

HiRISE photogrammetry of proposed MSL landing sites

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The Mars Science Laboratory (MSL) spacecraft has a number of constraints on acceptable parameters for a landing site [1]. These constraints are based on its entry, descent, and landing system, in addition to its ground mobility system. One of those constraints is that on length scales of 2 to 5 m, the slope should not exceed 15°. This constraint ensures stability and trafficability of the rover in the touchdown condition.

The HiRISE [2] instrument's sub-meter resolution, combined with a point photogrammetry technique [3] allows rapid evaluation of these slope parameters for landing sites early in the planning process. This point photogrammetry technique successfully predicted the upper bounds to the meter-scale slopes at the MER Spirit and Opportunity landing sites.

These results complement roughness information at many different scales from different techniques and data sets. This HiRISE-derived slope information serves as a quantitative measurement of surface roughness at these length scales.

The limitations of the technique are outlined in Beyer et al. [3]. However, this point photogrammetry technique does do a good job of providing an upper bound to the down-sun slope values within the images processed.

This process was used prior to the second landing site workshop to evaluate 19 of the almost 40 candidate landing sites. These 19 had HiRISE coverage of a portion of their landing ellipse and did not have albedo variations which prevented their measurement via this technique.

Of the six sites which went forward from that workshop, only the Miyamoto Crater site did not have adequate HiRISE coverage at the time. Of the remaining five sites which could be measured, Holden Crater, Eberswalde Crater, and North Meridiani all satisfy this 2-5 m 15° slope requirement. The Nili Fossae Trough and Mawrth Vallis sites have slope values that do not meet the criteria as well as the others, but are not completely out of range.

Although improved precision digital terrain models will be made from HiRISE stereo pairs for each of these locations, point photogrammetry results for the expanded HiRISE coverage of each of these sites will be presented.

References

[1] Mars Science Laboratory Project. MSL landing site selection user's guide to engineering constraints. Technical report, Jet Propulsion Laboratory, California Institute of Technology, 2007. URL <http://marsoweb.nas.nasa.gov/>

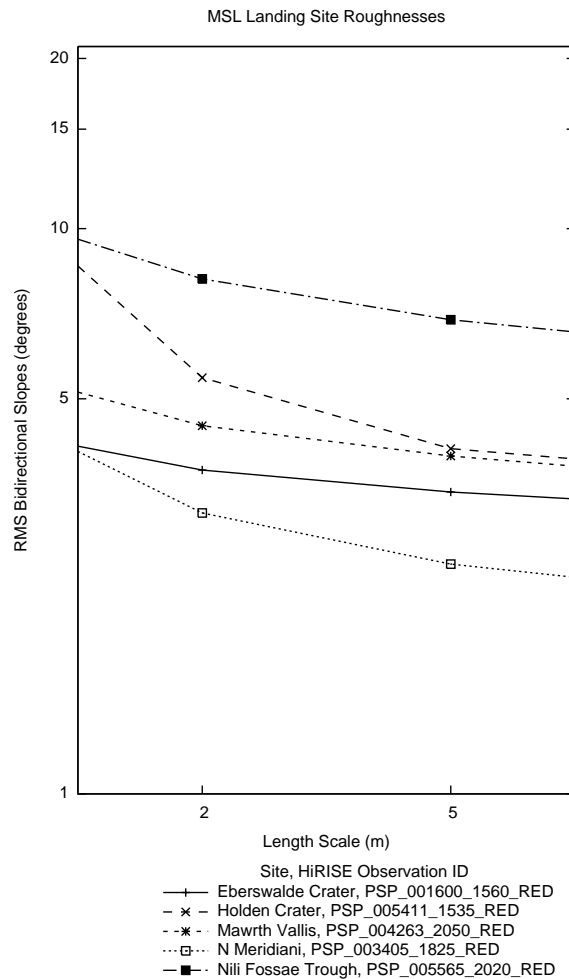


Figure 1: RMS roughness at 2 and 5 m/pixel length scales.

landingsites/msl/memoranda/MSL_Eng_User_Guide_v4.5.1.pdf.

- [2] A. S. McEwen, E. M. Eliason, J. W. Bergstrom, N. T. Bridges, C. J. Hansen, W. A. Delamere, J. A. Grant, V. C. Gulick, K. E. Herkenhoff, L. Keszthelyi, R. L. Kirk, M. T. Mellon, S. W. Squyres, N. Thomas, and C. M. Weitz. Mars Reconnaissance Orbiter's High Resolution Imaging Science Experiment (HiRISE). *Journal of Geophysical Research (Planets)*, 112(E11), May 2007. doi: 10.1029/2005JE002605.
- [3] R. A. Beyer, A. S. McEwen, and R. L. Kirk. Meter-scale slopes of candidate MER landing sites from point photogrammetry. *Journal of Geophysical Research*, 108(E12):26-1, December 2003. doi: 10.1029/2003JE002120.

