



# MarsSI

## Martian surface data processing application

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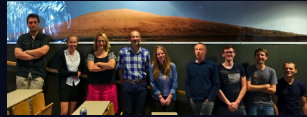
Matthieu Volat <sup>1</sup> Cathy Quantin-Nataf <sup>1</sup>  
rdatadev session , 15 November 2019, Grenoble

<sup>1</sup>Université de Lyon

## Service overview

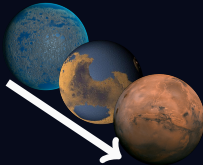
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## Planetology research in Lyon

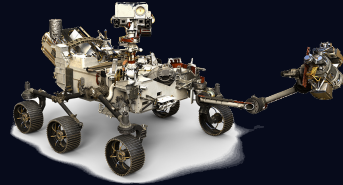


## Fields of interest

Geological Evolution of Mars



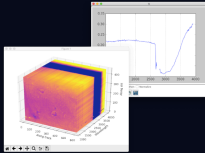
Future landing missions



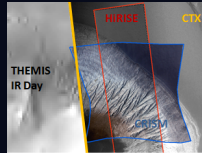
# Scope statement

## Geological investigation requirements

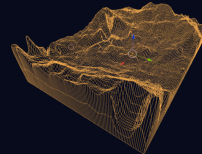
### Composition



### Imagery



### Topography



## For a martian data service

- Geographical **search**
- **Index** agencies catalogs
- **Data**-specific pipelines
- **Automated** processing
- **GIS**-ready products
- Results available for **all**

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



## 2011 - 2016: e-Mars ERC project

- MarsSI birth: developed by L. Lozach, C. Quantin-Nataf
- Demoed at EPSC 2015, LPSC 2016
- Quantin-Nataf et Al. 2018 in *Planetary and Space Science Vol 150*

## 2016 - present: Planetary SURface Portal (PSUP)

- Promoted to CNRS national observation service
- Permanent engineer attached to the project (M. Volat)

# Noteworthy uses

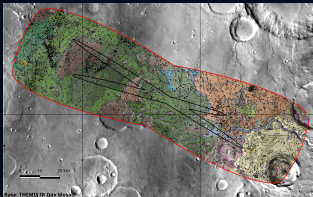
## 2015: Mark Watney's Epic Trek on Mars

*Follow Watney's intended path from Acidalia Planitia to Schiaparelli with NASA's Mars Trek<sup>1</sup> web tool!*

The topology was computed using MarsSI.



## 2018: MarsSI helps surveying Exomars landing site candidates



MarsSI was also used to provide data to the scientists surveying the Oxia Planum landing site that was selected. It was also used by Thales engineers to review navigability in both proposals.

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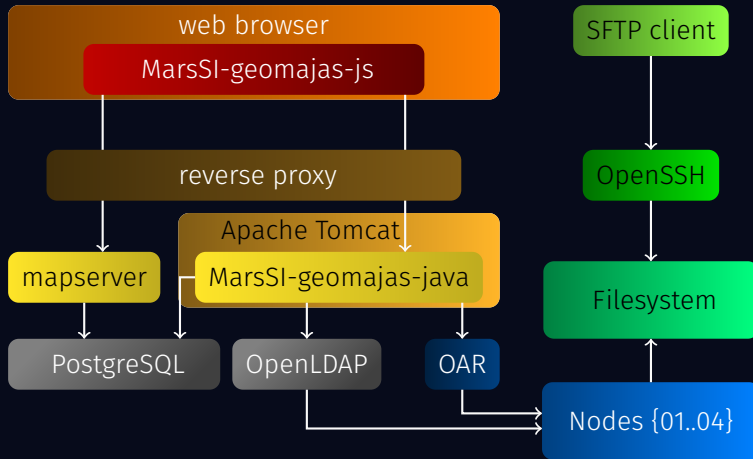
<sup>1</sup><https://trek.nasa.gov/mars/>

## The platform

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## A closer look to the infrastructure



