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Orbit determination of the Lunar Reconnaissance Orbiter using laser ranging and radiometric tracking data

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The Lunar Reconnaissance Orbiter (LRO) launched in 2009 by the National Aeronautics and Space Administration (NASA) still orbits the Moon in a polar orbit at an altitude of 50 kilometers and below. Its main objective is the detailed exploration of the Moon's surface by means of the Lunar Orbiter Laser Altimeter (LOLA) and three high resolution cameras bundled in the Lunar Reconnaissance Orbiter Camera (LROC) unit. Referring these observations to a Moon-fixed reference frame requires the computation of highly accurate and consistent orbits. For this task only Earth-based observations are available, primarily radiometric tracking data from stations in the United States, Australia and Europe. In addition, LRO is prepared for one-way laser measurements from specially adapted sites. Currently, 10 laser stations participate more or less regularly in this experiment.

For operational reasons, the official LRO orbits from NASA only include radiometric data so far. In this presentation, we investigate the benefit of the laser ranging data by feeding both types of observations in an integrated orbit determination process. All computations are performed by an in-house software development based on a dynamical approach improving orbit and force parameters in an iterative way. Special attention is paid to the determination of bias parameters, in particular of timing biases between radio and laser stations and the drift and aging of the LRO spacecraft clock. The solutions from the combined data set will be compared to radio- and laser-only orbits as well as to the NASA orbits. Further results will show how recent gravity field models from the GRAIL mission can improve the accuracy of the LRO orbits.