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OPERATING GUIDE FOR USING MATISSE FOR THE VISUALIZATION AND ANALYSIS OF PLANETARY MISSION DATA

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Documentazione di Riferimento

Identificativo	Nome esteso	Versione
DR-1		
DR-2		
DR-3		

DR-4		

1. ACCESSING THE TOOL

MATISSE can be accessed using the most common web browsers at the following URL:

https://tools.ssdc.asi.it/Matisse

After the homepage loads, the main interface of the tool appears, which includes the query panel. This panel allows users to select and configure the parameters required to filter the observations available in the database and identify datasets of interest.

2. DATASET SELECTION

In the query panel, it is possible to define the main parameters that characterize the dataset to be analyzed. The first step consists of selecting the planetary body of interest.

From the Target menu, the user can select the planet or celestial body on which the analysis will be performed; For example: Mercury.

Once the target has been selected, the Mission menu is automatically updated and displays the space missions available in MATISSE that have acquired data for that planetary body. For example: MESSENGER.

Next, from the Instrument menu, the user can choose the scientific instrument from which the data originates. This step further refines the search by restricting it to datasets produced by a specific instrument of the selected mission. For example: MDIS-NAC.

It is worthy to note that the Mission and Instrument menus allow multiple selection, where available.

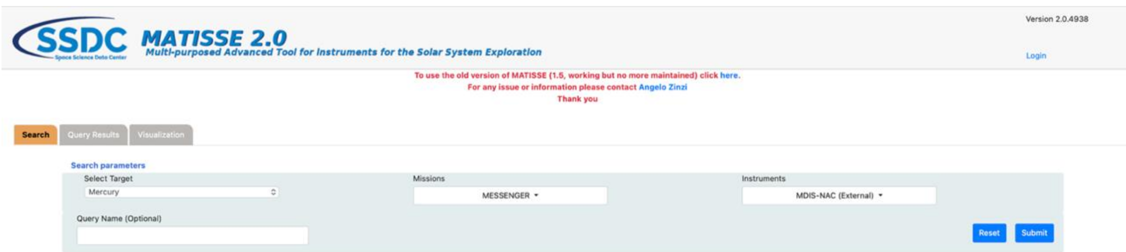


Figure 1. MATISSE main interface showing the query panel for selecting search parameters (Target, Mission, Instrument)

3. DEFINING THE AREA OF INTEREST

Once the target, mission, and instrument have been selected, it can be necessary to define the area of the planetary surface to be analyzed. MATISSE provides several methods for identifying and delimiting the study region, allowing the user to precisely select the area of interest.

Search by Feature Name (a)

The first method consists of searching for a geological feature present in the database. In the Search field, it is possible to type the name of a surface feature, such as an impact crater.

Example: Hokusai crater

After entering the feature name, the map automatically centers on the corresponding location, allowing immediate visualization of the area of interest.

Manual Area Selection (b)

Alternatively, the study region can be defined manually using the drawing rectangles available on the basemap to delimit the desired area. Once the drawing is completed, the selected region is used as the geographic boundary for the subsequent database query.

Coordinate Input (c)

Another method for defining the study area consists of manually entering geographic coordinates. In this case, the region boundaries can be specified using:

- minimum and maximum latitude
- minimum and maximum longitude

This approach allows the definition of a precise geographic bounding box and is particularly useful when performing accurate geospatial analyses or reproducing a study area defined in previous works or datasets.

