HiRISE photoclinometry of final 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 photoclinometry technique [3] allowed rapid evaluation of these slope parameters for landing sites early in the planning process, and also provided a consistency check with the terrain models derived from stereo observations. We will present results for the Gale, Eberswalde, and Holden landing ellipses (Mawrth Vallis could not be measured due to albedo variations).

Now that all of the data has been collected and analyzed, we can directly compare the slope data produced by the point photoclinometry technique with that derived from the HiRISE stereo terrain models created by the USGS [4].

Although adirectional slopes can be gathered from the stereo DTMs, the point photoclinometry technique produces bidirectional slopes, so we extracted bidirectional slopes from the five USGS terrain models that cover the Eberswalde crater landing ellipse for direct comparison to the photoclinometry-derived slopes. Figure 1 shows that in most cases the photoclinometry statistics provide a reasonable estimate of the slopes provided in the stereo-derived DTMs. The large spread on the 'East' DTM is because the photoclinometry slope statistics are from the whole area of the HiRISE image, and the two high data points include rough terrain outside of the ellipse to the south.

In order to compare like with like, we have selected a specific portion of the area covered by the 'Gale W' DTM and the exact same area from the photoclinometry data (area above the line in fig. 3). When we compare the statistics here, the stereo-derived slope standard deviation (same as the vertical axis in fig. 1) is 2.15° and the photoclinometry-derived slope standard deviation is 2.24°. These values are very similar, and their slope histogram also shows a similar shape (fig 2), indicating that photoclinometry is doing an excellent job of predicting the slopes.

At the meeting, we shall present more detailed comparisons of photoclinometry results with stereo DTMs, and previous MOC-based photoclinometry results from the Viking, Pathfinder, and MER landing sites.

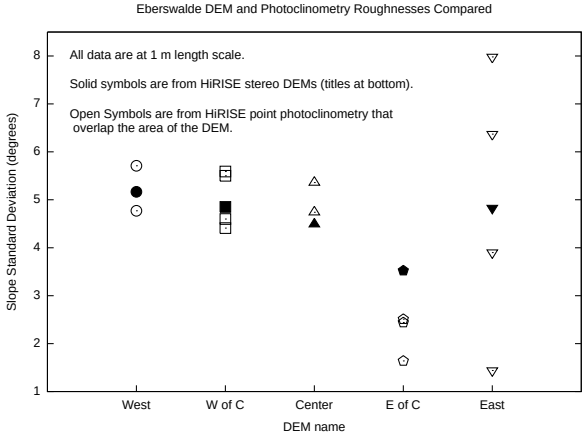

Figure 1: Comparison of slopes at 1 m length scale computed from various USGS DTMs and slopes computed from HiRISE images with point photoclinometry. Data are grouped by area overlap. There are at least two HiRISE images that can be measured via point photoclinometry for each DTM. In cases where there are more than two photoclinometry data points, there were additional HiRISE images that overlapped the same area.

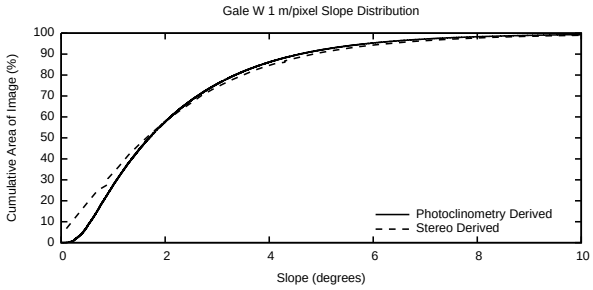

Figure 2: Histogram of slopes versus areal coverage in the area above the line in fig. 3.

