PORPASS: Planetary Orbital Radar Processing and Simulation System

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Introduction

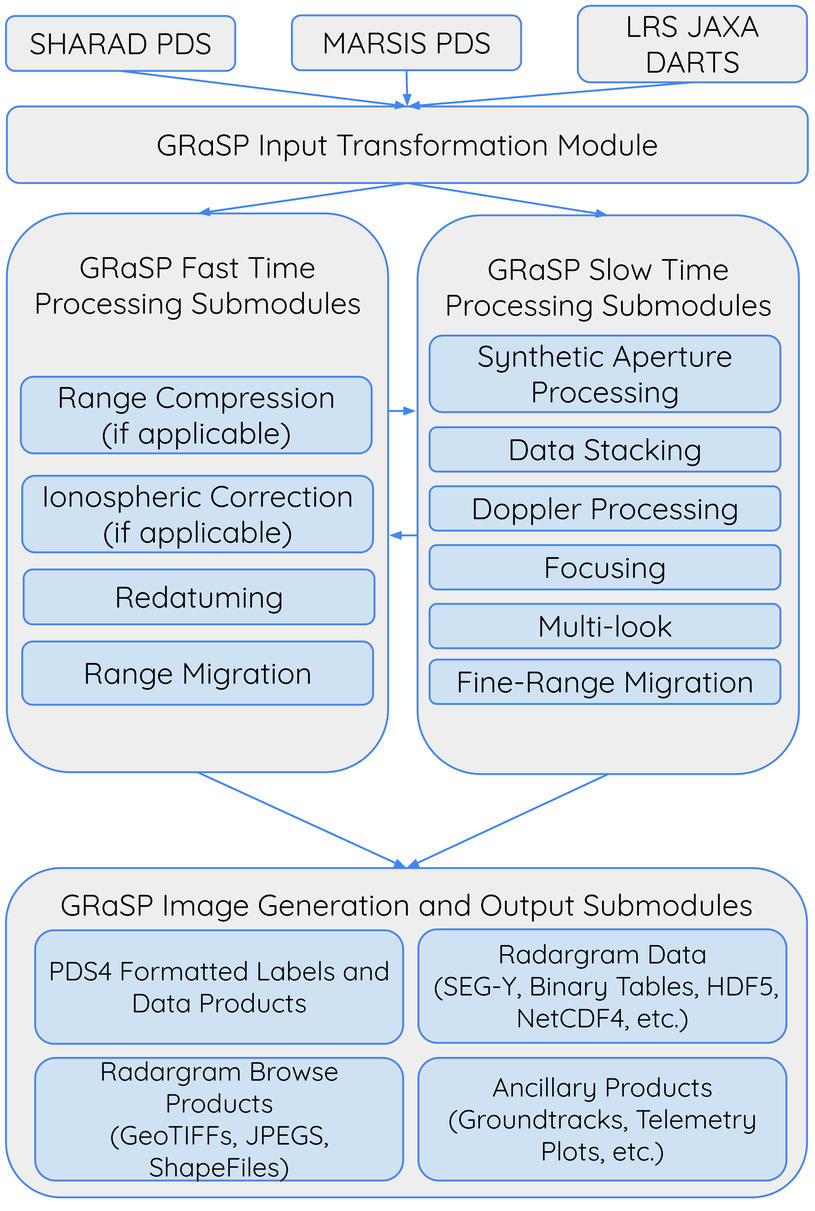
The Planetary Orbital Radar Processing and Simulation System (PORPASS) will revolutionize the processing and simulation of planetary orbital radar sounding data by bringing the typically esoteric subject into a more public sphere. The overarching goal of PORPASS is to enhance mission legacy by providing custom processing of planetary radar datasets beyond the life of any particular mission, ensuring data and code longevity and relevance as well as opening the door to the next generation of researchers. PORPASS will facilitate and strengthen current and future scientific investigations that use planetary radar data, provide an avenue for citizen science and education endeavours, and enable greater collaboration and understanding within the planetary science community. For more information on the PORPASS project, please visit https://porpass.psi.edu.

Stage 1

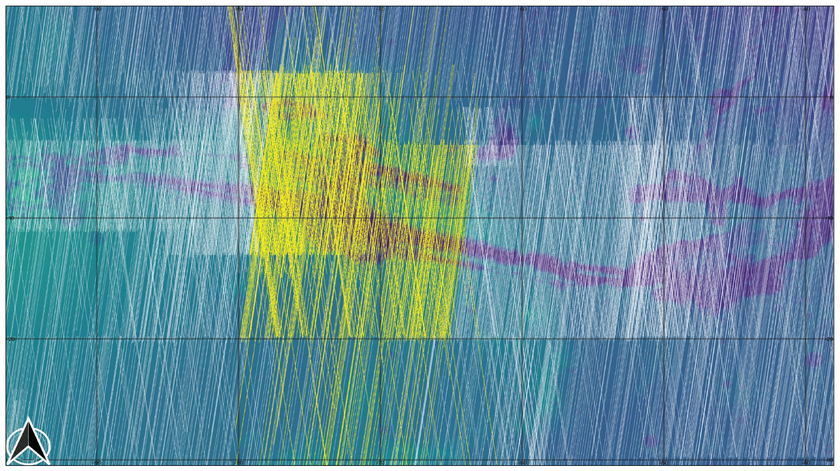
Stage 1 (presently funded) will establish PORPASS and start separating custom processing and simulation of orbital radar sounder data from mission funding, beginning with data from the Mars Reconnaissance Orbiter (MRO) Shallow Radar[1] (SHARAD), Mars Express (MEx) Mars Advanced Radar for Subsurface and Ionosphere Sounding[2] (MARSIS), and Selenological and Engineering Explorer (Selene) 'Kaguya' Lunar Radar Sounder[3] (LRS).

