THE MULTI-TEMPORAL DATABASE OF PLANETARY IMAGE DATA (MUTED)

A TOOL TO SUPPORT THE IDENTIFICATION OF SURFACE CHANGES ON MARS

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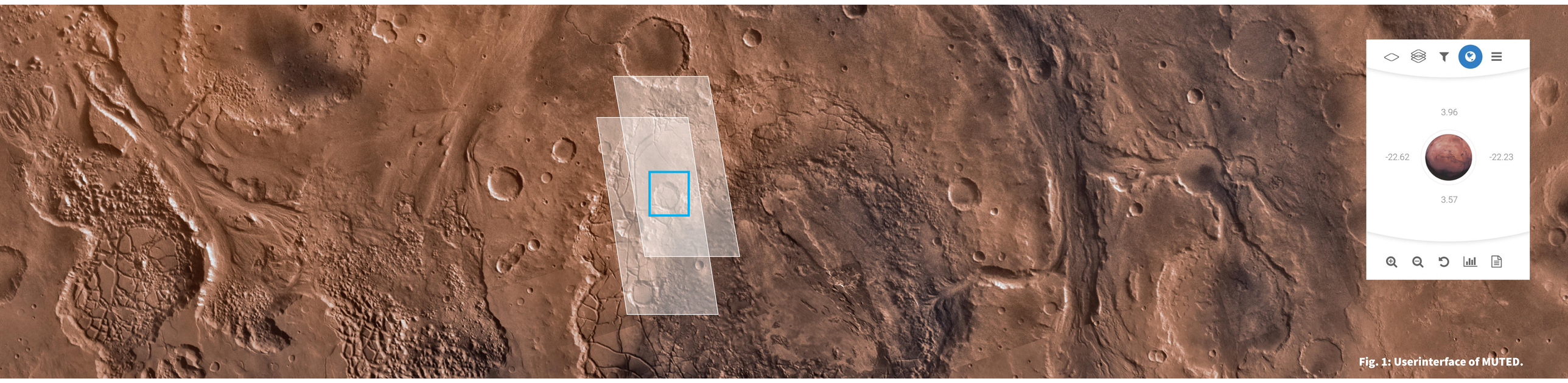


Fig. 1: Userinterface of MUTED.

INTRODUCTION

Multi-temporal observations are key to detect and analyze surface changes and processes on Mars. Since the 1970s, spacecraft observations have revealed that the surface of Mars is changing [1-6]. The modifications are attributed to exogenic processes, including eolian activity [7], mass movement [8, 9], the growth and retreat of the polar caps [10, 11], and crater-forming impacts [12]. The observation of these variable features became possible by the increasing number of repeated image acquisitions of the same surface areas.
MUTED comprises metadata of all major Mars missions and enables scientists to quickly identify the spatial and multi-temporal coverage of planetary image data from Mars [13, 14]. Images can be searched in temporal and spatial relation to other images on a global scale or for a specific region of interest.

ARCHITECTURE

MUTED is based on free and open source software, and consists of a three level architecture. Metadata of the planetary image datasets are included from NASA's Planetary Data System (PDS) into PostgreSQL database. Additional information, e.g., the number and time span of overlapping images are derived for each image data respectively. A Geoserver translates the metadata stored in the relational database into web map services (WMS) and web features services (WFS). All services are combined and visualized in the web-based user interface (Fig. 1). The user interface was built using HTML, PhP, and JavaScript and provides several features for data and base map selection, spatial definition of the area of interest and data filtering. Another feature of the user interface is a timeline that displays all selected images in chronological order.

FEATURES

Images can be searched in temporal and spatial relation to other images.

Define an area of interest based on global multi-spectral, topographical or geological information.

Filter data by date, solar longitude or in order to the acquisition geometry.

Show data statistics and the temporal context to other datasets.

