Long-term variations in the properties of large solar energetic particle events.

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The occurrence of large solar energetic particle (SEP) events (30MeV fluence $>$2x10^9 cm^{-2}) is reviewed, using data obtained by satellites, ground based instrumentation, and from the glaciological record. It is shown that the frequency of occurrence of large fluence events during the space era, 1960 *et seq*, was one of the lowest in the past 400 years. Large SEP were up to 6 to 8-times more frequent during periods of low solar activity, such as the Gleissberg minimum, *circa* 1890-1900. The possibility that the frequency of occurrence of SEP is inversely related to the strength of the magnetic fields near the Sun is discussed, and advanced as a working hypothesis that allows the occurrence of SEP during the 11-year solar cycle, and over centennial scales, to be better understood. The energy dependence of the particle spectra at high energies; the occurrence of large ephemeral anisotropies; and the dependence of the particle intensities upon heliographic longitude are summarized. The "Carrington white light flare" of 1859 resulted in the greatest 30MeV fluence (18.8x10^{9}cm^{-2}) near Earth in the past 400 years, however, evidence from the ^{10}Be record might indicate a significantly greater event during the Spoerer "grand minimum" of the Sun (1420-1540). A cumulative probability curve for the occurrence of very large SEP events is presented. In closing, a prediction is made regarding the occurrence of large SEP events until 2050AD.