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MESSENGER Observations of Extreme Space Weather in Mercury's Magnetosphere

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Abstract

Increasing activity on the Sun is allowing MESSENGER to make its first observations of Mercury's magnetosphere under extreme solar wind conditions. At Earth interplanetary shock waves and coronal mass ejections produce severe "space weather" in the form of large geomagnetic storms that affect telecommunications, space systems, and ground-based power grids. In the case of Mercury the primary effect of extreme space weather in on the degree to which this it's weak global magnetic field can shield the planet from the solar wind. Direct impact of the solar wind on the surface of airless bodies like Mercury results in space weathering of the regolith and the sputtering of atomic species like sodium and calcium to high altitudes where they contribute to a tenuous, but highly dynamic exosphere. MESSENGER observations indicate that during extreme interplanetary conditions the solar wind plasma gains access to the surface of Mercury through three main regions: 1. The magnetospheric cusps, which fill with energized solar wind and planetary ions; 2. The subsolar magnetopause, which is compressed and eroded by reconnection to very low altitudes where the natural gyro-motion of solar wind protons may result in their impact on the surface; 3. The magnetotail where hot plasma sheet ions rapidly convect sunward to impact the surface on the nightside of Mercury. The possible implications of these new MESSENGER observations for our ability to predict space weather at Earth and other planets will be described.