



SHARAD/MARSIS Data Users' Workshop: MARSIS data characteristics

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MARSIS data



- Limited data resources on board Mars Express forced the designers of MARSIS to implement a sophisticated and flexible on-board processor.
- Because of this, MARSIS data come in a variety of formats and content, depending on sounding mode (subsurface vs. ionosphere sounding) and on-board processing (from raw to azimuth and range-compressed, corrected for ionospheric distortion and multi-looked).



Instrument modes

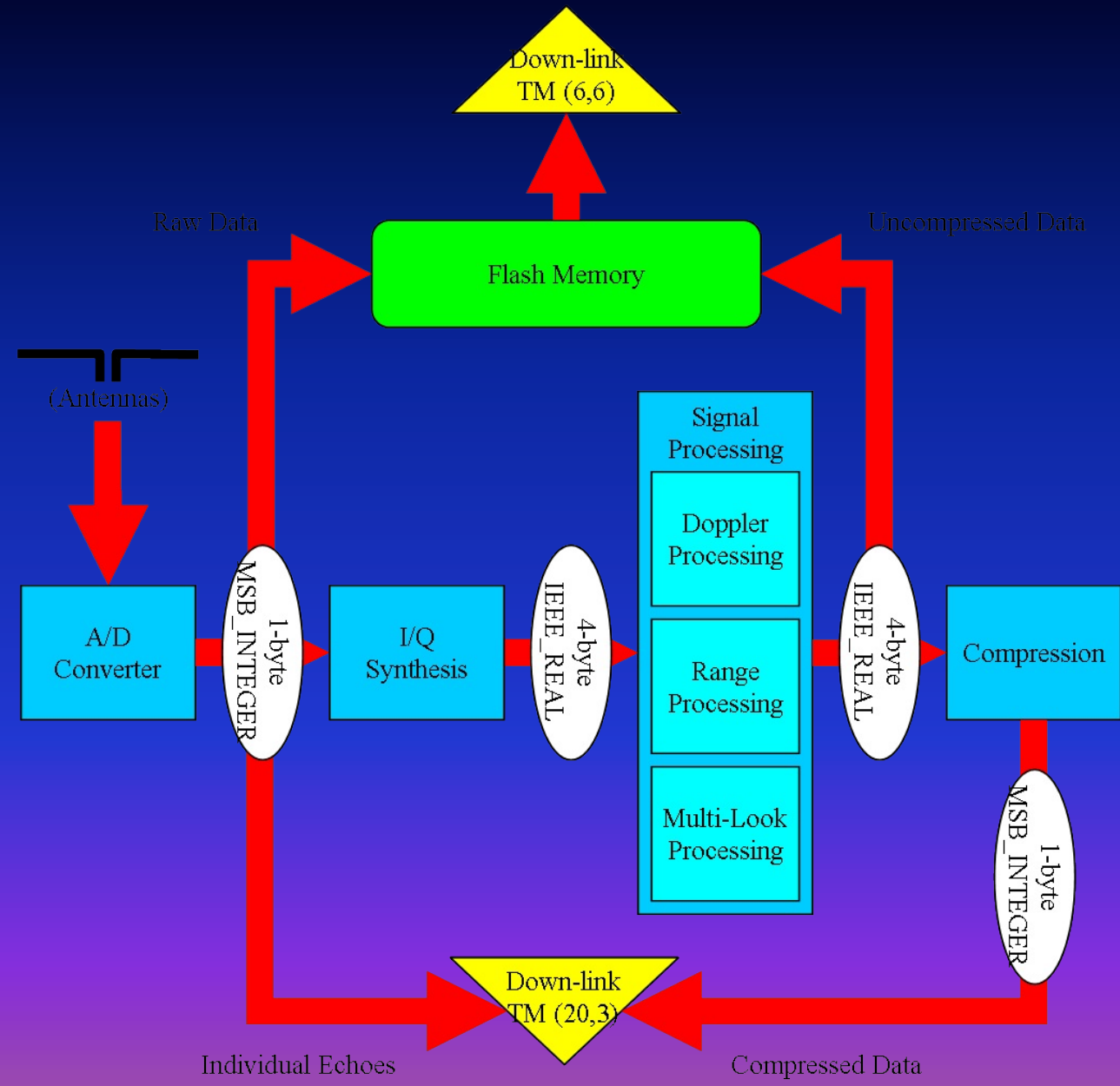
- We neglect AIS data, only SS are considered.
- There are five Subsurface Sounding modes, characterized by the use of different waveforms, multiple frequencies, different antennas (not to mention on-board processing).
- 95% of MARSIS SS data have been acquired using mode SS3:
 - Chirped waveform
 - Dipole antenna
 - Two frequencies
 - Three «filters» per frequency (see following slides)

A look at on-board processing



- MARSIS tracks the time of arrival of echoes, so as to open the receiver just before the expected time of arrival of the echo.
- Raw echoes are down-converted to zero central frequency and digitalized as complex numbers.
- Azimuth processing consists in summing a batch of 100-200 echoes (depending on altitude) to maximize constructive sum of echoes from a desired direction.

On-board processing scheme

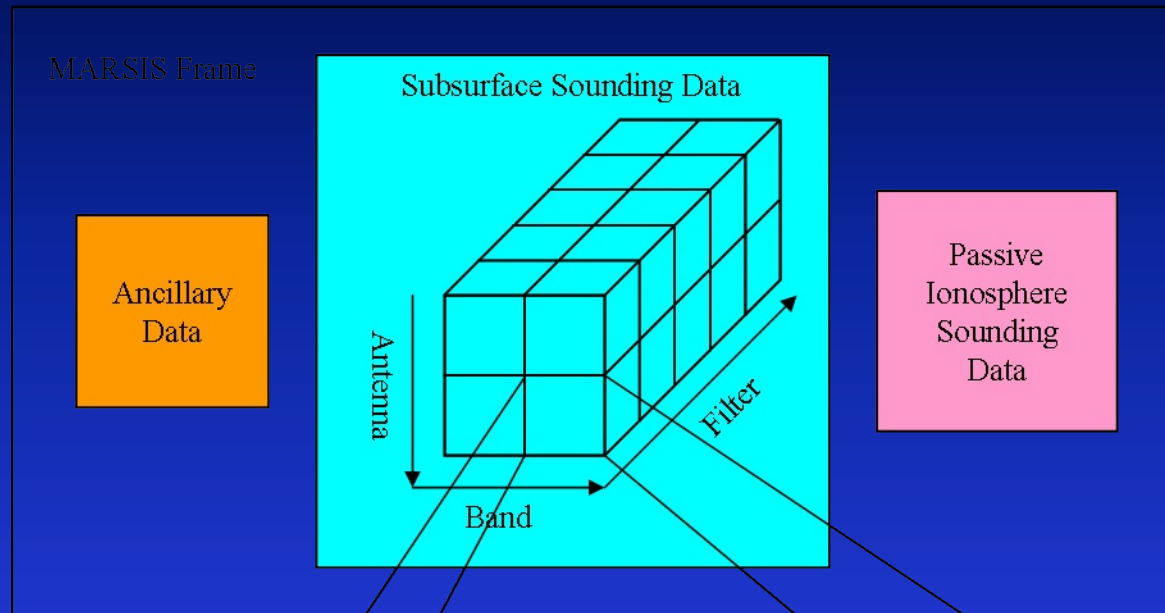


Spacecraft telemetry

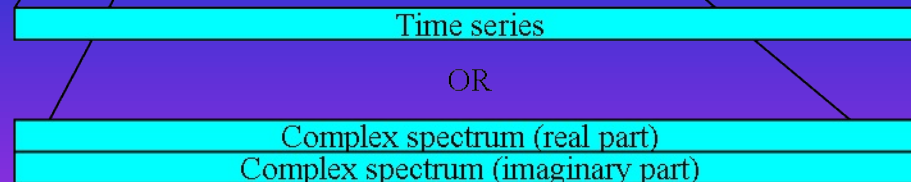


- Data are organized into «frames» before downlink.
- A frame is the result of the processing of a group of 100-200 echoes (depending on altitude) that have been processed together to produce one or more filters.
- A frame also contains auxiliary data reporting parameters used in on-board processing.
- Data are downlinked in the frequency domain, as complex (real and imaginary part) spectra.

