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Induced magnetic field variability between day and night in the Martian ionosphere: Insights from MAVEN/MAG

Mars does not possess a global magnetic field like Earth; instead, it has localized crustal magnetic fields that are primarily found in the southern hemisphere. These crustal fields show spatial variability and can change over time. A significant focus of research into the interaction between these crustal fields and the Martian ionosphere is their influence on total ion loss over time. This central question is being investigated by the Mars Atmospheric and Volatile EvolutioN (MAVEN) spacecraft, which is currently in orbit around Mars. The spacecraft has a periapsis altitude of 150 km and an apoapsis of 6200 km. To study variations in magnetic field strength, we have compared crustal field models with the magnetic field measurements collected by MAVEN's magnetometer instrument (MAG). The MAG measures vector magnetic fields along MAVEN's orbit, while the crustal fields are derived from the Morschhäuser (2014) model, following the same orbital trajectory as MAVEN/MAG. The differences between the measured and crustal fields are termed induced magnetic fields. In this study, we calculate the induced magnetic fields for both the dayside and nightside of Mars, up to an altitude of 1000 km with data coverage from 2015 to 2019.

Our observations reveal that induced magnetic fields on the dayside are larger than those on the nightside. In the northern hemisphere, higher induced fields are observed during both the dayside and nightside. Specifically, on the dayside, low-latitude induced magnetic fields in the northern hemisphere dominate up to an altitude of 800 km; above that altitude, the southern hemisphere takes precedence. Additionally, mid- and high-latitude induced fields in the northern hemisphere are more pronounced up to 600 km, after which the southern hemisphere becomes dominant. Conversely, on the nightside, the northern hemisphere consistently shows stronger induced fields across all latitudes. During periods of high solar wind dynamic pressure, the induced magnetic fields increase by 50% on both the dayside and nightside of Mars. On the dayside, these induced fields in the northern hemisphere are significantly influenced by open and draped fields, with maximum induced fields observed below 500 km. Similarly, on the nightside, the northern hemisphere continues to exhibit stronger induced fields compared to the southern hemisphere, once again driven by open and draped fields. These findings are crucial, as they have a direct impact on the ionosphere.

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