New open source tools for MARSIS

Providing access to SEG-Y data format for 3D analysis

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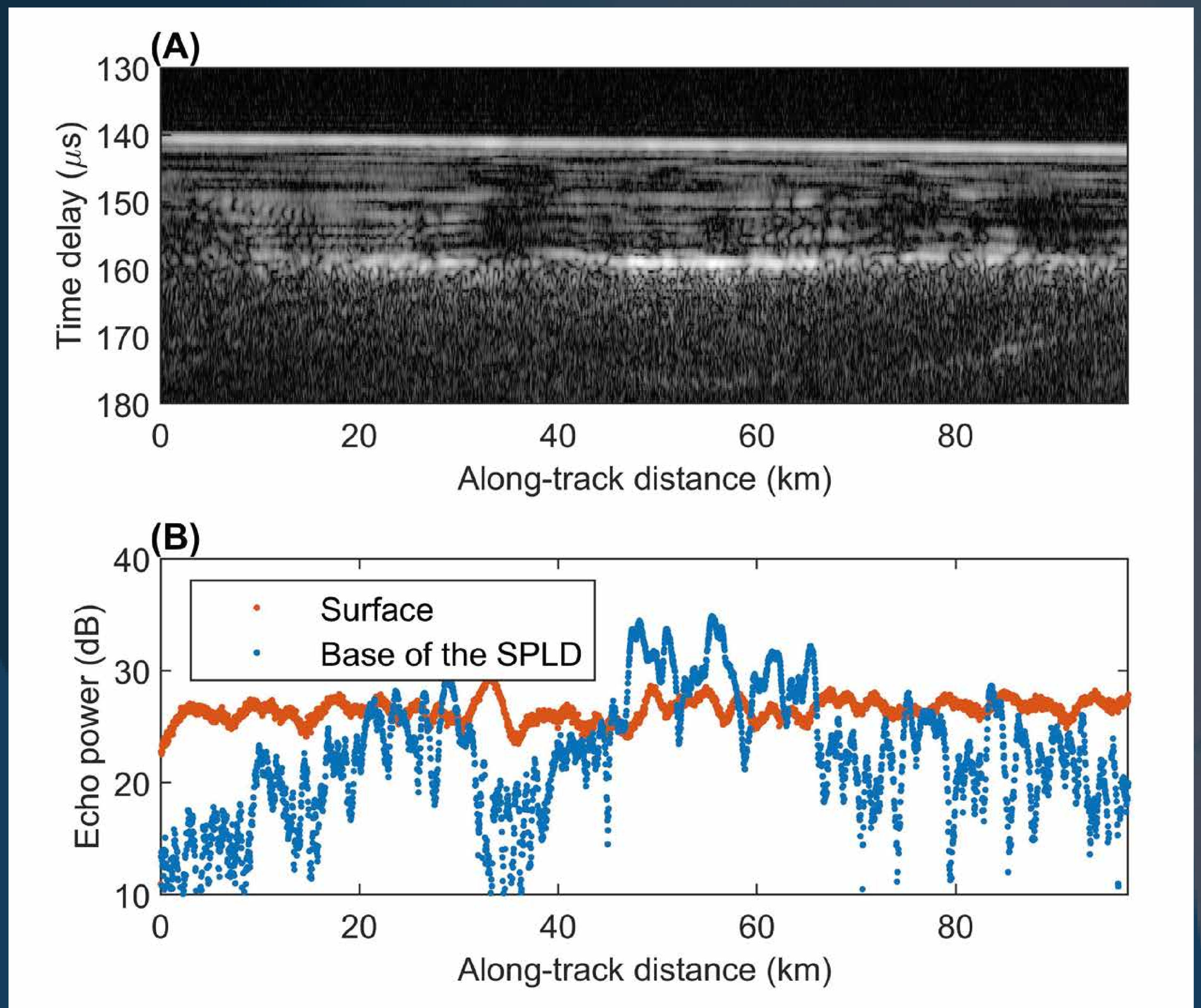
MARSIS Instrument

The Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS) is an orbital synthetic aperture radar sounder on board Mars Express (MEX) orbiting Mars since 2005.
It operates with dual-frequency between 1.3 and 5.5 MHz and wavelengths between 230 and 55 m for subsurface sounding.
The Experiment Data Record (EDR) and Reduced Data Record (RDR) datasets are available for download on public access platforms such as the Planetary Science Archive fo ESA and the PDS-NASA Orbital Data Explorer (ODE) while Flash Memory Data are released publicly after principal investigator's analyses.