# Working with the OGC standards

## The Open Geospatial Consortium (OGC)

*An international not for profit organization committed to making quality open standards for the global geospatial community.*



<http://www.opengeospatial.org/>

## Why use those in planetary science?

- Define **formats** (raster, vector), processing, **network** protocols
- Multiple **implementations** to work with
- Subject closer to earth sciences than deep space observation
- Widely interoperable range of **GIS** products

## TODOs

**EPSG** codes projections only: propose also using **IAU** codes

# Available data sources

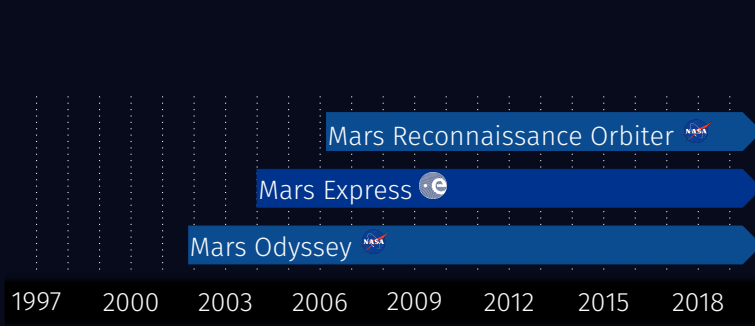
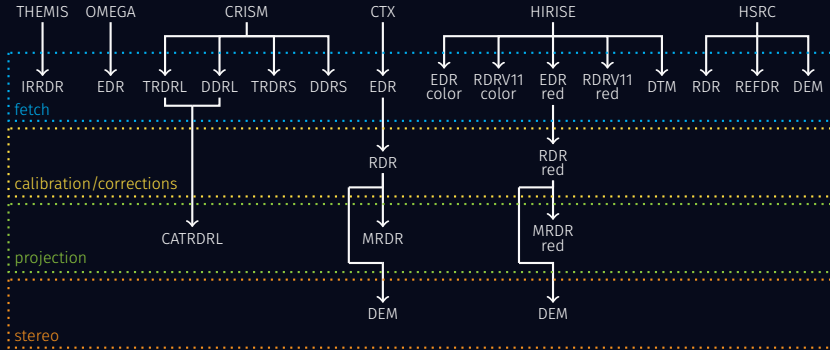


Figure: Missions we use **orbital data** from and their timelines

# Data and pipelines



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

# A few numbers regarding data

## Database:

- 50k HRSC, 103k CTX, 119k HiRISE
- 9k HRSC-DEM, 110k CTX-DEM, 53k HiRISE-DEM, 592 HiRISETeam-DEM
- 27k OMEGA, 172k CRISM

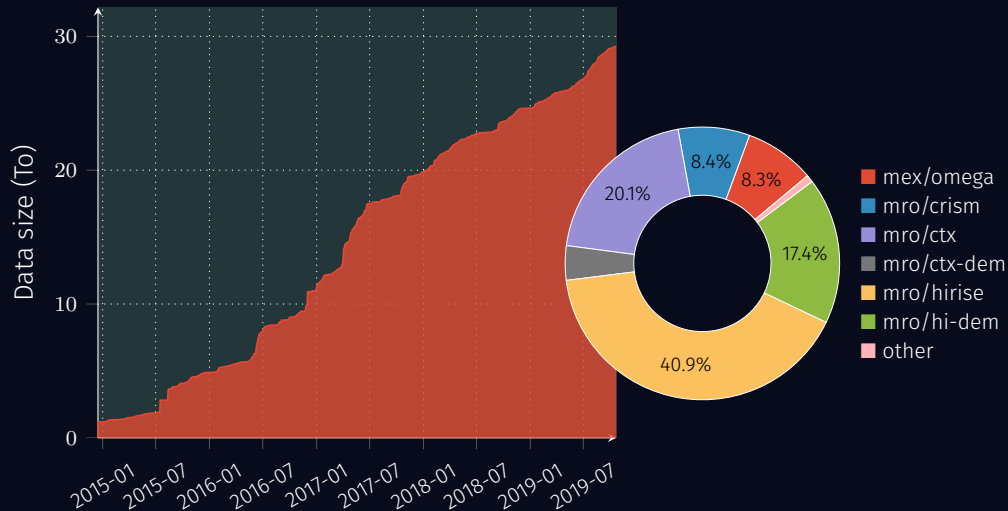
## Coverage for (potential) DEMs:

