MATISSE 2.0: the SSDC Webtool for Integrated Planetary Science Analysis.
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Introduction: MATISSE (Multi-purpose Advanced Tool for the Solar System Exploration) is the Space Science Data Center (SSDC) scientific webtool dedicated to planetary sciences.

Its first version has been released in early 2013 [1] (https://tools.ssdc.asi.it/matisse.jsp) and, since about one year, its 2.0 version is available to the public [2, 3] (https://tools.ssdc.asi.it/Matisse).

This version is completely written as a series of Python modules, using a GIS-oriented database solution (e.g., PostgreSQL+PostGIS), allowing reading the input from the user, finally providing in output the 2D/3D representations of the processed data.

Current capabilities: MATISSE 2.0 can be either accessed by a web-browser or by script, exploiting a REST protocol.

The tool's homepage allows the user to perform a query based on target, missions, instruments and to several geographical, geometrical, temporal metadata. The geographical selection can be made also by using a user-friendly map or looking for predefined areas (e.g., craters) on the target (Fig. 1).

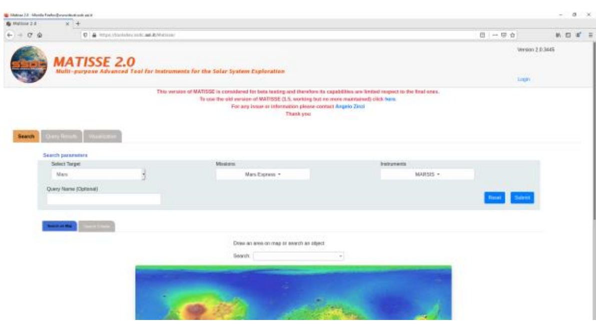

Figure 1: MATISSE homepage.

The current version of the tool ingests data from 5 targets (1 Ceres, 4 Vesta, Mars, Mercury and Venus), 3 missions and 5 instruments (NASA Dawn VIR VIS and IR, ESA Venus Express VIRTIS-M VIS and IR, NASA MRO CRISM), exploiting both datasets stored at SSDC premises and remotely archived data, accessed by means of different standard protocols.

To these instruments a numerical thermophysical model for airless bodies [4], available for Mercury and 1 Ceres, has to be added.

MATISSE 2.0 provides as output a 2D Planetary FITS file [5] and, where available, a 3D VTP file: both of them can be either visualized and analysed directly on the web browser (Fig. 2) in the MATISSE output page or downloaded.

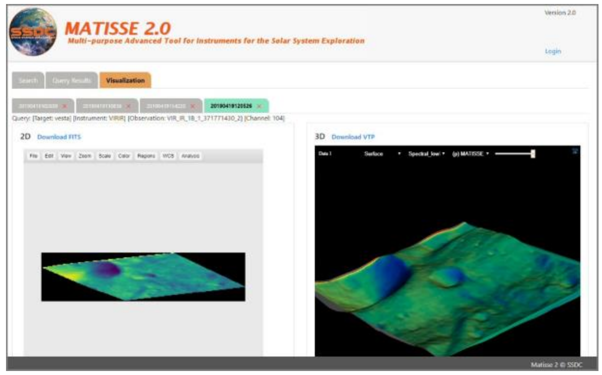

Figure 2: MATISSE output page for a VIR Vesta observation.

Planned upgrades: We are now working to increase the MATISSE capabilities, by adding new datasets and also totally new functionalities, as explained below.

At the present time, these updates are being tested in the SSDC development area (not accessible from the outside) and should be made available to the public in the next months.

MATISSE for geological maps. In the GIS framework in which MATISSE is embedded, the capability of exploiting semantic information coming from planetary geological maps is of capital importance. For example a user would be able to look for hyperspectral observations of Mars included in a selected geological unit of a crater (Fig. 3), so that a detailed study of the spectral features can be performed exploiting the advanced solutions provided by MATISSE.

Figure 3: MATISSE output of the selected geological unit.

For this task Mars, Mercury and 1 Ceres has been chosen as targets for the presence of a wealth of data from previous and active missions (Mars and Ceres) and to be ready for upcoming missions (e.g. BepiColombo) that will benefit of this capability, also exploting the thermophysical model already available.

MATISSE for MARSIS data. MARSIS is the sub-surface Martian radar onboard the ESA Mars Express mission, thanks to whom a series of liquid lakes under the Martian South Pole has been discovered [6].

SSDC stores MARSIS data (both public and private ones) since long time and, at the end of the previous year, a collaboration between the SSDC MATISSE team and the MARSIS and G-MAP ones, started, with the aim of providing a tool to efficiently search and visualize MARSIS radargrams.

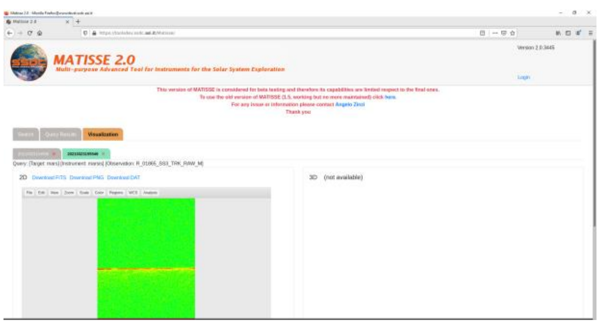

Figure 4: MATISSE output page showing a MARSIS radargram.

The search functionality is now under test for private data (Fig. 4), whereas public data will be accessed via ESA PSA using the EPN-TAP protocol.

In the future we will work on advanced algorithms to visualize the radargrams in a three-dimension way.

Future works: Together with the above mentioned updates currently under development, we are planning to work on further modification to MATISSE, as scientific teams of future missions are looking at this tool as a way to easily integrate and fuse several datasets, thus increasing scientific production.

Among these, the closest one, in a temporal way, is the ASI LICIACube mission [7], directed to the 65803 Didymos system as a piggyback of the NASA DART mission [8].

LICIACube main aim will be to witness DART impact with Dimorphos and then study the consequent plume.

SSDC is involved in this mission as responsible of the Scientific Operations Center and we are planning to modify MATISSE with GIS-focused features, such as crater/boulder counting and area selection directly on the 3D visualization.

It is also worth to mention the collaboration with the NASA Juno JIRAM team, for what regards the visualization of some atmospheric retrieval parameters.

Once the software pipeline used by [9] will be adequately transferred to the SSDC infrastructure, its results could be ingested by MATISSE and an advanced visualization solution adopted.

References: [1] Zinzi A. et al. (2016) *Astronomy and Computing*, *15*, 16–28. [2] Zinzi A. et al. (2018) *Planetary Science Informatics and Data Analytics Conference, held 24-26 April, 2018 in St. Louis, Missouri. LPI Contribution No. 2081, 2018, id.6002*. [3] Zinzi A. et al. (2019) *EPSC-DPS Joint Meeting 2019, held 15-20 September 2019 in Geneva, Switzerland, id. EPSC-DPS2019-1272*. [4] Rognini et al. (2019), *Journal of Geophysical Research*, https://doi.org/10.1029/2018JE005733. [5] Marmo C. et al. (2018), *Earth and Space Science*, 5, 10, 640-65. [6] Lauro S. E. at al. (2021), Nature Astronomy, 5, 63-70. [7] Dotto E. et al. (2021) *Planet. Space Sci.*, 199, article id. 105185. [8] Cheng A. F. et al. (2018) *Planet. Space Sci.*, 157, 104-115. [9] Grassi D. et al. (2017), *Journal of Quantitative Spectroscopy and Radiative Transfer*, Vol. 202, p. 200-209**.**