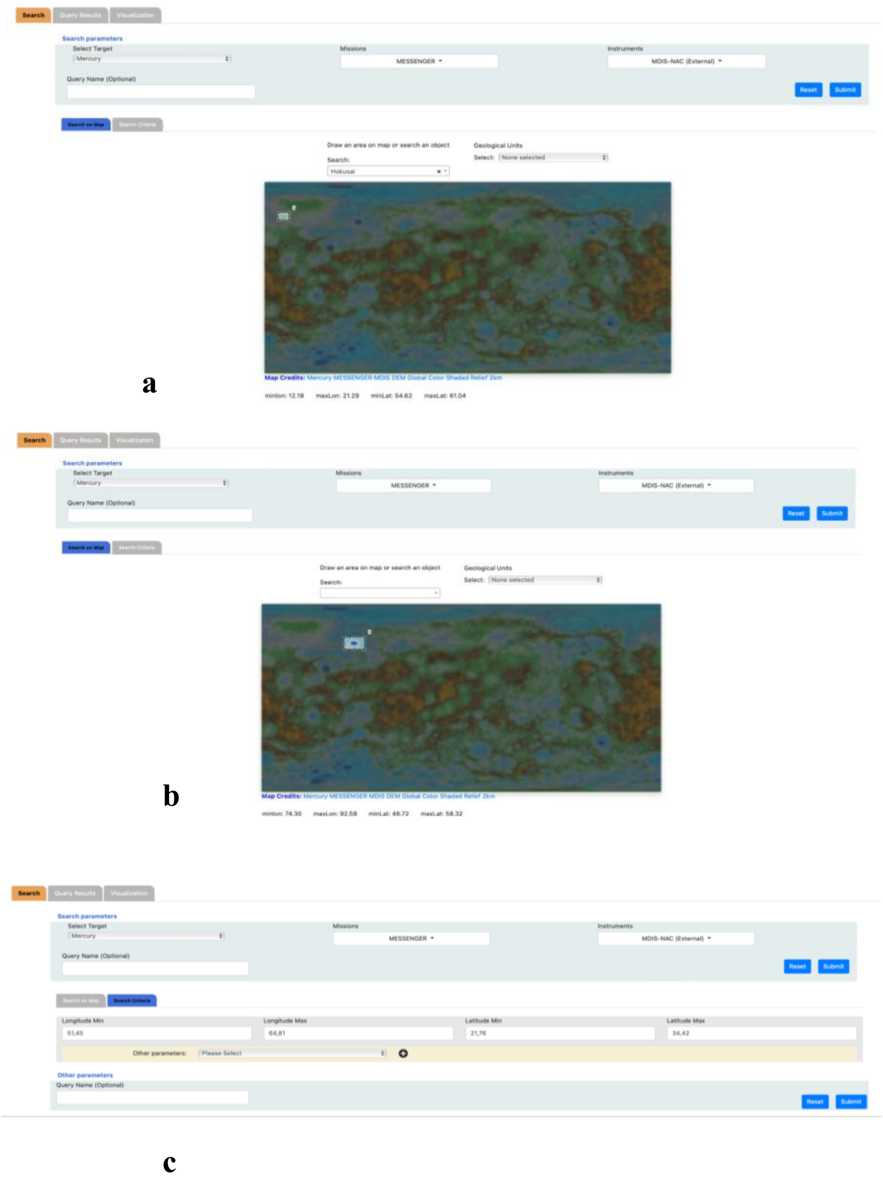


Figure 2. Methods for defining the study area in MATISSE: (a) search by feature name, (b) manual selection using drawing tools, (c) input of geographic coordinates.

This last option also allows to select different parameters, such as time of acquisition and geometric angles of acquisition, but these are not present for all the datasets in MATISSE.