Schematic of a MARSIS frame



- This structure is usually 1 x 2 x 3 ("SS3")
- 1 antenna,
2 bands,
3 Doppler filters

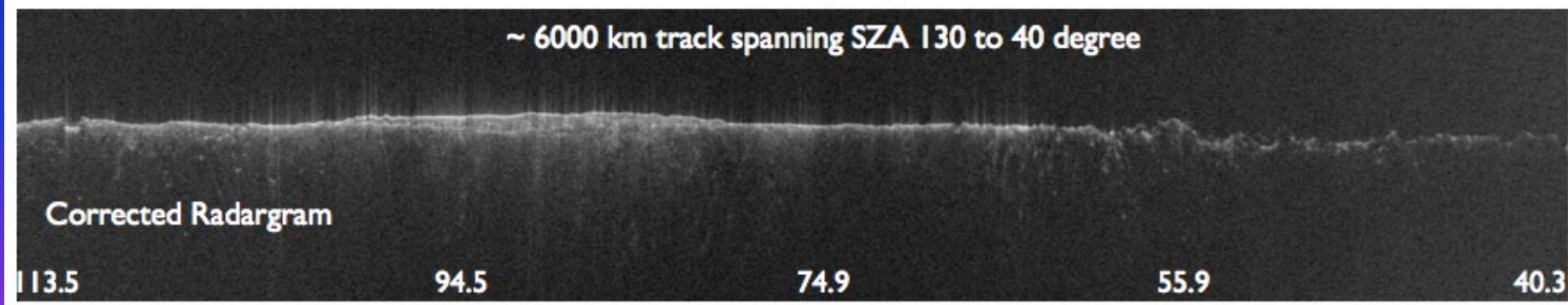
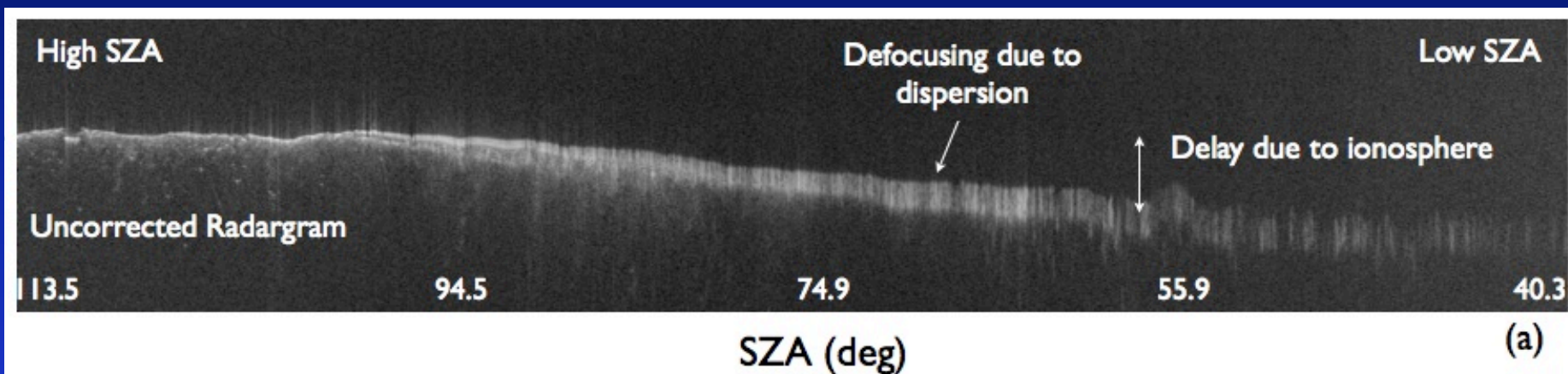


Ground processing



- Main steps in the processing of SS3 data are range compression and the correction of ionosphere distortion.
- There are several algorithms to perform this correction: the one implemented in the processor for the production of PDS data is called contrast method.

