A SPECTRAL STUDY OF VENUS TOPOGRAPHY IN TWO SELECTED EQUATORIAL REGIONS; A.B. Kucinskas, D.L. Turcotte, and J. Huang, Department of Geological Sciences, Cornell University, Ithaca, NY 14853; P.G. Ford, Center for Space Research, Massachusetts Institute of Technology, Cambridge, MA 02139.

As a means of differentiating between alternative models for the thermal evolution of Venus and the resulting tectonics and volcanism, it is useful to examine gravity and altimetry data for correlations. Indeed, direct correlations should provide constraints on the depth of compensation for static models and the required strength of convection for dynamic models. Thus it is worthwhile to test alternative methods for quantitatively analyzing the Magellan topography and gravity data.

In this paper we have applied a technique for the one-dimensional spectral analysis of digitized topography to the study of altimetry data from the Magellan spacecraft. We have focused our attention on two topographically different $20^\circ \times 20^\circ$ equatorial regions on Venus: a lowland area in Tinatin Planitia and highlands in Ovda Regio.

The topography of a planet is the surface expression of a variety of complex geological processes. On Earth, fractal statistics apply to many geological and geophysical data sets as a result of a scale invariance (1). The height of topography along a linear track is an example of a self-affine fractal if the power spectral density $P$ of the profile has a power-law dependence on the wave number $k$ (2):

$$P(k) \sim k^{-\beta}.$$  

Several authors (3, 4, 5) have found that terrestrial topography and bathymetry is Brownian noise ($\beta = 2$) with the amplitude proportional to the wavelength, for wavelengths from $10^3$ to 0.1 km. Expanding topography of the Earth, Venus, Mars, and Moon in spherical harmonics, Turcotte (6) confirmed this result on a global planetary scale. Fractal analyses of topography provide two quantities, the amplitude and the slope of the power spectrum, which can be used to carry out textural analyses of the data sets. The slope $\beta$ of the power spectrum yields a fractal dimension $D = (5 - \beta) / 2$ and the y-intercept at a specified wave-number gives an overall roughness amplitude $R_A$ for the profile (7, 8).

For each region of interest we selected several equally spaced longitudinal and latitudinal tracks from Magellan altimetry data products using the general image processing system (GIPS) (9). We then performed a one-dimensional discrete Fast Fourier Transform (FFT) spectral analysis on each profile. Results for individual tracks were then averaged, in each direction, yielding mean values for $D$ and $R_A$ for the two regions studied. These results are listed in Table 1.

To a reasonable approximation we find that the spectral correlation for Venus topography in those regions is a fractal over a $32 \text{ km} - 10^3 \text{ km}$ range in wavelength. There is little variation in the mean fractal dimension $D$ for all the tracks considered in the two perpendicular directions, suggesting that isotropy is a good approximation. However, there is variability in $D$ from track to track within a given region. The averaged fractal dimensions in Tinatin and Ovda show a significant difference with $D_{\text{Tinatin}} = 1.41 < D_{\text{Ovda}} = 1.64$. This is not observed on Earth where regional and global $D$ values are very close to the Brown noise value of $D = 1.5$. The measure of roughness ($R_A$) correlates well with variations in relief; we find amplitudes in the Tinatin lowlands are less than those observed on Earth in a much smaller planetary region (8, 9).

The preliminary results presented in this paper are based only on two locations and many other regions must be studied before systematic correlations of the fractal dimension with tectonic regimes can be established. Thus, it seems worthwhile to pursue spectral studies of Venus topography in a systematic way. Work in progress will extend the results described here to two dimensions, yielding maps of regional $D$'s and $R_A$'s.
A SPECTRAL STUDY OF VENUS TOPOGRAPHY: Kucinskas, A.B. et al.

References:

TABLE 1. Regional Averages Over One-Dimensional Profiles of Venus Topography

<table>
<thead>
<tr>
<th>Area</th>
<th>Mean D</th>
<th>Mean RA</th>
<th>σ_D</th>
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<td><strong>TINATIN LOWLANDS</strong></td>
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<td>Latitude</td>
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