

15 years of fascinating Mars press images and movies from the High Resolution Stereo Camera on Mars Express, prepared at Freie Universität Berlin

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Abstract

Almost 15 years have passed since the transmission of the first images of the High Resolution Stereo Camera (HRSC) to the experiment teams on Earth in January 2004. The HRSC is the most comprehensive German research instrument on a planetary mission, it has been orbiting Mars onboard ESA's Mars Express spacecraft since 2003. Decompression, calibration and projection of the raw image data are performed at the Institute of Planetary Research of the German Aerospace Center (DLR), before the level 2-4 data are transferred to the Planetary Sciences and Remote Sensing Team situated at Freie Universität Berlin (FU Berlin) for higher-level processing. Here, the camera data from the various channels (stereo, color, nadir) are combined to produce color images, anaglyphs, digital terrain models, 3D perspectives and movies of the Martian surface and Martian moons. In a joint effort, ESA, DLR and FU Berlin are publishing these HRSC products online on a regular basis since 2003. During the last 15 years more than 1000 images [1] and 24 movies were released, the latest on YouTube [2].

1. Achievements after five years

After five years in orbit HRSC has captured nearly half of the surface of Mars in high resolution <20 m/px, color and stereo. For the first time, a comprehensive set of digital terrain models was released through ESA's Planetary Science Archive [3] and NASA's Planetary Data System [4], platforms that are mostly used by scientists and planetary experts. To enable any interested user to work with the data, a public website hosted at FU Berlin was established [5]. A special release was prepared by FU Berlin to demonstrate the outstanding benefit of the camera to record data in three dimensions: a digital terrain model of Olympus Mons, the largest volcano

on Mars (Fig. 1), composed of 16 orbit strips and with a terrain resolution of 150 m/px.

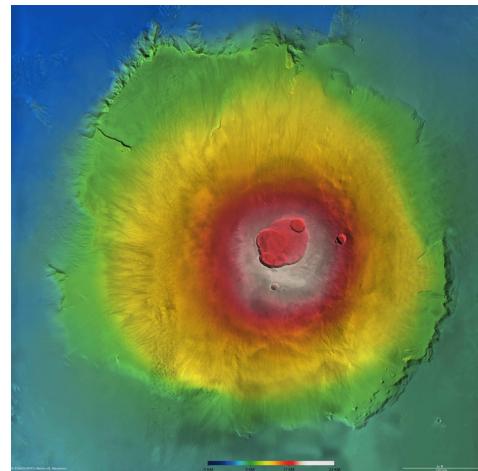


Figure 1: Color-coded digital terrain model of Olympus Mons, combined with ortho-image mosaic.

The combination of three-dimensional datasets with color information enabled unprecedented animations of the Martian landscape. In 2008 the first simulated flights were produced at FU Berlin featuring the Hebes Chasma canyon, the Mawrth Vallis outflow channel, and Nicholson impact crater. These movies were presented at the DLR 3D photo traveling exhibition 'Das neue Bild vom Nachbarn Mars' that was and is still presented in several national and international locations.

2. Achievements after ten years

After ten years in orbit, the HRSC has mapped about two-thirds of the surface of Mars with a resolution <20 m/px. In addition to numerous color and terrain model mosaics already released (e.g., Dao and Niger Valles region, Valles Marineris, Elysium), the up-to-

date largest color mosaic consisting of 67 single image strips was produced and color-adjusted at FU Berlin (Fig. 2). It shows one of the largest outflow channel systems on Mars, the 3000 km Kasei Valles which was flooded several times and also shaped by tectonic and volcanic activity. The color mosaic and associated 100 m/px digital terrain model are the basis of an animation that was released in 2014 [6].



Figure 2: Kasei Valles color image mosaic of 67 orbits with accompanied digital terrain model.

A further highlight of color mosaic processing was the north polar ice cap of Mars produced from 32 orbit strips in 2017 [7]. This is the first image mosaic of this region in high resolution showing fine details of the dark troughs and trenches (Fig. 3).

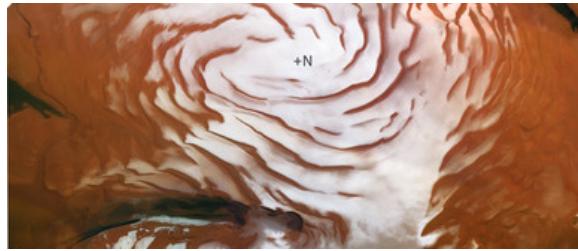


Figure 3: Section of the north polar ice cap mosaic.

3. Fifteen years and beyond

In order to calibrate the individual sensors of the HRSC and to guarantee the quality of the image data throughout the camera's lifetime, the sensors can be directed over a wide extended area in a sweeping movement, a practice called 'broom calibration'. One of these calibration orbits yielded a spectacular global view of Mars, displaying Tharsis, Valles Marineris and Noctis Labyrinthus, that will be

released in June 2018 at the occasion of 15 years successful launch of HRSC on Mars Express (Fig. 4).

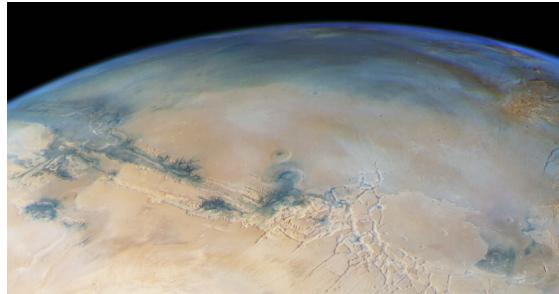


Figure 4: Section of the color composite of calibration orbit 17444.

In the future, the plan is to fill in successively the quadrangle scheme of 30 Mars charts (MC) with high resolution HRSC color mosaics and digital terrain models. The ambitious goal is a global dataset that can be used for Mars science research and also for public relations.

Acknowledgements

Image credit: ESA/DLR/FU Berlin (CC BY-SA 3.0 IGO). This work was supported by the German Space Agency (DLR Bonn), grants 50QM1301 and 50QM1702 (HRSC on Mars Express), on behalf of the German Federal Ministry for Economic Affairs and Energy. We want to thank our former team members that were involved in public relations. Our results build on the work of the former Principal Investigator of the HRSC, Gerhard Neukum, who also designed the camera technically.

References

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- [3] [https://archives.esac.esa.int/psa/](http://archives.esac.esa.int/psa/)
- [4] <http://pds-geosciences.wustl.edu/>
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- [7] www.fu-berlin.de/planets (Press Releases – 2017 – North Polar Ice Cap)