The Near-Earth Radiation Environment and its Impact on Satellites

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The near-Earth radiation environment consists of high-energy charged particles, some of which are trapped by the Earth's magnetic field in the Van Allen radiation belts. Some come directly from solar flares, and some from cosmic rays (extra-solar sources.) The trapped-particle Van-Allen belts consist of inner and outer bands. The inner-band population is relatively stable and contains both electrons and protons. The outer-band population is relatively dynamic and contains primarily electrons. Cosmic rays and solar energetic particle events (SEPs, driven by solar flares), on the other hand, consist of many heavy ion species, in addition to protons. All of these particles interact destructively with satellite surfaces, internal instrumentation, and humans in space, causing a variety of harmful effects. The most severe of these effects include surface charging and arcing;, deep dielectric charging and discharging; single-event upsets; and cumulative dose accumulation. Most of these processes affect electronic components on satellites and other spacecraft, however cumulative dose also adversely affects humans in space and is one of the primary safety concerns for manned spaceflight. A precise knowledge of these "Space Environment Effects" (SEE), their expected severity, occurrence rates, and cumulative effect, is essential for satellite design, mission planning, and mission operations. The first step in developing this knowledge is to obtain an accurate picture of the near-Earth radiation environment and this is done primarily through numerical modeling of that environment, supported by any available in-situ data sources. Here, a descriptive overview of the near-Earth radiation environment will be given, followed by a discussion of the interplay of the environment with satellite instrumentation, and a brief synopsis of the current 'state-of-the-art' in radiation environment modeling.