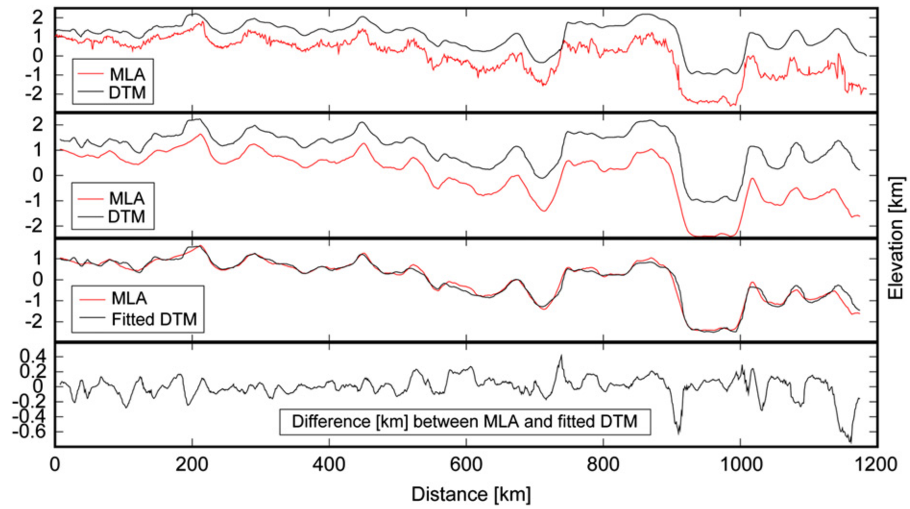

Fig. 12. Comparisons between the M1 MLA profile (red) and M3 DTM profile (black). (Top panel) Raw profiles. (Second panel) Comparison after the DTM profile has been smoothed by binning over a running box of width 15 km. (Third panel) Profiles after removal of offset and linear trend. (Bottom panel) Difference between the MLA and corrected DTM profiles (black).

three DTMs for which both data sets were obtained during the same flyby.

5.3. M3 DTM vs. MLA profile from M1

There is substantial overlap between the M3 DTM and the MLA profile obtained during M1. The overlap extends from 58° to 86°E longitude over a distance of ~1200 km, which makes it possible to compare the two topographic data sets in detail (Fig. 10a).

Although there is an overall agreement between topographic features seen in the MLA profiles and DTMs, lateral and vertical offsets between profiles from the two data sources are apparent. Root-mean-squared (RMS) height differences between the M1 MLA profile and a profile through the M3 DTM could be reduced to a minimum by shifting the MLA profile by approximately 2 km (0.05°) each in latitude and longitude (Fig. 10b) relative to the DTM. Linear regression analysis was used to determine a best-fitting linear trend in the offset between the M3 DTM and the MLA profile, which varied from 0.3 to 1.8 km from west to east. Such offsets may reflect small unmodeled pointing offsets between MDIS and MLA, errors in spacecraft trajectory knowledge, or perhaps limitations in the realization of the current Mercury-fixed coordinate system, i.e., the International Astronomical Union planetary rotation model, given that the M3 DTM was constructed from data taken during two different flybys.

From the MLA data, we made an attempt to determine the "effective resolution" of the M3 DTM. Relative height offsets and trends were first removed from the data. Next, the MLA profile was smoothed by binning within running boxes of progressively greater along-track extent to find the smoothing length that provides the best match to the corresponding profile from the DTM. On the basis of RMS residuals, best agreement between the two profiles was found when the MLA track was binned within a running 15-km-long box (Figs. 11 and 12), an indication of the "effective resolution" of the DTM. The RMS residual at best fit is 135 m. Outliers are found where slopes are steep, conditions under which DTM accuracy is affected adversely by the presence of shadows.

Hence, although the DTMs show many details of interest that are smaller than the "effective resolution" of 15 km, we suggest that quantitative measurements involving features less than 15 km in horizontal extent (e.g., measurements of the floor depths of small craters) should be treated with care. At the same time, we note that the MLA data set may not provide a fully ideal measurement reference, as the data are discontinuous and are the product of smoothing effects on the scale of the laser spot size. Hence, our estimate of effective resolution for the DTM represents an upper limit. It should also be emphasized that the comparison applies to the particular stereo data set described here, at the given resolution, stereo angles, and illumination conditions.

6. Outlook

The stereo DTMs produced from the MESSENGER flybys will allow us to carry out a variety of morphologic studies of surface features on Mercury. The DTMs, for instance, include 400 craters larger in diameter than the effective resolution limit of 15 km, which will provide a basis for in-depth morphological study.

During its orbital mission phase, MESSENGER will obtain dedicated stereo observations under ideal illumination and viewing condition (incidence angles between 5°and 75° and low emission angles), and optimized parallax angles (approximately 20°) for global topographic models of reduced noise level and higher spatial resolution. Also, we expect that with global coverage the image blocks will be more stable and able to overcome residual height offsets and long-wavelength trend errors in the terrain models.

Moreover, MLA will obtain topographic data for the northern hemisphere as well as sparse data from the equator southwards to 20°S. These profiles, with their greater height precision, will provide absolute control and permit removal of ambiguities affecting lateral positioning and absolute heights of the stereo-derived models. Ultimately, MLA cross-track analysis will resolve remaining spacecraft orbit and instrument pointing errors, which will benefit all imaging and stereo observations. In addition, occultation measurements will provide several hundred control points for the southern hemisphere.

The currently available models constitute important tools for a variety of geological studies and will provide new insight into Mercury's surface morphology and tectonics. The models developed in this paper are available at: http://europlanet.dlr.de/MESSENGER/.