MER Landing Site Hectometer Slopes

Albert Haldemann  
Scott Anderson  
JPL
• Assume all topography on Mars is self-affine: implies that a fractal scaling law can be applied to the rms height deviation,

\[ = < [z(x) - z(x+L)]^2 >^{1/2} \]

where \( L \) is a lag interval along a profile; \( = (L) \).

• The scaling behavior is:

\[ (L) = (L_0) [ L / L_o ]^H \]

• A log-log plot of \( (L) \) vs. \( L \) will be linear under the self-affine assumption with Hurst exponent, \( H \), as slope of line.

• The rms slope for lag \( L \) is

\[ s_{rms} = \tan \left( \frac{(L)}{L} \right) \]

• Use MOLA profiles to calculate \( (L) \) for \( L = 300 \) m to 3000 m. Fit the linear region in the range \( L = 0.3 \) km to 1.2 km and extrapolate back to \( (100 \) m) to get \( s_{rms}(100 \) m)
Example Allen Deviation Fit

Hematite Ellipse Hectometer Roughness

Fit between 300 m and 1200 m:

$H = 0.53$

$s_{rms}(100 \text{ m}) = 1.93$
- MOLA track no. 1601 from 20.9599°N to 23.9841°N.
- Comparison of Shepard and Haldemann processing.
- Allan deviations for each lag are identical; both codes are doing the same things.
- Agreement of fits in this case are fortuitous as Haldemann fits 300 m to 1200 m only, which Shepard fits all profile scales.

Fit between 300 m and 1200 m:

- H = 0.43
- \( s_m(100 \text{ m}) = 2.67 \)

At 300m scale, Allan dev = 7.4 m
At 100m scale, Allan dev estimate = 4.7 m
Hurst exponent for this profile = 0.43
<table>
<thead>
<tr>
<th>Site</th>
<th>H (100 m)</th>
<th>S_{rms} (100 m)</th>
<th>(1 m)</th>
<th>S_{rms} (1 m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hematite</td>
<td>0.53</td>
<td>1.9</td>
<td>0.30</td>
<td>16.7</td>
</tr>
<tr>
<td>Melas</td>
<td>0.81</td>
<td>5.7</td>
<td>0.24</td>
<td>13.5</td>
</tr>
<tr>
<td>Gusev</td>
<td>0.56</td>
<td>3.3</td>
<td>0.44</td>
<td>23.8</td>
</tr>
<tr>
<td>Isidis</td>
<td>0.51</td>
<td>1.5</td>
<td>0.25</td>
<td>14.0</td>
</tr>
<tr>
<td>Athabasca</td>
<td>0.76</td>
<td>2.5</td>
<td>0.13</td>
<td>7.4</td>
</tr>
<tr>
<td>Eos</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>MPF (326.4°E,19.3°N ± 0.2°)</td>
<td>0.37</td>
<td>2.9</td>
<td>0.92</td>
<td>42.6</td>
</tr>
<tr>
<td>MPF (0.5° “radius”)</td>
<td>0.77</td>
<td>2.9</td>
<td>0.15</td>
<td>8.5</td>
</tr>
<tr>
<td>VL1 (311.8°E,22.3°N ± 0.2°)</td>
<td>0.53</td>
<td>1.0</td>
<td>0.15</td>
<td>8.5</td>
</tr>
</tbody>
</table>
Site Hectometer Slope Map: Hematite

hem1_y100.slope
Site Hectometer Slope Map: Gusev

gus_y100.slope
Site Hectometer Slope Map: Melas

mel_y100.slope
Site Hectometer Slope Map: Isidis
Site Hectometer Slope Map: Athabasca

atn_y100.slope