Removing Ionospheric Distortion

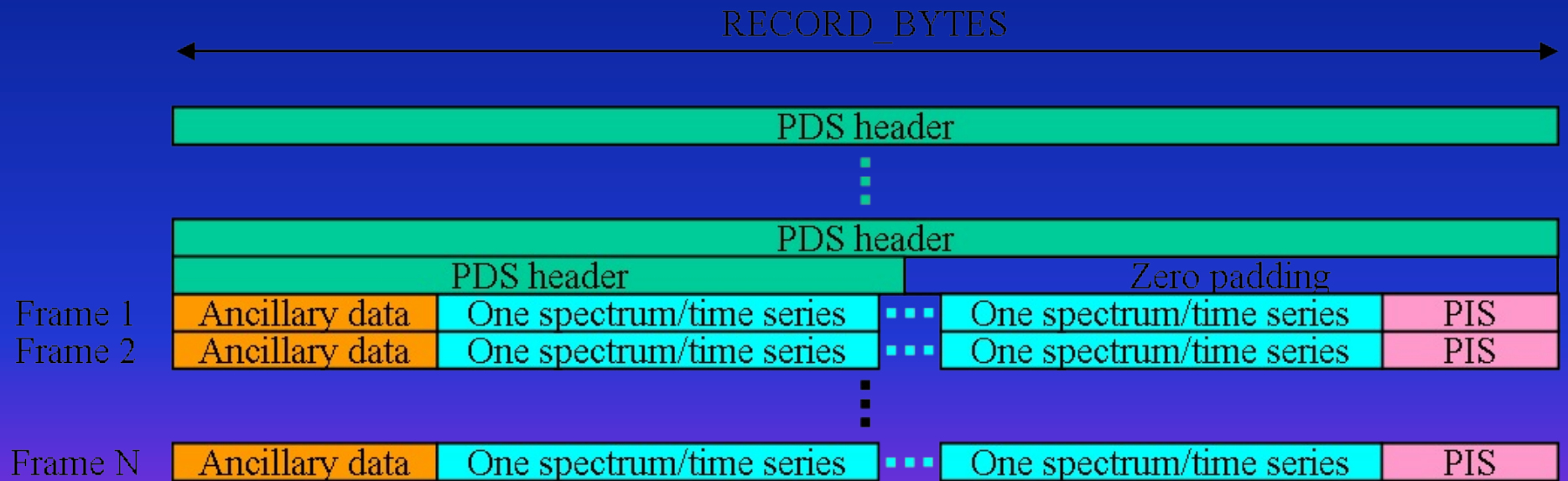


Further processing on ground

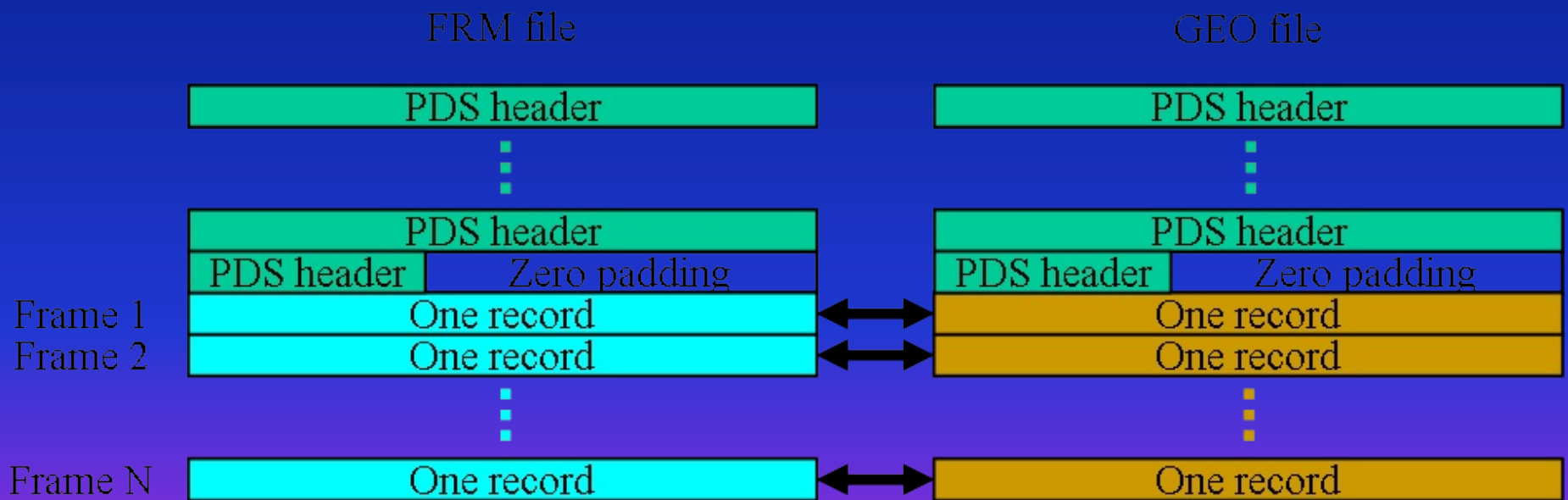


- All frames acquired in a single orbit using the same instrument mode constitute a single data file (called frame file or FRM).
- Another file is computed on ground, reporting geometric information for every observation in the processed data file (called geometry file or GEO).
- An attached PDS label is added to both files. This constitutes a data product.

Schematic of a MARSIS processed data file



Schematic of a MARSIS data product





How to visualize data

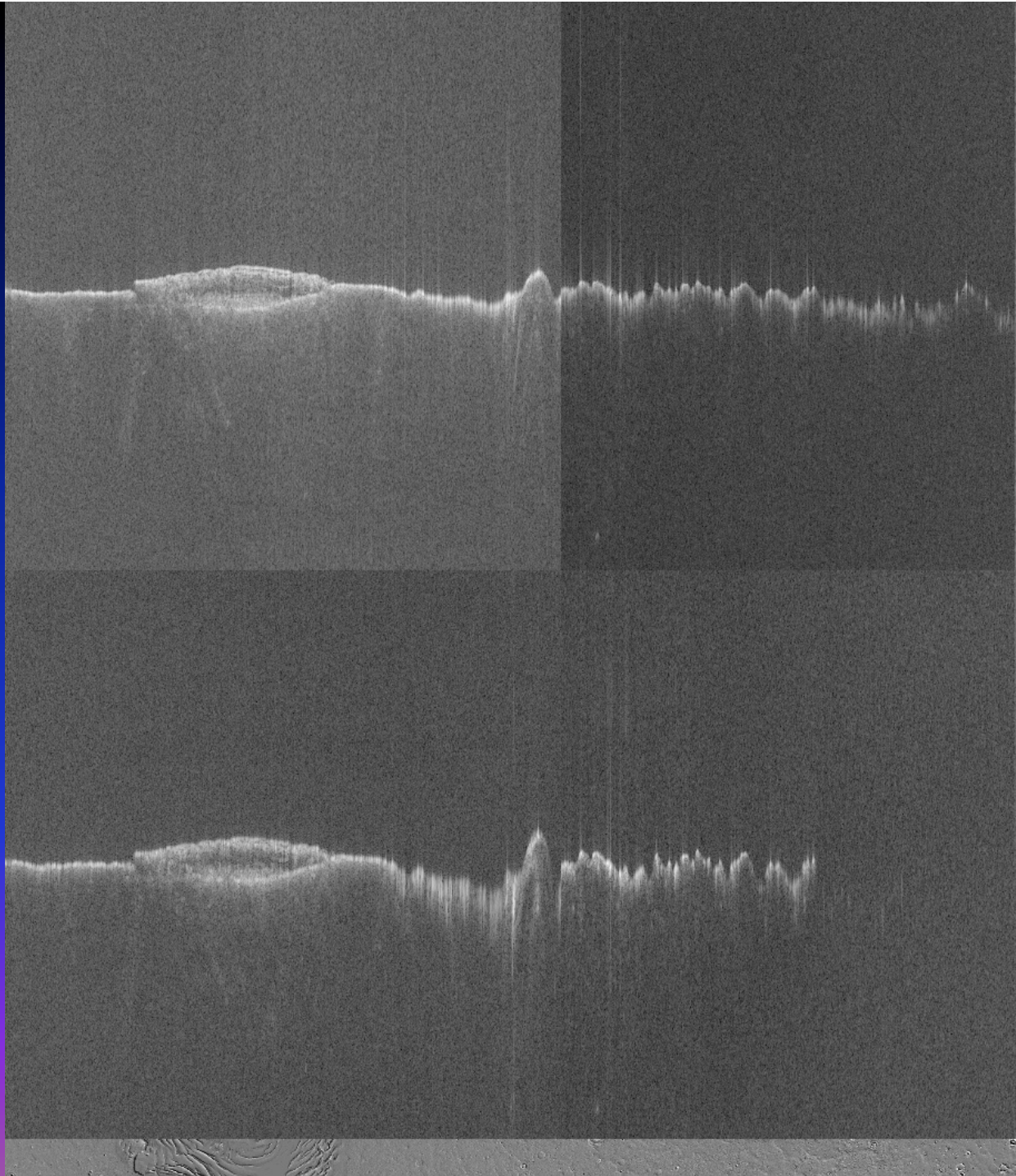
- No browse products are currently available in the PDS archive
- Data are stored as complex echoes, but only the absolute value is used for visualization.
- Signal power is best visualized in a logarithmic scale (dB) to enhance weak subsurface echoes.

All this must be done manually by the user
(no software available to do it)

Future upgrades to the archive



- The PDS processor is being revised to include changes that are meant to make MARSIS data products more user-friendly.
- Alignment of echoes to a common time reference is being implemented.
- Inclusion of simulations of surface scattering for subsurface echoes identification is foreseen.



