MODELING EROS WITH STEREOPHOTOCLINOMETRY. R. W. Gaskell[1], O. S. Barnoiun-Jha[2] and D. J. Scheeres[3], [1]Planetary Science Institute, 1700 E. Fort Lowell, Suite 106, Tucson, AZ 85719, rgaskell@psi.edu, [2]Applied Physics Laboratory, Johns Hopkins University, [3]University of Michigan.

Introduction: In the last few years, techniques have evolved [1-3] for constructing shape and topography of small bodies directly from imaging data, at a resolution comparable to that data. The basic data product is a set of overlapping digital topographc/albedo maps (L-maps) which tile the surface of the body. The slopes and albedo at each pixel in an L-map are determined by an estimation procedure called stereophotoclinometry (SPC) that minimizes the least square residuals between predicted and observed brightness in multiple images. The slopes are then integrated to produce the heights relative to a local coordinate system.

The central pixel of an L-map represents a control point whose body-fixed location is determined in a simultaneous estimation with the camera location and orientation, constrained by apriori information, that minimizes the residuals between predicted and observed image space locations, limb locations and correlations between overlapping L-map topography. Laser ranging has now been added as a new data type [4].

Global Topography: Eros is currently tiled with about 9000 overlapping L-maps, each representing about 10000 surface vectors and constructed from about 15000 NEAR images. From the resulting 90 million vectors, a 1.57 million vector global topography model (GTM) is constructed.

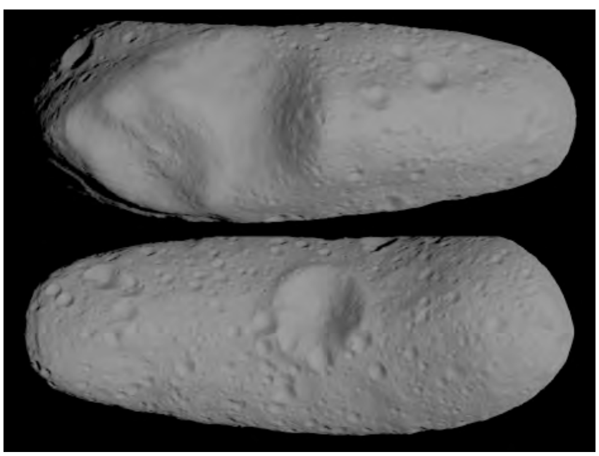

Figure 1: Eros global topography

The GTM provides a framework for estimating the surface gravity, gravity harmonics, and inertia tensor, assuming a homogeneous mass distribution. The current GTM has a volume of 2507.79 km^3 and a surface area of 1137.98 km^2. The prime meridian is shifted 9.786° from the principal x-axis and the principal moments of inertia per unit mass are (15.1308, 73.0922, 74.3518) km^2.

The Bouguer anomaly, the difference between measured and predicted harmonics on a 16 km sphere, has been reduced significantly from earlier shape estimates [5], suggesting that the interior of Eros is homogeneous.

Figure 2: GTM Bouguer anomaly

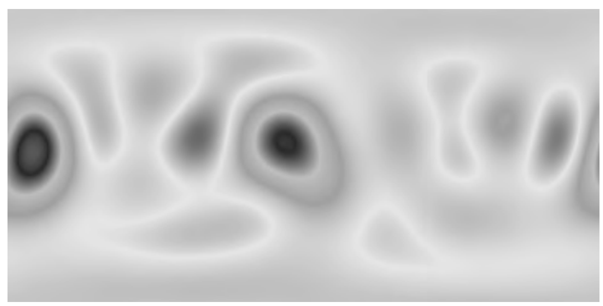

Figure 3: NLR Bouguer anomaly

Very preliminary results using the GTM in conjunction with Near Laser Ranger (NLR) data indicate a center of mass to center of figure offset of less than 10 meters, again supporting a homogeneous interior. The same analysis suggests that the NLR footprint is centered at pixel (259.0,134.7) in the raw NEAR images, (259.0,227.1) in the rectified images. The RMS range residuals were 16 meters, about half the resolution of the GTM. This can be reduced to 8 meters with a 0.07% decrease in focal length, increasing the size of Eros by the same factor. Ongoing work will increase the number of images, and compute the ranges using the higher resolution HRTMs rather than the GTMs.

