

FIGURE 1: Frequency distribution of Mesoscale Roughness in meters (*rms roughness* in the plot) for Venus, Earth, and Mars.