DATASETS

At the current state, metadata pertaining to over 1.03 million images from various instruments including the Viking Orbiter (VO) [15], the Mars Orbiter Camera (MOC) [16] on board Mars Global Surveyor (MGS), the High Resolution Stereo Camera (HRSC) [17] on board Mars Express (MEx), the THermal EMission Imaging System (THEMIS) [18] on board Mars Odyssey, the Compact Reconnaissance Imaging Spectrometer of Mars (CRISM) [19], the Context Camera (CTX) [20], and the High Resolution Imaging Science Instrument (HiRISE) [21] on board the Mars Reconnaissance Orbiter (MRO) are integrated into the database (Fig. 2). The spatial resolution of the integrated images varies from ~25 centimeters (HiRISE) to several kilometers per pixel (global observations of Viking and MOC-WA). Data analyses showed that 52.3% of all images integrated into MUTED have a spatial resolution of < 50 m and cover about 99.98% of the surface of Mars (Fig. 3).

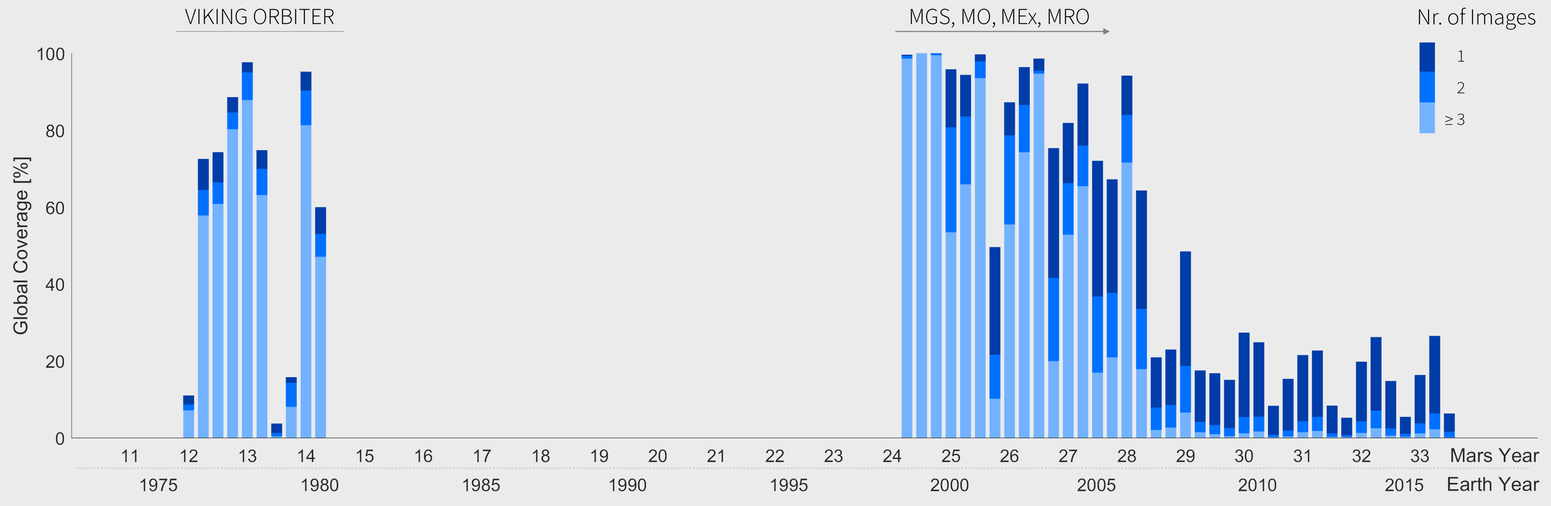
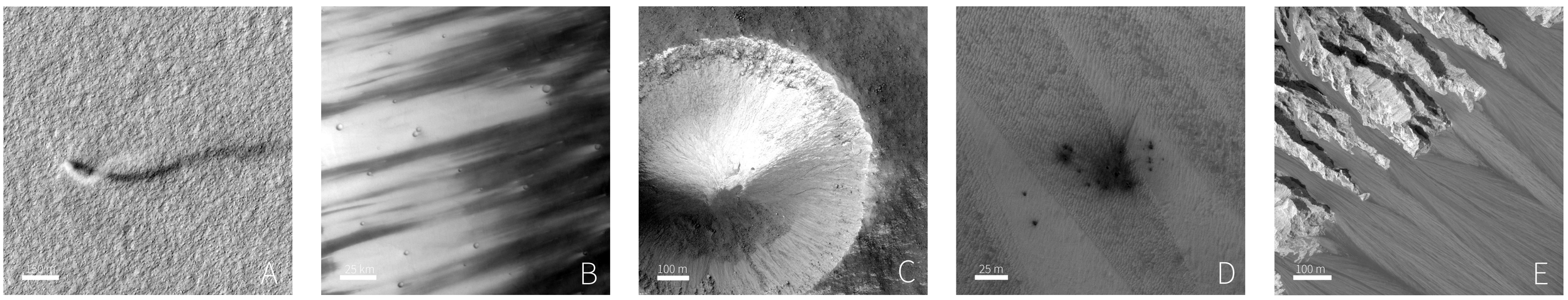


