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Filament Eruptions Outside of Active Regions as Sources of Large Solar Energetic Particle Events

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Gradual solar energetic ($E > 10$ MeV) particle (SEP) events are produced in shocks driven by fast CMEs, which are nearly always spatially associated with ARs. Several cases of SEP events associated with CMEs originating in large filament eruptions (FEs) from outside ARs have previously been known, but four more such cases from solar cycles 23 and 24 have been described by Gopalswamy et al.(2015). The CMEs were fast (~ 1000 km s⁻¹), appeared as coronagraph halo CMEs, and were associated with interplanetary type II bursts over a wide wavelength range. On the basis of their observed weak post-eruption arcade X-ray flare enhancements, several more candidate large SEP events resulting from eruptions of filaments adjacent to but outside ARs were identified. Thus, large SEP events can arise not only from unobserved ARs behind the disk, but also from non-AR filament eruptions. SEP event forecasting, currently based on observations of front-side solar ARs and X-ray flares, therefore can not predict either kind of SEP event. For the two SEP events with STEREO observations we confirm that despite their good magnetic connections to Earth, the SEP longitudinal distributions are broad. Neither Ulysses SEP observations nor CMEs associated with shocks and type II bursts give any indication that high-latitude polar-crown filament eruptions may have produced SEP events.

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