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Lunar Topography and Regional Gravity Field Modeling Using Multiple Platform Laser Altimetry and Crossovers

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Recently available laser altimeter measurements onboard China's Chang'E-1 (CE-1), Japan's SELenological and ENngineering Explorer (SELENE or Kaguya), and U.S.'s Lunar Reconnaissance Orbiter (LRO) lunar orbiting platforms have already significantly improved and will continue to enhance the accuracy and resolution of the lunar topography modeling, providing new insights into the interior and origin of the Moon. More missions which had been or are in operation or are being planned, including India's Chandrayaan-1, ESA's Smart-1, China's CE-2, and Japan's SELENE/Kaguya-2. The improved topography or shape of the Moon, its gravity field, and its rotation/libration allow one to address open lunar science questions, including quantifying the causes of global scale-asymmetry, impact basin sizes/location/features, interior composition, crustal thickness, lunar isostacy, moho depth, and constraints on lunar tidal parameters. Japan's Kaguya mission's 3-satellite constellation enables accurate orbit determination over the far-side and thus its data have substantially improved lunar far-side gravity field modeling. LRO's multi-beam laser altimetry (LOLA) provides the most accurate lunar laser altimeter instrument in terms of ranging and pointing precision and has the lowest orbital altitude ($\sim$50 km) to-date, affording more sensitivity for its data to improve the resolution of gravity field modeling and more accurate geolocation for topography modeling, in particular over the lunar near-side. Due to the polar orbital inclinations, the conventionally generated crossover measurements are concentrated over the polar region, and with the exception of the LRO, SELENE and CE-1 crossovers suffer from substantial geolocation errors. Here we report work-in-progress results on the integration of laser altimeter data from CE-1, SELENE (Kaguya), and LRO, using single-satellite crossover and dual-satellite crossover techniques for orbit error adjustment, altimeter time bias corrections, geolocation corrections, and regional gravity field modeling experiments. The subsequent topography model obtained integrating the three distinct measurements is shown to have higher spatial resolution and improved accuracy. The use of dual-satellite crossover data improves lunar topography and regional gravity field modeling.