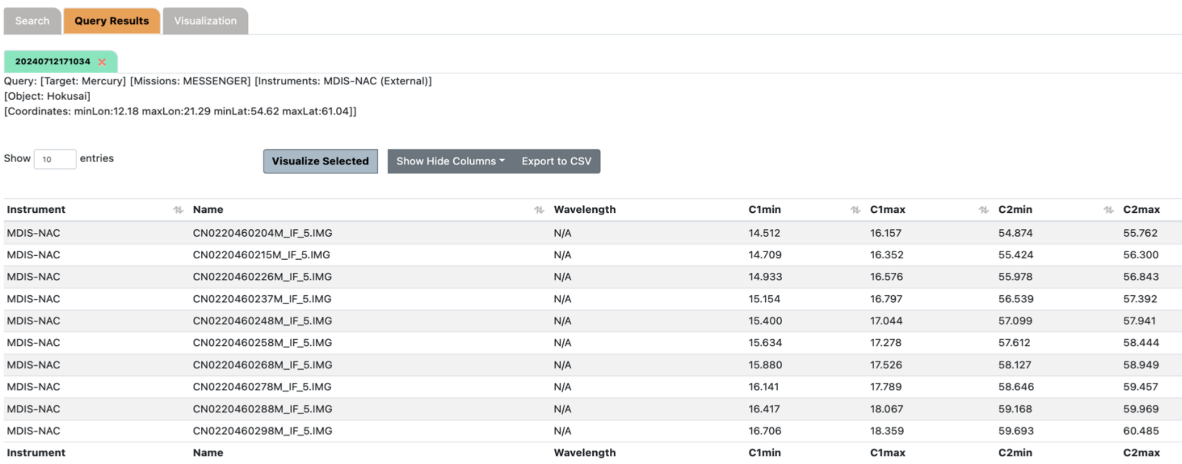
4. EXECUTING THE QUERY

Once the search parameters and the area of interest have been defined, the data query can be executed. At this stage, MATISSE interrogates the database and returns a table containing all observations that intersect the selected region.

The results table provides several pieces of information associated with each available dataset, including the instrument name, the observation identifier (Observation ID or Name), the wavelengths or spectral channels (where available), and the geographical boundaries of the observation, expressed through the minimum and maximum latitude and longitude coordinates.

The user can also visualize other parameters, by acting on the "Show/Hide columns" menu.

Each row of the table corresponds to a specific observation that satisfies the selected search criteria and that covers, either fully or partially, the selected area. This structure allows the user to quickly explore the available datasets and identify the observations most relevant for scientific analysis.



Instrument	Name	Wavelength	C1min	C1max	C2min	C2max
MDIS-NAC	CN0220460204M_IF_5.IMG	N/A	14.512	16.157	54.874	55.762
MDIS-NAC	CN0220460215M_IF_5.IMG	N/A	14.709	16.352	55.424	56.300
MDIS-NAC	CN0220460226M_IF_5.IMG	N/A	14.933	16.576	55.978	56.843
MDIS-NAC	CN0220460237M_IF_5.IMG	N/A	15.154	16.797	56.539	57.392
MDIS-NAC	CN0220460248M_IF_5.IMG	N/A	15.400	17.044	57.099	57.941
MDIS-NAC	CN0220460258M_IF_5.IMG	N/A	15.634	17.278	57.612	58.444
MDIS-NAC	CN0220460268M_IF_5.IMG	N/A	15.880	17.526	58.127	58.949
MDIS-NAC	CN0220460278M_IF_5.IMG	N/A	16.141	17.789	58.646	59.457
MDIS-NAC	CN0220460288M_IF_5.IMG	N/A	16.417	18.067	59.168	59.969
MDIS-NAC	CN0220460298M_IF_5.IMG	N/A	16.706	18.359	59.693	60.485
Instrument	Name	Wavelength	C1min	C1max	C2min	C2max

Figure 3. Results table returned by MATISSE, listing the observations intersecting the selected area along with their associated parameters.

5. SELECTING AN OBSERVATION

Once the observation of interest has been identified among those available, the user can select the corresponding row in the table and activate the *Visualize Selected* command. This opens the dataset visualization interface and allows direct exploration of the data associated with the selected observation.

6. DATASET VISUALIZATION

After selecting the desired observation, MATISSE opens the data visualization interface. The main panel displays the image acquired by the selected instrument, allowing the dataset to be explored directly within the context of the analyzed region.

Users can interact with the image using the navigation tools made available by the JS9 application used. For example, it is possible to zoom in and out, move across the scene to examine geological structures in greater detail, and modify the color scale or other visualization parameters to highlight specific morphological or radiometric characteristics of the dataset.

7. THREE-DIMENSIONAL VISUALIZATION

When available, MATISSE also provides the option to visualize the dataset in three-dimensional mode. This feature enables users to explore the surface model in 3D, allowing the terrain to be rotated and observed from different perspectives in order to more effectively analyze its morphology.
For example, the three-dimensional visualization of the CaSSIS instrument uses a vertical exaggeration factor of 4.5, meaning that elevation differences are amplified by four and a half times relative to the horizontal scale. This enhancement makes variations in surface morphology more evident and facilitates the analysis of topographic features.

