MARSSI: MARTIAN SURFACE DATA PROCESSING SERVICE. M. Volat[1] and C. Quantin-Nataf[1] and L. Mandon[1] and P. Thollot[1], [1]Univ Lyon, Observatoire, F-69622, LYON, France (matthieu.volat@univ-lyon1.fr)

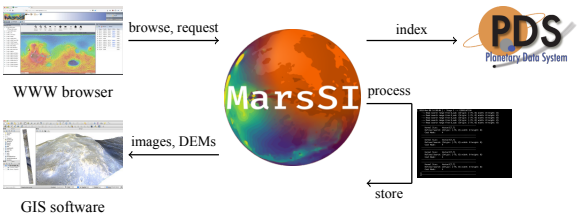

Figure 1: MarsSI overview

Abstract: *MarsSI ("Mars Système d'Information", French for Mars Information System) is a platform and service to catalog, process and retrieve data from orbiters.* `https://marssi.univ-lyon1.fr/MarsSI`.

Introduction: Geological investigations of planetary surfaces require the combination of orbital datasets. Missions being often multiple-instruments platforms from multiple space agencies, the quantity of data available increased quickly. It is now large enough that a dedicated system has to be used to explore, calibrate, process and retrieve the relevant information.

MarsSI [1] is a platform to help find and process Mars orbital data. Originaly developed in the context of the e-Mars project (2012-2017) funded by the European Research Council, it was certified in 2017 as french national Research Infrastructure by the Centre National de la Recherche Scientifique (CNRS) as part of the Planetary Surface Portal (PSUP) [2]. The staff currently consists of one scientist and one engineer.

User interface: MarsSI client interface is a web application that aims to be as straightforward as possible. As shown on figure 2, the user is provided a map based interface where available products are displayed as footprints. The user can browse and select data from here. A workspace view, shown on figure 3, allows the user to better review product selection individually. This is also the view where user will be able to request dataset processing.

All MarsSI proposed pipelines are fully automated and do not require user parametrization. This allows us to keep our global catalog reasonable and have only one version of a single product at a time, that is shared between all users.

To retrieve a product, the user will request a copy operation to its home directory, where it will be available for 30 days through SFTP access (the product is kept can be copied again after this).

Data & pipelines: As of 2021, MarsSI indexes and give access to the optical data (visible, multi and hyper-spectral) and derived products from three missions: Mars Odyssey, Mars Express and Mars Reconnaissance Orbiter. Figure 4 shows all the referenced products and the processing that can be applied to them. Our emphasis was to provide "ready-to-use" products in regards of calibration, refinements and georeferencing. The user will be able to visualize and interpret the data in GIS or remote sensing software.

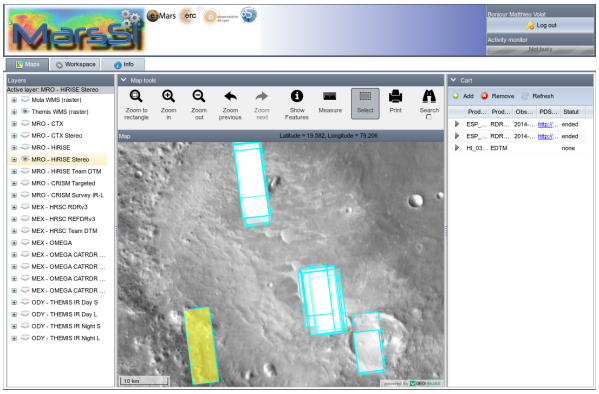

Figure 2: MarsSI web interface map view. The left panel is a layer list from which the user can choose instrument footprints to display on the central map. Here, we displayed HiRISE DEM footprints over a THEMIS-Day background. The datasets can be selected and added to a user cart, whose content is listed on the right panel. When the user is done with selection, he can proceed to the workspace view.

Imagery. MarsSI provides access to various optical datasets for visible, multi- and hyper-spectral data from the various martian orbital missions over the years. For example, for the MRO mission, CTX and HiRISE images are calibrated and map projected using the ISIS software suite (`https://isis.astrogeology.usgs.gov/`). CRISM hyperspectral data is processed using the CRISM Analysis Toolkit (CAT) pipeline developed by the CRISM team [3][4]. Spectral cubes are calibrated to I/F and corrected from the atmospheric contribution with the volcano-scan method [5] and spectral parameter maps are produced.

