REGIONAL HRSC MULTI-ORBIT DIGITAL TERRAIN MODELS FOR THE MARS SCIENCE LABORATORY CANDIDATE LANDING SITES. K. Gwinner[1], J. Oberst[1], R. Jaumann[1], G. Neukum[2]. [1]DLR Institute of Planetary Research, Berlin, Germany (Klaus.Gwinner@dlr.de), [2]Institute of Geosciences, Free University, Berlin, Germany

Introduction: The High Resolution Stereo Camera (HRSC) [1,2] on board the Mars Express (MEX) orbiter has acquired a large number of pushbroom stereo datasets covering the current prospective landing sites of the Mars Science Laboratory (MSL) mission [3] and their regional surrounding areas [4]. Systematic derivation of high-resolution digital elevation models (DTMs) and orthoimages from HRSC data for distribution via the PDS and PSA data systems was started in 2007 and has since then produced photogrammetric data products for most of the datasets acquired before 2008, covering some 30 percent of the surface of Mars [5].

Building upon the methods and procedures for deriving these archival DTM products for individual HRSC datasets [6], we developed specific techniques for integration of multi-orbit stereo height measurements that allowed us to produce regional DTMs with 50 m horizontal resolution (i.e. grid spacing) for each of the current MSL prospective landing sites. These were derived from stereo information of all currently existing HRSC datasets for the areas, i.e. up to MEX orbit 7422 acquired in October 2009. We discuss the characteristics of these DTMs and possible directions for further analysis of the data. The datasets are available via the EUROPLANET-IDIS web-site at DLR (http://europlanet.dlr.de/msl).

Methods: Multi-orbit DTMs can provide improved reliability of heights through multiple observations and can overcome specific shortcomings of DTM mosaics produced from DTMs that have been derived separately from individual stereo image tracks. In particular, surface coverage is improved by reducing local DTM gaps caused by image gaps, infavourable imaging conditions (i.e. clouds, shadows), insufficient image ground resolution for a specific target, or in between of adjacent tracks due to border effects of image correlation.

DTM generation from multiple orbits exploits the full set of stereo analysis techniques applied for single-track processing, which are well established and thoroughly validated [5,6,7]. This includes the techniques for image matching and image and object point filtering [6] as well as for photogrammetric adjustment [5,7,8]. Although for some of the latest image datasets the full set of adjustment results is not available yet at present, these were also included in the present work wherever routine validation procedures using MOLA data [9] indicate compliance with standard accuracy requirements [5](e.g. horizontal position accuracy better than DTM grid spacing, mean vertical offset from MOLA heights less than a few meters).

In a second stage, DTM interpolation of 3D points from multiple orbits is implemented as an adaptive processes applying distance weighted mean interpolation with variable interpolation radii for factoring in variations of point density and precision, as well as additional point selection criteria. This ensures that, if both higher and lower precision data are present in the same area, the higher precision (or, likewise, density) data will have stronger influence on the resulting DTM heights. Nevertheless, for the case of the most accurate individual datasets, in certain local areas surface topography may still be represented at the highest available detail in the single-track DTMs.

Results:

Holden and Eberswalde Craters: The DTM covers 625x235 km. The standard deviation of height differences with MOLA, excluding measurement gaps, is 29.5 m with a mean height offset of 1.1 m. Note that the deviation from MOLA heights includes uncertainty related to both datasets as well as sampling effects, as discussed in [5] and [6]. The uncertainty of HRSC 3D points, derived from redundant point observations (multiple ray intersection), was found to account for about 30-50 percent of the total deviation between HRSC and MOLA heights.

The DTM completely covers both craters as well as their flanks. Point coverage is almost complete for Eberswalde crater and the rims of Holden crater, but locally reduced on the westernmost part of the floor of Holden crater due to lack of image texture, including the area of the landing ellipse.

Mawrth Vallis: The DTM covers 530x650 km. The standard deviation of height differences with MOLA, excluding measurement gaps, is 26.8 m with a mean height offset of 0.5 m.

The DTM covers Mawrth Vallis and large parts of the adjacent lowlands. Point density is very high for almost the entire model, including the prospective landing ellipse.

Gale Crater: The DTM covers 275x205 km. The standard deviation of height differences with MOLA, excluding measurement gaps, is 29.1 m with a mean height offset of 0.7 m.

Point coverage is very good for most parts of both the rims and floor of the crater. However, as in Holden crater, the landing ellipse corresponds to an area of reduced point density.

Conclusions: Applying an adaptive technique for DTM interpolation specifically designed for integration of HRSC 3D points from multiple orbits, we were able to derive regional DTMs with 50 m horizontal grid spacing for each of the current MSL prospective landing sites and their surrounding areas. The DTMs cover a total area of about 0.55 Mio km^2, while providing improved average height accuracy as compared to the average height accuracy of single-track DTMs with respect to the deviation from MOLA heights [5].

From the achieved 3D point accuracy and density, and from inspection of the areas corresponding to the proposed landing ellipses, we conclude that the DTMs should provide valuable information for addressing-various key questions related to the regional geologic and morphological context of the sites. This is suggested in particular for addressing e.g. layer attitude geometries, slope properties on horizontal distances on the order of 100-1000 meters, and the morphologies of small topographic features (like channels and scarps with horizontal dimensions of few hundred meters to few kilometers), since considerable additional detail is provided with respect to the MOLA DTM at the respective scale. The new HRSC data also provides an improved basis for co-registration and ortho-rectification of data products from other instruments (e.g. CTX, HiRISE). Cautious utilization of the heights is indicated, however, for the areas *inside* the 20 km diameter landing ellipses of Holden and Gale craters. These are characterised by very smooth surface texture in the HRSC imagery, which led to locally reduced 3D point densities in these areas.

References: [1] Neukum, G., et al. (2004) *ESA SP-1240*, 17-35. [2] Jaumann, R., et al. (2007), *PSS 55*, 928-952. [3] Golombek, M., et al. (2009), 40th LPSC. [4] Gwinner, K., et al. (2007), 38th LPSC. [5] Gwinner, K., et al. (2009), *EPSL, in press.* [6] Gwinner, K., et al. (2009), *PERS* 75(9), 1127-1142. [7] Heipke, C., et al. (2007), *PSS* 55, 2173-2191. [8] Spiegel, M. (2007), *IntArchPhRS 36(3)*/ W49B, 161-166. [9] Smith, D.E., et al. (2001)., *JGR 106(E10),* 23689-23722.