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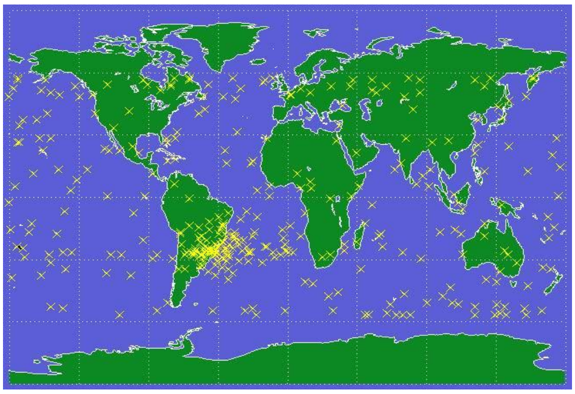
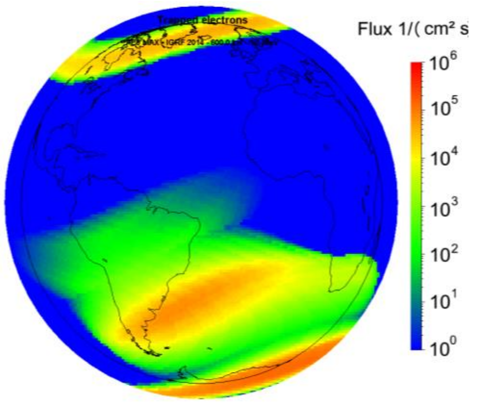
Bachelor/Master thesis

Single Event Upset evaluation and analysis for the Flying Laptop mission

Low Earth Orbit (LEO) satellites traveling on quasi-circular orbits between 300 km and 1000 km height will pass through the Van Allen Radiation Belts. This includes the low altitude regions of the inner Van Allen belt within the South Atlantic Anomaly where energetic protons up to 400 MeV and energetic electrons of several MeV are present. For spacecraft orbits with high inclination, the spacecraft in addition will sample the Auroral Horns of the outer Van Allen belt with significant populations of energetic electrons. Digital equipment of a LEO spacecraft is prone to Single Event Upsets (SEU) when crossing these regions. Such SEUs are be observed on the University's small satellite "Flying Laptop" which was launched into a LEO on July 14th, 2017.



Computer upsets during Space Shuttle missions STS-37..44 (1991) [Joe H. Allen, SCOSTEP "Historical and Recent Solar Activity and Geomagnetic Storms Affecting Spacecraft Operations" GOMAC 2002]



Electron contribution both from SAA as well as from auroral horns in the polar cusp (Data generated using OMERE®)

Tasks in detail:

1) Compilation of on-board events and plotting into a suitable map format.
2) Comparison of observation data to models: The actual spacecraft trajectory during the observation of upsets shall be analyzed using the radiation analysis tool SPENVIS. Expected outcomes are energetic proton and electron fluxes from the inner Van Allen radiation belt, with special emphasis on the South Atlantic Anomaly and energetic electron fluxes from the Auroral Horns of outer Van Allen belt mapped to the spacecraft trajectory. Upset rates shall be estimated using assumptions on the radiation sensitivity of selected digital circuits (e.g. memories) and their shielding using the respective analysis modules of SPENVIS, and compared to the observations. Suitable assumptions of shielding by the satellite's structure shall be made.
3) Conclusions of the use of commercial grade digital circuitry on such spacecraft shall be given, resulting in conclusions on how to design future spacecrafts more resistant against and better measure such events during further missions.

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