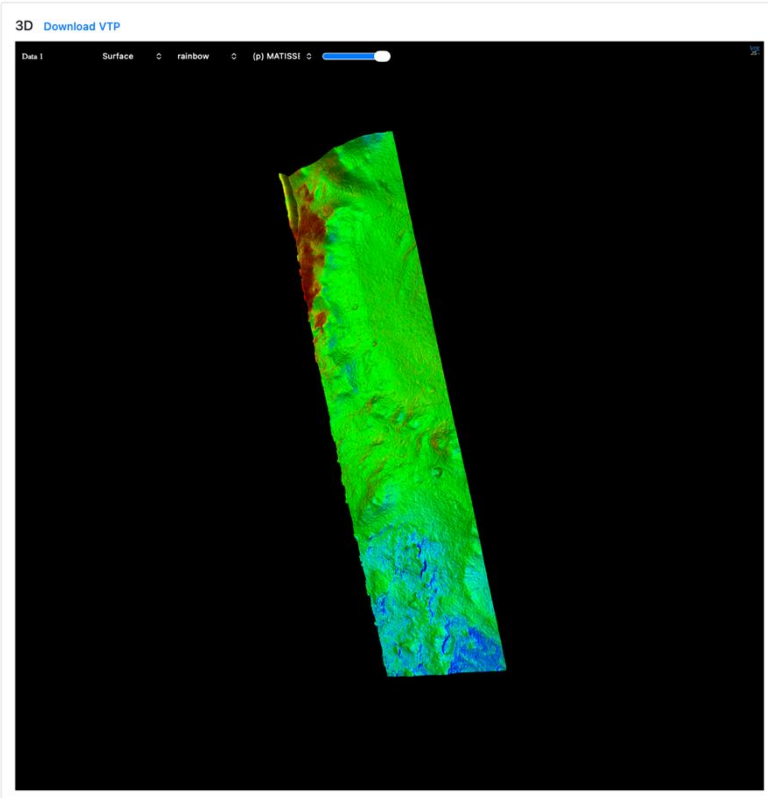


Figure 4. Example of three-dimensional visualization of a dataset in MATISSE with vertical exaggeration applied

Topographic Model Visualization

In the MATISSE three-dimensional viewer, the 3D output can be displayed using different surface rendering modes, which control how the topographic model is visualized. These visualization options can be selected from the “Surface” drop-down menu located above the 3D image.
The available options allow the user to show or hide the mesh derived from the Digital Elevation Model (DEM) associated with the image. The Hidden option completely hides the surface. The Points option displays only the nodes of the DEM grid, representing the points that form the basis of the topographic reconstruction. The Wireframe mode shows the triangular mesh structure that discretizes the surface, allowing users to observe the geometry of the model and the distribution of the triangles used to represent the terrain. The Surface mode displays the continuous surface of the three-dimensional model, applying a color scale or a texture derived from the dataset, and it is the most commonly used mode for morphological analysis. The Surface with Edge option combines the

visualization of the surface with the edges of the mesh, enabling simultaneous observation of the terrain morphology and the structure of the surface discretization.