Local Topography: The vast majority of L-maps have a resolution of 6 m/pixel. Some L-maps have lower resolution and provide context for the global fit, while others have higher resolution in order to better characterize regions of particular interest. Since the GTM has an average resolution of about 27 meters, it does not contain the full information provided by the ensemble of L-maps. High resolution topography maps (HRTMs) can be constructed from the L-map ensemble for areas of interest, such as the 6 meter resolution 1025x1025 pixel topographic map of Himeros Regio shown as a stereo pair in Figure 4.

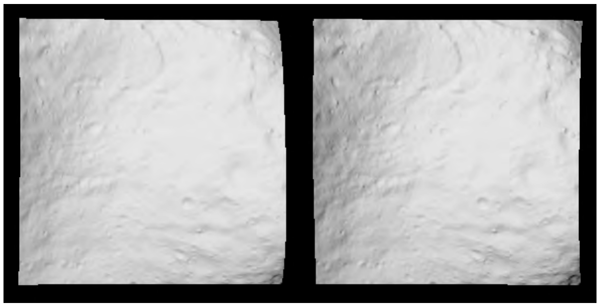

Figure 4: HRTM of Himeros Regio

Since HRTMs can be constructed with almost the resolution of the best images, they summarize that data with very little loss of information. These new representations can be recast in a variety of ways to assist in data analysis. Another map of Himeros Regio made by computing $\nabla^2 h$ from the HRTM data is shown in Figure 5. In this form, craters and boulders are much easier to identify, and this may eventually lead to an automatic cataloging capability.

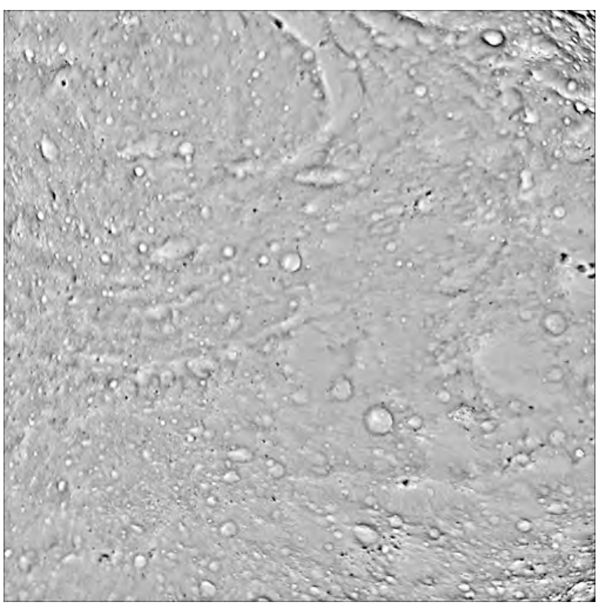

Figure 5: Enhanced topography in Himeros Regio

Ongoing Work: The recent completion of the set of 6 meter/pixel L-maps tiling the entire surface has made it possible to rapidly introduce higher resolution images into the data set at a rate of about 1000/wk. Data from each image is digitally correlated with illuminated pre-existing L-maps and the resulting image-space control point locations enable the rapid registration of the images. L-maps are then identified and located on the limbs, and the new imaging data is used to refine the L-map topography solutions and ultimately the GTM. The 9000 L-map centers are currently constrained by more than one million “observations”, an average of more than 100 per control point, and are determined to about 2.3 meters per degree of freedom. Addition of another 40000 images should bring this down to about one meter/dof, increase the overall resolution of the L-maps and derived HRTMs, refine the GTM, and allow for the integration of the NLR ranges into the data set.

References: [1] Gaskell R. W. et al. (2006) AIAA-2006-6660. [2]] Gaskell R. W. et al. (2006) *LPS XXXVII*, Abstract #1876. [3] Gaskell R. W. (2005) *AAS 05-289.* [4] Barnouin-Jha O. S. et al. (2006) *LPS XXXVII*, Abstract #1773. [5] Zuber M. T. et al. (2000) Science 289, 2097-2101.

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