

# A NEW ROTATION MODEL AND REFERENCE GRID FOR MERCURY FROM COMBINED MESSENGER LASER ALTIMETRY AND STEREO PHOTOGRAMMETRY

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We have computed digital terrain models (DTMs) from MESSENGER stereo images using well-known image correlation and least-squares block adjustment techniques. We produced 165 individual small-area models (222 m grid spacing), which in total cover approximately 50% of the planet's northern hemisphere (Fig. 1). To correct for offsets and tilts with respect to the Mercury reference frame, we co-registered the DTMs to laser altimeter profiles. However, because the individual laser altimeter profiles were taken at different times, we have carried out a joint inversion in which we solved for Mercury rotation parameters as well as the static transformation parameters for each of the 165 DTMs. In particular, we solved for the orientation of Mercury's rotation axis, rotation rate, and forced libration amplitude as well as the spatial offsets, rotation angles, and scaling factors of the individual DTMs. We find a large libration amplitude, which, in combination with the measured obliquity, confirms that Mercury possesses a liquid outer core. The mean rotation rate during the observation interval is higher than the expected resonant rate, suggesting that the planet is undergoing long-period librations.

The corrected DTMs in the northern hemisphere, tied to all available laser altimeter data, and the new rotation model represent a valuable realization of the reference grid for mapping applications at Mercury.

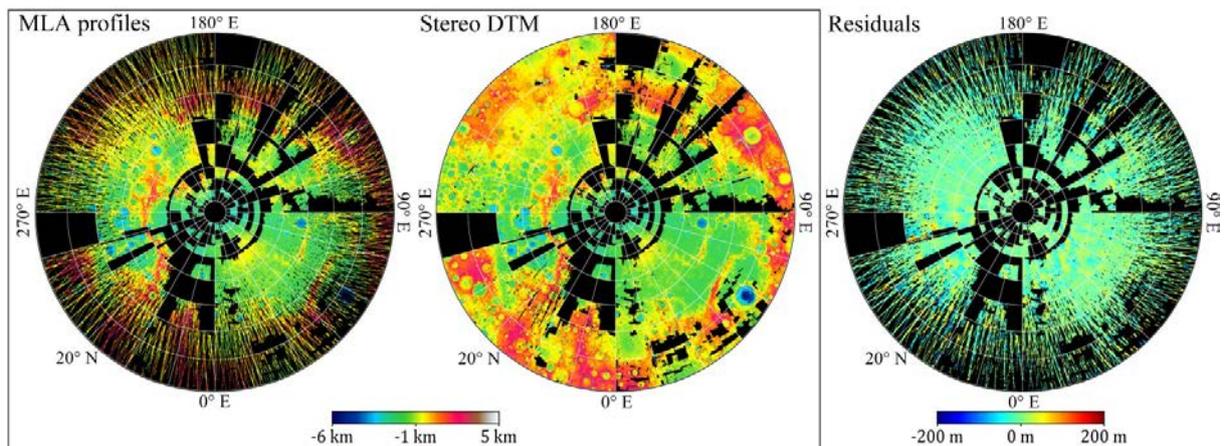


Figure 1: Left: MLA profiles used for measurement of rotational parameters, shown in a stereographic projection centered at the north pole. Center: DTM tiles as derived from stereo images by means of stereo photogrammetry. Each element of the grid corresponds to one DTM tile, for which separate offset and shift parameters are calculated. Gaps indicate lack of coverage by stereo DTMs. Right: Height residuals between MLA profiles and the stereo DTM tiles after co-registration. The mean value of the residuals is -1.2 m, and the standard deviation is 51.6 m.