THE MULTI-TEMPORAL DATABASE OF PLANETARY IMAGE DATA (MUTED): A TOOL TO SUPPORT THE IDENTIFICATION OF SURFACE CHANGES ON MARS.

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Introduction: Since the 1970s, spacecraft observations of Mars have revealed that the surface is continually changing [e.g., 1-12]. The modifications are attributed to exogenic processes, including eolian activity [11,13], mass movement [14], the growth and retreat of the polar caps [15], and crater-forming impacts [8,16]. To support the identification of surface modifications, we developed the Multi-temporal Database of Planetary Image Data (MUTED). Our database is a tool to identify the spatial and temporal coverage of planetary image data from Mars. Various image datasets are included such as from Viking Orbiter (VO) [16], the Mars Orbiter Camera (MOC) [17] on board Mars Global Surveyor (MGS), the High Resolution Stereo Camera (HRSC) [18] on board Mars Express (MEx), the THermal EMission Imaging Instrument (THEMIS) [19] on board Mars Odyssey, the High Resolution Imaging Science Instrument (HiRISE) [20], the Compact Reconnaissance Imaging Spectrometer of Mars (CRISM) [21] and the Context Camera (CTX) [22] on board the Mars Reconnaissance Orbiter (MRO) (Fig. 1). The database is accessible via a web-based user interface, where overlapping image data can be searched under user-defined spatial and temporal conditions. Furthermore, the temporal context of the data can be analysed.

Multi-temporal database: MUTED is based on free and open source software, and consists of a three level architecture.

(1) At the bottom of this architecture is a PostGreSQL database with a PostGIS geospatial extension. Metadata of the planetary image datasets are included from the Planetary Data System (PDS) of the National Aeronautics and Space Administration (NASA). Metadata contain product ID, acquisition date, spatial extent and other information about the image data. Additional information, e.g., the solar longitude, are derived for each image data respectively [23]. The number of overlapping images and the time distance between images are derived as a basis for the multi-temporal search function.

(2) The second level of the database comprises a geoserver for data management. The geoserver provides the web map services (WMS) and web feature services (WFS) based on metadata stored in the PostGreSQL database. The footprints of image data are generated in vector format for visualization. In addition to the image data footprints, base maps are integrated into the geoserver. With a global coverage, the base maps provide a quick overview and allow the definition of an area of interest based on multi-spectral, topographical or geological information. The base maps are integrated in raster format and provided by the geoserver via WMS.

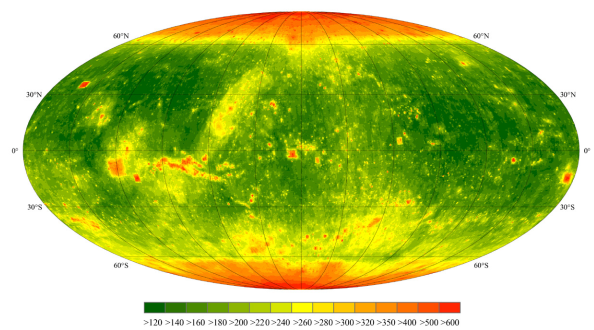

Figure 1: Number of images per 0.5° pixel. A global view of all datasets integrated into MUTED, including CTX, CRISM, HRSC, HiRISE, MOC NA/WA, THEMIS VIS, and Viking images.

(3) The web-based user interface is the top level of the database architecture. Using open source javascript code the WMS and WFS, generated by the geoserver, will be displayed.

The user interface provides several features for data and base map selection, spatial definition of the area of interest, and temporal filtering (Fig. 2). The temporal condition can be set by date as well as solar longitude.

A key feature is the multi-temporal search function. Overlapping datasets can be searched by a user-defined number of overlaps or time interval between overlapping datasets. After adjustment, footprints of the data appear on top of the base map. Related information, including a preview image, product ID, acquisition data and other metadata information are displayed.

Another feature of the user interface is a timeline that displays all selected images in chronological order. The timeline serves as quick overview of the data availability and their temporal context. Amongst others, it can be used to identify an overlapping dataset with the smallest or the longest time-interval, where most changes may be expected.

