High-resolution repeat imaging allows detecting dynamic surface processes on Mars

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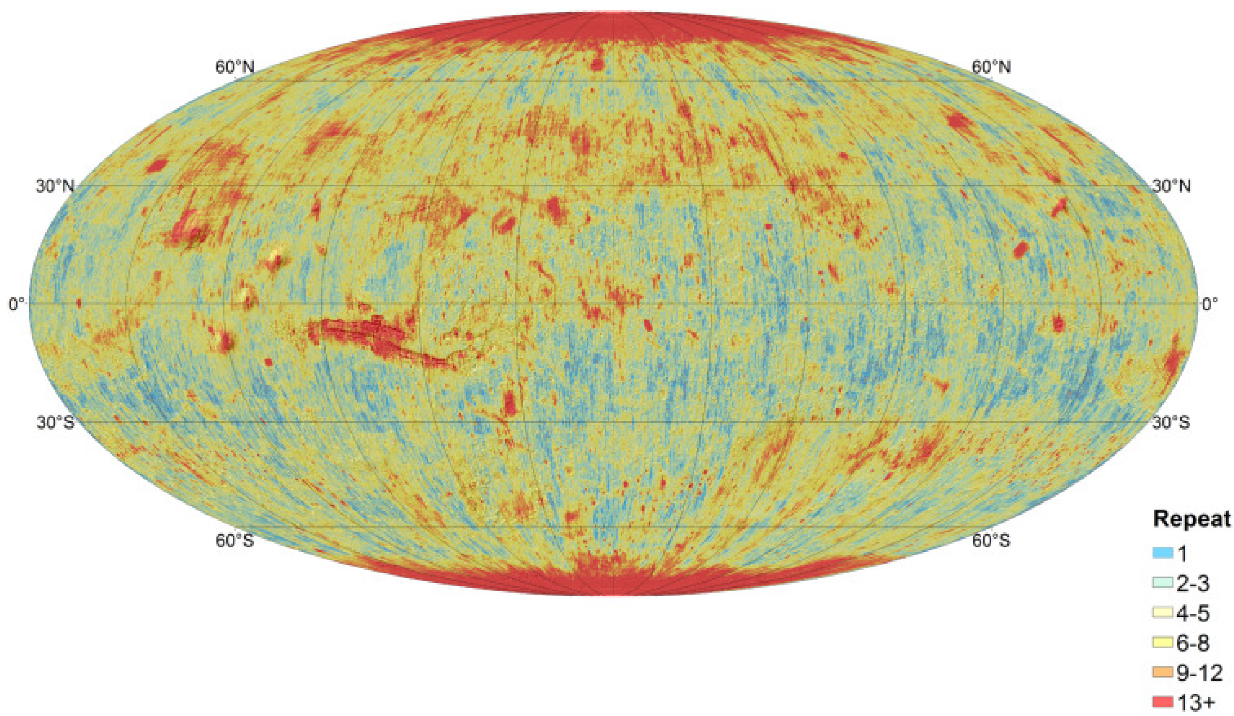

The overall repeat coverage of Mars with resolution finer than 100 m/pixel. Image credit: Panagiotis Sidiropoulos and Jan-Peter Muller, 2015.

(Phys.org)—Mars, which has constantly observed by space probes for over 40 years, still holds unresolved mysteries like its dynamic surface processes. The multitude of high-resolution images of the Red Planet at our disposal could provide crucial insights into these changes seen on the Martian ground. A new study conducted by the scientists from the

University College London, U.K., analyzes the available imagery and by producing a series of 35 global coverage maps of Mars, attempts to create an initial basis for researchers to better examine the dynamic natural phenomena on Mars.

The analysis, carried out by Panagiotis Sidiropoulos and Jan-Peter Muller, was published in the November issue of the *Planetary and Space Science* journal.

The research shows that, thanks to a fleet of spacecraft sent to Mars, there is sufficient coverage to systematically examine periodic and sporadic Martian phenomena. The plentiful image data resulted in creating global coverage maps demonstrating the high-resolution repeat coverage of Mars, under different temporal and viewing condition constraints.

"In this work, we present several groupings of the available high-resolution Mars orbiter images, aiming to facilitate change detection in various application scenarios," the paper reads.