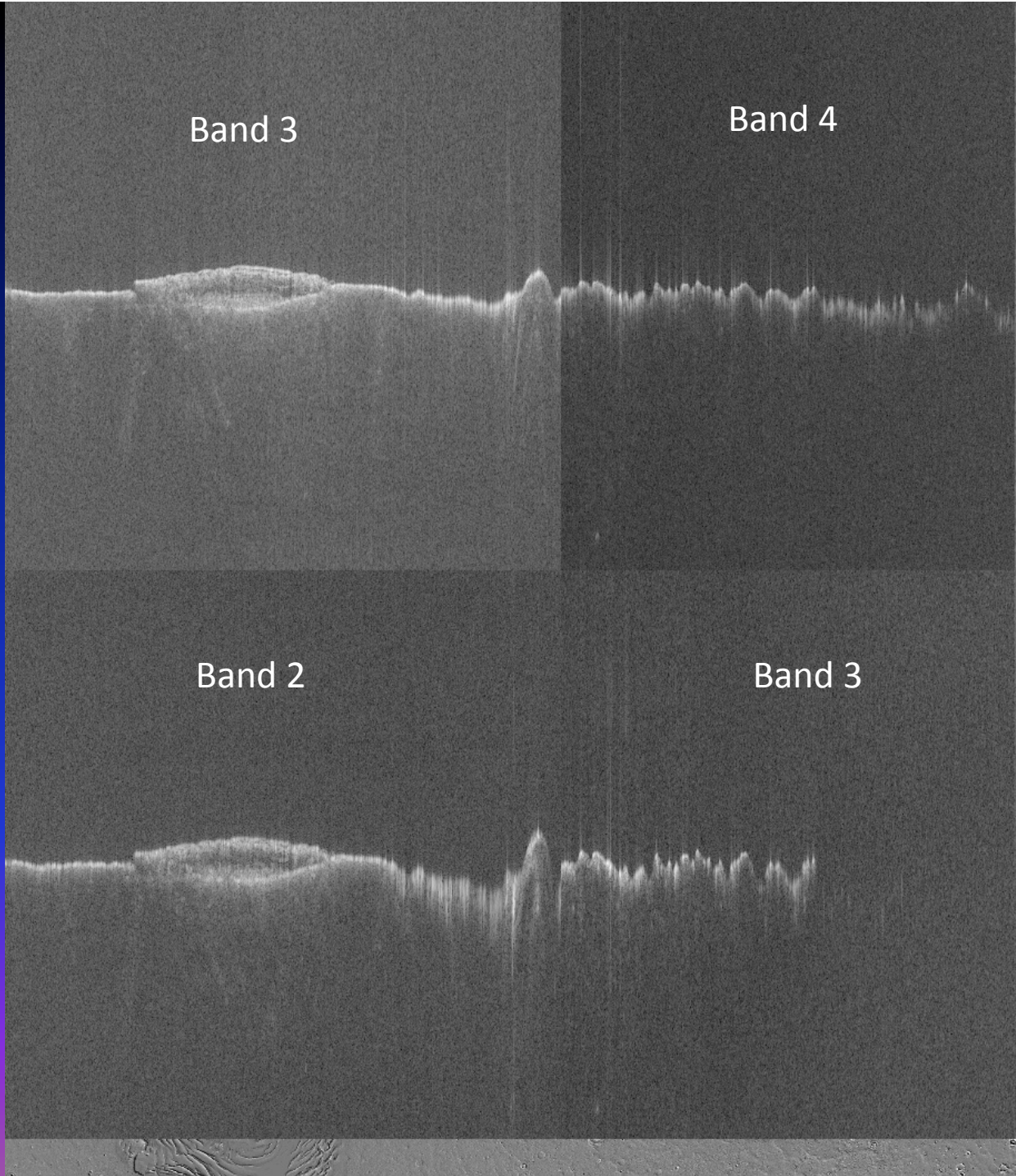
Band 3

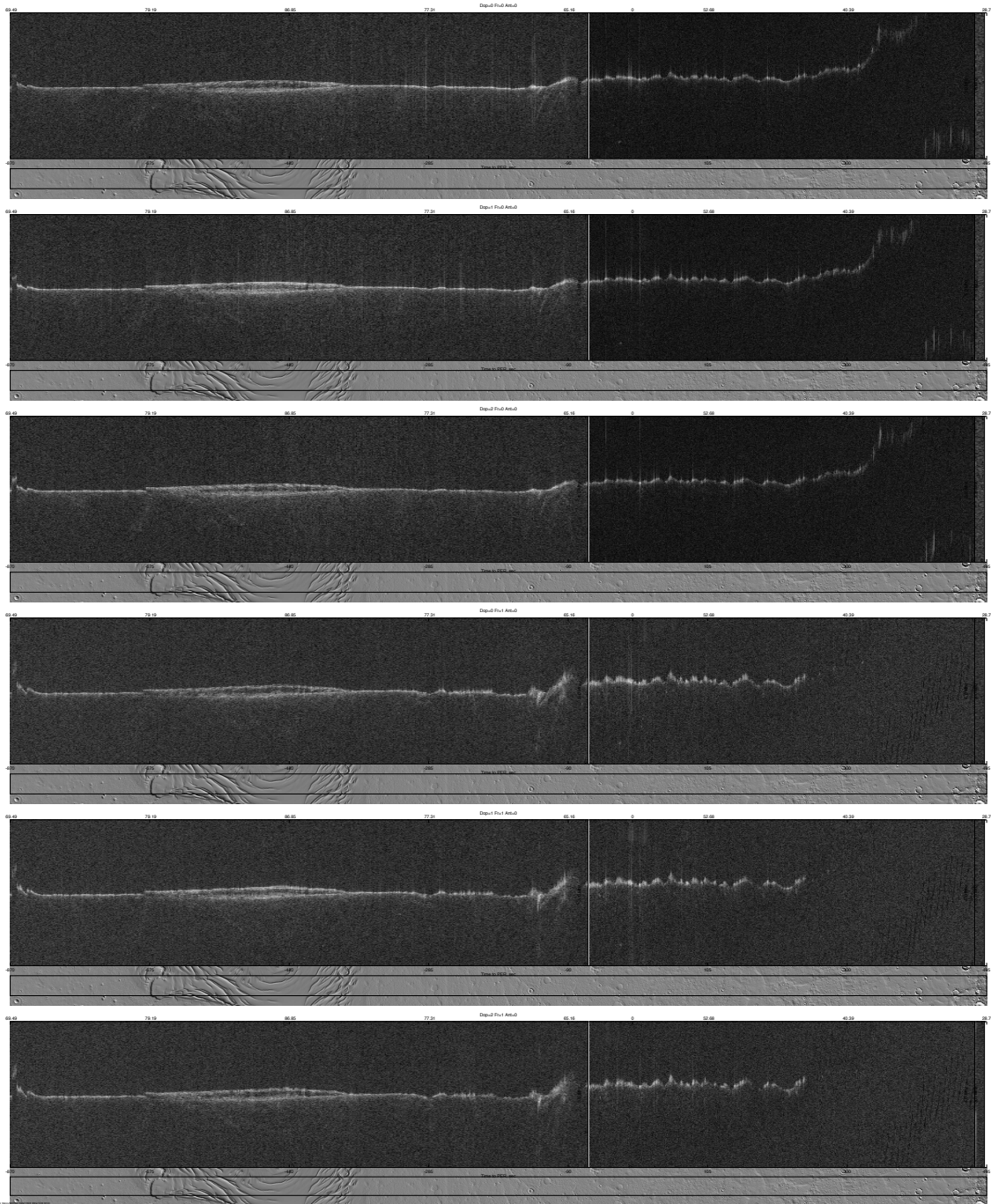
Band 4

