

## THE iMARS WEBGIS – SPACE-TIME QUERIES AND DYNAMIC TIME SERIES OF SINGLE IMAGES

S. H. G. Walter<sup>1</sup> ([s.walter@fu-berlin.de](mailto:s.walter@fu-berlin.de)), R. Steikert<sup>1</sup>, B. Schreiner<sup>1</sup>, J.-P. Muller<sup>2</sup>, S. van Gasselt<sup>1,3</sup>, Sidiropoulos, Panagiotis<sup>2</sup>, J. Lanz-Kröcher<sup>1</sup>; <sup>1</sup>Institute for Geological Sciences, Freie Universität Berlin, Germany; <sup>2</sup>Mullard Space Science Laboratory, University College London, United Kingdom; <sup>3</sup>Department of Geo-Informatics, University of Seoul, Korea.

**Introduction:** Web-based planetary image dissemination platforms usually show outline coverages of the data and offer querying for metadata as well as preview and download, e.g. [1]. Here we introduce a new approach for a system dedicated to change detection by simultaneous visualization of single-image time series in a multi-temporal context. While the usual form of presenting multi-orbit datasets is the merge of the data into a larger mosaic, we want to stay with the single image as an important snapshot of the planetary surface at a specific time. In the context of the EU FP-7 iMars project we process and ingest vast amounts of automatically co-registered (ACRO) images [2]. The base of the co-registration are the high precision HRSC multi-orbit quadrangle image mosaics [3], which are based on bundle-block-adjusted multi-orbit HRSC DTMs [4]. Additionally we make use of the existing bundle-adjusted HRSC single images available at the PDS archives [5]. A prototype demonstrating the presented features is available at [imars.planet.fu-berlin.de](http://imars.planet.fu-berlin.de).

**Multi-temporal database:** In order to locate multiple coverage of images and select images based on spatio-temporal queries, we converge available coverage catalogs for various NASA imaging missions into a relational database management system with geometry support. We harvest available metadata entries during our processing pipeline using the [Integrated Software for Imagers and Spectrometers \(ISIS\)](#) software. Currently, this database contains image outlines from the MGS/MOC, MRO/CTX and the MO/THEMIS instruments with imaging dates ranging from 1996 to the present. For the MEx/HRSC data, we already maintain a database which we automatically update with custom software based on the VICAR environment [6].

**Web Map Service with time support:** The [MapServer](#) software is connected to the database and provides Web Map Services (WMS) with time support based on the START\_TIME image attribute. It allows temporal WMS GetMap requests by setting additional TIME parameter values in the request. The values for the parameter represent an interval defined by its lower and upper bounds. As the WMS time standard only supports one time variable, only the start times of the images are considered. If no time values are submitted with the request, the full time range of all images is assumed as the default.

**Dynamic single image WMS:** To compare images from different acquisition times at sites of multiple coverage, we have to load every image as a single WMS

layer. Due to the vast amount of single images we need a way to set up the layers in a dynamic way – the map server does not know the images to be served beforehand. We use the MapScript interface to dynamically access MapServer's objects and configure the file name and path of the requested image in the map configuration. The layers are created on-the-fly each representing only one single image. On the frontend side, the vendor-specific WMS request parameter (PRODUCTID) has to be appended to the regular set of WMS parameters. The request is then passed on to the MapScript instance.

**Web Map Tile Cache:** In order to speed up access of the WMS requests, a [MapCache](#) instance has been integrated in the pipeline. As it is not aware of the available PDS product IDs which will be queried, the PRODUCTID parameter is configured as an additional dimension of the cache. The complete data flow of the described WMS request and its response is shown in Figure 1.

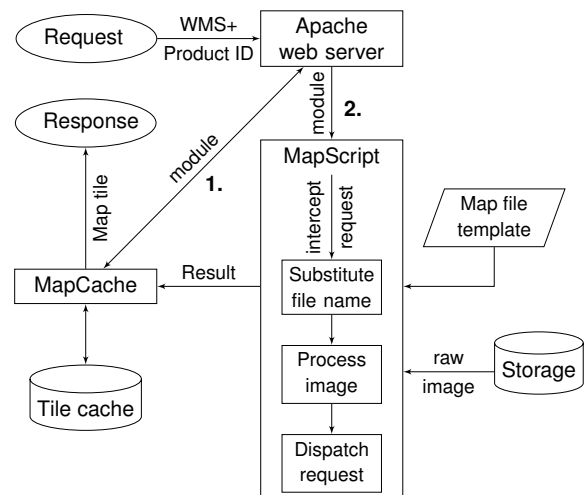


Figure 1: Diagram of the data workflow from the dynamic single-image WMS request to cache lookup to image processing and tile return. The numbers represent possible process paths as explained in the text.

The WMS request is received by the Apache web-server configured with the MapCache module. If the tile is available in the tile cache, it is immediately committed to the client (following path 1 in Fig. 1). If not available, the tile request is forwarded to Apache and the MapScript module (following path 2). The Python script intercepts the WMS request and extracts the product ID from the parameter chain. It loads the layer object from the map file and appends the file name and path of the inquired image. After some possible further image processing in-

side the script (stretching, color matching), the request is submitted to the MapServer backend which in turn delivers the response back to the MapCache instance.

