



# MarsSI

## Martian surface data processing service

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PSIDA 2022, 21-23 June 2022, Villanueva de la Cañada, Madrid, Spain

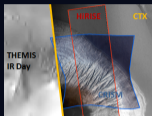
<sup>1</sup>Observatoire de Lyon, Université de Lyon

# Introduction

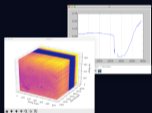
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# Scope statement

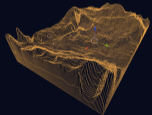
## Mars geological investigations requirements



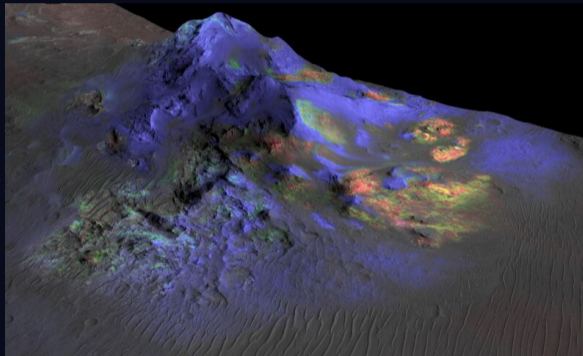
Imagery



Composition

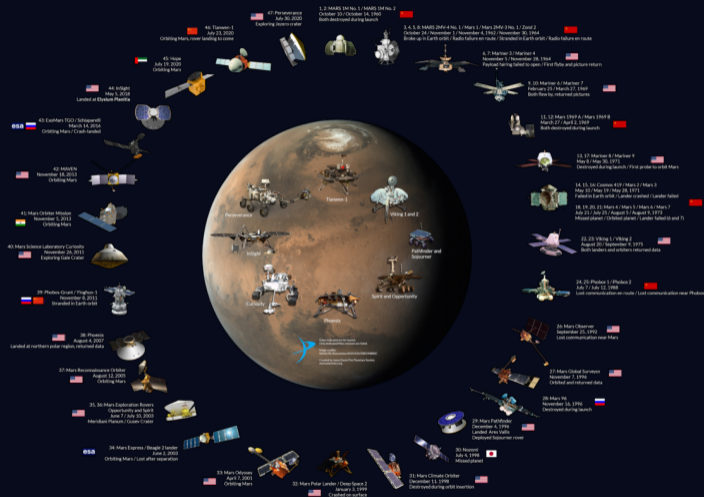


Topography

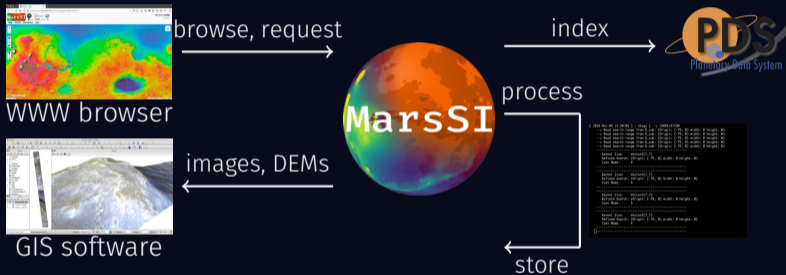


HiRISE DEM + CRISM parameters  
central peak of martian crater

# Mars exploration family portrait



# MarsSI: A tool to help explore and process martian orbital data

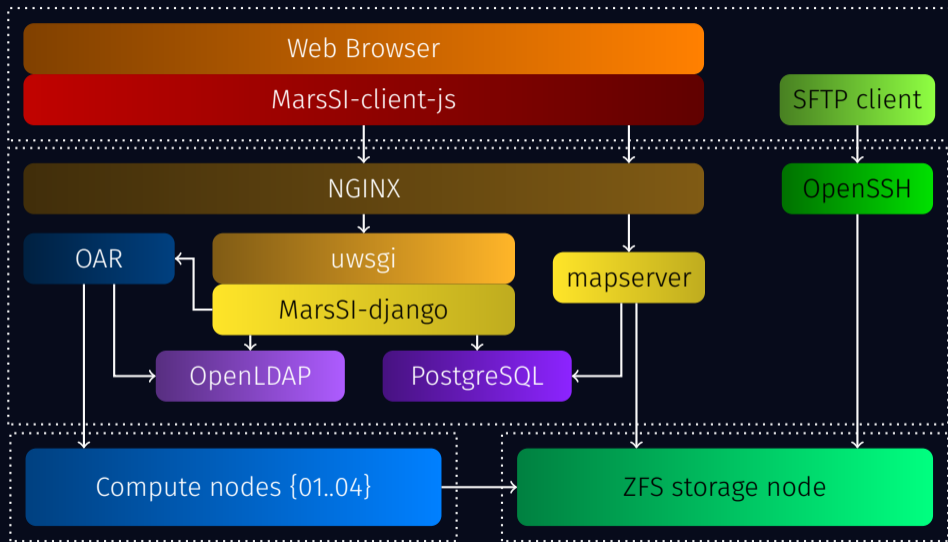


<https://marssi.univ-lyon1.fr/>

# The platform

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# A closer look to the infrastructure



