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Precision Orbit Determination for the Lunar Reconnaissance Orbiter

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We present results of the Precision Orbit Determination work undertaken by the Lunar Orbiter Laser Altimeter (LOLA) Science Team for the Lunar Reconnaissance Orbiter (LRO) mission, in order to meet the position knowledge accuracy requirements (50-m total position) and to precisely geolocate the LRO datasets. In addition to the radiometric tracking data, one-way laser ranges (LR) between Earth stations and the spacecraft are made possible by a small telescope mounted on the spacecraft high-gain antenna. The photons received from Earth are transmitted to one LOLA detector by a fiber optics bundle, and the LOLA timing system records their arrival time. Those full-rate data are then averaged into 5-s LR normal points, with precision better than 10cm. Other types of geodetic constraints are derived from the altimetric data itself. The orbit geometry can be constrained at the times of laser groundtrack intersections (crossovers). Due to the Moon's slow rotation, altimetric crossovers need to be processed in one-month periods. We assess the contributions of those data types, and the quality of our orbits. The use of altimetric crossovers improves the orbit accuracy (evaluated with overlap analysis), from about 50m with the radiometric data alone, down to 15-20m. We also obtain gravity field solutions based on LRO and historical data. The various LRO data are accumulated into normal equations, separately for each one month batch and for each measurement type, which enables the final weights to be adjusted during the least-squares inversion step. Expansion coefficients to degree and order 150 are estimated, and a Kaula rule is still needed to stabilize the farside field. Those new gravity fields further improve the accuracy of orbit reconstruction (10-15m level with altimetric crossovers), even with only the radiometric data (15-20m).