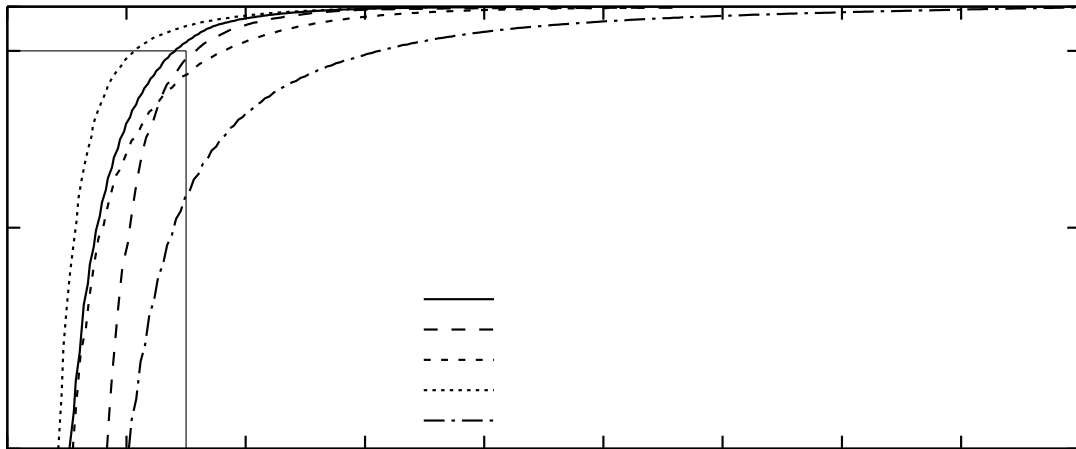


Figure 2: This cumulative slope histogram at 2 m/pixel shows the portion of the image that is covered by slopes of a particular value. A guide box for where 99% of the image is covered by 15° slopes is shown as an example. Curves that exit the top of that box have more than 99% of their area with slopes less than 15°, those that exit the side of that box have less than 99% of their area covered with acceptable slopes.

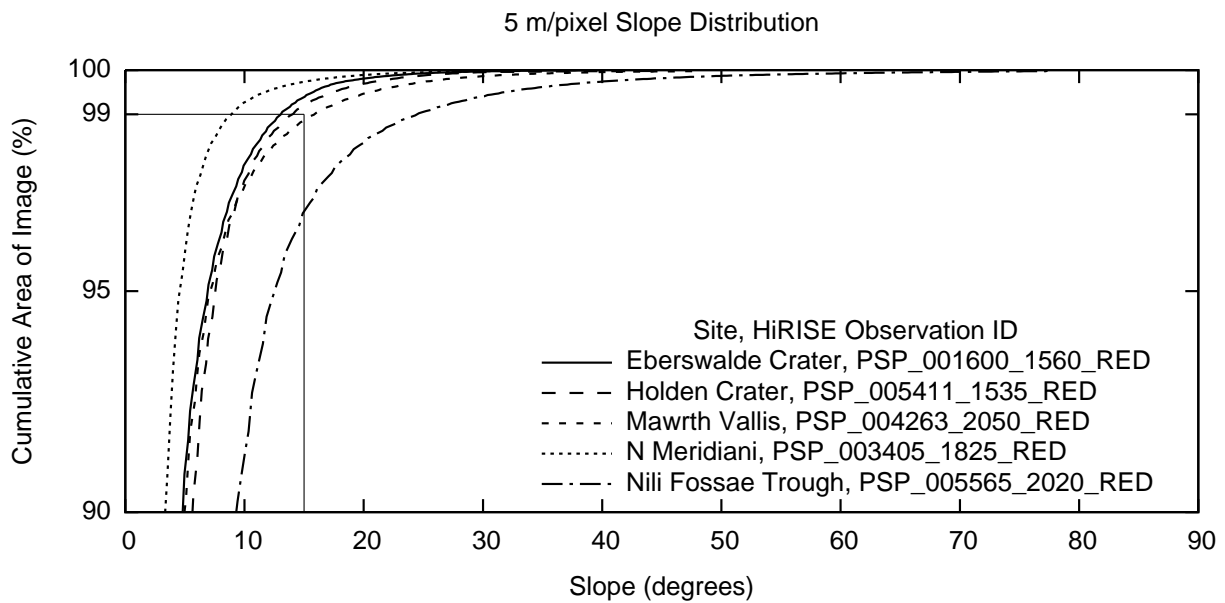


Figure 3: A cumulative slope histogram, at 5 m/pixel.