State of the art - 2D

These datasets have been widely used for different research, focused to study the subsurface of the red planet up to a depth of a few kilometres, and especially for studying ice caps and looking for subsurface ice and water deposits, producing relevant results. [1] [3]



Radargram for MARSIS orbit 10737 and plot of surface and basal echo power for the radargram in (A). [3]

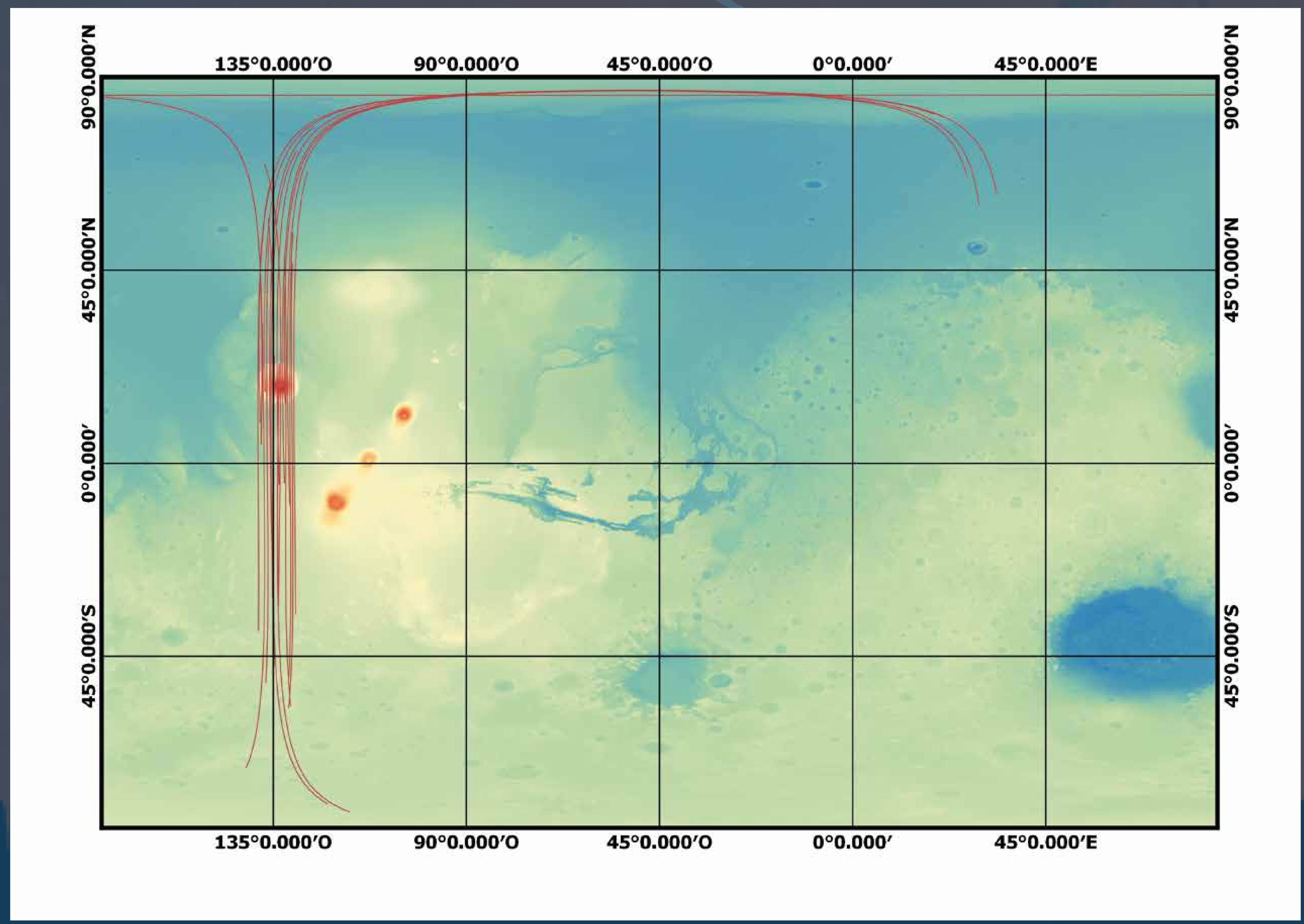
Tool's Features

The presented tool is publicly available [2], users can interactively configure data source, destination, pre-processing and type of outputs among:
- Geopackages: for GIS software,
- Numpy array dump: for fast reading and analysis of original data for both frequencies,
- PNG images: for fast inspections, created for each frequency, and saved.
Image pre-processing filters, such as image-denoising, standardization and normalization, can be selected by user.
SEG-Y: for analysing data with seismic interpretation and processing software, see e.g. OpendTect, consist of a SEG-Y file for each frequency.