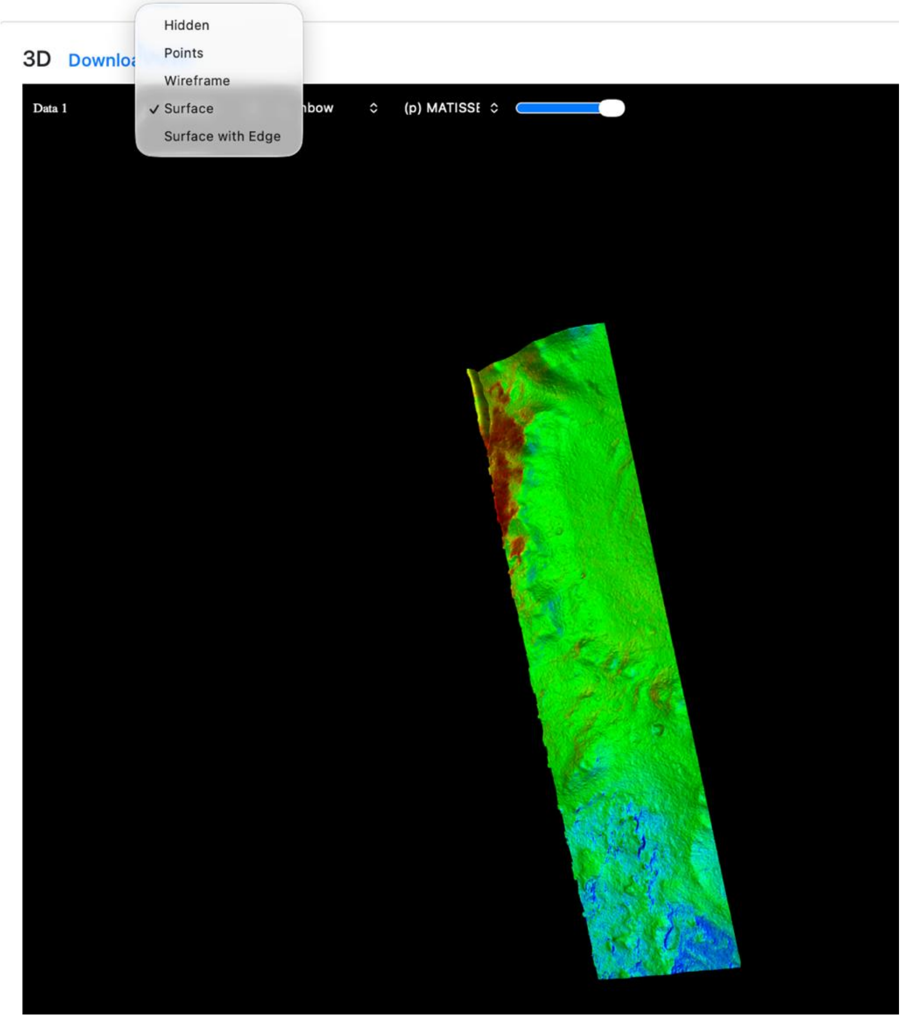


Figure 5. Surface rendering modes available in the 3D viewer: Points, Wireframe, Surface, and Surface with Edge.

Color Scale Visualization

The “MATISSE” drop-down menu, located on the right side of the interface, allows users to select the variable from the dataset that controls the coloring of the three-dimensional surface.
Solid color

The surface is displayed using a uniform color, without applying any dataset variable. This mode is mainly used to visualize the geometry of the three-dimensional model without additional information.

(p) Elevation

The surface coloring is based on the topographic elevation derived from the Digital Elevation Model (DEM). In this case, the colors represent variations in terrain elevation.

(p) Intensity

The coloring is derived from the radiometric intensity of the CaSSIS image, corresponding to the reflectance or brightness values of the observation pixels.

(p) Longitude

The surface coloring is based on the planetary longitude associated with each point of the mesh.

(p) Latitude

Similarly, the surface is colored according to the planetary latitude associated with each point of the mesh.

(p) MATISSE out

This option uses the output parameter generated by the MATISSE processing workflow, which may represent a variable derived from the dataset.

