LROC DTM Comparison Effort. Ross A. Beyer[1,2], B. Archinal[3], Y. Cheng[4], K. Edmundson[3], E. Howington-Kraus[3], R. Kirk[3], R. Li[5], A. McEwen[6], S. Mattson[6], X. Meng[5], Z. Moratto[2], J. Oberst[7,8], M. Rosiek[3], F. Scholten[7], T. Tran[9], O. Thomas[3], W. Wang[5], and the LROC Team. [1]Carl Sagan Center at the SETI Institute; [2]NASA Ames Research Center, Mail Stop 245-3 (Bldg. N245), Moffett Field, CA, USA (Ross.A.Beyer@nasa.gov); [3]Astrogeology Science Center, United States Geological Survey; [4]Jet Propulsion Laboratory, Caltech; [5]Ohio State University; [6]The University of Arizona; [7]German Aerospace Center (DLR), Institute of Planetary Research; [8]Technical University Berlin; and [9]Arizona State University. http://lroc.sese.asu.edu

This work involves several different groups using different techniques to build digital terrain models (DTMs) from the same starting data in order to assess various absolute and relative measures of the quality of Lunar Reconnaissance Orbiter Camera (LROC) narrow angle camera (NAC) derived terrain data, similar to previous studies for other data sets [1].

LROC [2] continues to capture multiple overlapping images in order to derive DTMs of the lunar surface [3]. There are already thousands of NAC stereo images with ground scales between 1.5 and 0.5 m/pixel which can be used to make DTMs. The LROC team has representatives from six different groups (ASU, DLR/TUB, NASA Ames, OSU, U of A, and the USGS) using four different methods [4, 5, 6, 7, 8, 9, 10] to create DTMs.

We have selected two sites for detailed study: the Apollo 15 site and a site in Tsiolkovskiy Crater (fig. 1). These sites both have at least two different LROC stereo sets taken with different lighting geometries, and contain diverse terrain. Ultimately, each group will build a terrain model from each stereo set, but as of this writing we only have models from the M111571816 and M111578606 LROC observations at the Apollo 15 site from all groups.

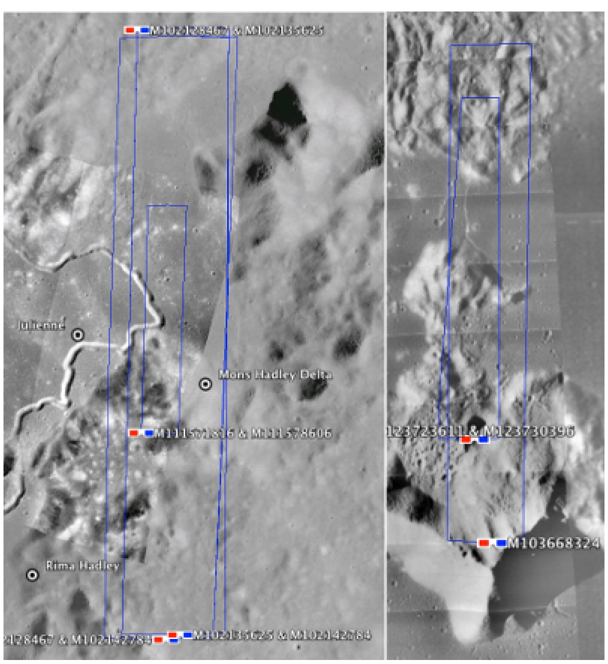

Figure 1: Stereo sets for the Apollo 15 site (left) and the Tsiolkovskiy Crater site (right).

Although each group is beginning from the same LROC images, SPICE data, and LOLA data, the resulting DTMs cannot be directly compared to each other even though they have the same ground scale and map projection parameters. This is illustrated via one measure of absolute position: the location of a known landmark in each model. In this case the location of the Apollo 15 ALSEP package varies by as much as 50 m (fig. 2). This variation probably arises from the way the different groups use the released LOLA data, which does not have the benefit of crossover corrections yet.

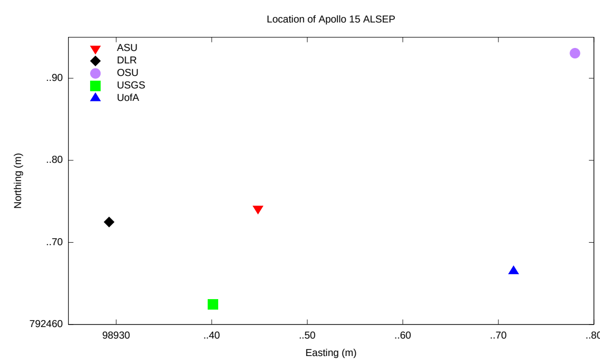

Figure 2: Locations of the Apollo 15 ALSEP as extracted from the different methods. Note that the OSU location benefits from a boresight calibration that the others do not.

We are currently working on a technique to transform all DTMs to a LOLA-based reference surface to allow a more detailed comparison in both absolute and relative sense. This will allow more detailed analysis of the quality of absolute position and evaluation of the vertical precision of LROC DTMs.

