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Solar wind control of lunar external magnetic enhancement: A case study

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We study an interaction between the solar wind (SW) and the magnetic anomalies on the lunar surface using SELENE (Kaguya) data. It has been known that magnetic enhancements are at times detected near the limb external to the lunar wake, which is thus called lunar external magnetic enhancement (LEME), as a result of direct interaction between the SW and the lunar crustal fields. Previous observational studies, based on statistical trends that stronger interplanetary magnetic field (IMF) and higher SW density favor the LEME in high solar zenith angle (SZA) region, suggested a fluid-type interaction as a candidate for formation mechanism of the LEME. However, neither the IMF orientation nor the crustal field direction has not been taken into account in the previous analyses.

We show evidence that relation between the IMF and crustal field orientation is also one of the key factors that control the extent of LEME, focusing on one-day observations (12 revolutions) that include data above South Pole-Aitken (SPA) basin which is characterized by strong crustal fields in a wide region. Strong LEMEs are detected at 100 km altitude around SPA basin under the stronger and northward IMF condition, while they weakens under southward IMF. We examined the crustal field model (uncompressed by the SW) constructed from the SELENE magnetometer data to know the orientation of the crustal field at 300 km, 100 km, and lower altitude. In the region where the peak of the magnetic enhancement is detected at 100 km altitude, the model crustal field at 300 km altitude is directed northward, while the model field at 100 km and lower altitude had a southward component in some revolutions. This suggests that the lunar crustal field is compressed by the SW dynamic pressure, and that its large scale component is essential to the formation of the LEME. In addition, our results show that pile-up of the IMF above the crustal fields becomes more effective under parallel field configuration, and suggests that magnetic reconnection between the IMF and the lunar crustal field may take place under anti-parallel field configuration.