## Post-2018 evolutions

Component	Previous	New
Web client framework	Geomajas/GWT	Leaflet, DataTables
Web backend framework	Geomajas/Servlets	Django
OGC server	Geoserver	MapServer
User auth	Table in PostgreSQL	OpenLDAP+Authelia
Batch scheduler	Torque	OAR
Monitoring	PHD student	Nagios

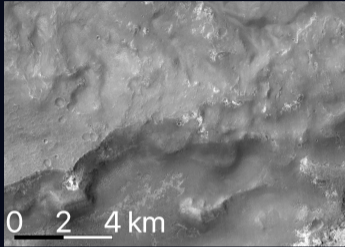


# Using the Open Geospatial Consortium (OGC) standards

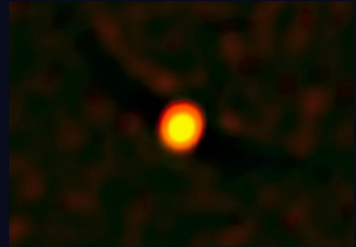
## Earth, planetology and astronomy observations:



Earth, Sentinel-2B



Mars, CTX



HIP 65426b, SPHERE

We're in the "space exploration" category, but it's really more like earth observation

**OGC** (<https://www.ogc.org/>) is well suited for our needs:

- Projections, formats (raster, vector), network protocols
- Multiple implementations
- Interoperability with GIS



## The service

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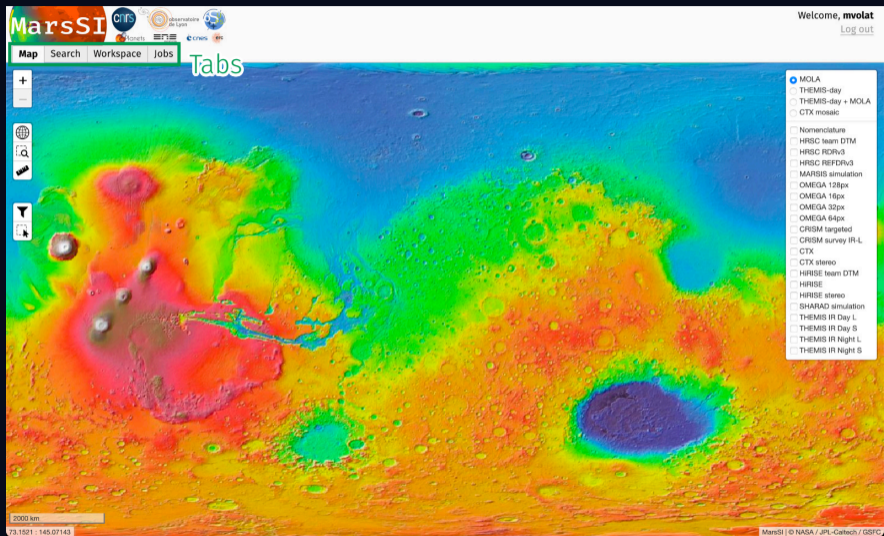
# Map view: exploring & selecting data

