Topographic mapping of the Mars MC quadrangles using HRSC data

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Abstract:

The High Resolution Stereo Camera (HRSC) of ESA’s Mars Express mission \cite{1,2} is designed to map and investigate the topography of Mars and its satellites. As a push broom scanning instrument with nine CCD line detectors mounted in parallel, its unique feature is the ability to obtain along-track stereo images and four colors during a single orbital pass (Fig. 1). Thus, panchromatic stereo and color images from single orbits of the HRSC have been used to produce digital terrain models (DTMs) and orthoimages of the Martian surface since 2004. The HRSC is still running nominally and delivering new image strips to fill remaining gaps that lead to a contiguous coverage of the surface at high resolution stereo. The very high degree of nadir image coverage (up to 96\%) of the Martian surface is an outstanding characteristic of the Mars Express mission, which no other mission has been achieved so far. The sub-pixel accuracy of derived 3D points results in DTMs with grid sizes of up to 50 m and height accuracy on the order of one pixel on the ground and better \cite{3}.

Since 2010 new HRSC multi-orbit data products have been generated, which have been developed into a global mapping program organized into MC-30 half-tiles, since 2014 \cite{4,5}. Based on continuous coverage of an area, regional DTMs and orthomosaics can be produced by combining image data from multiple orbits using specifically adapted techniques for block-adjustment, DTM interpolation and image equalization \cite{6}. The resulting DTMs and color orthomosaics are the baseline for a controlled topographic map series of Mars at a scale of 1:700,000. The extents of the regional products follow the MC-30 (Mars Chart) global mapping scheme of Greeley and Batson (Fig. 2) \cite{7}, which subdivides Mars into 30 quadrangles. Ronald Greeley and Raymond Batson were pioneers in planetary cartography and set fundamental standards for e.g., map formats and projections for planetary bodies. For the generation of the DTMs and color mosaics, the MC-30 quadrangles are further divided into East (E) and West (W). In parallel to the completion of the first half-tile DTM and color mosaic (MC-11-E) we developed a concept for a topographic map series of Mars \cite{8,9}. To limit data volumes and map sizes, each quadrangle is subdivided into eight tiles (i.e. each half-tile into four tiles, Fig. 3). The map scale of 1:700,000 is a compromise between the high DTM and orthomosaic resolution of 50 m/pxl and an acceptable hardcopy format of about 1 m in width to 2 m in height. This

Figure 1. HRSC imaging scheme showing the nine sensors

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Figure 2. MC-30 scheme tiling Mars into 30 quadrangles
color orthoimages are used, showing Mars-typical reddish-brown colors. The color comes from a combination of the HRSC color channels following a color standard by processing of the mosaic on ground, but is no true color. The cartographic context is given by a geographic coordinate grid with East longitudes from $0^\circ$ to $360^\circ$ and contour lines that depict the topography of the region. The top layer shows the names of the regions, craters and other landforms that have been named so far. On Mars we mostly have, from large to small, regions (planitia, planum, terra), valleys (vallis), linear features (chasma, fossa, rupes), mountains (mons, tholus), and craters. Also typical for Mars are chaotic terrains (chaos). Besides a text with explanations on the maps and the data we used side maps with a) the footprints of the HRSC image stripes and b) a color-coded and shaded DTM of the shown map tile.

All maps are available for the public at the HRSC team website (http://hrscteam.dlr.de/HMC30/index.html).

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References (optional)