- CTX-based: 16.93%
- HiRISE-based: 0.27% (HiRISE team DTMs: 0.04%)

# Storage

## Configuration

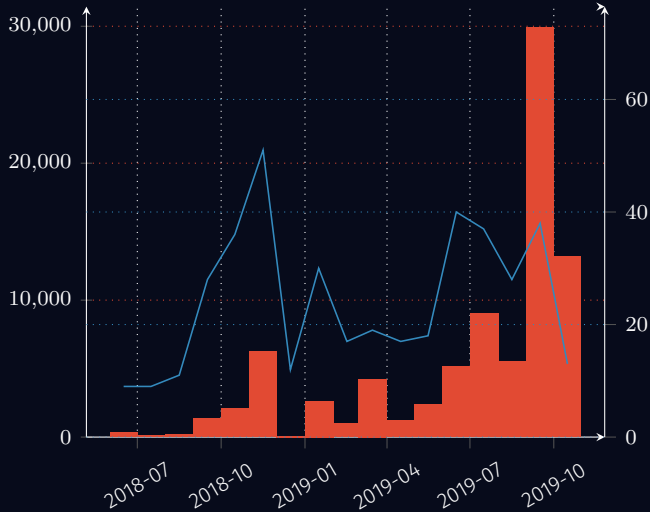
35TB raid nearline sas array + 35TB raid sas array



# The cluster

## Hardware & Operating system

4\*20 = 80 cores (Westmere), InfiniBand QDR, CentOS 6



## User interface

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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, along with navigation links for "Maps", "Workspace", and "About". A green arrow points to the "Map tools" section, which includes icons for "Zoom to rectangle", "Zoom in", "Zoom out", "Zoom previous", "Zoom next", "Show Features", "Measure", "Select", "Print", and "Search".

On the left, the "Layers" panel is highlighted with a red border and contains a list of data layers:

- Active layer: none
- 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

The central map area shows a topographic map of Mars with a scale bar indicating 2,000 km. The coordinates are Latitude = 73.619, Longitude = 250.728. A red arrow points to the "Layers" label on the map.

On the right, the "Cart" panel is highlighted with a blue border and contains a table of data:

Product	ProdTty	ObsTim	PDS Lir	Statut
MARS				
MRO				
HIRISE				
MEX				
HRSC				
H3081_DT	MRC	2006-06	<a href="http://oc">http://oc</a>	ended
H3081_DT	MRC	2006-06	<a href="http://oc">http://oc</a>	ended
H3081_DT	MRC	2006-06	<a href="http://oc">http://oc</a>	ended
H3081_DT	MRC	2006-06	<a href="http://oc">http://oc</a>	ended
H3081_DT	MRC	2006-06	<a href="http://oc">http://oc</a>	ended
H3081_DT	MRC	2006-06	<a href="http://oc">http://oc</a>	ended
H3081_DT	MRC	2006-06	<a href="http://oc">http://oc</a>	ended
H3081_DT	MRC	2006-06	<a href="http://oc">http://oc</a>	ended

The "Cart" panel also includes "Add", "Remove", and "Refresh" buttons. A blue arrow points to the "Cart" label on the map.

At the bottom right, it says "powered by geomajas".

# Map view: exploring & selecting data

The screenshot displays the Mars3D web application interface. At the top, there is a header with the Mars3D logo, navigation tabs for 'Maps', 'Workspace', and 'Info', and a user profile section for 'Benoit Mathieu Volat' with a 'Log out' button and an 'Activity monitor' showing 'Not busy'.