Horizontal resolution as compared to their parent images is another aspect of DTMs that we wish to evaluate. Fourier analysis and calculation of bi-directional RMS slopes are approaches that will be applied to the data sets. A qualitative analysis is to compare the contours

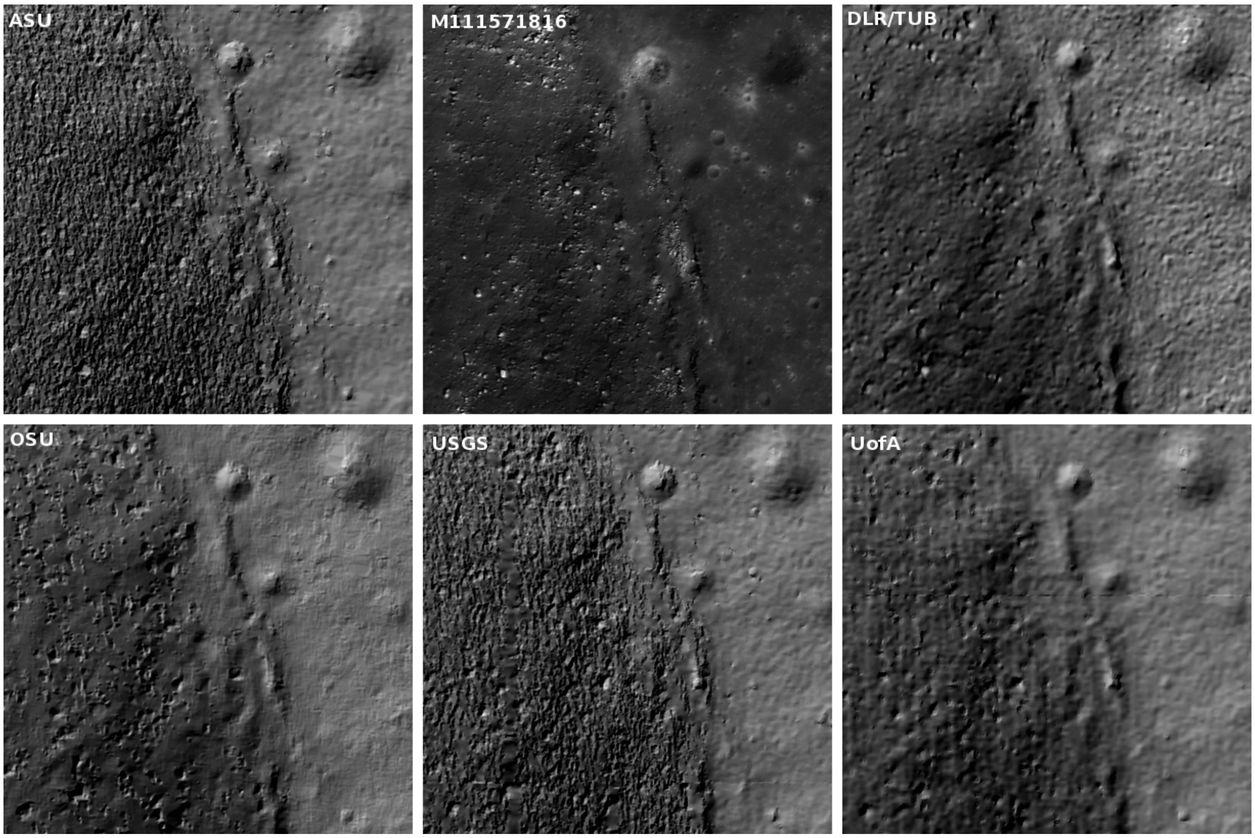

Figure 3: Portion of LROC image M111571816 (center top), on the rim of Hadley Rille, to the west of the Apollo 15 landing site (incidence angle 38°). The other images are shaded relief images (incidence angle 65° to highlight features) from the DTMs provided by the various groups: (upper left) ASU, (lower left) OSU, (lower center) USGS, (lower right) UofA, and (upper right) DLR/TUB. Each image is 600 m wide.

or a shaded relief version of the DTM to a corresponding ortho image (fig. 3). This kind of evaluation shows a very good correlation with surface features.

Finally, another metric for horizontal resolution are the results of crater counts on shaded relief images of the DTM and comparison of them to each other and to the actual images. This would normally be a labor-intensive process, but JPL's automatic crater detection algorithm is ideal for the task. Work has started on small patches of the DTMs, showing good initial results, but we look forward to more detailed results in the future.

Summary

Although there is much work ahead to completely characterize the quantitative quality of LROC DTMs, these initial results and others continue to indicate that the accuracy and precision of LROC stereo-derived topography are very good, at or better than the horizontal accuracy of LOLA data (which is about 50 m) [11].

References

[1] C. Heipke, et al. *P&SS*, 55:2173–2191, 2007. doi:10.1016/j.pss.2007.07.006.
[2] M. S. Robinson, et al. *SSR*, 150:81–124, 2010. doi:10.1007/s11214-010-9634-2.
[3] R. A. Beyer, et al. In *LRO Science Targeting Meeting*, volume 1483 of *LPI Contributions*, pages 15–16. 2009.
[4] R. A. Beyer, et al. In *LPSC 41*, #2678. 2010.
[5] J. Oberst, et al. In *LPSC 41*, #2051. 2010.
[6] S. Mattson, et al. In *LEAG*, volume 1595, page 38. 2010.
[7] T. Tran, et al. In *LPSC 41*, #2515. 2010.
[8] T. Tran, et al. In *ISPRS*, #7161. 2010.
[9] B. Archinal, et al. In *LPSC 42*, #2316. 2011.
[10] R. Li, et al. In *LPSC 42*, this meeting. 2011.
[11] E. Mazarico, et al. In *Fall AGU*, P51C-1465. 2010.