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THE MULTI-TEMPORAL DATABASE OF PLANETARY IMAGE DATA (MUTED): A COMPREHENSIVE TOOL TO STUDY DYNAMIC MARS. T. Heyer[1], H. Hiesinger[1], D. Reiss[1], G. Erkeling[2], H. Bernhardt[1], and R. Jaumann[3], [1]Institut für Planetologie, Westfälische Wilhelms-Universität, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany, [2]German National Library of Science and Technology (TIB), Hannover, Germany, [3]German Aerospace Center (DLR), Berlin, Germany. (thomas.heyer@uni-muenster.de)

Introduction: The Multi-Temporal Database of Planetary Image Data (MUTED) is a web-based tool to support the identification of surface changes and time-critical processes on Mars. The database enables scientiests to quickly identify the spatial and multi-temporal coverage of orbital image data of all major Mars missions. Since the 1970s, multi-temporal spacecraft observations have revealed that the martian surface is very dynamic [e.g., 1-3]. The observation of the surface changes and processes, including eolian activity [e.g., 5, 6], mass movement [e.g., 6, 7], the growth and retreat of the polar caps [e.g., 8, 9], and crater-forming impacts [10] became possible by the increasing number of repeated image acquisitions of the same surface areas. Today more than one million orbital images of Mars are available [11]. This increasing number highlights the importance of efficient and comprehensive tools for planetary image data management, search, and access.

MUTED is accessible at http:\\muted.wwu.de and will assist and optimize image data searches to support the analysis and understanding of short-term, long-term, and seasonal processes on the surface and in the atmosphere of Mars. In particular, images can be searched in temporal and spatial relation to other images on a global scale or for a specific region of interest. Additional information, e.g., data acquisition time, the temporal and spatial context, as well as preview images and raw data download links are available.

Structure: MUTED is based on a three-tier architecture. Metadata of the planetary image datasets are integrated from the Planetary Data System (PDS) into a relational database (PostGreSQL) at the bottom data storage level. In order to provide the multi-temporal coverage, additional information, e.g., the geometry, the number and time span of overlapping images are derived for each image respectively. At the service level, a Geoserver translates the metadata stored in the relational database into web map services (WMS) and web features services (WFS). Using Common Query Language (CQL), the web services can be filtered by date, solar longitude, spatial resolution, incidence angle, and spatial extend. A GeoWebCache is used to cache map tiles and accelerate, as well as optimize, the WMS delivery. At presentation level, all services are combined and visualized in the web-based user interface. The user interface was built using HTML, PhP, JavaScript, and Openlayers and provides several features for data selection, filtering, and visualization (Fig 1). A region of interest can be defined based on global spectral, topographical or geological information. The multi-temporal coverage, as well as meta data and the spatial and temporal context of the images, are presented on the map or within a timeline. Additionally, queries can be exported as text files. High-resolution previews of the image data provided by the Arizona State University allow for a quick and convenient evaluation of the mapped surface and image data quality.

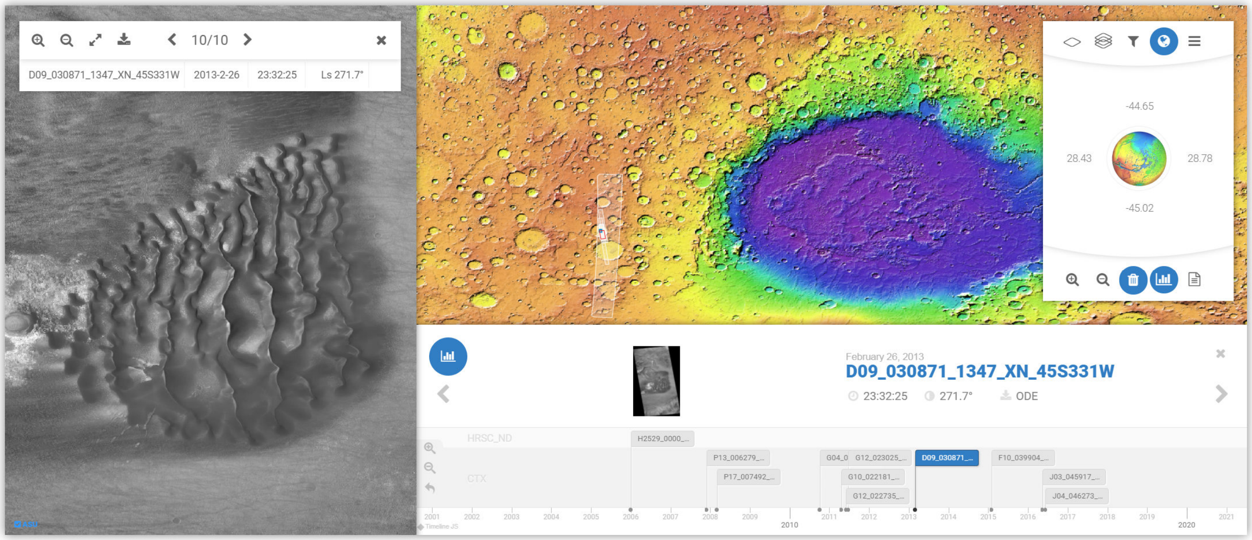

Fig. 1. Web user interface of MUTED showing the spatial (top right) and temporal (bottom right) coverage as well as high resolution data preview (left) for a region of interest at Neukum crater (28.3°E, 45°S).