The main interface is divided into three panels:

- Layers:** A list of data layers on the left. The active layer is 'none'. The selected layer is 'MRO - CTX Stereo'. Other layers include MOLA (background), THEMIS-day (background), MRO - CTX, MRO - HRISE, MRO - HRISE Stereo, MRO - HRISE Team DTM, MRO - CRISM Targeted, MRO - CRISM Survey IR-L, MEX - HRSC RDRv3, MEX - HRSC REFDRv3, MEX - HRSC Team DTM, MEX - OMEGA, MEX - OMEGA CATDR..., MEX - OMEGA CATDR..., MEX - OMEGA CATDR..., MEX - OMEGA CATDR..., 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 central map view showing a grayscale image of the Martian surface with several yellow rectangular selection boxes overlaid. The map coordinates are 'Latitude = 16.217, Longitude = 333.033'. A scale bar indicates '75 km'.
- Cart:** A table on the right side of the interface, titled 'Cart', with columns for 'Produ...', 'ProdT...', 'ObsT...', 'PDS ...', and 'Statut'. The table contains 12 rows of data, each with a play button icon and a link.

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

# Map view: exploring & selecting data

The screenshot displays the MarsSI web application interface. At the top, there is a header with the MarsSI logo, navigation icons for Mars, erc, and other services, and a user profile for "Bonjour Mathieu Volat" with a "Log out" button and an "Activity monitor" link.

The main interface is divided into several sections:

- Layers:** A list of data layers on the left side, including "MOLA (background)", "THEMIS-day (background)", "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 CATDR...", "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 above the map with icons for "Zoom to rectangle", "Zoom in", "Zoom out", "Zoom previous", "Zoom next", "Show Features", "Measure", "Select", "Print", and "Search".
- Map:** A central grayscale map of Mars showing a cratered surface. A cluster of cyan rectangular polygons is visible in the center, with one highlighted in red. The map includes a scale bar for 75 km and coordinates: "Latitude = 16.217, Longitude = 333.033".
- Cart:** A table on the right side showing a list of data items with columns for "Produ...", "ProdT...", "ObsTi...", "PDS ...", and "Statut".

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

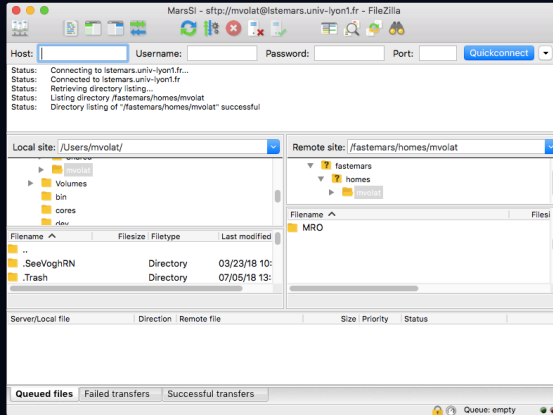
# Workspace view: request data & processing

The screenshot displays the MarsSi workspace interface. On the left is a 'Footprints overview' map with a cyan rectangular selection. The right side features three data processing panels:

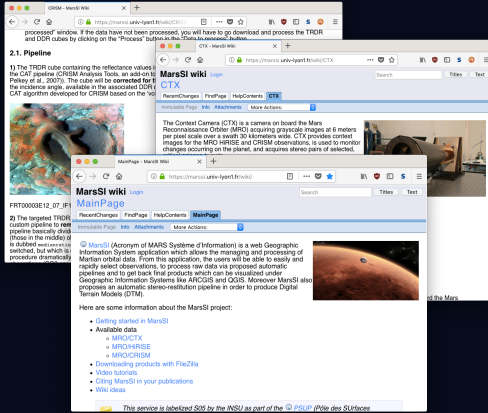
- Data to process:** A table with columns: ProductId, ObsTime, PDS Link, Statut, Stereo1 ProductId, Stereo2 ProductId, Status for Stereo, Status for Stereo2. It shows a tree view: MARS > MRO > HIRISE > ALEDTM. A yellow box highlights this section with the text 'Data to process'.
- Data under processing:** A table with columns: ProductId, ProdType, ObsTime, PDS Link, Statut, Process start, Process finish. It shows a tree view: MARS > MRO > HIRISE > EDTM. An orange box highlights this section with the text 'Data under processing'.
- Data processed:** A table with columns: ProductId, ProdType, ObsTime, PDS Link, Statut. It shows a tree view: HI\_037070\_1985\_037136\_1985 > HI\_037070\_1985\_037136\_1 EDTM (ended) > HI\_037070\_1985\_037136\_1 ALEDTM (ended) > PSP\_003195\_1985. A red box highlights this section with the text 'Data processed'.