The screenshot displays the MarsSI web application interface. At the top, the logo "MarsSI" is visible alongside logos for "e-Mars", "erc", "observatoire de Lyon", and "OS". The text "Map tools" is written in green above the toolbar. The top right corner shows a user greeting "Bonjour Lucia Mandon", a "Log out" button, and an "Activity monitor" showing "Not busy".

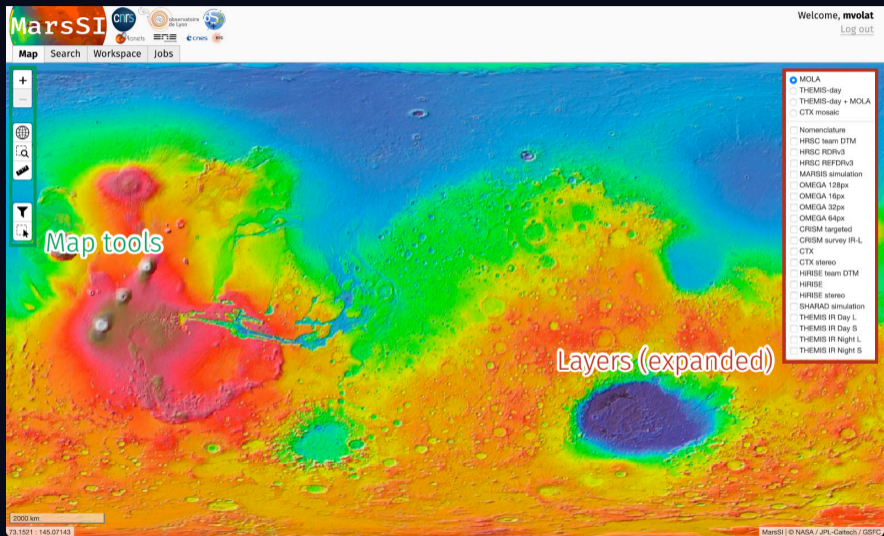
The main interface is divided into three main sections:

- Layers (left):** A list of data layers with a red border. The active layer is "none". The list includes:
  - Mola WMS (raster)
  - Themis WMS (raster)
  - MRO - CTX
  - MRO - CTX Stereo
  - MRO - HIRISE
  - MRO - HiRISE Stereo
  - MRO - HiRISE Team DTM
  - MRO - CRISM Targeted
  - MRO - CRISM Survey IR-L
  - MEX - HRSC RDRv3
  - MEX - HRSC REFDRv3
  - MEX - HRSC Team DTM
  - MEX - OMEGA
  - MEX - OMEGA CATRDR 128px
  - MEX - OMEGA CATRDR 64px
  - MEX - OMEGA CATRDR 32px
  - MEX - OMEGA CATRDR 16px
  - ODY - THEMIS IR Day S
  - ODY - THEMIS IR Day L
  - ODY - THEMIS IR Night S
  - ODY - THEMIS IR Night L
- Map tools (top center):** A toolbar with icons for:
  - Zoom to rectangle
  - Zoom in
  - Zoom out
  - Zoom previous
  - Zoom next
  - Show Features
  - Measure
  - Select
  - Print
  - Search
- Map (center):** A topographic map of Mars with a color scale from blue (low elevation) to red (high elevation). A red arrow points to the "Layers" list. The map shows a large crater in the lower right. Coordinates are Latitude = 73.619, Longitude = 250.728. A scale bar indicates 2,000 km. The text "powered by geomajas" is at the bottom right.
- Cart (right):** A panel titled "Cart" with a blue border. It contains a table of data with columns "Product", "ProdTy", "ObsTim", "PDS", "Lir", and "Statut". The table lists several "MARS" entries under the "HRSC" category, all with "ended" status and a "http://oc" link.

