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Mercury’s Gravity Field from BepiColombo MORE experiment

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The Mercury Orbiter Radioscience Experiment (MORE) is one of the main instruments on board the BepiColombo Mercury Planetary Orbiter (MPO), designed to provide an accurate estimation of Mercury’s gravity field by means of highly stable, multi-frequency radio links in X and Ka band. The state-of-the-art microwave equipment enables simultaneous two-way links in X/X (7.2 GHz uplink/8.4 GHz downlink), X/Ka (7.2/32.5 GHz) and Ka/Ka band (34/32.5 GHz), providing range rate accuracies of 3 micron/s (at 1000 s integration time) at nearly all elongation angles. Range observables accurate to 20 cm (two-way) will be attained using a novel, wideband (24 Mcps) ranging system, based upon a pseudo-noise modulation scheme. The multifrequency link, adopted for the first time by the Cassini mission to Saturn [1,2], allows a nearly complete cancellation of the plasma noise both in Doppler and range measurements and hence an accurate determination of Mercury’s gravity field and ephemerides.

The orbit determination of spacecraft in deep space is generally carried out by means of batch filters, for recovering the trajectory and the model parameters (i.e. gravity field coefficients). The complexity of Mercury’s environment penalizes strongly the accuracy of the orbit determination because of the non-gravitational perturbations, such as the solar radiation pressure. Although the non-gravitational accelerations of the MPO will be measured by a highly sensitive accelerometer (the Italian Spring Accelerometer, ISA), a classical, global batch filter proved to be inadequate for precise orbit propagation due to numerical instabilities. Therefore, a different approach has been devised, where the information accumulated previously is exploited in a batch-sequential filter. This paper reports on a new set of numerical simulations carried out with this strategy. The simulation setup takes into account the latest changes in the spacecraft design, the mission profile and the tracking system. We provide updated estimates of the uncertainties in the determination of Mercury’s gravity field. In spite of the changes in the spacecraft design and mission operations, the goals of the experiment are confirmed, with relative accuracies of 10ˆ4 for degree 2 harmonics, 10 for degree 20 harmonics, 50-100 for the tidal Love number k2, and 2-3 cm for the geoid over spatial scales of 300 km.

References

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