At the bottom left of the map, there is a '10 km' scale bar and the text 'powered by geomajas'.

# Retrieving the products



# Documentation/Help/Tutorials



Originally a 23 pages PDF manual...

Now a wiki:

- Navigable
- Searchable
- Collaborative effort

Ongoing work

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# Hardware evolutions

## Moving the platform

Now hosted at LGL, moving to **ENS-Lyon** next year:

- Power supply management
- Fire suppression system
- Link upgrade (100Mb/s to 1Gb/s)

## New main server (under deployment/test)

32-cores AMD **Zen** v1-based, 128GB of memory

## New storage server (no funding yet)

JBOD based **ZFS**, no more hardware RAID, hello **snapshots**





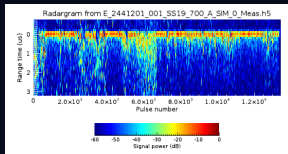
# Software evolutions

## Operating system migration (long overdue)

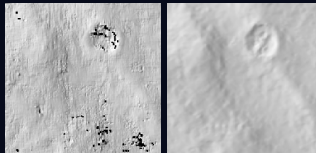
CentOS 6 -> **Devuan** 2.0 (Debian 9) yeah.

## Pipelines updates

- Radar simulation (IPAG partnership)
- DEM workflow/parameters rewrite



(a) A radargram



(b) Hillshade from current/new DEMs

### Geomajas-based web interface

Geomajas design issues, going nowhere<sup>2</sup>, increasingly buggy with newer browsers. Also java.

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<sup>2</sup>see FOSS4G 2016 presentation

## Geomajas-based web interface

Geomajas design issues, going nowhere<sup>2</sup>, increasingly buggy with newer browsers. Also java.

## New web interface

Using **Django** (Python web framework):

- Very **stable**/mature, helpful plugins
- **Customizable**, we won't follow its model too close
  - Url mapping, templating
  - Models, but not too much
- Mixed with javascript (**Leaflet** for maps)
- Production configured with uwsgi (nginx as http frontend)

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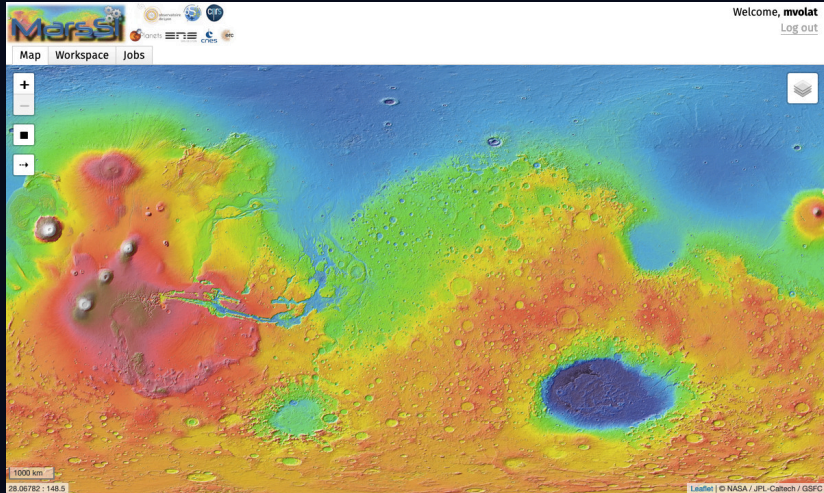
<sup>2</sup>see FOSS4G 2016 presentation