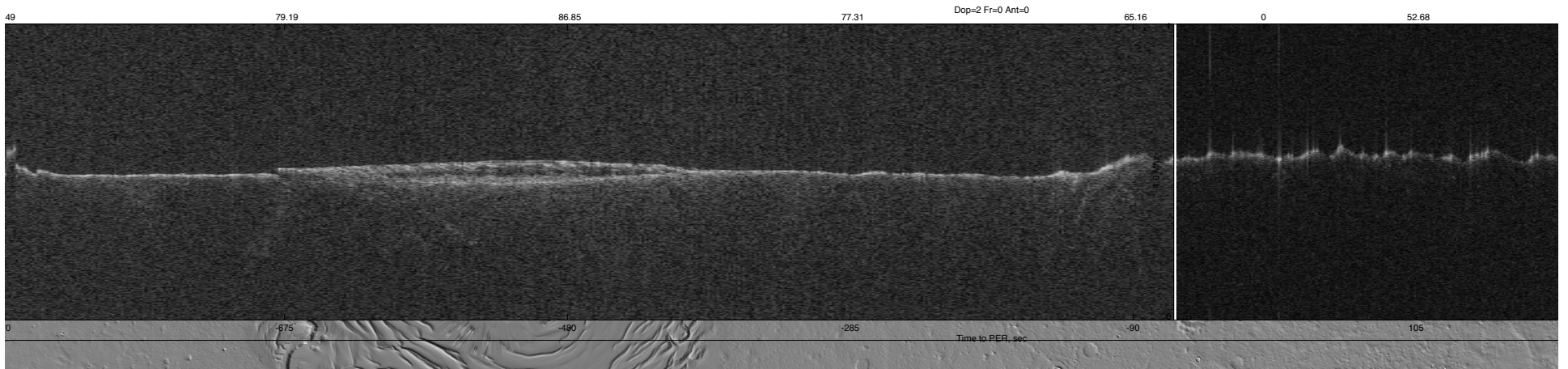
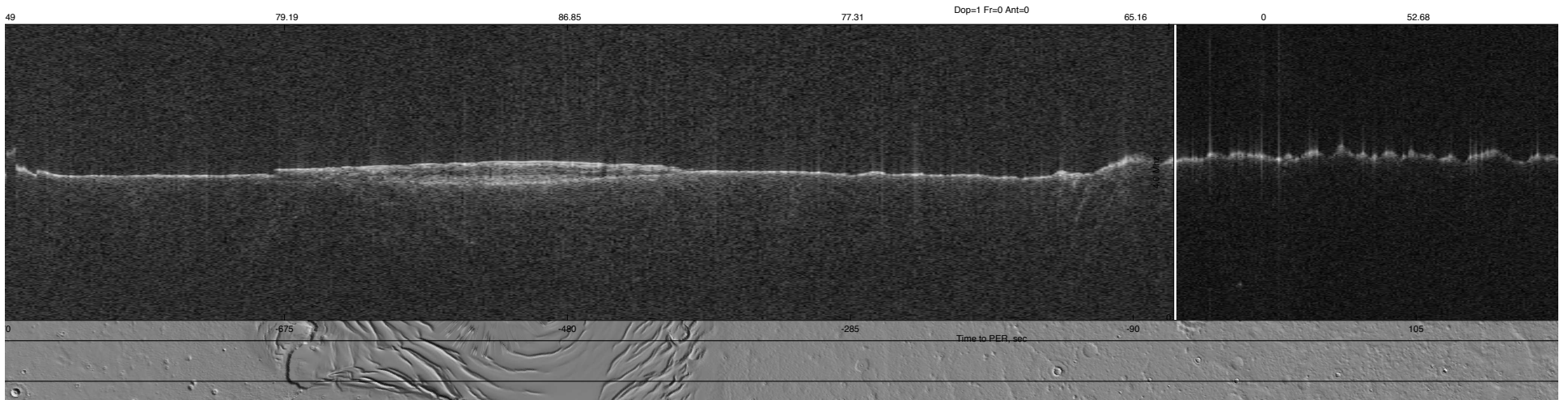
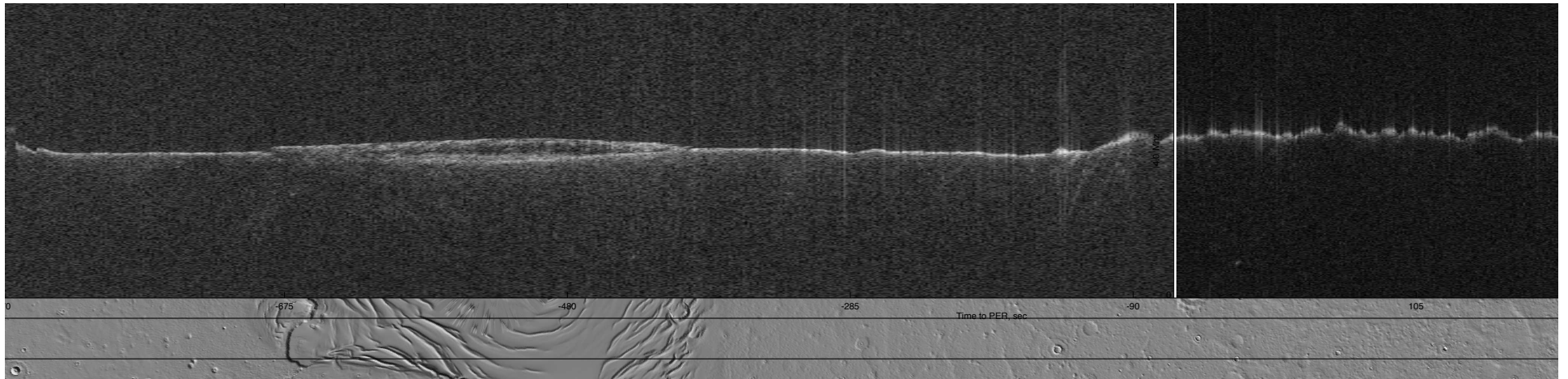


