

## Correlating Long-duration Gamma-ray Solar Flares with High Energy SEP Events, CMEs, X-ray Flares, and Type II Radio Bursts to Study Particle Acceleration Mechanisms

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Solar Energetic Particle events (SEPs) are important because they pose radiation hazards to spacecraft and astronauts and disrupt ionospheric communications. SEPs offer the opportunity to examine particle acceleration mechanisms associated with solar activity. The mechanism producing SEPs is unresolved, with possible contributions from gradual acceleration in coronal mass ejection (CME) shock-waves and impulsive acceleration in flares. In this study, we examined GOES X-ray and proton observation properties, CME speed and width from the SOHO LASCO CDAW catalog, type II radio burst properties and associated solar gamma-ray flare properties, along with the relationships between these space weather events, to better understand the mechanisms involved in SEP acceleration. Specifically, we correlated the SEP event properties (peak intensity at energies  $> 300$  MeV, duration, and timing) with the properties of associated long-duration gamma-ray flares, Wind/WAVES type II radio bursts, and fast, energetic CMEs and X-ray flares. These relationships also provide important information relevant to SEP forecasting.