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Relativistic E $>$ 0.6, $>$ 2.0 and $>$ 4.0 MeV electron acceleration and HILDCAAs

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Relativistic (E $\geq$ 0.6 MeV) electrons at geosynchronous orbit during solar cycle 23 are well-correlated with the intervals of High-Intensity, Long-Duration, Continuous AE Activity (HILDCAA) events. The response of the energetic electrons to HILDCAAs is found to vary with solar cycle phase. The initial electron fluxes are lower for events occurring during the ascending and solar maximum (AMAX) phases than for events occurring during the descending and solar minimum (DMIN) phases. The flux increases for the DMIN-phase events are $>$ 50% larger than for the AMAX-phase events. It is concluded that electrons are accelerated to relativistic energies most often and most efficiently during the DMIN-phases of the solar cycle. We propose two possible solar UV-related mechanisms to explain this solar cycle effect. Enhanced E $>$ 0.6 MeV electron fluxes at geosynchronous orbit are first detected $\sim$1 day after the statistical onset of HILDCAAs, E $>$ 2.0 MeV electrons after $\sim 1^1\!/_2$ days, and E $>$ 4.0 MeV electrons after $\sim 2^1\!/_2$ days. As expected from the above, for short-duration (D $\leq$ 3 days) HILDCAA events, there are no E $>$ 4.0 MeV electron enhancements. For longer-duration (D $>$ 3 days) HILDCAAs, the E $>$ 0.6 MeV and E $>$ 2.0 MeV fluxes appear to reach saturation values of $\sim$3-4$\times 10^5$ and 5-6$\times 10^3$ cm^{-2} s^{-1} sr^{-1} respectively. The above results are consistent with the general concepts of theoretical models of relativistic electron acceleration (and losses). Relativistic electrons are bootstrapped from high energy electrons: the E $>$ 0.6 MeV electrons are accelerated from HILDCAA-injected E $\sim$100 keV electrons, the E $>$ 2.0 MeV electrons from the E $>$ 0.6 MeV electron population, and consequently the E $>$ 4.0 MeV electrons are accelerated from the E $>$ 2.0 MeV population, etc. Relativistic electron acceleration and decay time scales will be provided for wave-particle investigators to attempt to match their models to empirically derived values.