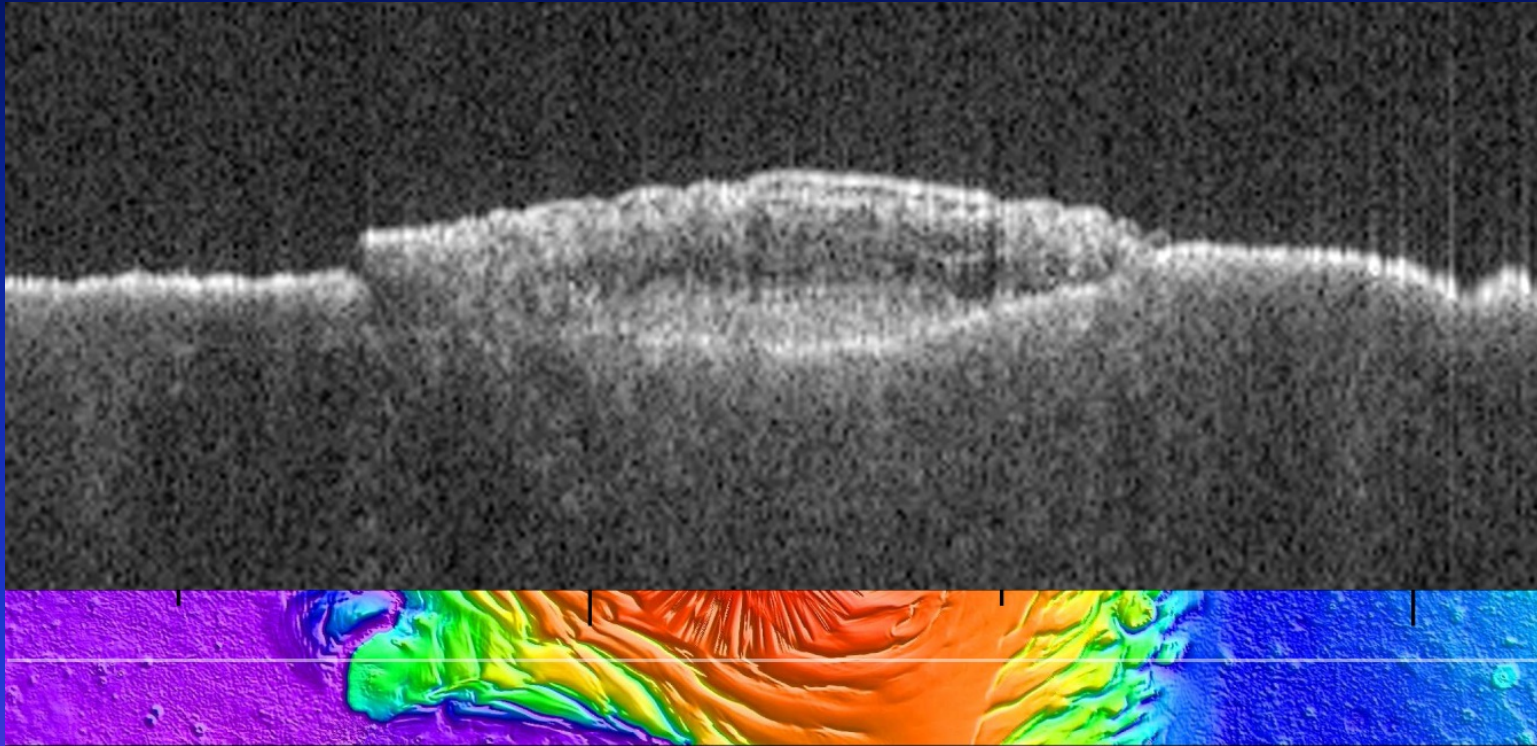
Band 2

Band 3



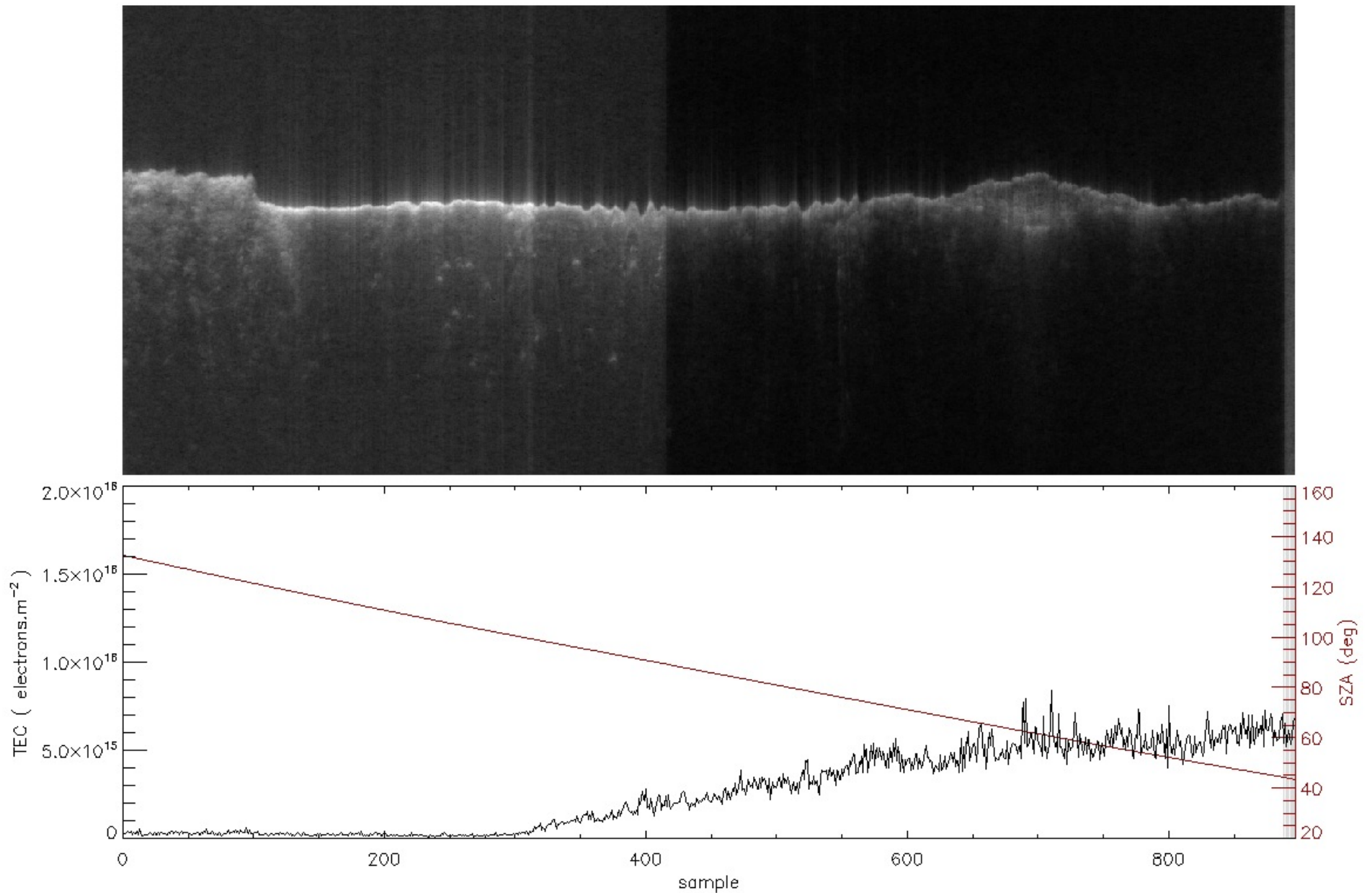




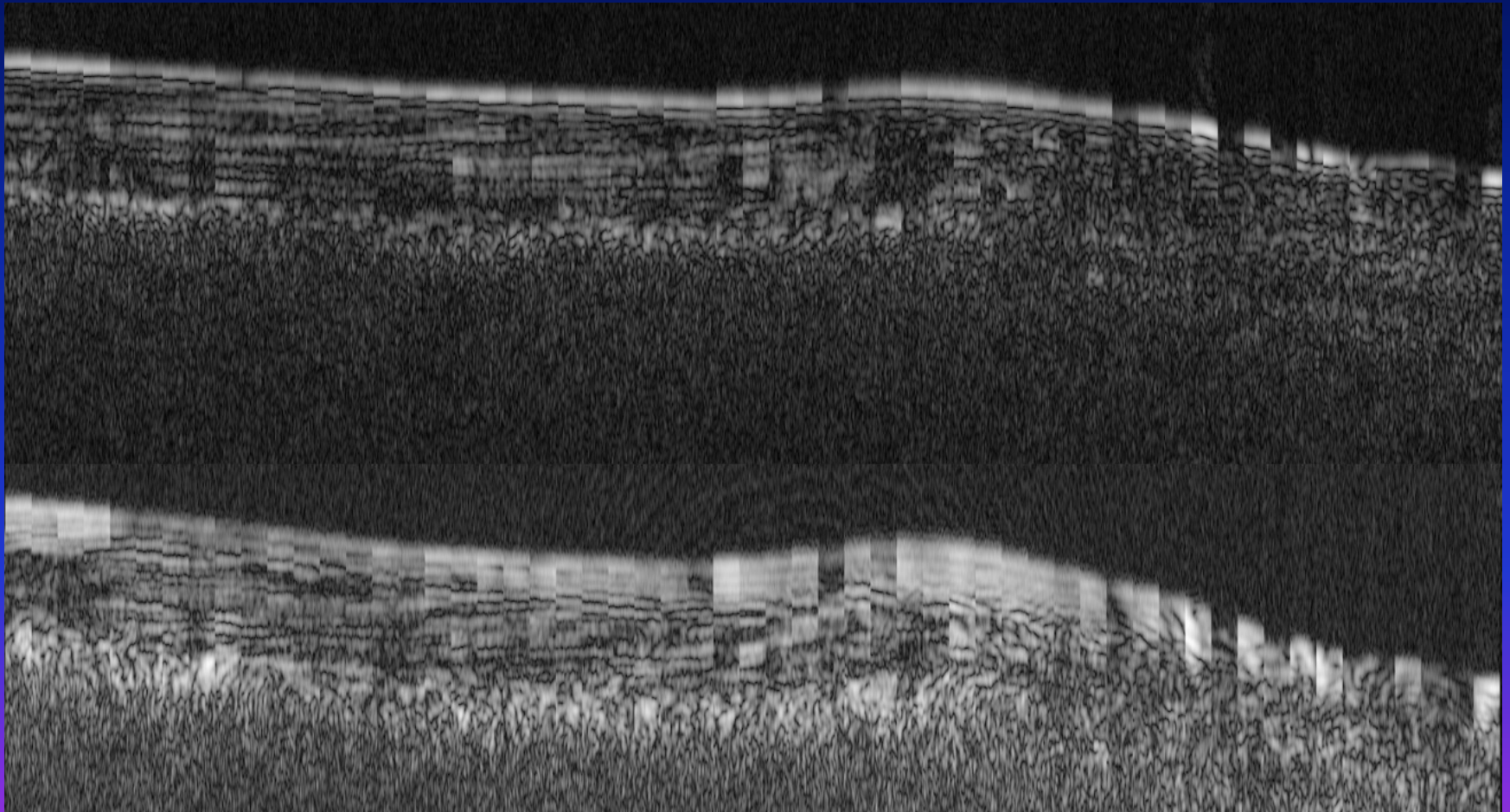


Total Electron Content (TEC) browse product

MARSIS 4646