GRaSP: Generalized Radar Sounder Processor

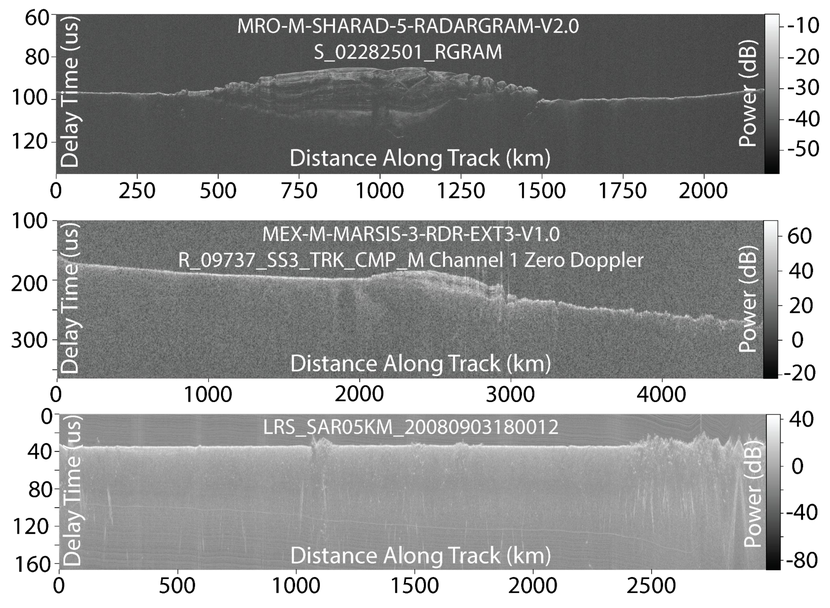
Most modern sounder systems rely on synthetic aperture radar (SAR) processing to enhance along-track resolution and boost the effective signal-to-noise ratio. Despite the differences across radar systems, the processors developed for each individual instrument rely on the same underlying physics allowing for the creation of a generalized radar sounder processor (GRaSP).



PORPASS Geographic Information System



Example GIS that will be employed on PORPASS to help users visualize the observation ground tracks and determine geological context for each observation. The GIS will be integrated with the processing system to enable efficient processing of radar observation selections (e.g. yellow tracks above) using the same processing parameters. It will also enable users to view their processed ground tracks on the basemap.



Example standard radargrams from the 3 radar sounders PORPASS will initially support.

- SHARAD US RDR (top) image of the Martian North Polar Layered Deposits (NPLD).
- MARSIS RDR (middle) images of the NPLD and surrounding terrain.
- LRS 5km SAR image of the lunar mare.

SHARAD offers the highest resolution observations (15-m in free-space), followed by LRS (75-m in free-space), then MARSIS (150-m in free-space). These products are all processed using a standardized workflow developed by the instrument teams for archival in the PDS or equivalent archive that may not be ideal for specific regions and geological settings.

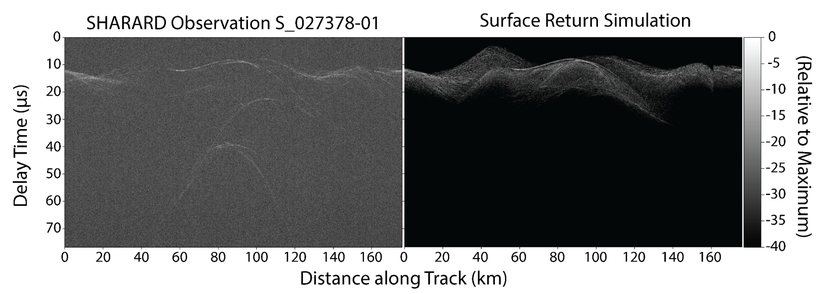
OaRS: Orbital Radar Sounder Simulator

As with all geophysical data, the interpretation of radar data is complicated by assumptions and inferences about subsurface structure and composition. Simulations of the electromagnetic propagation of radar waves through a modeled subsurface are often employed to reduce uncertainties in interpretations.

OaRS will be comprised of two main modules:

The Model Building module will construct virtual environments. Submodules include spacecraft orbital parameters and instrument configurations, instrument emission patterns, space environment, surface topography, and free-form subsurface stratigraphy and material properties.

The Simulation Module will produce simulated radar data that will be formatted in a manner consistent with GRaSP. The computational framework of this module will include physics specifications, numerical discretization, and computational methods submodules.



Example comparing a range-compressed SHARAD observation (left panel, S_027378-01) and the simulated radar return from the nadir and nearby off-nadir (5° aperture) surface produced through OaRS (right panel). Both data have been normalized to the maximum amplitude and converted to dB.

Continuing Work and Expected Launch

PORPASS is envisioned to be developed over 3 Stages.

- Stage 1 supports establishing PORPASS for the aforementioned radar sounder instruments.
- Stage 2 will be incorporating imaging SAR radar
- Stage 3 will bring in Earth-based planetary SAR imaging radar.

Stage 1 will enter a beta testing period at the beginning of 2023 and is expected to launch later that year or at the beginning of 2024.

Acknowledgements and References

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[1]Seu et al (2007), DOI: 10.1029/2006JE002745; [2]Jordan et al. (2009), DOI: 10.1016/j.pss.2009.09.016; [3]Onno et al. (2010), DOI: 10.1007/s11214-010-9673-8