# Back to map view

The screenshot displays the MarsSi web application interface. At the top, the logo "MarsSi" is visible, along with navigation links for "Maps", "Workspace", and "About". The user's name "Bonjour Lucia Mandon" and a "Log out" button are in the top right corner. The main interface is divided into three panels:

- Layers Panel (left):** A list of map layers with expand/collapse icons. The "Active layer: none" is indicated. The layers include:
  - 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 Panel (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 Panel (center):** A topographic map of Mars. The current location is Latitude = 73.619, Longitude = 250.728. A scale bar indicates 2,000 km. The text "powered by geomajas" is at the bottom right.
- Cart Panel (right):** A table listing data in the cart. The table has columns: Product, ProdTty, ObsTim, PDS Lir, and Statut. The data includes:
  - MARS
  - MRO
  - HIRISE
  - MEX
  - HRSC
  - H3081\_ DTMRC 2006-0€ [http://oc](#) ended
  - H3081\_ DTMRC 2006-0€ [http://oc](#) ended
  - H3081\_ DTMRC 2006-0€ [http://oc](#) ended
  - H3081\_ DTMRC 2006-0€ [http://oc](#) ended
  - H3081\_ DTMRC 2006-0€ [http://oc](#) ended
  - H3081\_ DTMRC 2006-0€ [http://oc](#) ended
  - H3081\_ DTMRC 2006-0€ [http://oc](#) ended
  - H3081\_ DTMRC 2006-0€ [http://oc](#) ended

# Back to map view



# Back to map view

The screenshot displays the MarsSI web application interface. At the top left, the 'MarsSI' logo is accompanied by logos for NASA, ESA, and other partners. The top right corner shows a user greeting 'Welcome, mvolat' and a 'Log out' link. Below the header, there are navigation tabs for 'Map', 'Workspace', and 'Jobs'. The main area is a topographic map of Mars, color-coded by elevation, with a scale bar indicating 1000 km. The map is overlaid with several data layers, which are listed in a 'Layers' panel on the right. The 'Layers' panel includes options for MOLA, THEMIS-day, MOLAIS, CTX mosaic, CTX, CTX stereo, HIRISE, HIRISE team DTM, HIRISE stereo, CRISM targeted, CRISM survey IR-L, HRSC RDRv3, HRSC REFDRv3, HRSC team DTM, MARSIS simulation, and Nomenclature. The 'Map tools' panel on the left contains zoom in (+), zoom out (-), and a full-screen icon. The bottom right corner of the map area shows the 'Leaflet' logo and copyright information for NASA, JPL, Caltech, and GSFC.

