ANALYSIS OF MERCURY LIMB PROFILES FROM MESSENGER IMAGES: RESULTS FROM LEAST-SQUARES ADJUSTMENTS OF CROSSOVER HEIGHTS.

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Introduction: We have analyzed images of Mercury's limb obtained by MESSENGER'S Mercury Dual Imaging System for studies of the planet's global shape.

Data and Technique: The MESSENGER spacecraft is determining Mercury's global shape and topography with several complementary techniques: laser altimetry [1], measurements of radio occultation timing [2], stereo image analysis [3-4], as well as limb imaging [5]. In orbit about Mercury since March 2011, MESSENGER has obtained more than 1,400 limb images through December 2011. From these we have constructed a near-global network of limb profiles, which include large numbers of crossovers between individual limb tracks (Fig. 1).

The image coordinates of limb positions were determined by a contrast-based search, and measured line and sample coordinates of limb positions were corrected for image geometric distortions, following methods developed earlier [5].

Whereas limb profiles obtained during MESSENGER's flybys of Mercury extended from pole to pole and are easily interpreted in terms of planet radius, limb images from orbit are typically obtained from closer range, show comparatively shorter arcs, and lack global geodetic control. It is therefore more difficult to derive the absolute distance of the limb from the planet's center and consequently the absolute heights of limb profiles. Hence, we use height information at crossovers between limb profiles and carry out a least-squares adjustment to obtain correct heights and tilts of the profiles.

Results: The first tests of our adjustment with about 150 limb images and 1,200 crossovers show a significant decrease in crossover height errors (Fig. 2) and lead to an overall standard deviation of height differences at crossover points of better than ± 0.8 km. The topography has a full dynamic range of 8.1 km and a standard deviation of ± 0.9 km over the entire limb network. Comparisons between individual limb profiles and digital terrain models (DTMs) derived by stereo photogrammetry [3-4] show good agreement (Fig. 3).

Ongoing Work: Limb profiles are being tied to Mercury Laser Altimeter (MLA) measurements in Mercury's northern hemisphere to provide absolute control and to increase the stability of the network. Comparisons are also being made with radio occultation measurements [2]. The limb networks provide an important framework for stereo topographic models of Mercury under parallel development [6].

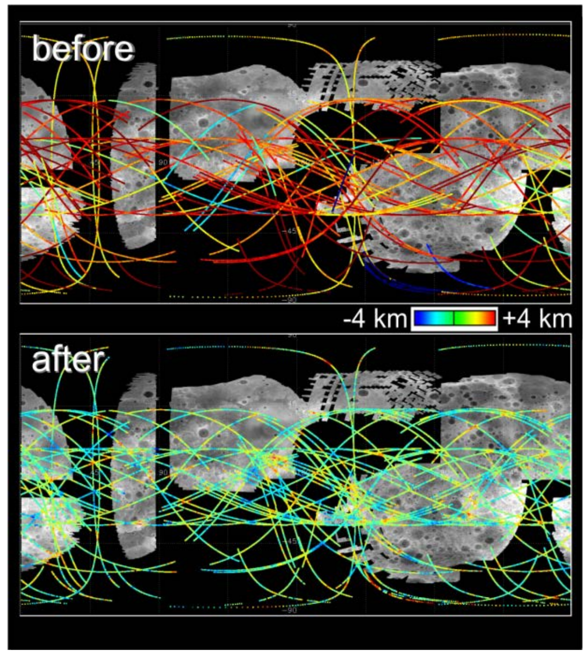

Fig. 1: Limb profile heights relative to a sphere of radius 2440 km before (top) and after (bottom) least-squares adjustment.

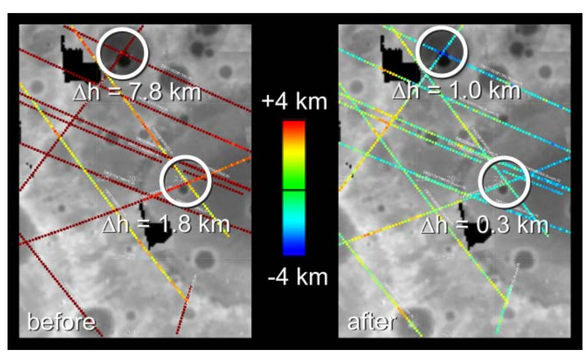

Fig. 2: Crossover height differences at Beethoven basin before (left) and after (right) the least-squares adjustment.

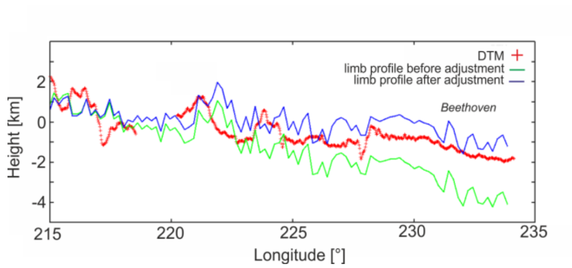

Fig. 3: Comparison between a limb profile at Beethoven basin (EW213392986G) and a stereo-derived DTM. Agreement between the data sets in terms of absolute height and trend is improved after the least-squares adjustment.

References: [1] M. T. Zuber et al. (2012) *Science*, submitted. [2] M. E. Perry et al. (2011) *Planet. Space Sci., 59*, 1925–1931. [3] J. Oberst et al. (2010) *Icarus, 209*, 230–238. [4] F. Preusker et al. (2011) *Planet. Space Sci., 59*, 1910–1917. [5] J. Oberst et al. (2011) *Planet. Space Sci., 59*, 1918–1924. [6] F. Preusker et al. (2012) *Lunar Planet. Sci., 43*, this meeting.