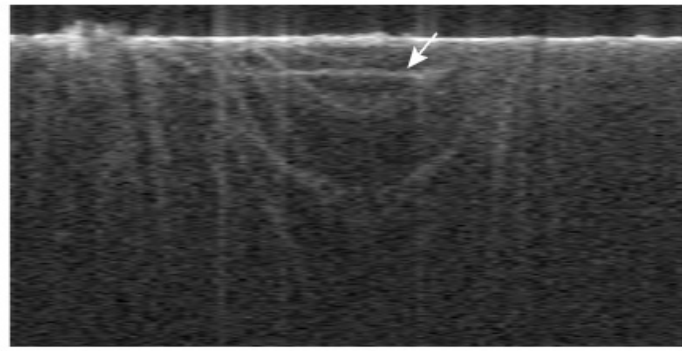
“Flash” data – Full res. Along-track



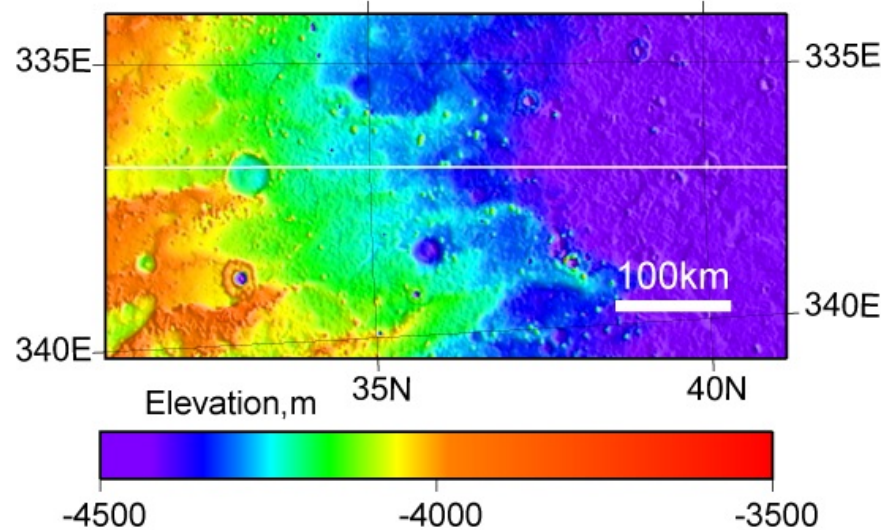
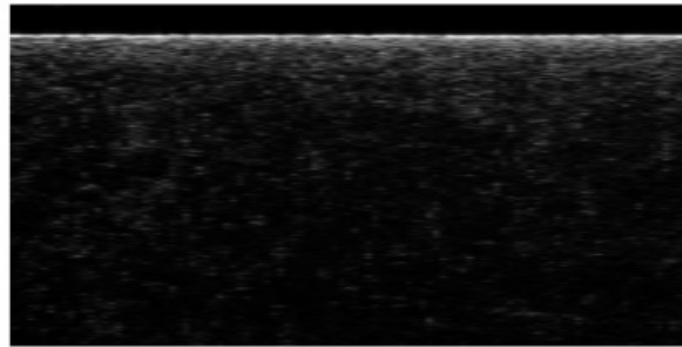
Ghost craters and other oddities