Map tools

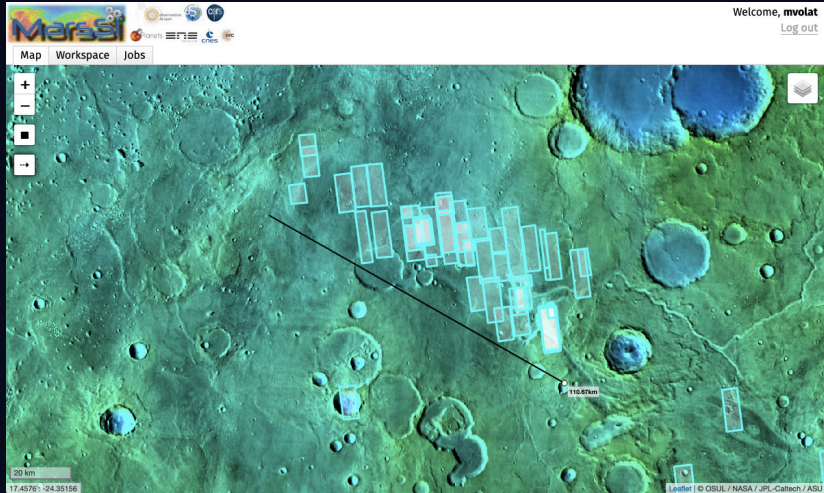
Layers

- MOLA
- THEMIS-day
- MOLAIS
- CTX mosaic
- CTX
- CTX stereo
- HIRISE
- HIRISE team DTM
- HIRISE stereo
- CRISM targeted
- CRISM survey IR-L
- HRSC RDRv3
- HRSC REFDRv3
- HRSC team DTM
- MARSIS simulation
- Nomenclature

1000 km  
68.34352 - 141.75

Leaflet | © NASA / JPL-Caltech / GSFC

# Back to map view



# Back to workspace/job view

Welcome, [mvolat](#)  
[Log out](#)

Map Workspace **Jobs**

Name	State	Submission time	Queue
<a href="#">stereo</a>	Running	2019-11-13 08:04:57	default
<a href="#">None</a>	Terminated	2019-11-12 09:43:14	default
<a href="#">mosaic_hirise</a>	Terminated	2019-11-12 09:08:06	default
<a href="#">stereo</a>	Running	2019-11-11 13:59:16	default
<a href="#">ESP_018412_2160_RED_RDR</a>	Terminated	2019-11-11 04:06:39	default
<a href="#">ESP_017700_2160_RED_RDR</a>	Terminated	2019-11-11 04:06:38	default
<a href="#">None</a>	Terminated	2019-11-10 19:54:57	default
<a href="#">DTEEC_042134_1985_053962_1985_L01</a>	Terminated	2019-11-10 14:07:10	download
<a href="#">DTEEC_039299_1985_047501_1985_L01</a>	Terminated	2019-11-10 14:07:10	download
<a href="#">DTEEC_037070_1985_037136_1985_L01</a>	Terminated	2019-11-10 14:07:09	download
<a href="#">DTEEC_009880_1985_009735_1985_L01</a>	Terminated	2019-11-10 14:07:09	download
<a href="#">DTEEC_003195_1985_002694_1985_L01</a>	Terminated	2019-11-10 14:07:08	download
<a href="#">DTEEC_036925_1985_037558_1985_L01</a>	Terminated	2019-11-10 14:07:08	download
<a href="#">ESP_018412_2160_RED</a>	Terminated	2019-11-10 12:20:08	download
<a href="#">ESP_017700_2160_RED</a>	Terminated	2019-11-10 12:20:08	download
<a href="#">ESP_013454_2160_RED</a>	Terminated	2019-11-10 12:20:07	download
<a href="#">ESP_018412_2160_RED_EDR</a>	Terminated	2019-11-10 12:20:06	download
<a href="#">ESP_017700_2160_RED_EDR</a>	Terminated	2019-11-10 12:20:06	download
<a href="#">ESP_013454_2160_RED_EDR</a>	Terminated	2019-11-10 12:20:06	download
<a href="#">DTEEC_034934_2155_034499_2155_A01</a>	Terminated	2019-11-10 12:19:29	copy
<a href="#">DTEEC_041277_2115_040776_2115_A01</a>	Terminated	2019-11-10 12:10:42	download
<a href="#">DTEEC_034934_2155_034499_2155_A01</a>	Terminated	2019-11-10 12:10:42	download
<a href="#">I10_048563_1344_XN_455215W</a>	Terminated	2019-11-09 18:57:11	download
<a href="#">mosaic_hirise</a>	Terminated	2019-11-09 15:46:13	default
<a href="#">mosaic_hirise</a>	Terminated	2019-11-09 15:43:19	default
<a href="#">FRT00009A7D</a>	Terminated	2019-11-08 16:30:42	copy



## Conclusion

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## A **stable** service

- No simple, but maintained by 1 engineer
- 258 registered users
- 3k CTX DEM products, 412 HiRISE DEMs

## Data expertise

Being an expert on everything looks hard: find collaborations

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

Thank you!