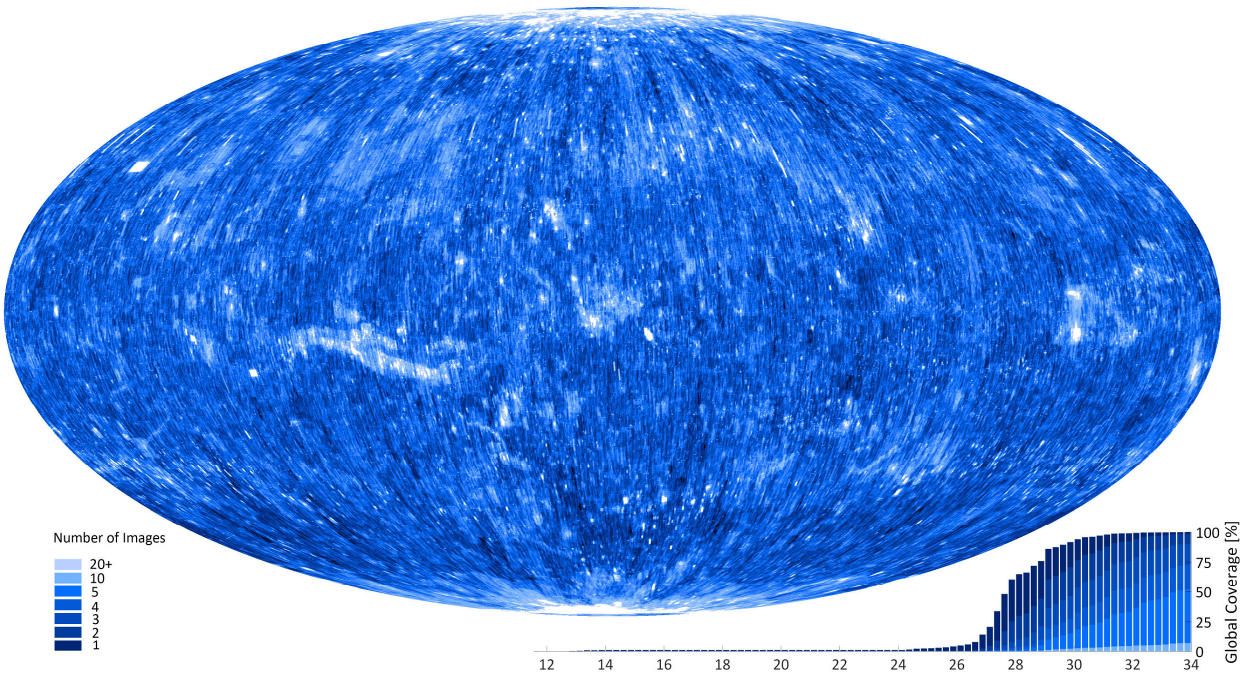

Fig. 2. Global coverage of high-resolution images (spatial resolution better than 25 meter/pixel)

Datasets: Metadata pertaining to more than 1.27 million orbital images of Mars are integrated into the database. The images taken by various instruments including the Viking Orbiter (VO) [14], the Mars Orbiter Camera (MOC) [15] on board Mars Global Surveyor (MGS), the High Resolution Stereo Camera (HRSC) [16] on board Mars Express (MEx), the Thermal Emission Imaging System (THEMIS) [17] on board Mars Odyssey, the Compact Reconnaissance Imaging Spectrometer of Mars (CRISM) [18], the Context Camera (CTX) [19], and the High Resolution Imaging Science Instrument (HiRISE) [20] on board the Mars Reconnaissance Orbiter (MRO) covering a time range of four decades. The spatial resolution ranges from ~25 centimeters to several kilometers per pixel.

A global coverage analysis reveals that high-resolution images with a spatial resultion better than 25 m/px cover 99.9% of the surface of Mars (Fig. 2). Over the last 10 Mars years, almost 60,000 high-resolution images per Mars year were acquired with a mean annual coverage of 26.4% of the surface of Mars. While 50% of the surface are covered with at least five high-resolution images, the coverage analysis reveals a comprehensive data availability for various change detection tasks.

Scientific applications: MUTED supports the identification of orbital images and their spatial and temporal context as a basis for various change detection analyses. In particular, the definition of a time span between repeated images enables users to discover surface changes caused by very short-term and temporal highly variable processes, e.g., dust devils. The number of images within a certain time period can be specified according to solar longitude, for example to observe seasonal changes and processes, e.g., seasonal ice and frost cover. The number of overlapping images can be defined to ensure data availability, e.g., long term changes of the surface of Mars.

Due to continuous data acquisition by spacecraft, the amount of image data is steadily increasing and enables further comprehensive analyses of martian surface changes, caused by eolian, mass wasting, polar, as well as impact cratering processes. The flexible structure of MUTED allows for a fast integration of upcoming data sets, e.g., from ESA's ExoMars Trace Gas Orbiter (TGO) mission.

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