Fig. 2: Global coverage of all datasets integrated into MUTED per quarter Mars year.



APPLICATION EXAMPLES

MUTED enables planetary scientist, engineers, and mission planners to access multi-temporal observations of Mars and their spatial and temporal context. The database will assist and optimize image data searches as a basis for various change detection tasks:

(1) The time span between repeated images can be defined to discover surface changes caused by very short-term and temporal highly variable processes, e.g., dust devils (**A**) [22].

(2) The number of images within a certain time period can be set according to solar longitude, for example to observe seasonal changes and processes, e.g., seasonal storm events (**B**) or seasonal ice and frost cover (**C**) [23, 24].

(3) The minimum number of overlapping images can be defined to ensure data availability for certain multi-temporal data analyses, e.g., long term changes of the surface of Mars, cratering (**D**) or mass wasting processes (**E**) [25, 26].

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, mass wasting, polar, as well as impact cratering processes.

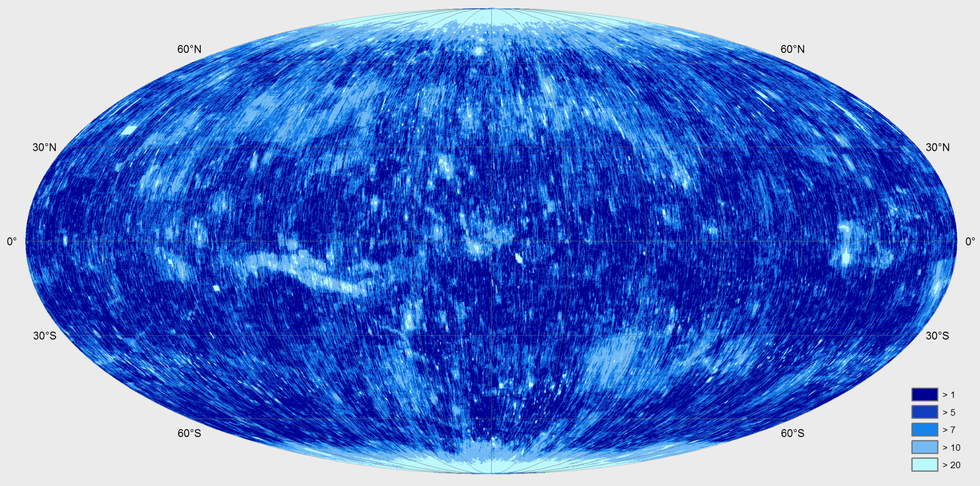


Fig. 3: Number of images per 0.01° pixel derived from MUTED. A global view of all high resolution datasets integrated into MUTED, including CTX, HiRISE, HRSC-ND, MOC-NA, and THEMIS-VIS.

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