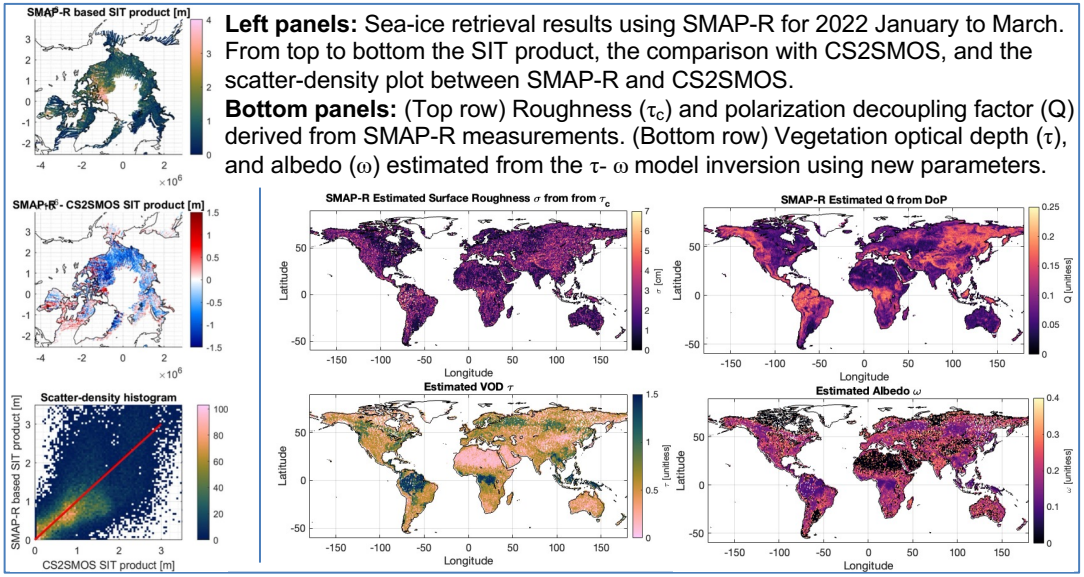
SMAP-Reflectometer (SMAP-R) Technical and Science Investigations

Problem: SMAP is the only mission capable of providing full-polarimetric GNSS-R measurements (SMAP-R). This unique capability remains underused in shaping future mission requirements. By exploiting SMAP-R's dataset to investigate both technical and scientific potential of the polarimetric information, we can define the science value and measurement needs that should guide the next generation of polarimetric GNSS-R missions.



Left panels: Sea-ice retrieval results using SMAP-R for 2022 January to March. From top to bottom the SIT product, the comparison with CS2SMOS, and the scatter-density plot between SMAP-R and CS2SMOS.
Bottom panels: (Top row) Roughness (τ_c) and polarization decoupling factor (Q) derived from SMAP-R measurements. (Bottom row) Vegetation optical depth (τ), and albedo (ω) estimated from the τ- ω model inversion using new parameters.

Finding: Recent studies using SMAP-R data have explore two main areas. First, the team explored retrieval enhancements, including both the initial benchmarking of land parameters via GNSS-R coherence inversion, and the analysis of GNSS-R vs radiometer Stokes synergies for enhanced fusion-based retrievals. Second, the team conducted sensitivity studies, including an integrated retrieval of sea-ice salinity, density, and thickness from full-polarimetric GNSS-R, and the sensitivity assessment of full-polarimetric GNSS-R data to ocean-surface roughness.

Impact: This work reinforces the unique technical and scientific value of full-polarimetric GNSS-R data from SMAP-R, showing its ability to enable advanced land, ocean, and cryosphere retrievals and to guide measurement priorities and instrument requirements for future polarimetric GNSS-R missions.

- J. F. Munoz-Martin, N. Rodriguez-Alvarez, X. Bosch-Lluis, and K. Oudrhiri (2025), Integrated retrieval of sea-ice salinity, density, and thickness using polarimetric GNSS-R, *Remote Sensing of Environment*, doi: 10.1016/j.rse.2025.114617.
- X. Bosch-Lluis, N. Rodriguez-Alvarez and K. Oudrhiri (2025), Full Polarimetric GNSS-R Sensitivity Assessment of Ocean Roughness, *IEEE Transactions on Geoscience and Remote Sensing*, doi: 10.1109/TGRS.2025.3583971
- N. Rodriguez-Alvarez, X. Bosch-Lluis, K. Oudrhiri, D. Entekhabi and M. D. Garcia (2025), GNSS-R Coherence Inversion for Land Surface Roughness and Vegetation Parameter Retrievals, *IEEE Transactions on Geoscience and Remote Sensing*, doi: 10.1109/TGRS.2025.3636048.
- N. Rodriguez-Alvarez, X. Bosch-Lluis, K. Oudrhiri, (2025) Synergies Between GNSS-R and Radiometer Stokes Parameters Seen From SMAP, *IEEE Transactions on Geoscience and Remote Sensing* (In review).