Modeling Relativistic Electron Precipitation Bremsstrahlung X-Ray Intensities at 10-100 km Manned Vehicle Altitudes

Relativisitic electron precipitation (REP) events occur when beams or bunches of relativistic electrons of mangetospheric orgin enter the Earth's atmosphere, typically at auroral latitudes. REP events are associated with a variety of space weather effects, including production of transitional and bremsstrahlung radiation, catalytic depletion of stratospheric ozone, and scintillation of transionospheric radio waves. This study examines the intensities of x-rays produced at airliner, manned ballon, and space reuseable launch vehicles (sRLVs). The monoenergetic beam is modeled in cylindrical symetry using the paraxial ray equation. Bremsstrahlung photon production is calcuated using the traditional Sauter-Elwert cross-section, providing x-ray emission spectra differential in energy and angle. Attenuation is computed for a plane-stratified standard atmosphere, and the loss processes include photoionization, Rayleigh and Compton scattering,

electron-positron pair production, and photonuclear interaction. Peak altitudes of electron energy deposition and bremsstrahlung x-ray production were calculated for beams of energies from 1 MeV through 100 MeV. The altitude peak of bremsstrahlung deposition was consistently and significantly lower that that of the electron deposition due to the longer mean free paths of x-rays compared to electrons within the atmosphere. For example, for a nadir-directed monoenergetic 5 MeV beam, the peak deposition altitude was calculated to be 42 km, but the resulting bremmstrahlung deposition peaked at 25 km. This has implications for crew and passenger safety, especially with the growth of the space tourism industry. A survey of results covering the 1-100 MeV spectrum for the three altitude ranges of interest will be presented.