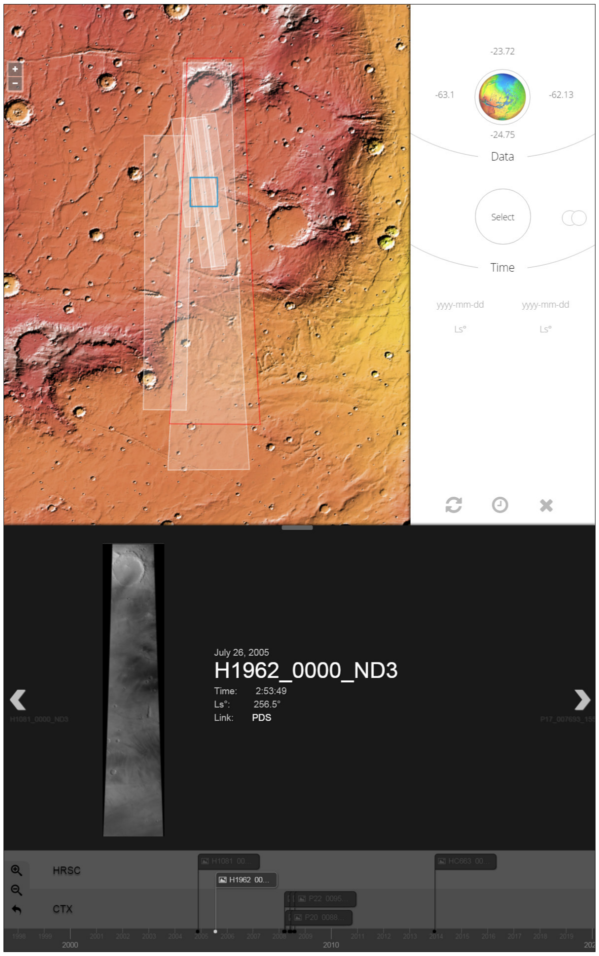

Figure 2: User interface and timeline of MUTED showing the spatial and temporal distribution of HRSC and CTX images for a small area in Thaumasia Planum.

Integrated datasets: At the current state, metadata information with an overall number of 1,372,877 images are integrated into the database. Fig. 1 shows the number of high resolution images at a global scale. Due to the orbits of the spacecrafts and the resulting overlapping footprints, the highest number of images with a maximum of 2362 images per 0.5° pixel can be found at the polar regions. Other areas with a high number of repeat images are the landing sites or prominent landscapes, e.g., Valles Marineris.

The base maps comprise four global datasets. A global overview is provided by the Viking MDIM2.1 Colorized Global Mosaic with a spatial resolution of 231 m per pixel at the equator [24]. Topographic information is provided by a Mars Orbiter Laser Altimeter (MOLA) shaded relief derived from altimetry colorized by elevation with a spatial resolution ~463.1 m per pixel [25]. A more detailed view with a higher spatial resolution of 100 m per pixel is available from the THEMIS Day IR Global Mosaic [26]. Global geological information of the Martian surface is available from a map by [27].

Scientific applications: Due to long-term and 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 processes, mass wasting, and polar processes, as well as impact cratering processes. Our database will assist the identification and selection of image data as a first step for surface change research.

Besides the basic spatial and temporal data search, the multi-temporal function of MUTED can be used to:

(1) Find datasets with a certain time distance between overlapping datasets to discover changes caused by very short-term and temporal highly variable processes, e.g., dust devils; (2) Find datasets with a certain number of overlapping observations within a certain time period, for example to observe seasonal processes, e.g., seasonal ice and frost cover; (3) Find data with a defined number of overlapping observations, e.g., multi-temporal change detection analyses, which requires a defined number of images.

Release of database: After server setup, we intend to release a first login restricted version of the multi-temporal database for usability tests and internal reviews to the HRSC team and the scientific community. Users will have access to the webclient, including full individual search and analyses functions for all integrated datasets. The database will finally be accessible at the Institut für Planetologie website, http://www.uni-muenster.de/Planetology/.

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