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Space weather at Mercury

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Mercury's interaction with the solar wind is unique in our solar system due to its weak global magnetic field and the planet's proximity to the Sun. This proximity to the Sun, with a heliocentric distance between 0.31 and 0.47 au, results in more extreme solar wind and interplanetary conditions than at any other planet in our solar system. The magnetosphere of Mercury is therefore highly dynamic, especially during times of interplanetary coronal mass ejections (ICMEs), which travel at high speeds compared to the solar wind and carry mass and magnetic field from the Sun. In extreme cases, ICMEs have been observed by the MESSENGER spacecraft to compress Mercury's dayside magnetosphere to the surface [1,2]. As a consequence, the ICME plasma likely interacted with Mercury's surface, evidenced by enhanced sodium ions in the exosphere on subsequent orbits. The collapse of Mercury's dayside magnetosphere has important implications for the habitability of close-in exoplanets around M dwarf stars, as such events may significantly contribute to planetary atmospheric loss in these systems.

The high frequency of ICMEs encountered during MESSENGER's four-year-long orbital mission (in part due to Mercury's short orbital period and to the orbital mission coinciding with the maximum of Solar Cycle 24) has allowed for both individual case studies and statistical studies of space weather effects on Mercury's magnetosphere. Here we summarize recent advances in this research area as we look forward to the arrival of the BepiColombo mission at Mercury in the next few years. We also predict that in the 1 yr nominal and 1 yr extended mission of BepiColombo, we can expect a total of ~35 ICME events based on the number of ICMEs detected by MESSENGER [3, 4] in the same part of the solar cycle. Out of these, ~10 events, or ~30% [4], will likely collapse at least part of Mercury's dayside magnetosphere to the surface. The upcoming data of such events from BepiColombo will greatly enhance our understanding of the physical processes at play during these extreme conditions affecting the solar system's innermost planet.

References

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