DEMs. We offer multiple Digital Elevation Model (DEM) datasets in MarsSI. Some of them are provided from external sources (such as those provided by the HiRISE and HSRC teams). But users can also requests med- and high- resolution DEMs generated using the Ames Stereo Pipeline software [6]. Possible DEMs are computed by analyzing the CTX and HiRISE coverage footprints to find image pairs with overlapping by at least

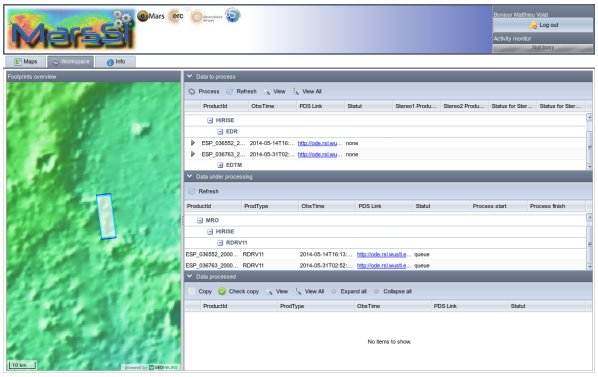

Figure 3: MarsSI web workspace view. Here the user can see the status of the data in the cart and trigger download and processing depending on the products types. Once the products reach a final state, the user can request a copy of the data to its home directory and retrieve them using an SFTP client.

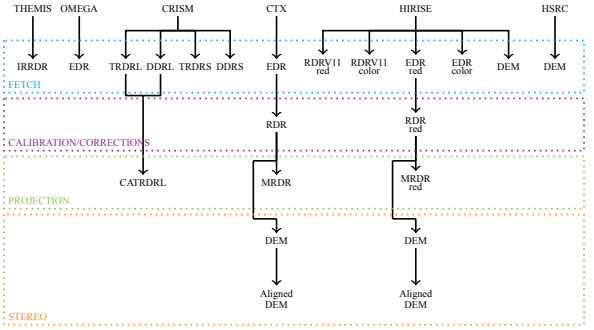

Figure 4: Data pipelines. MarsSI defines four levels of processing for the products it indexes. Level 0 is products fetched from sources such as PDS. Level 1 are products that measurements have been reprocessed, level 2 are products that have been georeferenced. Level 3 are products derived from combination of other products, such as creating DEMs from optical imagery.

60% and a minimum deviation of 10° in emission angle. While these products are the results of automated procedures and cannot benefit from human quality control and fine tuning, they do provide much larger coverage of Mars surface: HiRISE team provided DEMs cover 0.04% of Mars surface, while MarsSI HiRISE-based DEMs cover 3.84% and CTX-based DEMs 16.93%. It is of note that we rewrote this procedure in 2020 with a new approach described in a publication to be submitted soon.

Infrastructure: Hosted at the Ecole Normale de Lyon, MarsSI infrastructure is composed of a frontend server, a storage server and bay and four computing nodes, totaling 80 cores. For the software stack, we decided to rely mainly on software provided by the Free and Open-source communities and standard and documented protocols such as those proposed by the Open Geospatial Consortium (`http://www.opengeospatial.org/`).

Documentation: MarsSI is documented through a wiki that offer interface, pipelines and products descriptions, a FAQ section. There are also video tutorials.

User community: MarsSI is open to the worldwide scientific community. As of december 2020, we count 215 registered users across 128 institutes. Since it is a french service, 25% of the users are from France, but we also offer data to scientists from the USA, UK, India and China.

Perspectives: We are currently working on integrating other data types in MarsSI, such as the MARSIS and SHARRAD radar datasets.

Another aspect we are working on is a more efficient and intuitive web interface not based on Geomajas. The rewrite would also take into account other maps such as polar projections and other planetary bodies. Another improvement would be to offer product download through the web interface.

Conclusion: Built upon opensource frameworks and using standardized protocols, MarsSI offers the scientific communities an easy way to process data, most notably DEMs that can be derived from CTX and HiRISE data collection. We are now looking to modernize and extend the service with a newer interface that can present other planets and moons data.

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References: [1] C. Quantin-Nataf et al. In: *Planetary and Space Science* 150 (2018). [2] F. Poulet et al. In: *Planetary and Space Science* 150 (2018). [3] S. Pelkey et al. In: *Journal of Geophysical Research: Planets* 112.E8 (2007). [4] S. Murchie et al. In: *Journal of Geophysical Research: Planets* 112.E5 (2007). [5] P. C. McGuire et al. In: *Planetary and Space Science* 57.7 (2009). [6] Z. M. Moratto et al. In: *Lunar and Planetary Science Conference*. Vol. 41. 2010.