Solar Sources of Severe Space Weather

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Severe space weather is characterized by intense particle radiation from the Sun and severe geomagnetic storm caused by magnetized solar plasma arriving at Earth. Intense particle radiation is almost always caused by coronal mass ejections (CMEs) traveling from the Sun at super-Alfvénic speeds leading to fast-mode MHD shocks and particle acceleration by the shocks. When a CME arrives at Earth, it can interact with Earth's magnetopause resulting in solar plasma entry into the magnetosphere and a geomagnetic storm depending on the magnetic structure of the CME. Particle radiation starts affecting geospace as soon as the CMEs leave the Sun and the geospace may be immersed in the radiation for several days. On the other hand, the geomagnetic storm happens only upon arrival of the CME at Earth. The requirements for the production of particles and magnetic storms by CMEs are different in a number of respects: solar source location, CME magnetic structure, conditions in the ambient solar wind, and shock-driving ability of CMEs. Occasionally, intense geomagnetic storms are caused by corotating interaction regions (CIRs) that form in the interplanetary space when the fast solar wind from coronal holes overtakes the slow wind from the quiet regions. CIRs also accelerate particles, but when they reach several AU from the Sun, so their impact on Earth's space environment is not significant. In addition to these plasma effects, solar flares that accompany CMEs also produce excess ionization in the ionosphere causing sudden ionospheric disturbances. This paper highlights these space weather effects using space weather events observed by space and ground based instruments during of solar cycles 23 and 24.