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Geophysical Investigations of Celestial Bodies through the Combination of Radio Science and Altimetric Crossover Data

Edoardo Del Vecchio[1], Flavio Petricca[1], Antonio Genova[1], and Erwan Mazarico[2]
[1]Sapienza University of Rome, Department of Mechanical and Aerospace Engineering, Italy
(edoardo.delvecchio@uniroma1.it)
[2]NASA Goddard Space Flight Center, Greenbelt, MD, USA

The challenging science objectives of future planetary missions will require highly accurate trajectory reconstruction of deep space probes. Novel techniques that improve the navigation capabilities are developed with the purpose to expand the scientific return of geophysical investigations across the Solar System. Science instruments that provide geodetic data from the spacecraft orbit may support the orbit determination process in combination with deep space radio tracking measurements. Altimetric data that measure the relative distance of the spacecraft with respect to the celestial body's surface yield key constraints on the orbit evolution. Differential measurements, from observations that are repeated over the same location (*crossover*), are less prone to errors associated with surface mismodeling, leading to significant improvements in the estimation of the spacecraft position.

In this work, we present a method based on the combination of ground-based radio science and altimetric crossover measurements to enhance the estimation of the spacecraft orbit and geodetic parameters. The methodology is developed to carry out thorough numerical simulations of mission scenarios, including the generation of synthetic observables. We show the results of our covariance analysis of the NASA mission Europa Clipper by simulating and processing measurements of the Radar for Europa Assessment and Sounding: Ocean to Near-surface (REASON) and the Gravity and Radio science (G/RS) investigations.