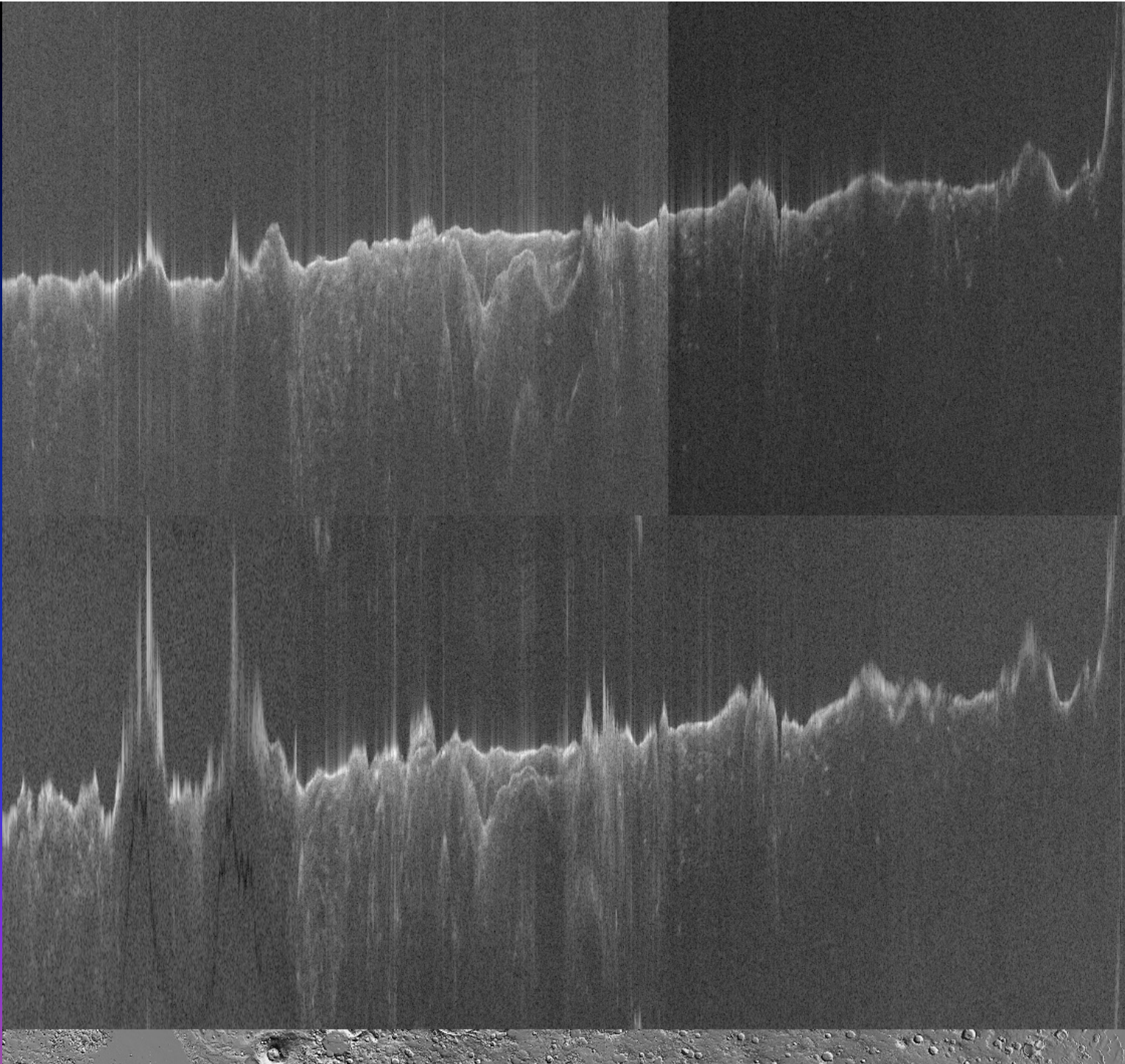
MARSIS data



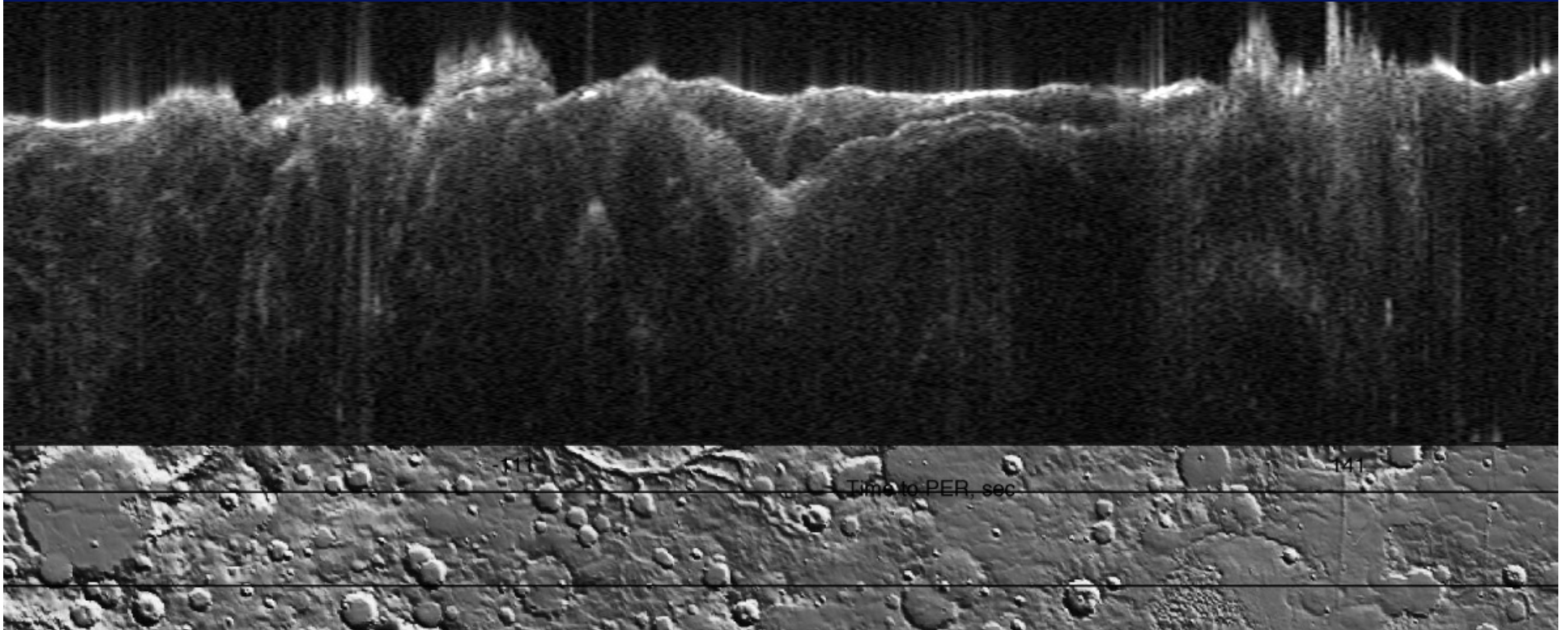
Clutter sim



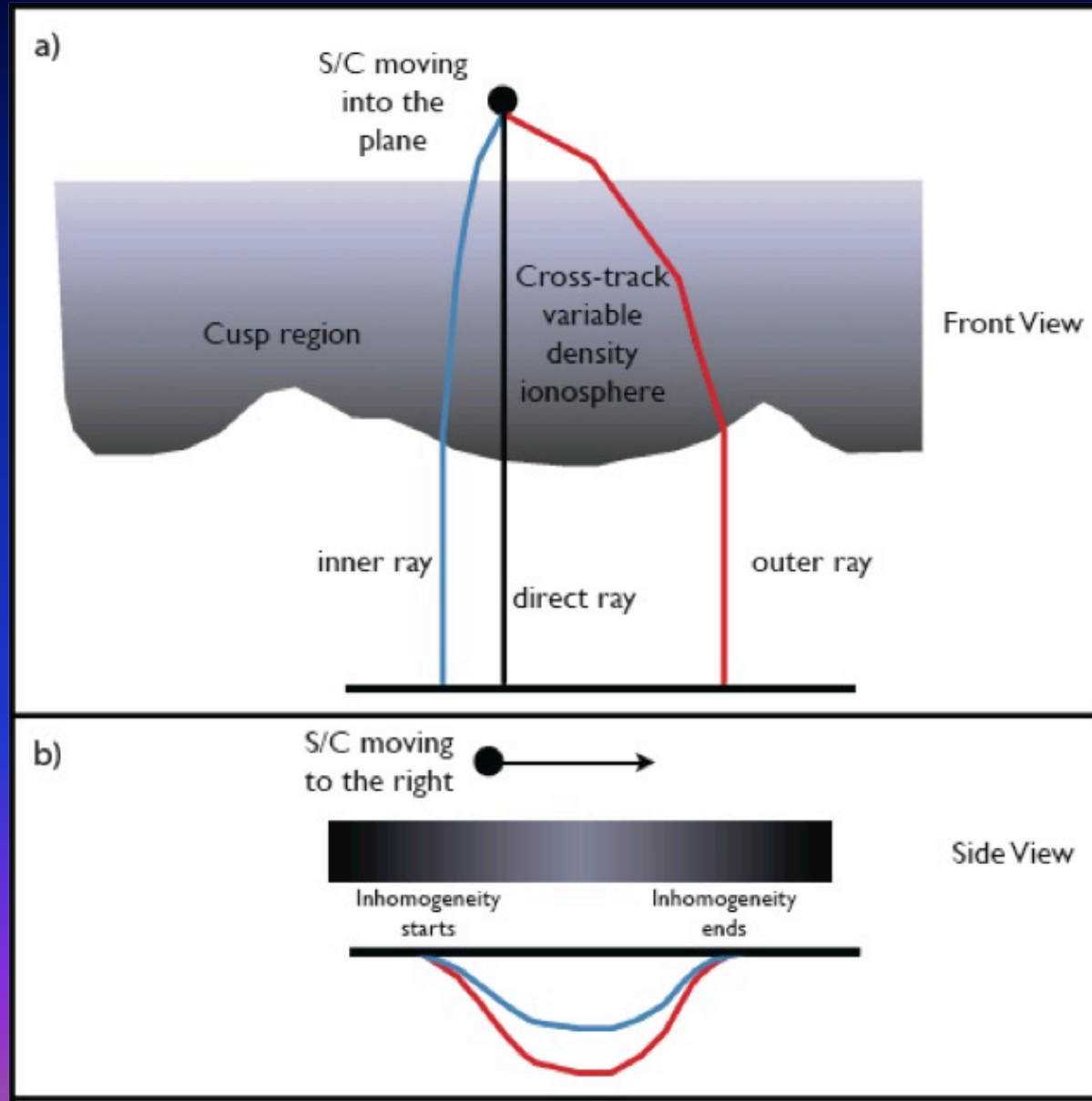
Picardi et al.,
2005 Science



Ma'adim Vallis



Likely cause of "ghost" features



MARSIS Summary



- “Low” frequency = best penetration
- 4 Subsurface bands
- Ionospheric mode (touched only briefly)
- Much processing already done onboard
- Key ground processing step: ionospheric correction
- “Ghosts” often lurk in radargrams