Work in progress

- export optimization
- SEGY files test and validation with terrestrial seismic software (e.g. OpendTect, Voxler)
- pre-processing integration
- Machine Learning / Deep Learning integration

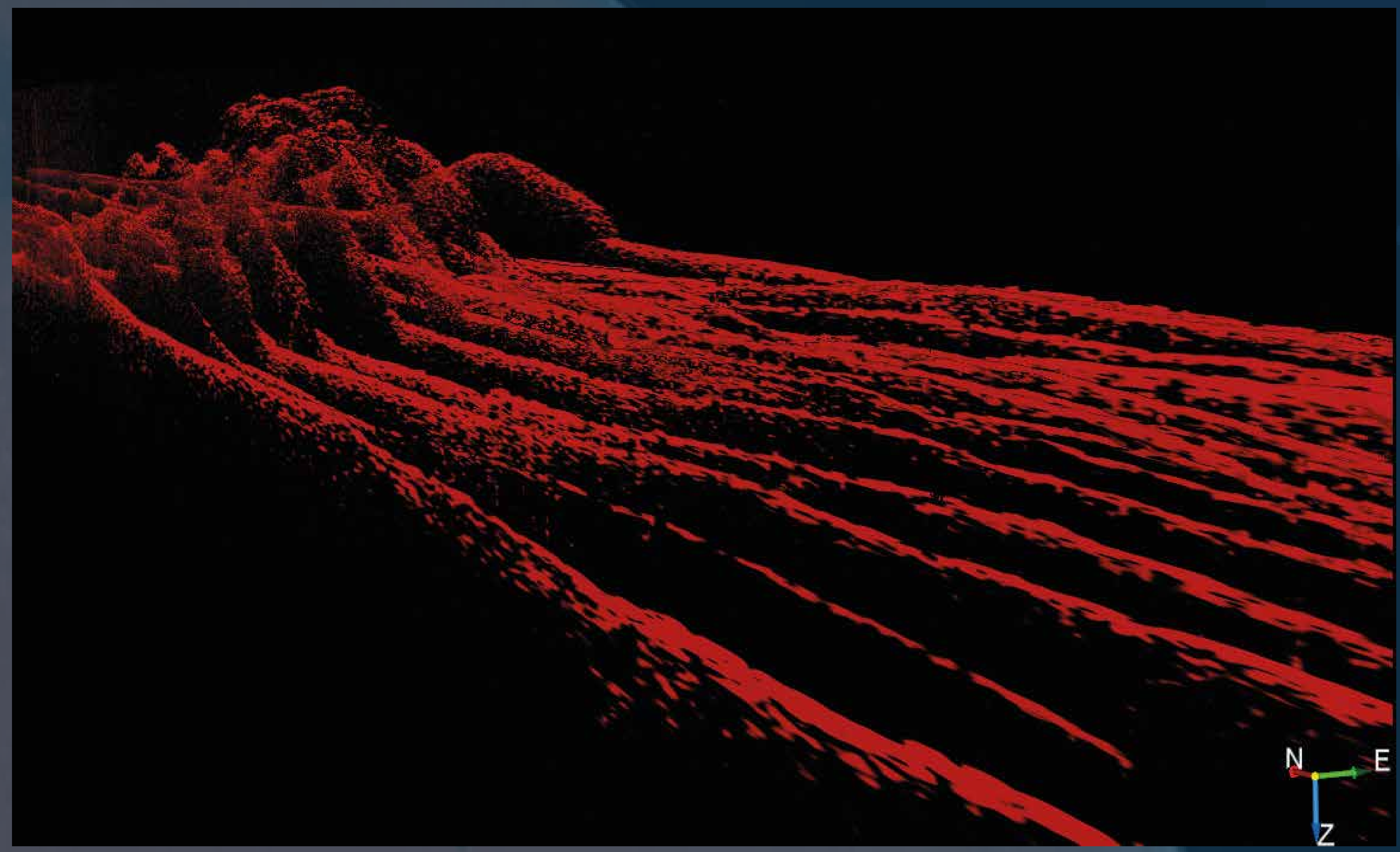
MARSIS Reduced Data Records

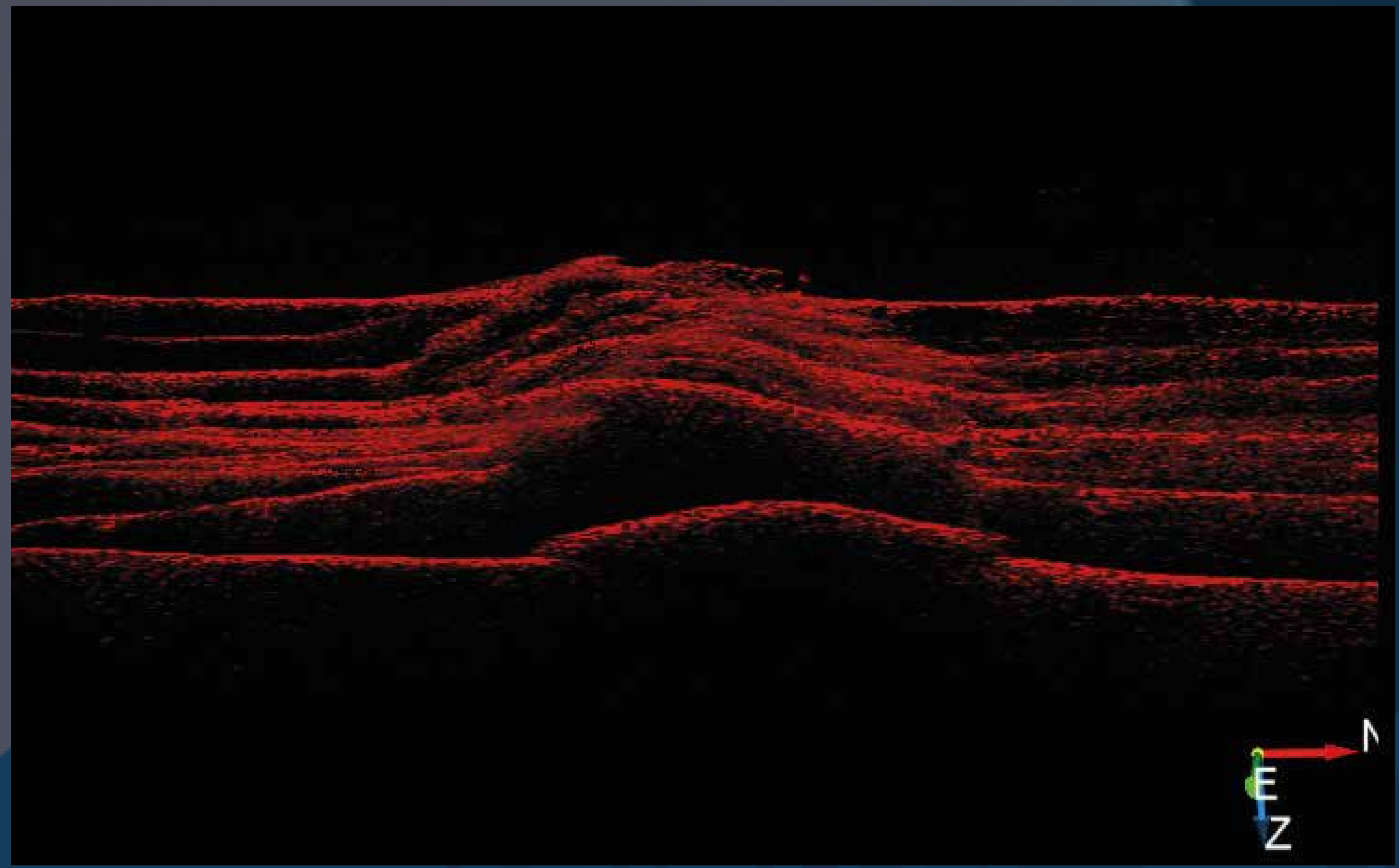


Footprints of RDR tracks used for preliminary test.

MARSIS Reduced Data Records - 3D

Test tracks have been imported into OpendTect and visualized with a colorbar that highligth reflections with highest intensity.





North-East facing 3D view of test tracks with elevation exagerated to better visualize the Olympus Mons.

References:

[1] Lauro, S. E. et al. (2020) 'Multiple subglacial water bodies below the south pole of Mars unveiled by new MARSIS data', doi: 10.1038/s41550-020-1200-6.
[2] Nodjoumi, G. (2021) 'MARSIS-xDR-READER', doi: 10.5281/zenodo.4436199
[3] Orosei, R. et al. (2020) 'The global search for liquid water on mars from orbit: Current and future perspectives', doi: 10.3390/life10080120.

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