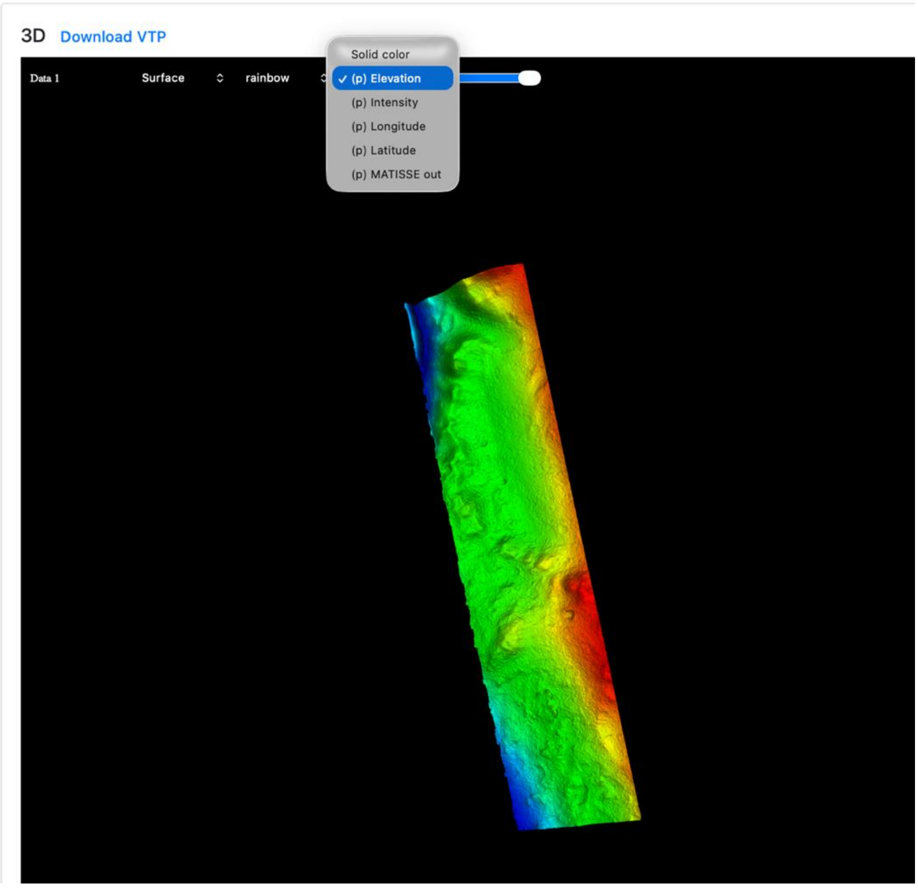


Figure 6. Selection of the variable controlling the 3D surface coloring (elevation, intensity, latitude, longitude, MATISSE output).

8. DATA DOWNLOAD

After visualization and preliminary analysis within the platform, MATISSE allows users to download the selected datasets for further processing in external environments.

The data are generally available in FITS (Flexible Image Transport System) format, a widely used standard within the scientific community for the distribution and analysis of astronomical and planetary data.

Once downloaded, the datasets can be used in various scientific analysis tools, including GIS software, programs dedicated to astronomical data analysis, and scientific programming environments, such as Python, enabling more advanced analyses and integration with other datasets. The 3D version of the data are available in VTP format.

9. GEOLOGICAL UNITS SELECTION

For specific target bodies MATISSE also integrates information derived from planetary geological maps, allowing mission datasets to be analyzed within their geological context. Through the Geological Units menu, it is possible to select a specific geological unit present within the study area. Once a unit has been selected, the system automatically applies a filter to the database and returns only the observations that intersect the chosen geological unit.

This approach allows datasets to be analyzed directly within their geological framework, facilitating the interpretation of observations and the correlation between instrumental data, surface morphology, and the geological units present in the region of interest.

<u>Dataset selection</u>

After selecting the Target, Mission, and Instrument, and after defining the area of interest, MATISSE automatically updates the Geological Units drop-down menu, displaying the geological units available within the selected region.

In this way, users can directly choose among the geological units present in the study area, facilitating the exploration and analysis of datasets within their specific geological context.

