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ESTIMATION EVALUATION OF THE RADIO SCIENCE PHASE OF THE OSIRIS-REX MISSION

Abstract

The Origins Spectral Interpretation Resource Identification Security Regolith Explorer (OSIRIS-REx) mission was launched in September 2016. The spacecraft is in route to its target near-Earth asteroid 101955 Bennu. The NASA mission is planned to survey the carbonaceous asteroid and orbit it during 2018 and 2019 after which the spacecraft will obtain a regolith sample from the asteroid surface to be returned to Earth in 2023. In addition to the sample return, OSIRIS-REx's scientific objectives include mapping and documenting Bennu's global properties, chemistry, and mineralogy, measuring the orbital perturbations that affect the asteroid, and characterizing global properties of carbonaceous asteroids for comparison with other observed asteroids. In the mission's Orbital B phase the spacecraft will orbit Bennu in a close-to-circular terminator orbit with a semi-major-axis of 1.0 km. During this phase time will be dedicated for the Radio Science Campaign in which the spacecraft's non-gravitational perturbations will be minimized. During this 9-day period the spacecraft orbit will be perturbed by the asteroid's non-uniform gravity field, enabling the low degree and order gravity coefficients to be estimated. Several measurement types will be used in the estimation process and include: range and Doppler measurements from Earth, optical imagery of the asteroid surface, and altimeter measurements of the surface topography. The Radio Science team at the University of Colorado Boulder has selected NASA's GEODYN-II software as the orbit determination and geodetic parameter estimation tool for solving for the spherical harmonics coefficients. GEODYN-II uses the partitioned Bayesian least squares method to estimate the a-priori dynamical variables and orbital parameters of a spacecraft orbiting a celestial body. As part of the estimation process the software propagates the spacecraft orbit for the selected estimation periods. Using GEODYN-II, an Orbital B phase is simulated and corresponding measurement inputs are generated. These are input back into GEODYN-II with added noise. This setup assists in evaluating the estimation process for different Orbital B scenarios and variations in orbital parameters and operational measurement schemes. The key parameters for the analysis being the spherical harmonics coefficients' estimation errors and covariances. In particular, a combination of radio, optical, and altimeter measurements is compared to a radio-optical only scheme. This analysis is then compared to results from additional tools used by the Radio Science team and will assist in determining recommended operational schemes and orbital parameters for the Radio Science portion of the Orbital B phase.