References

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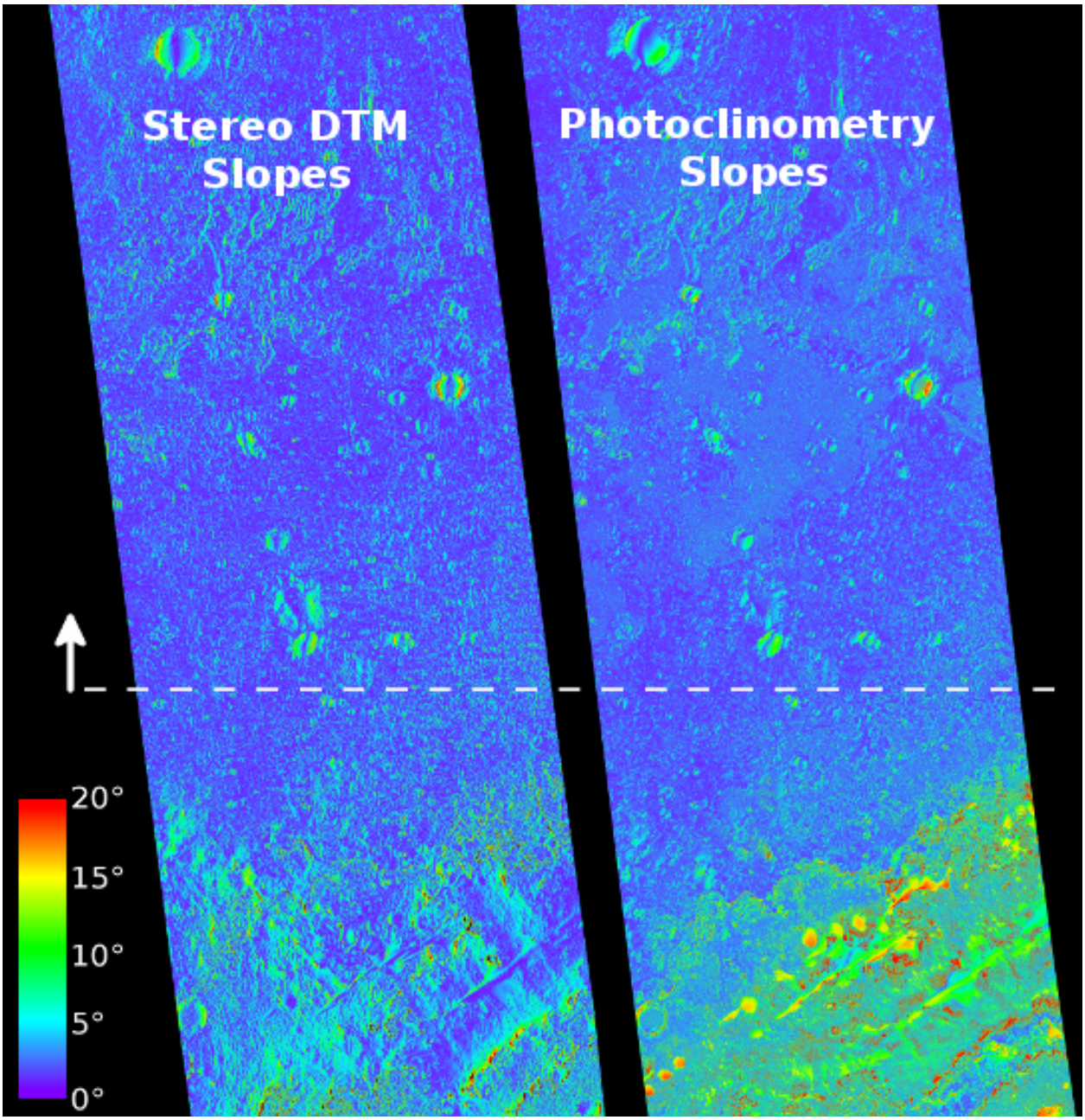

Figure 3: These are maps of bidirectional slopes from the HiRISE stereo DTMs and the photoclinometry technique. Areas of even tone in the northern and central areas compare well between the two maps. However, further to the south, there are areas of dark dunes, which the photoclinometry technique misidentifies as steep slopes. The area above the dashed line is the area used in the slope statistics compared in the text and in fig. 2.