**Web frontend:** We have implemented a web-GIS frontend based on various [OpenLayers](#) components. The basemap is a global color-hillshaded HRSC bundle-adjusted DTM mosaic with a resolution of 50 m per pixel. The new bundle-block-adjusted quadrangle mosaics of the MC-11 quadrangle, both image and DTM, are included with opacity slider options. The layer user interface has been adapted on the base of the [ol3-layerswitcher](#) and extended by foldable and switchable groups, layer sorting (by resolution, by time and alphabetically) and reordering (drag-and-drop). A collapsible time panel accommodates a time slider interface where the user can filter the visible data by a range of Mars or Earth dates and/or by solar longitudes. The visualization of time-series of single images is controlled by a specific toolbar enabling the workflow of image selection (by point or bounding box), dynamic image loading and playback of single images in a video player-like environment (Figure 2). During a stress-test campaign we could

demonstrate that the system is capable of serving up to 10 simultaneous users on its current lightweight development hardware. It is planned to relocate the software to more powerful hardware by the time of this conference.

**Conclusions/Outlook:** The iMars webGIS is an expert tool for the detection and visualization of surface changes. We demonstrate a technique to dynamically retrieve and display single images based on the time-series structure of the data. Together with the multi-temporal database and its MapServer/MapCache backend it provides a stable and high performance environment for the dissemination of the various iMars products.

**Acknowledgements:** This research has received funding from the EU's FP7 Programme under iMars 607379 and by the German Space Agency (DLR Bonn), grant 50 QM 1301 (HRSC on Mars Express).

**References:** [1] S. H. G. Walter et al., LPSC, 45, 2014, #1088. [2] J.-P. Muller et al., *ISPRS* 41B4 (2016), 453–458. [3] G. G. Michael et al., *PSS* 121 (2016), 18–26. [4] K. Gwinner et al., *PSS* 126 (2016), 93–138. [5] K. Gwinner et al., *EPSL* 294 (2010), 506–519. [6] S. H. G. Walter et al., EPSC 2006, 2006, #508.

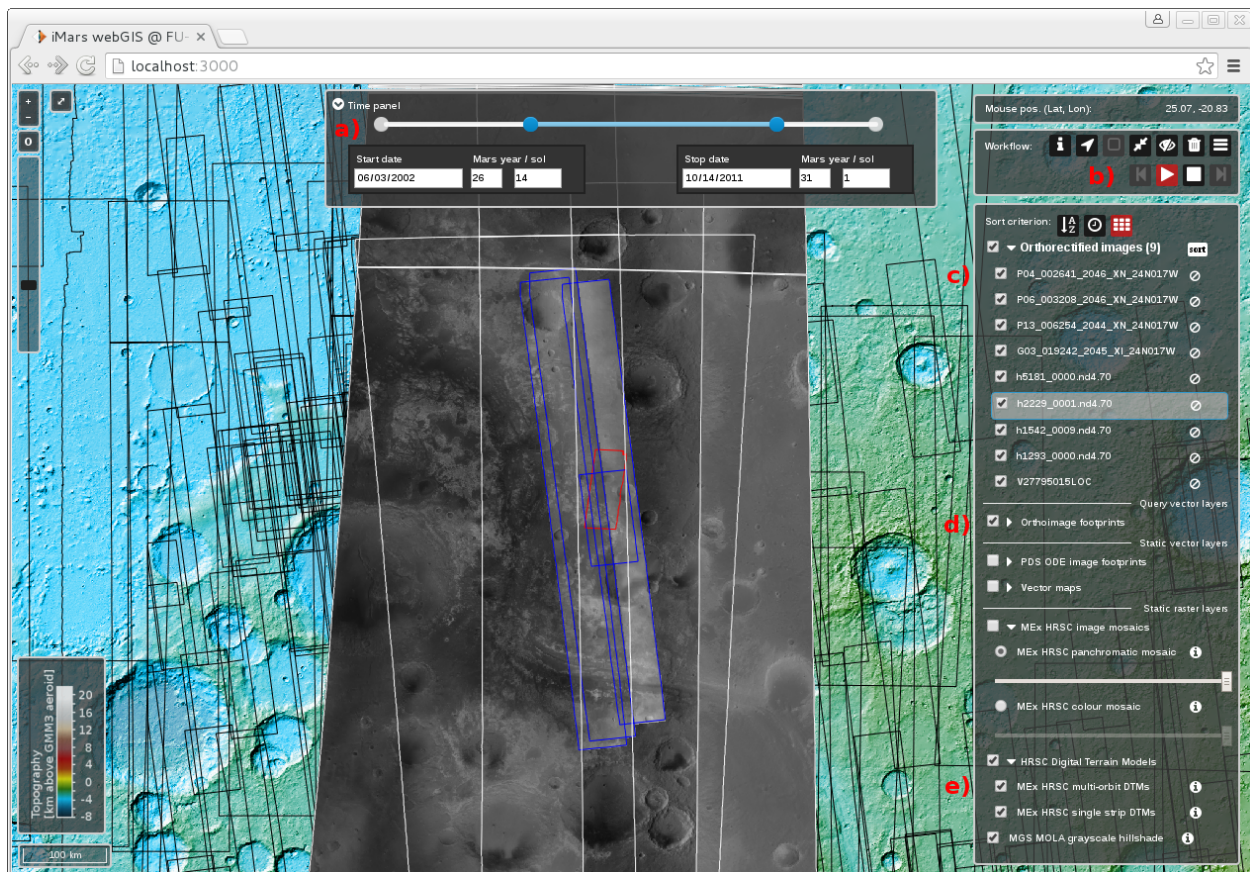


Figure 2: The iMars webGIS frontend with time selection panel (a), video toolbar (b) and extended layer menu showing dynamic single-image layers (c), footprint query layers (d) with time support and topographic base maps (e). The ortho-images visible in grayscale are loaded separately as single superimposed images and can be animated by alternation (play-button).