HRSC on Mars Express – Recent advances in the processing of quadrangle image mosaics. W. Zuschneid[1], G.G. Michael[1], S.H.G. Walter[1], A. Dumke[1], K. Gwinner[2], R. Jaumann[1], [1]Institute of Geological Sciences, Planetary Sciences and Remote Sensing Group, Freie Universität Berlin, Germany (w.zuschneid@fu-berlin.de), [2]Institute of Planetary Research, German Aerospace Center (DLR), Berlin, Germany.

Abstract / Overview: Among the mission goals of the High Resolution Stereo Camera (HRSC) on board of ESA's Mars Express is a complete coverage of Mars with photogrammetically derived Digital Terrain Models (DTMs) and orthorectified high-resolution image mosaics [1].

We describe recent technical improvements to the generation of image mosaics and to the dissemination via the FUB's Planetary Science department's Mapserver.

Introduction: In the recent years, an increasing number of HRSC image mosaics have been created using a refined approach based on the one outlined in [2]. These are an important part of the high-resolution topographic data provided by HRSC for geomorphological and geologic analyses at a regional and planetary scale [3]

These improvements were made by 1) introducing a higher resolution dataset as the reference for brightness adjustment (see [2]), 2) a new system for recording and aggregating changes to image sequencing and contrast. New image mosaics are made available continuously via the FUB Mapserver as they are completed [4]. The main data products are the archive datasets of the bundle-block-adjusted (level 5) DTM, and their primary derived data products, the HRSC image mosaics in grayscale and HSV transformed RGB colour, which are compiled from single-strip level 5 images orthorectified using the same DTM [2]. All HRSC archival data products are available through PSA and PDS and, in the case of Level-5, the HRSC team site (hrscteam.dlr.de/HMC30, release through PSA in preparation).

Level 3 image mosaics: With mosaics based on the so-called level 3 HRSC image products, an additional un-controlled (and non-archive) data product was developed. As the level 3 image data are orthorectified using predicted orientation data and the Mars Orbiter Laser Altimeter (MOLA) DTM, these have a significantly lower accuracy and are distributed at a lower resolution. However, as the source data is automatically created following image acquisition and downlink, it becomes available within days. It is thus possible to assemble mosaics as soon as the spatial coverage is sufficient. The level 3 data also provide a somewhat more complete coverage, as some of the HRSC strips do not provide stereo images (usually this are low resolution images). For this reason, level 3 images cannot be subject to the same geometric evaluation processes as in level 5 processing, and significant geometric offsets may remain undetected. However, level 3 mosaics are a very useful step in preparing the later production of the level 5 mosaics, as sequencing and image quality adjustments can be made based on already available data. Using this information, level-5 mosaics can be created more quickly when the data becomes available, requiring only minimal additional manual interaction.

New basemap / brightness map: The elliptical orbit of the Mars Express spacecraft offers the opportunity to capture high-altitude, wide-coverage imagery of the Martian surface, albeit at lower surface resolution. From these images, a planet-wide mosaic was compiled and brightness-referenced to Mars Global Surveyor (MGS) Thermal Emission Spectrometer (TES) albedo data. This medium resolution dataset is used to replace the intermediate brightness reference processing step [2]. With a resolution of 1 km/pixel, the new dataset exceeds the resolution of ~7 km/pixel of the TES brightness reference and is without interpolation artifacts.

Image processing and sorting: Images are pre-processed to level 3 using an orthorectification on a

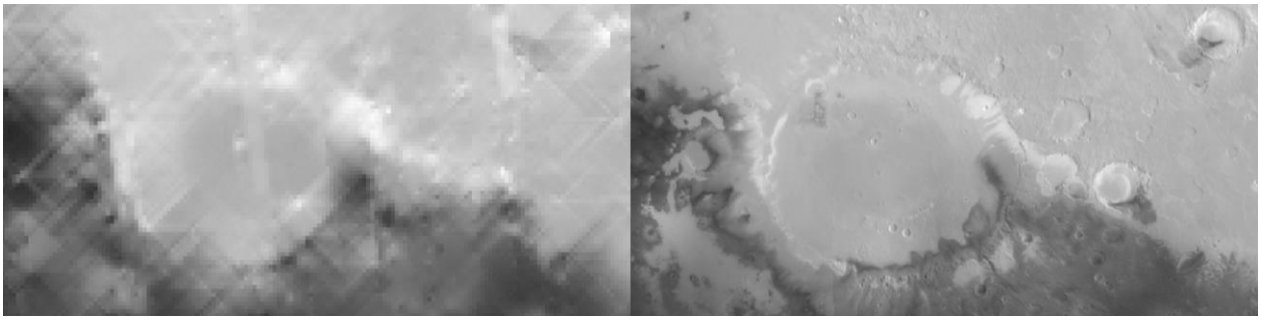

Fig. 1: Old TES (left) and new HRSC (right) brightness reference: Schiaparelli Crater (460 km diameter)

