

## **The Impacts of Space Weather on Society and the Economy**

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This talk describes both routine and extreme space weather impacts and their economic and societal costs. Modern society depends heavily on a variety of technologies that are vulnerable to the effects of intense geomagnetic storms and solar storms. Strong currents flowing in the ionosphere can disrupt and damage Earth-based electric power grids and contribute to the accelerated corrosion of oil and gas pipelines. Magnetic storm-driven ionospheric disturbances interfere with high-frequency radio communications and navigation signals from Global Positioning System (GPS) satellites. Exposure of spacecraft to solar particles and radiation belt enhancements can cause temporary operational anomalies, damage critical electronics, degrade solar arrays, and blind optical systems such as imagers and star trackers. Moreover, intense solar particle events present a significant radiation hazard for astronauts during the high-latitude segment of the International Space Station (ISS) orbit as well as for future human explorers of the Moon and Mars. In addition to such direct effects as spacecraft anomalies or power grid outages, a thorough assessment of the impact of space weather events on present-day society must include the collateral effects of space-weather-driven technology failures. For example, polar cap absorption events due to solar particles can degrade – and, during severe events, completely black out – radio communications along transpolar aviation routes. Modern technological society is characterized by a complex set of interdependencies among its critical infrastructures. A complete picture of the socioeconomic impact of space weather must therefore include both direct, as well as collateral, effects of space-weather-driven technology failures on dependent infrastructures and services. It is also imperative that we—as a global society—develop a truly operational space weather observing and modeling system in which the benefits of accurate forecasts are clearly established.