Revisiting the NEAR mission with radiometric, altimetric and image tracking data

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The NEAR mission to asteroid 433 Eros in 2000-2001 was the first extended survey of an asteroid. In orbit around Eros for about one year, NEAR acquired a wealth of global and high-resolution data about this Near-Earth Asteroid. The primary geodetic dataset is the radiometric tracking data collected by the NASA Deep Space Network, which have been used to reconstruct the orbits of multiple planetary orbiter missions and determine the gravity field of their target body. However, given the small size of Eros compared to terrestrial bodies, the gravitational environment is relatively weak, and the constraints from Doppler data are not as strong. Altimetric data from the NLR instrument, in the form of altimetric crossovers, were used by the NLR team to support the radio data. Image-based constraints, such as landmark data, were used by the navigation team to provide out-of-plane orbital information. Here, we process the three types of measurements simultaneously. We use the altimetric data not as crossovers, but as direct shot-to-shot distance constraints. We implemented in our GEODYN software both the landmark data type and a constraint on the geometry of image pairs which does not rely on prior accurate knowledge of surface point locations. We present results from this analysis, in terms of spacecraft orbits, gravity field and orientation solution, and shape of 433 Eros.