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Science orbits of the Lunar Reconnaissance Orbiter: an independent solution

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Accurate maps and terrain models of the lunar surface are only made possible by remote sensing data from lunar orbiters. The currently most productive source of such data is NASA's Lunar Reconnaissance Orbiter (LRO) acquiring images and altimetric profiles along its path since 2009. Highly precise and consistent orbits are required to refer these observations to a Moon-fixed reference system. In this contribution, we present five years of LRO orbits (from 23 June 2009 to 9 September 2014) based on radiometric data processed with a software tailored to this mission. The solution shown is the first independent validation of the NASA science orbits and is available for public use as an alternative to them.

A key feature of our processing is the elaborate treatment of model and observation errors by empirical parameters and an adaptive data weighting by variance component estimation. The benefits of such process refinements are quantified in the presentation by comparing solutions from different setups; the quality of the solutions is each assessed through an analysis of overlapping arcs. For our definitive solution, based on an arc length of 2.5 days, such analysis yields an averaged precision of 2.80 m for the position vector and 0.12 m in radial direction. The precision varies, indeed, strongly, dependent on the observation geometry which changes periodically with time. To mitigate this dependency, the arc length was extended in steps up to 10.5 days leading in the best case to a further improvement of 0.80 m.