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Injections of Near-Relativistic and Relativistic Electrons into Earth's Radiation Belts

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Injections of electrons into Earth's radiation belts occur in at least two different flavors: 1) those associated with substorm activity, and 2) those injected into the slot region and inner radiation belt during geomagnetically active periods. Classic substorm injections involve the sudden, localized enhancement of intensity of 10s to 100s and infrequently >1 MeV electrons and protons at similar energies. These injections are thought to result from electrons being rapidly transported toward Earth by electric fields associated with jets of reconnection from X-lines in the near-Earth magnetotail. Substorm injections are considered to play an important role for Earth's outer radiation belt electrons, since injected electrons can result in the growth of whistler mode chorus waves and also provide the seed population of 100s of keV electrons that can be further accelerated to energies on the order of ~1 MeV. In addition to classic substorm injections, during some geomagnetically active periods, electrons ranging in energy from 10s of keV up to ~1 MeV can be quickly (in a few hours or less) injected into the slot and inner radiation belt (L < 3). Evidence has been shown that these injections may serve as the dominant source of 10s to 100s of keV electrons in Earth's inner radiation belt. Intriguingly, protons of the same energy are not injected in the same events, implying some species dependent process. Currently, the underlying physical mechanism responsible for these sudden particle enhancements at low L-shells (SPELLS) remains a mystery. In this presentation, we will compare and contrast SPELLS and substorm injections. Several example cases of both types of injections will be used to introduce their characteristics and what we currently know about them. We will focus in particular on the underlying mechanisms responsible for each type of injection and the important roles these injections play as a source of electrons in the inner and outer electron radiation belts.