# Map view: exploring & selecting data



# Map view: exploring & selecting data



# Map view: exploring & selecting data

The screenshot displays the MarsSI web application interface. At the top, there are logos for Mars, ERC, and Observatoire de Lyon. A user greeting "Bonjour Matthieu Volat" and a "Log out" button are visible in the top right. Below the navigation tabs (Maps, Workspace, Info), the interface is divided into three main sections:

- Layers:** A list of data layers including MOLA (background), THEMIS-day (background), THEMIS-day (backgr...), MRO - CTX, MRO - CTX Stereo (selected), All Polygons, MRO - HIRISE, MRO - HIRISE Stereo, MRO - HIRISE Team DTM, MRO - CRISM Targeted, MRO - CRISM Survey IR-L, MEX - HRSC RDRv3, MEX - HRSC REFDRv3, MEX - HRSC Team DTM, MEX - OMEGA, MEX - OMEGA CATRDR..., MEX - OMEGA CATRDR..., MEX - OMEGA CATRDR..., MEX - OMEGA CATRDR..., MEX - OMEGA CATRDR..., ODY - THEMIS IR Day S, ODY - THEMIS IR Day L, ODY - THEMIS IR Night S, and ODY - THEMIS IR Night L.
- Map tools:** A toolbar with icons for "Zoom to rectangle", "Zoom in", "Zoom out", "Zoom previous", "Zoom next", "Show Features", "Measure", "Select", "Print", and "Search".
- Map:** A grayscale map of Mars with several yellow rectangular selection boxes overlaid. The map shows the surface with craters and terrain. A scale bar indicates 75 km. The current coordinates are Latitude = 16.217, Longitude = 333.033.
- Cart:** A table listing data products with columns for "Produ...", "ProdT...", "ObsTi...", "PDS ...", and "Statut".

Produ...	ProdT...	ObsTi...	PDS ...	Statut
▶ G03_0...	EDR	2010-0...	<a href="#">http://o...</a>	ended
▶ G02_0...	EDR	2010-0...	<a href="#">http://o...</a>	ended
▶ CTX_0...	EDTM	22T14:...		ended
▶ F05_0...	EDR	2014-0...	<a href="#">http://o...</a>	ended
▶ CTX_0...	EDTM			ended
▶ J04_0...	EDR	2016-0...	<a href="#">http://o...</a>	ended
▶ CTX_0...	EDTM			ended
▶ F03_0...	EDR	2014-0...	<a href="#">http://o...</a>	ended
▶ F05_0...	EDR	2014-0...	<a href="#">http://o...</a>	ended
▶ CTX_0...	EDTM			ended
▶ K06_0...	EDR	2018-0...	<a href="#">http://o...</a>	ended
▶ CTX_0...	EDTM			none
▶ CTX_0...	EDTM			none

# Map view: exploring & selecting data

The screenshot displays the MarsSI web interface. The main map shows a topographic view of Mars with several yellow rectangular selection boxes overlaid. A small white dialog box is centered on the map with the text "Add selection to workspace" and "Clear selection". On the left side, there are navigation controls including zoom in (+), zoom out (-), a globe icon, a search icon, and a "Finish Clear Cancel" button. The top navigation bar includes "Map", "Search", "Workspace", and "Jobs". The right sidebar shows a data table for a selected feature.

