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A search for magnetic reconnection signatures on lunar crustal magnetic fields: Kaguya low-altitude observations

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The Moon is an airless obstacle with no intrinsic global magnetic field, while the solar wind interaction with lunar crustal magnetic anomalies (LMAs) forms mini-magnetospheres. The spatial scales of LMAs are smaller than local ion gyroradii and inertial length, thus solar wind ions are demagnetized near LMAs while electrons are still magnetized. An important question related to the solar wind-LMA interaction concerns the possible occurrence of magnetic reconnection between interplanetary magnetic fields and LMAs. A recent study based on ARTEMIS observations at 15 km altitude has reported a closed magnetic field line structure containing solar wind electrons, suggestive of magnetic reconnection occurred at some point between the solar wind interplanetary magnetic field and lunar crustal magnetic field (Sawyer et al., 2023). Also, 2D fully kinetic simulations show an intermittent electron-only magnetic reconnection in the solar wind-LMA interaction region (Stainer et al., 2024). In this study, we analyze magnetic field data obtained by Kaguya at low altitudes (<~30 km), in order to find potential magnetic reconnection signatures on LMAs. We identified several tens of candidate events of flux rope-like magnetic field structures near the solar wind-LMAs interaction regions. We discuss the possibility that the flux ropes can be an indicator of the occurrence of magnetic reconnection between interplanetary magnetic fields and LMAs.