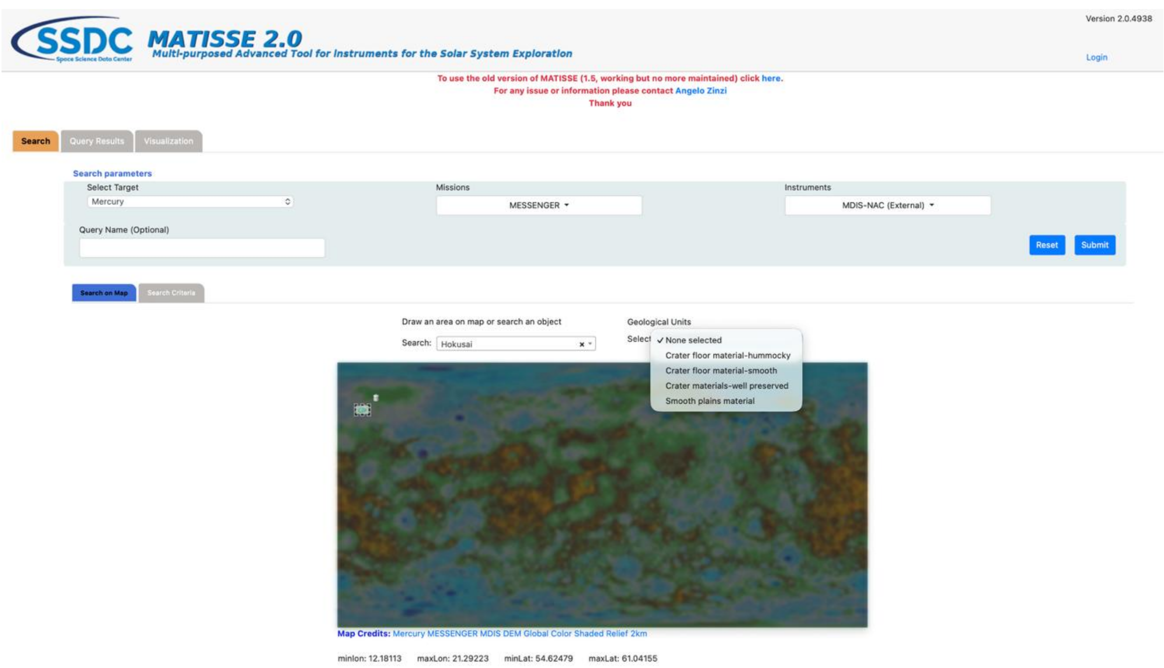


Figure 7. Selection of geological units within MATISSE to filter observations based on geological context.

Dataset visualization

Once the search parameters have been defined — including the planetary body, mission, instrument, area of interest, and the selected geological unit — the user can proceed with executing the query. At this stage, the MATISSE system interrogates the database and returns a set of observations that simultaneously satisfy all the selected criteria.

In particular, the query displays only the datasets that intersect the previously selected geological unit within the study area. This approach allows the search to be restricted to a specific geological context, making the analysis more focused and efficient. As a result, users can explore and analyze only the observations relevant to the geological unit of interest, adapting the scientific investigation to the morphological and stratigraphic characteristics of the studied region.

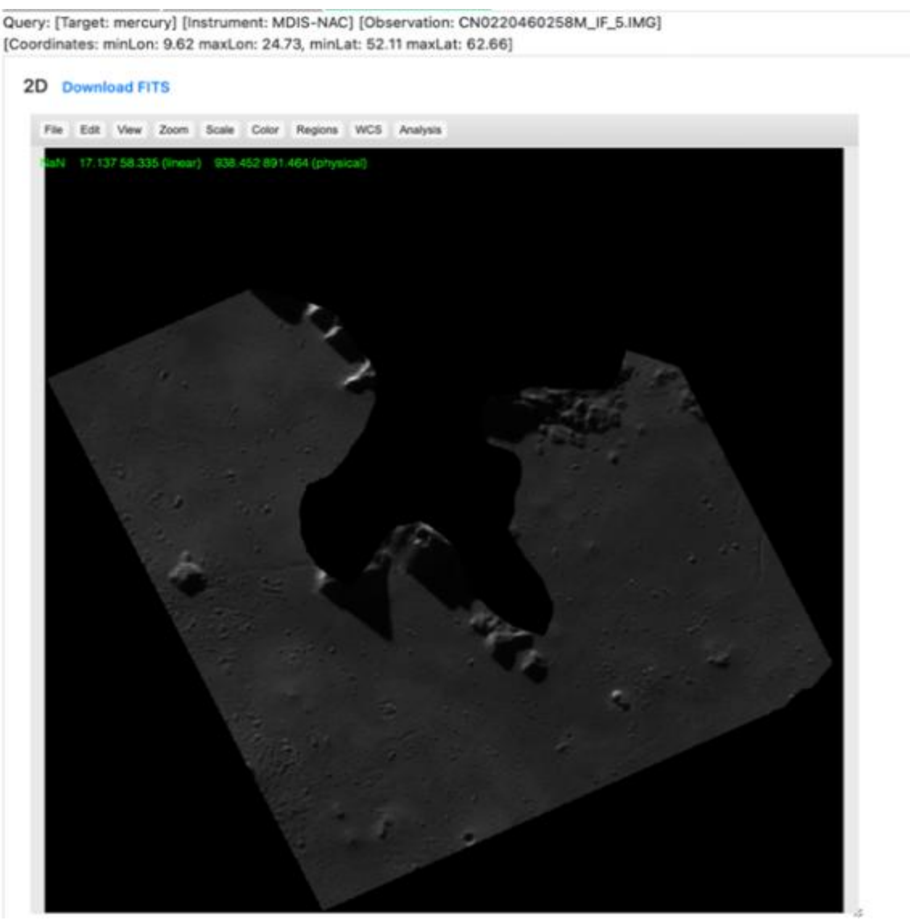


Figure 8. Query results filtered by geological unit within the selected study area.