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Title: Global High Resolution Crustal Magnetic Field at the Surface of the Moon from Low-altitude Lunar Prospector Magnetic Gradient Data

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We derived new vector gradients based models of crustal magnetic field at the lunar surface with data from the Lunar Prospector (LP) satellite using two model parameterization approaches: a global set of 35820 1° spaced (~30 km) equal area monopoles at 20 km below the surface (O'Brien and Parker, 1994; Olsen et al., 2017) and combined results of subsets of 100000 0.66° spaced monopoles at the same depth. We use the scheme of iteratively reweighted least-squares inversion to compute the initial model. Then the amplitudes of these monopoles are determined by minimizing the misfit to the components together with the global average of |Br| at the ellipsoid surface (i.e. applying a L1 model regularization of Br). In previous approaches using vector fields for modeling, we found that external field contamination leads to spurious anomalies in the downward continued field models even with stringent data selection criteria and ad-hoc noise removal techniques (e.g., satellite's position in the Moon's wake w.r.t. the solar wind and in the Earth's magnetotail, internal/external dipoles fields removal, low-order polynomial removal, joint equivalent source cross-validation technique and visually removing remaining anomalous segments). On the other hand, with the use of gradients-only data (along-track first finite differences), we were able to completely bypass the ad-hoc techniques. Similar processing of Kaguya magnetic data, which have only higher altitude coverage over the most of the Moon except in the region of the South Pole–Aitken (SPA) basin, completely misses some of the anomalies seen in the Lunar Prospector data. The combined Lunar Prospector and Kaguya gradient-based models also severely degrade the derivation of the anomaly fields in many regions. Euler analysis of isolated anomaly features from the Reiner Gamma swirl suggests top depths of about 0.3 to 1.5 km and center depths of 10-14 km; in the region between Stein and Vallier craters north of the SPA basin our analysis suggests top depths of around 1.5 km and center depths of 13-15 km. With the spectral depth determination techniques, the SPA basin region yields depths to the base of magnetization ranging between 15 and 40 km. Three-dimensional modeling and the bulk magnetization determinations of the sources constrained by the Euler and spectral methods is underway.