Understanding the Drivers of Space Weather: New Insights from Theory and 3-D Numerical Modeling

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Ejections of magnetized plasma from the Sun, commonly known as Coronal Mass Ejections (CMEs), are one of the most stunning manifestations of solar activity. These ejections play a leading role in the Sun-Earth connection, because of their large-scale, energetics and direct impact on the space environment near the Earth. As CMEs evolve in the solar corona and interplanetary space they drive shock waves, which act as powerful accelerators of charged particles in the inner solar system. Some of these particles, known as Solar Energetic Particles (SEPs), can strike our planet, and in doing so they can disrupt satellites and knock out power systems on the ground, among other effects. These particles, along with the intensive X-ray radiation from solar flares, also endanger human life in outer space. That is why it is important for space scientists to understand and predict the ever-changing environmental conditions in outer space due to solar eruptive events – the so-called space weather. To enable the development of accurate space weather forecast, in the past three decades solar scientists have been challenged to provide an improved understanding of the physical causes of the CME phenomenon and its numerous effects. This talk summarizes the most recent advances from theory and modeling in understanding the origin and evolution of solar eruptive events and related phenomena.

Keywords: solar corona; solar magnetic fields; coronal mass ejections (CMEs); solar energetic particles (SEPs); shock waves; space weather.