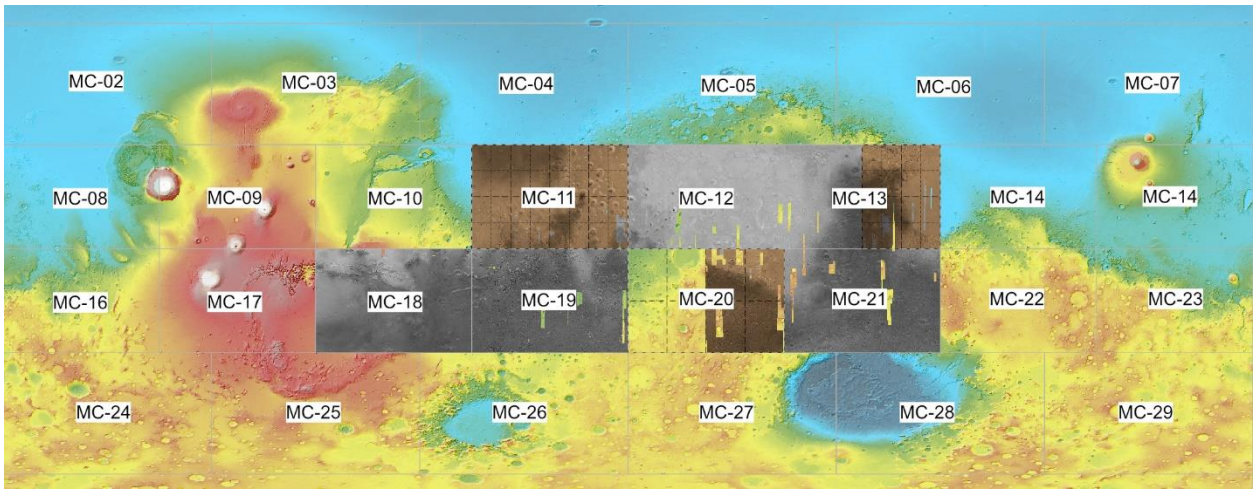

Fig. 2: Screenshot from FUB Mapserver with completed MC quadrangles as of Jan 7, 2021

MOLA DTM. These images undergo Lambert correction and are cropped when exceeding 85° incidence angle. Image sequence adjustments are now made using QGIS, as this software utilizes the open QGS project file format which can be read out directly. Previously, a special tool was necessary to log changes in image sequence and contrast adjustments in a proprietary GIS system.

Initially, images are automatically sorted according to their true ground sampling distance, which is included in the displayed QGIS layer name. The next step is made interactively in QGIS, where several changes can be made to each image: It can be moved to another position in the mosaic sequence, the contrast can be adjusted, missing lines can be replaced from a stereo channel (only in level 5 processing), or it can be excluded altogether from processing. The contrast adjustment values are derived by manually stretching the individual images to achieve a uniform mosaic. These changes are recorded in the layer name and are stored in the QGIS project file.

Images are sorted manually to create a mosaic optimized for visual interpretation. If an image of insufficient quality can be replaced by another, better image, it is moved downwards in the image sequence. The new position is recorded by assigning an "effective ground sampling distance", which is recorded manually in the layer name.

On mosaic processing, the QGS file is read out and sequencing information, effective ground sampling distance and other information are retrieved.

The brightness is adjusted as described in [2] by tying high-resolution HRSC brightness to the new global brightness map, which in itself is tied to TES albedo. Contrasts are adjusted using a linear stretch (QGIS values are recalculated to ArcGIS values). Multiple iterative processing steps are required for an optimal result.

Mapserver: As new image or DTM quadrangle-based products become available, we convert them to the GeoTIFF format with structured metadata to be used in a Geographic Information System (GIS) either as local full-file-downloads or as Cloud Optimized GeoTIFF (COG). In the latter, only the pre-tiled version of the appropriate zoom level of the requested region is transferred. The HRSC Mapserver [4] serves as the Planetary Spatial Data Infrastructure (PSDI) for direct preview and download of the quadrangle-based products as well as their raw data in single-strip file versions. Level-3 single strip images (panchromatic channel only) are automatically updated on a daily basis. The map server of FUB is available at: https://maps.planet.fu-berlin.de/.

Outlook: We're currently completing a number of Level 3 mosaics, and are confident to produce a majority of all Mars MC Level 3 mosaics in the course of 2021. Completion and release of level 5 mosaics continues at a slower pace, as the production follows the high-quality standards required for this archive product. The new DEM quadrangles and mosaics will be a major addition to the available topographic datasets.

References:

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