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Direct Observations of Magnetic Anomalies on the Lunar Surface under Varying Solar Wind Conditions

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In contrast to Earth, the Moon does not have a global dipolar magnetic field. Since the first lunar landing with Apollo 11, we know, though, that localised magnetic fields exist on the lunar surface. Measurements conducted by the Lunar Prospector magnetometer and electron reflectometer suggested that these localised magnetic fields are able to deflect the impinging solar wind in favourable cases (Lin et al., Science 1998). Magnetohydrodynamic simulations support the implication that mini-magnetospheres are formed above the locations of strong localised magnetic fields and can hold off the impinging solar wind (Harnett and Winglee, JGR 2002). Analysis of magnetic field data from Lunar Prospector of the Reiner Gamma anomaly region showed that the distortion of the magnetic field of this anomaly strongly depends on the impinging solar wind parameters, which was interpreted that the size and shape of the mini-magnetosphere changed with the solar wind parametes (Kurata et al., GRL 2005). Wieser et al., GRL 2010 showed that SARA, the Sub-KeV Atom Analyzer on board Chandrayaan-1, is able to detect an ENA image of the mini-magnetosphere in the measured energetic neutral atom flux. Here we analysed all orbits where CENA, the Chandrayaan-1 Energetic Neutral Analyzer, recorded data when a magnetic anomaly was in CENA's field-of-view. Our goal was to determine if 1) a signature of the magnetic anomaly is always visible in the ENA signal and if 2) there is a correlation between the solar wind dynamic pressure, the solar wind magnetic field, the local magnetic field strength and the reduction in the reflected ENA flux. Our results show that for the simplest case, i.e. the Gerasimovich anomaly, there is indeed a clear correlation between the shielding efficiency, the magnetic field strength and the solar wind dynamic pressure. For the other observed magnetic anomalies, for which the magnetic fields are not only weaker but also spatially more variable than that of the Gerasimovich anomaly, only in about half of the cases such a correlation was found. We therefore conclude that the magnetic anomaly interaction is in general quite complex and that data with higher spatial resolution and more detailed modelling is required to understand this process better.