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Calibration Cross Validation of Bistatic Radar Observations with Mars Express

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Abstract

One objective of the Mars Express Radio Science Experiment (MaRS) [1] is to address the dielectric properties and surface roughness of Mars. They can be determined by bistatic radar measurements (BSR) a surface scattering experiment [2, 3]. The radio subsystem transmitter located on board the Mars Express spacecraft transmits right circularly polarized (RCP) radio signals at two wavelengths – 3.6 cm (X-Band) and 13 cm (S-Band) – toward Mars' surface. Part of the impinging radiation is then scattered toward a receiver at a ground station on Earth. Both, the right and left circularly polarized echo components (RCP and LCP, respectively), are recorded (see Fig. 1) at the ground station.

From the RCP-to-LCP power ratio the dielectric constant can be derived. This approach eliminates the need for absolute end-to-end calibration. Relative calibration of the RCP and LCP ground receiver channels can be used instead. Nonetheless, accurate relative calibration of the two receiving channels remains challenging.

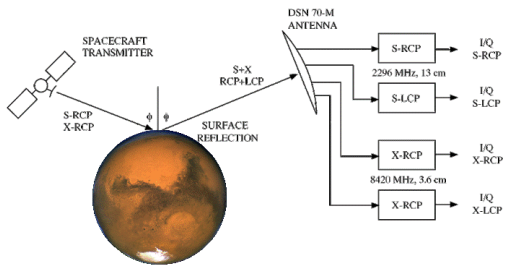

Figure 1: Mars Express BSR experiment configuration. As the spacecraft orbits, its antenna is aimed at the predicted specular point where angle of incidence equals angle of reflection ϕ, measured from local vertical. The resulting scattered signals are received on Earth [3].

Due to the changing geometry and the varying orbit of Mars Express, the ground tracks of the specular points overlap only occasionally. These intersections, provide a unique opportunity to cross-validate the calibration procedures.

The most favorable constellation for bistatic radar experiments with Mars Express is the opposition between Earth and Mars every two years. During the BSR season in 2016 two out of the eleven conducted experiments showed similar ground tracks (Fig .2). The specular point travelled over the Syrtis Major region on April 27th and June 2nd and the data were collected using the same Earth-based antenna. The separation in time and the different observing angles provide an opportunity to confirm reproducibility of the calibrations and analysis methods.

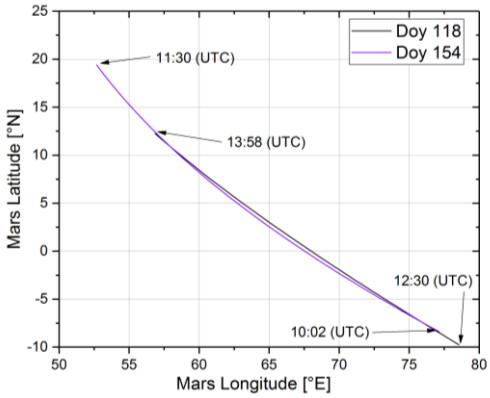

Figure 2: Ground track of the specular point on Mars during the BSR measurement on doy 118 and on doy 154 in 2016.

The results from the relative calibration of the two receiving channels are in good agreement for the two apocenter BSR tracks across southeast Syrtis Major. The derived dielectric constant for both measurements agrees relatively well but showing still

smaller deviations. Within the scope of the investigation, these deviations are to be analyzed with the use of further intersection points of the specular point tracks in order to further improve the calibration procedure for BSR measurements.

Acknowledgements

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References

[1] M. Pätzold et al., "Mars Express 10 years at Mars: Observations by the Mars Express Radio Science Experiment (MaRS)," Planetary and Space Science, vol. 127, pp. 44–90, Aug. 2016.

[2] R. A. Simpson, G. L. Tyler, M. Pätzold, and B. Häusler, "Determination of local surface properties using Mars Express bistatic radar," Journal of Geophysical Research (Planets), vol. 111, no. #E10#, p. 6, 2006.

[3] R. A. Simpson, "Spacecraft studies of planetary surfaces using bistatic radar," IEEE Transactions on Geoscience and Remote Sensing, vol. 31, pp. 465–482, 1993.

[4] R. A. Simpson, G. L. Tyler, M. Pätzold, B. Häusler, S. W. Asmar, and A. K. Sultan-Salem, "Polarization in Bistatic Radar Probing of Planetary Surfaces: Application to Mars Express Data," Proceedings of the IEEE, vol. 99, no. 5, pp. 858–874, 2011.