Interested in the Martian geological context, the scientists, by producing these maps, try to assess the potential of multi-instrument surface change detection for each geographic region on the surface of the Red Planet. Their goal was to present a method to aggregate images according to their metadata and use this to conduct an analysis of Mars' surface coverage with high-resolution imaging products.

"Through this analysis, we have demonstrated that for a substantial part of Mars, multi-instrument pairs can be established, additionally satisfying (at least partially) constraints about the Martian year and the Martian season they were acquired in, as well as their illumination conditions," the researchers wrote.

Six orbiter missions were analyzed: NASA's Viking Orbiter 1 and 2, Mars Global Surveyor, Mars Odyssey, Mars Reconnaissance Orbiter and ESA's Mars Express. India's Mars Orbiter Mission (MOM), which arrived at the Red Planet in September 2014, was omitted, as the research includes the period of time until the end of July 2013.

The Viking Orbiter missions were the first to perform extensive high-resolution orbital mapping of the Martian surface. They achieved complete global coverage of Mars with resolution finer than 1 km/pixel and the first medium-resolution global mosaic of Mars (231 m/pixel at the equator).

The Mars Global Surveyor, with the Mars Orbiter Camera Narrow Angle (MOC-NA) and Mars Orbiter Camera Wide Angle (MOC-WA) onboard, acquired images over selected regions of interest with a spatial resolution varying from 1.5 to 12 m/pixel (MOC-NA) and from 240 m to 7.5 km/pixel (MOC-WA).

The Mars Odyssey, with the Thermal Emission Imaging System (THEMIS), mapped the Martian surface with a resolution of 18 m/pixel.

The Mars Reconnaissance Orbiter has two high-resolution cameras: the High Resolution Imaging Science Experiment (HiRISE) and the Context Camera (CTX). It still acquires images at a local resolution of 0.25 to 0.5 m/pixel resolution, which is the best orbital imaging resolution that has been achieved so far.

Finally, ESA's Mars Express mission, equipped in the High Resolution Stereo Coverage (HRSC) camera, continues imaging today, achieving the most complete high-resolution, multi-angle coverage so far, since HRSC is by default a stereo camera. The nominal HRSC resolution is 12.5 to 25 m/pixel for the nadir and most extreme off-nadir (18.9 degrees) images respectively, a resolution that allows the generation of

3D models of the surface with spatial resolution 30 to 100 m.

The scientists noted that the first step when using the variety of images from Mars spacecraft to detect dynamic surface changes would be to identify the Martian regions that, based on the available data, should be prioritized for examination whether the surface appearance has changed.

"Even though this seems a rather straightforward goal, it does not have a unique solution. However, it can be approached differently depending on the main application objectives of the change detection task," the scientists wrote in the paper.

"For example, if change detection is performed so as to examine processes that happen periodically each and every Martian season (e.g. seasonal flows at high latitude areas), the prioritized regions should be the ones that show repeat coverage with high-resolution images taken during the same season. On the other hand, if change detection related to non-seasonal phenomena is performed, regions with multiple high-resolution coverage over several Martian Years should be prioritized," they added.

The scientists believe that their work will be helpful in future studies trying to detect surface changes on Mars, attempting to fully understood its natural phenomena. They also plan to prepare a similar analysis for the moon.

The maps included in this study are available on the i-Mars.eu project website.

More information: On the status of orbital high-resolution repeat imaging of Mars for the observation of dynamic surface processes, *Planetary and Space Science*, Volume 117, November 2015, Pages 207–222. DOI: 10.1016/j.pss.2015.06.017

Abstract
This work deals with the meta-data analysis of high-resolution orbital imagery that was acquired over the last four decades of Mars. The objective of this analysis is to provide a starting point for planetary scientists who are interested in examining the martian surface in order to detect changes that are related to not fully understood natural phenomena. An image aggregation method is introduced and used to generate image groupings related to prioritising regions for change detection. The parameters determining each grouping are the season, the Martian Year and the local time that an image was acquired, the imaging instrument and its resolution. The analysis shows that there is sufficient coverage to systematically examine periodic martian phenomena in images that depict the same area over the same season, as well as sporadic martian phenomena (e.g. a new crater) in images that depict the same area in different time periods. The end product of this work is a series of 35 global coverage maps demonstrating the high-resolution repeat coverage of Mars up to Martian Year 31 under different temporal and viewing condition constraints. These are available both through supplementary material as well as via a web-GIS.