Map Search Workspace Jobs

Finish Clear Cancel

Add selection to workspace  
Clear selection

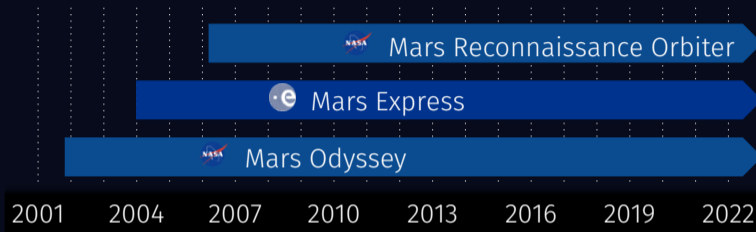
10 km  
18.57787 -23.95815

MarsSI © NASA / JPL-Caltech / GSFC, © OSUL / NASA / JPL-Caltech / ASU

Welcome, mvolat  
[Log out](#)

HI_041422_1985_051839_1985	
gid	619737
centerlat	18.1561
centerlon	-24.036839
maxlat	18.2326
minlat	18.079574
eastlon	-23.983
westlon	-24.09085
emangle	
inangle	
phangle	
sollong	
npolestate	
spolestate	
target	MARS
productid	HI_041422_1985_051839_1985
datasetid	
insthstid	MRO
instid	HIRISE
utcstart	
utcend	
pdsolid	
prodtype	DEM
createdate	
shpsource	
exturl	
ext2url	
ext3url	
produrl	
filesurl	
labelurl	

# Instruments we use data from and their timelines



ODY : Themis<sup>2</sup>

MEX : HRSC<sup>1</sup>, OMEGA<sup>3</sup>

MRO : CRISM<sup>3</sup>, CTX<sup>1</sup>, HiRISE<sup>1</sup>

<sup>1</sup>Regular grayscale/color imagery

<sup>2</sup>Infrared imagery

<sup>3</sup>Hyperspectral imagery



# Workspace view: request data & processing

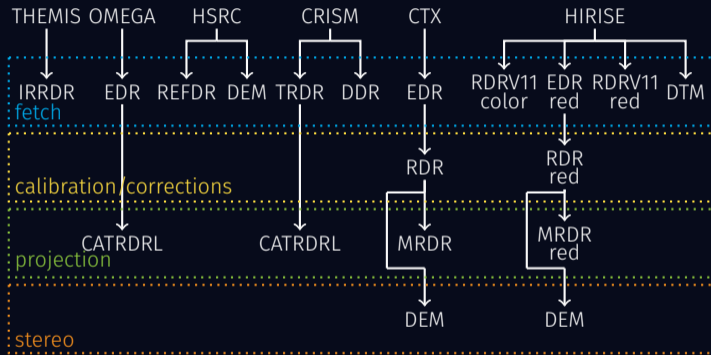
The screenshot displays the MarsSI workspace interface. At the top, there are navigation tabs for 'Map', 'Search', 'Workspace', and 'lobs'. The 'Workspace' tab is active. Below the navigation, there are buttons for 'Select all', 'Select none', 'Remove selected', 'Process selected', and 'Copy selected'. The 'Process selected' button is highlighted with a green box. A green text overlay reads 'Select products & click process'. The main content area shows a table with columns for 'DATASET', 'INSTRUMENT', 'OBSERVATION TIME', and 'PRODUCTS'. The 'PRODUCTS' column is highlighted with a red box, and a red text overlay reads 'State of (sub)products'. Below the table, there is a 'product processing status' section with a legend: 'to-be-requested', 'queued', 'running', 'done', and 'error'. The interface also includes a search bar, a 'Show 25 entries' dropdown, and pagination controls for 'Previous', '1', and 'Next'.

DATASET	INSTRUMENT	OBSERVATION TIME	PRODUCTS
<input type="checkbox"/> CTX_027009_1981_033668_1969	CTX	None	EDTM
<input type="checkbox"/> D17_033668_1969_XI_16N025W	CTX	2013-10-01T22:48:41.645	EDR, RDR, MRDR
<input type="checkbox"/> ESP_028130_1975	HIRISE	2012-07-27T09:47:53.117	COLOR-EDR, RED-EDR, RED-RDR, RED-MRDR, COLOR-RDRV11, RED-RDRV11
<input type="checkbox"/> ESP_061202_1980	HIRISE	2019-08-17T08:31:19.145	COLOR-EDR, RED-EDR, RED-RDR, RED-MRDR, COLOR-RDRV11, RED-RDRV11
<input type="checkbox"/> FRS000451EE	CRISM	2017-10-12T07:20:50.440	01_IF125S-TRDR, 01_DE125S-DDR
<input type="checkbox"/> HI_044257_1980_061202_1980	HIRISE	None	RED-EDTM

Showing 1 to 6 of 6 entries

product processing status: to-be-requested, queued, running, done, error

# Data and pipelines



CRISM processing: CAT, Optical calibration/projection: ISIS, DEM: Ames Stereopipeline

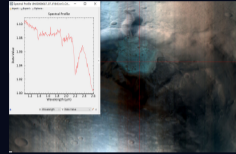
# A bit more about our processing

## CRISM (**hyperspectral data cubes**)

Use Hopkin CRISM Analysis Toolkit for:

- Calibration
- Atmosphere, destripe, despoke
- Map-projection

Compute **Spectral parameter maps**



*Spectrum & parameter map used in silica search, Pan et al. 2020*

# A bit more about our processing

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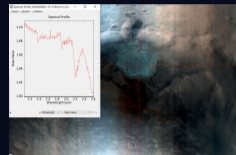
Compute **Spectral parameter maps**

## DEMs (CTX & HiRISE, updated in 2020)

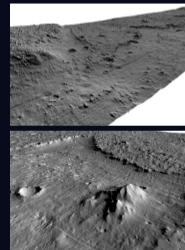
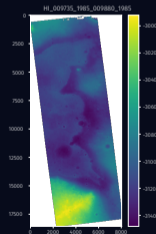
**Stereophotogrammetry** using ASP:

- 2 step workflow
- output aligned to MOLA

**Mosaics** of DEM/orthoimages were used in ESA's Exomars 2022 **mapping** exercise of Oxia Planum.



*Spectrum & parameter map used in silica search, Pan et al. 2020*



# Some more information

## Idea of the scale

- 450 users
- 58.1To of data (we compress)
- 6825 CTX DEMs, 865 HiRISE DEMs already done

## Documentation/Help/Tutorials



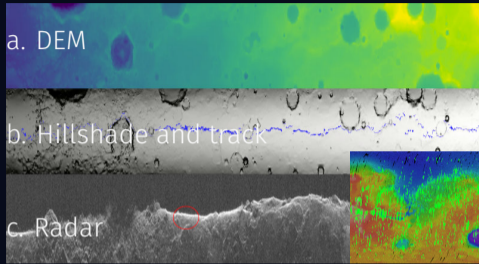
We use a **wiki**:

- Navigable
- Searchable
- Collaborative effort

And some tutorial videos to get you started!

## Perspectives, conclusion

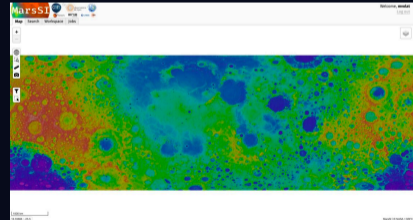
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## Surface clutter simulation

MarsSI would compute **surface clutter simulations**, useful to interpret real radar acquisitions.

Partnership w/ Y. Rogez, A. Herique<sup>1</sup>



## Other planets/moons

Allow to display the moon, titan or venus?

<sup>1</sup>Institut de Planétologie et d'Astrophysique de Grenoble

# Conclusion

How can **MarsSI** help:

- **Finding data** in the mass of available products
- **Process** (not an expert? have no cluster?)
- **Refer/point/share** what you used

Challenges

- **Expertise** to handle other data types (collaborations!!)
- Keep and improve the **platform**
- Not being (re)viewed as an astronomy service



<https://marssi.univ-lyon1.fr/>